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EfxINNOs

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

Tbilisi, 17/04/2026

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Training on assessment of chlorophyll-a concentration

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

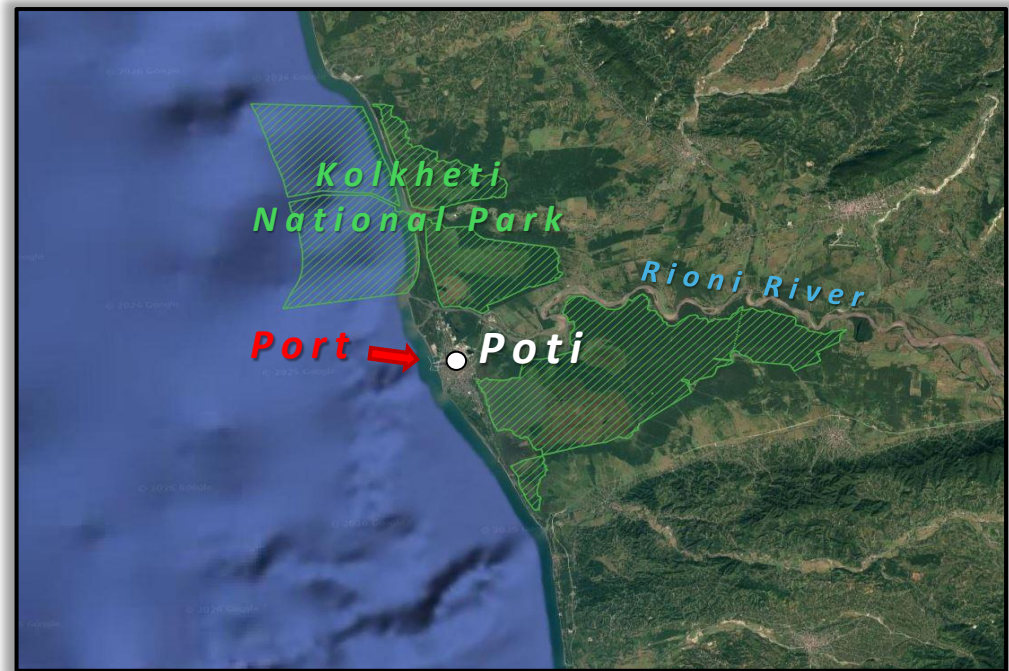
G. Mikeladze, N. Megvinetukhutsesi



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
Number
field

Product Unique
Identifier

level of product
processing

PDGS processing
baseline number

number

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



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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 is a search results panel with a list of satellite images. Each entry includes a thumbnail, mission name (SENTINEL-2), instrument (MSI), size, and sensing time. A blue selection box is overlaid on the map view, indicating the area of interest. The map shows a coastal region with a blue selection box. The interface also includes a search bar at the top right, a workspace area, and various map controls like zoom and pan.



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✓ Selecting the area

The screenshot displays the Copernicus Browser interface. On the left, a sidebar contains the following elements:

- Logo: Copernicus BROWSER
- Language: EN
- Workspace: Nutsa Megvinetuk...
- Buttons: VISUALISE, SEARCH
- Navigation: SH DASHBOARD, WORKSPACE
- DATE: SINGLE (with icons for calendar, globe, and refresh)
- Filter: < YYYY-MM-DD > 30%
- Action: Show latest date ↗
- Link: Find products for current view
- CONFIGURATION: Default
- DATA COLLECTIONS: Sentinel-2 (selected), Sentinel-2 L1C, Sentinel-2 L2A

The main map area shows a satellite view of the Black Sea Basin with a yellow rectangular selection box. The map includes labels for various locations and geographical features. The bottom status bar shows the coordinates: Lat: 41.112, Lng: 44.456 and a 20 km scale bar.



✓ Specifying the date



The screenshot shows the OpenMatics Browser interface. On the left, there is a sidebar with a search bar and a list of data layers: Sentinel Mosaics, CLMS Land Cover and Land Use in Priority Areas, CLMS Land Cover and Land Use Mapping, CLMS Bio-geophysical Parameters, and Complementary Data. Below these is a 'TIME RANGE:' section with 'From:' and 'Until:' date pickers. The 'From:' date is set to 2026-02-28 and the 'Until:' date is set to 2026-03-31. A calendar for June 2025 is visible below. A red circle highlights the date pickers, and a red arrow points to it from the text 'Specifying the date'. The main area shows a satellite map of the Black Sea Basin with a yellow bounding box. The top right corner has a search bar and a scale of 5806.69 km². The bottom of the interface shows logos for the European Union, OpenMatics, and ESA, along with a footer with 'v1.34.1', 'Leaflet | © OpenStreetMap contributors - Disclaimer, © Sentinel Hub', and coordinates 'Lat: 41.387, Long: 44.288' and a 20 km scale bar.

✓ choosing a satellite platform

✓ Determining cloudiness

The screenshot shows the Copernicus Browser interface. The left sidebar contains search criteria and data sources. Under 'DATA SOURCES', 'SENTINEL-2' is selected with a checkmark, and 'MSI' is also selected. A cloudiness slider is set to 25%. Below this, 'L1C' and 'L2A' are also listed. The main area shows a satellite image of the Black Sea Basin with a yellow rectangular selection box. The top right of the interface includes a search bar, a scale of 5806.69 km², and various map controls. The bottom of the interface shows logos for the European Union, Copernicus, and ESA, along with version information (v1.34.1) and a disclaimer.

✓ check selected
image settings
and download

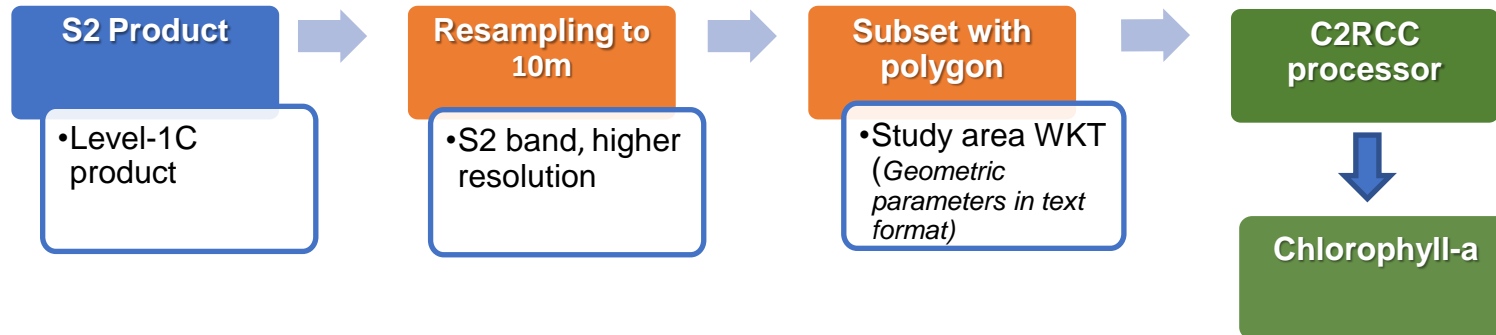


The screenshot shows the Copernicus Browser interface. On the left, a sidebar contains a search bar and a list of 22 satellite image results. The third result is selected, indicated by a checkmark in its thumbnail. A red circle highlights the 'Visualise' button for this selected entry. The main area displays a satellite map of a region in the Black Sea Basin, with a blue rectangular area of interest overlaid. The map includes various UI elements like a search bar, scale (5806.69 km²), and navigation tools. The footer contains logos for Copernicus, ESA, and Leaflet, along with a disclaimer.

Thumbnail	Filename	Mission	Instrument	Size	Sensing time	Visualise	Info	Download
	_202603141113448_SAF-E	SENTINEL-2	MSI	731MB	2026-03-14T07:56:09.024000Z	Visualise	Info	Download
	S2C_MSIL1C_20260312T080731_N0512_R078_T37TFH_20260312T101921_SAFE	SENTINEL-2	MSI	675MB	2026-03-12T08:07:31.025000Z	Visualise	Info	Download
	S2C_MSIL1C_20260312T080731_N0512_R078_T38TKM_20260312T101921_SAFE	SENTINEL-2	MSI	650MB	2026-03-12T08:07:31.025000Z	Visualise	Info	Download
	S2C_MSIL1C_20260312T080731_N0512_R078_T37TFG_20260312T101921_SAFE	SENTINEL-2	MSI	491MB	2026-03-12T08:07:31.025000Z	Visualise	Info	Download
	S2C_MSIL1C_20260312T080731_N0512_R078_T37TGG_20260312T101921_SAFE	SENTINEL-2	MSI	632MB	2026-03-12T08:07:31.025000Z	Visualise	Info	Download
	S2C_MSIL1C_20260312T080731_N0512_R078_T37TGH_20260312T101921_SAFE	SENTINEL-2	MSI	833MB	2026-03-12T08:07:31.025000Z	Visualise	Info	Download
	S2A_MSIL1C_20260311T080021_N0512_R035_T37TGG_20260311T100431_SAFE	SENTINEL-2	MSI	814MB	2026-03-11T08:00:21.024000Z	Visualise	Info	Download

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.

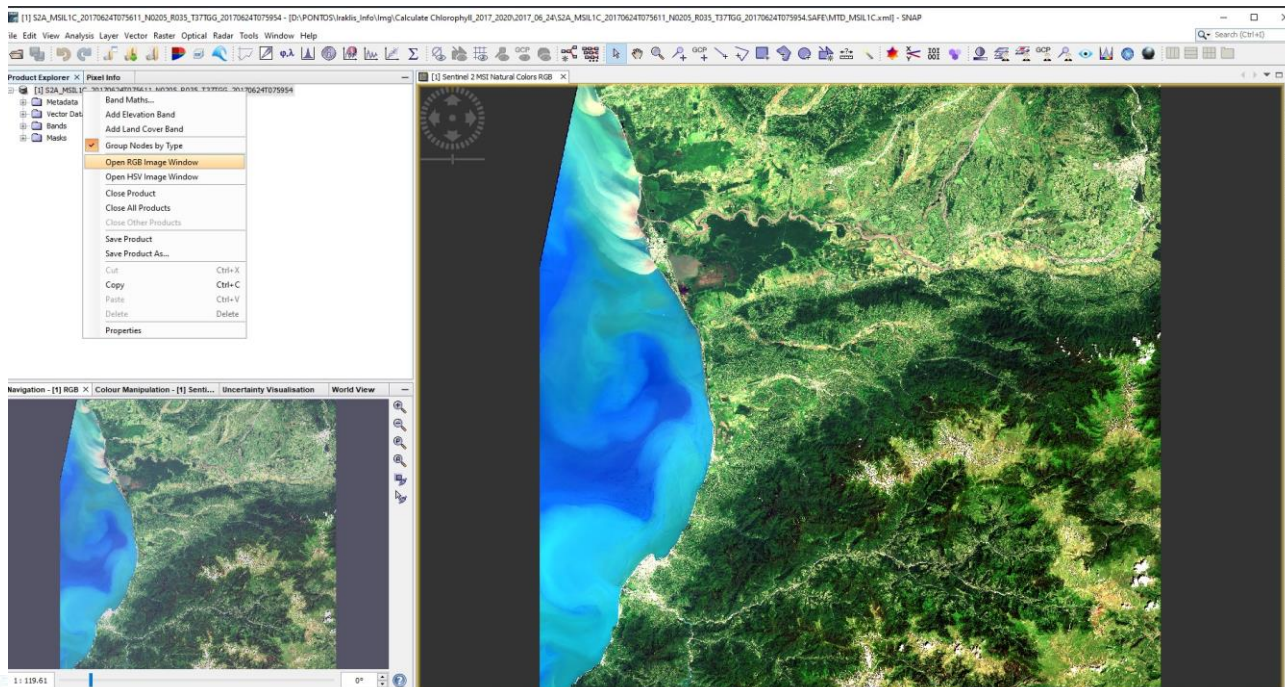
The processor is based on neural networks trained to perform the following tasks:

- 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



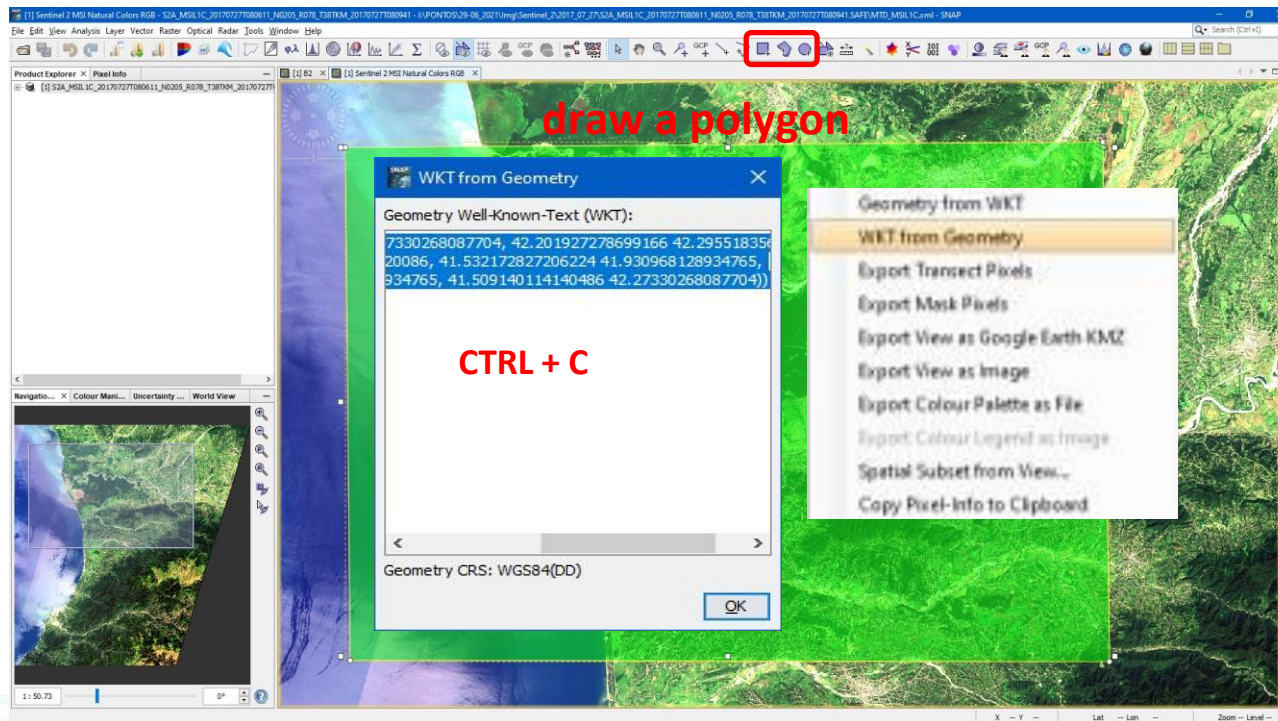
Calculating chlorophyll-a concentration from Sentinel-2 images using SNAP (Sentinel Application Platform)



Import and
visualization of
satellite imagery

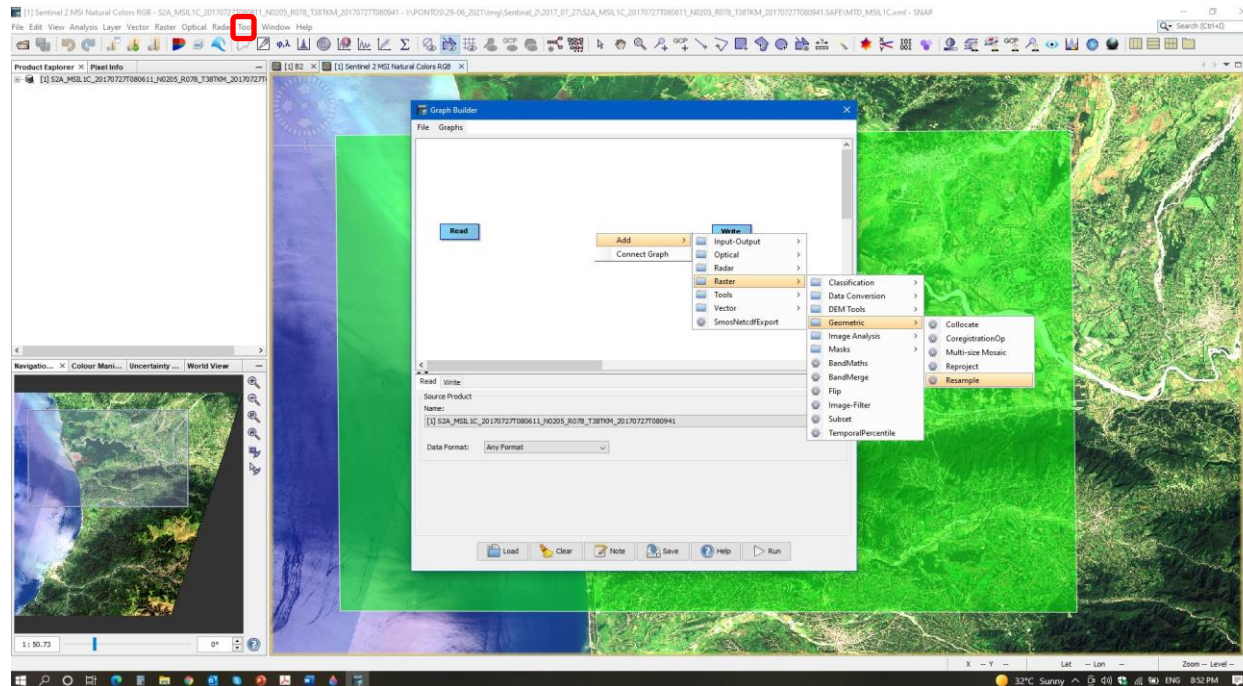


Calculating chlorophyll-a concentration from Sentinel-2 images using SNAP (Sentinel Application Platform)



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 software interface. The main window is titled "Graph Builder" and contains a "File" menu and a "Graphs" panel. The "File" menu is open, showing options like "Add", "Connect Graph", and "SmosNetcdfExport". The "Raster" option is selected, opening a sub-menu with "Classification", "Data Conversion", "DEM Tools", "Geometric", "Image Analysis", "Masks", "Band Maths", "Band Merge", "Flip", "Image-Filter", "Subset", and "Temporal Percentile". The "Geometric" sub-menu is further open, showing "Collocate", "CoregistrationOp", "Multi-size Mosaic", "Reproject", and "Resample". The "Resample" option is highlighted. Below the menu, there are fields for "Source Product" (Name: [1] S2A_MSIL1C_20170624T075611_N0205_R035_T37TGG_20170624T075954) and "Data Format" (Any Format). At the bottom, there are buttons for "Load", "Clear", "Note", "Save", "Help", and "Run".

1. Ac



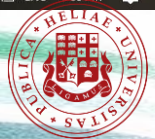
The screenshot shows the QGIS Graph Builder window. The 'Add' menu is open, showing a tree structure of tool categories. The 'Raster' category is expanded, and the 'Subset' tool is selected. The 'Source Product' field is populated with the file path: [1] S2A_MSIL1C_20170624T075611_N0205_R035_T37TGG_20170624T075611_N0205_R035_T37TGG_20170624T075954.SAFE.MTD_MSIL1C.xml. The 'Data Format' is set to 'Any Format'. The 'Run' button is visible at the bottom of the Graph Builder window.

2. Add → Raster → Subset



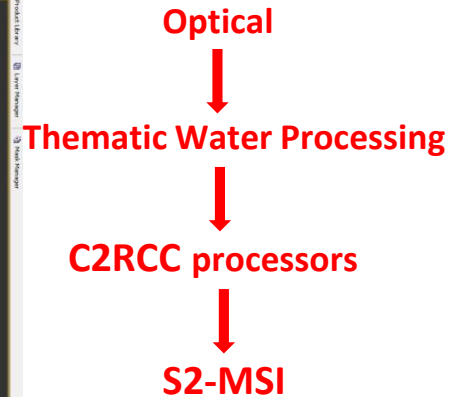
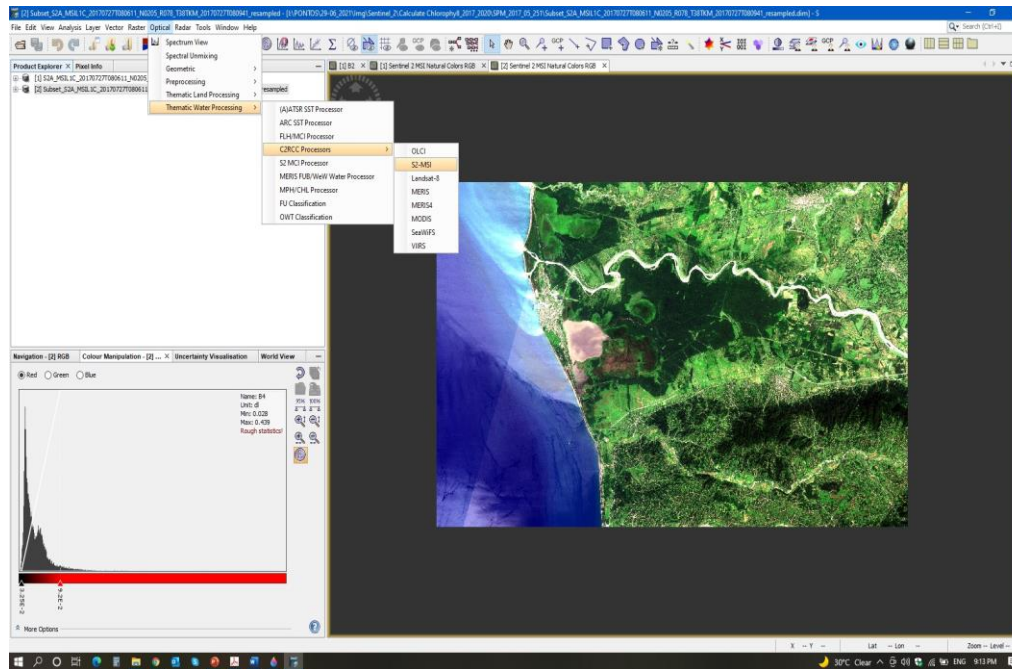
NEXT Black Sea Basin

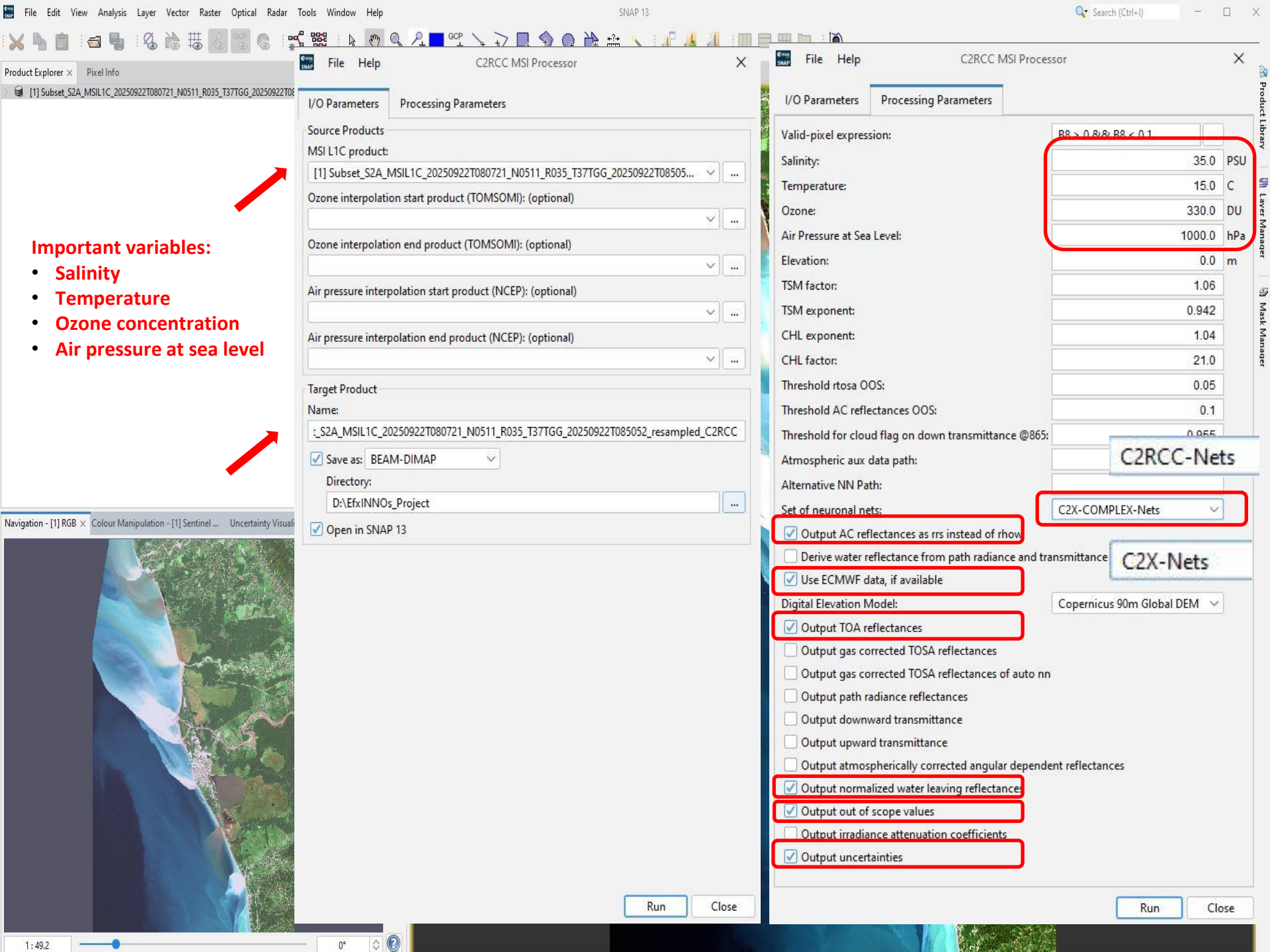
The screenshot displays the Graph Builder software interface. At the top, a workflow graph consists of four blue rectangular nodes connected by red arrows: **Read** → **Resample** → **Subset** → **Write**. Below the graph, the 'Read' node is selected, and its configuration panel is visible. It features two radio buttons: Pixel Coordinates and Geographic Coordinates. The 'Reference band' is set to 'B1'. A map view below shows a satellite image of the Black Sea region with a yellow rectangular selection box. At the bottom of the configuration panel, there is an 'Update' button. The main toolbar at the bottom of the software includes buttons for 'Load', 'Clear', 'Note', 'Save', 'Help', and 'Run'. A red arrow points from the 'Save' button in the toolbar to the 'Update' button in the configuration panel. The background of the software interface shows a satellite map with a green vertical strip indicating the area of interest.



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**

I/O Parameters | Processing Parameters

Source Products

MSI L1C product:
[1] Subset_S2A_MSIL1C_20250922T080721_N0511_R035_T37TGG_20250922T08505... [v] [...]

Ozone interpolation start product (TOMSOMI): (optional)
[v] [...]

Ozone interpolation end product (TOMSOMI): (optional)
[v] [...]

Air pressure interpolation start product (NCEP): (optional)
[v] [...]

Air pressure interpolation end product (NCEP): (optional)
[v] [...]

Target Product

Name:
_S2A_MSIL1C_20250922T080721_N0511_R035_T37TGG_20250922T085052_resampled_C2RCC

Save as: BEAM-DIMAP [v]

Directory:
D:\Efx\INNOs_Project [v]

Open in SNAP 13

Run Close

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 rtoa OOS:	0.05	
Threshold AC reflectances OOS:	0.1	
Threshold for cloud flag on down transmittance @865:	0.065	

Atmospheric aux data path:
C2RCC-Nets

Alternative NN Path:
C2X-COMPLEX-Nets [v]

Set of neuronal 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 [v]

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



Product Explorer x Pixel Info

- [1] Subset_S2B_MSIL1C_20260126T081119_N0511_R078_T37TGG_20260126T114502_resampled_C2RCC
- [2] Subset_S2B_MSIL1C_20240612T075609_N0510_R035_T37TGG_20240612T095735_resampled_C2RCC
- Metadata
- Flag Codings
- Vector Data
- Tie-Point Grids
- Bands
 - iop
 - conc
 - conc_tsm
 - conc_chl**
- Masks
 - rtoa
 - rhorn
 - oos
 - unc
 - c2rcc fla

Context menu for conc_chl:

- Propagate Uncertainty...
- Add Elevation Band
- Band Maths...
- Convert Band**
- Filtered Band...
- Linear to/from dB
- Export Transect Pixels
- Open Image Window
- Add Land Cover Band
- Cut Ctrl+X
- Copy Ctrl+C
- Paste Ctrl+V
- Delete Delete

Navigation - [2] conc_c certainty Visualisation ... World View

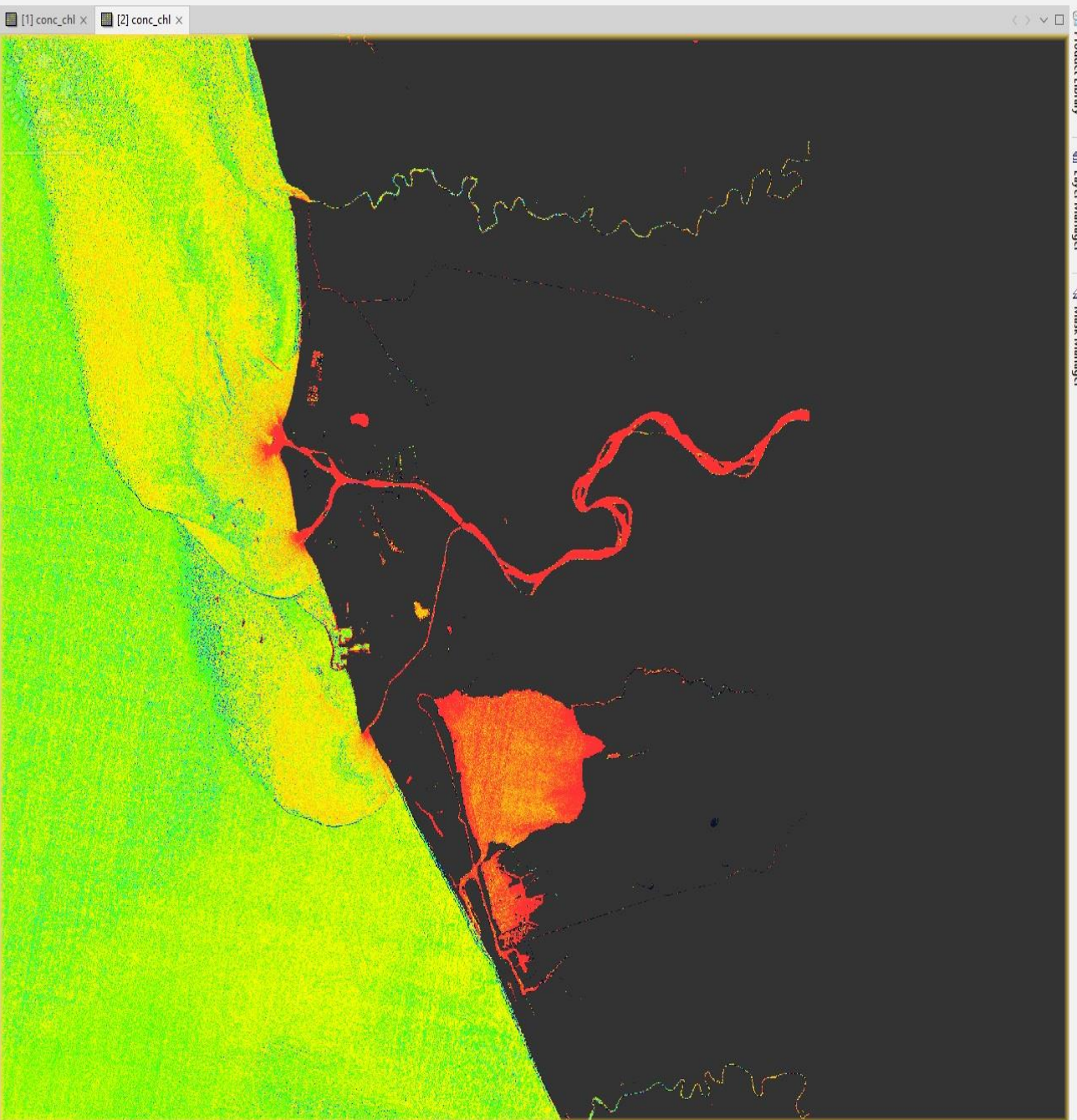
Editor: Basic Sliders Table

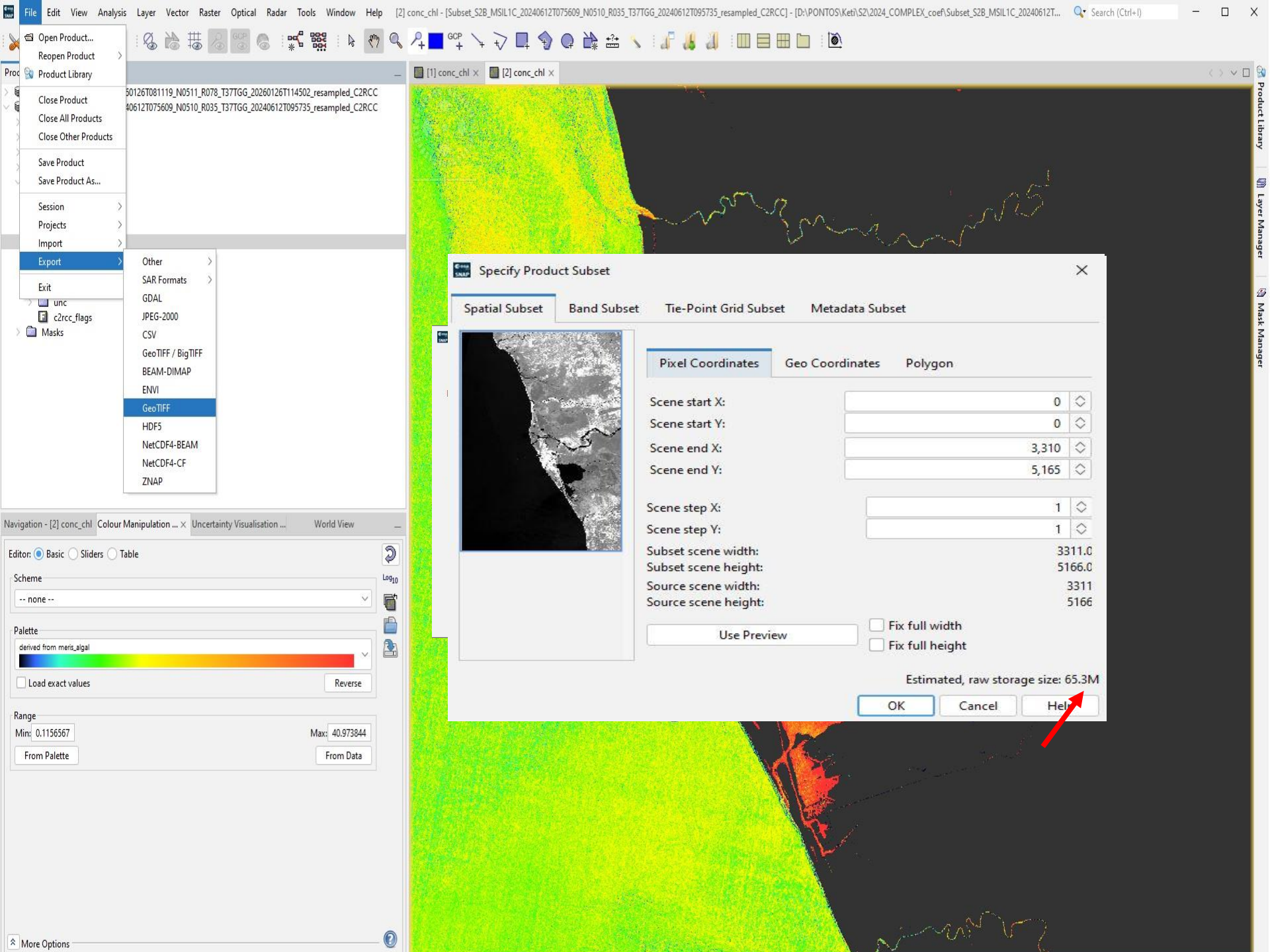
Scheme: -- none --

Palette: derived from meris_algal

Load exact values

Range: Min: 0.1156567 Max: 40.973844





Open Product...
Reopen Product >
Product Library
Close Product
Close All Products
Close Other Products
Save Product
Save Product As...
Session >
Projects >
Import >
Export >
Exit

Other >
SAR Formats >
GDAL
JPEG-2000
CSV
GeoTIFF / BigTIFF
BEAM-DIMAP
ENVI
GeoTIFF
HDF5
NetCDF4-BEAM
NetCDF4-CF
ZNAP

Editor: Basic Sliders Table

Scheme: -- none --

Palette: derived from meris_algal

Load exact values Reverse

Range: Min: 0.1156567 Max: 40.973844
From Palette From Data

Specify Product Subset

Spatial Subset Band Subset Tie-Point Grid Subset Metadata Subset

Pixel Coordinates Geo Coordinates Polygon

Scene start X: 0
Scene start Y: 0
Scene end X: 3,310
Scene end Y: 5,165
Scene step X: 1
Scene step Y: 1

Subset scene width: 3311.0
Subset scene height: 5166.0
Source scene width: 3311
Source scene height: 5166

Use Preview Fix full width Fix full height

Estimated, raw storage size: 65.3M

OK Cancel Help

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Thank you!

