



## COPERNICUS/SATELLITE APPLICATIONS INFOKIT

### BACKGROUND

Copernicus is the most ambitious Earth observation programme to date. It will provide accurate, timely and easily accessible information to improve the management of the environment, understand and mitigate the effects of climate change and ensure civil security (source: ESA). The main rationale for Copernicus is to fill some gaps in European EO capabilities, and to ensure European institutions and industry have access to useful and key EO data, in a free and open manner. It results from a joint initiative between the European Union (EU), its Member States, and the European Space Agency (ESA).

Take a look at the Copernicus official video by ESA:

<https://www.youtube.com/watch?v=MGJss4lDaBo>

Or read more: [https://www.esa.int/Our\\_Activities/Observing\\_the\\_Earth/Copernicus/Overview3](https://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Overview3)

Copernicus has six thematic services supporting the development of many applications:

- land management
- the marine environment
- atmosphere
- emergency response
- security
- climate change

Most of Sentinel data is allowed to download and access through a web mapping service (WMS). For processing and analysis intention one should process the data further in their computer and visualize the data with software on their own computer.

Where can I access Sentinel data?

The data from Finhub can be downloaded after registration at [http://nsdc.fmi.fi/services/service\\_finhub\\_overview](http://nsdc.fmi.fi/services/service_finhub_overview)

Other way to access (Katriina Veijola from FMI):

Using Copernicus Open Access Hub portal (previously SciHub)

- The Copernicus Open Access Hub (<https://scihub.copernicus.eu/>) portal is similar to FinHub portal for accessing the Sentinel Data. Therefore the steps are quite similar.
- Using Google Earth Engine
- Google Earth Engine (<https://earthengine.google.com/>) is free for research, education and nonprofit use. You have to sign in with your google account. In code editor platform you can use JavaScript/python to get data and make analysis. In code editor help there is information about the manual and user forum.
- Using Amazon S3
- For accessing Sentinel data, Amazon can be used. The Amazon S3 archive is one option to download Sentinel data. Sentinel on AWS (<http://sentinel-pds.s3-website.eu-central-1.amazonaws.com/>) is a platform to use Sentinel 1 and Sentinel 2 data through Amazon3. The search is fast and images can be previewed. The format of data is Cloud optimized geotiff (COG) for Sentinel 1 and .jp2 for Sentinel 2. In Cloud optimized geotiff format, the whole file is not needed to be downloaded.

Key links in world:

- The Copernicus Open Access Hub provides complete, free and open access to Copernicus Satellite – EsaHub <https://scihub.copernicus.eu/dhus/#/home>
- Esa Thematic Exploitation Platform aims to create an ecosystem of interconnected Thematic Exploitation Platforms (TEPs) on European footing about coastal, forestry, hydrology, geohazards, polar, urban themes and food security (under definition). It provides access to Earth Observation Data, tools and information and communication technology resources. <https://tep.eo.esa.int/e.gUrbanTEP:https://urban-tep.eu/#/>  
Target audience: all users interested in EO data in particular scientist and researchers
- Spectator provides free online tracking of Copernicus-Sentinel Satellite (2A and 2B) and others (USGS/NASA) and free imagery downloading <https://spectator.earth/>  
Target audience: all users interested in EO data
- PEPS French Platform provides free and open access to Copernicus Sentinel Data (S1A, S1B, S2A e S2B, S3A e S3B, except level 0) <https://peps.cnes.fr/rocket/#/home>  
Target audience: scientific community and public policy decision making to monitor and manage environmental resources
- Theia Platform aims to facilitate the use of satellite images and to provide services and spatial data with added value for continental surface [www.theia-land.fr](http://www.theia-land.fr)
- Target audience: scientific community and public policies aiming to monitor and manage environmental resources
- Hellenic National Sentinel Data Mirror Site (HNSDMS) offers searching, cataloguing, sorting and dissemination capabilities of Sentinel products over the region of South & Southeastern Europe, Middle East and North Africa <https://sentinels.space.noa.gr/>

- Target audience: scientific community, researchers, public policy decision making, space industry
- Catapult provides Satellite Applications helping organization to enhance satellite based services and market <https://sa.catapult.org.uk/>  
Target audience: scientific and academic community, public policy decision making, space industry, commercial service providers

#### Other national platforms

- USGS Earth Explorer
- REMOTE PIXEL
- EUMETSAT CODA
- In addition, there is a python tool called Sentinelsat and a python script called Sentinel\_download.py.

## SATELLITES

Copernicus is built on Sentinels satellite family owned by EU.

- Sentinel-1, 2, 3, 5p and 6 with different sensors (e.g. radar, optical, altimetry)
- Sentinel-4 and 5 as instruments on-board EUMETSAT' weather satellites
- Sentinel-6 expected in the coming year

#### Overview of Sentinel data

- Sentinel 1 has a C-band radar instrument on board. There are two Sentinel 1 satellites: Sentinel 1A and Sentinel 1B.
- Sentinel 2 has a high resolution optical instrument on board. There are two Sentinel 2 satellites: Sentinel 2A and Sentinel 2B.
- Sentinel 3 has seven instruments on board: OLCI (Ocean and Land Colour Instrument), SLSTR (Sea and Land Surface Temperature Radiometer), SLAR (SAR Radar Altimeter), MWR (MicroWaveRadiometer), GNSS (Global Navigation Satellites Systems), DORIS (Doppler Orbit determination and Radio-positioning Integrated on Satellite) and LRR (Laser Retro-Reflector).
- Satellite data can be in different acquisition modes (for Sentinel 1: SM, IW, EW or WV), polarisations (for Sentinel 1: HH, VV, HH+HV or VV+VH) and product types (for Sentinel 1: SLC, GRD or OCN). There can be different levels of satellite data: For Sentinel 1 Level0 (raw data), Level1 (raw data with correction, in SLC or GRD modes) and Level2 (derived geophysical variables, in OCN mode). More information about Sentinel satellites can be found from <http://www.copernicus.eu/main/sentinels>.

## SENTINEL THEMES / APPLIED USE

### COASTAL AND MARINE EXPLOITATION USING SATELLITE DATA

Main raw data used in marine environment exploitation comes mostly from Sentinel-3 complemented by Sentinel-1. Ready products are chlorophyll-A, sea surface temperature, wave and CMEMS sea level data sets.

Some Copernicus applications for marine environment:

- mapping of fishing zones
- forecasting algal blooms
- monitoring and prevention of coastal erosion
- water depth, winds, waves and current monitoring for renewable energies and ship routing

SATELLITES and programs providing remote sensed products in world:

- NASA satellites (NOAA)
- Landsat
- Sentinel data
  - Sentinel -1 for shipping & sea ice navigation , and fishing & aquaculture
  - Sentiner-2 for water quality & marine ecosystems
  - Sentinel-3 for most application domains
- ENVISAT
- Private satellite operators (Cosmos, Radarsat, etc.)
- Copernicus products (CMEMS\*)
- Meteorological and hydrology data

\*CMEMS – Copernicus Marine Environment Monitoring Service, managed by Mercator Océan International, aim to provide regular and systematic information about the physical state and dynamics of the ocean and marine ecosystems. Coverage range are global oceans and European regional seas. Used for ship routing services, offshore operations and aquaculture.

### SOME CASE EXAMPLES/ REMOTE SENSING PRODUCTS

Earth Observation provide critical information for water resource managers around world. Some case examples how satellite images can be applied in different applications:

#### Water quality & marine ecosystems

- Detecting oil spills for marine life and environmental preservation
- Watching algae grow as an indicator of environmental health: It is an indicator of the amount of nitrogen and phosphorous is being fed into the water. Reducing nutrients is important because it affects local economies like fisheries and tourism. Using hyperspectral sensors to learn biochemical properties of algae blooms and even predict their locations

- Snorkeling in an oasis of marine vegetation with the coastal channel: Snorkel in an oasis of marine vegetation using Worldview's coastal channel. Because of its finer level of spectral penetration in coastal areas, underwater reefs and bathymetric mapping makes for some unique remote sensing applications. Source: <https://gisgeography.com/100-earth-remote-sensing-applications-uses/>

For water quality purposes, the key element is to have good spectral characteristics. Satellite derived water quality information is essential to assess the ecological state of inland and coastal waters and to identify changes or trends in water quality over time. This service will cover three of the most important water quality indicators that can be readily monitored from space: Chlorophyll concentrations, Total Suspended Matter (TSM), and water temperature. Read more from Water Resource Management from EO4SD - ESA initiative to support the uptake of EO-derived information in sustainable development.

UNESCO WaterQualityApp is a free online visualiser for global water quality products of all inland and coastal waters worldwide. It allows you to interactively browse water quality products and select various water quality parameters, set desired virtual sampling station, gather values and time series information. In addition following indicators can be observed: Chlorophyll-a, turbidity (scattering of particles), total absorption (organic and anorganic water components), Harmful Algae Bloom product (HAB)

Finnish Environment Institute (SYKE) produce satellite image based products in order to monitor environmental changes. These products are: sea surface temperature, algal blooms, water turbidity and chlorophyll-a concentration in the Baltic Sea, snow covered area in Finland and the Baltic Sea area, and snow water equivalent in Finland. Daily and weekly images and time series are published on the [SYKE's Remote Sensing Products website](#).

Check out daily and weekly images and time series published on the [SYKE's Remote Sensing Products website](#). Water quality and true color (RGB) products are also available in [TARKKA web map service](#).

#### Fishing & aquaculture applications

- Support to fish farmer decision making. Predictive statistical models that allow predicting future temperature for specific areas. Sea temperature plays an important role on fish production due to the sea temperature effects on fish mortality rate, average maturation time of the fish, and average harvested weight of the fish.

What will happen to a given salmon population development if the sea temperature increases by 2° C?

Catching fish and improving long-term fisheries sustainability: Satellites monitor sea surface temperature and ocean colors because they are indicative of specific fish species. The top-down view of remotely sensed data can be communicated with local fisherman. Fishermen use this information to save time and fuel in real-time. In terms of remote sensing applications in fisheries and marine environment, algal blooms can be mapped which are harmful to aquaculture. This improves overall long-term sustainability.

## Urban planning

- Assessing fuel economy of vehicle emissions: Governments have been putting pressure on vehicles to meet emission standards. Satellites can monitor fuel economy and emission standards with minimal interference from the sky. Multispectral remote sensing can measure vehicle emissions such as CO, HC and NO. Ideas have been toyed around with to impose surcharges based on distance driven and improperly maintained equipment. Satellites offer a golden opportunity to control pollution from motor vehicles.
- Observing population growth in urban areas using land use change: Urban planners want to know population growth and distribution to optimize development and improve the well-being of citizens. Land use change can be modeled to provide an accurate measure for population growth. Not only is it accurate, but land cover provided more detail for population growth distribution within cities and census tracts.
- Reducing traffic jams using change detection: Our increasing populations and urbanization has led to increasing amounts of traffic in urban centers. Traffic jams mean wasted fuel and time. Ground measuring systems provide extremely precise traffic volumes but it's limited to selected roadways. Traffic density is being monitored using change detection. Traffic analysts can compare two satellite images with slight lags. This shows traffic movement over a larger picture.

## Coastal management

- Measuring the rise of sea levels: Measuring the rise of sea levels is a perfect example of a large-scale application done in a cost-effective manner. There is no need to go on the beach and bring out your measuring stick at sea level all along the coast. In order to understand sea level rise, you need good baseline spatial data. Measuring sea level rise is a function of time with centimeter accuracy measurements using remote sensing data.

Source:

- <https://gisgeography.com/100-earth-remote-sensing-applications-uses/>
- Copernicus Market Report publication, Issue 2, February 2019  
[https://www.copernicus.eu/sites/default/files/2019-02/PwC\\_Copernicus\\_Market\\_Report\\_2019\\_PDF\\_version.pdf](https://www.copernicus.eu/sites/default/files/2019-02/PwC_Copernicus_Market_Report_2019_PDF_version.pdf)
- <http://marine.copernicus.eu/markets/use-case-books/>

## **USEFUL LINKS**

EU Marine related information is found from here:

<http://marine.copernicus.eu/markets/>

Copernicus at your fingertips: 20 apps that you can use today!

<https://www.copernicus.eu/en/copernicus-your-fingertips-20-apps-you-can-use-today>

Sodankylä National satellite Data Centre

<http://nsdc.fmi.fi/>