Interreg

Co-funded by the European Union

NEXT Black Sea Basin

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

Interreg

Co-funded by the European Union

NEXT Black Sea Basin

EfxINNOs

Training on assessment of chlorophyll-a concentration

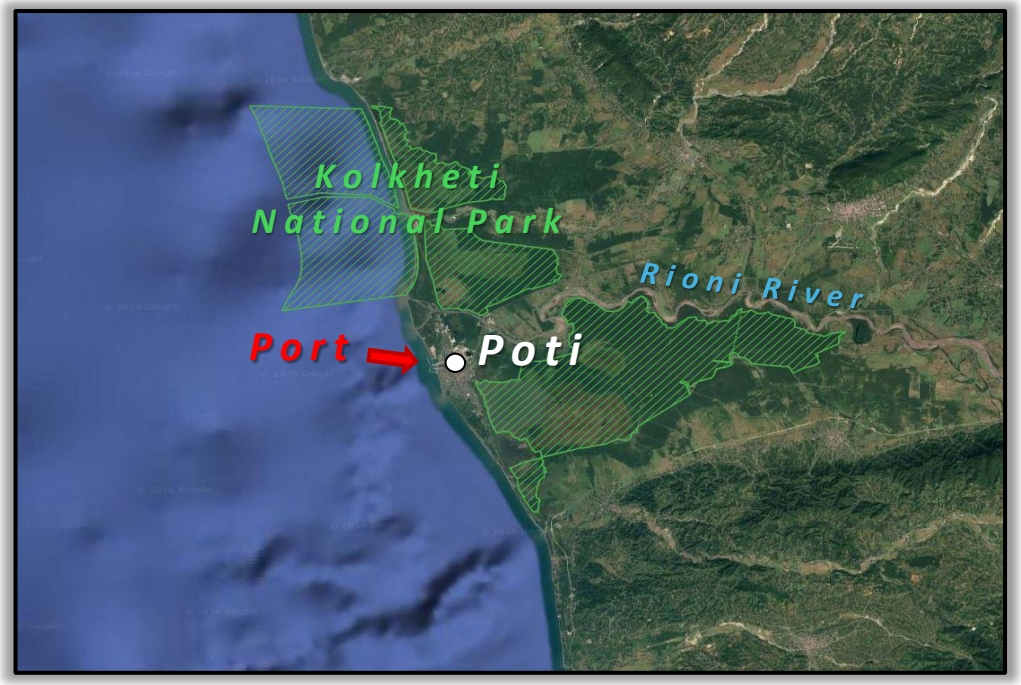
Methodology For Calculating Chlorophyll-a Concentration From Sentinel-2 Images Using SNAP (Sentinel Application Platform)

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).

Sentinel naming scheme

S2A _MSIL1C _ 20240312T080731 _N0510 _ R078 _T37TGG _20240312T085424.SAFE

- **Mission ID**
- **Acquisition time**
- **Relative Orbit number**
- **Tile Number field**
- **Product Unique Identifier**
- **level of product processing**
- **PDGS processing baseline number**

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

Interreg

Co-funded by the European Union

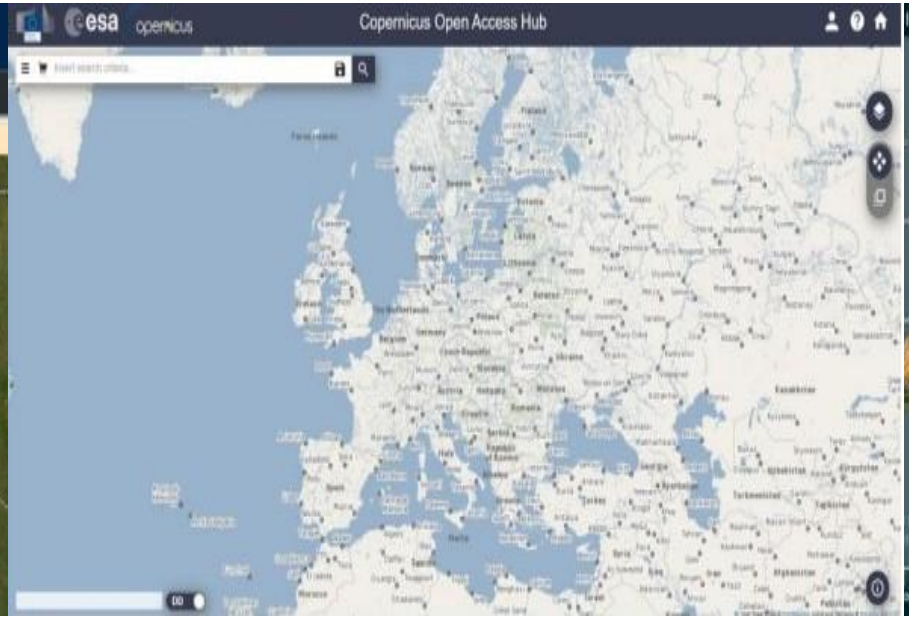
NEXT Black Sea Basin

EfxINNOs

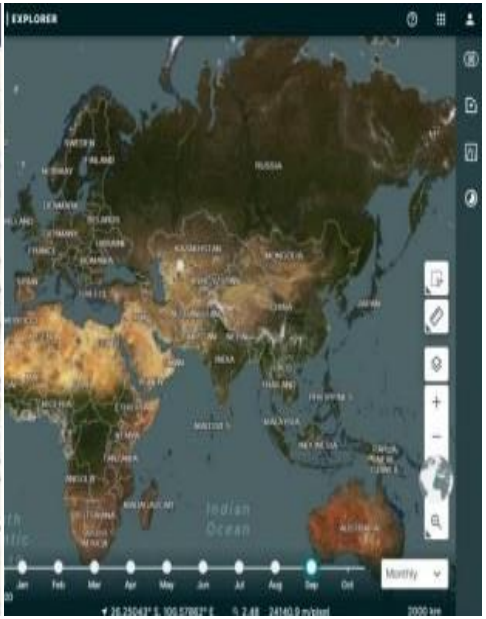
How To Download Satellite Imagery From Open-Access Geospatial Data Portals

Open-source databases for satellite images

https://earthexplorer.usgs.gov/



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

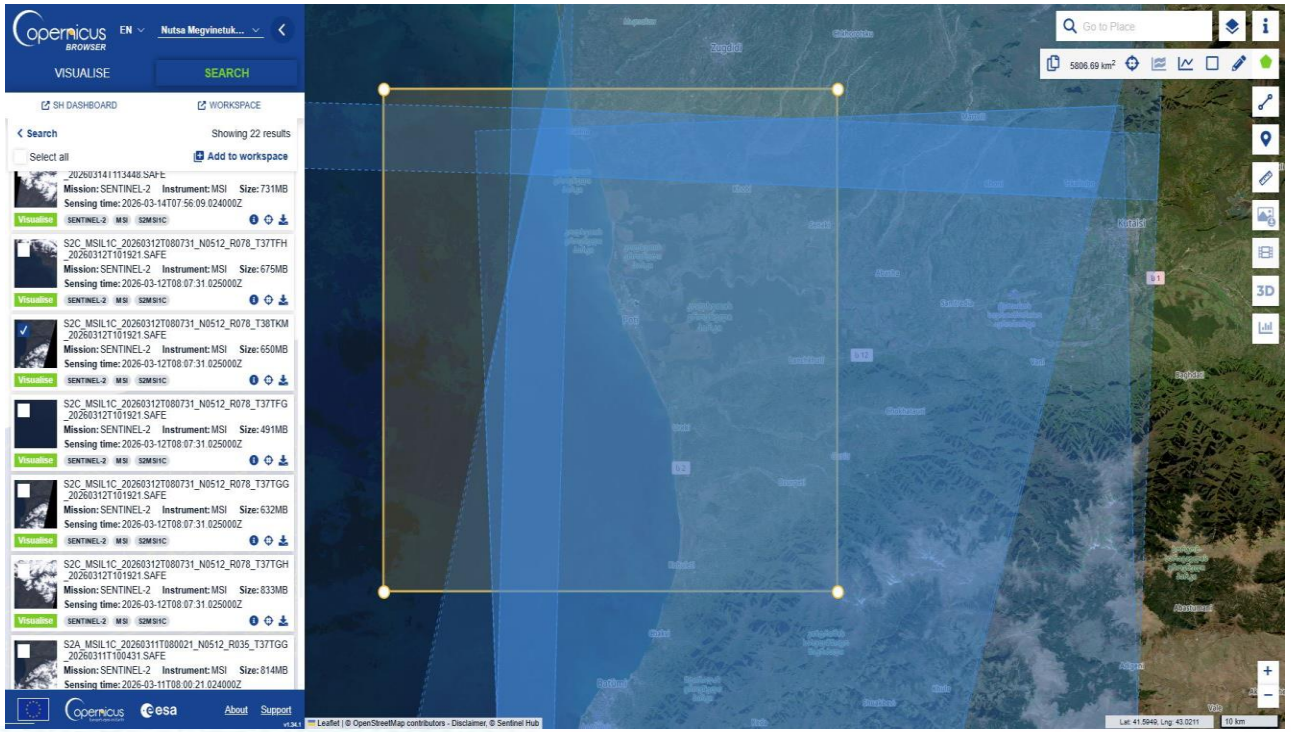


https://www.planet.com/explorer

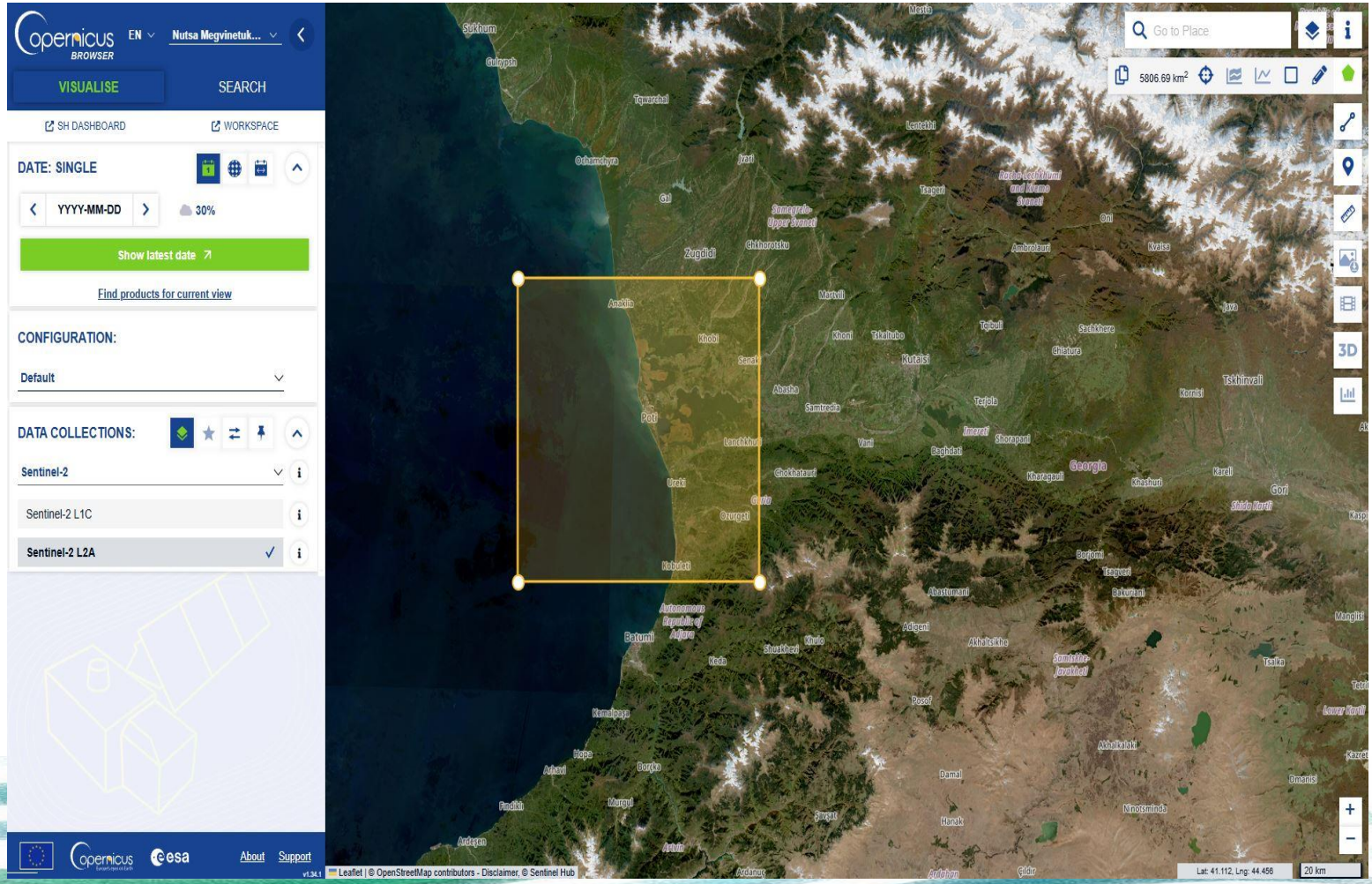
Selection and downloading satellite images

Sentinel 2 (10m)

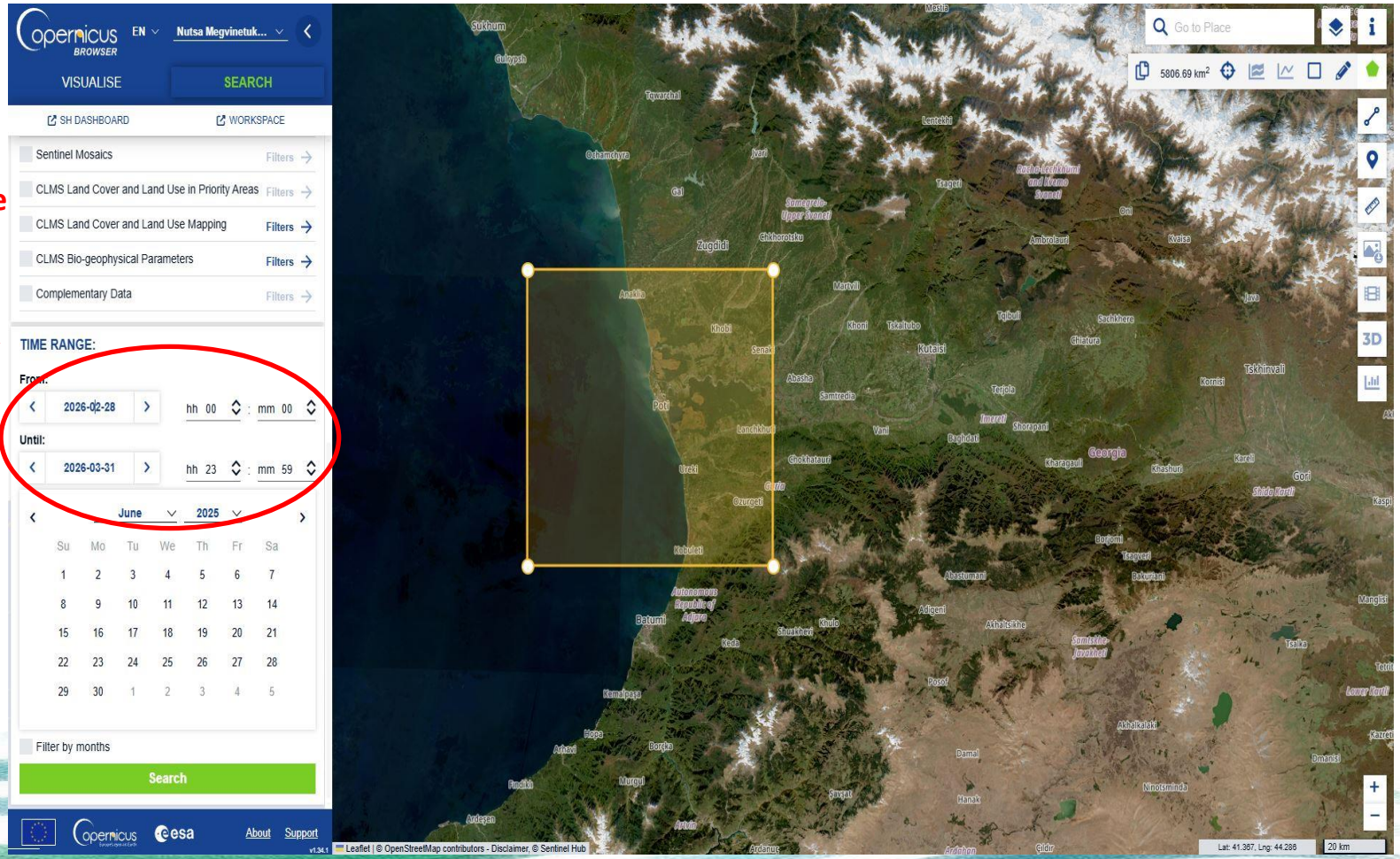
- ✓ **Selecting the area**
- ✓ **Specifying the date**
- ✓ **choosing a satellite platform**
- ✓ **Determining cloudiness**



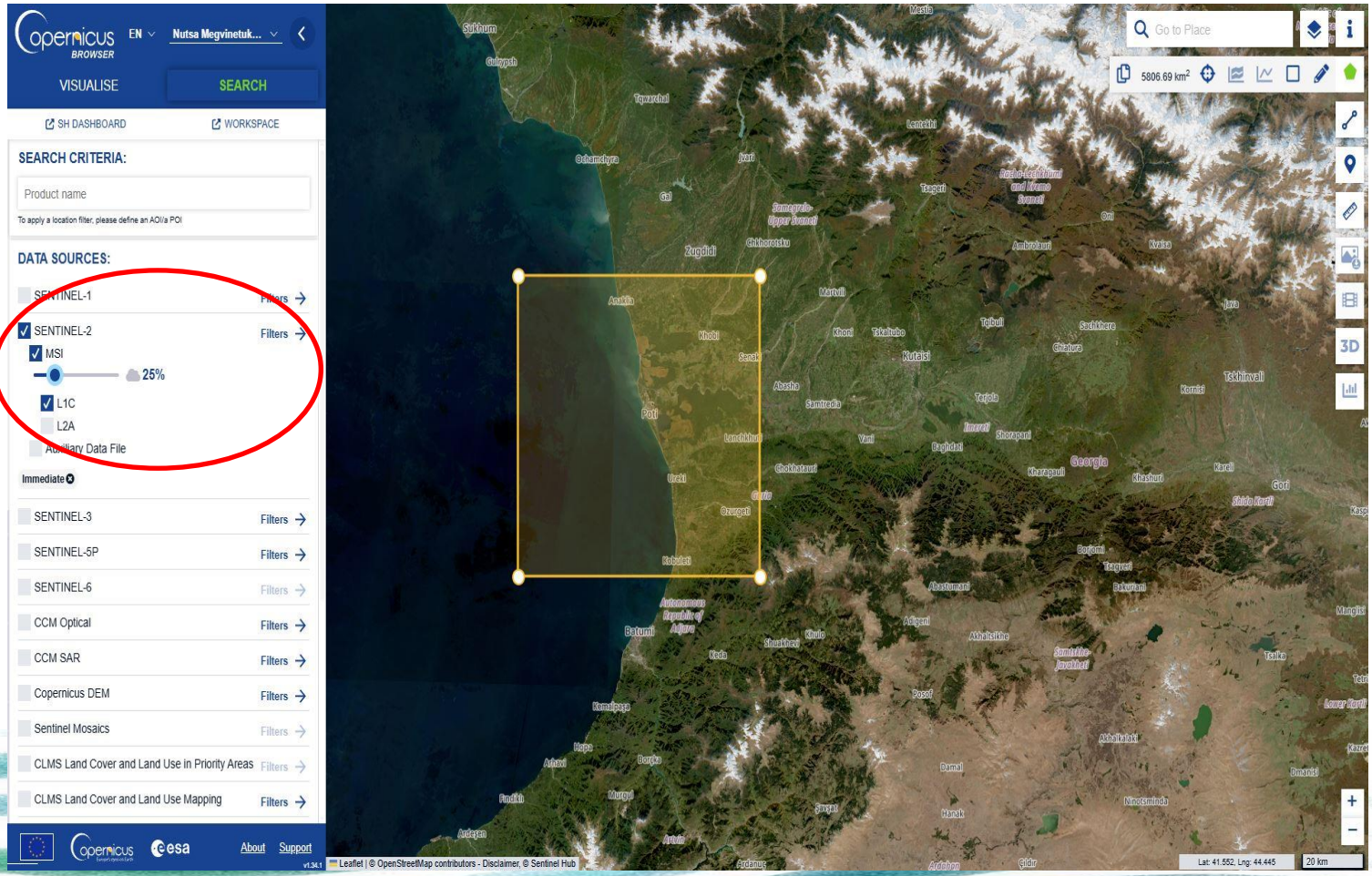
✓ **Selecting the area**



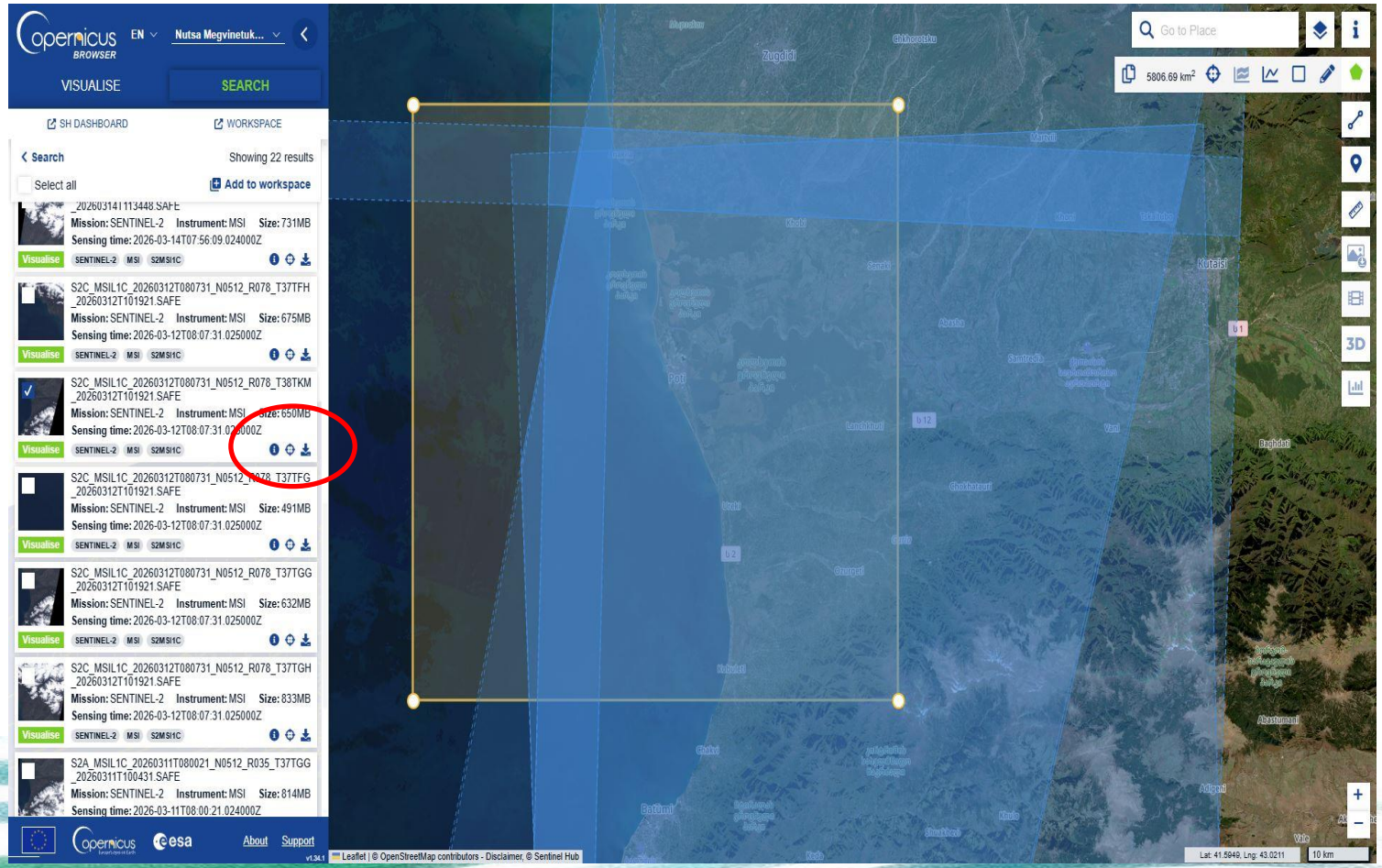
✓ **Specifying the date**



- ✓ choosing a satellite platform
- ✓ Determining cloudiness

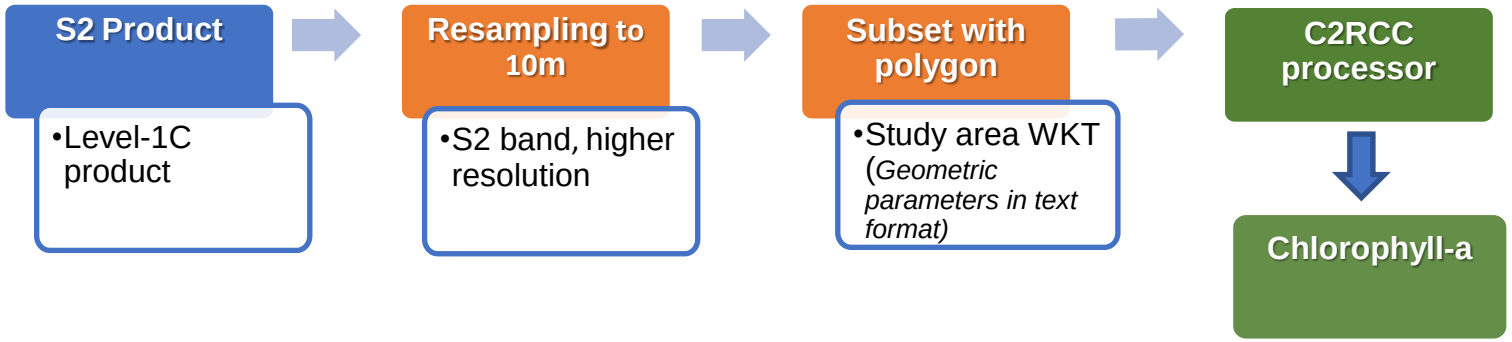


✓ **check selected image settings and download**



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

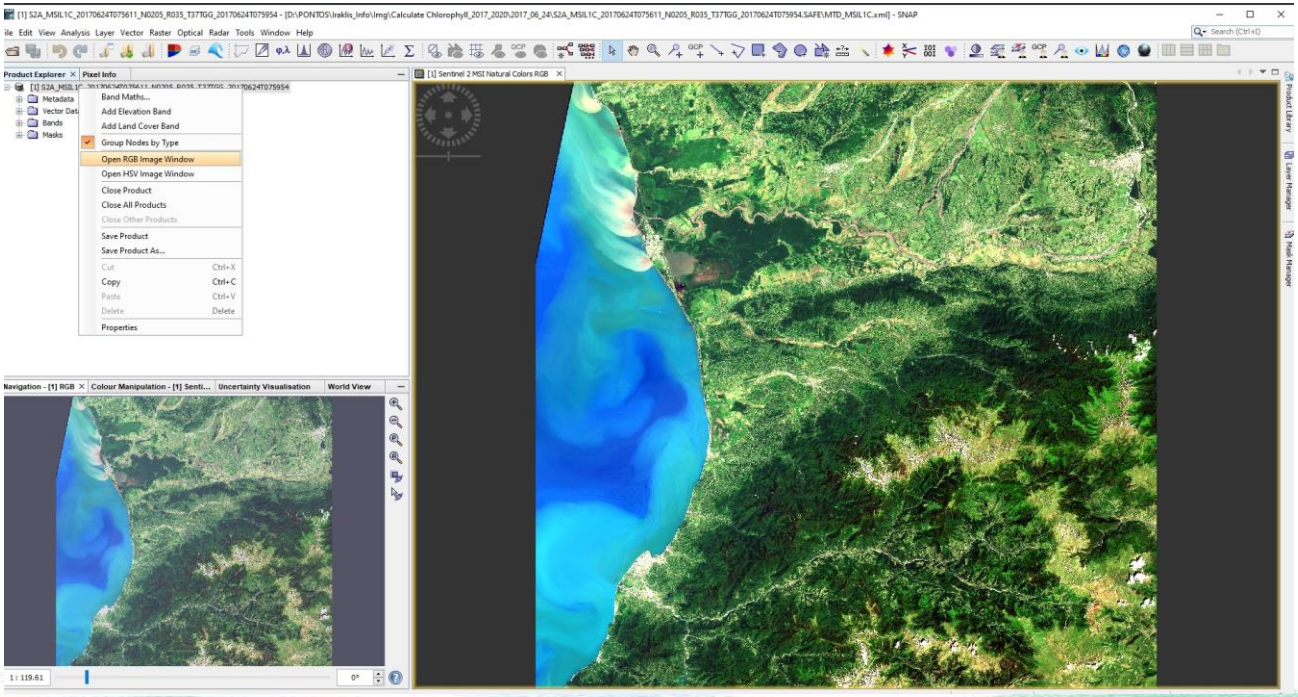
Conversion of "IOPs into concentrations" is carried out using scaling factors

Interreg Co-funded by the European Union

NEXT Black Sea Basin

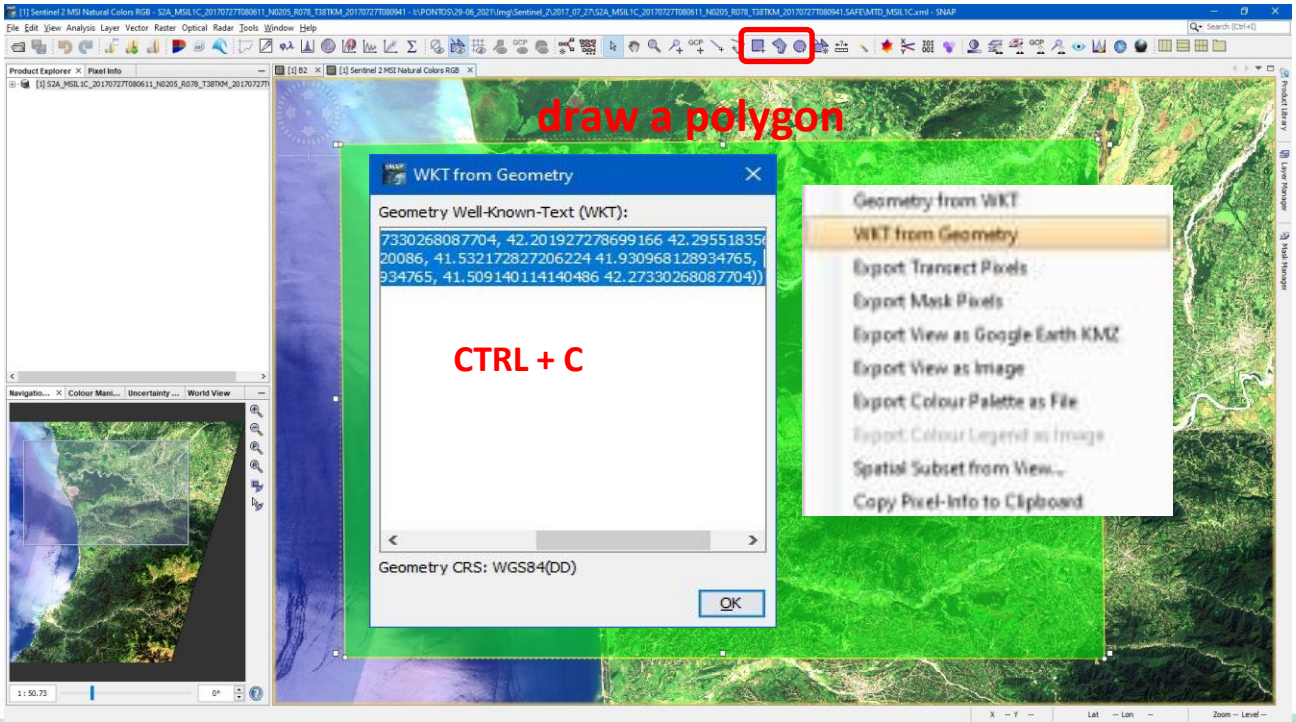
EfxINNOs

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)

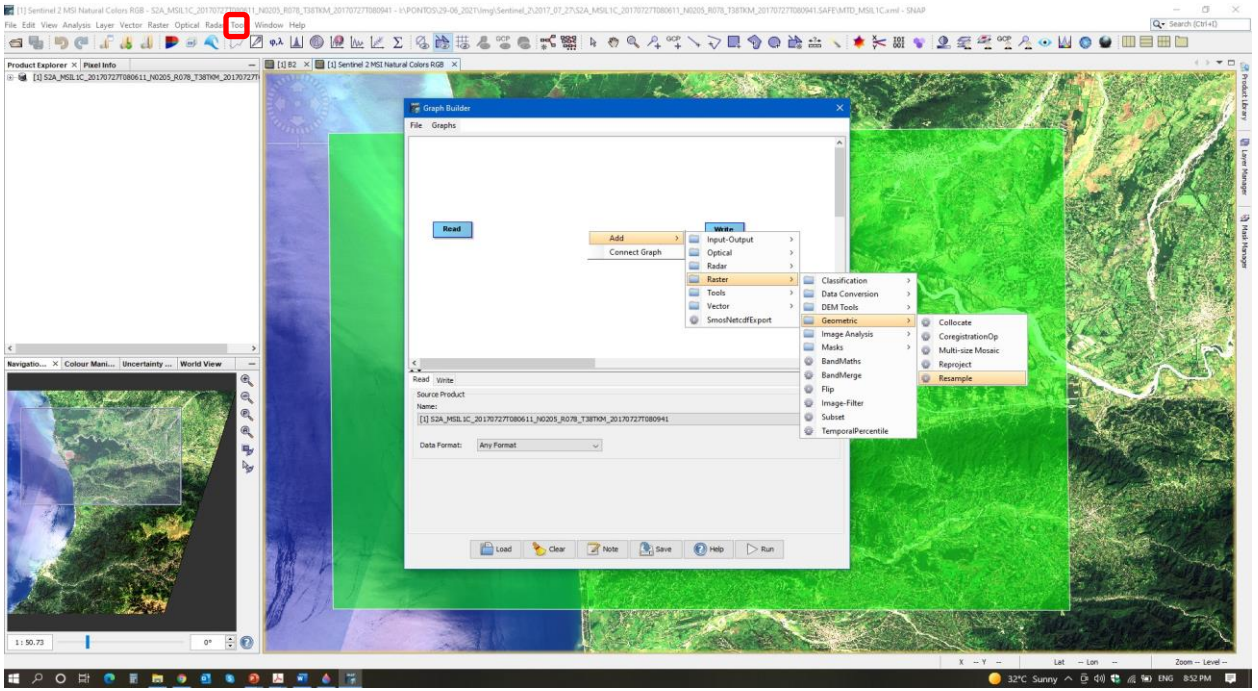


WKT - geometric parameters in text format

Tools

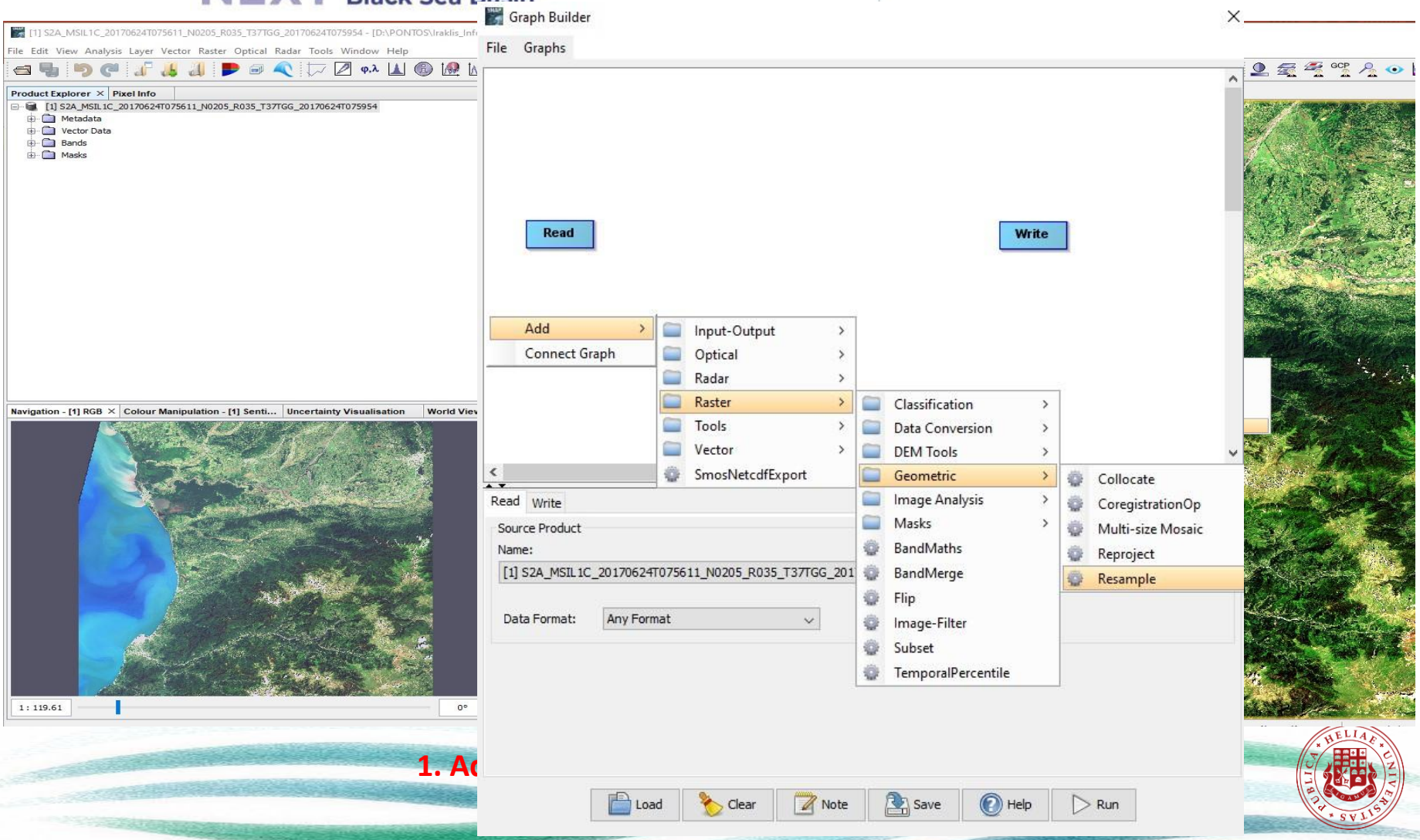
↓

Graph Builder

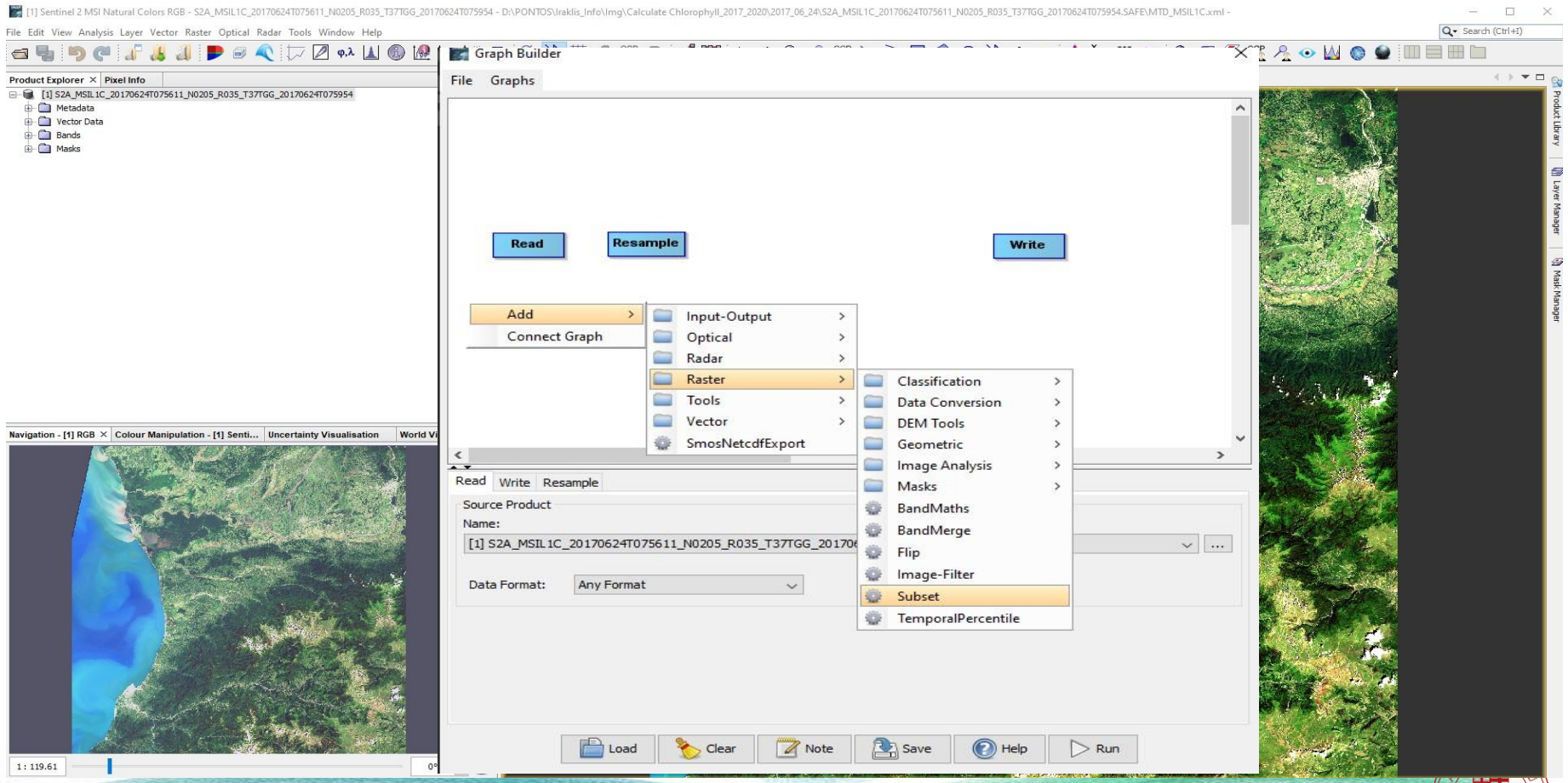


1. Add ➔ Raster ➔ Geometric ➔ Resample

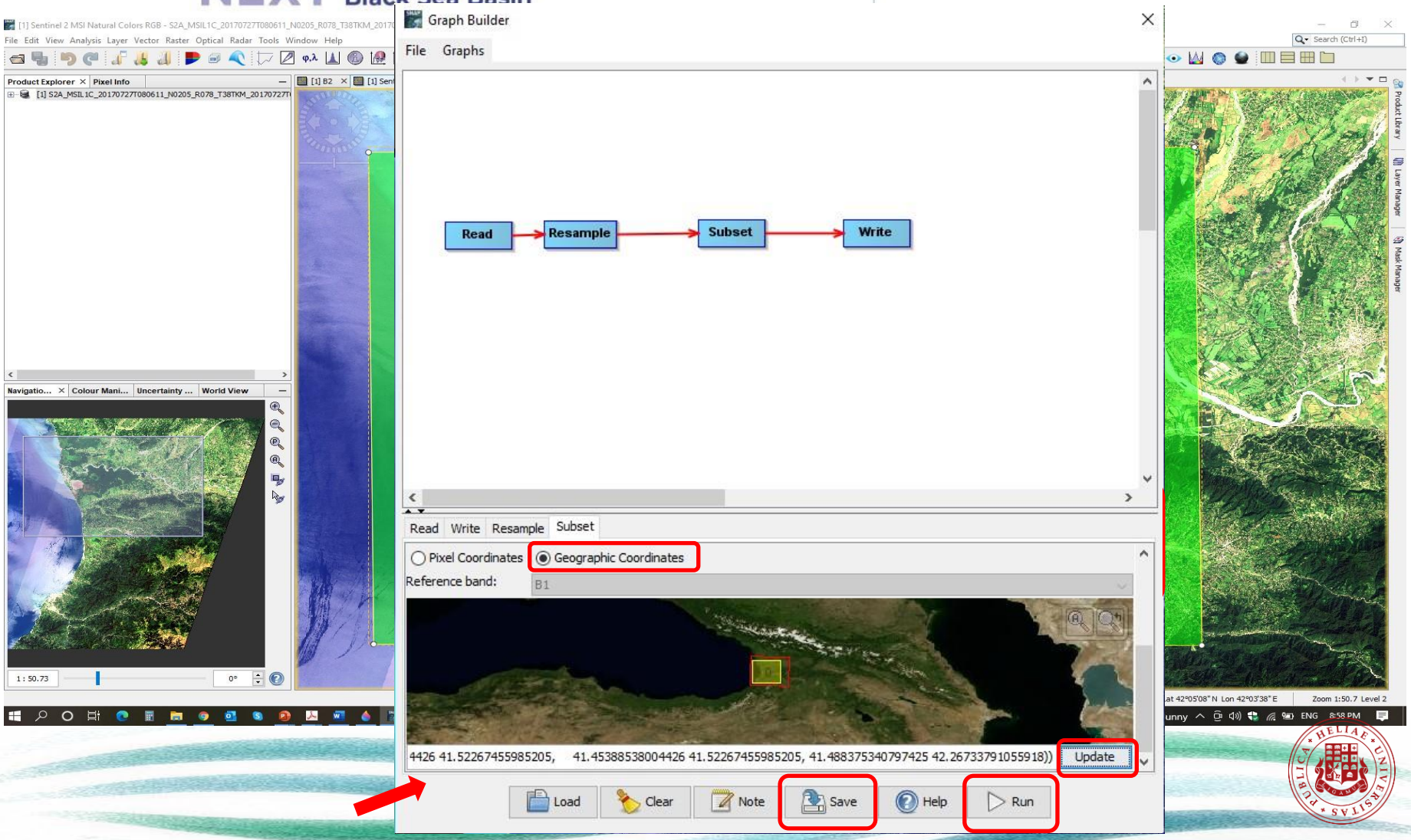
2. Add ➔ Raster ➔ Subset


Graph Builder
File
Graphs
Read
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
Collocate
CoregistrationOp
Multi-size Mosaic
Reproject
Resample
Read
Write
Source Product
Name:
[1] S2A_MSIL1C_20170624T075611_N0205_R035_T37TGG_201
Data Format:
Any Format
Load
Clear
Note
Save
Help
Run
Product Explorer
Pixel Info
[1] S2A_MSIL1C_20170624T075611_N0205_R035_T37TGG_20170624T075954
Metadata
Vector Data
Bands
Masks
Navigation - [1] RGB
Colour Manipulation - [1] Senti...
Uncertainty Visualisation
1 : 119.61
0°

1. Ac

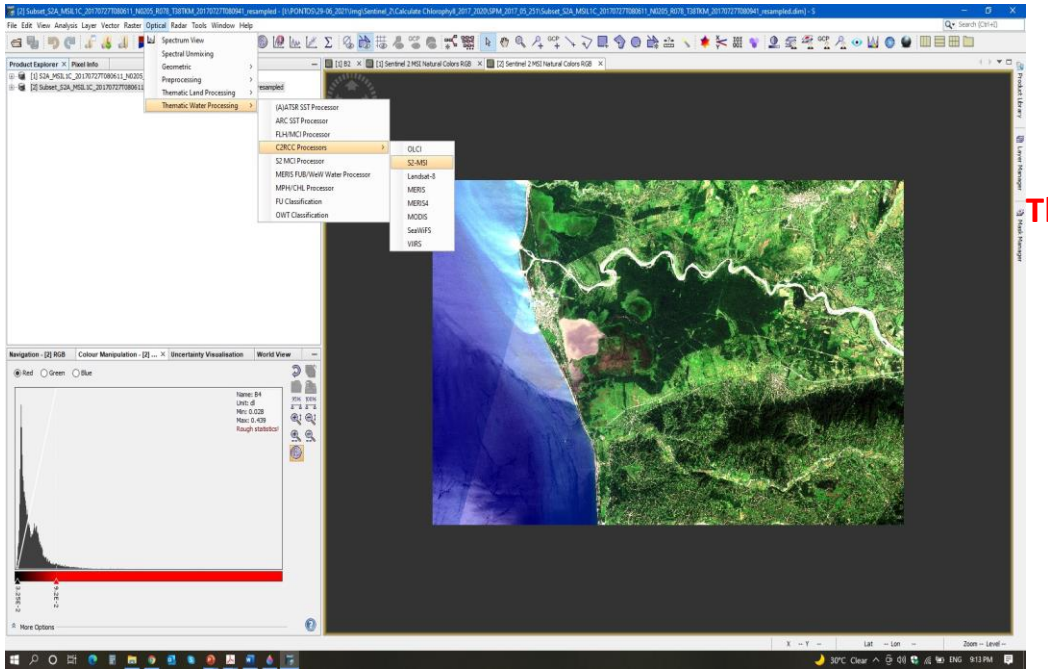


2. Add ➔ Raster ➔ Subset


Graph Builder
File
Graphs
Read
Resample
Subset
Write
Read
Write
Resample
Subset
Pixel Coordinates
Geographic Coordinates
Reference band:
B1
4426 41.52267455985205, 41.45388538004426 41.52267455985205, 41.488375340797425 42.26733791055918))
Update
Load
Clear
Note
Save
Help
Run

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

C2RCC processor



Optical

↓

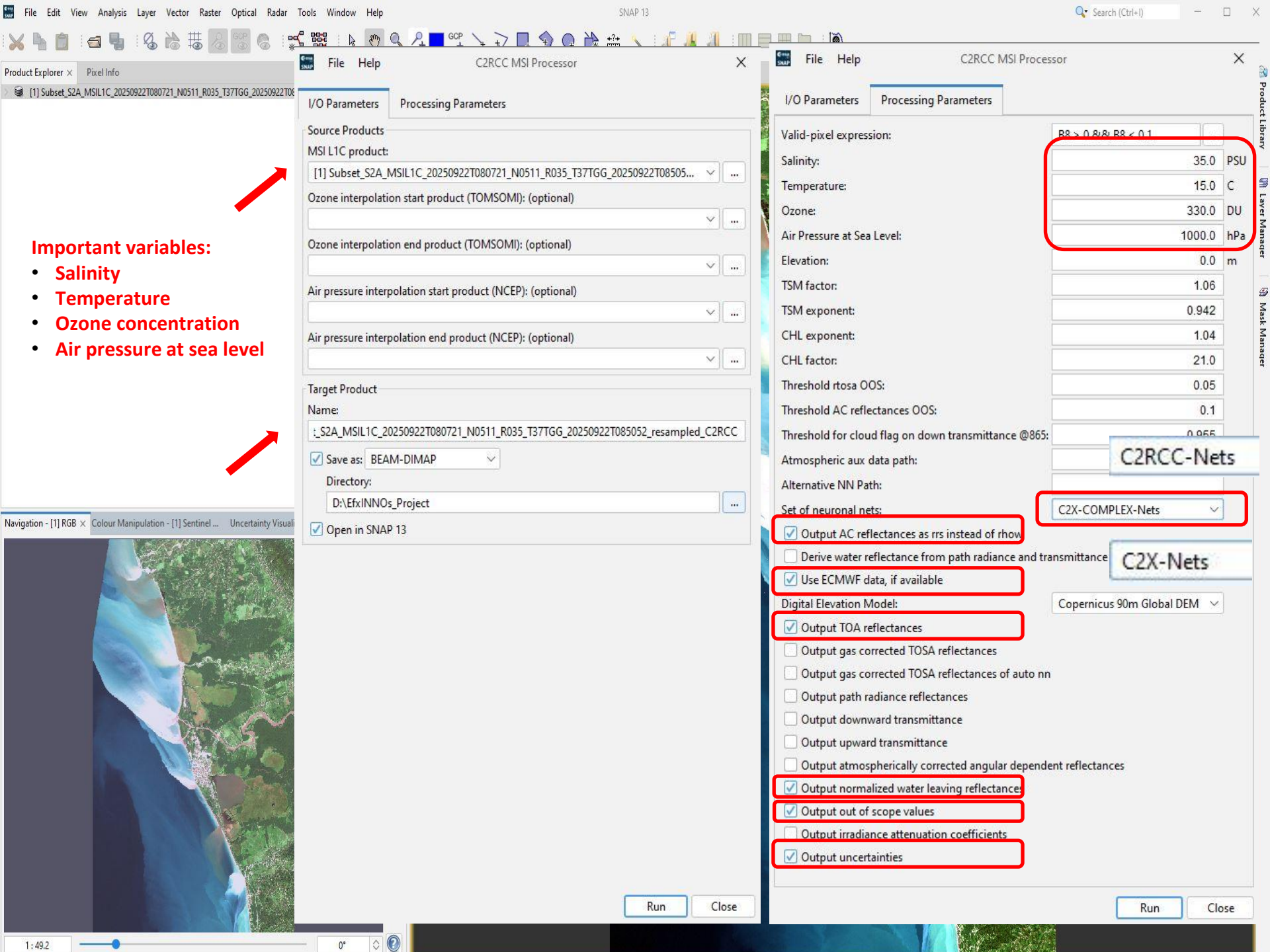
Thematic Water Processing

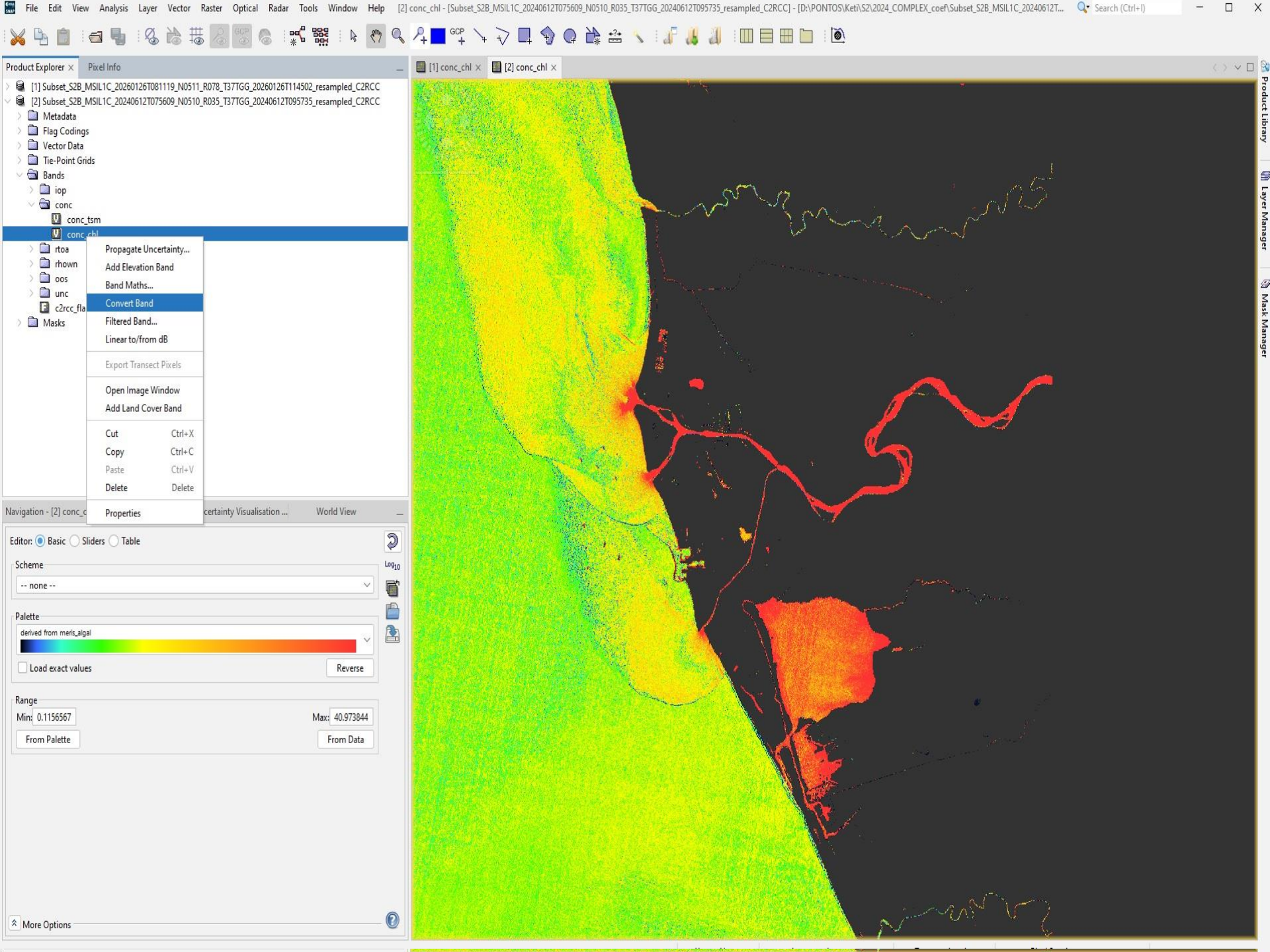
↓

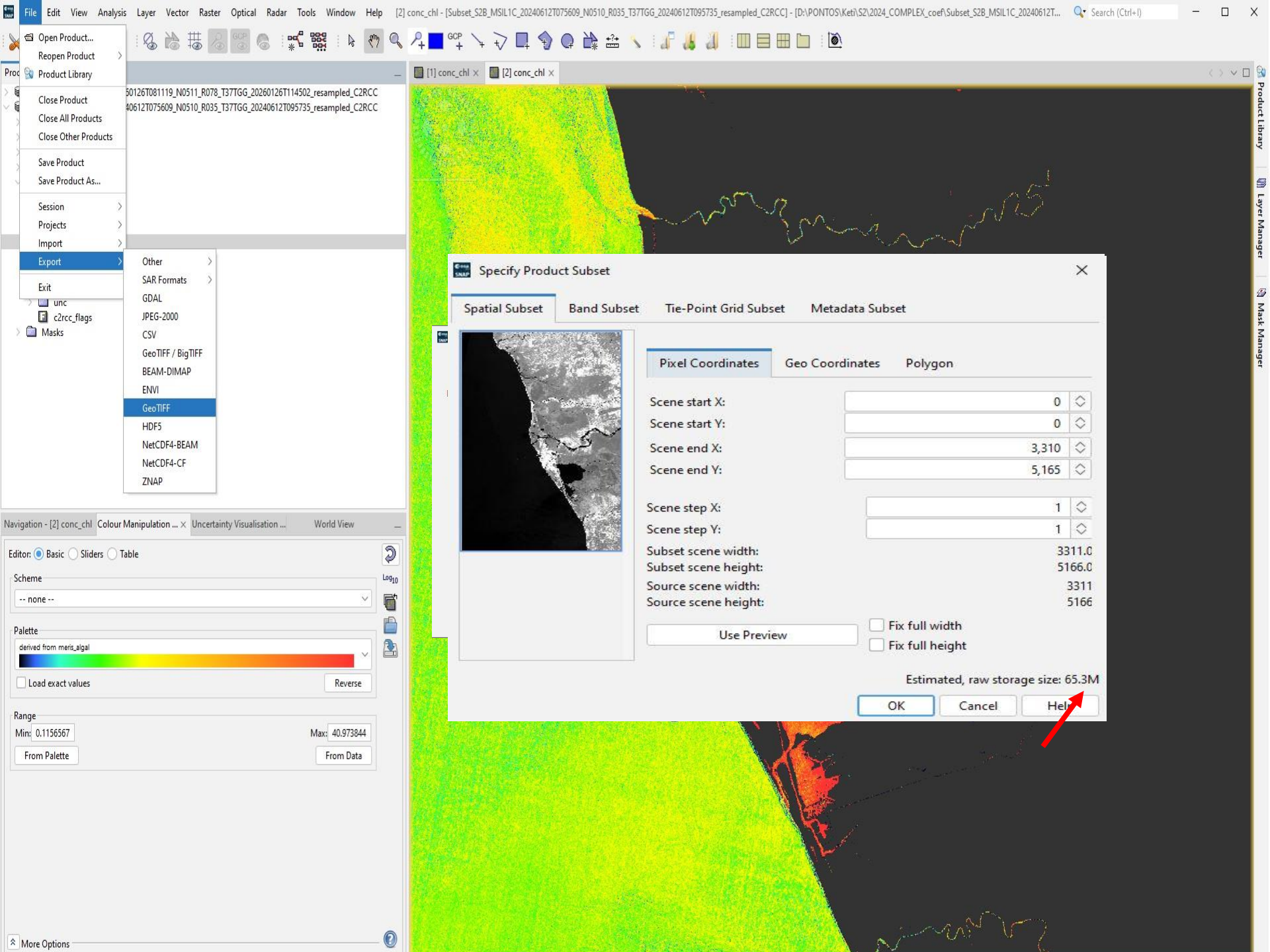
C2RCC processors

↓

S2-MSI


File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
SNAP 13
Search (Ctrl+I)
Product Explorer
Pixel Info
[1] Subset_S2A_MSIL1C_20250922T080721_N0511_R035_T37TGG_20250922T08
File Help
C2RCC MSI Processor
I/O Parameters
Processing Parameters
Source Products
MSI L1C product:
[1] Subset_S2A_MSIL1C_20250922T080721_N0511_R035_T37TGG_20250922T08505...
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
Important variables:
Salinity
Temperature
Ozone concentration
Air pressure at sea level
Navigation - [1] RGB
Colour Manipulation - [1] Sentinel ...
Uncertainty Visuali
1 : 49.2
0°
File Help
C2RCC MSI Processor
I/O Parameters
Processing Parameters
Valid-pixel expression:
B8 > 0 && 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:
Atmospheric aux data path:
Alternative NN Path:
Set of neuronal nets: C2X-COMPLEX-Nets
C2RCC-Nets
C2X-Nets
Output AC reflectances as rrs instead of rhow
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
Product Library
Layer Manager
Mask Manager


File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
[2] conc_chl - [Subset_S2B_MSIL1C_20240612T075609_N0510_R035_T37TGG_20240612T095735_resampled_C2RCC] - [D:\PONTOS\Keti\S2\2024_COMPLEX_coef\Subset_S2B_MSIL1C_20240612T...
Search (Ctrl+I)
Product Explorer
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
rtoa
rhown
oos
unc
c2rcc_fla
Masks
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
Properties
Navigation - [2] conc_c
certainty Visualisation ...
World View
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
More Options
[1] conc_chl
[2] conc_chl
Product Library
Layer Manager
Mask Manager


File
Edit
View
Analysis
Layer
Vector
Raster
Optical
Radar
Tools
Window
Help
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
[1] conc_chl
[2] conc_chl
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
Navigation - [2] conc_chl
Colour Manipulation ...
Uncertainty Visualisation ...
World View
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
More Options
Product Library
Layer Manager
Mask Manager

Thank you!