

→ E04SD – EARTH OBSERVATION FOR SUSTAINABLE DEVELOPMENT

Marine Resources | Service Portfolio

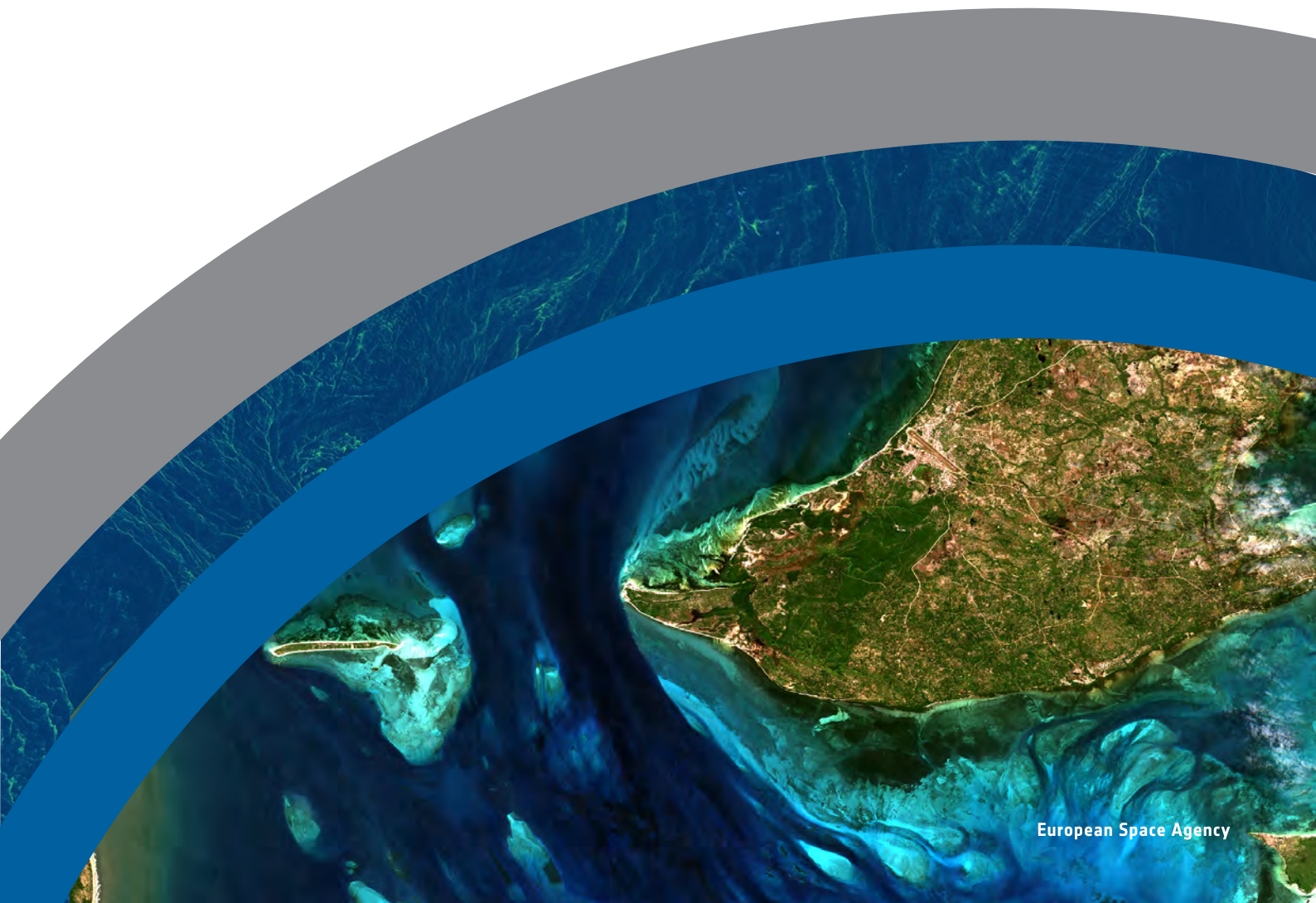


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Collecting data in marine environments can be difficult and expensive. Earth observation (EO) provides a relatively low-cost means of acquiring environmental information which is essential to evidence-based planning and management. The E04DS Marine and Coastal Resources portfolio comprises a range of EO-derived services designed to provide information required for the management of coastal and marine environments and for planning and implementing Blue Economy initiatives to support sustainable economic development for coastal regions and island states.

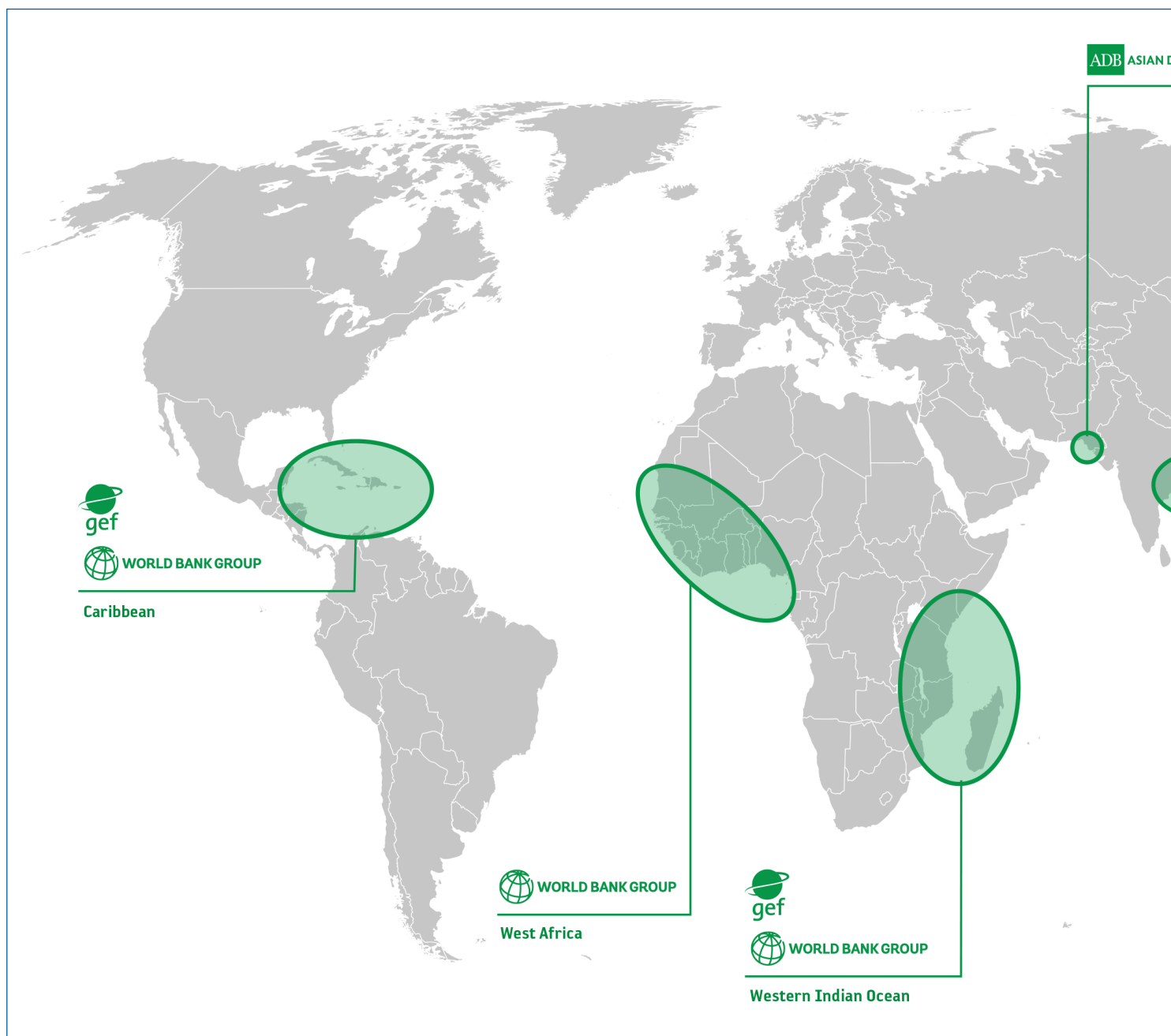
THEMATIC AREAS

Cartographic services include the monitoring of land use along coasts and in river watershed, as well as the mapping of shoreline locations and coastal bathymetry.

Coastal environment information covers the mapping of coastal and shallow-water habitats to monitor changes to their extent and status, and provide information for the planning and management of Marine Protected Areas.

Near real-time monitoring services are designed to support the implementation of environmental legislation to protect coastal environments and marine resources.

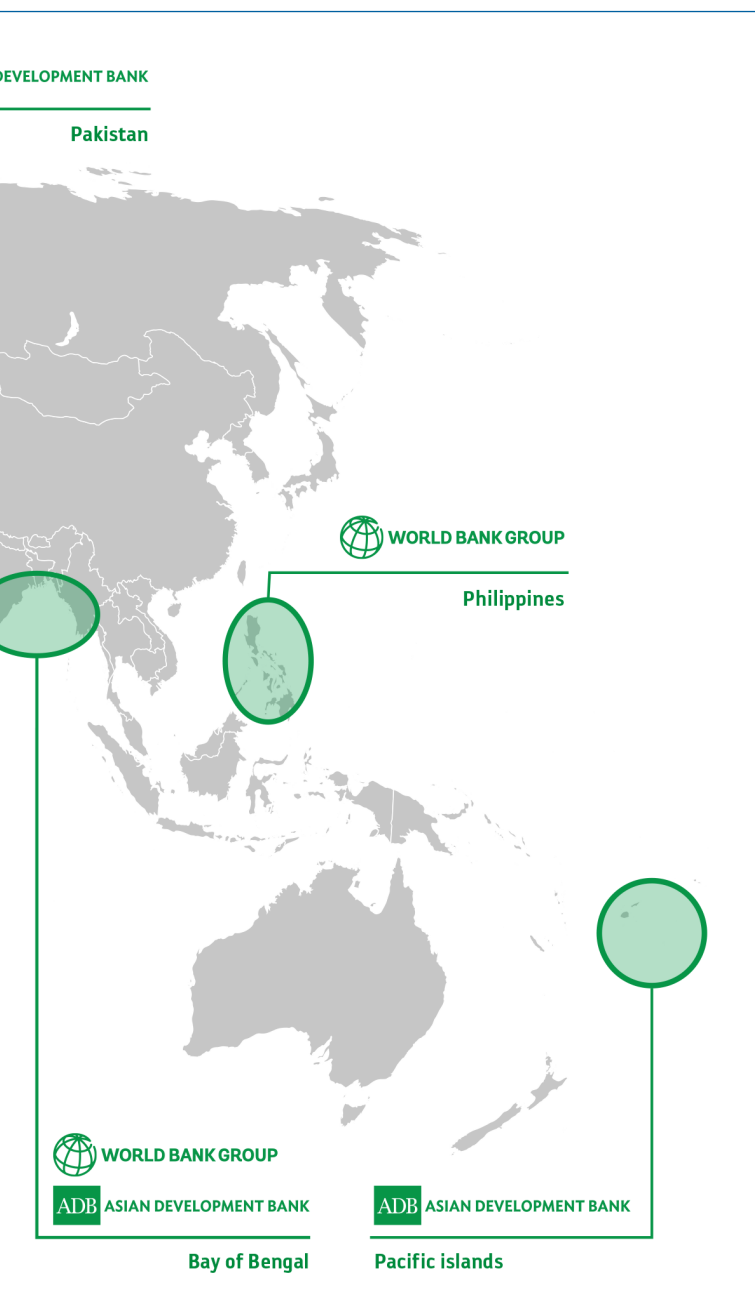
Blue Economy support services bring together information from across the rest of the service portfolio to deliver information for the planning and implementation of initiatives that aim to support economic growth and improve the livelihoods and well-being of coastal communities, whilst ensuring the continued health of coastal and marine ecosystems and the services they provide.



The expertise for delivery of the planned EO services is drawn from some of the leading European institutes, companies and individuals working in satellite oceanography. The team are working with marine and coastal experts and stakeholders in each region to deliver information that is consistent and meets local, national and regional information requirements.

WHERE WE WORK

The E04SD Marine and Coastal project is working with regional development projects and programmes to demonstrate the utility of EO-derived environmental information in five regions around the world: the Caribbean, West Africa, the Western Indian Ocean, the Northern Indian Ocean, and South-East Asia and the Pacific.



MAPPING AND INFORMATION SERVICES

The mapping and information products provided by the E04SD marine and coastal resources services fall into four broad themes:

CARTOGRAPHIC INFORMATION

- › Land use mapping and land use change detection.
- › Shore line mapping and shore line change detection.
- › Shallow water bathymetry mapping.

COASTAL ENVIRONMENT INFORMATION

- › Shallow water benthic habitat mapping.
- › Coastal habitats - extent and status.
- › Information to support Marine Protected Area planning and management.
- › Local water quality monitoring and assessment.
- › Pollution from land-based sources

SURVEILLANCE AND MONITORING INFORMATION

The four services in this category are based on satellite data available in near real-time (NRT)

- › Monitoring of Sargassum blooms
- › Fisheries surveillance for detection of illegal, unreported and unregulated (IUU) fishing and fishery support activities
- › Monitoring of oil spills from accidents and illegal discharges from ships and off-shore activities
- › Monitoring of aggregate extraction and dredging operations

INFORMATION TO SUPPORT BLUE ECONOMY DEVELOPMENT

The services designed to support Blue Economy planning and monitoring

- › Information to support Maritime Spatial Planning (MSP)
- › Coastal infrastructure status
- › Aquaculture site selection and monitoring
- › Support for blue economy planning and monitoring (tourism, transport, energy).
- › Coastal and marine environmental impact monitoring and assessment

Working in collaboration with local stakeholders and marine and coastal experts, E04SD will be supporting projects in IFI client states, including: **Caribbean:** Caribbean Regional Oceanscape Project (CROP), the Caribbean Oceans and Aquaculture Sustainability Facility (COAST) and the WBG Sargassum initiative.

West Africa: West African Coastal Area Management Programme (WACA) and the West African Regional Fisheries Program (WARFP).

Western Indian Ocean: SW Indian Ocean Fisheries Governance and Shared Growth Project (SWIO-FISH).

North Indian Ocean: Bay of Bengal Large Marine Ecosystem project (BOBLME) and Myanmar Climate Change Resilience.

South East Asia: WBG Aquaculture initiative in the Philippines.

Pacific: Climate Smart Coastal Management (ADB)

Additional projects and initiatives will be added as the project progresses.

→ COASTAL LAND USE MAPPING

DESCRIPTION

Mapping of land use and land use changes to support studies of land-based influences on coastal water quality and dynamics.

USE

- › Land use and land cover inventories.
- › Monitoring of land use changes.
- › Statistical analysis of land cover changes.
- › Assessment of influence of changes on coastal water quality.
- › Input into environmental impact assessments and spatial planning activities.

INPUT PRODUCTS

- › Copernicus Global Land Service and ESA CCI Land Cover.
- › ESA Globwetland Africa Toolbox, data from Urban and Coastal TEPs, GlobLand30, Copernicus Hot Spot Service.
- › Landsat and Sentinel-2 data for higher resolution needs.

SPATIAL RESOLUTION AND COVERAGE

- › 300m for national to regional coverage.
- › 300m for large water-shed applications.
- › 10-30m for local to water-shed applications.

BENEFITS

Improved strategy and decision making:

- › Better understanding of land use impacts on the water cycle, soil erosion, coastal water quality, shoreline changes and status of coastal and marine habitats.
- › Decision support for integrated management of water sheds and coastal environments.

DELIVERY FORMAT

- › GeoTIFF, NetCDF for land use maps
- › Animated GIFs for time series of change
- › Tabulated data for statistics
- › pngs/jpeg/pdf for graphs

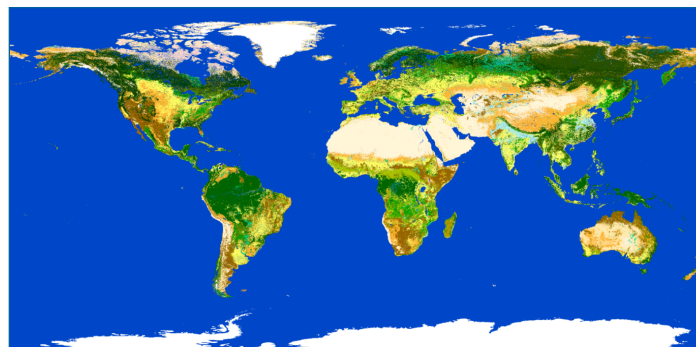
FREQUENCY

- › Yearly maps for 1995-2015 for 300m products
- › Yearly maps for selected years for higher resolution products

Land use and land use changes along coasts and in river watersheds have direct influence on water quality in coastal areas. Sediment transport in rivers responds to erosion processes which often increase when permanent vegetation such as forests are removed, and these changes will be visible in coastal water quality. The light field and nutrient availability are the main factors controlling the growth of algae – the base of the marine food web. Increases in the flow of nutrients and pollutants from land-runoff and waste water discharges also tend to accompany urbanisation and other changes in land uses.

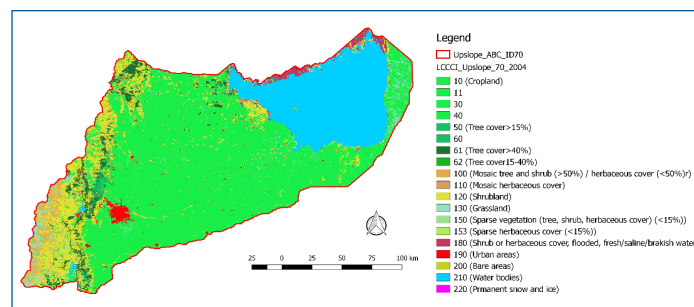
The service will combine data from global land cover services with data from higher resolution, thematically focused approaches in order to retrieve value added information and answer questions regarding the influence of land use changes on the water quality dynamics of coastal waters.

Exact product selection depends on the information requirements of the user and the scales that are of most interest. Where necessary, adaptations are available for retrieving finer scale information which is not currently available from existing data services.

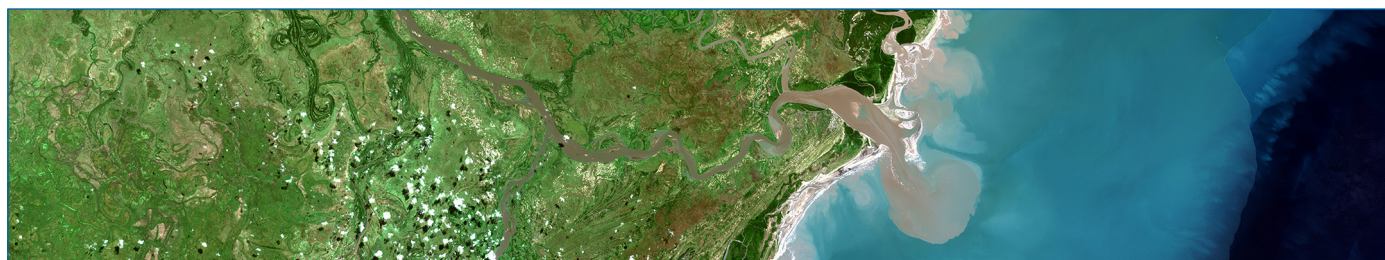


VALUE	LABEL	COLOR	VALUE	LABEL	COLOR
9	No Data		230	Shrubland	
10	Cropland, rainfed		130	Grassland	
20	Cropland, irrigated or post-flooding		140	Lichens and mosses	
30	Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%)		150	Sparse vegetation (tree, shrub, herbaceous cover) (<15%)	
40	Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)		160	Tree cover, flooded, fresh or brackish water	
50	Tree cover, broadleaved, evergreen, closed to open (>15%)		170	Tree cover, flooded, saline water	
60	Tree cover, broadleaved, deciduous, closed to open (>15%)		180	Shrub or herbaceous cover, flooded, fresh/saline/brackish water	
70	Tree cover, needleleaved, evergreen, closed to open (>15%)		190	Urban areas	
80	Tree cover, needleleaved, deciduous, closed to open (>15%)		200	Bare areas	
90	Tree cover, mixed leaf type (broadleaved and needleleaved)		210	Water bodies	
100	Mosaic tree and shrub (>50%) / herbaceous cover (<50%)		220	Permanent snow and ice	
110	Mosaic herbaceous cover (>50%) / tree and shrub (<50%)				

Global Land Use map provided by ESA Landcover CCI



Land use types for a water shed area



Sediment plume in the Zambezi delta as observed by the Sentinel-2A satellite

→ SHORELINE MAPPING AND CHANGE DETECTION

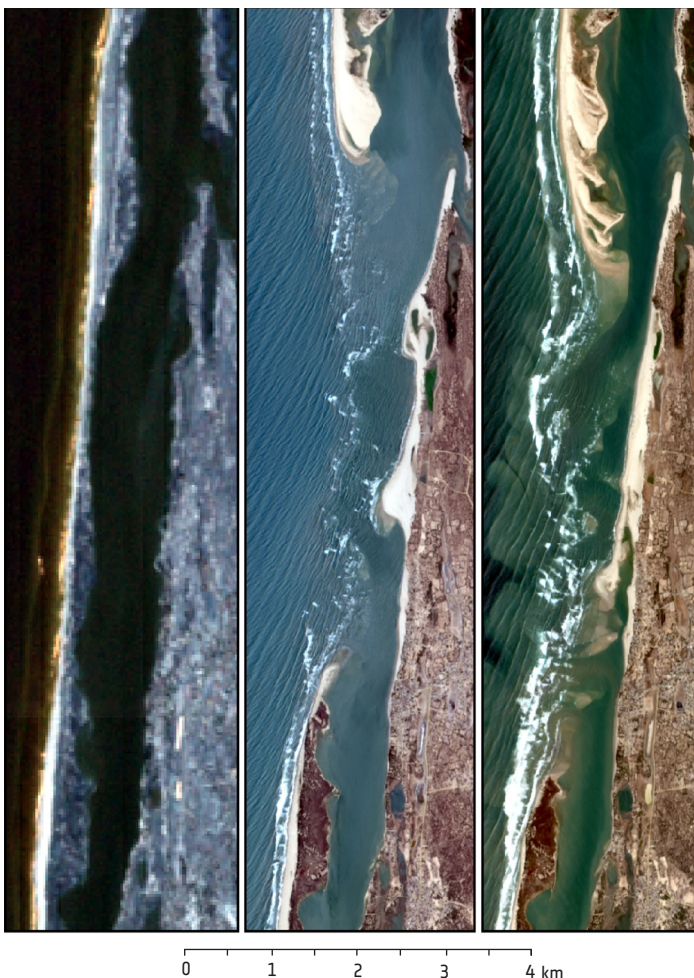
Coastal erosion can cause flooding, rock falls, landslides, loss of land and damage to infrastructure. Sediment deposition and moving sandbanks obstruct port inlets and reduce maritime safety. Regular monitoring of shoreline changes allows a better understanding of the processes involved and helps to identify susceptible locations, so that measures may be taken to reduce risk to people, businesses and infrastructure.

This service will deliver coastline maps for selected regions identified in consultation with stakeholders and local experts. The method works by identifying land-water boundaries in time series of SAR data and high-resolution optical images. Tidal correction will be necessary, in order to establish locations for high and low water shorelines, and the location of mean sea level. This is particularly important for locations with flat topography. In such locations, the data processing may yield a secondary map of intertidal bathymetry. The tidal correction will be based on available tidal models, supplemented with available tide gauge data and sea level measurements from coastal altimetry.

The coastline maps will be updated annually. A comparison with the baseline map will reveal locations of shoreline change due to coastal erosion or sediment deposition. The maps may thus be used to monitor regions that are known to suffer rapid shoreline change, for example to establish annual erosion/deposition rates, and also to identify new locations where shoreline changes occur.

Langue de Barbarie, Senegal

Landsat-5 26-Feb-1998 Sentinel-2 14-Apr-2016 Sentinel-2 27-Feb-2018



DESCRIPTION

Shoreline maps at 10m resolution for selected locations, with estimated locations for high and low water lines. In areas with a flat topography, a second map of intertidal bathymetry will be available.

For locations where the coastline changes rapidly, maps may be updated annually. 'Before and after' maps for specific locations are available on request, as part of a wider environmental impact assessment service.

USE

- › Updates to existing charts and maps.
- › Defining legal and other boundaries.
- › Assessment of coastal change dynamics.
- › Risk mapping for coastal hazard management.
- › Coastal zone planning and development.
- › Monitoring impacts of coastal defence initiatives.

INPUT PRODUCTS

- › Sentinel-1 SAR and Sentinel-2 MSI data
- › Tidal model output
- › Sea level data from altimetry and tide gauges

SPATIAL RESOLUTION AND COVERAGE

- › 10m resolution for up to 100km coverage per map
- › Coverage determined in consultation with stakeholders

BENEFITS

Improved strategy and decision making:

- › Safety of navigation
- › Understanding of shoreline change dynamics
- › Informed planning of coastal defences
- › Safety for coastal populations
- › Reduced risk to buildings, business and infrastructure

DELIVERY FORMAT

- › GEO-TIFF, NetCDF

FREQUENCY

Frequency of the mapping is determined in consultation with stakeholders to meet local needs.

- › Baseline mapping.
- › Annual update to maps for rapidly changing coastlines.
- › Seasonal maps where change dynamics indicate a need.

Coastline changes in Saint-Louis, Senegal. After the flood of October 2003, an artificial breach was opened in Langue de Barbarie in order to release flood water. Since then the city has not been flooded by the river because the wide breach allows the water to escape, but tidal range has risen sharply. Currents and waves now erode the coast south of the breach, while sediments are deposited to the north, moving the breach southward at a rate of around 1km per year.

→ COASTAL BATHYMETRY MAPPING

DESCRIPTION

This service provides estimates of water depth in shallow near-shore water to a depth of 15m or more in clear water with good under-water visibility. Reliability is improved if local measurements of depth and water turbidity are available to support the data processing.

USE

- › Fine-scale bathymetric mapping of shallow water to complement existing charts and fill gaps
- › Updating of bathymetric charts for regions with rapidly changing bathymetry, such as moving underwater sand dunes, estuaries and deltas.

INPUT PRODUCTS

- Optical data at 10m resolution from Sentinel-2 MSI.
- › Commercial high resolution data for fine scale bathymetry when requested for specific projects.
- › Local, geo-located measurements of water depth and turbidity from selected locations (if available)
- › Local information on bottom substrate and habitats at selected locations (if available).

SPATIAL RESOLUTION AND COVERAGE

- › 10m resolution maps derived from free Sentinel-2 data.
- › Finer resolution (1-5m) available on request, using commercial data where user bears the cost of data acquisition.
- › Vertical resolution depends on depth and water quality, and ranges from 10cm in very shallow water to 1-2m at depths over 6 metres.

BENEFITS

Improved strategy and decision making:

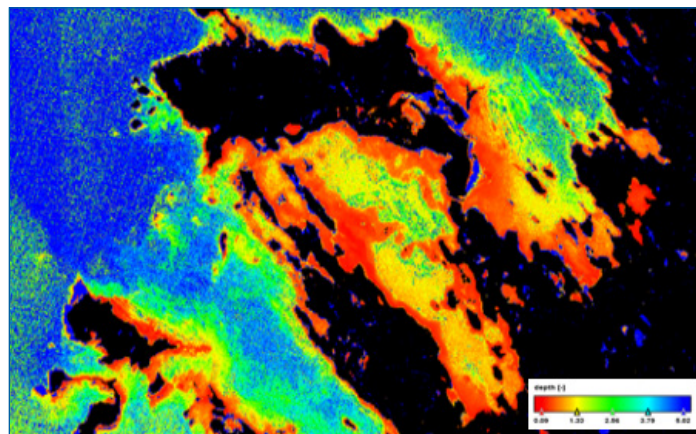
- › Safety of coastal navigation.
- › Bathymetric estimates in areas where no data is available from conventional hydrographic surveys.
- › Bathymetric maps for shallow regions inaccessible to hydrographic survey ships.
- › Frequent updates for areas with rapid change in bathymetry.

DELIVERY FORMAT

- › GeoTIFF, NetCDF.

FREQUENCY

- › Single baseline maps for areas with low rate of change.
- › For rapidly changing areas updates may be available annually.



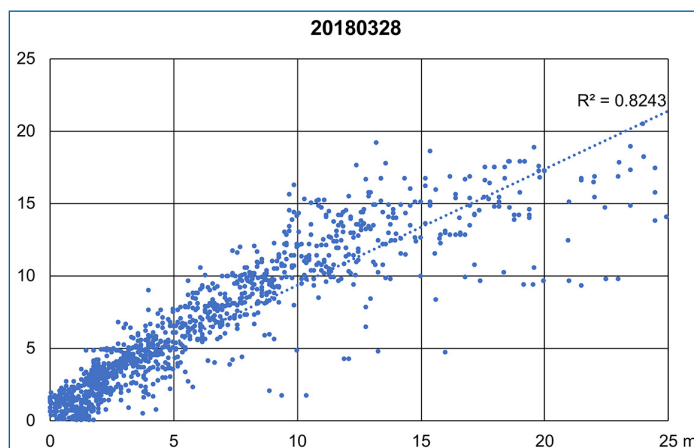
Bathymetry map of Vilsandi National Park (Estonia) obtained from a Sentinel-2 image using the SWAM model.

There is lack of detailed bathymetry data in many parts of the world. Sonar-based hydrographic mapping is time consuming and expensive, and hydrographic survey ships cannot access some of the shallowest coastal areas.

Bathymetric estimates derived from satellite data can achieve good accuracies in such areas, especially if supported by some *in situ* depth measurements. If so, bathymetric retrieval is relatively fast, and can be quite accurate. Where no *in situ* data are available, analytical model inversion can retrieve water depth and bottom type simultaneously, but the method is time consuming. The retrieval requires water quality information. If this is not available from independent measurements it must be retrieved from the satellite data. In this case the accuracy of the bathymetric maps may be reduced, particularly in areas where water quality is spatially variable.

Bathymetric accuracy and vertical resolution depend on water quality and water depth. In clear oceanic waters results are reliable down to 15-20m. For very shallow water accuracies may be as high as 10cm, but reach 1-2m in depth over 6m. In turbid coastal waters maximum depths and accuracies drop significantly.

In regions with persistent cloud cover for much of the year it may be difficult to find suitable satellite data. However, bathymetric mapping is typically a one-off activity and thus not time-critical. The exception is areas where the bathymetry can change rapidly over relatively short time scales, such as river estuaries, sand dunes and deltas.



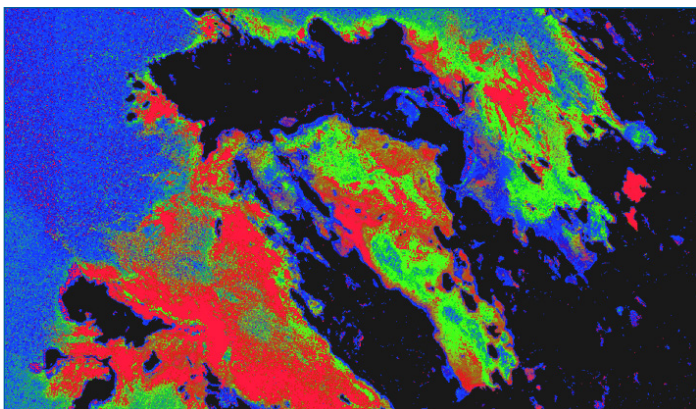
Correlation between sonar and Sentinel-2 bathymetry in a coral reef environment (Lizard Island, Australia).

→ BENTHIC HABITAT MAPPING

Empirical methods can produce relatively accurate maps of broad benthic habitat types such as red, green or brown macro-algae, live coral, sea grass beds, sand and other bare substrates. Where survey data is limited or not obtained near-simultaneously with the satellite image, inversion may still be relatively reliable, particularly if initial analysis of classification results draws on the experience of local experts familiar with the area. Analytical inversion, based on radiative transfer modelling, can simultaneously retrieve water depth and bottom type from the satellite data alone, but the processing is time consuming, and accuracy may be low and hard to assess in optically complex coastal waters.

The service will be available for selected regions, with priority given to areas where local scientific support can assist with interpretation and/or supporting in situ data. Standard spatial resolution is 10m, but 1-5m resolution is available for specific surveys of patchy environments, where the user agrees to bear the cost of acquiring commercial data and support the mapping with in situ surveys.

Frequency of map updates will depend on the application. For spatial planning a single map showing maximum extent of cover by different habitats may be sufficient. Updates may be produced annually for management purposes. In regions with strong seasonality two to four products per year may be necessary. Baseline and impact maps may be produced on request for specific events such as tropical storms or periods with high coral bleaching risk.



Benthic habitat map of Vilsandi National Park (Estonia) derived from a Sentinel-2A image acquired 13 April 2018, atmospherically corrected with the C2RSS and processed with the SWAM analytical model. Bottom types are presented as probabilities between 0% and 100% where red is sand, green is green algae, and blue is red and brown algae.



Sentinel-2 image of Heron and Wistari Reefs taken at June 24, 2017.

DESCRIPTION

Maps of benthic habitat types - macroalgae, live coral, sea grass beds, sand and other bare substrates - are derived from Sentinel-2 data at 10m resolution.

The maps are most reliable when supported by data from in situ surveys. Accuracy decreases with depth and increasing water turbidity.

USE

- › Current distribution of shallow water benthic habitats.
- › Area and extent, patchiness and density.
- › Change detection and status assessment.
- › Decision support for management of marine parks.
- › Assessing impacts of coral bleaching events or storms.

INPUT PRODUCTS

- › Sentinel-2 MSI data.
- › If available: bathymetry; water quality; benthic survey data.

SPATIAL RESOLUTION AND COVERAGE

- › Local to sub-national at 10m resolution.
- › 1-5m resolution on request for specific projects when users cover the cost of commercial data acquisition.
- › Shallow areas to 15m depth (in clear water).

BENEFITS

Improved strategy and decision making:

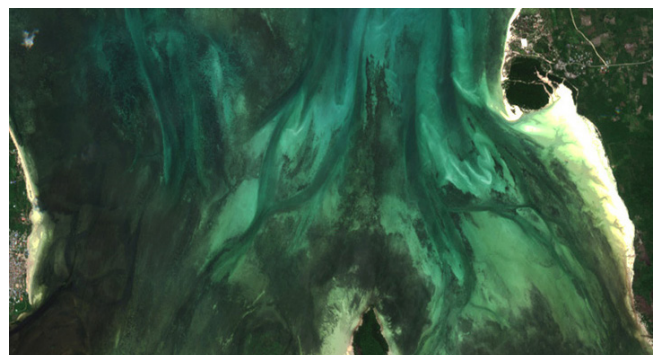
- › Better understanding of coastal habitat dynamics.
- › Assess the impact of natural and human forcing.
- › Identification of sensitive habitats in need of protection.

DELIVERY FORMAT

- › GEO-TIFF, NetCDF

FREQUENCY

- › Baseline map with annual updates.
- › More frequent for regions with strong seasonality.
- › Before and after maps for environmental impact assessment of specified events.



Sentinel-2 image of sea grass beds in Chakwa Bay, Tanzania, 6 June 2018.

→ COASTAL HABITAT MAPPING

DESCRIPTION

This service will provide coastal habitat maps and will extend across supra-tidal and intertidal zones. Optical data-gaps caused by cloud covers will be filled with SAR observations and historical optical-data that have hydro-meteorological conditions similar to the missing data, e.g. the same growing season with comparable patterns of annual precipitation and temperature.

USE

- › Assessment of current state of coastal habitats in the supra and intertidal zones based on extent, type and density.
- › Change detection as part of on-going monitoring efforts.
- › Comparison with historical data to assess longer term change.
- › Monitoring to assess efficacy of conservation measures such as habitat restoration.

INPUT PRODUCTS

- › Sentinel-1 and Sentinel-2 MSI data.
- › For global products, Sentinel-3 OLCI data.
- › Land cover/land use maps of the area.

SPATIAL RESOLUTION AND COVERAGE

- › Local/national (10-30m) and regional (300m) scales.

BENEFITS

- › Better understanding of coastal habitat dynamics.
- › Assess the impact of natural and human forcing.
- › Allowing policy makers to set evidence-based management objectives as part of efforts to support SGD target 6.6 (protection and restoration of water-related ecosystems).

DELIVERY FORMAT

- › GEO-TIFF, NetCDF.

FREQUENCY

- › Monthly.

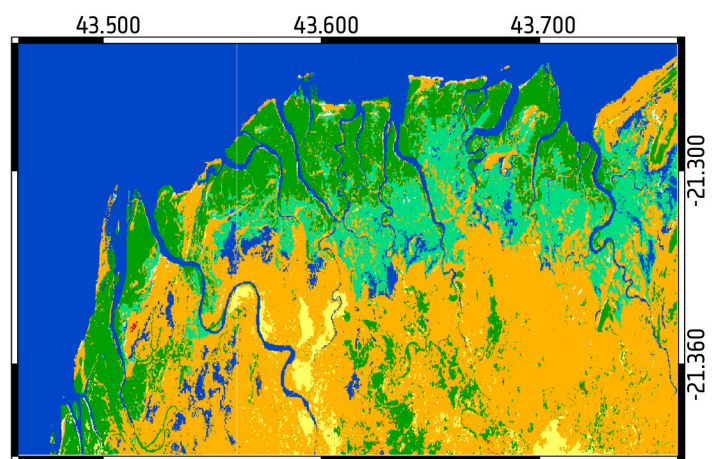


River delta near Freetown, Sierra Leone seen from Sentinel-2A.

Coastal habitats lie in the interface between land and water and are habitats of constant change due to the interaction between land and ocean and growing human population. These ecosystems produce disproportionately more services relating to human well-being than most other systems. However, the extensive usage of coastal areas comes at the cost of accelerated degradation; for example, 35% of mangrove area has been lost or converted.

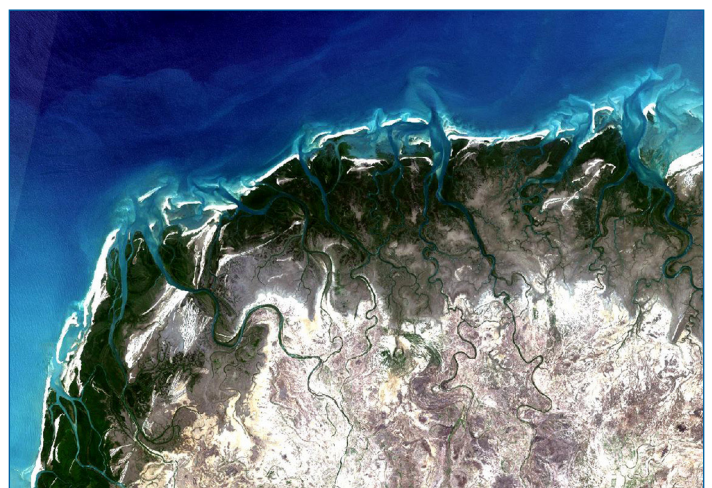
This service will provide maps of the coast, the shore and the nearshore, covering dunes and coastal wetlands, estuaries, lagoons, and mangroves 10 to 300m resolution for selected coastal areas. A global products covering a full region may be provided, as in the example below for the Ayeyarwady delta.

Optical data-gaps due to cloud will be filled with SAR observations and historical optical-data that have hydro-metrological conditions similar to the missing data, e.g. the same growing season with comparable patterns of annual precipitation and temperature.



- No data
- Tree covered areas
- Shrub covered areas
- Grassland
- Cropland
- Aquatic or regularly flooded vegetation
- Lichens, mosses/sparse vegetation
- Bare areas
- Built-up areas
- Snow and/or ice
- Open Water

Example of coastal habitat mapping using land cover classification for the Ayeyarwady Delta in Myanmar based on a Sentinel 3 image acquired on 22 November 2018. The Sentinel-2 data used for the classification is seen below as a colour composite image.

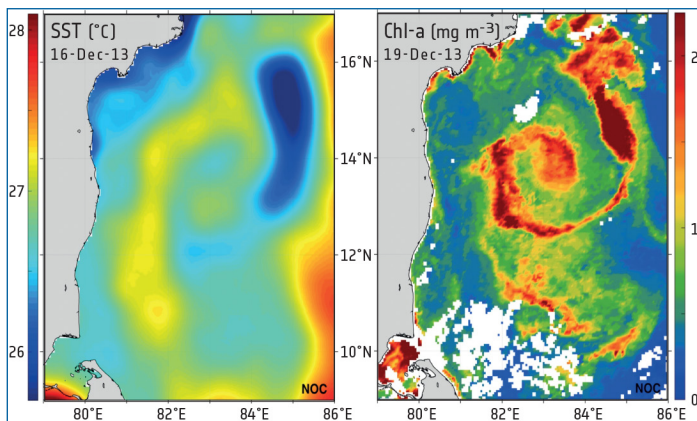


→ SUPPORT FOR MARINE PROTECTED AREA MANAGEMENT

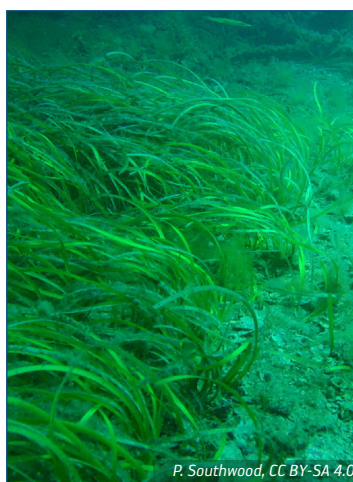
MPAs include marine parks, nature reserves and locally managed marine areas that protect biodiversity and fish stocks, and may include, for example reefs, seagrass beds, tidal lagoons, mudflats, saltmarshes, mangroves, rock platforms or coastal dunes. Planning and management of MPAs focuses on the need to protect marine flora and fauna, but it has to be considered in the context of other planning and management activities related to fisheries, aquaculture, transport, mineral extraction, tourism and other uses of marine space, as well as ecosystem-based adaptation to climate change.

Depending on the nature of and purpose of the MPA the information needed for planning and management may vary significantly. For example, managing an MPA to protect pelagic fish stocks may require time series analysis of sea surface temperature and chlorophyll-a concentration; while planning an ecosystem-based adaptation scheme to protect and restore natural coastal defences such as coral reefs, beaches, dunes or mangroves and other wetlands will require coastal habitat maps, bathymetry and shoreline change information, and may also need information about temperature, water quality, currents, wind and waves.

The service will therefore advise on choice and analysis of data products on a case by case basis, working with stakeholders and local experts.



Planning and implementing an MPA to protect fish stock in the open ocean may require time-series analysis of chlorophyll and sea surface temperature (SST) data as shown above for an eddy in the Bay of Bengal (above). Time series analysis of such data can provide information about ecosystem dynamics that sustain key species. Efforts to enforce protection measures may benefit from knowing the location of ocean fronts, where fish are found in greater abundance.



Management of coastal habitats such as seagrass beds, corals, mangroves or coastal dunes will require habitat maps, and other data to help understand changes.

DESCRIPTION

Advisory service designed to work with local stakeholders and marine experts to select EO-derived data relevant to their information requirements and support analysis of these in conjunction with available local data and information.

USE

- › Development of ecosystem-based options for planning MPA networks to protect biodiversity, fish stocks and key ecosystem services.
- › Provide evidence-based feedback on efficacy of management measures as part of adaptive MPA management
- › Improve understanding of ecosystem dynamics and interaction with management efforts.
- › Development of measures to protect and /or restore habitats identified as important for natural defences against marine hazards as part of ecosystem-based climate adaptation.

INPUT PRODUCTS

- › Mapped data products from other E04SD-marine services.
- › Additional satellite data from global archives as required.

SPATIAL RESOLUTION AND COVERAGE

- › 10m to 1km, depending on data type.

BENEFITS

- › More informed decision-making and improved planning and field management for decision-makers and interest groups.
- › Evidence-based, adaptive MPA management.

DELIVERY FORMAT

- › Mapped data in GEOTIFF /NetCDF.
- › Analysis support, reports and summary information.

FREQUENCY

- › As agreed in consultation with stakeholders.

→ WATER QUALITY MONITORING

DESCRIPTION

A water quality service based on maps of chlorophyll-*a* concentration at medium resolution. Other products may be available for specific case studies selected in consultation with stakeholders or to support the Blue Economy services.

USE

- › Monitoring of possible eutrophication when used with thresholds and information on natural variability
- › Monitoring of potentially harmful algal blooms
- › Identification of ocean fronts and potential fishing zones
- › Monitoring of water clarity and suspended sediment concentration
- › Supporting information for analysis of coastline changes due to sediment transport and deposition

INPUT PRODUCTS

- › Optical data from the OLCI instrument on Sentinel-3
- › Optical data from the MSI instrument on Sentinel-2 (high-resolution studies of selected areas only).

SPATIAL RESOLUTION AND COVERAGE

- › 300m and 1km for routine monitoring of larger areas.
- › 10m resolution for specific small scale coastal studies.

BENEFITS

Improved strategy and decision making:

- › Operational monitoring agencies gain information on natural variability and long term changes in eutrophication
- › Aquaculture farms and health authorities may use operational real-time information on potentially harmful blooms
- › Input into coastal change process studies to inform development of options for shoreline protection

DELIVERY FORMAT

- › NetCDF, PNG.

FREQUENCY

- › Daily for 300m and 1 km. Monthly composites at 1 km.
- › As available for 10m resolution from Sentinel-2 data.

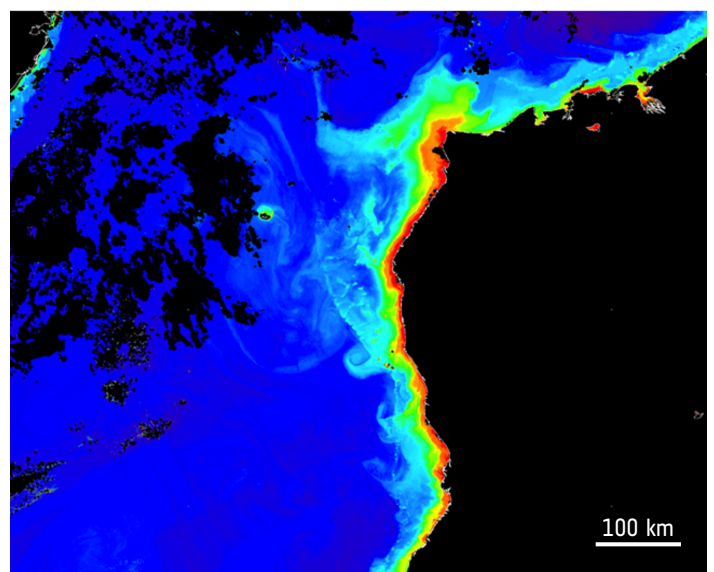
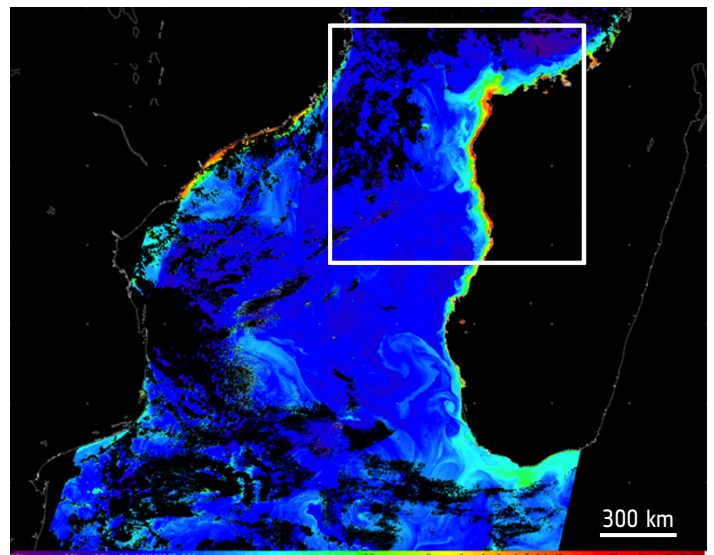


Algal blooms may be harmful due to toxins from the plankton or because the high concentrations smother gills and lead to deoxygenation of water.

Good water quality is essential for the aquaculture industry and fisheries, and is also important for leisure use: beaches, swimming, surfing etc. Poor water quality can reduce biodiversity and put sensitive coastal habitats at risk. The ability to monitor water quality is thus important for coastal planners and managers in a range of different contexts – from the protection of important coastal habitats to the development of Blue Economy sectors such as aquaculture and tourism.

The E04SD coastal water quality service will deliver daily maps of chlorophyll-*a* concentration at 1km or 300m resolution based on measurements from the OLCI instrument on the Sentinel-3 satellites. Chlorophyll is a measure of phytoplankton productivity, with high concentrations acting as an indicator of high nutrient content and possible eutrophication of coastal water.

Where higher resolution is required for specific coastal areas, the service may deliver water quality information from Sentinel-2 MSI, which has capabilities for the retrieval of suspended particulate matter and possibly chlorophyll-*a*.

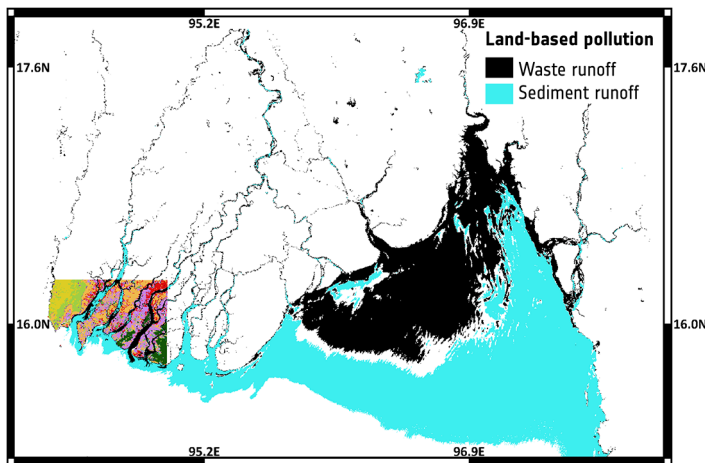


Sentinel 3 OLCI image based on Eumetsat L2 data from 15 November 2018 mapped for Mozambique channel at resolutions of 1km (top) and 300m (bottom).

→ MONITORING POLLUTION FROM LAND BASED SOURCES

Many coastal areas are affected by land based pollution resulting from wastewater effluents, oil spills and thermal pollution, e.g. from power stations. The service focuses on detecting land-based effluents of untreated sludge from sewage treatment plants and near-shore oil spills, e.g. from ports, marinas, oil pipelines and refineries. The service is complementary to other E04SD marine and coastal services - in particular the water quality service (eutrophication from sewage and agricultural land run-off) and the monitoring of dredging activities (resuspension of polluted sediments).

Most land-based discharges originating from rivers or on-shore activities require high-resolution data capable of resolving these potential pollution sources. For this reason, the service is based on synthetic aperture radar (SAR) and high-resolution optical data from the Sentinel 1 and 2 series of satellites to provide maps at 10 to 30m resolution. However, the impacts may often be seen over wide areas off-shore, usually in diluted form. The low concentrations and wide spread requires medium-resolution (300m to 1km) data from Sentinel-3. These may be combined as in the example below.



Example of land-based runoff for the Ayeyarwady Delta in Myanmar based on data from Sentinel-3 and Sentinel-2 (lower left coloured area), acquired on 22-11-2018. The Sentinel-2 data provide land use classification that may contribute to identifying potential causes of the pollution.



Sentinel-2 image of the Ayeyarwady delta from March 2017 showing suspended sediment in land runoff. Right: detail from the larger image.

DESCRIPTION

Mapping service to help identify land-based sources of marine pollution and assess the extent of the areas affected.

USE

- › Assess the extent of marine pollution from land runoff and their potential impact on sensitive ecosystems.
- › Assess potential impacts on coastal environments of land use changes and urban development.
- › Baseline and post-development impact assessments for blue economy development (ports, marinas, tourist resorts, etc.)
- › Change detection to assess efficacy of pollution prevention measures.

The service could be combined with other services: land use change, water quality, oil pollution, aggregates and dredging to help identify sources of the pollution.

INPUT PRODUCTS

- › MSI data from the Sentinel-2.
- › SAR data from the Sentinel-1.
- › Ocean colour data from Sentinel-3.

SPATIAL RESOLUTION AND COVERAGE

- › 10 - 30m resolution for fine scale studies of coastal environments.
- › 300m - 1km resolution for regional impact studies.

BENEFITS

- › Allowing policy makers to set evidence-based management objectives as part of efforts to meet SGD target 14.1.
- › Evidence-based assessment of the efficacy of measures taken to reduce marine pollution from land-based sources.

DELIVERY FORMAT

- › Maps in NetCDF and PNG format.
- › Open-source tools to allow users to generate maps

FREQUENCY

- › To be determined in consultation with stakeholders, based on their information requirements and use of the map.



DESCRIPTION

The service provides maps of potential Sargassum blooms and extracted time series for user-defined regions that allow the user to monitor the extent, duration and evolution of the blooms to assess the risk for impacts on coasts and beaches.

USE

- › Maps may be used to assess bloom location and size.
- › Time series may be used to assess the evolution and duration of a bloom.
- › Combining the two with other data and numerical models will allow users to assess the risk of a bloom reaching the coast.
- › Baseline data and longer time series may be used to study variability and change in the timing, intensity and duration of bloom for a given region.

INPUT PRODUCTS

- › Sentinel-2 and Landsat images.
- › Sentinel-3 OLCI daily L1 product.
- › Existing medium resolution Sargassum monitoring services.

SPATIAL RESOLUTION AND COVERAGE

- › 10-30m for high resolution coverage of specified areas.
- › 300m for regional coverage of known Sargassum areas.

BENEFITS

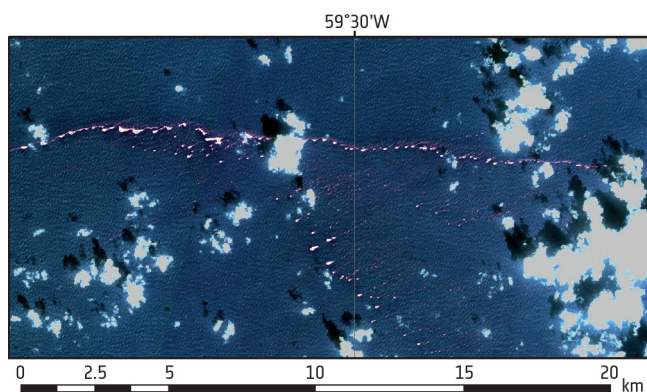
- › Early warning of potentially harmful Sargassum blooms that may impact coastal areas, allowing time for measure to reduce adverse impacts.
- › Identification of blooms for potential harvesting of Sargassum for nutritional and pharmaceutical use.

DELIVERY FORMAT

- › NetCDF or GEOTIFF for data analysis and GIS.
- › PNG images.
- › Time series in tabulated form and as plots.

FREQUENCY

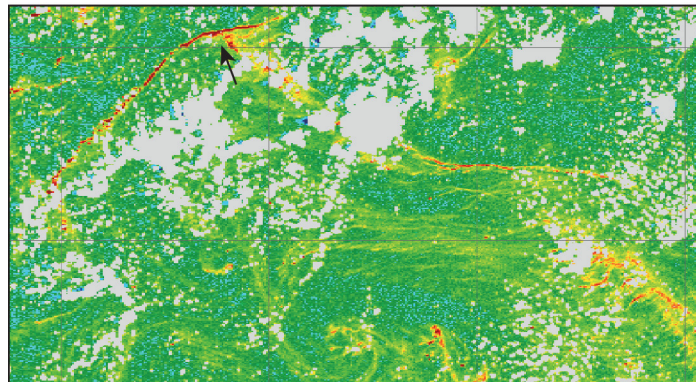
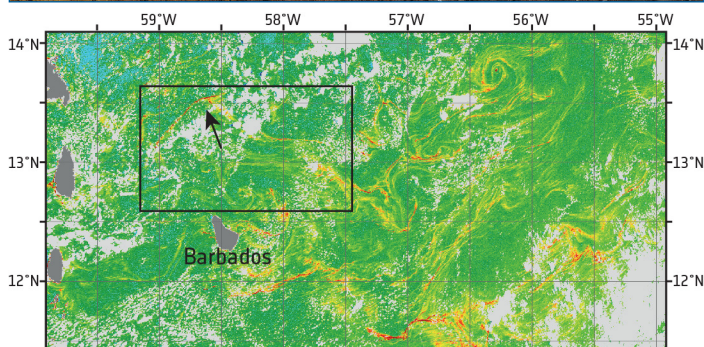
- › Monthly baseline service with bloom indicators.
- › Short-term delivery for specified user regions.



Sargassum is an important nursery habitat, providing food and shelter for many species. It is also highly nutritious and contains a large number of bioactive compounds with pharmaceutical potential. Sargassum mats can protect coasts by reducing wave and wind erosion. However, in high concentrations or on the beaches, Sargassum has a negative impact on human activities such as tourism. It smells strongly of hydrogen sulfide gas and may choke fishing gear and engines. Sargassum blooms may also harm the environment. For example, dense mats may prevent hatching sea turtles from reaching the water, and floating mats can give a lift to invasive species.

The service focusses on detecting floating Sargassum blooms in open and near-shore waters. A first indication of a bloom may be detected using an existing monitoring service or daily images from Sentinel-3 OLCI. A detailed assessment of the areas that have been identified may then be performed using high-resolution Sentinel-2 data. Regular processing during the blooming season, may yield the following products:

- › Maps showing a potential Sargassum indicator.
- › Time series plots for specific areas showing the evolution of blooms.
- › Indicators for size and duration of blooms for user-defined areas.

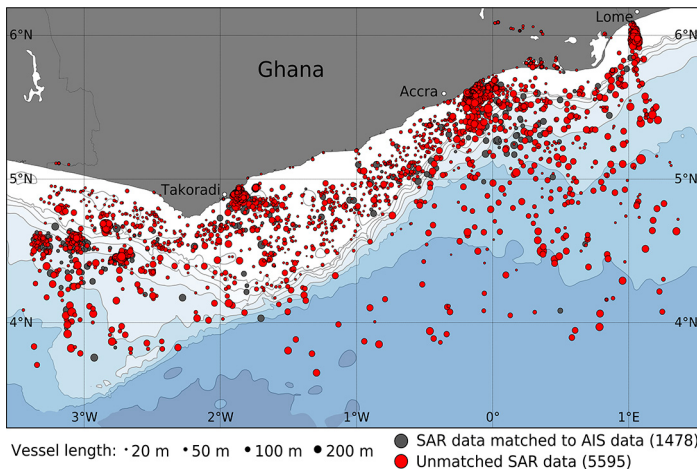


Above top: Sargassum bloom along the coast in St Vincent, Caribbean in January 2019. Floating vegetation is shown in red; submerged vegetation in green/yellow. **Middle:** Potential sargassum bloom 19-Jan-2019 detected in OLCI data from Sentinel-3. **Bottom:** the bloom shown in higher resolution. **Left:** the bloom may be observed more closely in data from Sentinel-2.

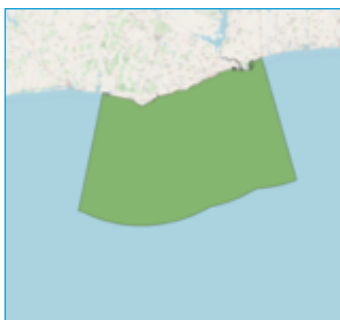
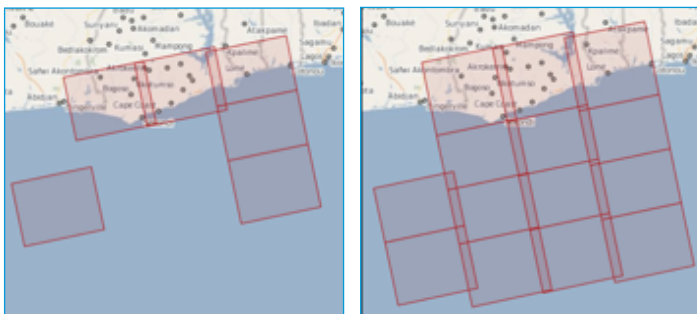
→ FISHERIES SURVEILLANCE

The fisheries surveillance service makes use of fast-delivery data from the Synthetic Aperture Radar (SAR) instrument on the Sentinel-1 satellites by detecting objects that differ markedly from their immediate background using a constant false alarm rate (CFAR) test. The detection algorithms have a high success rate with 91% of registered vessels being matched to satellite detection, with coordinates for half the cases agreeing to within 100m.

The satellite data also provide estimates for length and width of ships that matched the distribution found in the area. The selected objects are discounted from further analysis if they fall within the bespoke land mask or can be shown from time series analysis to be static (signals associated with jetties, oil platforms and “ghost objects” arising from very bright land targets). Detections are matched to, and verified by, the automatic identification system (AIS) data, which provides location and dimensions of ships that are legally in the region.



The number of vessels recorded in SAR matched to AIS (black) versus those that exist in the SAR record, but have no AIS counterpart (red). The size of each point corresponds to its size either detected from the SAR record, or as reported by the AIS transponder at the time of SAR sensor overpass.



Above: available SAR scenes for the Ghanaian coast (spanning one complete revisit cycle) for Sentinel-1A (left) and Sentinel-1B (right). The pass times for Sentinel-1A and Sentinel-1B are 18:10 and 18:20 GMT respectively.

Left: the Ghanaian EEZ.

Right: ocean front maps showing a snapshot of the location and strength of thermal fronts around the African continent during 11-17 Aug. 2017.

DESCRIPTION

Calibrated maps of vessels detected in Sentinel-1 SAR data, with position, heading, and estimates of vessel length and width. Classification of the detected objects as 'static', 'registered' or 'suspect' (not matched with AIS/VMS data).

USE

- › Monitoring of ships potentially involved in fishing and related activities.
- › Used with inspections at sea and control of landings to enforce fisheries regulations and prevent illegal fishing.
- › Use with front detection maps to identify ship activity in potential fishing zones in order to optimize inspections at sea.
- › Statistical analysis of time series to give seasonal or annual estimates of IUU fishing in a given region.

INPUT PRODUCTS

- › Fast delivery SAR data from Sentinel-1A/B.
- › Commercial SAR data if requested and paid for by user.
- › Ship location data from AIS and VMS.

SPATIAL RESOLUTION AND COVERAGE

- › 20m resolution images for ship detection maps.
- › 7km resolution for ocean front (PFZ) maps.

BENEFITS

Improved strategy and decision making:

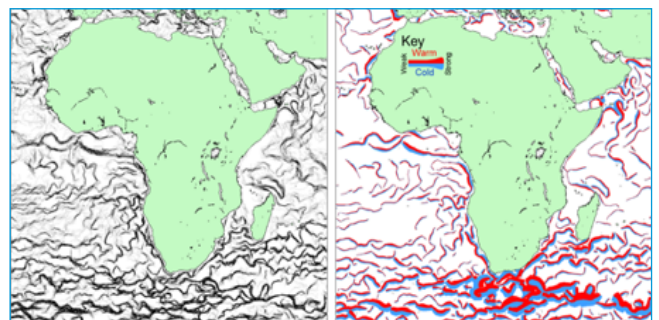
- › Support for national and international strategies to limit fishing efforts, reduce overall catches and combat IUU fishing.
- › Reduction in overfishing ultimately allowing improved efficiency (CPU) of legal fishing effort.

DELIVERY FORMAT

- › Web portal with satellite data display overlaid with AIS trajectories of vessels known to be active in the region.
- › Aggregate information on vessels operating without an identification system as additional layers on web portal.
- › Ocean front maps on portal and in PNG and NetCDF format.

FREQUENCY

- › Every 6 days for ship detection data from Sentinel-1 available within 7 hours of satellite overpass.



DESCRIPTION

Service providing information on illegal oil discharge from commercial vessels, and potential breaches of discharge limits from off-shore installations.

USE

- › Monitoring of illegal oil discharges from commercial ships by detecting oil and identifying the potential polluters.
- › Used to direct inspections at sea as part of efforts to enforce of regulations governing oil discharges from ships and offshore industries.
- › Statistical analysis of time series of images as part of environmental impact assessment associated with port development or off-shore oil extraction.

INPUT PRODUCTS

- › Fast delivery SAR data from Sentinel-1A/B.
- › Near real-time commercial SAR data if requested and paid for by users.
- › Ship location data from AIS and VMS.

SPATIAL RESOLUTION AND COVERAGE

- › 20m resolution images for oil spill and ship detection maps.

BENEFITS

- › Improved overall control over illegal oil discharges through regular and timely information provided to authorities tasked with enforcing discharge limits.
- › Ultimately monitoring an enforcement will lead to a reduction in illegal oil discharges and a reduced damage to marine and coastal environments arising from oil pollution.

DELIVERY FORMAT

- › Web-based GIS portal with satellite-based oil spill maps, and potential for overlaying AIS trajectories of vessels known to be active in the region.
- › Aggregate information on vessels operating without an identification system as additional layers on web portal.
- › SAR images with known oil spills in NetCDF and PNG format.
- › SMS alerts to authorities tasked with marine pollution control when a spill has been detected.

FREQUENCY

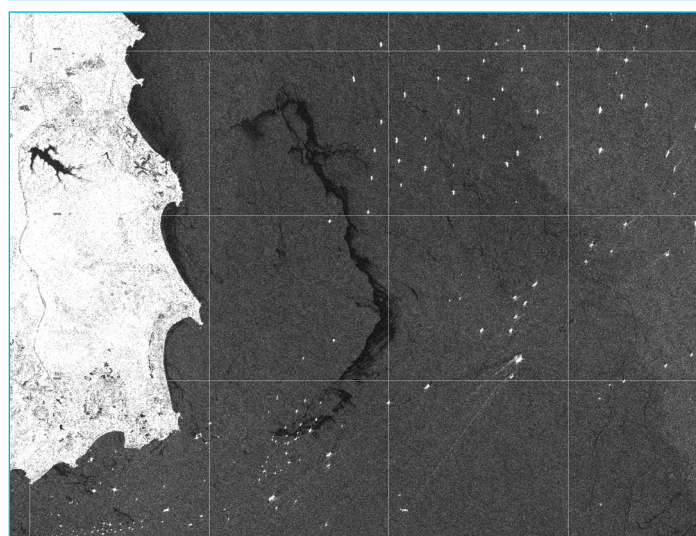
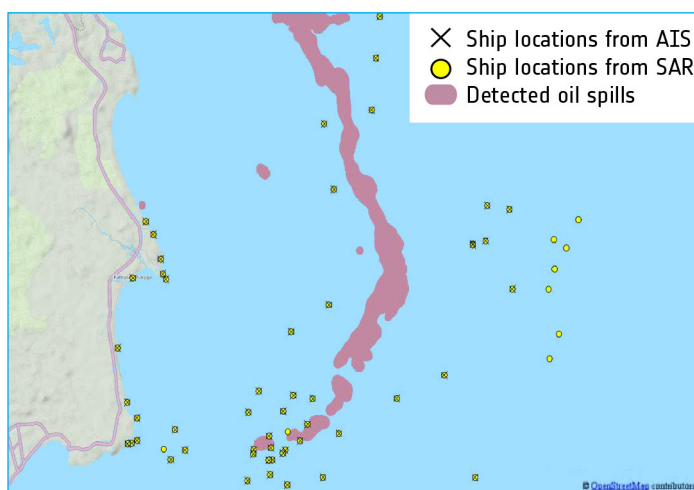
- › Potential alerts with associated images available every 6 days within 12 hours of satellite overpass.
- › More frequent if users are prepared to pay for commercial SAR data, e.g. from RADARSAT and other sources.

Most incidents of marine oil pollution are caused by operational discharges from oils tanks and bilge cleaning. Oil waste can destroy marine life and may reach coastal areas, causing habitat-losses that may lead to increased coastal erosion, loss of biodiversity and depletion of fish stocks.

The monitoring service provides information on illegal oil discharge from from commercial vessels using SAR data from Sentinel-1A and Sentinel-1B, which which together deliver data every 5-6 days over tropical regions. The data are automatically downloaded when available (typically 12 hours after acquisition) and pre-processed to a calibrated and georeferenced product. An automated slick detection algorithm distinguishes oil slicks from look-alikes.

The detection algorithm is designed to work for wind speeds between 2ms^{-1} and 10ms^{-1} . Outside this range, the contrast between areas with oil and those without is not great enough for accurate detection.

For the monitoring of specific oil spills after accidents, the observation frequency may be insufficient for monitoring specific oil spills. For targeting small areas covering specified spills, more frequent (daily) observations are provided through commercial Cosmo SkyMed SAR. Frequency of observations may be further increased using Radarsat data, but costs are considerable and must be borne by the end-user.



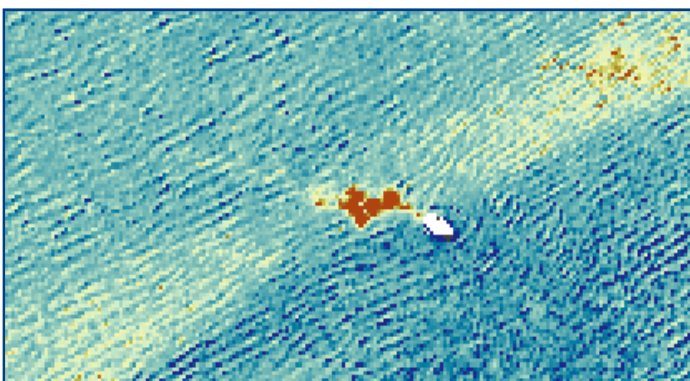
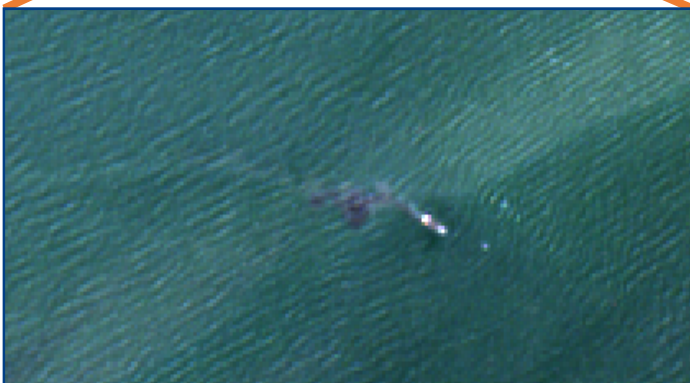
An example of oil spill detection based on Sentinel-1A data (top). The ships, shown in yellow, are automatically detected from the SAR image (bottom); the oil (dark area) is detected using an automatic slick detection algorithm.

→ MONITORING OF AGGREGATE EXTRACTION AND DREDGING OPERATIONS

Human activities due to dredging and other coastal engineering work in coastal waters have a large impact on local and regional water quality and sedimentology. The phenomena are of comparable small spatial scale but can be mapped with spatial high-resolution images such as Landsat-8 or Sentinel-2. Different water masses are identified by their colour and interpreted accordingly.

Depending on the source, dredging material can be contaminated with heavy metals and other potentially harmful organic or inorganic substances. Dumping areas should therefore be chosen carefully, taking account of distance to marine protected areas and other sensitive ecosystems, and mechanisms that may transport dredged materials away from the dump site.

The service will provide regular, high-resolution maps of the region of interest in, along with information on whether dumped material can be associated with nearby ships. Where information about designated dumping areas is available, it will be included in the maps, making it possible to distinguish licenced activities from illegal dumping.



DESCRIPTION

High-resolution monitoring of suspended sediment from aggregate extraction and dredging operations, including identification of un-licensed activities.

USE

- › Identification of dumping activities.
- › Assessment of impact on (marine) protected areas.
- › Assessment of impact on coastal habitats.
- › Support for designation of dumping areas.

INPUT PRODUCTS

- › Sentinel-2 MSI.
- › Landsat-8 OLI.

SPATIAL RESOLUTION AND COVERAGE

10-30 m.

BENEFITS

Improved strategy and decision making:

- › Monitoring of coastal activities.
- › Assessment of spatial distribution of dumped material and coastal constructions.
- › Detection of illegal dumping (only in conjunction with information about official dumping areas).

DELIVERY FORMAT

- › Shapefile with identified dumping events
- › Raster RGB image in PNG format for visual assessment by the user
- › Periodic summary reports and documentation

FREQUENCY

Depends on user requirements; on a regular basis (e.g. monthly) or when an event is detected.

Left: Different water types of dumped material and surrounding water. Dredged and transported material usually has a different colour than the water where it is dumped. The True colour image (middle) shows a dark spot behind the ship. The absorption parameter (bottom) reveals the full extent of the dumped material. more clearly.

→ SUPPORT FOR MARITIME SPATIAL PLANNING

DESCRIPTION

Analysis and advisory service that draws together multiple EO datasets to inform and enhance existing or emerging maritime spatial planning processes.

USE

- › Environmental analysis to support environmental analysis to inform maritime spatial planning.
- › Information and analysis to support mitigation measures and development of zonation options to reduce conflict between different blue economy sectors.

INPUT DATA AND INFORMATION

- › Mapped data products from other E04SD services.
- › Geographical information on coastal infrastructure status available from national / local sources.
- › Environmental data and information available from past assessments and existing research.
- › Information provided by local experts and stakeholders.

SPATIAL RESOLUTION AND COVERAGE

- › 10m to 1km or more, depending on data type.
- › Coverage may be national, sub-national or local.

BENEFITS

- › Evidence-based support for choice of marine protected areas and zonation of different economic activities.
- › Reduction in potential conflict of interest between economic sectors and different stakeholder groups.

DELIVERY FORMAT

- › Mapped data in GEOTIFF /NetCDF formats suitable for GIS.
- › Analysis support, reports and summary information.

FREQUENCY

- › As agreed in consultation with stakeholders.

Maritime spatial planning (MSP) analyses and allocates regions of a three-dimensional marine and coastal space to specific uses based on ecological, economic and social objectives that are usually specified through a political process.

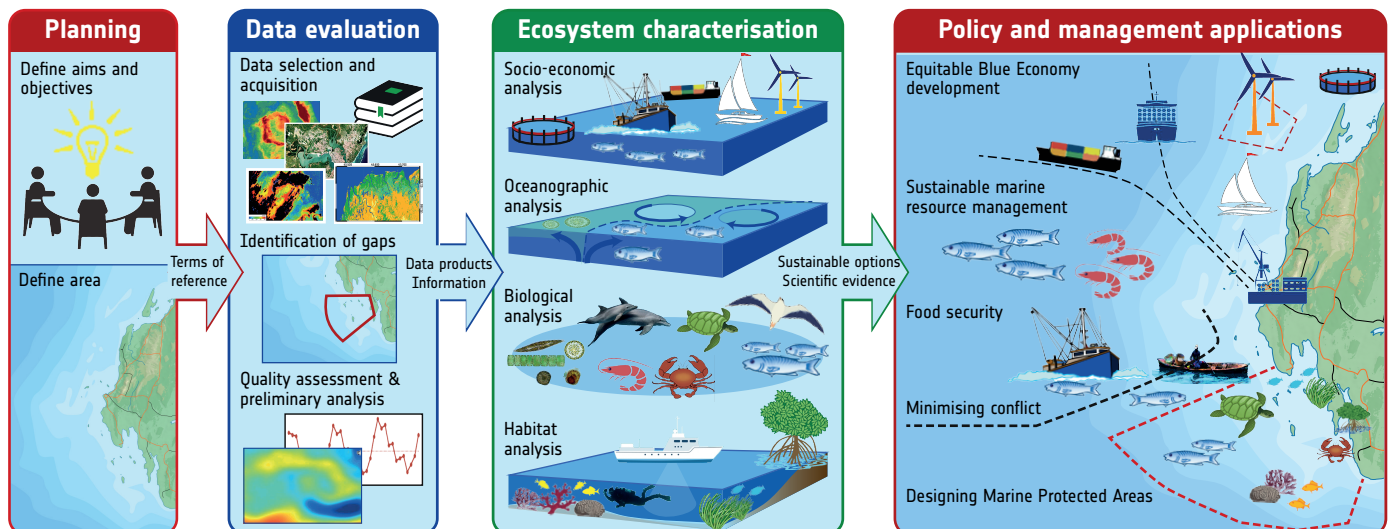
MSP is an adaptive process, which cuts across economic sectors and government agencies to consider interactions between human activities and coastal and marine ecosystems. Earth observation (EO) can provide essential geographic and environmental information to support this process. However, the choice of EO products and the mechanisms for delivery of derived information must be agreed on a case-by-case basis, in collaboration with local planners and the experts contributing to the development of planning options.

The service will prioritise locations where there is existing political buy-in and agreed over-arching objectives for maritime spatial planning at national, sub-national or local level. The E04SD marine consortium will work with identified local planners and/or experts involved the development of planning options to tailor the choice of data and environmental analysis to meet local information needs.



Above: Maritime spatial planning needs to consider how different economic sectors use the marine environment, and how developments within each sector may impact marine ecosystems, the services they provide and the livelihood and wellbeing of marine-dependent groups.

Below: broad overview of the steps involved in evidence-based spatial planning. The E04SD support service will provide support for local planners and marine experts during data evaluation and ecosystem characterisation.



→ COASTAL INFRASTRUCTURE STATUS

Coastal infrastructure mapping is an integral component of Blue Economy growth and development. In addition to information about land-use, shorelines, and bathymetry, satellite data can also provide information about the location and status of existing infrastructure, to facilitate infrastructure planning, monitoring and management in a timely and cost-effective way.

Free data from Sentinel-1 and 2 at 10m resolution form the core of this service, and may be used to give a broad overview of urban areas and large infra-structure features such as major roads, airports, ports, location of off-shore platforms etc.

In order to map features with a finer spatial scale, or obtain more detailed information about the nature and status of infrastructure in specific locations, higher resolution images are needed. These are currently only available from commercial providers of satellite data, or through surveys from aircraft or drones. E04SD marine can provide advice on the acquisition of such data, and support for data analysis and interpretation, but cannot cover the cost of acquiring high resolution data.



Port of Rohuküla (Estonia) seen from Sentinel-2 imagery (top, 10m spatial resolution) and Estonian Land Board ortho-photo (bottom, 20cm resolution).

DESCRIPTION

This service will map current status (presence/absence) of different coastal infrastructure objects (ports, wind farms, oil/gas rigs) and monitor their development over time in order to support spatial planning and Blue Economy related decisions.

USE

- › Providing input for spatial planning and blue economy decision-making in data-poor areas.
- › Detecting illegal or unplanned developments.

INPUT PRODUCTS

- › Sentinel-2 MSI (and possibly Sentinel-1) data.
- › Airborne or high resolution commercial satellite data.

SPATIAL RESOLUTION AND COVERAGE

- › Local to national with 10m resolution (standard product)
- › Higher resolution (0.2-5m) can be provided if the stakeholder has high resolution airborne or satellite imagery or is willing to cover the cost of acquiring such data.

BENEFITS

Improved strategy and decision making:

- › Covering long stretches of coastline (often hard to access) with minimum expense.
- › Allows the monitoring of marine infrastructure without going to the sea.
- › Critical input for many spatial planning and blue economy services

DELIVERY FORMAT

- › GEO-TIFF, NetCDF

FREQUENCY

- › Typically, one-off products with the possibility of change detection if desired by the stakeholder.

DESCRIPTION

Bespoke service working with aquaculture experts in selected regions to develop options for sustainable development of new or existing aquaculture activities.

USE

- › Selection of suitable areas for new aquaculture development, based on species-specific requirements and tolerances.
- › Identification of areas where changes in climate, hydrodynamics, or eutrophication are making an area more or less suitable for designated aquaculture practises.
- › Setting upper limits for the number of farms and their intensity of production that retain environmental and social impacts at acceptable levels for overall sustainability.

INPUT PRODUCTS

- › Archive medium resolution optical data (10 years or more).
- › Archive time series on currents, waves, sea level (optional).
- › Optical data from Sentinel-3 (for updates and trends).
- › Bathymetry data (where available).

SPATIAL RESOLUTION AND COVERAGE

- › 300m or 1km resolution at national or sub-national coverage.

BENEFITS

- › Evidence-based decision support for spatial planning and Blue Economy development.
- › Support for adaptive planning and management of existing and new aquaculture development initiatives.
- › Alternative livelihoods for fishery-dependent communities.

DELIVERY FORMAT

- › Mapped data in GeoTIFF or NetCDF format for use with GIS and ecological models.
- › Web-GIS data portal for display and aggregation of maps.

FREQUENCY

- › One-off baseline and climatology maps.
- › Frequency of updates for monitoring purposes will be determined in collaboration with stakeholders.



QFSE Media, CC BY-SA 3.0

Above: green lipped mussel farm near Havelock, New Zealand.

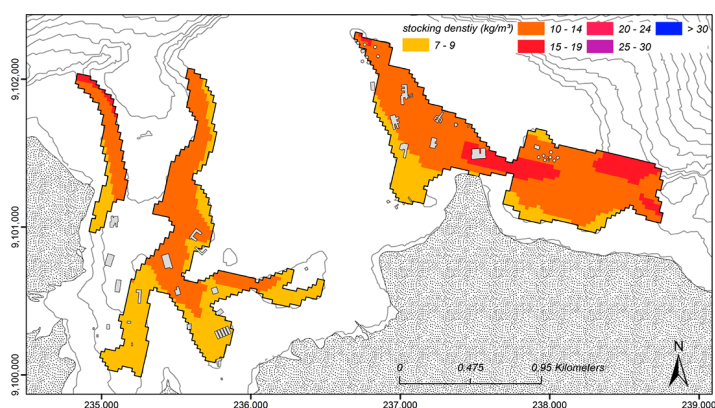
Right: finfish aquaculture cages in the sea of Igoumenitsa, Greece. Photo by Dreamstime: Ollirg.

Fisheries and aquaculture are recognised drivers of Blue Economy development around the world. While many fish stocks are exploited to their limit or beyond, sustainable expansion of the aquaculture sector can contribute to food security as well as to social and economic inclusion for low-income coastal communities.

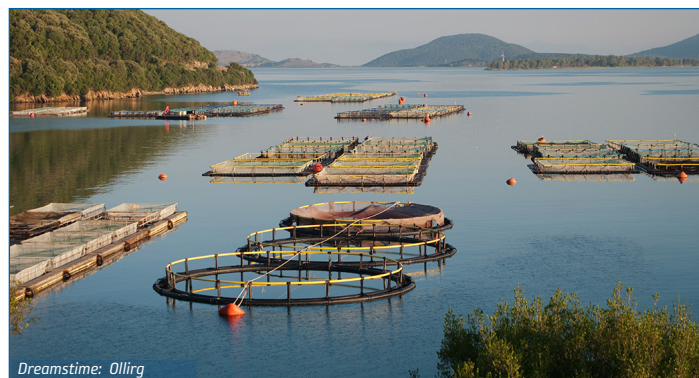
Both long-term and up-to-date observational data are required to make informed decisions for aquaculture development. This services will advise on the choice of satellite products and use of centralized or tailor-made aggregation engines for specified regions of interest, working with local expert user to translate the aggregated maps into suitable aquaculture sites, based on local expectations on the target species, yield, and species-dependent seasonality of harvesting. The service comprises:

- › Baseline characterization: mapping of zones that are dynamic and/or stable within user-designated limits for (seasonal) productivity, biomass peaks indicating blooms, etc. Where required climatologies may also be provided for surface currents, waves, and sea-level.
- › Trend detection: maps of deviations from the multi-year climatology for physical and biogeochemical parameters. This allows identification of areas which are becoming more or less suitable for designated aquaculture practises due to changes in climate, hydrodynamics, or eutrophication.
- › Satellite data support for collaborative modelling of aquaculture ecological carrying capacity for selected regions.

This service is complementary to the 2b water quality service, which provides up-to-daily information that can be used, for example, to identify the need for early harvesting in case of pollution events or harmful algal blooms.



Example of ecological carrying capacity for aquaculture site selection: predicted stocking densities for finfish mariculture in suitable sites for cages (6m net depth) in Pegametan Bay, northwest Bali (Roberto Mayerle, 2019).



Dreamstime: Ollirg

→ SUPPORT FOR BLUE ECONOMY DEVELOPMENT

The world's oceans generate goods and services with an estimated value of over \$49.7 trillion per annum, equivalent to the world's seventh largest economy. The success of a sustainable ocean-based economy, or Blue Economy, and the extent to which it contributes to social development, as well as the health and well-being of dependent populations, is closely related to the state of the marine environment.

EO data can provide unique perspectives and evidence to support decision making processes in efforts to develop and manage the Blue Economy on regional, national and local scales. Resolving potential conflicts of interest between different sectors of the Blue Economy is an important part of the planning process. This requires careful site selection for new developments, evaluation of the economic contribution by both new and existing activities and assessment of their impacts on sensitive ecosystems and the livelihoods and well-being of coastal populations. Examples include tourism, energy and shipping infrastructure, coastal defences, habitat management and ecosystem services.

The maritime regions, and in particular coastal zones are notoriously expensive and challenging to measure and monitor using in-situ techniques. Hence, it is in these regions where EO data has a particularly vital role to play; in many cases there are no viable alternatives to accessing information essential to decision making and economic development of these zones.



Whether planning transport infrastructure or renewable energy installations, EO data can deliver some of the necessary environmental information, for example on shoreline stability, waves, currents, sea level and sensitive habitats.



Mangroves support important fisheries and offer coastal protection, shore stabilisation, water filtration, building materials, and fuelwood. Restoration and management may also provide income through tourism and carbon offset schemes.

DESCRIPTION

Analysis and advisory service that draws together multiple EO datasets to inform and enhance existing or emerging planning processes.

USE

- › Provision of evidence and data to support the assessment of economic development options and plans.
- › Information and analysis targeted at increasing the sustainability and resilience of the blue economy.

INPUT PRODUCTS

- › Mapped data products from other EO4SD-marine services.
- › Additional satellite data from global archives as required.

SPATIAL RESOLUTION AND COVERAGE

- › 10m to 1km, depending on data type.
- › Coverage may be national, sub-national or local.

BENEFITS

- › More informed and robust decision making through access to consistent, validated information.
- › Access to new cost effective data sources to enable improvements in option assessment processes.

DELIVERY FORMAT

- › Mapped data in GEOTIFF /NetCDF formats suitable for GIS systems.
- › Analysis support, reports and summary information.

FREQUENCY

- › As agreed in consultation with stakeholders.



Artisanal sea weed farming (top) can provide alternative livelihoods and a source of export income, but may conflict with ecotourism and development of beach resorts that want to offer pristine beaches and clear water.

→ SUPPORT FOR ENVIRONMENTAL IMPACT ASSESSMENT

DESCRIPTION

A service designed to support impact assessments associated with blue economy development, providing information on the state of natural environments and associated ecosystem services, as well as natural resources of importance to other economic sectors.

USE

- › Baseline environmental assessment to provide decision support for blue economy or coastal development planning.
- › On-going assessment to identify and mitigate problems emerging during project implementation, focussing on areas that have been identified as environmentally sensitive, or where activities in one blue economy sector may have potentially significant impact on other economic sectors.
- › Post-development monitoring and impact assessment of MPAs and other environmentally sensitive areas.
- › On-going monitoring and summary assessments of uncontrolled economic activity, urbanisation and tourism.
- › Baseline assessment and on-going monitoring to identify impacts of land-use changes along the coast or in the watershed of major rivers.
- › Post-event impact assessment of natural hazards such as storm surges, high waves and extreme temperatures.

INPUT PRODUCTS

- › Mapped data and information from other E04SD services.
- › Data from global archives (if required).
- › Relevant environmental, geographic and socio-economic data and information from local sources where available.

SPATIAL RESOLUTION AND COVERAGE

- › Variable, depending on assessment objectives and context.

BENEFITS

- › Improved capacity to ensure that Blue Economy or Coastal Zone Development projects address requirements of environmental and social policy criteria for international financing of investment project.
- › Evidence-based assessment of risks associated with different development options.

DELIVERY FORMAT

- › Mapped value added products in GEOTIFF or NetCDF format.
- › Reports and report summaries.
- › Tools and recommendations for follow-on assessments.

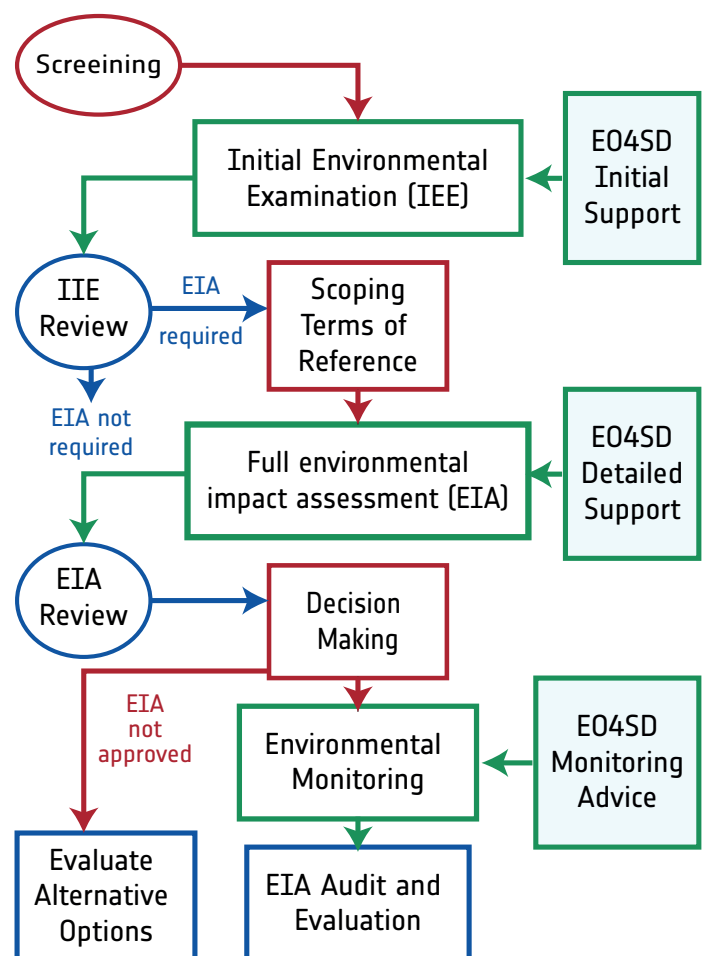
FREQUENCY

- › Typically, one off assessments with potential for follow-up to support adaptive implementation or assess efficacy of mitigation measures.

Satellite-derived data from E04SD and other sources may be combined within a wider evaluation framework to assess environmental impacts of efforts to promote economic growth, food security or well-being of coastal communities. By analysing data products delivered in other E04SD services and, where necessary, supplementing this with selected data from global archives, this service will provide information about the distribution, extent and health of coastal and marine habitats and work with local experts to deliver information about the status of associated ecosystem services.

The service may also advise on the use of E04SD data products with other data, e.g. from global archives or climate model output, in order to identify potential impacts on ecosystems and their services due to interannual climate variability and change, where this is required as input into maritime spatial planning, coastal development planning or the development of climate change adaptation options.

To be effective this service will require collaboration with local stakeholders and marine/coastal experts, and priorities will be given to areas where blue economy projects are in a planning or implementation phase, or where there is a desire to improved regulation of existing activities.



Schematic overview of the main steps in Environmental Impact Assessment (EIA). The E04SD service will offer support for the selection and analysis of data use for initial environmental screening (IEE) and more detailed support for the use of E0 data in the full EIA, as well as on setting up a monitoring regime to evaluate the actual impact once a project has been approved.

Partners of the Marine Resources Cluster



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