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PONTOS VIRTUAL TRAINING MODULES

December 2022

PONTOS-EU.AUA.AM

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Module 5

**The Application of Earth Observation: Chlorophyll-A
Concentration & Eutrophication Dynamics
with the Example of Assessments via PONTOS platform**



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Responsible Partner - American University of Armenia

Supporting Partner - Environmental Protection and Mining Inspection Body of the Republic of Armenia

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This module is developed in the frames of the BSB 889 PONTOS Project

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LEARNING OBJECTIVES OF MODULE 1

Learn about the causes and impacts of eutrophication in water ecosystems

Familiarize yourself with the history of remote sensing and chlorophyll-a (challenges and solutions)

Identify the satellites used for water quality monitoring

Download freely available satellite images

Learn how to calculate chl-*a* concentrations from satellite images using ESA's SNAP toolkit

Use the PONTOS Data Cube to calculate Total Suspended Matter (TSM) concentrations

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MODULE STRUCTURE

01 Eutrophication in water ecosystems (causes and impacts)

02 Using remote sensing to monitor eutrophication dynamics

03 Calculating chl-*a* using the SNAP toolkit and C2RCC processor

04 Using the PONTOS Data Cube to calculate Total Suspended Matter

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01

Eutrophication in water ecosystems (causes and impacts)

This section will introduce you to the classification of water ecosystems and their trophic states, issues related to water quality monitoring, eutrophication and its drivers, as well as, the importance of ensuring the good status of water bodies.

Image source: ConserveEnergyFuture



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Eutrophication in water ecosystems

Aquatic ecosystems are classified into 3 main trophic states
(i.e. nutrient content):

1. Oligotrophic systems:

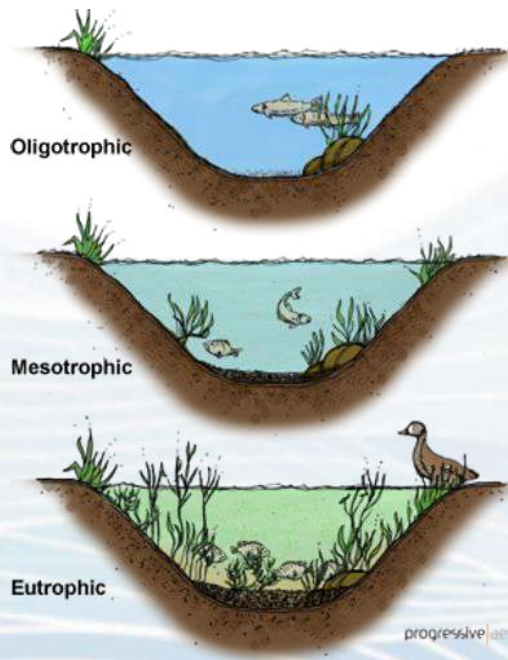
Characterized by very low nutrient content (likely nitrogen (N) and/or phosphorus (P) being a limiting factor, thus very low productivity. Very high water transparency.

2. Mesotrophic systems:

Higher nutrient content leads to higher primary productivity (more plants and algae), likely higher secondary productivity, lower water transparency due to higher dissolved organic matter and algal growth.

3. Eutrophic systems:

Very high nutrient content, excessive algal blooms, turbid waters.



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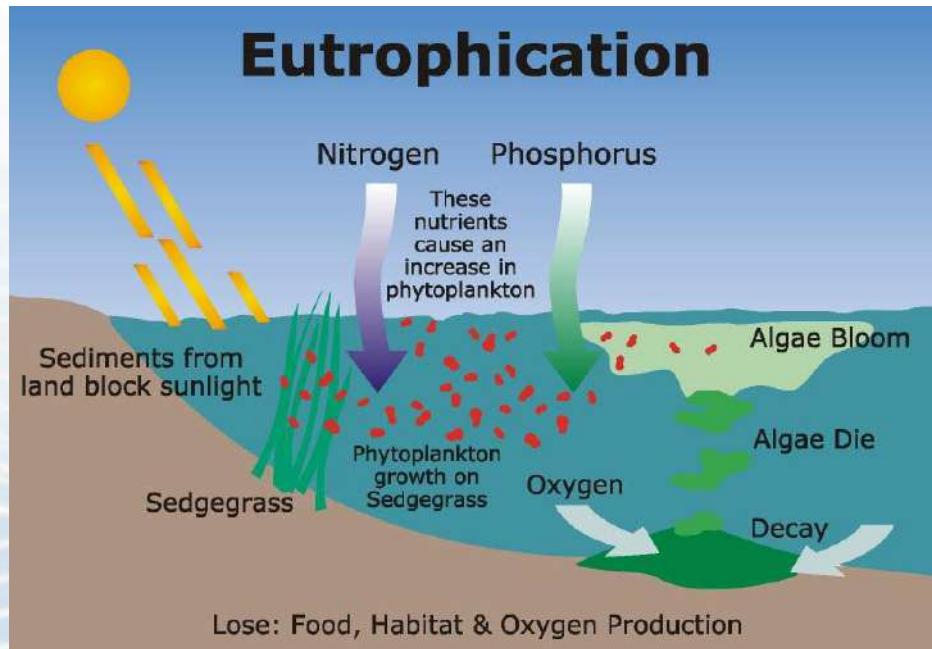
Eutrophication in water ecosystems

Image source: tnluser

Eutrophication is the process of excessive algal growth due to increased nutrient (particularly N & P loading).

Eutrophication can lead to:

- Increased BOD (Biological O₂ Demand)
- Potential anoxia
- Reduced biodiversity
- Toxic cyanobacterial blooms
- Increased undesirable emissions (CH₄, H₂S)
- Release of bad odours
- Loss of ecosystem services



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Eutrophication in water ecosystems

Causes of eutrophication may include:

- **Agriculture & husbandry**
- **Urbanization**
 - **Habitat destruction/land change**
 - **Untreated sewage**
 - **Land erosion**
- **Floods**

=> Indicator / outcome of anthropogenic impacts and water quality deterioration.

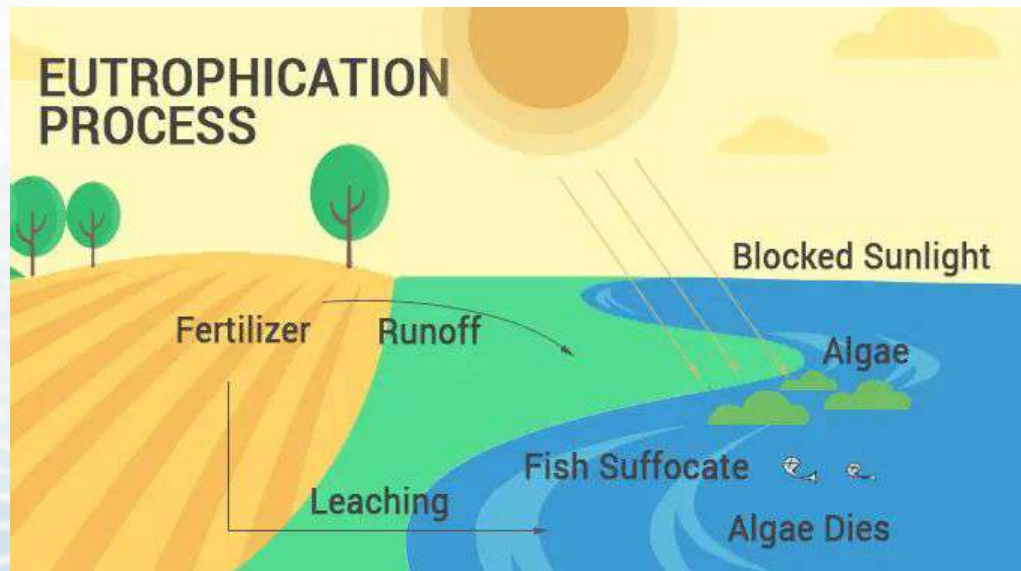


Image source: earthhow

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Eutrophication in water ecosystems

To assess eutrophication and algal biomass in water ecosystems, researchers often use the concentrations of chlorophyll-*a* (chl-*a*) as a proxy measurement. Chl-*a* is:

- A pigment found in plants & algae. It is vital for photosynthesis and is what gives plants their green color.
- Positively correlated with algal biomass.
- Often used as an indicator to monitor water quality. For instance, reporting of chl-*a* concentrations is required as part of the EU Water Framework Directive (WFD).

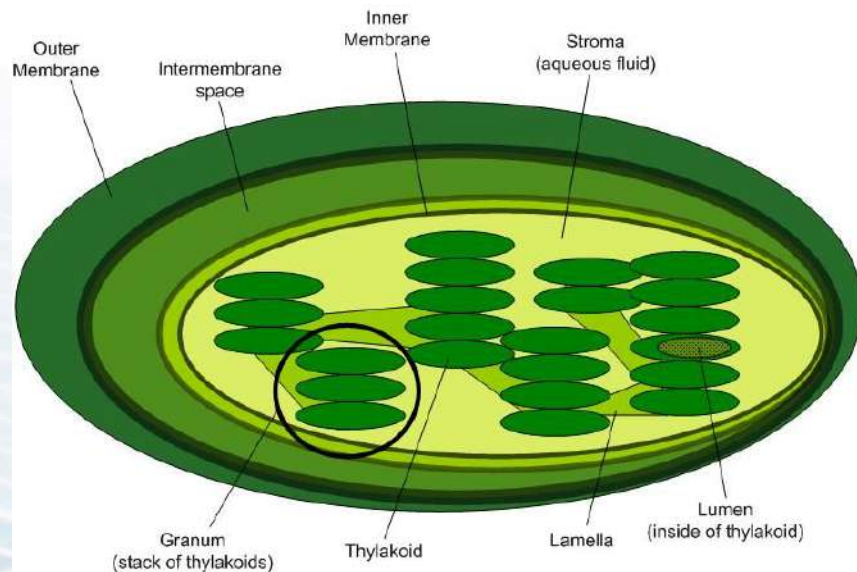


Image source: Wikimedia Commons

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02

Using remote sensing to monitor
eutrophication dynamics

To compliment the *in-situ* measurements of chl-*a*
and algal biomass / productivity

To measure other water quality parameters:
Turbidity, Total suspended matter (TSM), Dissolved
Organic Matter (DOM), etc.

But there are challenges:

- Isolating the chl-*a* signal from other optically active compounds
- The diel (vertical) movements of plankton in the water column
- Atmospheric correction



Image source: NASA/Science Photo Library

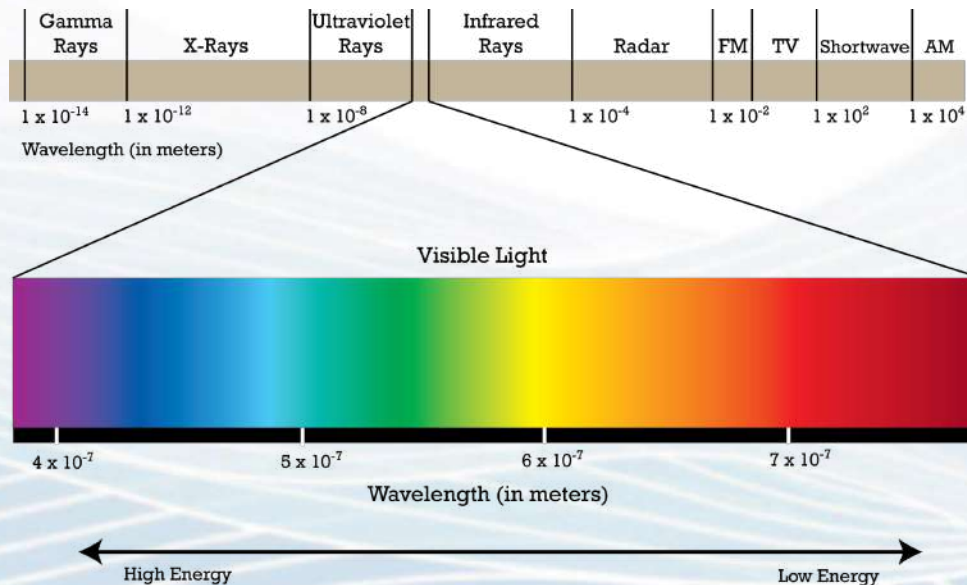
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Using remote sensing to monitor eutrophication dynamics

To assess eutrophication dynamics via remote sensing, it is convenient to measure chl-*a* concentrations due to its optical properties.

Chl-*a* has higher reflectance in lower wavelengths (blue + green regions) at lower concentrations.

=> It works very well in marine ecosystems but has historically posed challenges in inland waters with higher [chl-*a*]+ humic substances



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Using remote sensing to monitor eutrophication dynamics

Historical overview:

Earliest chl-*a* estimation via remote sensing started in the late 1970s in marine waters [Nimbus 7, Coastal Zone Color Scanner (CZCS), based on 2 bands]

SeaWiFS, MODIS, MERIS, Landsat 7,8,9, Sentinel 2, 3 (OLCI) have all since been launched that can estimate chl-*a*.

Satellites with multispectral images \Rightarrow possibility of more complex algorithms to estimate chl-*a* in inland waters

Making use of neural networks to better isolate and identify specific optical characteristics



Image source: ESA

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Satellites used in water quality remote sensing



Landsat 4-5



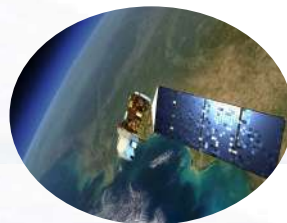
2009-2011



Landsat 7 ETM+



2012



Landsat 8



2013-2015



Sentinel 2

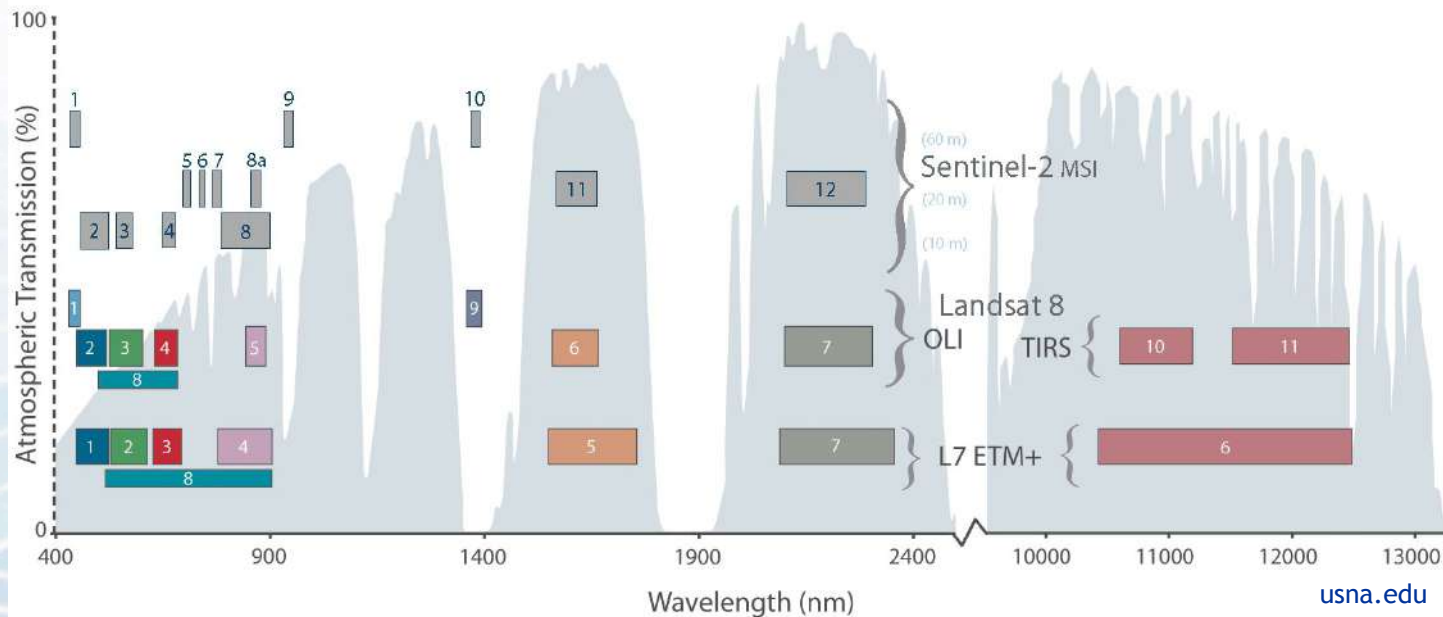


2015-2019

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Wavelengths & bands of satellites used in water quality remote sensing

Comparison of Landsat 7 and 8 bands with Sentinel-2



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Wavelengths & bands of satellites used in water quality remote sensing

Sentinel-2 properties:

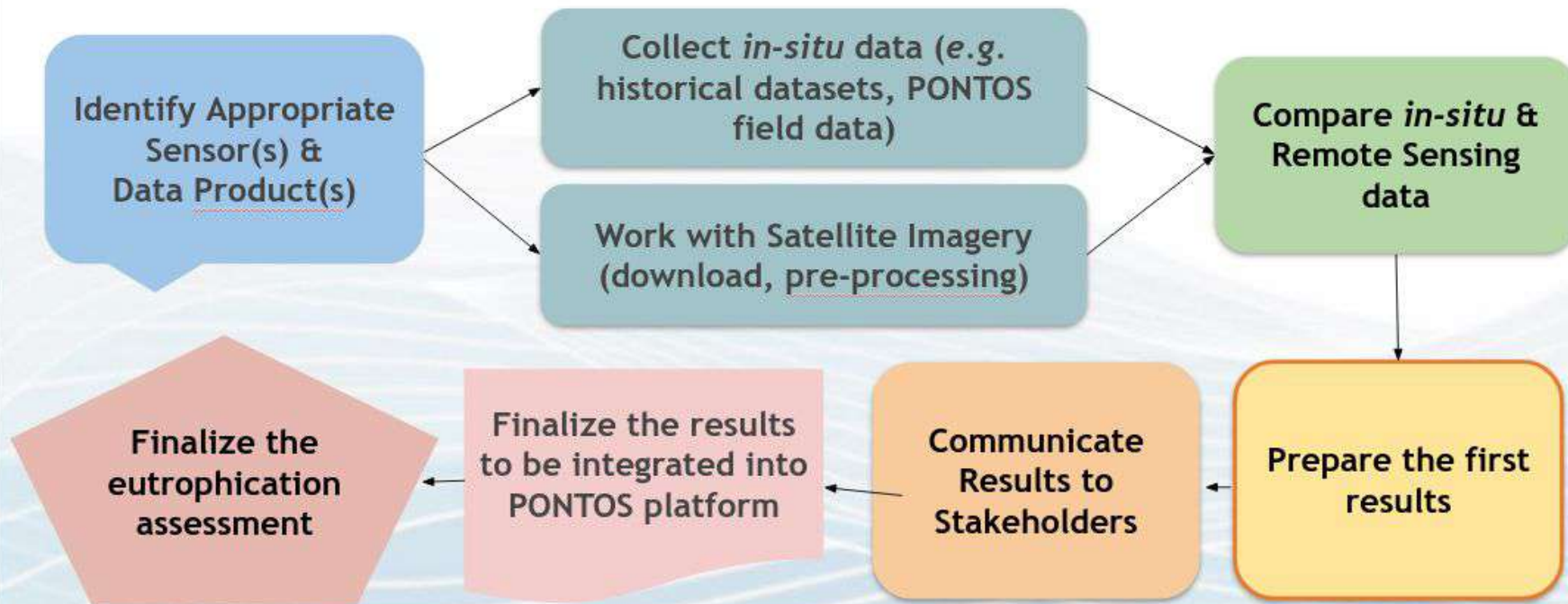
- Time period: 2015 - 2021
- Sentinel 2A and 2B: polar orbit, phased at 180° to each other
- Equipped with multispectral instrument (MSI) with 13 spectral bands
- Wide swath width (290 km)
- Revisit: 5 days at equator (2 satellites)
- Level 1C and 2A (atmospherically corrected)

	Waveband	Central λ (nm)	Bandwidth (nm)	Spatial resolution (m)
1	Coastal aerosol	442.7	21	60
2	Blue	492.4	66	10
3	Green	559.8	36	10
4	Red	664.6	31	10
5	Vegetation red edge	704.1	15	20
6	Vegetation red edge	740.5	15	20
7	Vegetation red edge	782.8	20	20
8	Near infrared	832.8	106	10
8A	Narrow near infrared	864.7	21	20
9	Water vapour	945.1	20	60
10	Shortwave infrared – Cirrus	1373.5	31	60
11	Shortwave infrared	1613.7	91	20
12	Shortwave infrared	2202.4	175	20

Sentinel 2 bands and their characteristics (sentinel.esa.int)

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Using remote sensing to monitor eutrophication dynamics



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03

Calculating chl-*a* using the SNAP toolkit and C2RCC processor

Estimating chl-*a* concentrations using the C2RCC processor:

- It started as ‘The CoastColour’ Project
- It was amended by additional neural networks and eventually renamed as Case 2 Regional CoastColour (C2RCC)
- It is applicable to all past and current ocean colour sensors as well as Sentinel-2
- It is available as a package in ESA’s SNAP Toolbox

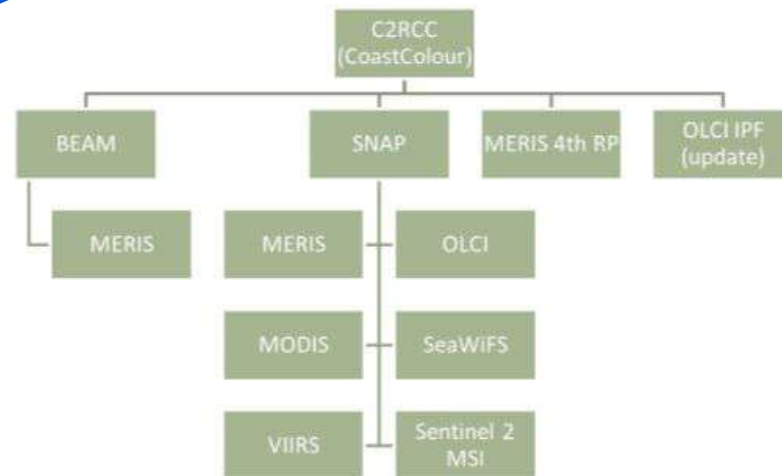


Figure 4: C2RCC processor family tree

Image source: Brockmann *et al.*, 2016

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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

Estimating chl-*a* concentrations using the C2RCC processor

The model uses 5 components for scattering and absorption:

1. pigment absorption (apig)
2. detritus (adet)
3. gelbstoff (agelb)
4. white scatterer (bwhit) - calcareous material
5. typical sediment scatterer (btsm)

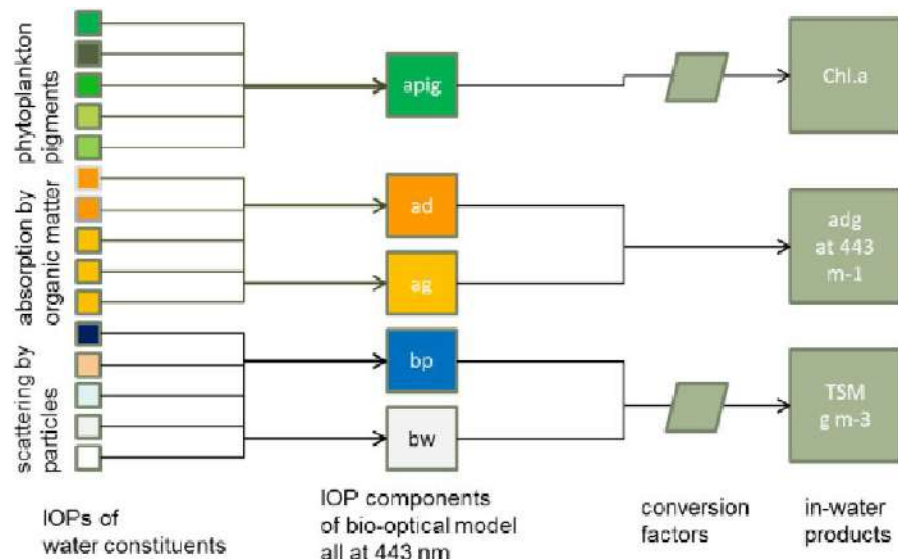


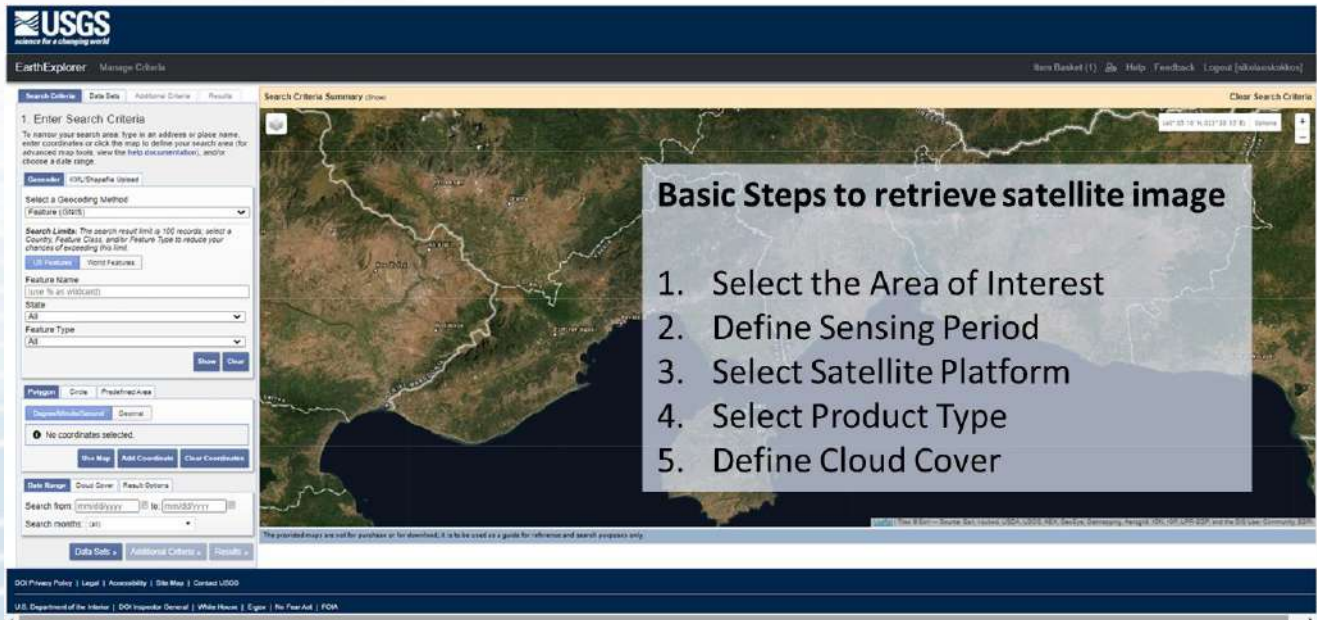
Image source: Brockmann *et al.*, 2016

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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

Downloading freely
available satellite images:

1. For Landsat images,
use the USGS Earth
Explorer website
[earthexplorer.usgs.gov]



USGS
science for a changing world

EarthExplorer Manage Criteria

Item Basket (1) Help Feedback Logout [ukolanssk@kkr]

Search Criteria Summary show Clear Search Criteria

1. Enter Search Criteria

To narrow your search area, type in an address or place name, enter coordinates or click the map to define your search area (for advanced map tools, view the help documentation), and/or choose a date range.

Geocode: KRS/Thapae United

Select a Geocoding Method
(Feature (GPO))

Search Limits: The search result limit is 100 records; select a Country, Feature Class, and/or Feature Type to reduce your chances of exceeding this limit.

Feature Name: (Type in an address)

State: All

Feature Type: All

Program: Drive / Predefined Area

Display/Hide/Reset: Done

☒ No coordinates selected.

Map: Show Map Add Coordinates Clear Coordinates

Date Range: Default Range / Patch Range

Search from: mm/dd/yyyy to mm/dd/yyyy

Search months: (all)

Data Sets: Additional Criteria Results

Basic Steps to retrieve satellite image

1. Select the Area of Interest
2. Define Sensing Period
3. Select Satellite Platform
4. Select Product Type
5. Define Cloud Cover

The provided images are not for purchase or for download, it is to be used as a guide for reference and search purposes only.

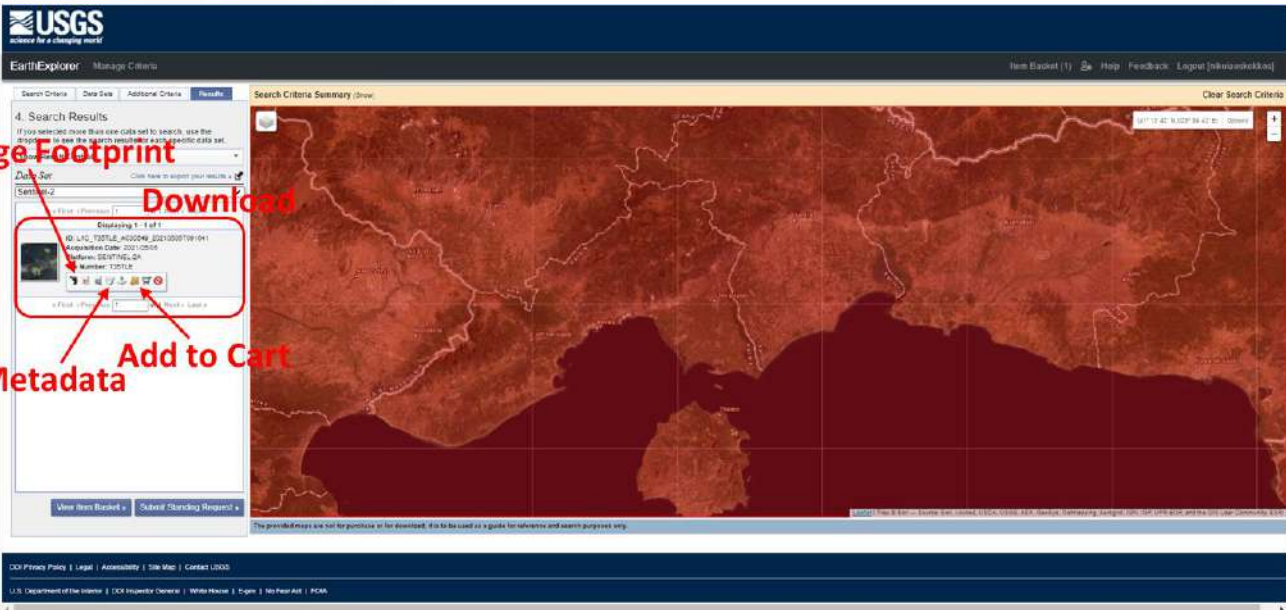
DOI Privacy Policy | Legal | Accessibility | Site Map | Contact USGS
U.S. Department of the Interior | DOI Inspector General | White House | ECHO | The Four A's | FOIA

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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

Downloading freely
available satellite images:

You can then add the
selected product to cart,
view its metadata, or
download it directly.



The screenshot shows the USGS EarthExplorer interface. On the left, under '4. Search Results', a search result is displayed with a thumbnail image. Red arrows point to the following elements:

- Image Footprint**: Points to the thumbnail image of the satellite data.
- Download**: Points to the 'Download' button.
- Metadata**: Points to the 'View Metadata' button.
- Add to Cart**: Points to the 'Add to Cart' button.

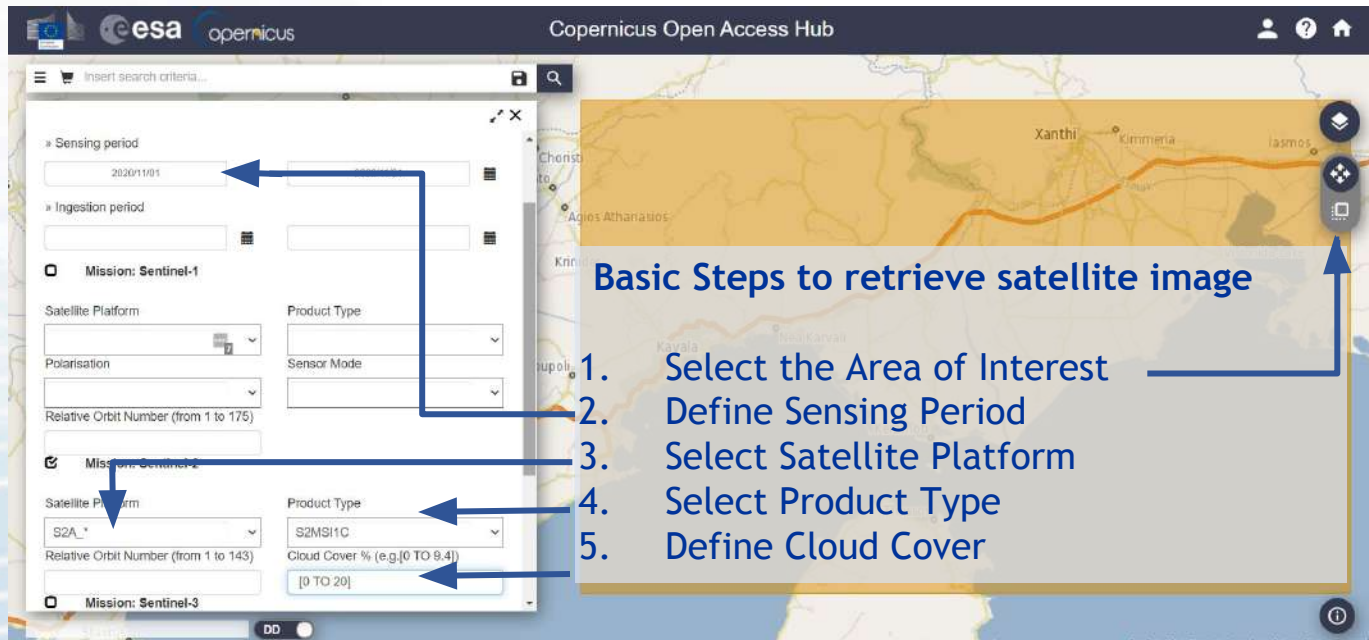
The main map area shows a satellite image of a coastal region. The USGS logo and 'EarthExplorer' text are visible at the top left. The bottom of the page contains links for 'USGS Privacy Policy', 'Legal', 'Accessibility', 'Site Map', 'Contact USGS', and 'U.S. Department of the Interior'.

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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

Downloading freely
available satellite images:

2. For Sentinel images,
use the Copernicus Open
Access Hub
[scihub.copernicus.eu/dhus/]



Copernicus Open Access Hub

Basic Steps to retrieve satellite image

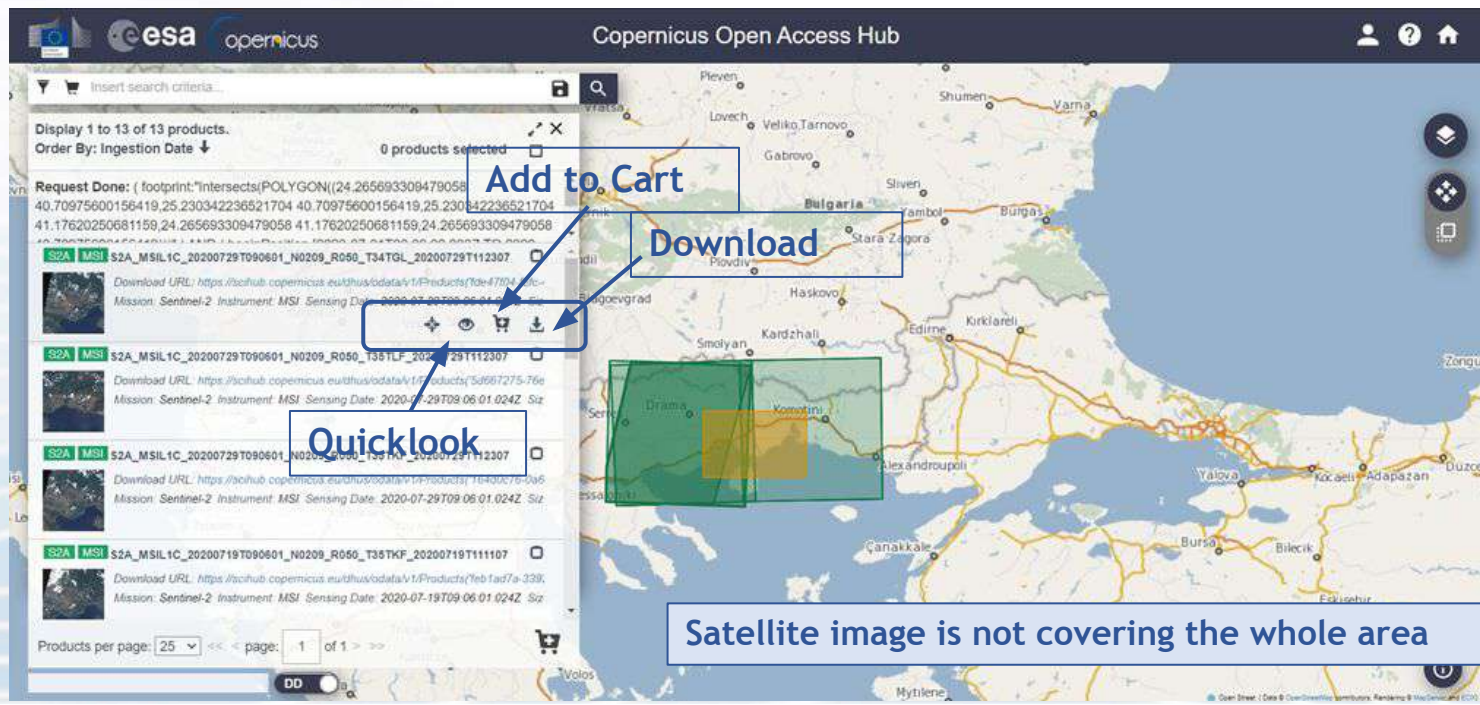
1. Select the Area of Interest
2. Define Sensing Period
3. Select Satellite Platform
4. Select Product Type
5. Define Cloud Cover

The screenshot shows the Copernicus Open Access Hub search interface. The interface includes a search bar at the top, a map on the right, and a search criteria panel on the left. The search criteria panel is divided into sections for Sensing period, Ingestion period, Mission (Sentinel-1, Sentinel-2, Sentinel-3), Satellite Platform, Product Type, and Cloud Cover. Blue arrows point from the numbered steps to the corresponding fields in the search criteria panel: Step 1 points to the map, Step 2 points to the Sensing period field, Step 3 points to the Mission field, Step 4 points to the Product Type field, and Step 5 points to the Cloud Cover field.

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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

Choose image(s)
and add to cart or
download directly.



The screenshot displays the Copernicus Open Access Hub interface. On the left, a list of products is shown, including Sentinel-2 MSI images. Annotations point to specific actions: 'Add to Cart' points to the cart icon, 'Download' points to the download icon, and 'Quicklook' points to the quicklook icon. A map of Bulgaria is shown on the right, with a green rectangular area indicating the satellite image's footprint. A blue box with the text 'Satellite image is not covering the whole area' is overlaid on the map. An arrow points from the text 'Calculating chl-*a* using the SNAP toolkit and C2RCC processor' to the Black Sea Cross Border Cooperation logo.

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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

Sentinelsat:

makes searching,
downloading and
retrieving the metadata of
Sentinel satellite images
from the Copernicus Open
Access Hub easy.

[sentinelsat.readthedocs.io/en/stable/]

```
from sentinelsat import SentinelAPI, read_geojson, geojson_to_wkt
from datetime import date
api = SentinelAPI('user', 'password', 'https://scihub.copernicus.eu/dhus')

# search by polygon (WKT format), time, and SciHub query keywords
footprint = geojson_to_wkt(read_geojson('/path/to/map.geojson'))

products = api.query(footprint,
                     date = ('20151219', date(2015, 12, 29)),
                     order_by = 'ingestiondate',
                     orbitdirection: 'DESCENDING',
                     platformname = 'Sentinel-2',
                     producttype = 'S2MSI1C',
                     cloudcoverpercentage = (0, 20))

# download all results from the search
api.download_all(products)
# GeoJSON FeatureCollection containing footprints and metadata of the scenes
api.to_geojson(products)
```

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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

Sentinel nomenclature:

Identifies a **Level-1C** product acquired by **Sentinel-2A** on the **29th of July, 2020** at **9:06:01 AM**. It was acquired over Tile **35TKF** during **Relative Orbit 050**, and processed with **PDGS Processing Baseline 02.09**.

S2A_MSIL1C_20200729T090601_N0209_R050_T35TKF_20200729T112307			
mission ID	sensing start time	Relative Orbit number	Product Discriminator
Product Level	PDGS Processing Baseline number	Tile Number field	

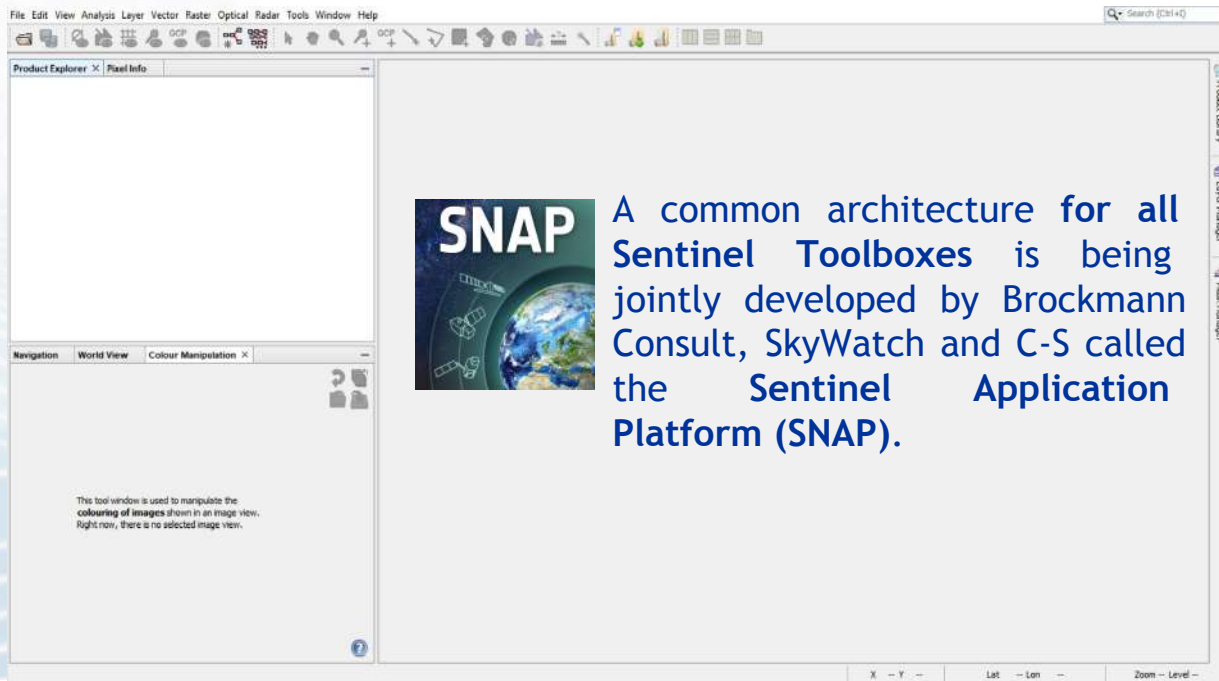
All the bands included in the file are in JPEG2000 format.

In addition, a “True Colour Image” in JPEG2000 format is included within the Tile folder of Level-1C products in this format and a manifest xml file that tells the computer what is inside the file.

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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

To process the downloaded images, we will use the European Space Agency's (ESA) Sentinel Application Platform (SNAP)
[<https://step.esa.int/main/download/snap-download/>]

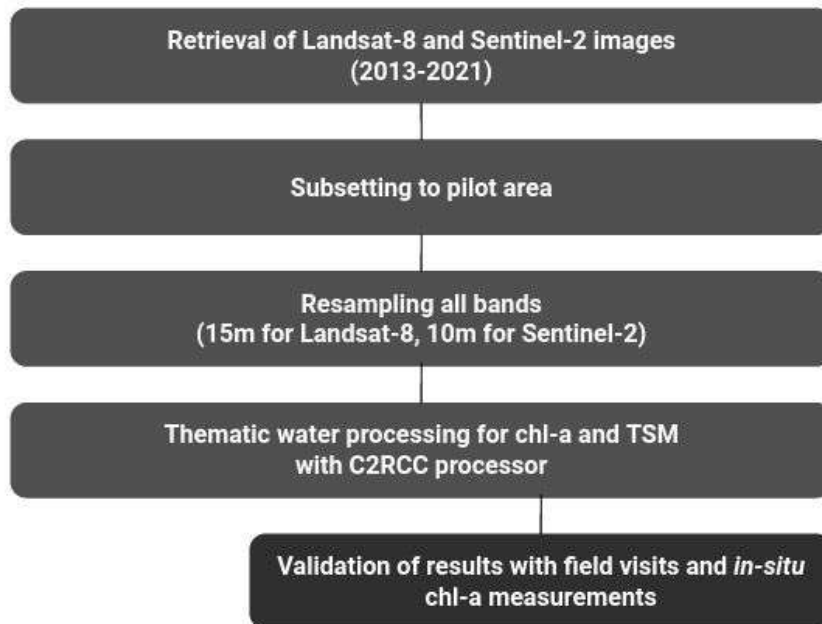


A common architecture for all Sentinel Toolboxes is being jointly developed by Brockmann Consult, SkyWatch and C-S called the Sentinel Application Platform (SNAP).

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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

Overview of method:

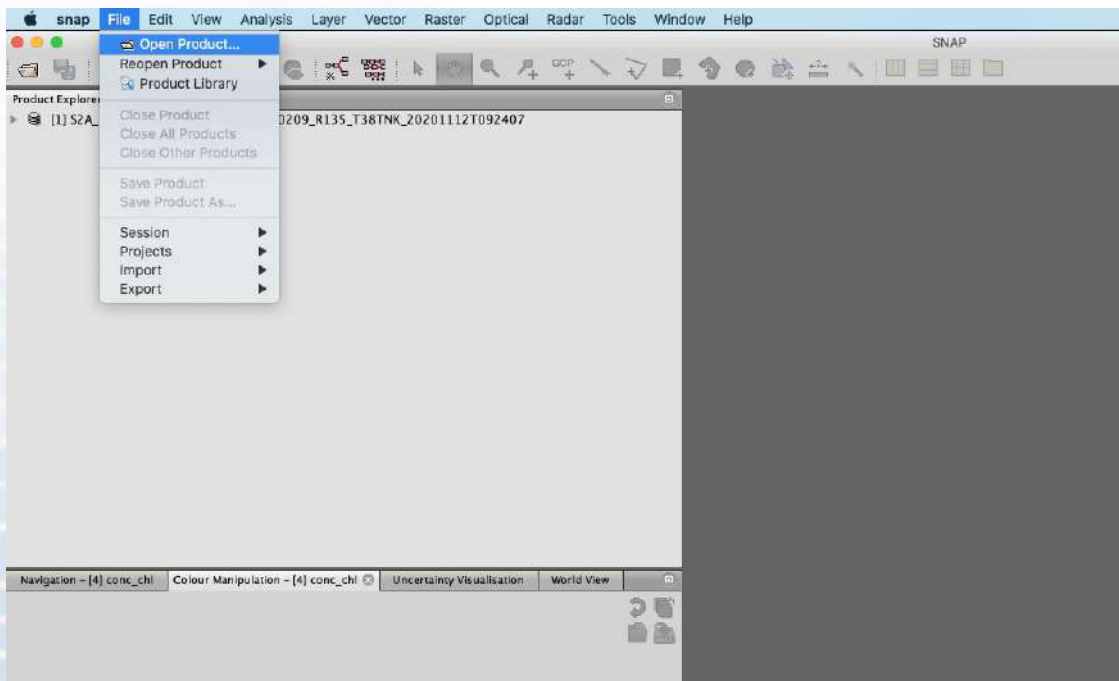


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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

To import satellite image, go to File → Open Product.

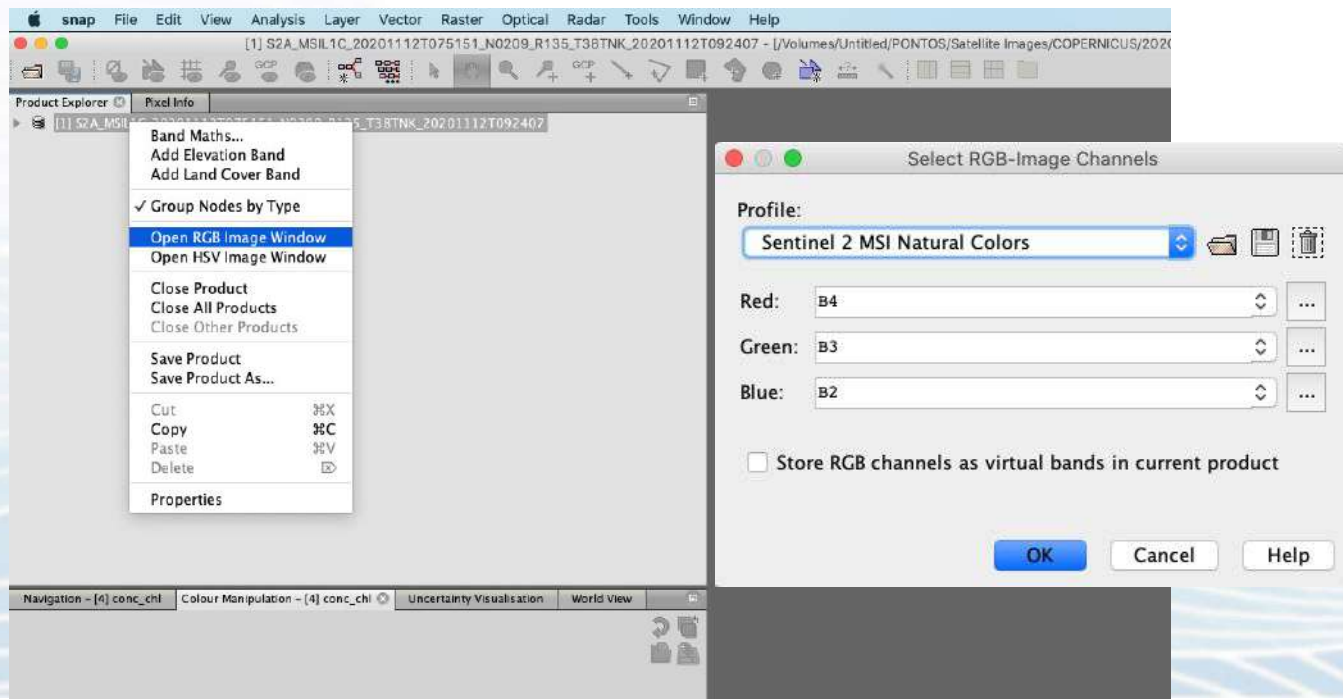
Alternatively, you can also 'Drag & Drop' the file into the Product Explorer window.



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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

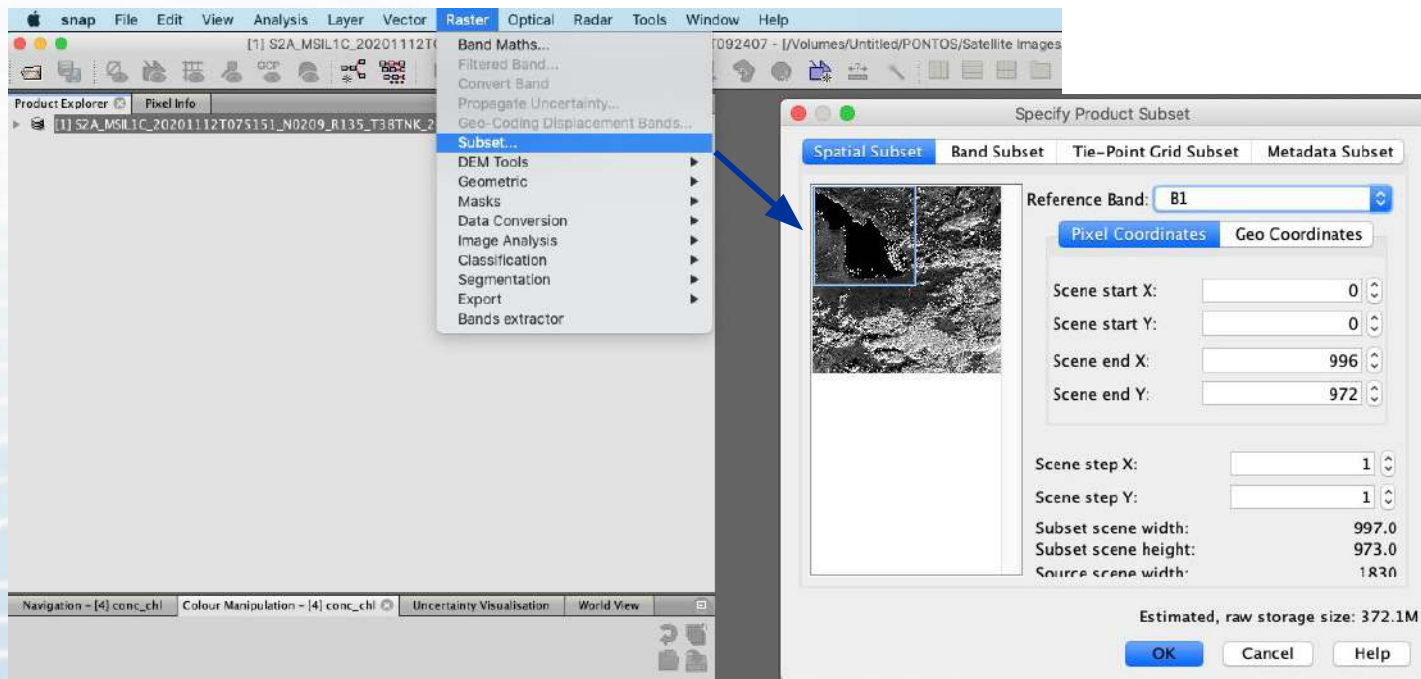
To visualize the imported image, right click on the product and press on ‘Open RGB Image Window’.



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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

To select an area of interest, go to the 'Raster' tab and select subset. There you can use the visual tool, to choose your focus area.



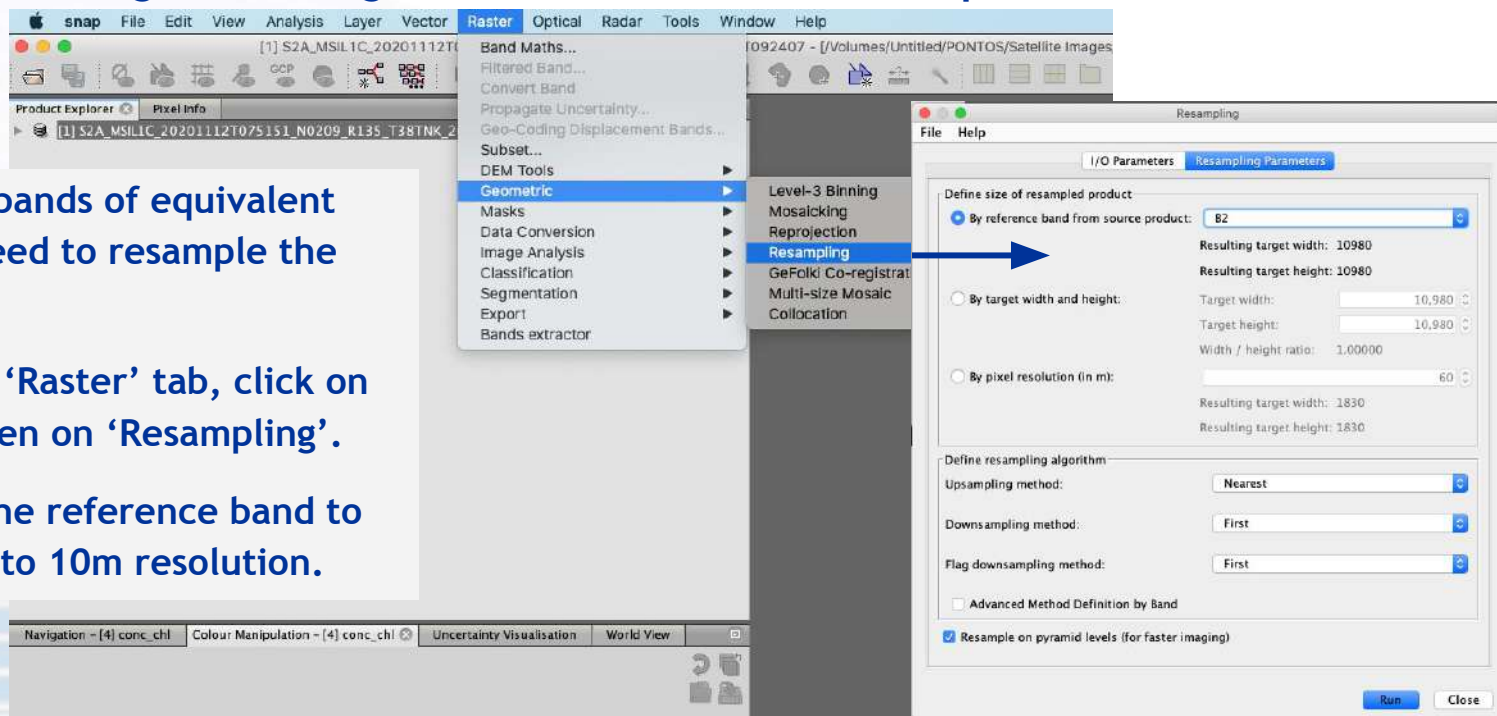
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Calculating chl- a using the SNAP toolkit and C2RCC processor

To make all image bands of equivalent resolution, we'll need to resample the product file.

To do so, go to the 'Raster' tab, click on 'Geometric' and then on 'Resampling'.

We will use B2 as the reference band to resample all bands to 10m resolution.



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Calculating chl-a using the SNAP toolkit and C2RCC processor

Alternatively, you can perform bulk processing using the Graph Processor Tool (GPT).

Bulk Processing with Graph Processor Tool (GPT)

```

1 <graph id="graph">
2   <version>1.0</version>
3   <node id="Read">
4     <operator>Read</operator>
5     <sources>
6       <parameters class="com.bc.ceres.binding.dom.XppDomElement">
7         <file>D:\Desktop\Inpoveicon SPM\images from SPM MARre\satellite\s2A_MS11LC_20200729T090601_N0209_R050_T35TAP_20200729T112307.tif</file>
8       </parameters>
9     </sources>
10    <node id="Resample">
11      <operator>Resample</operator>
12      <sources>
13        <sourceProduct refid="Read"/>
14      </sources>
15      <parameters class="com.bc.ceres.binding.dom.XppDomElement">
16        <referenceBand>2</referenceBand>
17        <targetWidth/>
18        <targetHeight/>
19        <targetResolution/>
20        <upsampling>Nearest</upsampling>
21        <downsampling>First</downsampling>
22        <flagDownsampling>First</flagDownsampling>
23        <resampling>Bilinear</resampling>
24        <bandResampling/>
25        <resampleOnPyramidLevels>true</resampleOnPyramidLevels>
26      </parameters>
27    </node>
28    <node id="Subset">
29      <operator>Subset</operator>
30      <sources>
31        <sourceProduct refid="Resample"/>
32      </sources>
33      <parameters class="com.bc.ceres.binding.dom.XppDomElement">
34        <sourceBands/>
35        <region>0,0,0,0</region>
36        <referenceBand/>
37        <geoRegion>POLYGON ((23.58807945251465 41.0165901184082, 24.727497100830078 41.0165901184082, 24.727497100830078 40.66456985473633, 23.58807945251465 40.66456985473633, 23.58807945251465 41.0165901184082))
38        <subSamplingX>1</subSamplingX>
39        <subSamplingY>1</subSamplingY>
40        <fullSwath>false</fullSwath>
41        <tiePointIdNames/>
42        <copyMetadata>true</copyMetadata>
43      </parameters>
44    </node>
45    <node id="Write">
46      <operator>Write</operator>
47      <sources>
48        <sourceProduct refid="Subset"/>
49      </sources>
50    </node>
51  </graph>

```

\$variable

Resample

Subset

eXtensible Markup Language file length: 2,470 lines: 70 Ln: 18 Col: 22 Sel: 0 | 0 Unix (LF) ISO 8859-7 (NS)

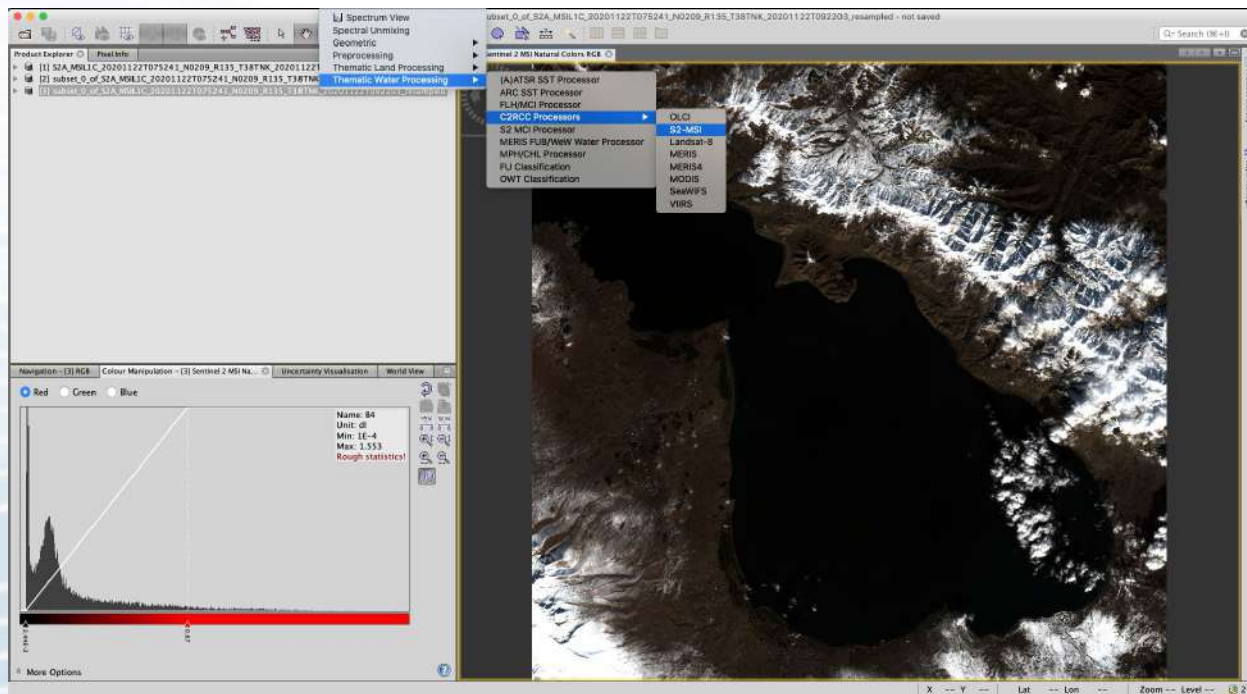
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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

Now to calculate chl-*a* and TSM concentrations, we will use the C2RCC processor.

To do so, go to the 'Optical' tab, then select 'Thematic Water Processing' and choose 'C2RCC Processors'.

Select the processor equivalent to your product (e.g. S2-MSI for Sentinel-2 images).



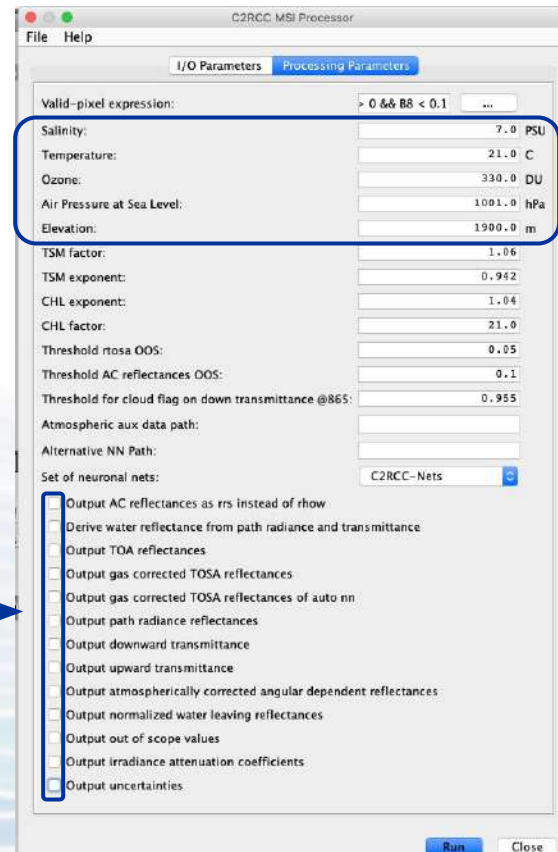
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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

There, change the values of the following parameters to match the *in-situ* conditions at the time the image was taken:

- Salinity
- Temperature
- Ozone
- Pressure
- Elevation

+ untick all below boxes



C2RCC MSI Processor

File Help

I/O Parameters Processing Parameters

Valid-pixel expression:

Salinity: PSU

Temperature: C

Ozone: DU

Air Pressure at Sea Level: hPa

Elevation: m

TSM factor:

TSM exponent:

CHL exponent:

CHL factor:

Threshold rtosa OOS:

Threshold AC reflectances OOS:

Threshold for cloud flag on down transmittance @865:

Atmospheric aux data path:

Alternative NN Path:

Set of neuronal nets:

☒ Output AC reflectances as rrs instead of rho_w

☐ Derive water reflectance from path radiance and transmittance

☐ Output TOA reflectances

☐ Output gas corrected TOSA reflectances

☐ Output gas corrected TOSA reflectances of auto nn

☐ Output path radiance reflectances

☐ Output downward transmittance

☐ Output upward transmittance

☐ Output atmospherically corrected angular dependent reflectances

☐ Output normalized water leaving reflectances

☐ Output out of scope values

☐ Output irradiance attenuation coefficients

☐ Output uncertainties

Run Close

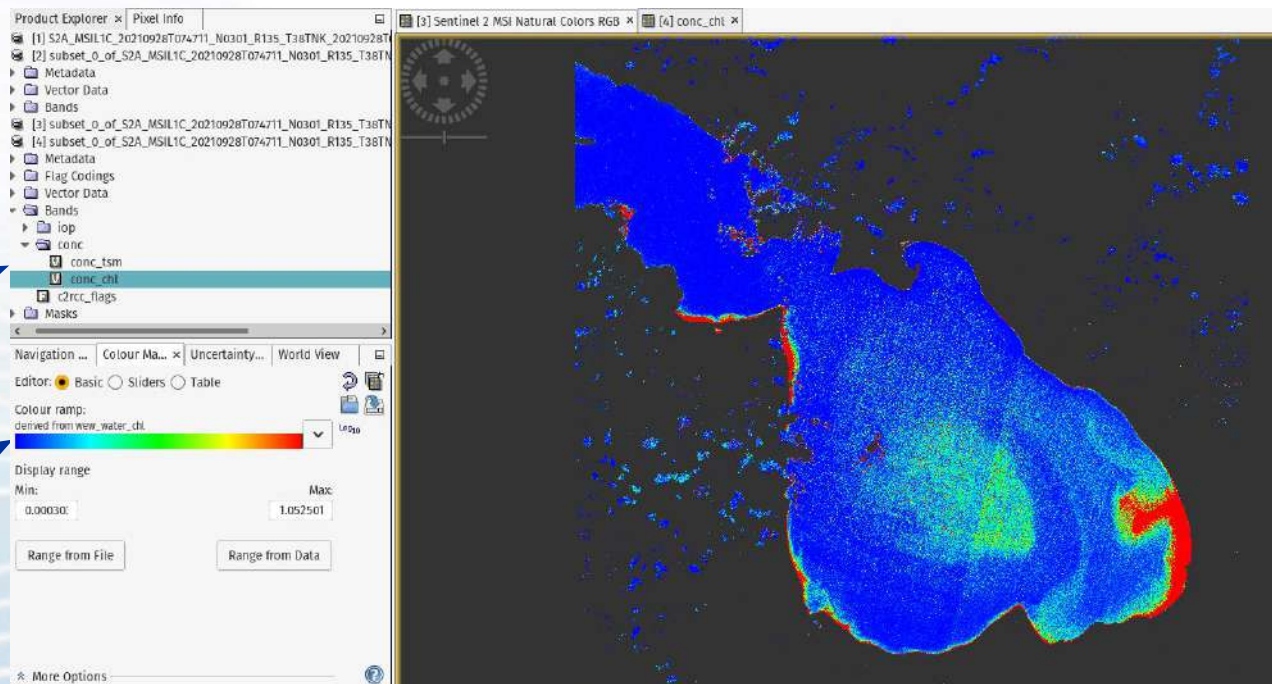
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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

Double click on the latest created product to expand, then click on 'Bands' → 'conc'. There you will have 2 newly created images:

- chl-*a* concentration
- TSM

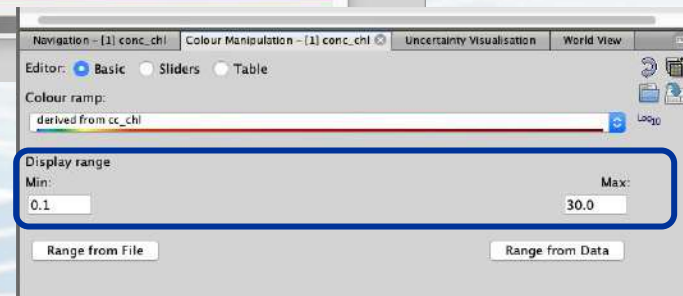
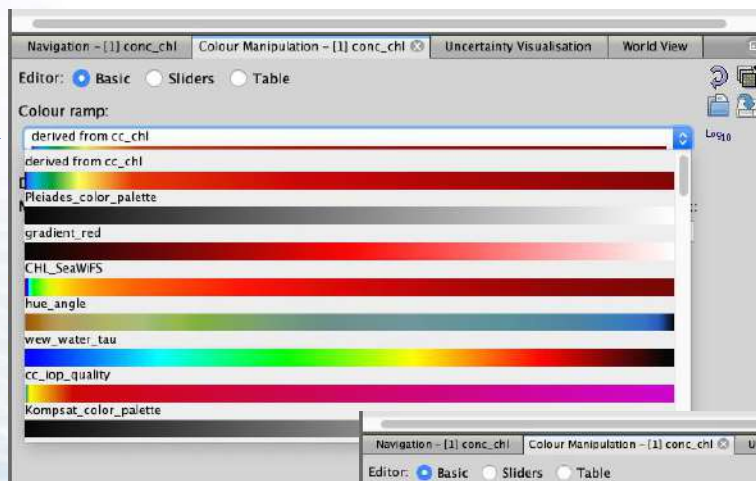
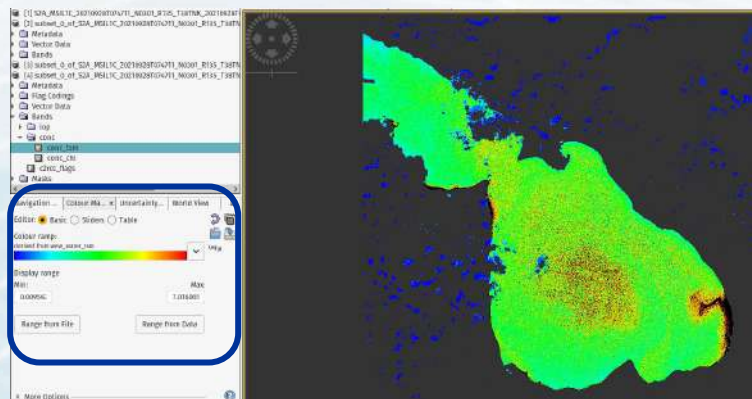
You can select the colour of each image from a number of available templates and specify the data range.



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Calculating chl-*a* using the SNAP toolkit and C2RCC processor

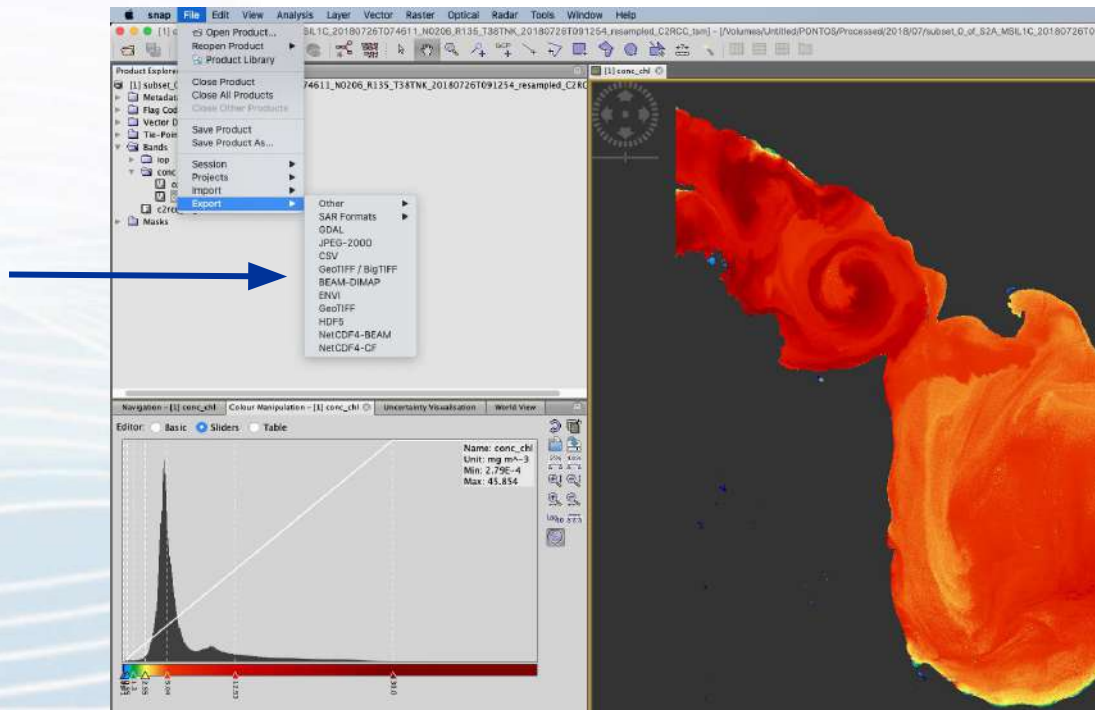
Select the colour of each image from a number of available templates and specify the data range.



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Calculating chl- a using the SNAP toolkit and C2RCC processor

You can export the created images by clicking on 'File' → 'Export' and selecting on any of the desired file formats, including GeoTIFF, JPEG-2000, NetCFD4, ENVI, HDF5, etc.



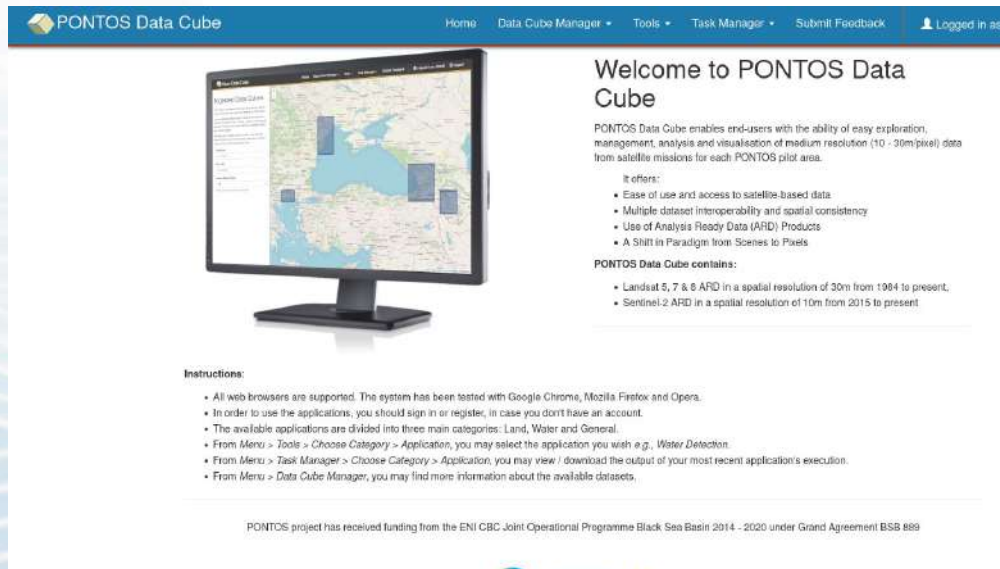
Common borders. Common solutions.

04

Using the PONTOS Data Cube to calculate Total Suspended Matter

The last part of this module will describe how to use the PONTOS Data Cube to calculate the Total Suspended Matter (TSM) in water bodies.

TSM is an indication of water turbidity (*i.e.* low water clarity), thus high TSM concentrations could often indicate low water quality, water pollution, and anthropogenic pressure.



The screenshot shows the PONTOS Data Cube web application. The header includes the logo and navigation links: Home, Data Cube Manager, Tools, Task Manager, Submit Feedback, and a user login status. The main content area features a large map of the Black Sea region with several data layers overlaid. To the right of the map, there is a welcome message and a list of features and datasets. Below the map, there is an 'Instructions' section with a list of guidelines for using the application.

PONTOS Data Cube Home Data Cube Manager Tools Task Manager Submit Feedback Logged in as

Welcome to PONTOS Data Cube

PONTOS Data Cube enables end-users with the ability of easy exploration, management, analysis and visualisation of medium resolution (10 - 30m/pixel) data from satellite missions for each PONTOS pilot area.

It offers:

- Ease of use and access to satellite-based data
- Multiple dataset interoperability and spatial consistency
- Use of Analysis Ready Data (ARD) Products
- A Shift in Paradigm from Scenes to Pixels

PONTOS Data Cube contains:

- Landsat 5, 7 & 8 ARD in a spatial resolution of 30m from 1984 to present.
- Sentinel-2 ARD in a spatial resolution of 10m from 2015 to present

Instructions:

- All web browsers are supported. The system has been tested with Google Chrome, Mozilla Firefox and Opera.
- In order to use the applications, you should sign in or register, in case you don't have an account.
- The available applications are divided into three main categories: Land, Water and General.
- From Menu > Tools > Choose Category > Application, you may select the application you wish e.g., Water Detection.
- From Menu > Task Manager > Choose Category > Application, you may view / download the output of your most recent application's execution.
- From Menu > Data Cube Manager, you may find more information about the available datasets.

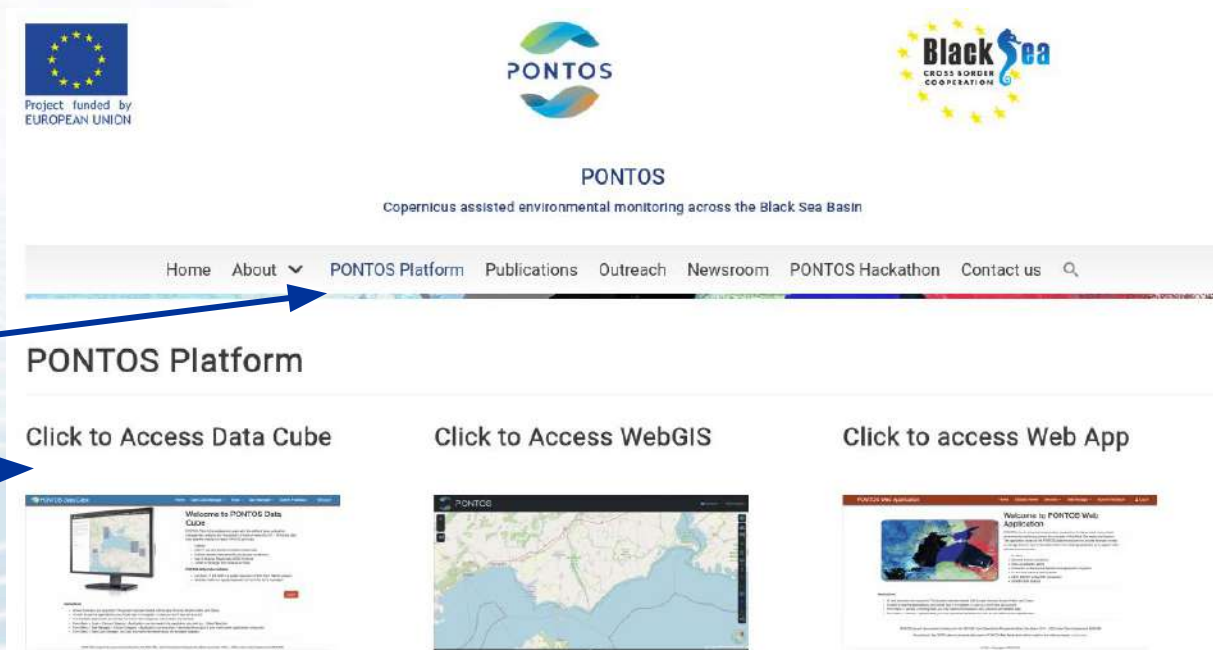
PONTOS project has received funding from the ENI CBC Joint Operational Programme Black Sea Basin 2014 - 2020 under Grant Agreement BSB 889

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Using the PONTOS Data Cube

To access the PONTOS Data Cube:

- 1. Go to the PONTOS project website (pontos-eu.aua.am)**
- 2. Click on the tab entitled “PONTOS Platform”**
- 3. Now, click to Access Data Cube**

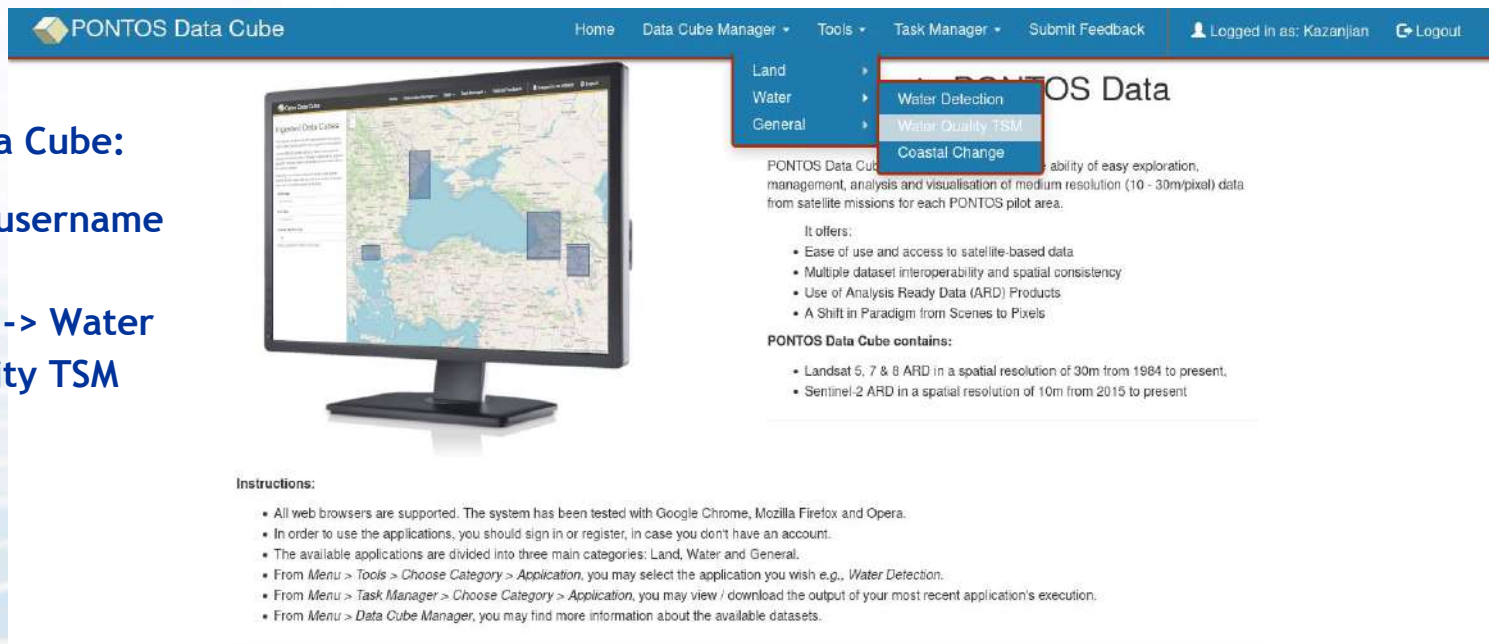


The screenshot shows the PONTOS website interface. At the top, there are logos for the European Union, PONTOS, and Black Sea Cross Border Cooperation. Below the logos, the text 'PONTOS' is displayed, followed by the subtitle 'Copernicus assisted environmental monitoring across the Black Sea Basin'. A navigation menu is visible with links: Home, About, PONTOS Platform, Publications, Outreach, Newsroom, PONTOS Hackathon, and Contact us. A blue arrow points from the 'PONTOS Platform' link in the menu to the 'PONTOS Platform' section below. This section contains three clickable buttons: 'Click to Access Data Cube', 'Click to Access WebGIS', and 'Click to access Web App'. A second blue arrow points from the 'Click to Access Data Cube' button to a thumbnail image of the Data Cube interface.

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On the PONTOS Data Cube:

1. Register your username
2. Sign in
3. Click on Tools -> Water
-> Water Quality TSM



PONTOS Data Cube

Home Data Cube Manager Tools Task Manager Submit Feedback Logged in as: Kazanjian Logout

Tools

- Land
- Water
- General

Water

- Water Detection
- Water Quality TSM**
- Coastal Change

PONTOS Data Cube

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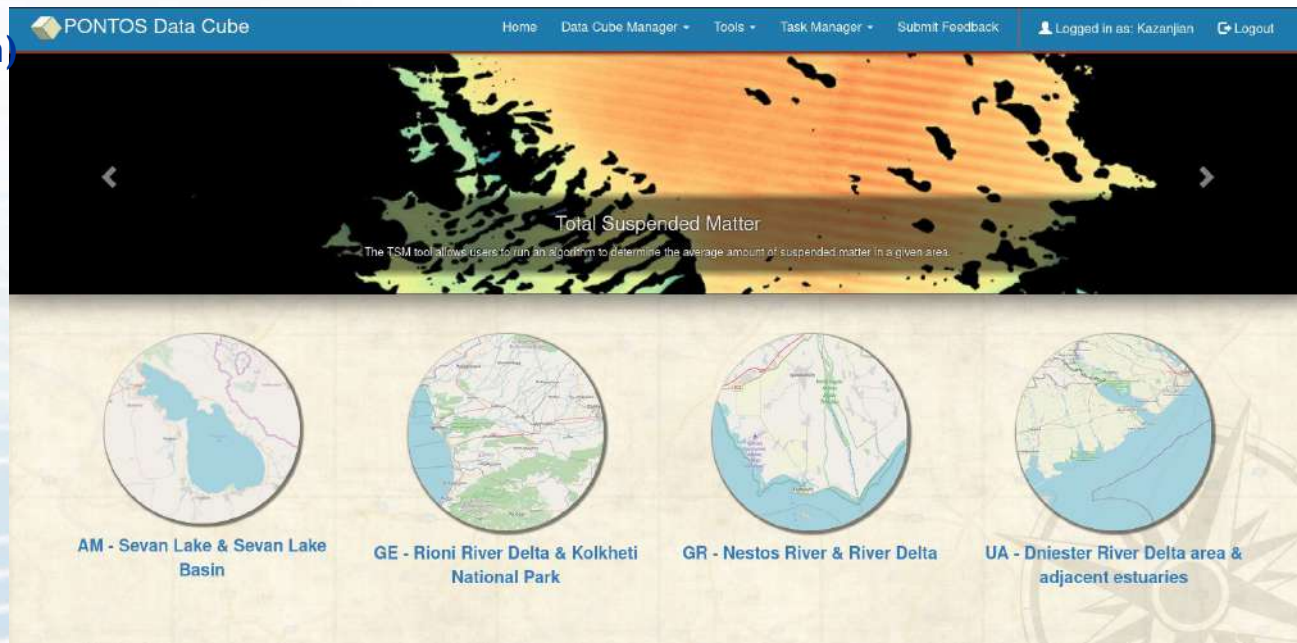
Instructions:

- All web browsers are supported. The system has been tested with Google Chrome, Mozilla Firefox and Opera.
- In order to use the applications, you should sign in or register, in case you don't have an account.
- The available applications are divided into three main categories: Land, Water and General.
- From *Menu > Tools > Choose Category > Application*, you may select the application you wish e.g., *Water Detection*.
- From *Menu > Task Manager > Choose Category > Application*, you may view / download the output of your most recent application's execution.
- From *Menu > Data Cube Manager*, you may find more information about the available datasets.

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Using the PONTOS Data Cube

**Choose the pilot site (location)
you are interested in to
perform your query.**

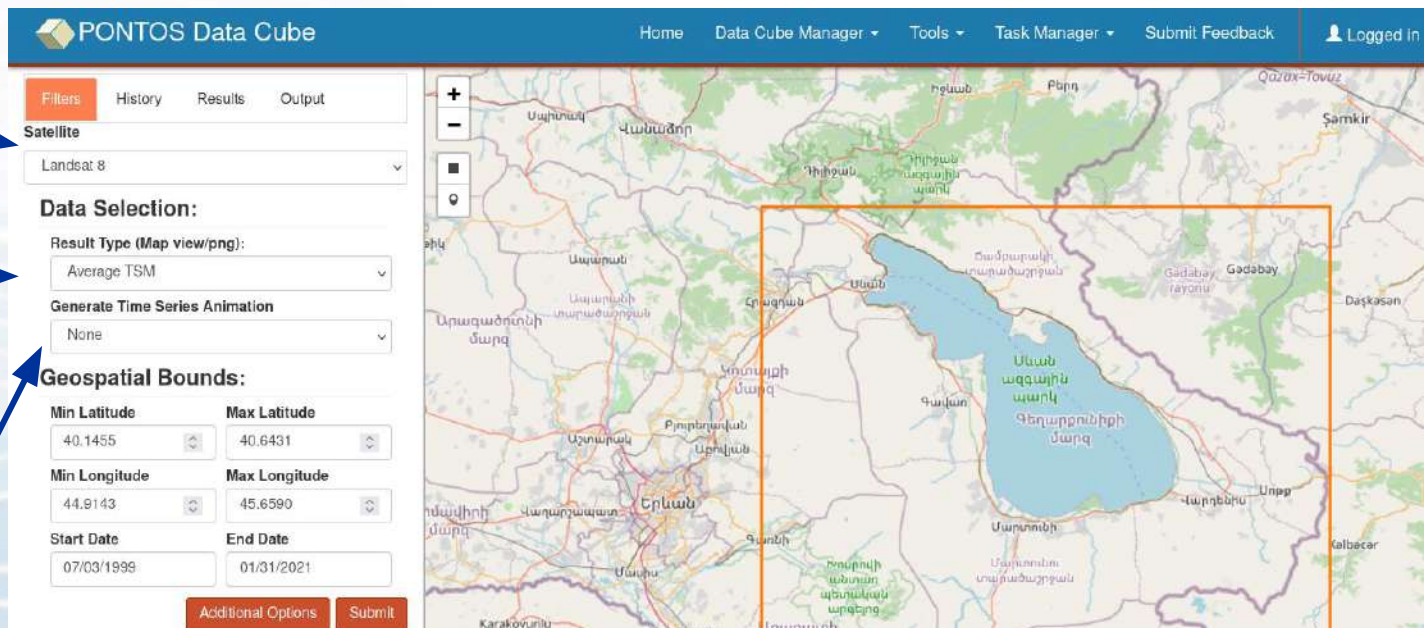


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Using the PONTOS Data Cube

Here you can select:

1. Images from specific satellites
2. TSM results shown as
 - a. Average
 - b. Minimum
 - c. Maximum
 - d. Variability
3. Option to generate a time series animation



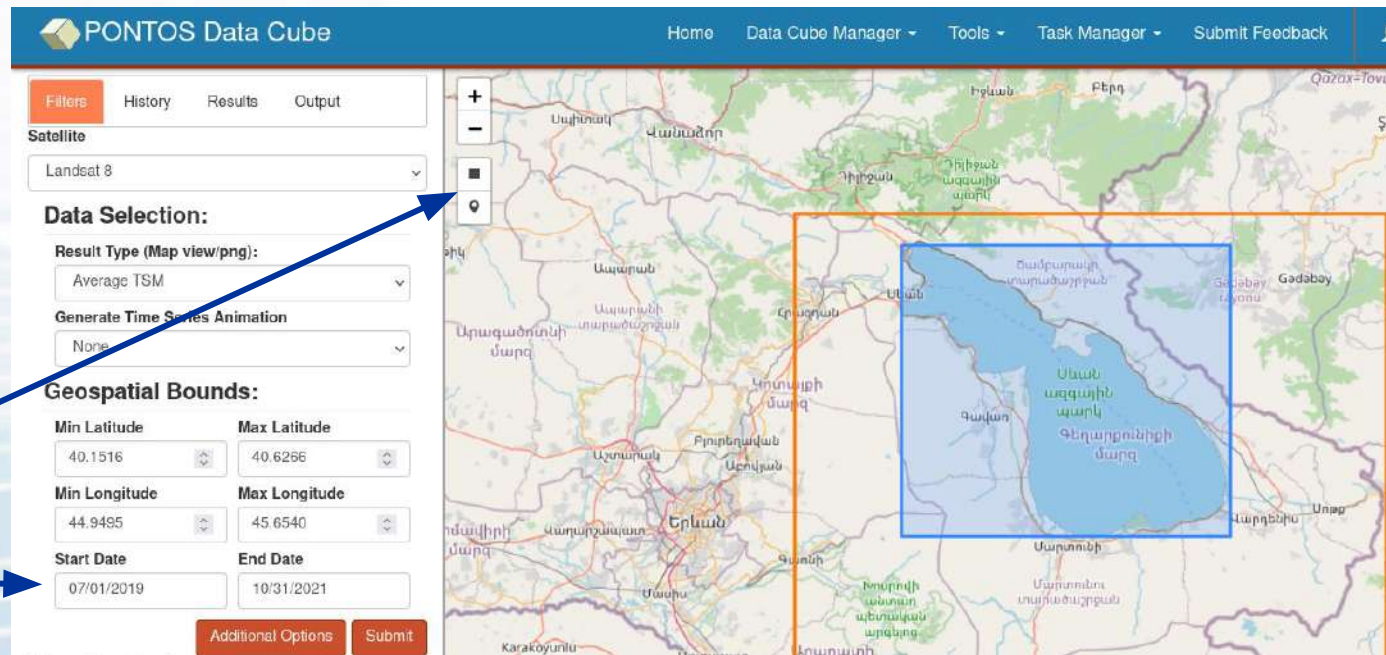
The screenshot shows the PONTOS Data Cube web application interface. The top navigation bar includes links for Home, Data Cube Manager, Tools, Task Manager, Submit Feedback, and a user login status. The main interface is divided into a left sidebar with tabs for Filters, History, Results, and Output, and a right panel displaying a map of the Caucasus region. The Filters tab is active, showing options for Satellite (Landsat 8), Data Selection (Result Type: Average TSM, Generate Time Series Animation: None), and Geospatial Bounds (Min/Max Latitude and Longitude, Start/End Date). The map on the right shows a region with a blue lake and surrounding land areas, with a red rectangle indicating the selected geospatial bounds.

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Using the PONTOS Data Cube

Here you can select
(cont'd):

1. The spatial boundaries either
 - a. via entering the exact coordinates
 - b. By drawing a polygon
2. The period of interest for your analysis



PONTOS Data Cube

Home Data Cube Manager Tools Task Manager Submit Feedback

Filters History Results Output

Satellite: Landsat 8

Data Selection:

Result Type (Map view/png): Average TSM

Generate Time Series Animation: None

Geospatial Bounds:

Min Latitude: 40.1516 Max Latitude: 40.6266

Min Longitude: 44.9495 Max Longitude: 45.6540

Start Date: 07/01/2019 End Date: 10/31/2021

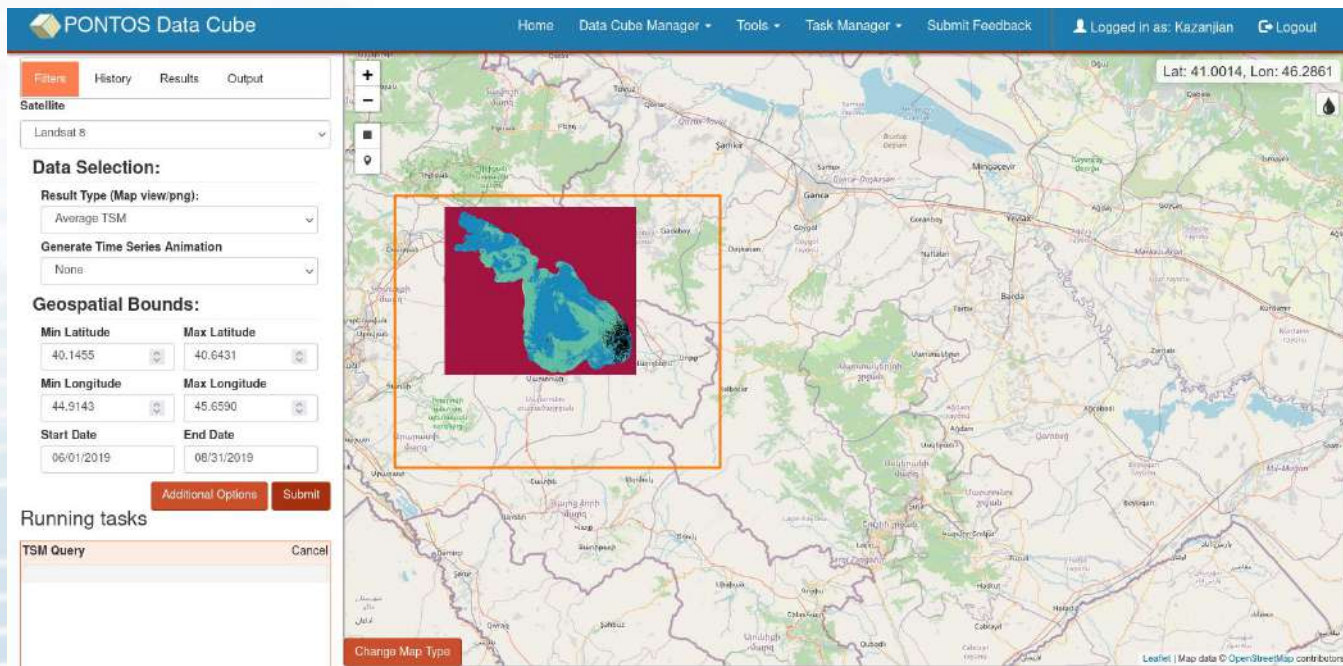
Additional Options Submit

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Using the PONTOS Data Cube

When you click submit, you will notice a TSM Query appear under running tasks.

Wait till the query is completed and a colored picture will appear within the selected boundaries, showing the TSM concentrations as specified in your query.



The screenshot displays the PONTOS Data Cube web application interface. The top navigation bar includes links for Home, Data Cube Manager, Tools, Task Manager, and Submit Feedback, along with a user login status (Logged in as: Kazanjian) and a Logout button. The main interface is divided into a left sidebar and a right map area. The sidebar contains tabs for Filters, History, Results, and Output. Under the Filters tab, there are sections for Satellite (set to Landsat 8), Data Selection (Result Type: Average TSM, Generate Time Series Animation: None), and Geospatial Bounds (Min/Max Latitude and Longitude, Start/End Date). Below these are buttons for Additional Options and Submit. The bottom of the sidebar shows a 'Running tasks' section with a 'TSM Query' entry and a 'Cancel' button. The right map area shows a satellite image of a coastal region with a red rectangular bounding box. A small inset image within the bounding box shows a colored map of TSM concentrations. The map area also includes a 'Change Map Type' button at the bottom left and a coordinate display (Lat: 41.0014, Lon: 46.2861) at the top right.

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Using the PONTOS Data Cube

To review any of your previous queries, you can click on 'Task Manager' → Water → Water Quality TSM.

There you will see a list of all your requested queries.

Click on Details for more information.



The screenshot shows the PONTOS Data Cube web application. The top navigation bar includes links for Home, Data Cube Manager, Tools, Task Manager, Submit Feedback, and a user login status (Logged in as: Kazanjian). The Task Manager dropdown menu is open, showing options for Land, Water, and General. The Water dropdown menu is also open, showing options for Water Detection, Water Quality TSM, and Coastal Change. The main content area displays a table of queries. The first query is for LANDSAT_8 over Sevan_Lake, with a time range from July 1, 2019, to July 1, 2020. The second query is for LANDSAT_8 over Sevan_Lake, with a time range from June 1, 2019, to Aug. 31, 2019. Both queries are of type TSM Query. The table also shows columns for Latitude Max, Latitude Min, Longitude Max, and Longitude. A 'Details' button is visible next to each query entry. A search bar is located on the right side of the interface.

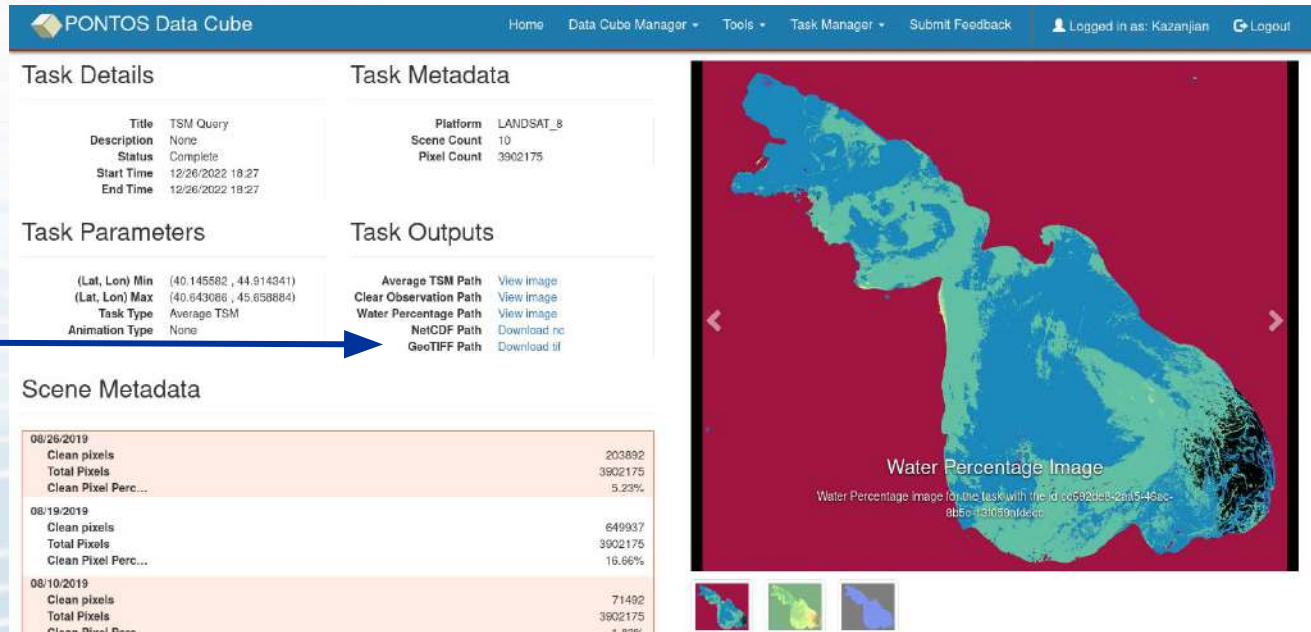
Satellite	Area Id	Time Start	Time End	Latitude Max	Latitude Min	Longitude Max	Longitude	Type	Animated Product	More Info
LANDSAT_8	Sevan_Lake	July 1, 2019	July 1, 2020	40.5336218414586	40.5336208414586	45.0788807818663	45.0788797818663	TSM Query	None	Details
LANDSAT_8	Sevan_Lake	June 1, 2019	Aug. 31, 2019	40.6430863023654	40.1455815899712	45.6588838121224	44.914341170133	TSM Query	Average TSM	Details

Showing 1 to 2 of 2 entries

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Using the PONTOS Data Cube

Here you will see the details of your query and be able to download the produced images in GeoTIFF or NetCDF format.



PONTOS Data Cube Home Data Cube Manager Tools Task Manager Submit Feedback Logged in as: Kazanjian Logout

Task Details

Title	TSM Query
Description	None
Status	Complete
Start Time	12/26/2022 18:27
End Time	12/26/2022 18:27

Task Metadata

Platform	LANDSAT_8
Scene Count	10
Pixel Count	3902175

Task Parameters

(Lat, Lon) Min	(40.145582, 44.614341)
(Lat, Lon) Max	(40.643086, 45.658884)
Task Type	Average TSM
Animation Type	None

Task Outputs

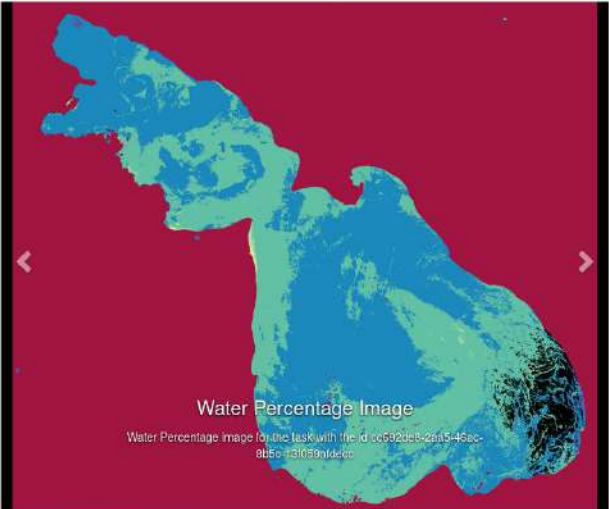
Average TSM Path	View image
Clear Observation Path	View image
Water Percentage Path	View image
NetCDF Path	Download netcdf
GeoTIFF Path	Download tif

Scene Metadata

08/26/2019		
Clean pixels		203892
Total Pixels		3902175
Clean Pixel Perc...		5.23%
08/19/2019		
Clean pixels		649937
Total Pixels		3902175
Clean Pixel Perc...		16.66%
08/10/2019		
Clean pixels		71492
Total Pixels		3902175
Clean Pixel Perc...		1.83%

Water Percentage Image

Water Percentage Image for the task with the id ee592043-26a5-468c-8b5c-43059b1d4000



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Joint Operational Programme Black Sea Basin 2014-2020
Copernicus Assisted Environmental Monitoring across the Black Sea Basin - PONTOS
December 2022

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This publication has been produced with the financial assistance of the European Union. The contents of this publication are the sole responsibility of Copernicus assisted environmental monitoring across the Black Sea Basin - PONTOS and can in no way be taken to reflect the views of the European Union.