

Interreg



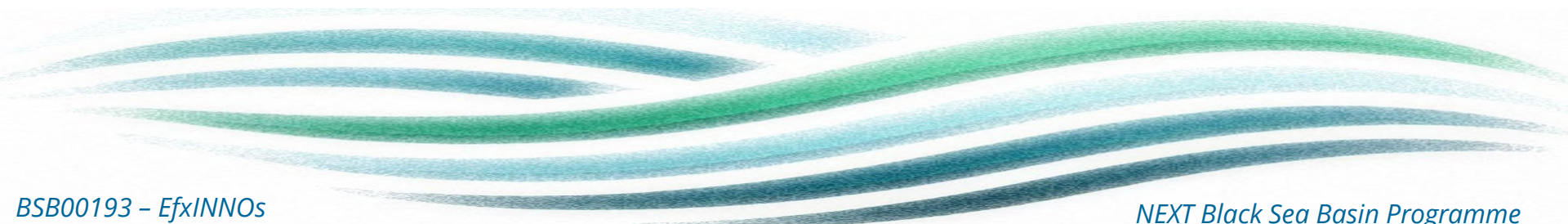
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EfxINNOs in Georgia

**Establishing and Operating an Innovative Marine Technology Transfer
Network for Enhancing the Transition to a Sustainable Blue Economy in
the Black Sea Basin**



Training on assessment of chlorophyll-a concentration

Methodology For Calculating Chlorophyll-a Concentration From Sentinel-2 Images Using SNAP (Sentinel Application Platform)

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Research motivation and The Study Area

Why Poti ?

- *The "Hydrological Crossroads" of Georgia.*
 - *Highly complex coastal system.*
 - *One of the most ecologically valuable territory .*
- *Goals: Quantifying human impact (Port/City) vs. natural dynamics (Wetlands/MPAs).*



Key topics: Anthropogenic, Estuarine Dynamics, High Conservation Value



Assessment of chlorophyll-a concentration

Problems/Impacts

- **River discharge** (nutrients (nitrogen, phosphorus), sediments, organic matter)
- **Urban / industrial discharge** (wastewater from cities or industry)
- **Agricultural runoff** (rain washing fertilizers off land into the river/Water pollution with organic matter from agricultural wastes)
- **Coastal local currents and winds**



Satellites Used In Remote Sensing

- Sentinel 2A and 2B: Two polar orbiting satellites positioned 180° apart.
- Equipped with multispectral instruments - 13 spectral bands.
- The swath width is 290 km.
- The revisit time is 5 days at the equator (with both satellites).
- Processing levels include Level-1C and Level-2A (atmospherically corrected).



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Sentinel naming scheme

S2A_MSIL1C_20240312T080731_N0510_R078_T37TGG_20240312T085424.SAFE

Mission ID

Acquisition time

Relative Orbit

Tile

Product Unique

level of product
processing

number

PDGS processing
baseline number

Number
field

Identifier

The diagram shows the **Level-1C** product acquired by **Sentinel-2A** on **March 12, 2024**, at **8:07:31 AM**.



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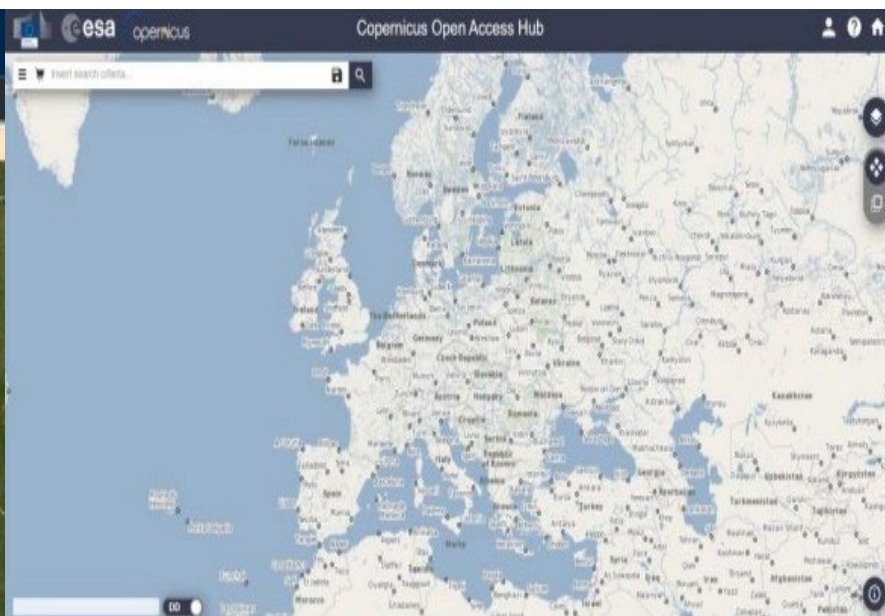


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How To Download Satellite Imagery From Open-Access Geospatial Data Portals



Open-source databases for satellite images



<https://earthexplorer.usgs.gov/>

<https://scihub.Copernicus.eu/dhus/>

<https://www.planet.com/explorer>

Selection and downloading satellite images

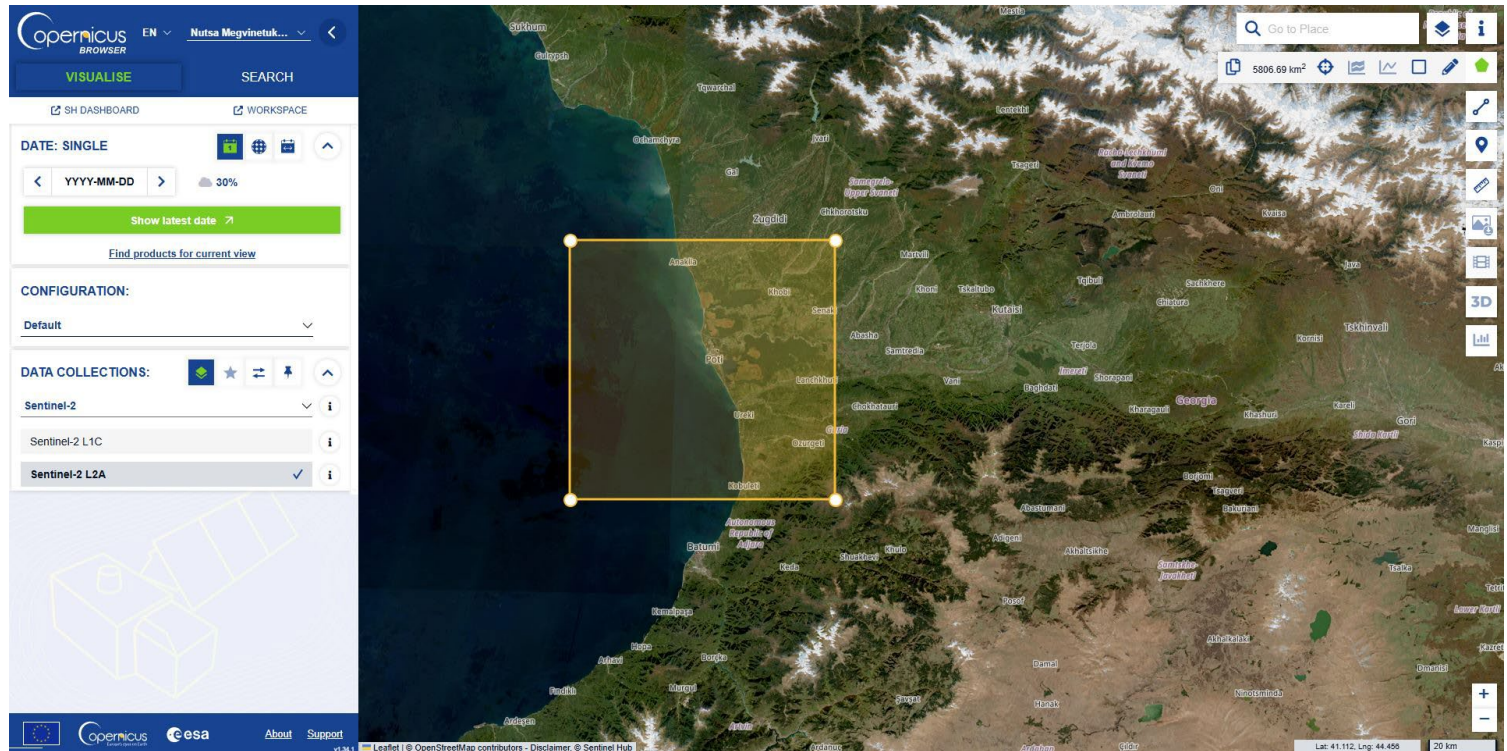
Sentinel 2 (10m)

- ✓ Selecting the area
- ✓ Specifying the date
- ✓ choosing a satellite platform
- ✓ Determining cloudiness

The screenshot shows the Copernicus Browser interface. On the left, there's a sidebar with 'VISUALISE' and 'SEARCH' tabs. Below 'SEARCH', there's a search bar and a list of results. The results list includes columns for 'Select all', 'Mission', 'Instrument', 'Size', and 'Sensing time'. The main map area on the right shows a satellite image of a coastal region with a blue rectangular selection box. The top right of the map shows a search bar and a scale bar indicating 5806.69 km².

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✓ Selecting the
area



✓ Specifying the date

The screenshot displays the Copernicus Browser interface. On the left, a sidebar lists various data layers under 'Sentinel Mosaics', including 'CLMS Land Cover and Land Use in Priority Areas', 'CLMS Land Cover and Land Use Mapping', 'CLMS Bio-geophysical Parameters', and 'Complementary Data'. The 'TIME RANGE' section is highlighted with a red circle, showing 'From: 2026-02-28' and 'Until: 2026-03-31'. Below this is a calendar view for June 2025. The main area shows a map of the Black Sea region with a yellow rectangular selection box. The bottom of the interface includes logos for the European Union, Copernicus, and ESA, along with navigation links like 'About' and 'Support'.

The screenshot shows the Copernicus Browser interface. On the left, the 'DATA SOURCES' section is visible, with 'SENTINEL-2' and 'MSI' selected and circled in red. A red arrow points to this selection. Below the selection, a cloudiness slider is set to 25%. On the right, a map of the Black Sea region is displayed with a yellow rectangular area of interest. The interface includes a search bar, a dashboard/workspace toggle, and various map controls.

✓ choosing a satellite platform

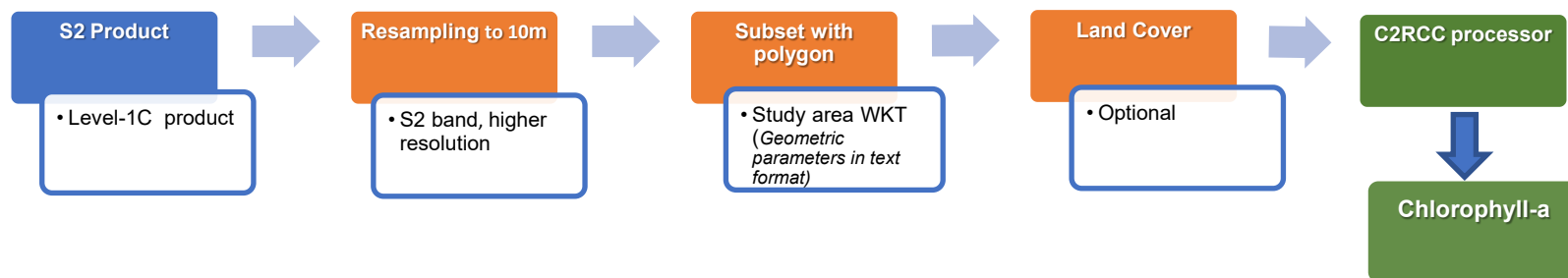
✓ Determining cloudiness

check selected image settings and download

The screenshot shows the Copernicus Browser interface. On the left, a list of satellite images is displayed. The third item in the list is selected, and its 'Visualise' button is circled in red. A red arrow points from the text 'check selected image settings and download' to this button. The main area of the interface shows a map of the Black Sea region with a blue rectangular area of interest. The top right corner of the map shows a search bar and a scale of 5806.69 km². The bottom of the interface shows the Copernicus logo and the ESA logo.

Calculating chlorophyll-a concentration from Sentinel-2 images using SNAP (Sentinel Application Platform)

W O R K F L O W



C2RCC processor

The processor retrieves modeled water reflectance coefficients from the database, along with the radiance of the associated upper atmospheric layers.

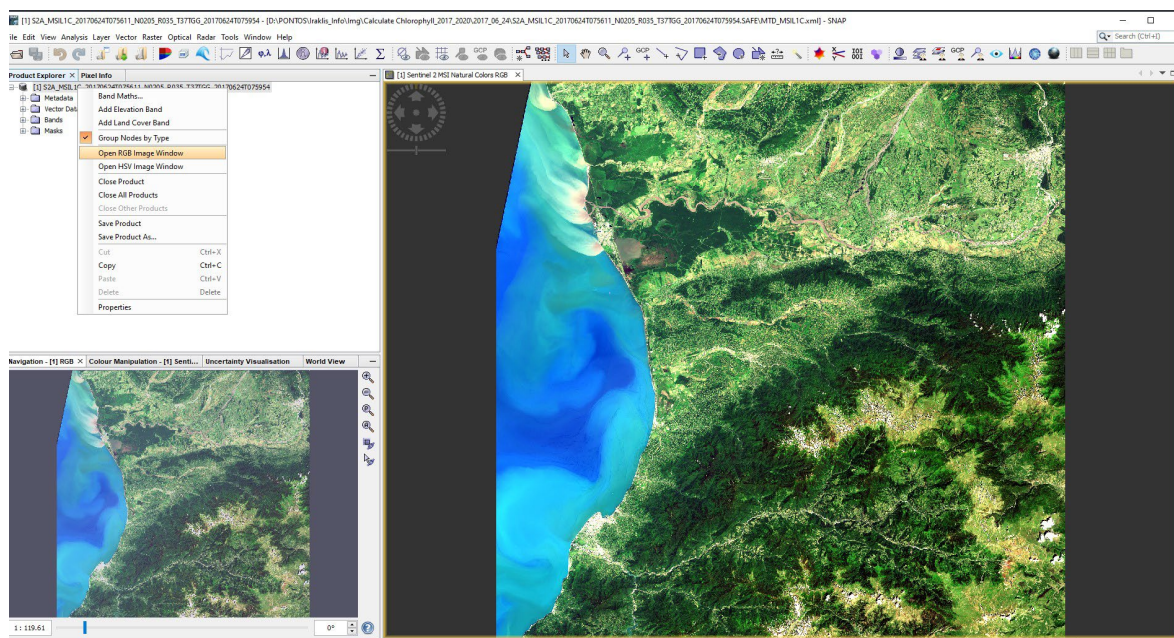
The processor is based on neural networks trained to perform the following tasks:

- Determination of water reflectance from top-of-atmosphere radiance
- Retrieval of the inherent optical properties (IOPs) of the water body

Conversion of “IOPs into concentrations” is carried out using scaling factors

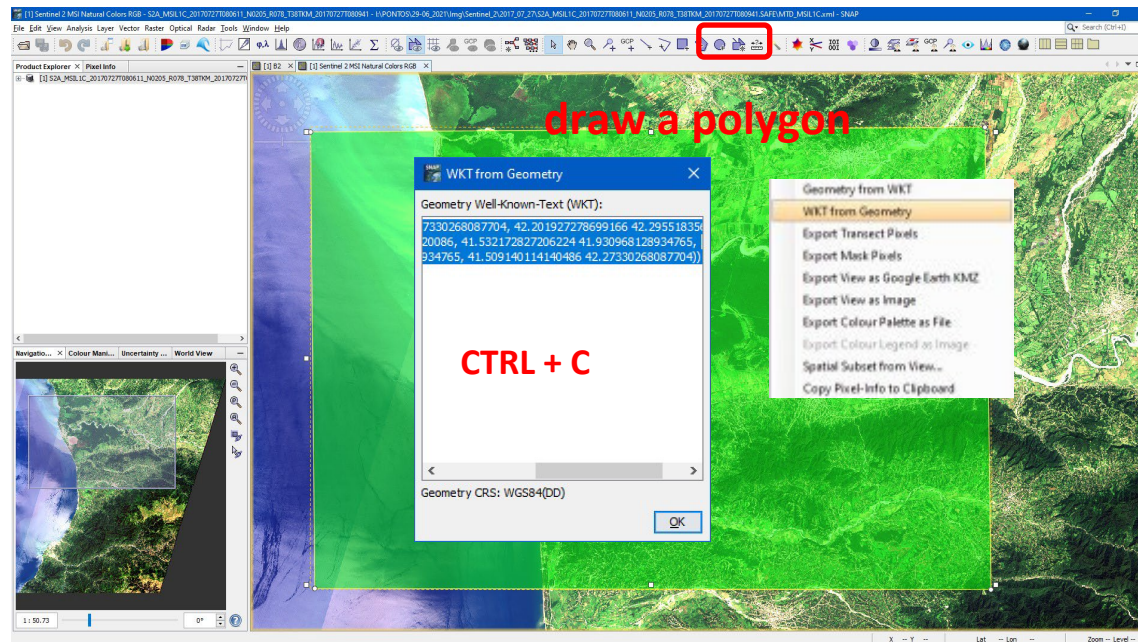


Calculating chlorophyll-a concentration from Sentinel-2 images using SNAP (Sentinel Application Platform)

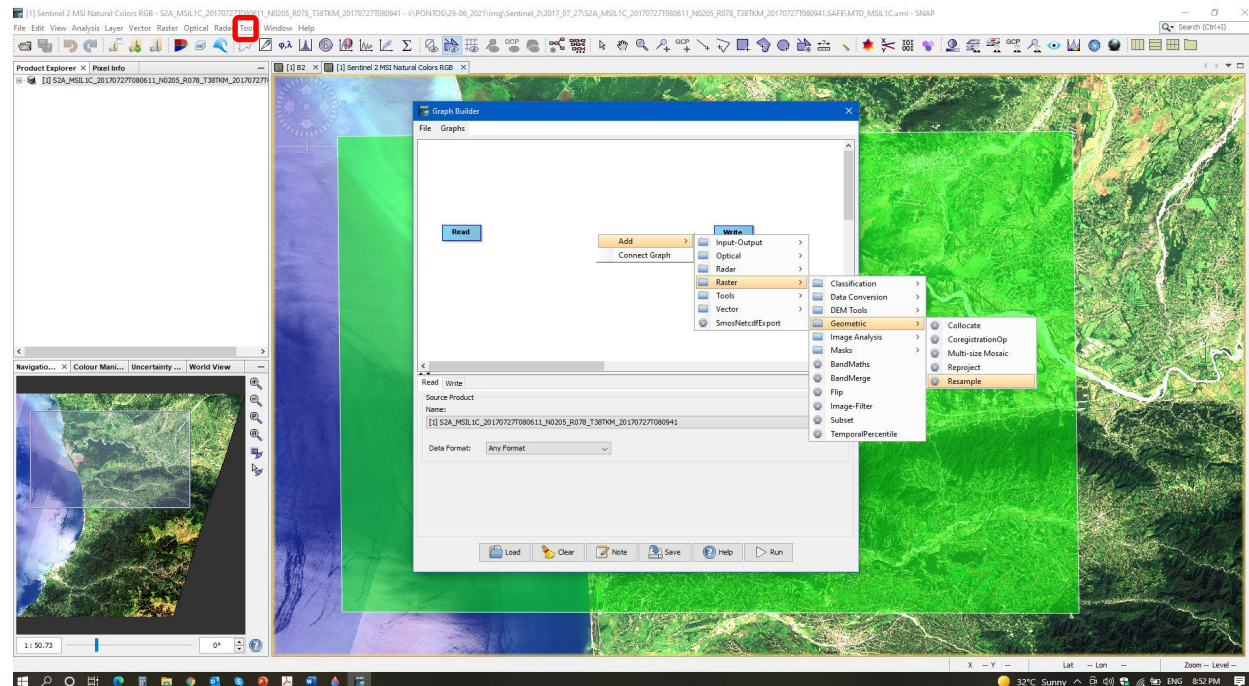


**Import and
visualization of
satellite imagery**

Calculating chlorophyll-a concentration from Sentinel-2 images using SNAP (Sentinel Application Platform)



WKT - geometric
parameters in
text format



Tools



Graph Builder

1. Add ➔ Raster ➔ Geometric ➔ Resample

2. Add ➔ Raster ➔ Subset

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The screenshot displays the Graph Builder application window. The top menu bar includes File, Graphs, and a close button. The main workspace contains 'Read' and 'Write' buttons. A context menu is open, showing a tree structure of processing tools. The 'Raster' category is selected, revealing a list of tools including Classification, Data Conversion, DEM Tools, Geometric, Image Analysis, Masks, Band Maths, Band Merge, Flip, Image-Filter, Subset, and TemporalPercentile. The 'Geometric' sub-menu is further expanded, showing 'Resample' as the selected tool. On the left, the Product Explorer shows a tree view of the data source: [1] S2A_MSIL1C_20170624T075611_N0205_R035_T37TGG_20170624T075954, with sub-items for Metadata, Vector Data, Bands, and Masks. The bottom left shows a navigation pane with a map view and a zoom level of 1:119.61. The bottom right corner features a circular logo for the University of Ioannina.

Graph Builder

File Graphs

Read Write

Add Connect Graph

- Input-Output
- Optical
- Radar
- Raster**
 - Classification
 - Data Conversion
 - DEM Tools
 - Geometric**
 - Collocate
 - CoregistrationOp
 - Multi-size Mosaic
 - Reproject
 - Resample**
 - Image Analysis
 - Masks
 - Band Maths
 - Band Merge
 - Flip
 - Image-Filter
 - Subset
 - TemporalPercentile
- Tools
- Vector
- SmosNetcdfExport

Source Product
Name:
[1] S2A_MSIL1C_20170624T075611_N0205_R035_T37TGG_20170624T075954

Data Format: Any Format

Load Clear Note Save Help Run

1. Ac

[1] Sentinel 2 MSI Natural Colors RGB - S2A_MSIL1C_20170624T075611_N0205_R035_T37TGG_20170624T075954 - D:\PONTOS\Iraklis_Info\img\Calculate Chlorophyll_2017_2020\2017_06_24\S2A_MSIL1C_20170624T075611_N0205_R035_T37TGG_20170624T075954.SAFE\MTD_MSIL1C.xml -

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer X Pixel Info

- [1] S2A_MSIL1C_20170624T075611_N0205_R035_T37TGG_20170624T075954
 - Metadata
 - Vector Data
 - Bands
 - Masks

Graph Builder

File Graphs

Read Resample Write

Add Connect Graph

- Input-Output
- Optical
- Radar
- Raster
- Tools
- Vector
- SmosNetcdfExport

Classification

Data Conversion

DEM Tools

Geometric

Image Analysis

Masks

BandMaths

BandMerge

Flip

Image-Filter

Subset

TemporalPercentile

Source Product

Name:

[1] S2A_MSIL1C_20170624T075611_N0205_R035_T37TGG_20170624T075954

Data Format: Any Format

Load Clear Note Save Help Run

Navigation - [1] RGB Colour Manipulation - [1] Senti... Uncertainty Visualisation World View

1: 119.61

2. Add → Raster → Subset

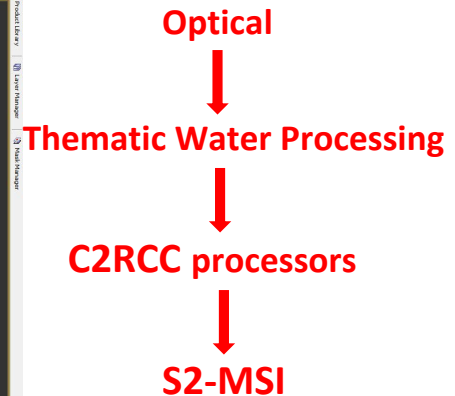
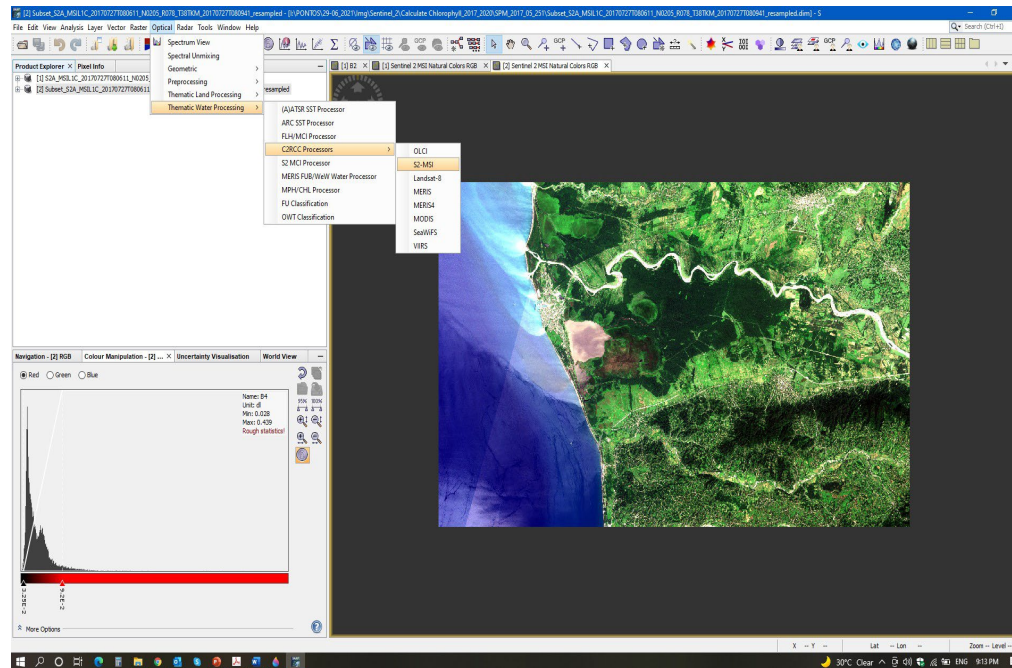


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The screenshot displays the Graph Builder software interface. The main workflow consists of four steps: **Read**, **Resample**, **Subset**, and **Write**. The **Resample** step is highlighted with a red box. Below the workflow, the **Read** step is expanded, showing **Geographic Coordinates** selected (highlighted with a red box) and a map of the Black Sea region. The **Update** button is also highlighted with a red box. A red arrow points from the **Update** button to the **Resample** step. The background shows a satellite image of a coastal area.

Calculating chlorophyll-a concentration from Sentinel-2 images using SNAP (Sentinel Application Platform)

C2RCC processor



Important variables:

- Salinity
- Temperature
- Ozone concentration
- Air pressure at sea level

Product Explorer x Pixel Info

[1] Subset_S2A_MSIL1C_20250922T080721_N0511_R035_T37TGG_20250922T085052_resampled

Navigation - [1] RGB x Colour Manipulation - [1] Sentinel ... Uncertainty Visualisation World View

1: 49.2 0°

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

C2RCC MSI Processor

File Help

I/O Parameters Processing Parameters

Source Products

MSI L1C product:

[1] Subset_S2A_MSIL1C_20250922T080721_N0511_R035_T37TGG_20250922T085052...

Ozone interpolation start product (TOMSOMI): (optional)

Ozone interpolation end product (TOMSOMI): (optional)

Air pressure interpolation start product (NCEP): (optional)

Air pressure interpolation end product (NCEP): (optional)

Target Product

Name:

_S2A_MSIL1C_20250922T080721_N0511_R035_T37TGG_20250922T085052_resampled_C2RCC

☒ Save as: BEAM-DIMAP

Directory:

D:\EfxINNOs_Project

☒ Open in SNAP 13

Run Close

File Help

C2RCC MSI Processor

File Help

I/O Parameters Processing Parameters

Valid-pixel expression: $B8 > 0.8/B8 < 0.1$

Salinity: 35.0 PSU

Temperature: 15.0 C

Ozone: 330.0 DU

Air Pressure at Sea Level: 1000.0 hPa

Elevation: 0.0 m

TSM factor: 1.06

TSM exponent: 0.942

CHL exponent: 1.04

CHL factor: 21.0

Threshold rtosa OOS: 0.05

Threshold AC reflectances OOS: 0.1

Threshold for cloud flag on down transmittance @865: 0.955

Atmospheric aux data path:

Alternative NN Path:

Set of neuronal nets: C2X-COMPLEX-Nets

☒ Output AC reflectances as rrs instead of rho_w

☐ Derive water reflectance from path radiance and transmittance

☒ Use ECMWF data, if available

Digital Elevation Model: Copernicus 90m Global DEM

☒ 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 reflectance

☒ Output out of scope values

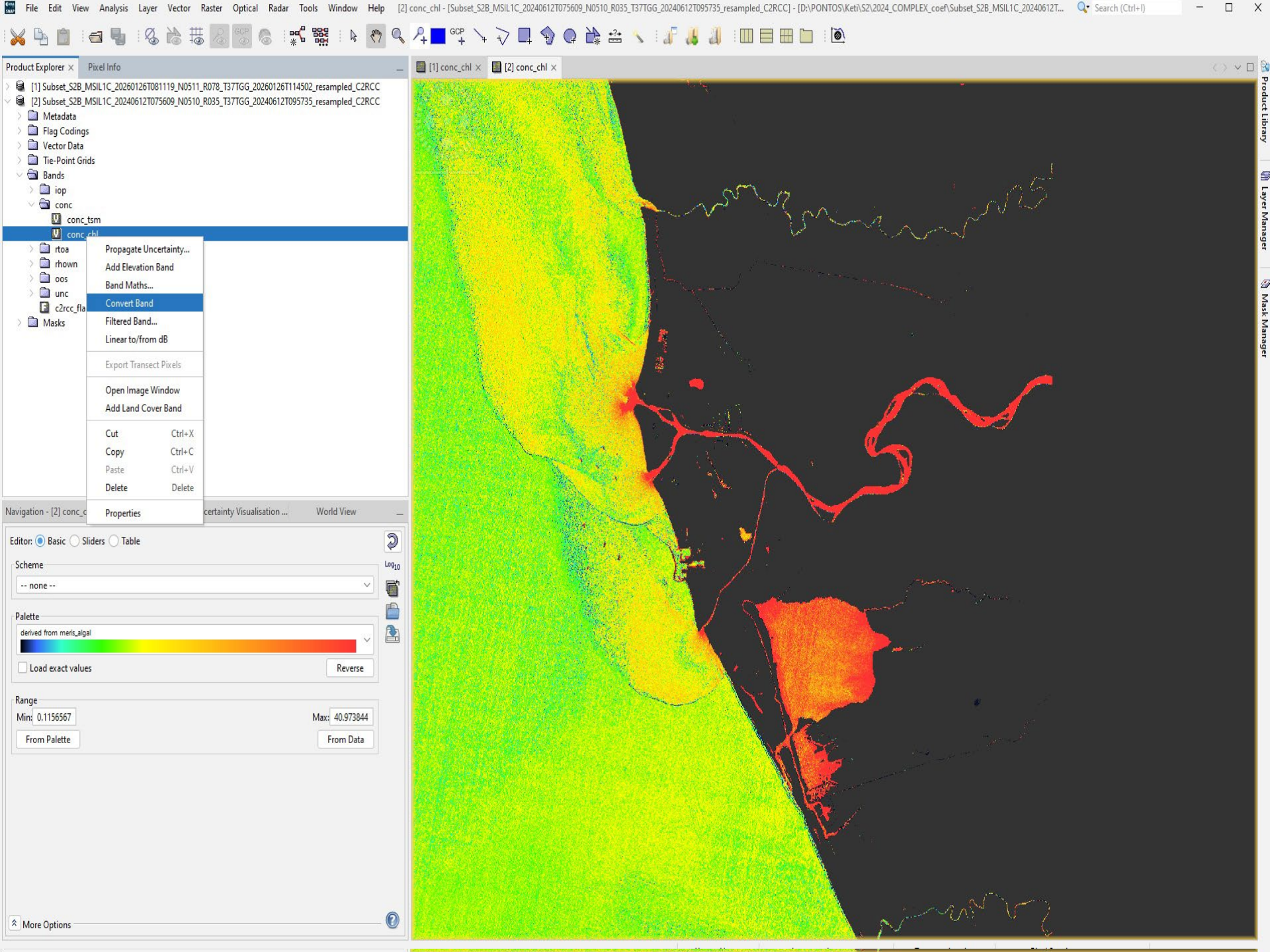
☐ Output irradiance attenuation coefficients

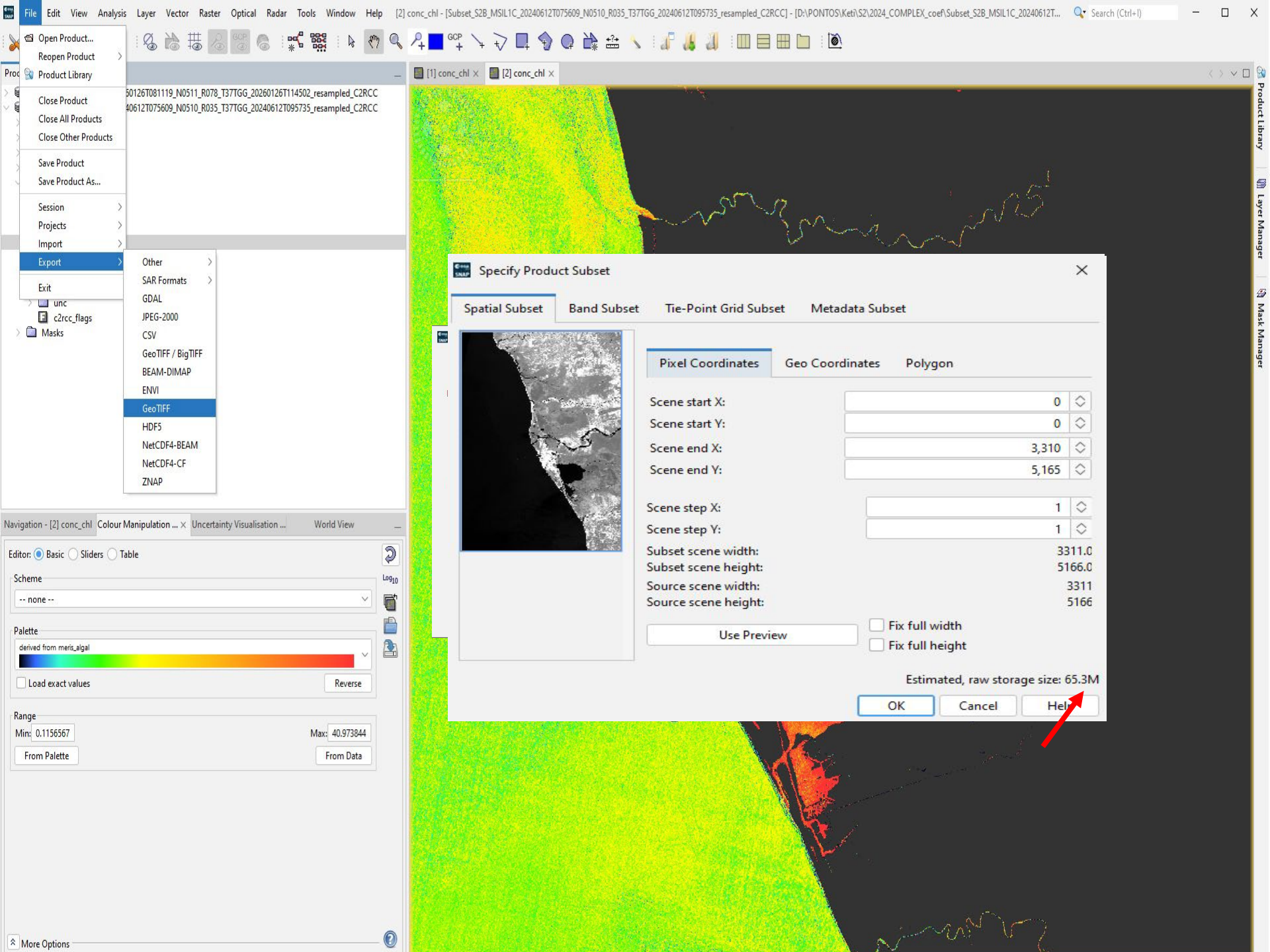
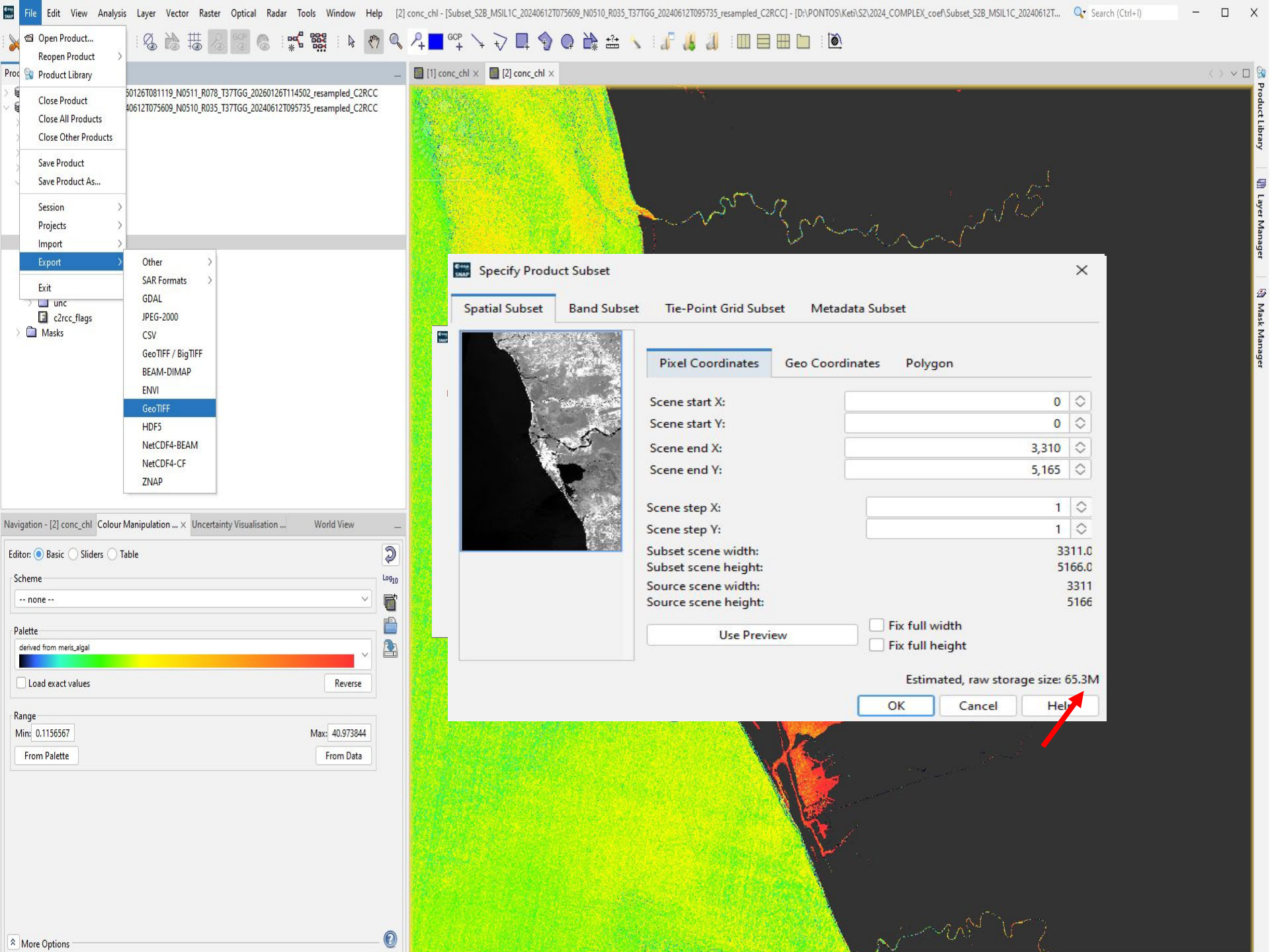
☒ Output uncertainties

Run Close

C2RCC-Nets

C2X-Nets





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Thank you!

