Tutorial in SNAP Desktop for Sentinel 2 Data Pre Processing Applications – GNU GPL Environment

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1 author:

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National Institute of Hydrology
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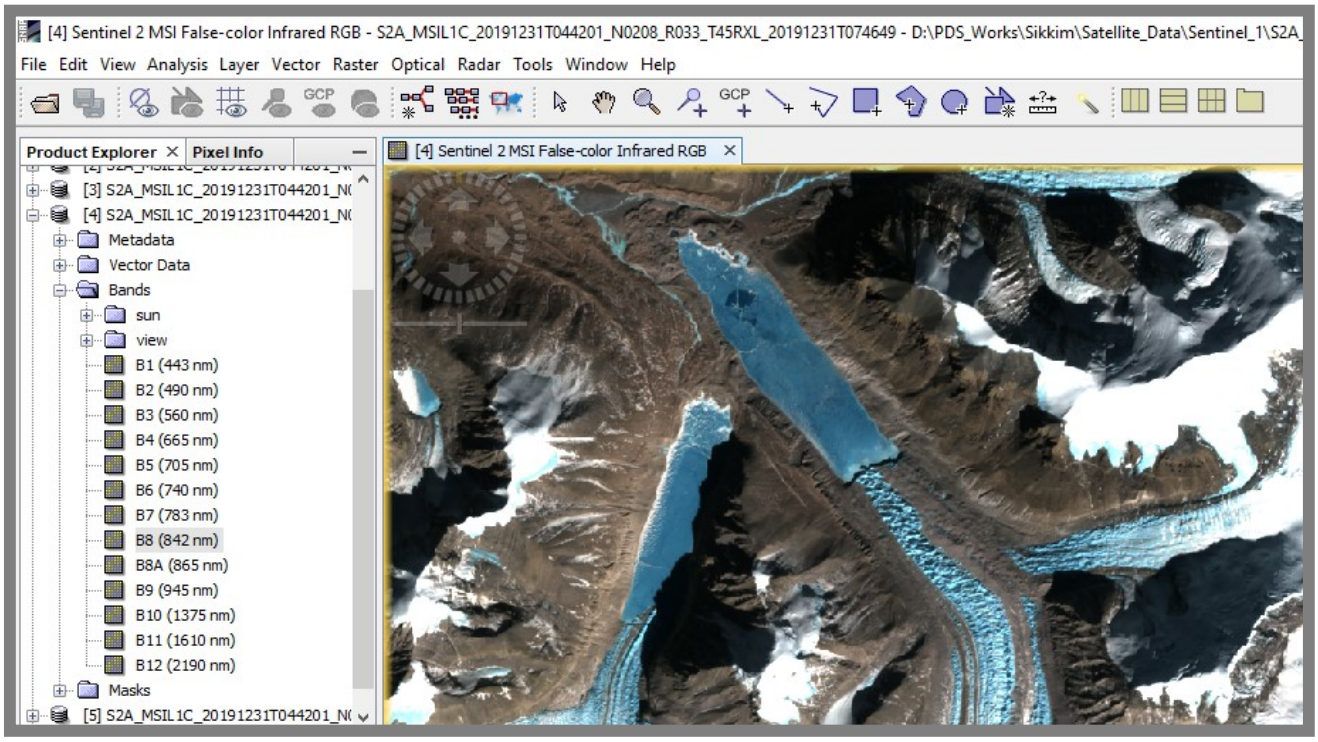
Tutorial in SNAP Desktop for Sentinel 2 Data Pre Processing Applications - GNU GPL Environment



Pre-Requirements for the Tutorial

1. SNAP 6.0 or Higher Version (GNU GPL)
2. Compatible Desktop or Laptop for SNAP
3. Sentinel 2 User Book (SCIHUB)
4. Sentinel 2 L1C Data (USGS Earth Explorer / ESA Sentinel SCIHUB)
5. Basic knowledge in Remote Sensing & GIS Applications
6. Expert Support and guidance during training this process

Prepared by:

G. Arun, Research Scientist
National Hydrology Project
CFMS, NIH - Guwahati

Undertaking:

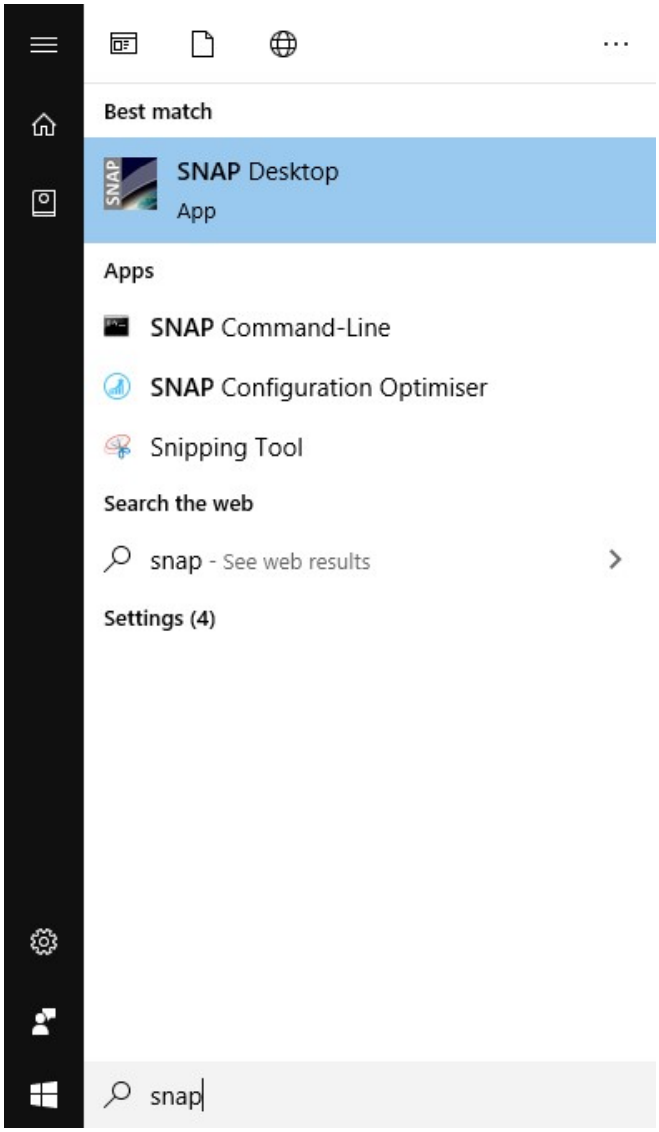
Concern expert is the solely responsible for any issues while doing this tutorial. Neither the working organization nor the ESA Sentinel Team responsible for the issues found in this tutorial.

Acknowledgements:

My special Thanks and Acknowledgements to Water Resources Dept. IIRS - Dehradun, Remote Sensing Studies Group, SASE - Chandigarh & National Hydrology Project, NIH - Roorkee for being motivational for working in the needful areas of Research in the South Asian Region.

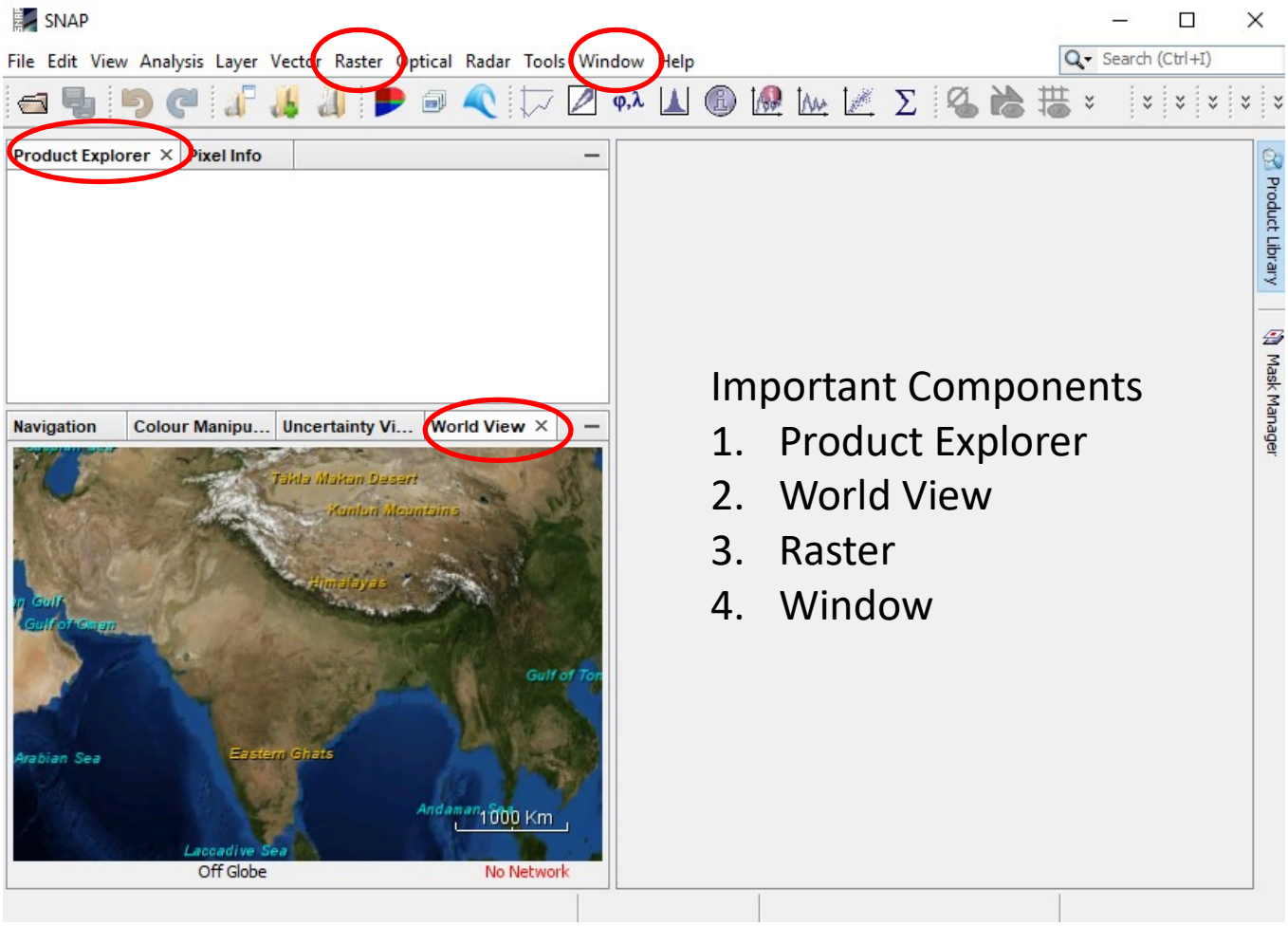
Tutorial topics included:

- Sentinel 2 Data Visualization
- Details about Sentinel 2 Bands
- RGB - False Color Composite Generation
- Spatial and Spectral Subset
- Mosaicking Sentinel 2 Data
- Support in all Satellite Image based operations

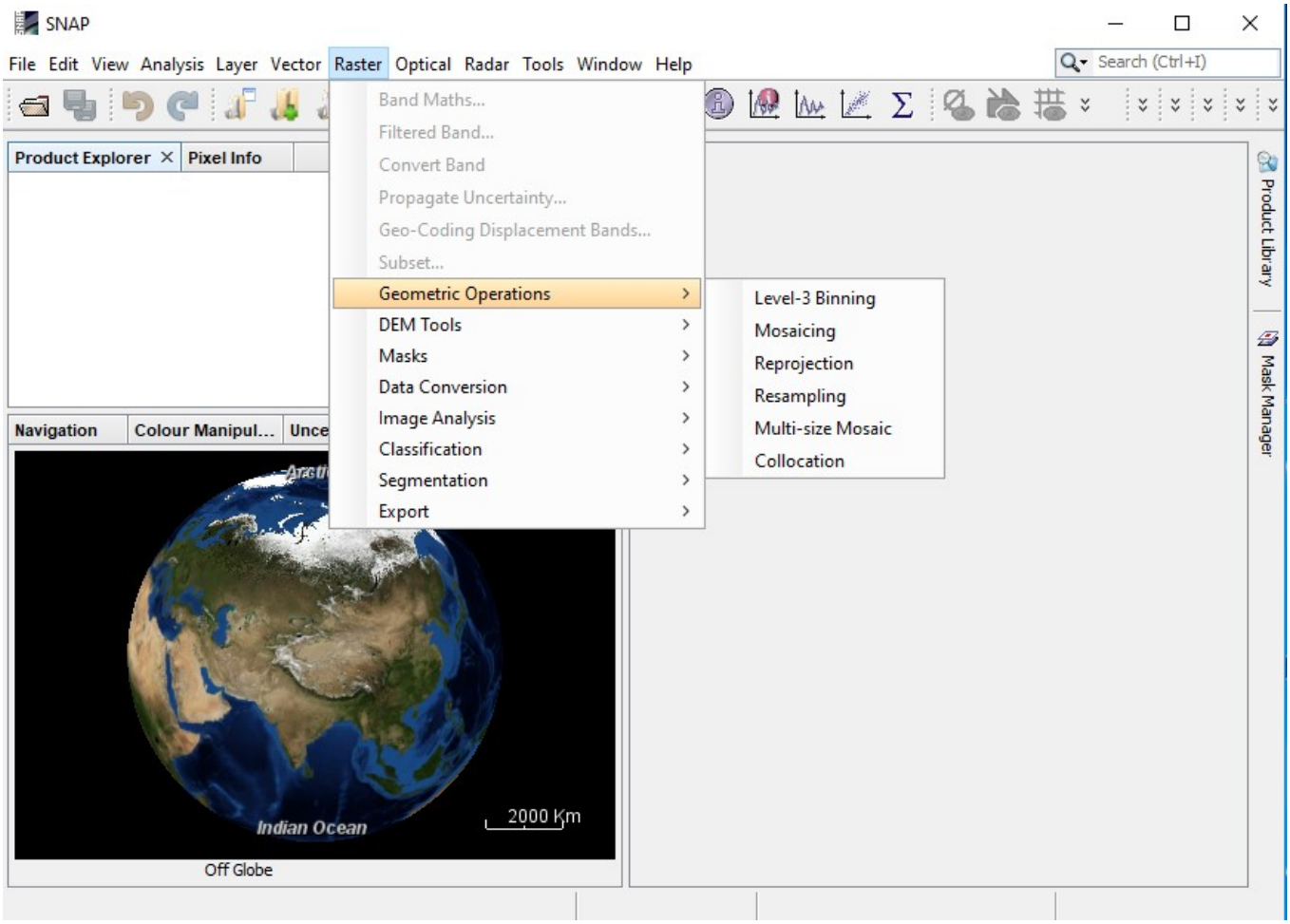


Start With:

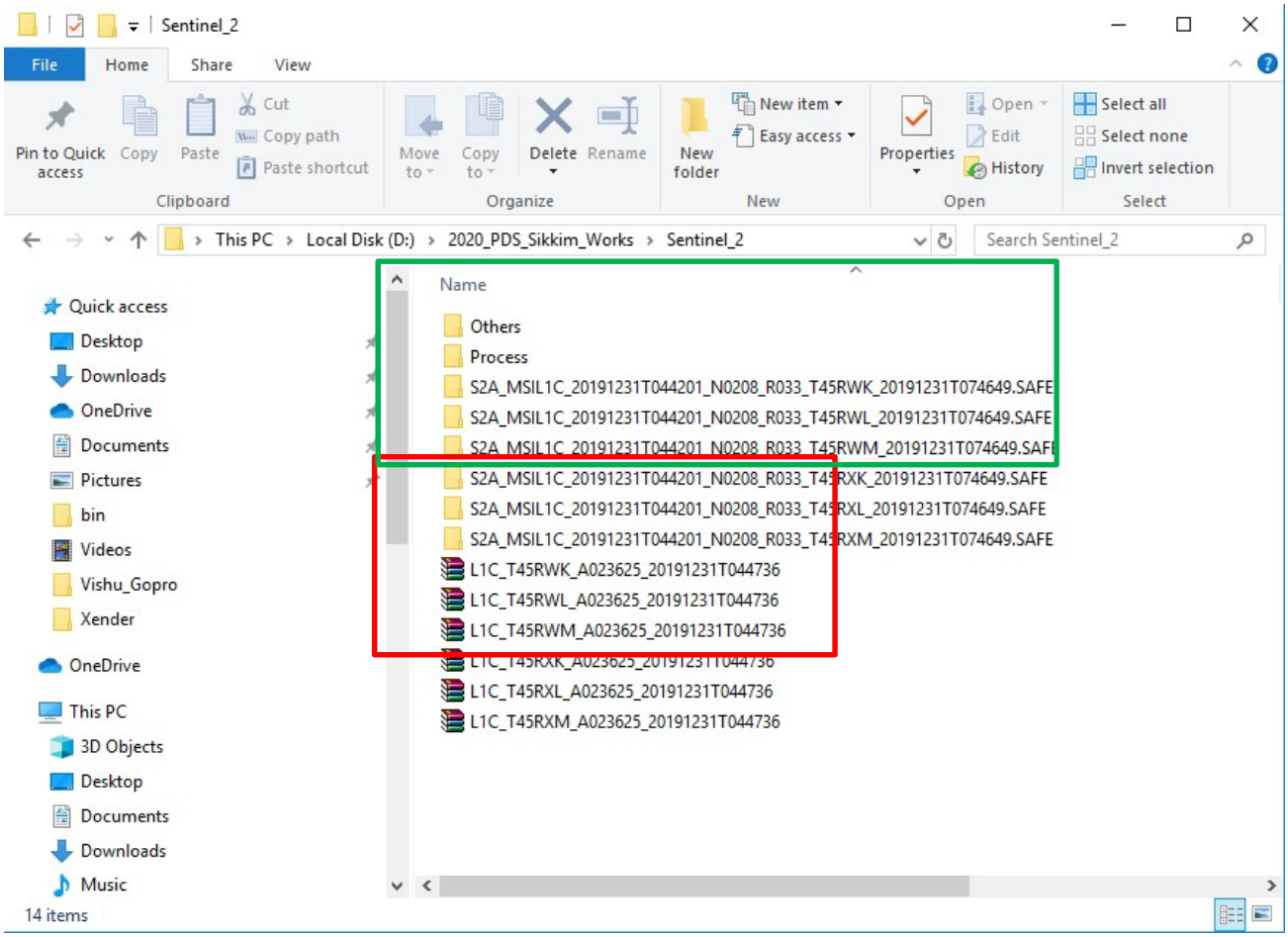
- Download Sentinel 2 Data required for your Area of Study via SCIHUB/Earth Explorer
- Unzip Sentinel 2 Data shows .SAFE Extension
- Open Sentinel Tool Box SNAP 6.0 or higher
- Drag and Drop Data in Product Explorer



1. SNAP Desktop tool looks like picture shown above



2. Geometric operations are main pre-processing essentials



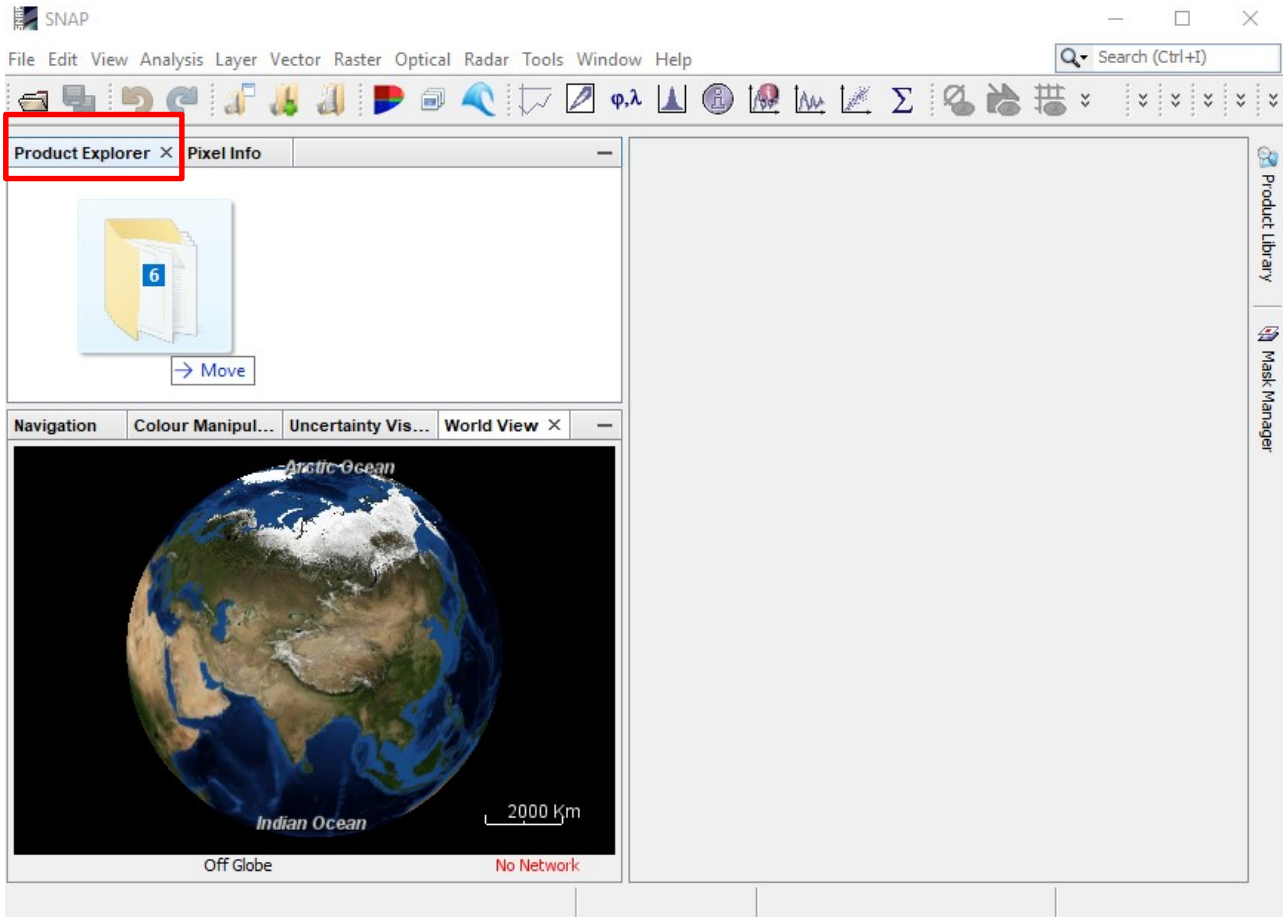
1. Red Box showing the zip files downloaded from the Earth Explorer

2. Green box showing the extracted data in .safe format.

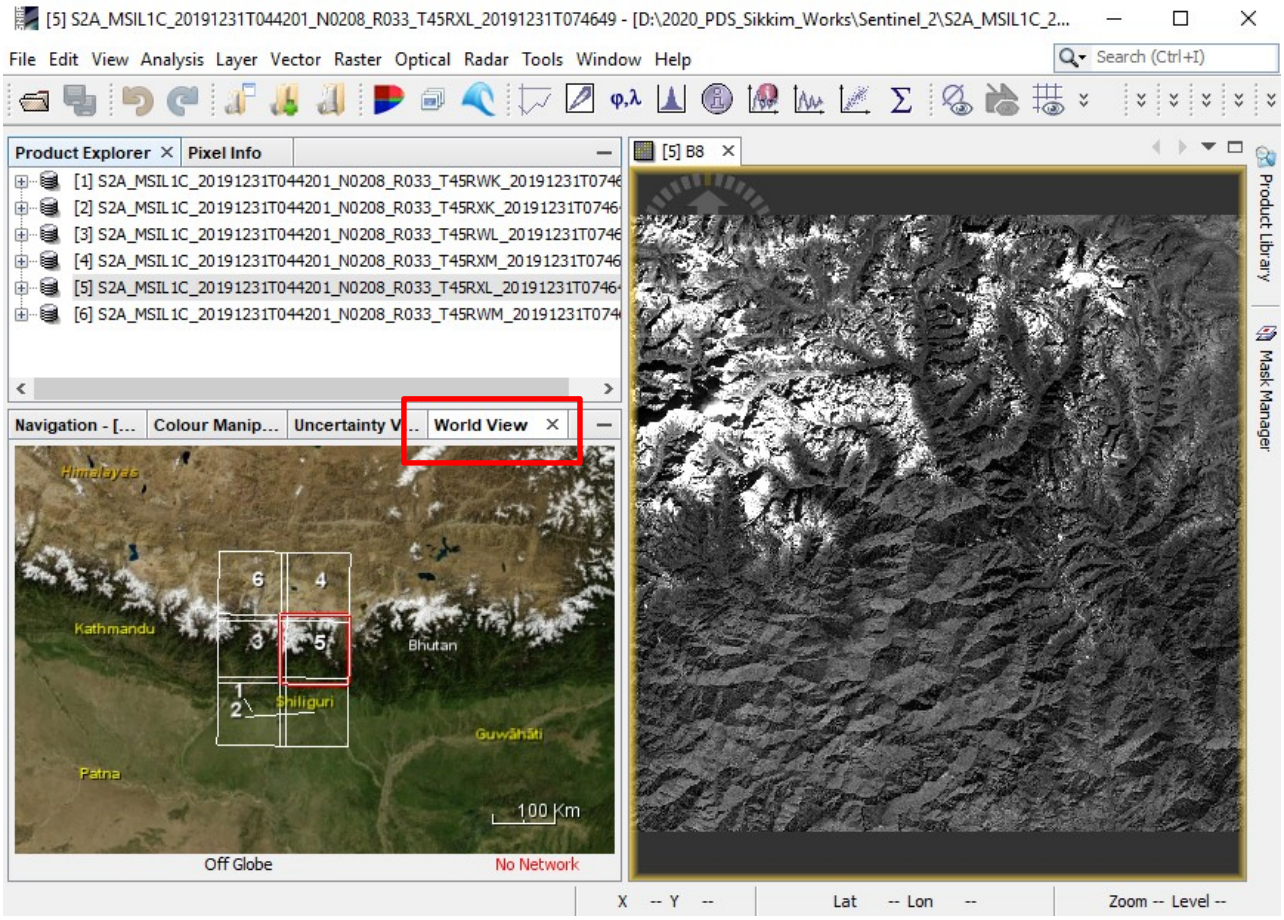
3. The Data needs to be pre processed to get the geocoded output in the form of .tif, .img or .hdr format

4. The .SAFE folders can be directly dragged ad dropped in the product explorer.

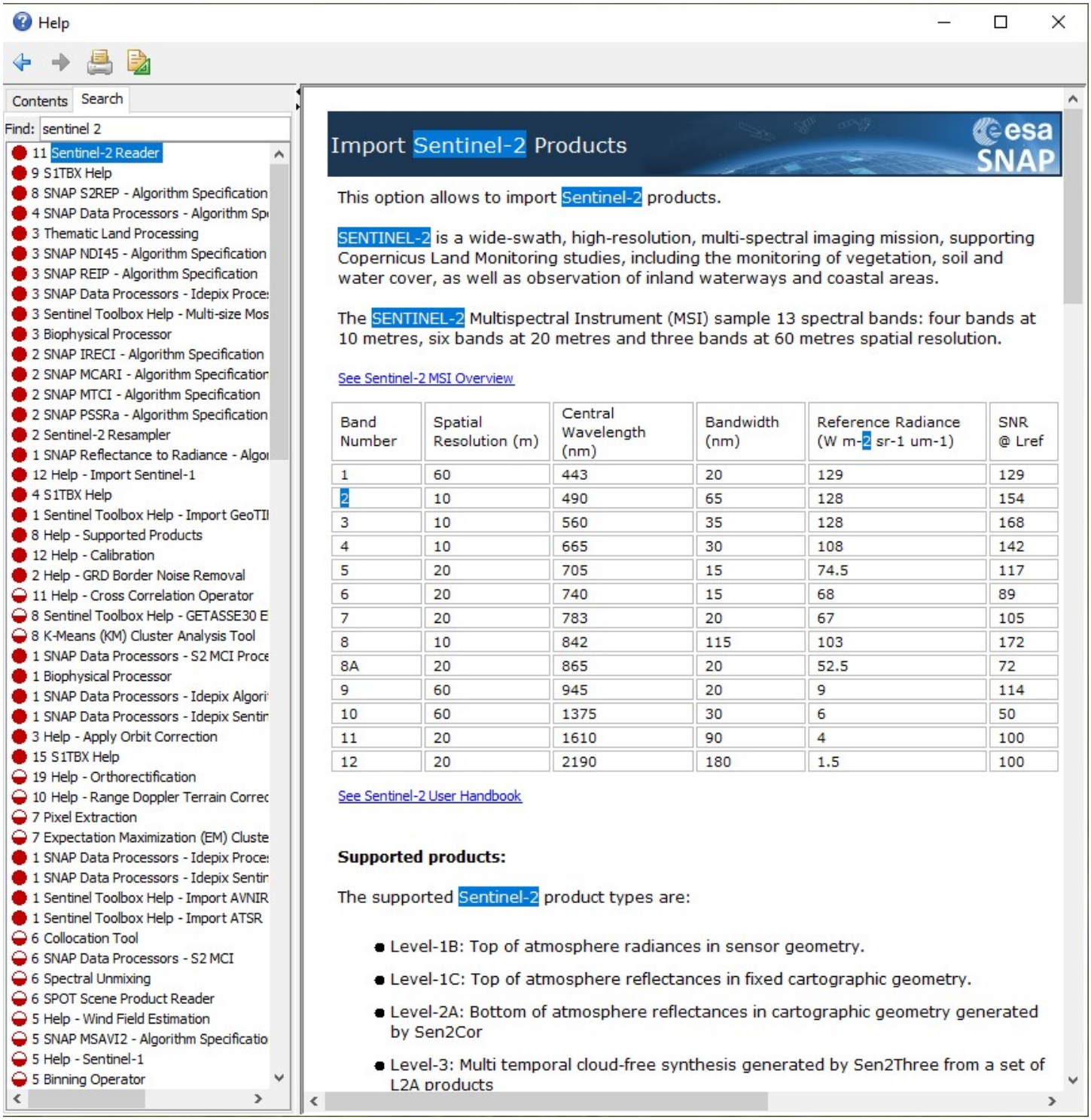
Drag and Drop .SAFE folders can be directly in the product explorer and click on the particular image and band to open in window



World View shows the extent of the opened images as shown in the bottom left pan of the window

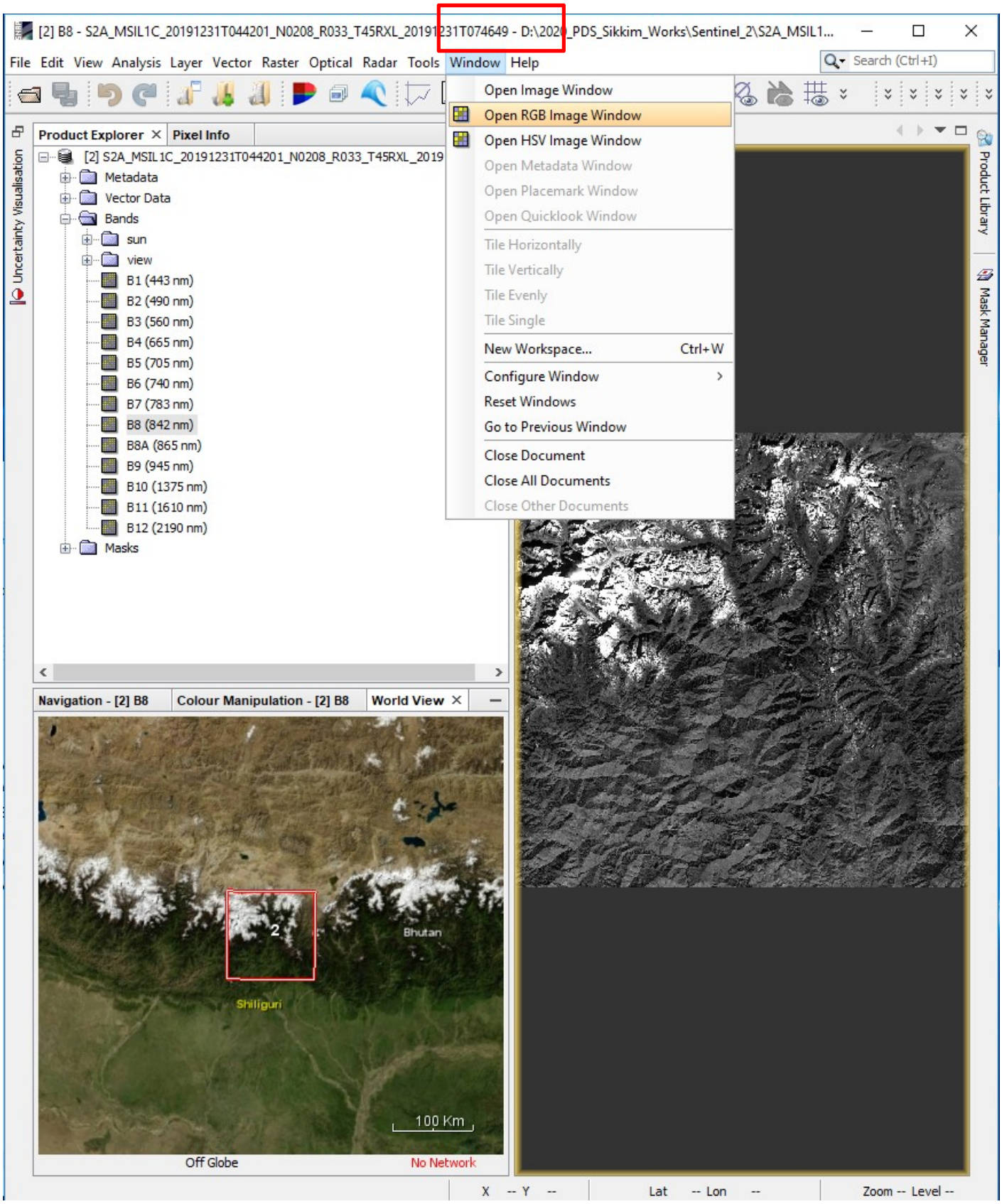


Sentinel 2 Spatial, Spectral & Radiometric Information as available in SNAP Desktop Help



Click on bands and open any band in the window to do particular operations on the required image. i.e., Resample, Subset etc..

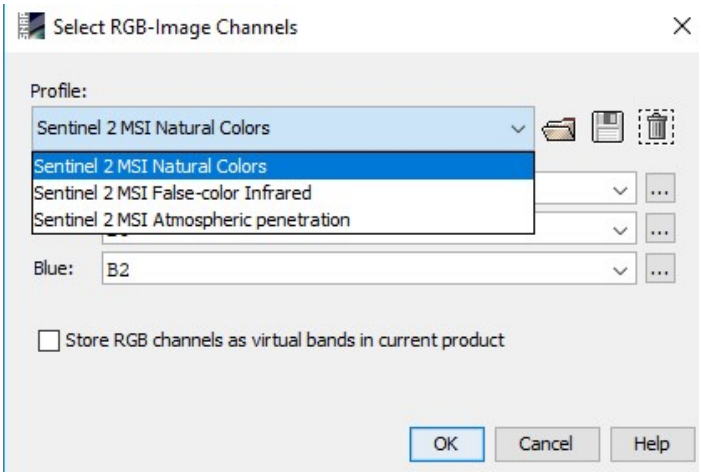
Click on **Windows -> Open RGB Image Window** to explore further

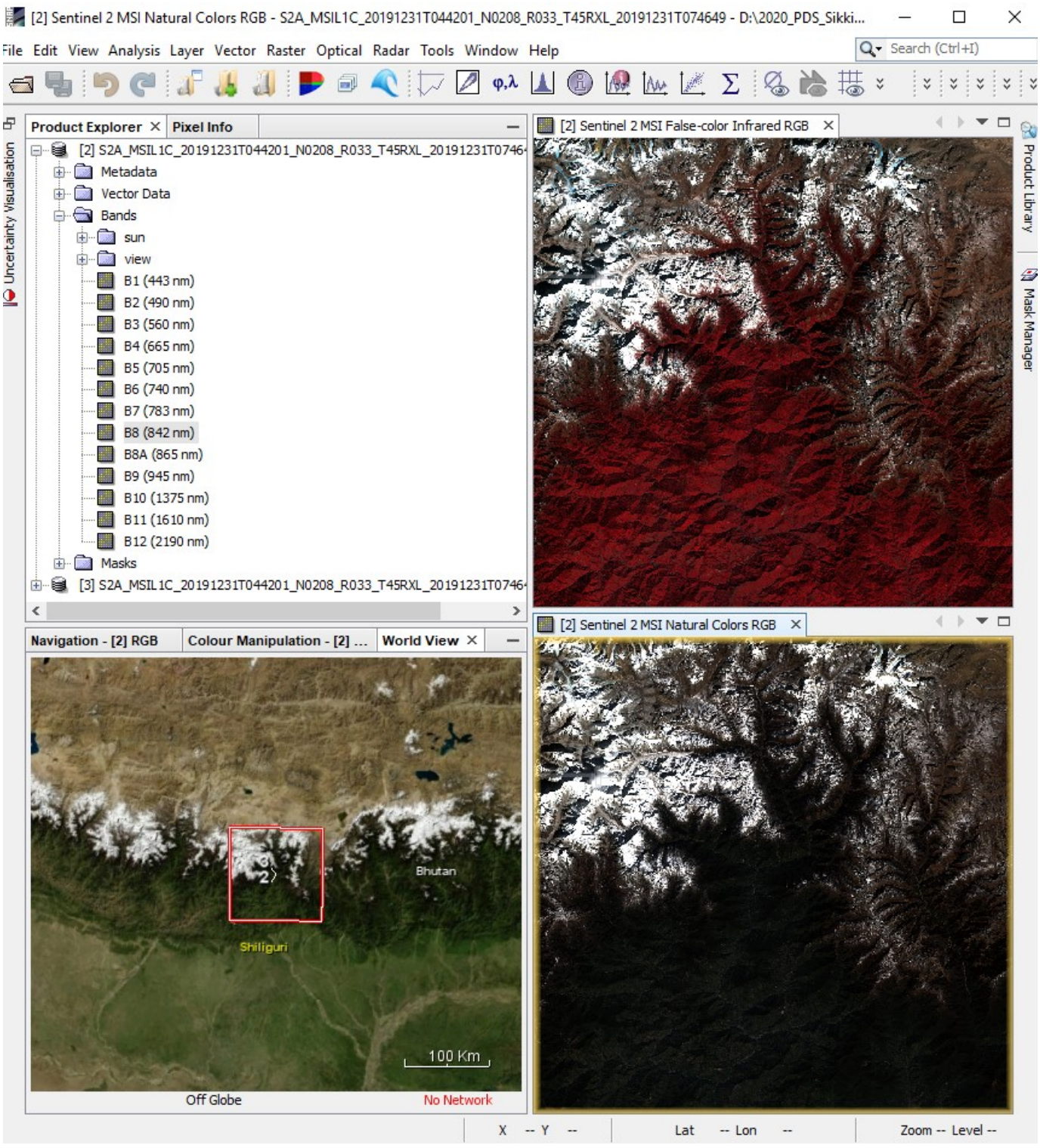


Before Resampling:

(3 RGB Channels)

1. MSI Natural Colors
2. MSI False Color IR
3. MSI Atmospheric penetration

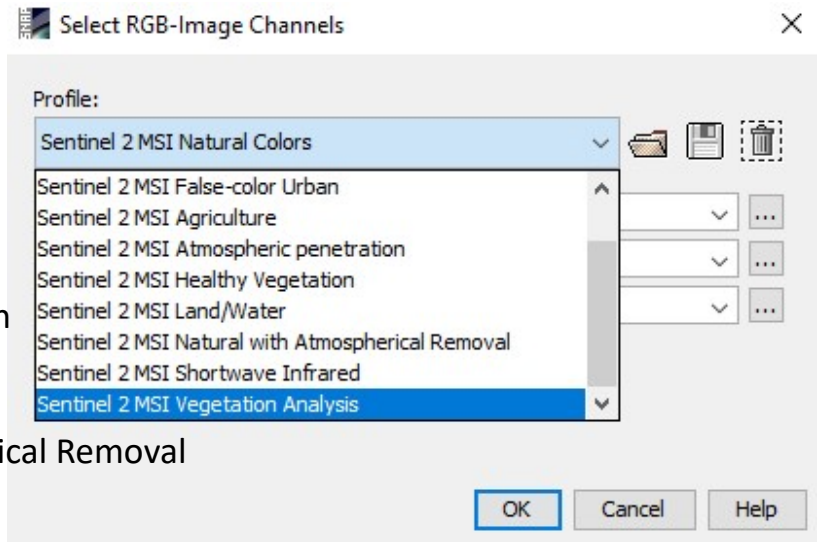


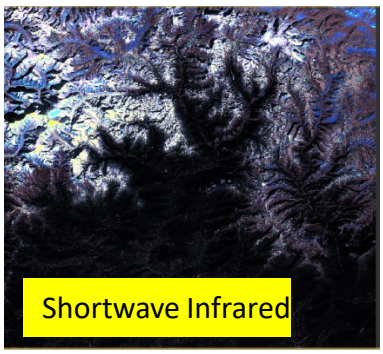


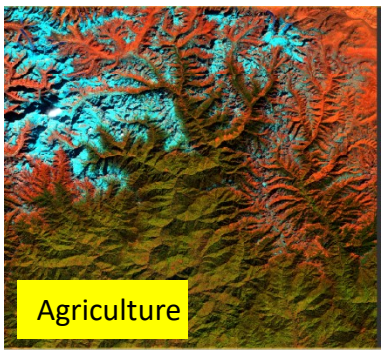
After Resampling:

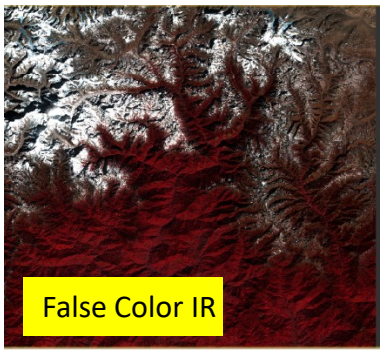
(10 RGB Channels)

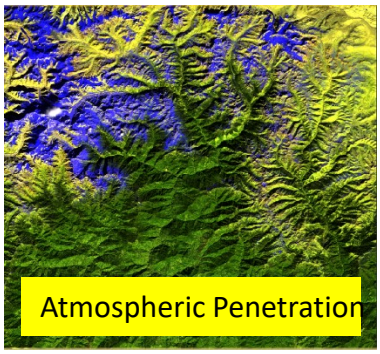
1. MSI Natural Colors
2. MSI False Color IR
3. MSI False Color Urban
4. MSI Agriculture
5. MSI Atmospheric penetration
6. MSI Healthy Vegetation
7. MSI Land/Water
8. MSI Natural with Atmospherical Removal
9. MSI Shortwave Infrared
10. MSI Vegetation Analysis

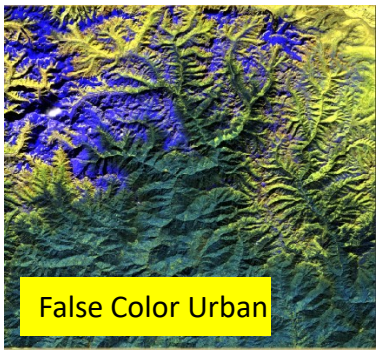


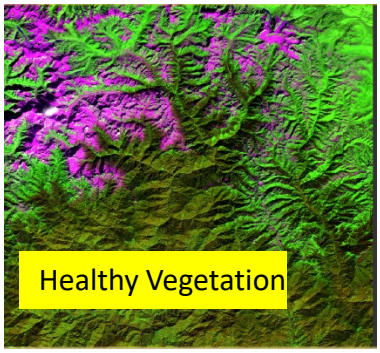


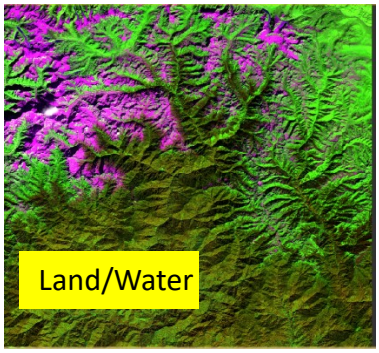


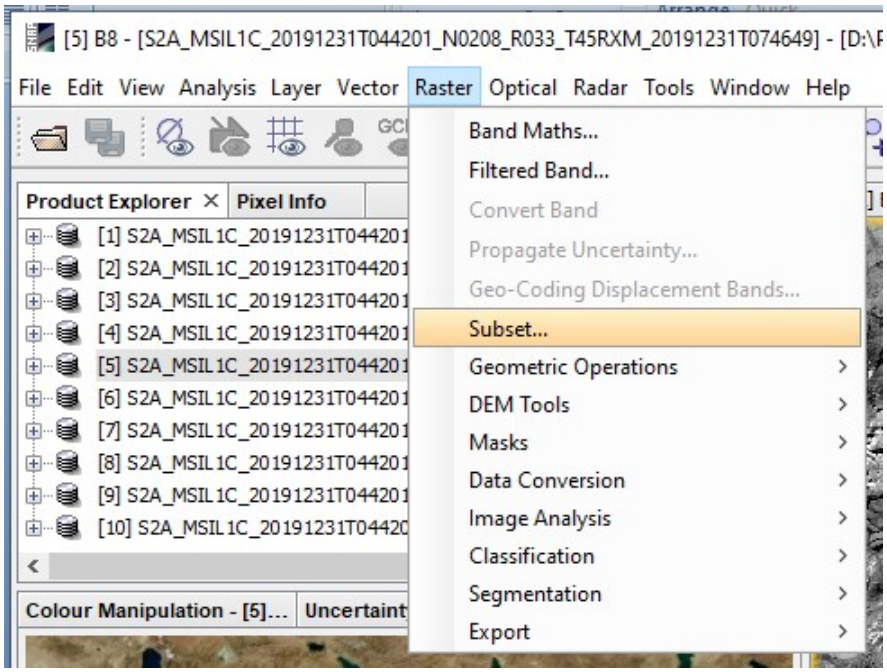




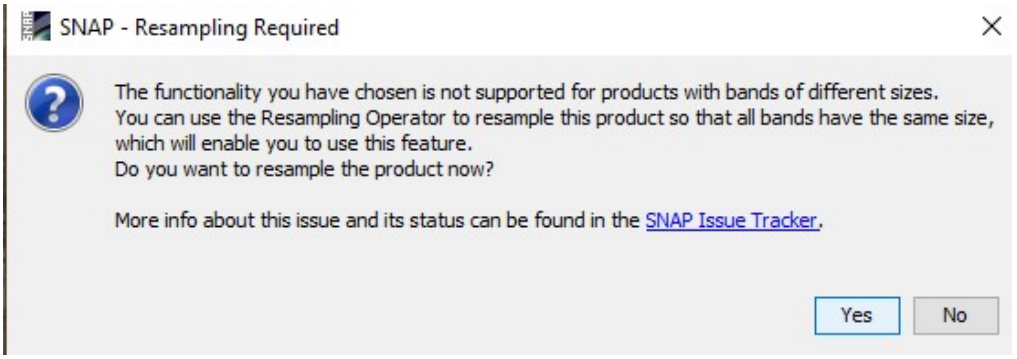


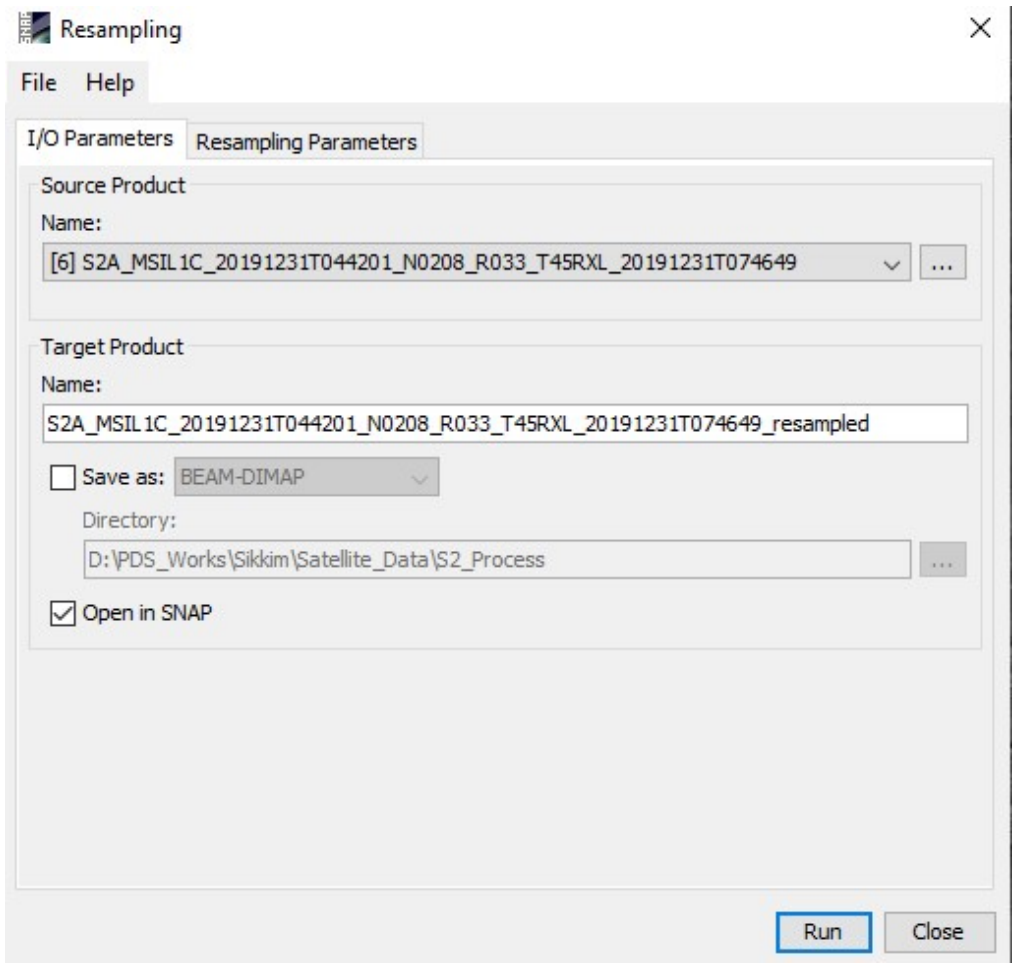




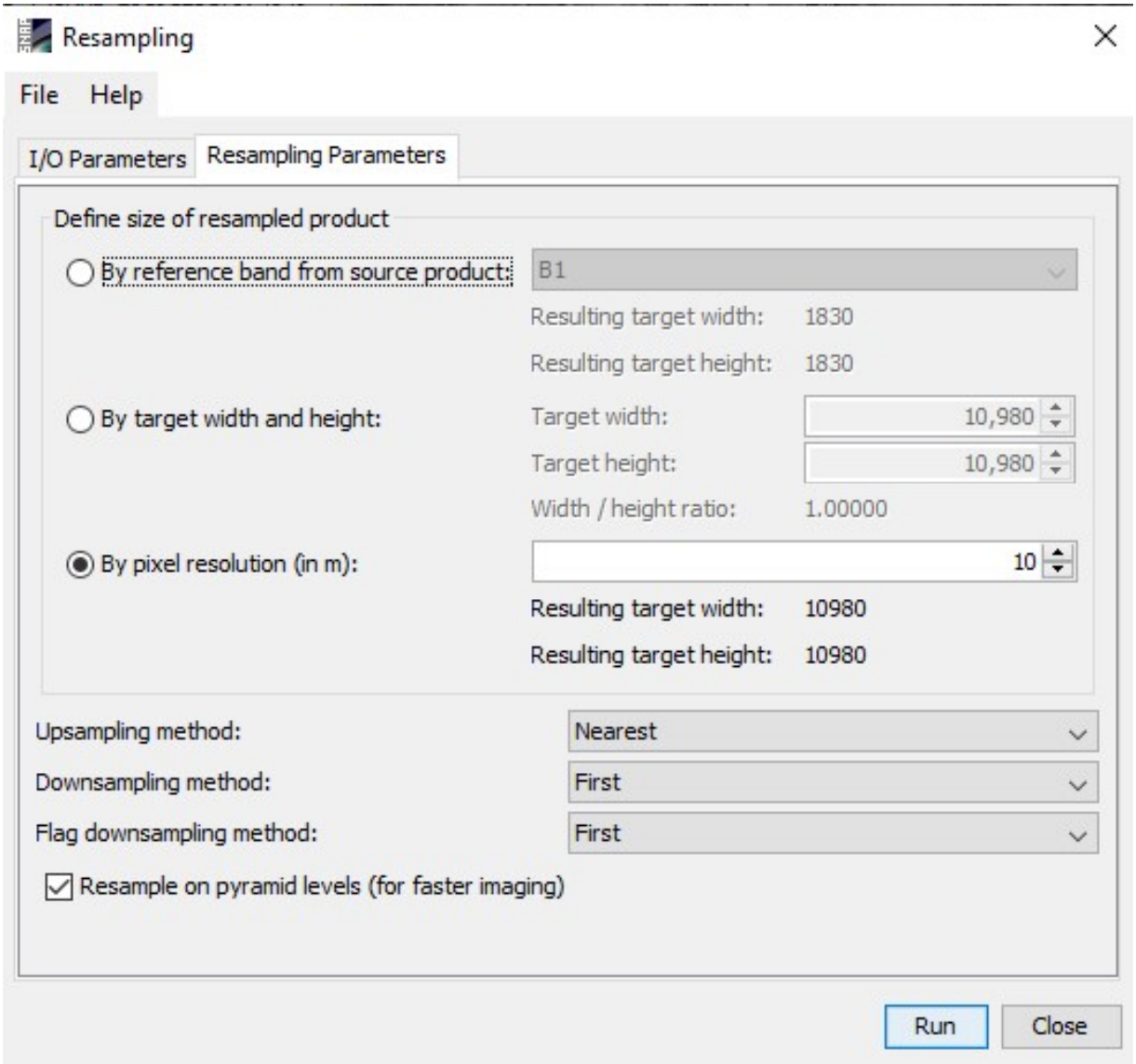


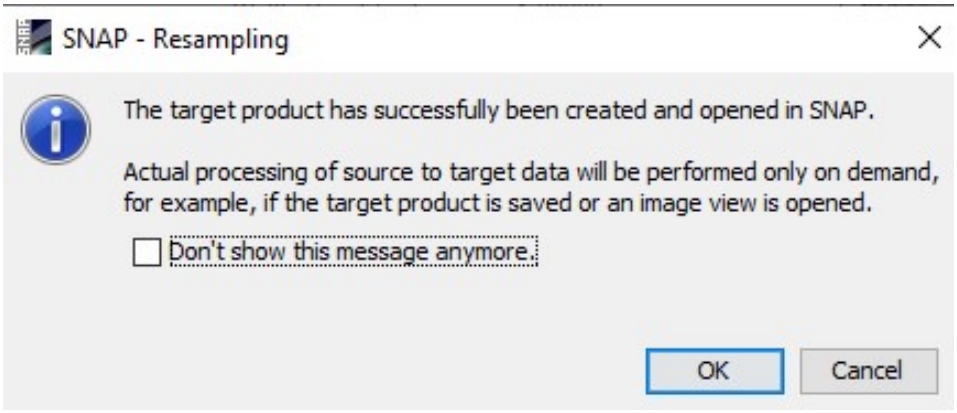
- Go to **Raster -> Subset** (Image 1)
- A dialogue box shows you need to **Resample this product** as shown in Image 2
- Click Yes, **Resampling Operator** opens as shown in Image 3



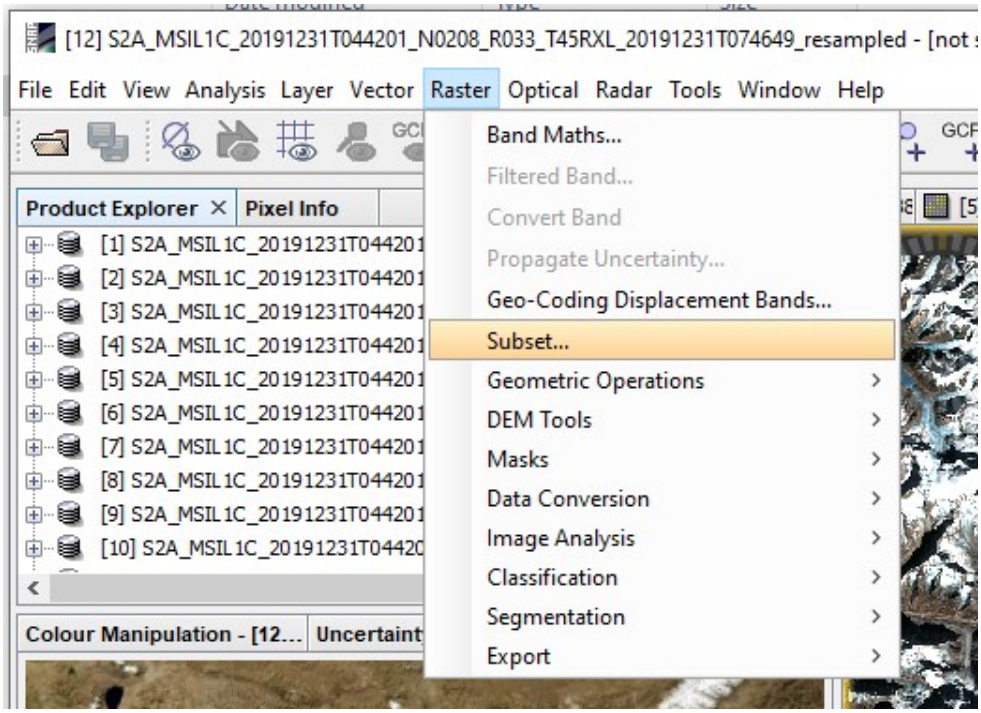


- **I/O Parameters** are taken by default for the image opened in the window (**refer. Slide 10, Image 3**)
- Please set **Pixel resolution** (in m) in the resampling parameters
- Applicable resampling resolutions **10, 20 & 60 m**, which depends upon the user need and system ability of representing image in the window later to the process
- Click **Run** as shown in Image 1 and **ok** as shown in image 2 when the Dialogue box appears.

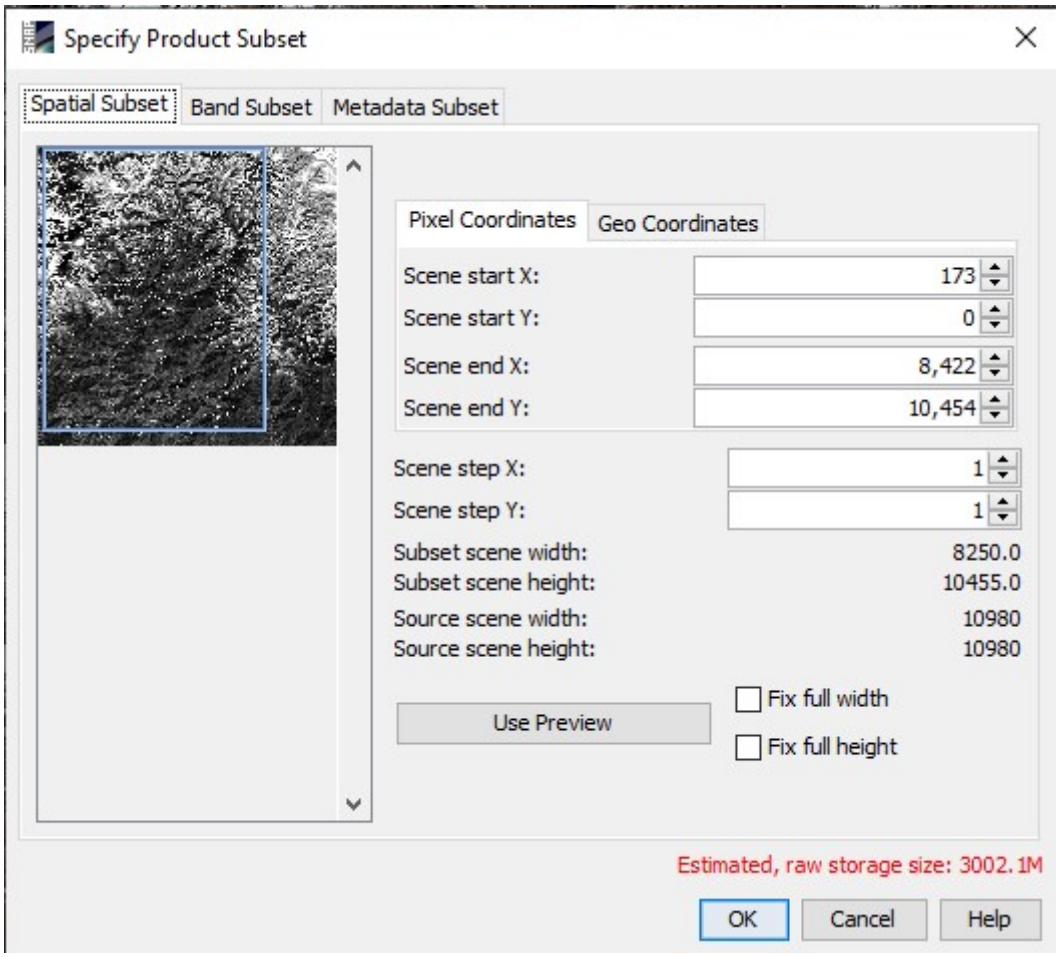




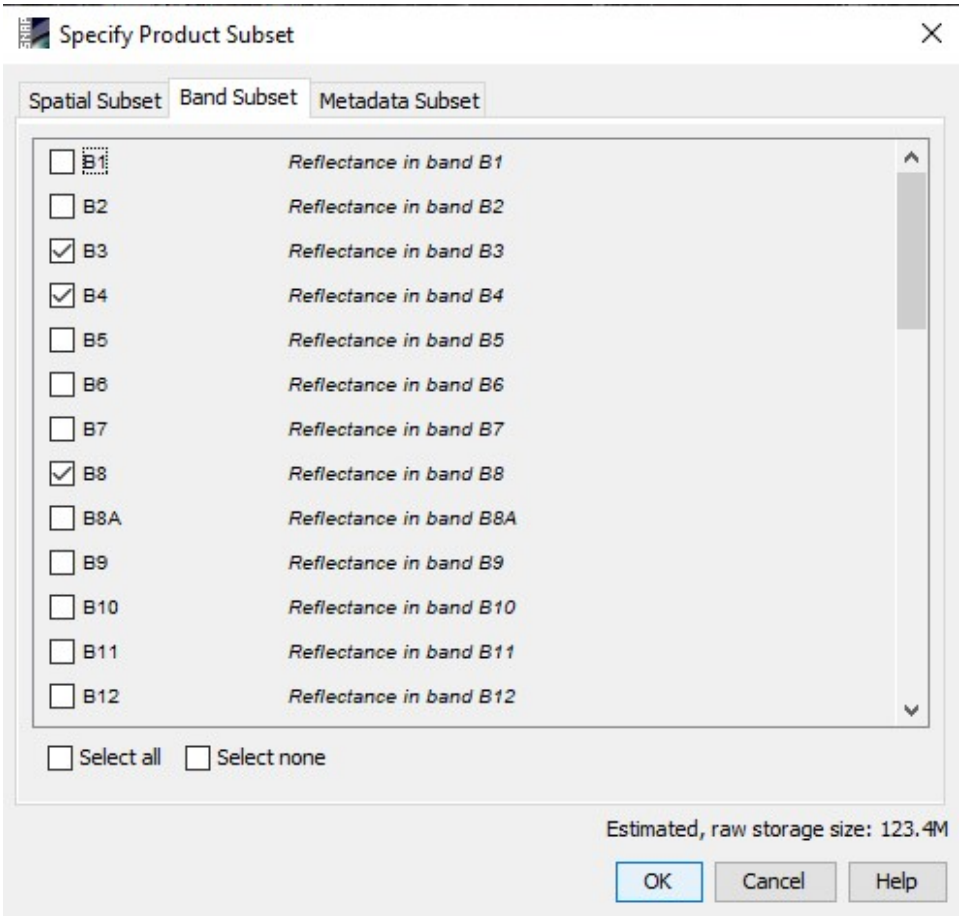
Click on **Raster -> Subset** to do spatial as well as spectral subsets



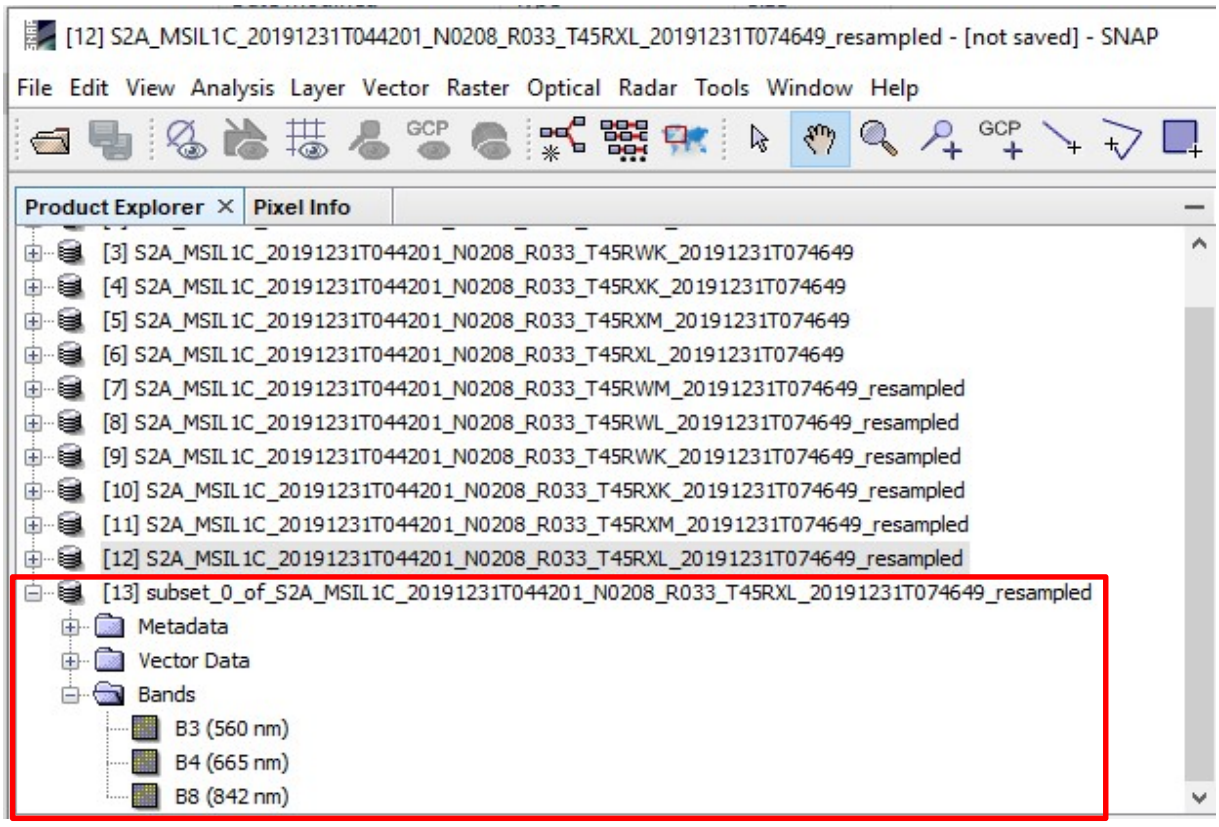
- Product Subset Dialogue box opens as shown below
- Check Fix full width, Fix full height checkbox if there is no need of Spatial subset.
- If you wish to subset Use Preview and alter the blue box from preview

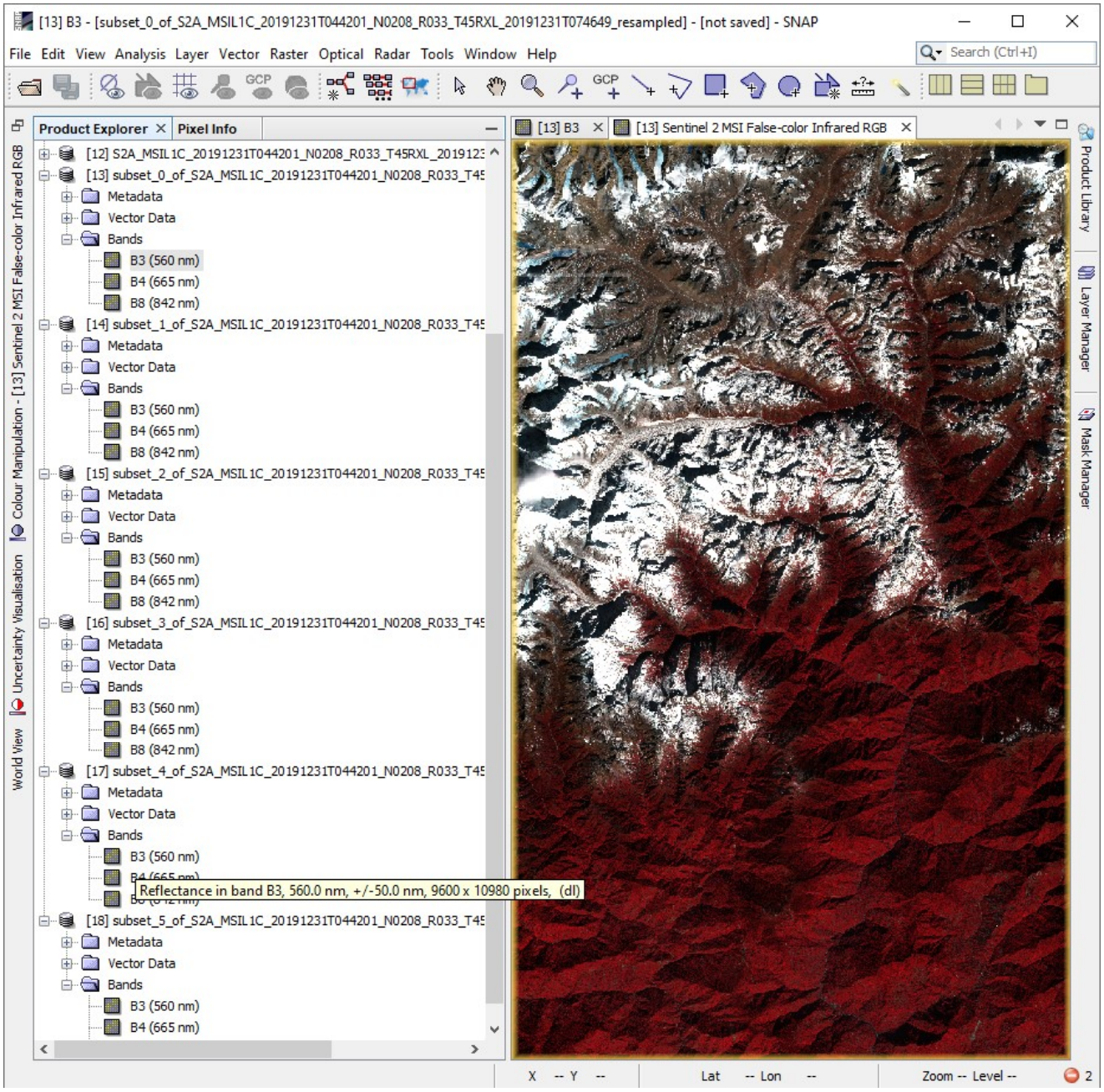


Check only required bands for Band subset, then **click OK**



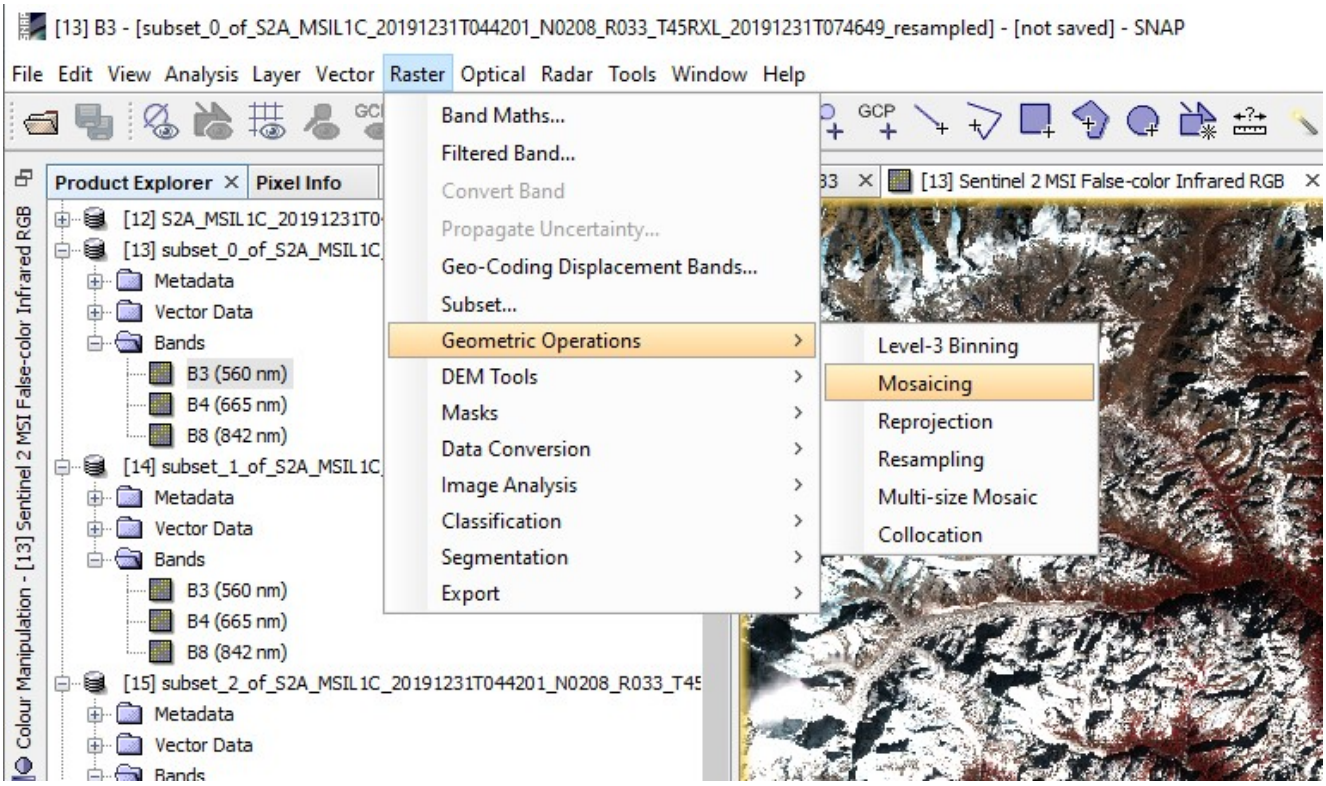
Subseted Image will show only the bands selected, this will reduce the size and operation time in the further processes. **Write the image** before **mosaic** operation



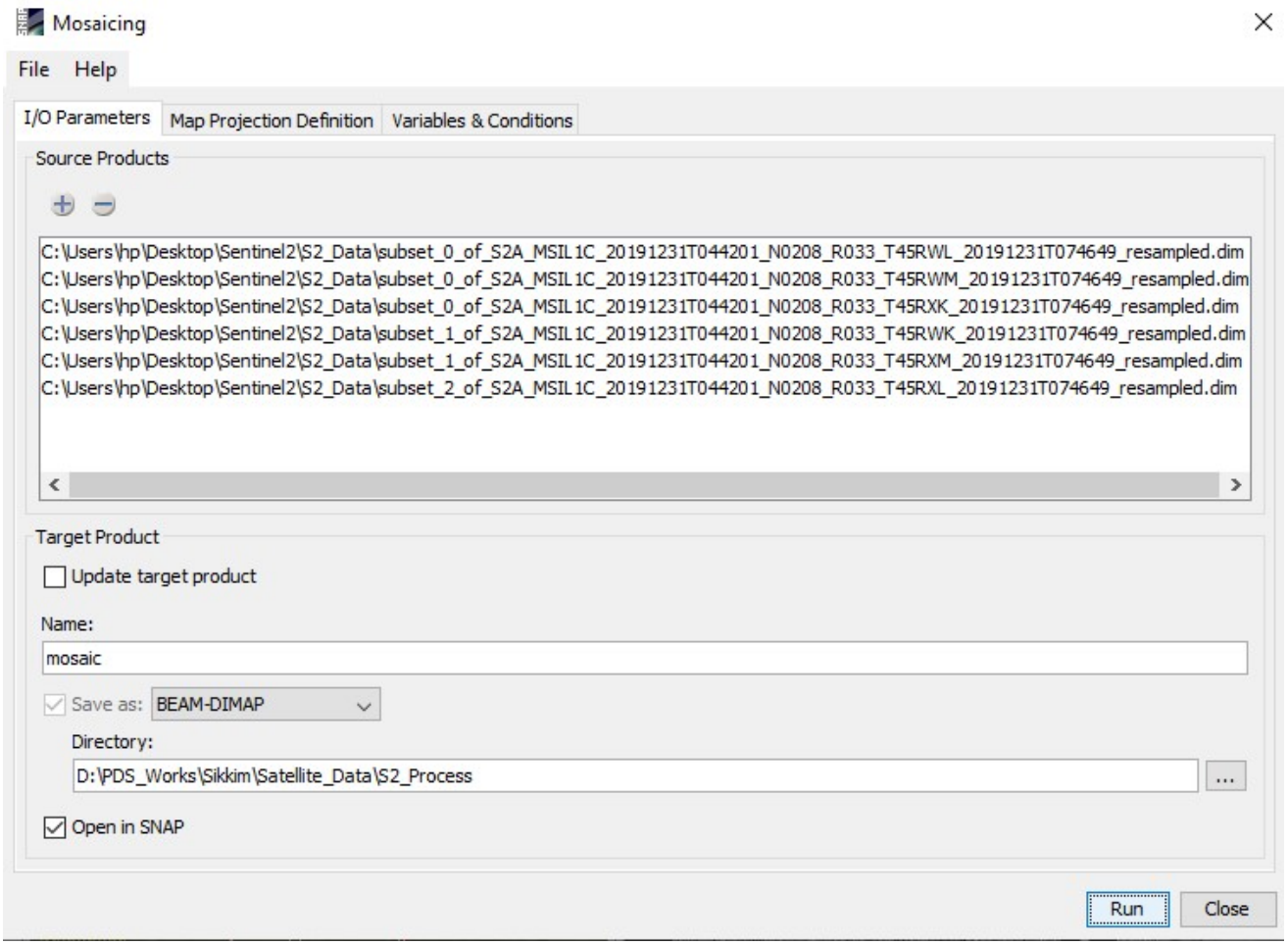


- Subsequently Resample and subset all the images required for the study area
- Click File -> Save Product to save all the subseted image
- Note: Corresponding Subseted image is needed to be opened in the window to save the product

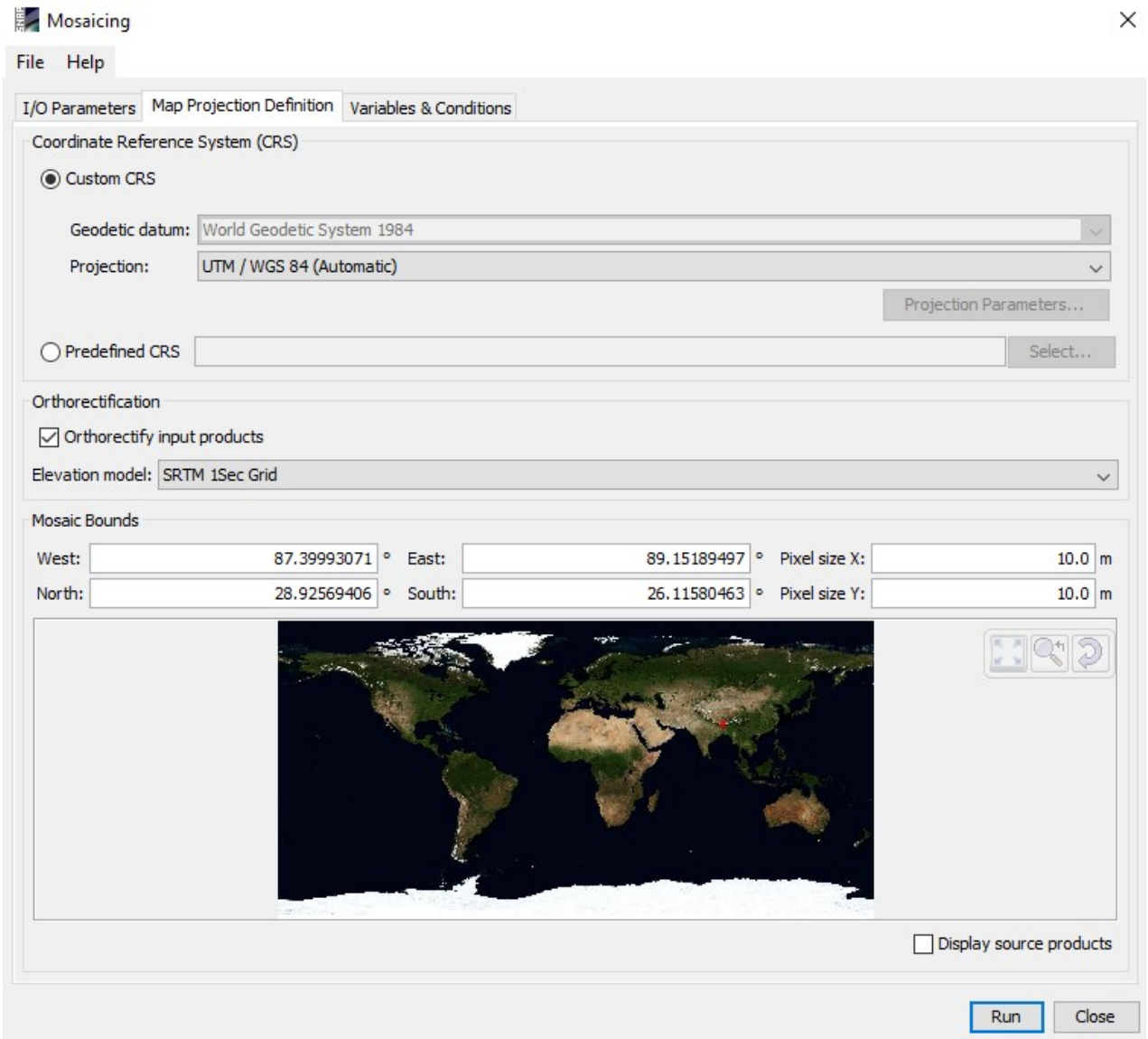
Click **Raster -> Geometric Operations -> Mosaicking** to do mosaic image

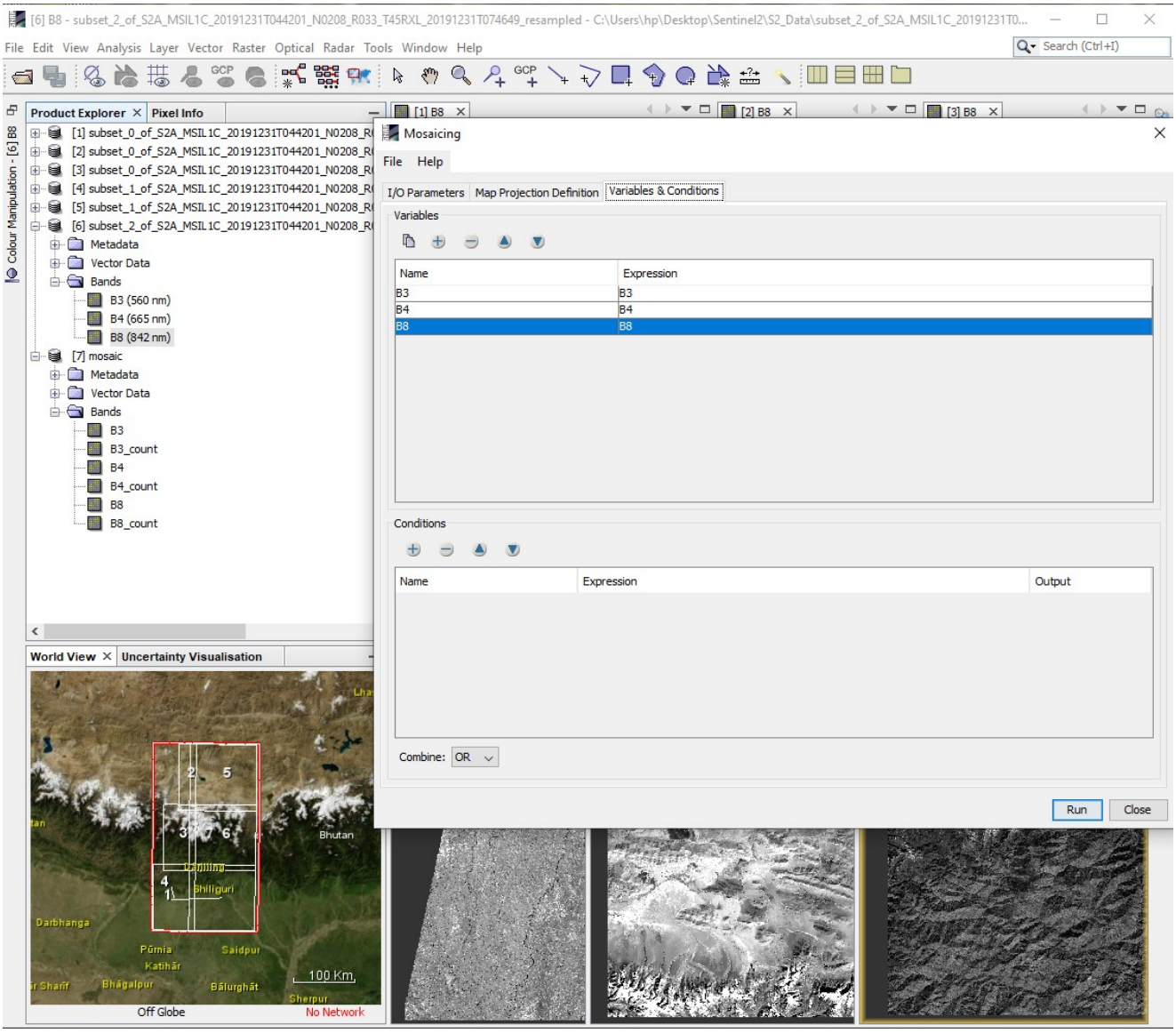


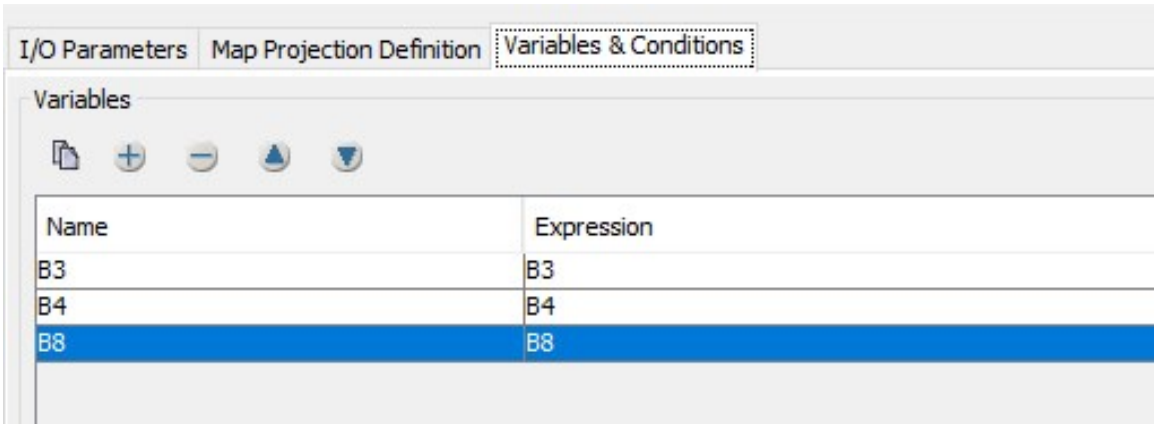
Open all the images from the **I/O Parameters**, & Go to **Map Projection Definition**



- Set Coordinate Reference System CRS as Shown in the Image below
- Geodetic Datum would be set as World Geodetic System 1984 by default
- Check Orthorectify input products checkbox and select SRTM 1Sec Grid Elevation Model (Not Required for L1C Products
- Select Pixel Size X and Pixel Size Y as 10m, 20m or 60m based on the need. (Best to go for 10m)
- Then go for Variables & Conditions

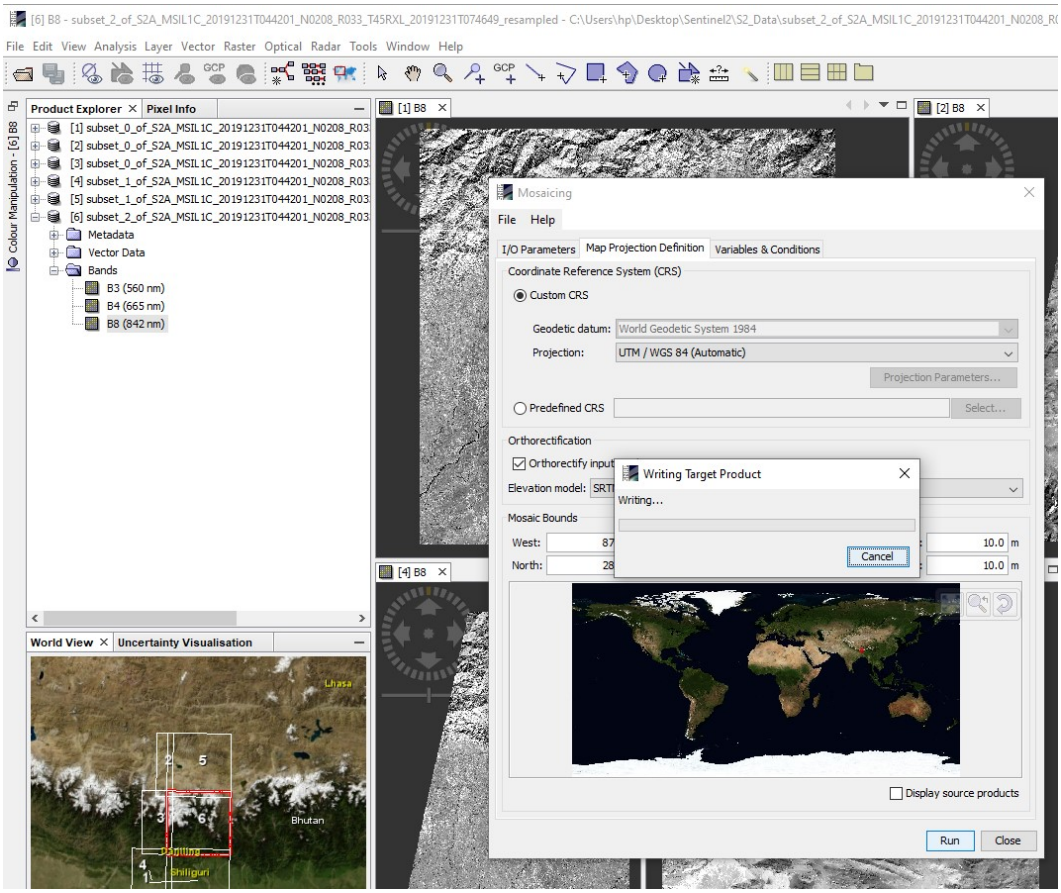




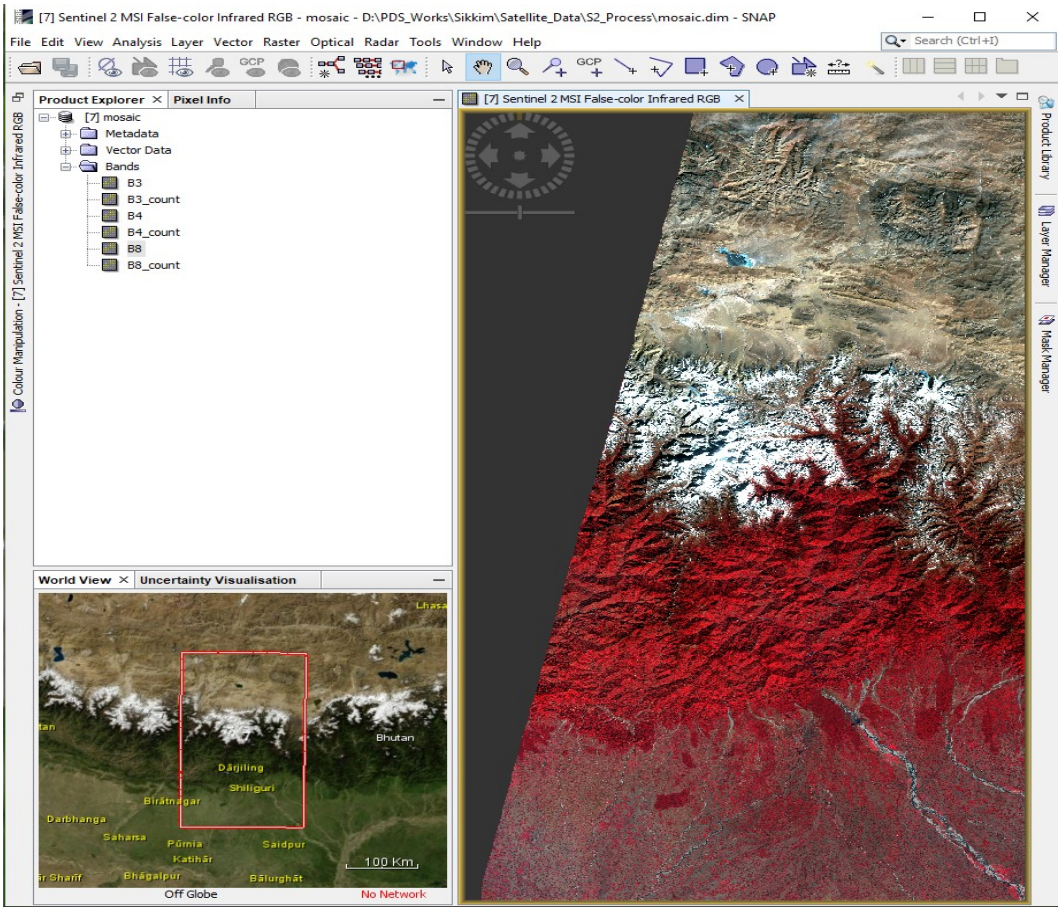


- Click > sign in the variables to add Name and Expression as shown in the Variables and conditions option & Click Run to run the mosaic operation.

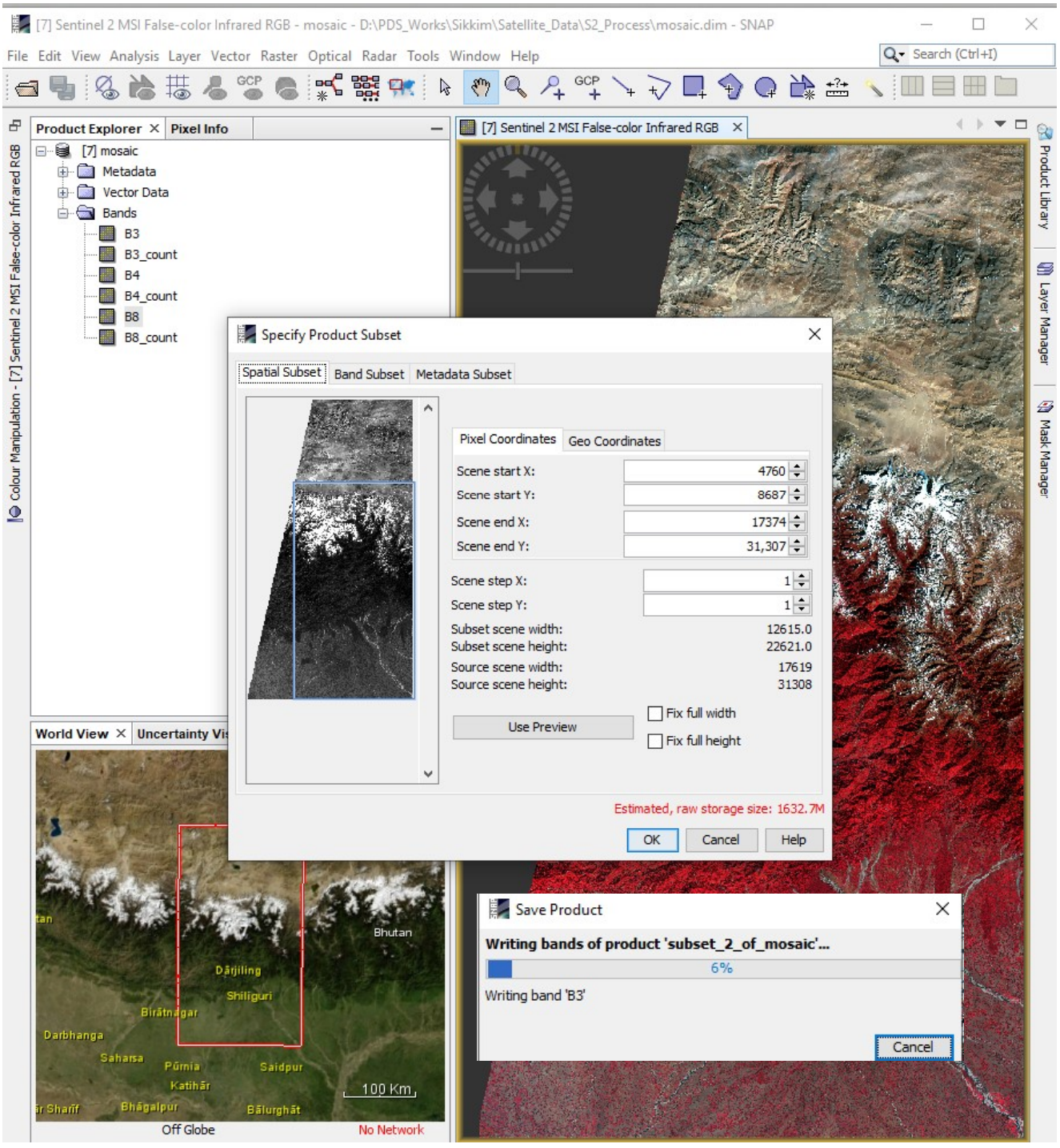
It Shows Writing Target product while processing the product



Once after running the Mosaic Operation Product will be displayed in the product Explorer. One can open and subset further based on the need.



- Subset can be don accordingly based on the need as shown in the preview, it shows the estimated Raw Storage capacity
- Once it is Subseted, the Image has to be saved.
- It can also be exported into other Image formats, keep the native format for later processing in SNAP Desktop.

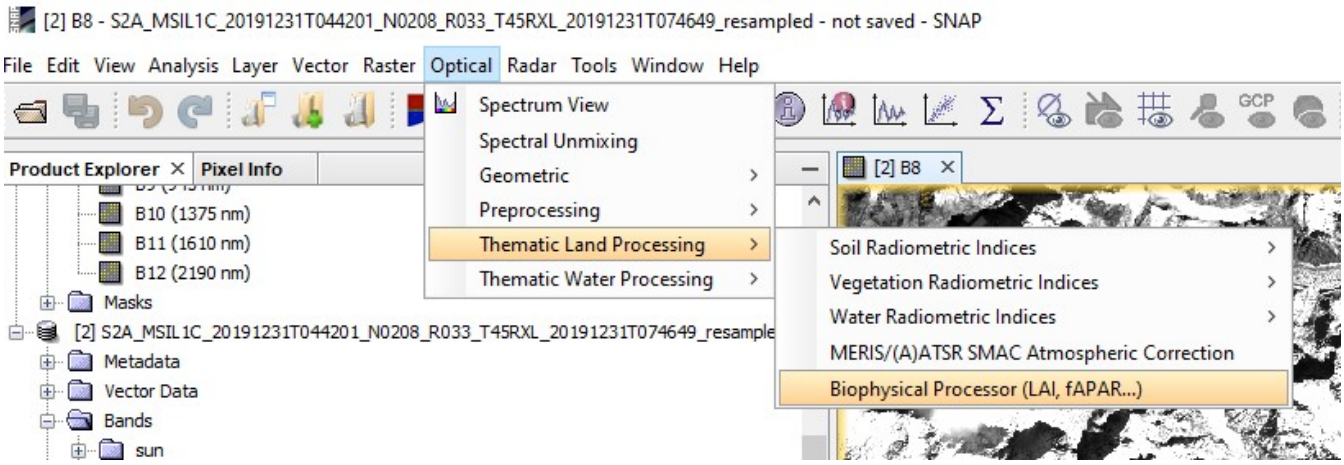


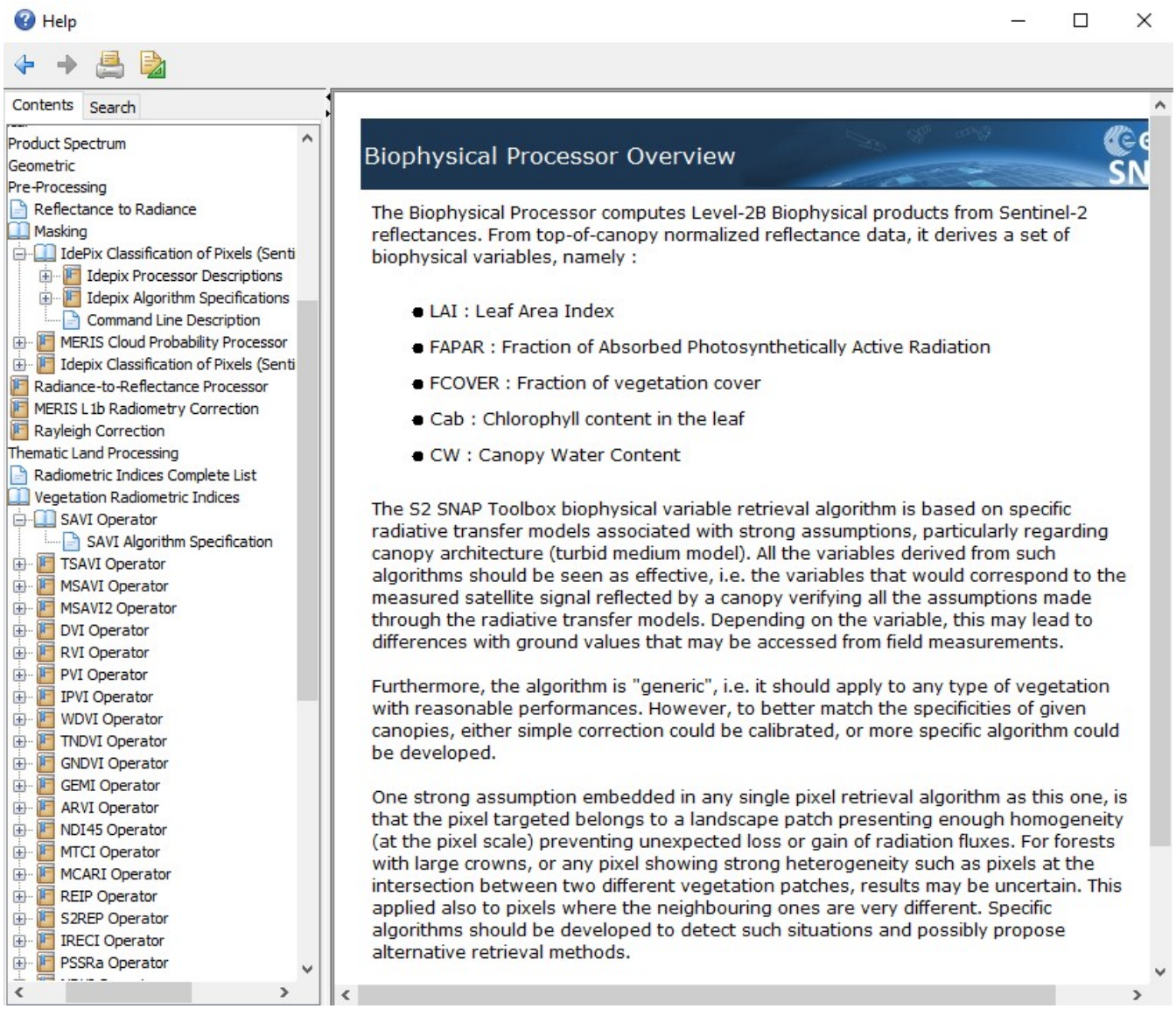
SNAP Desktop is a powerful tool for various land & Water Related Applications listed below are some:

- **Radiometric Indices**
  - Biophysical Processer (Slide 21)
  - Soil Indices (Slide 22)
  - Vegetation Indices
  - Water Indices
- **Raster Processing (Slide 23)**
  - Subset, Mosaic, Resample
  - Principal Component Analysis
  - Masking & Segmentation
  - Image Classification
    - Unsupervised Classification
    - Supervised Classification
- **Vector Data**
  - Create
  - Import
  - Export
- **Layer Manager**
- **Product Library**
- **AOI Mapping**

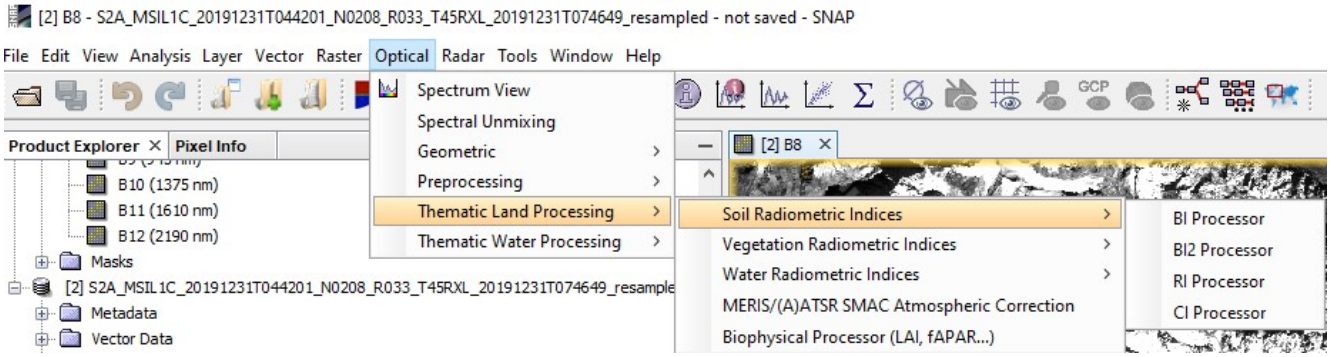
Radiometric Indices and Raster Processing can be readily applied in the Processed Sentinel 2 Images. Vector Data, Layer Manager, Product Library & AOI Mapping Needs further support in the tool (Preparation of manual in process)

Biophysical Processer (LAI, Chlorophyll, Canopy Water, FAPAR etc.,)





Radiometric Indices (Soil, Water & Vegetation)



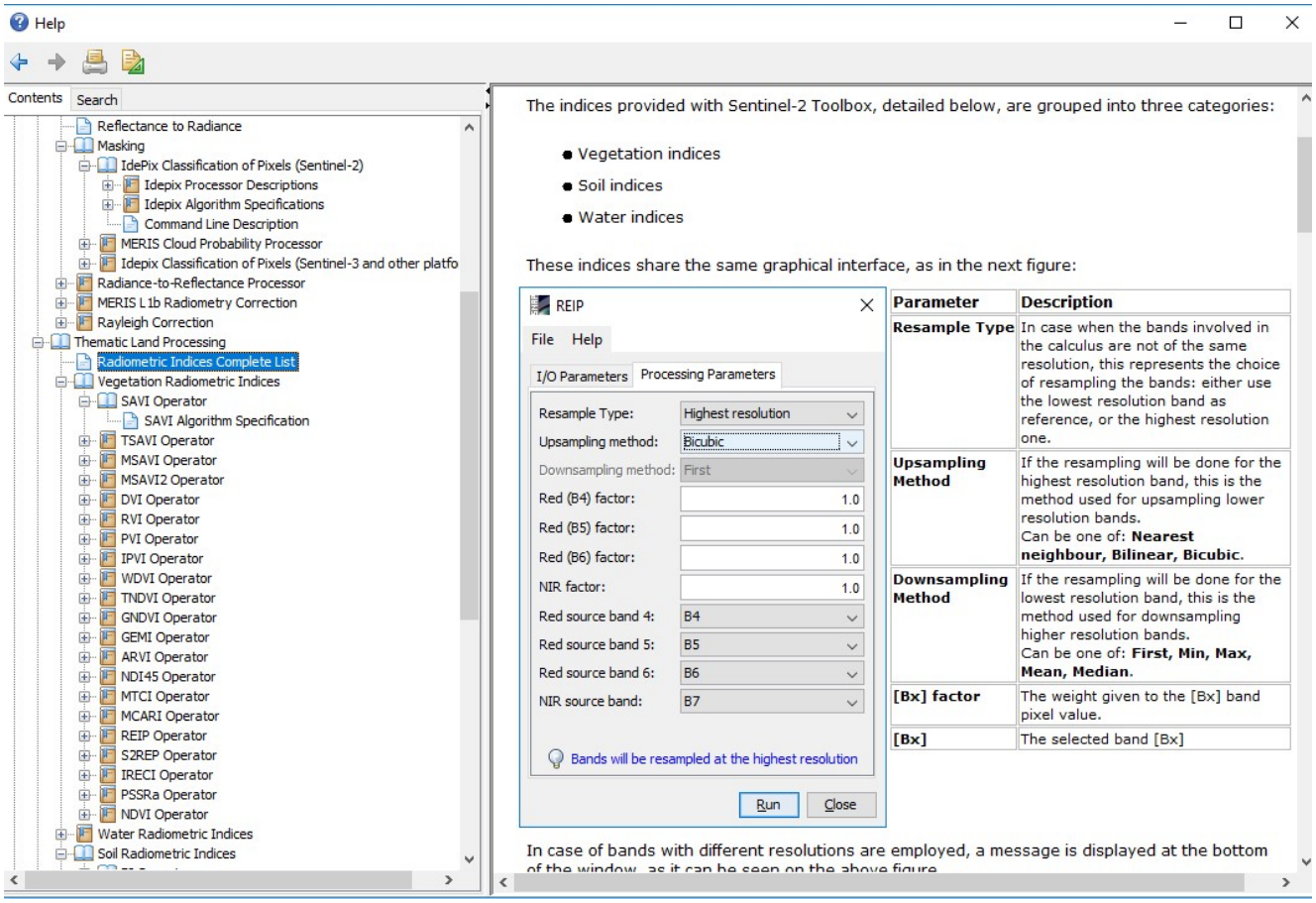
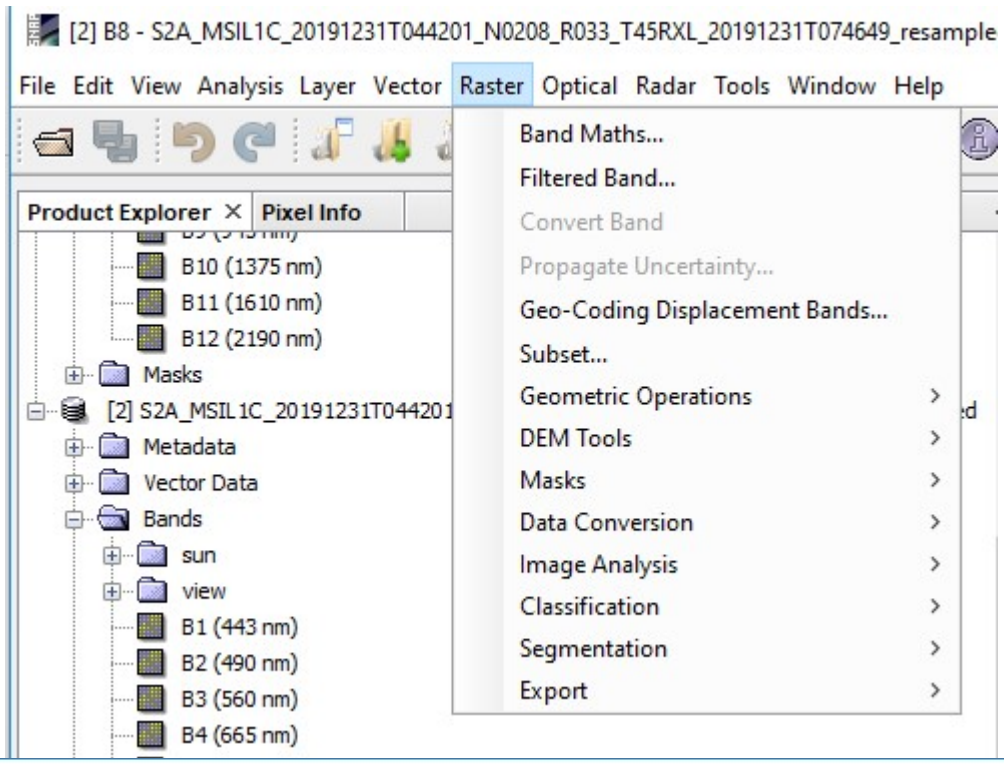
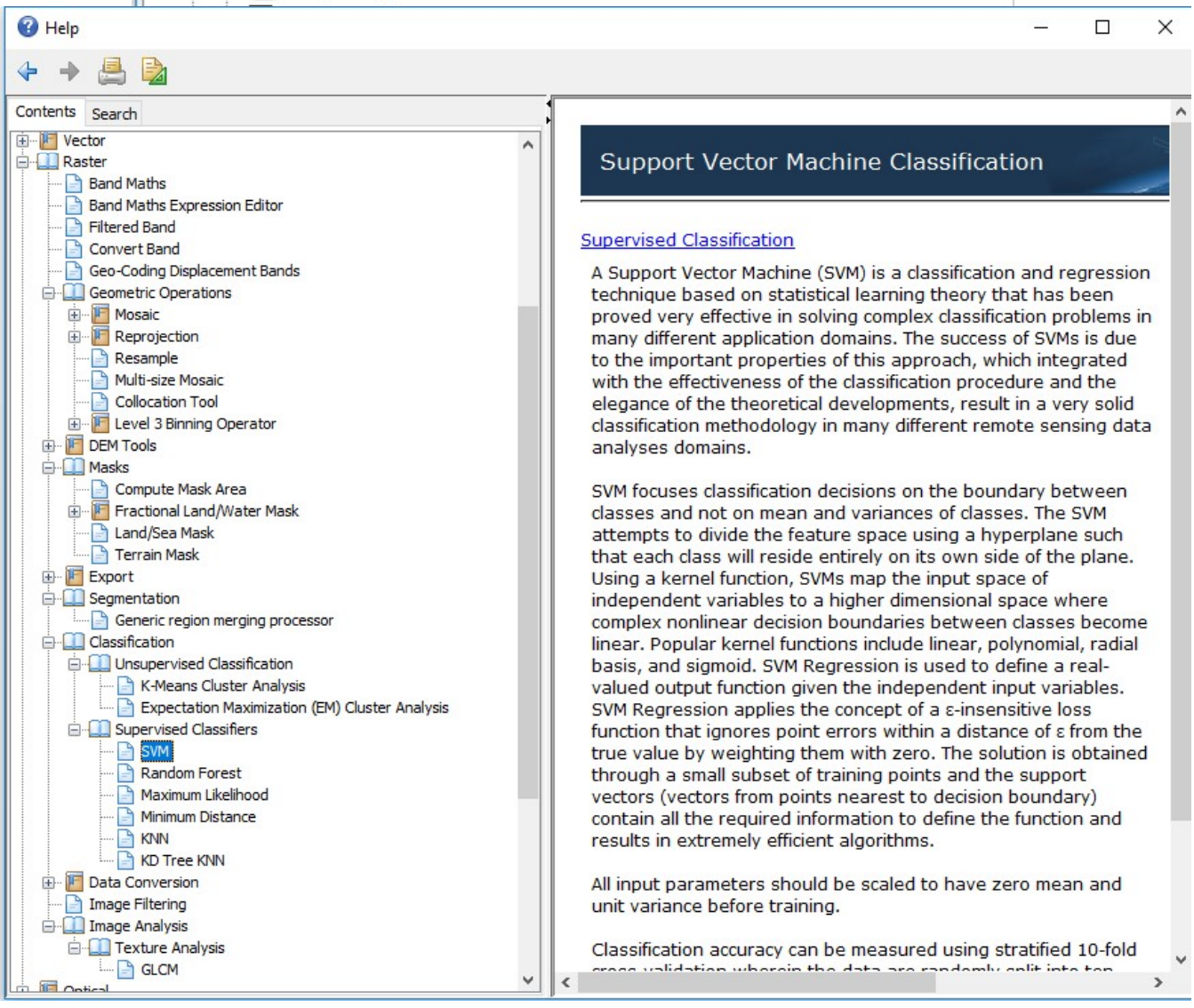


Image Processing & Classifiers





Create, Add & Edit Vector Layers through Layer Manager

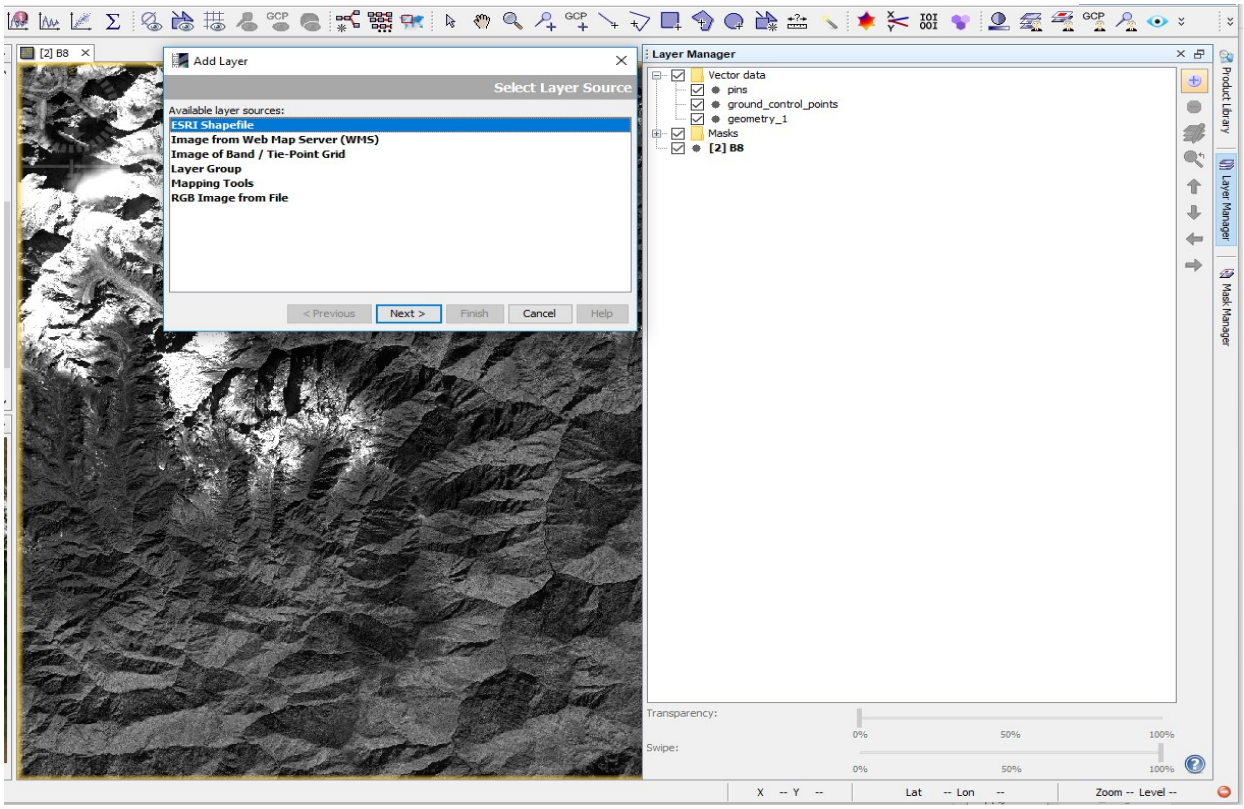
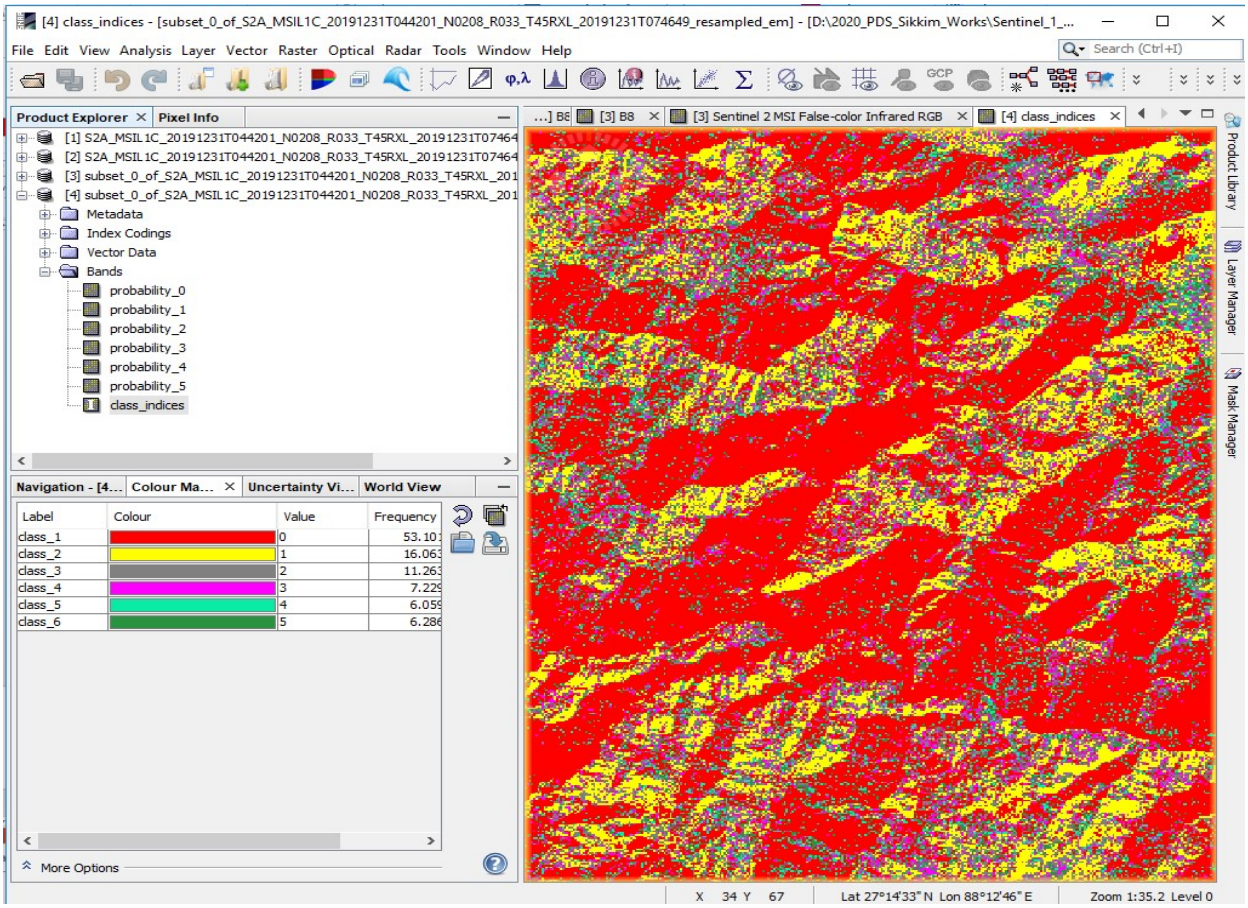
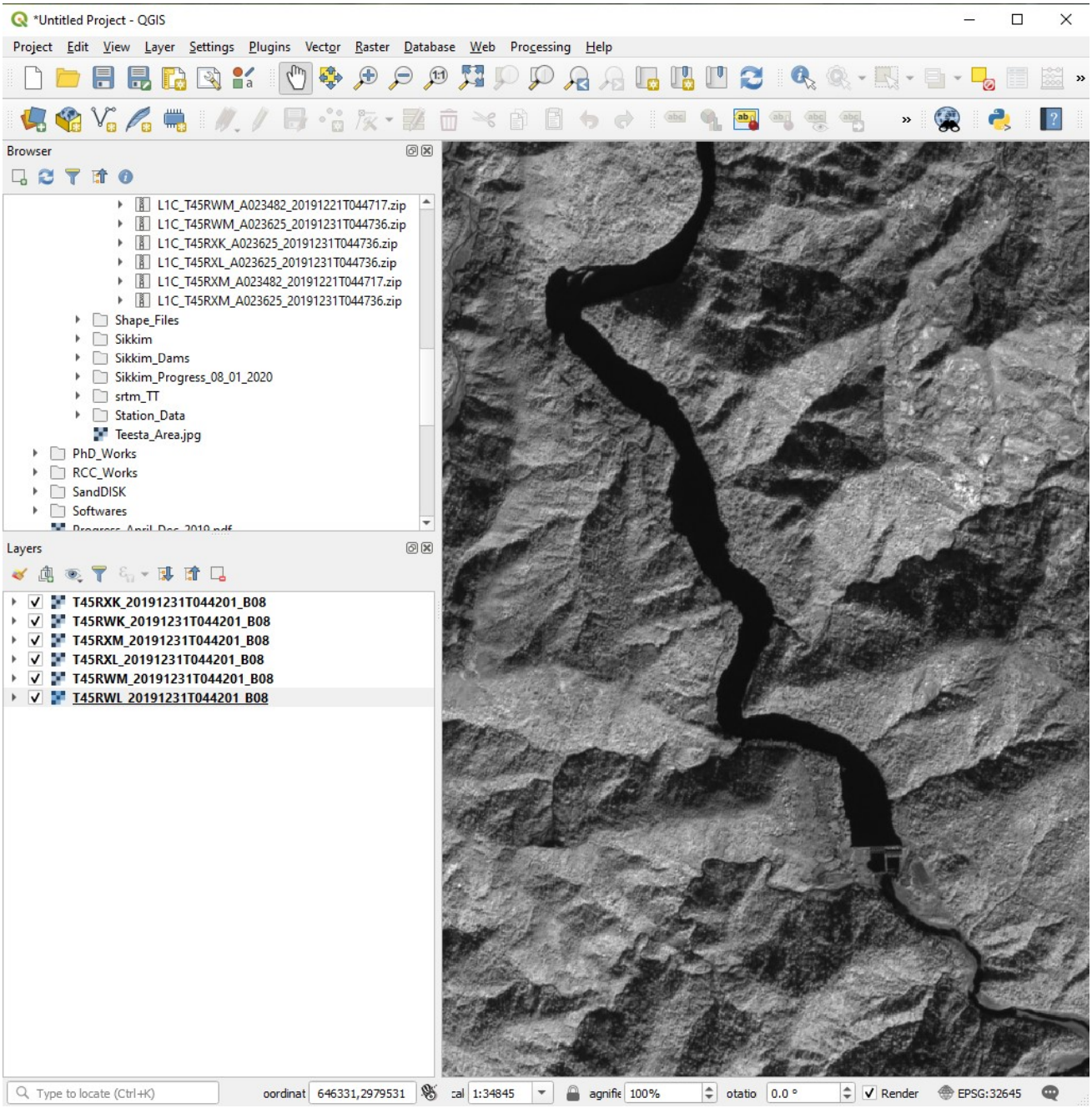


Image Classification



QGIS for Visualization

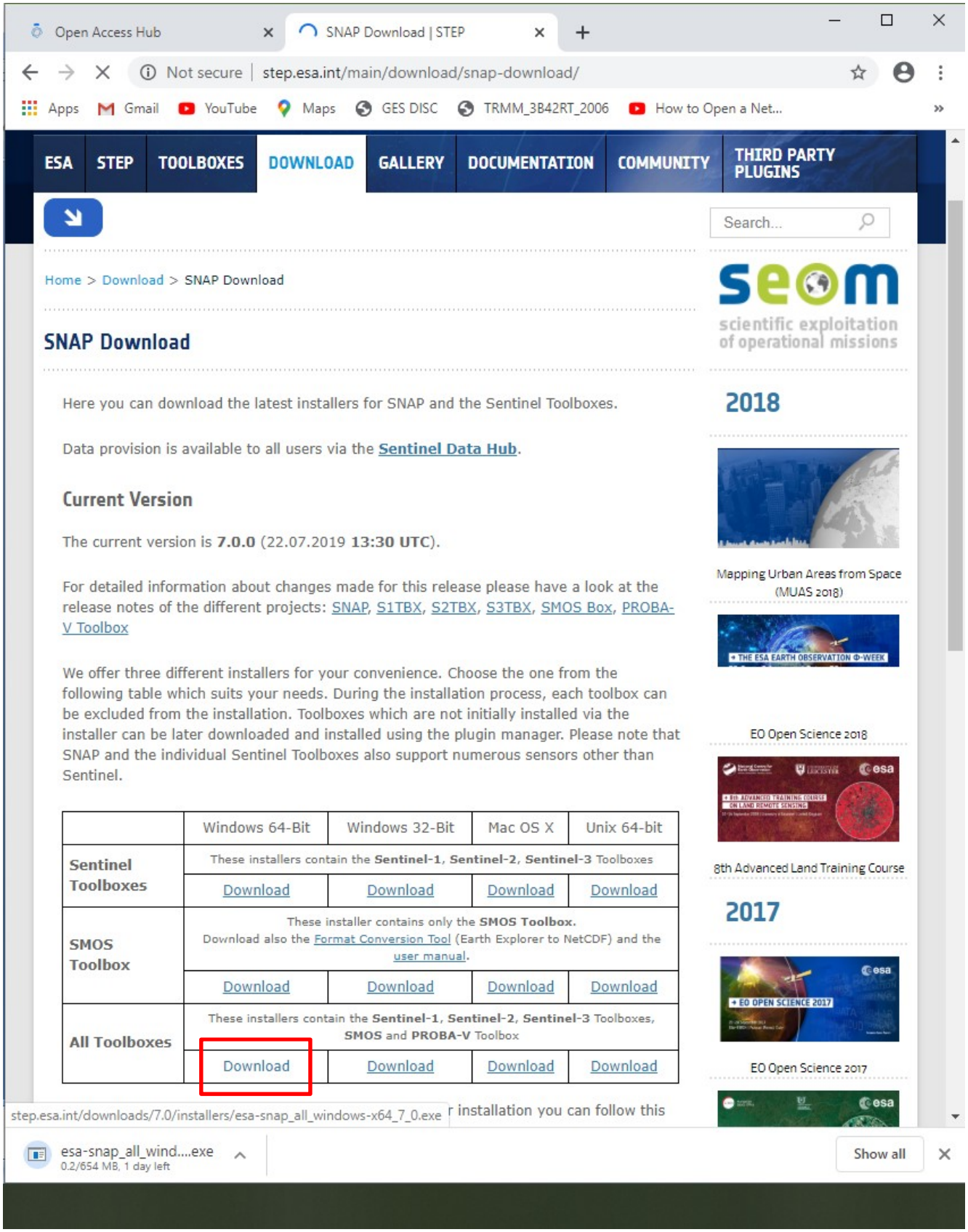
The **Raw Bands** and **Processed Images** can be opened in **QGIS** by directly **double clicking** processed bands in the **Browser** as follows. The corresponding **RAW IMAGE** or **Processed Data** would be **opened** on **layers** which may be used further **Map & Layout** making processes.



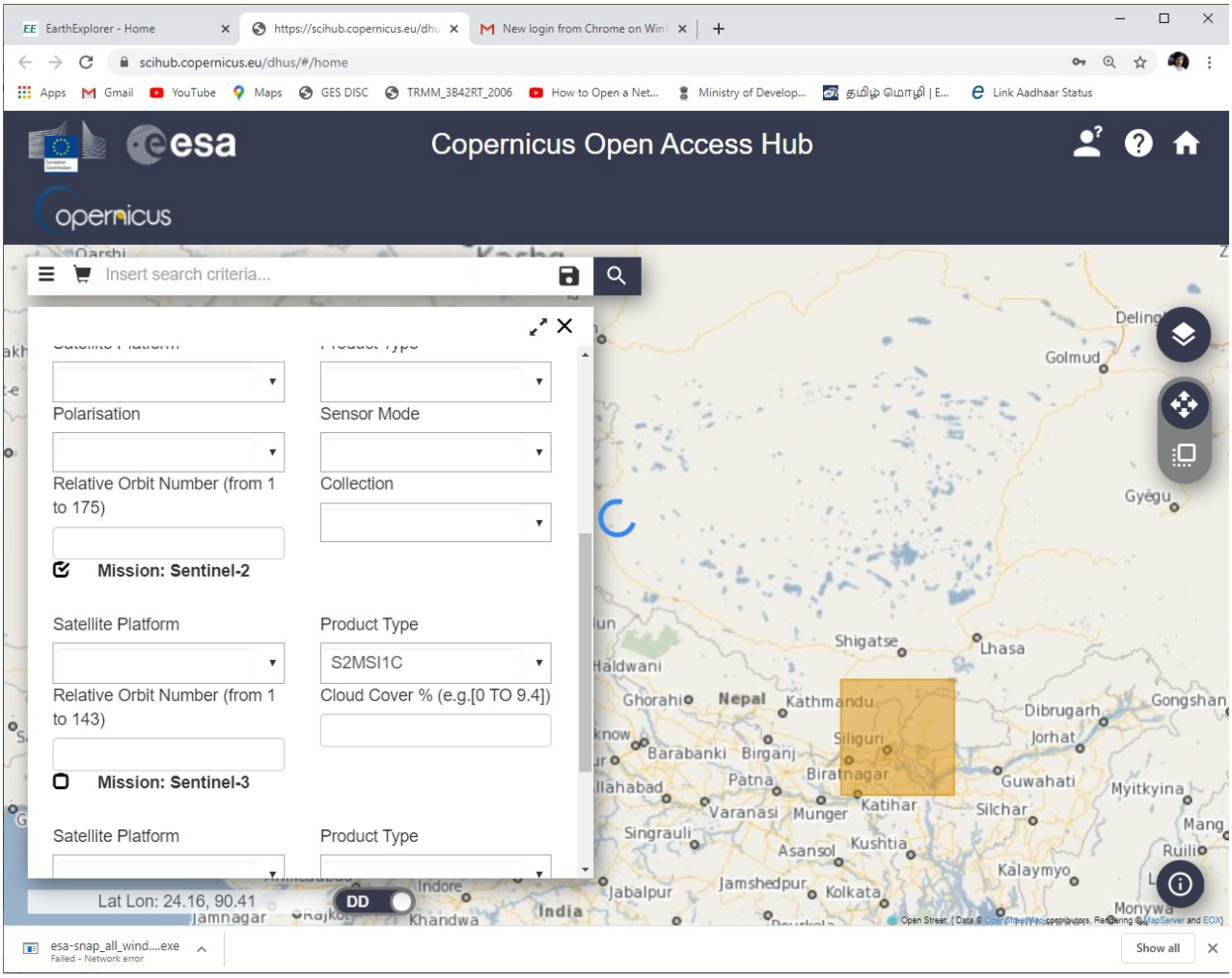
Other Resources

- Sentinel 2 SNAP 7.0 Link
  - http://step.esa.int/main/download/snap-download/
- Sentinel SCIHUB Link
  - https://scihub.copernicus.eu/dhus/#/home
- QGIS Software Download Link
  - https://qgis.org/en/site/forusers/download.html#
- Sentinel 2 User Handbook Link
  - https://sentinel.esa.int/documents/247904/685211/Sentinel-2_User_Handbook
- Sentinel 2 Online Resources
  - https://sentinel.esa.int/web/sentinel/user-guides/sentinel-2-msi
- Earth Explorer Data Download Link
  - https://earthexplorer.usgs.gov/

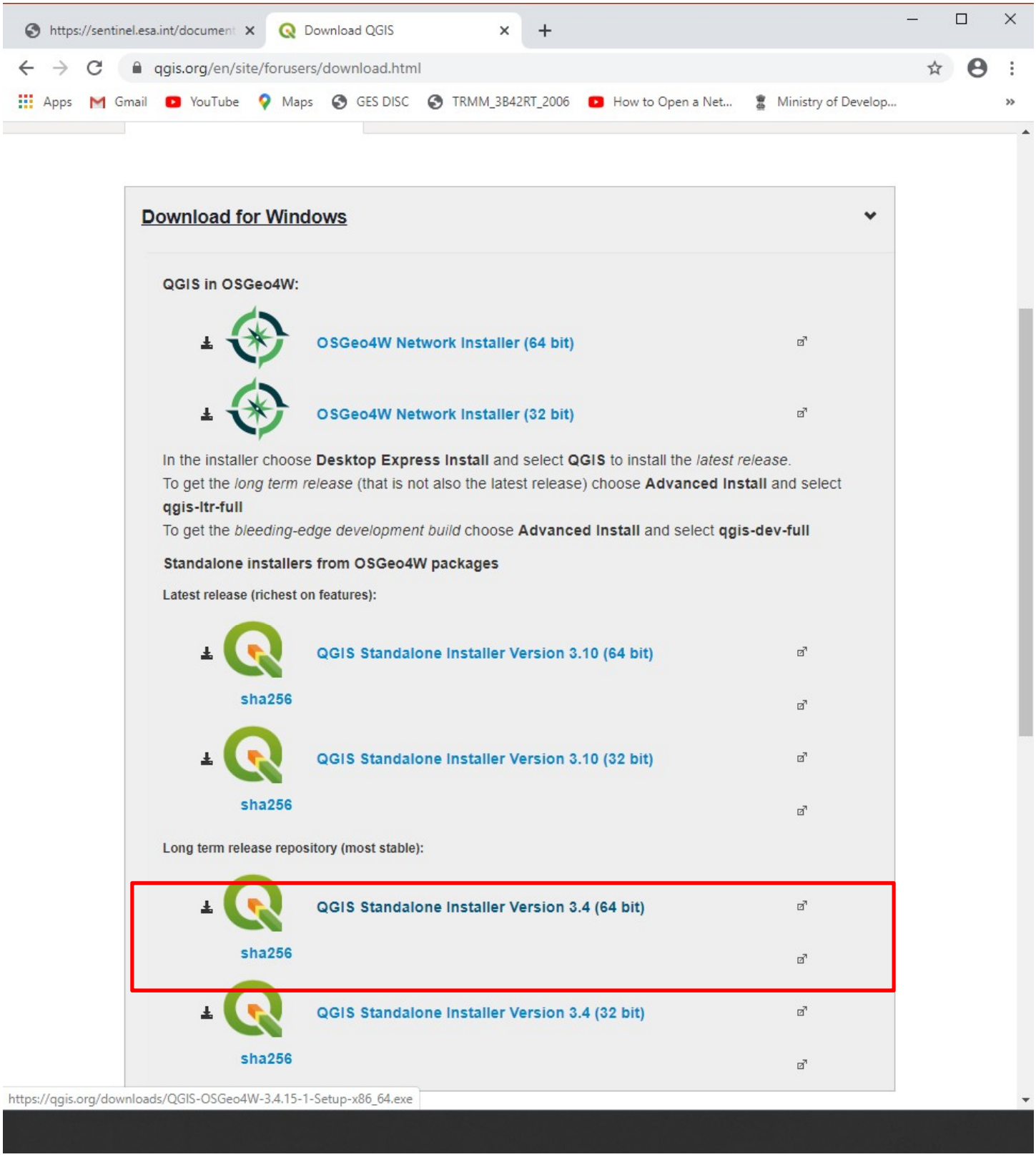
Sentinel 2 SNAP 7.0 Download



Sentinel 2 Data Download from SCIHUB



QGIS Software Download



QGIS Standalone Installer Version 3.4 is best suitable for Beginners. Click on the link as shown in Red box to get the software and download and install like **usual installation**

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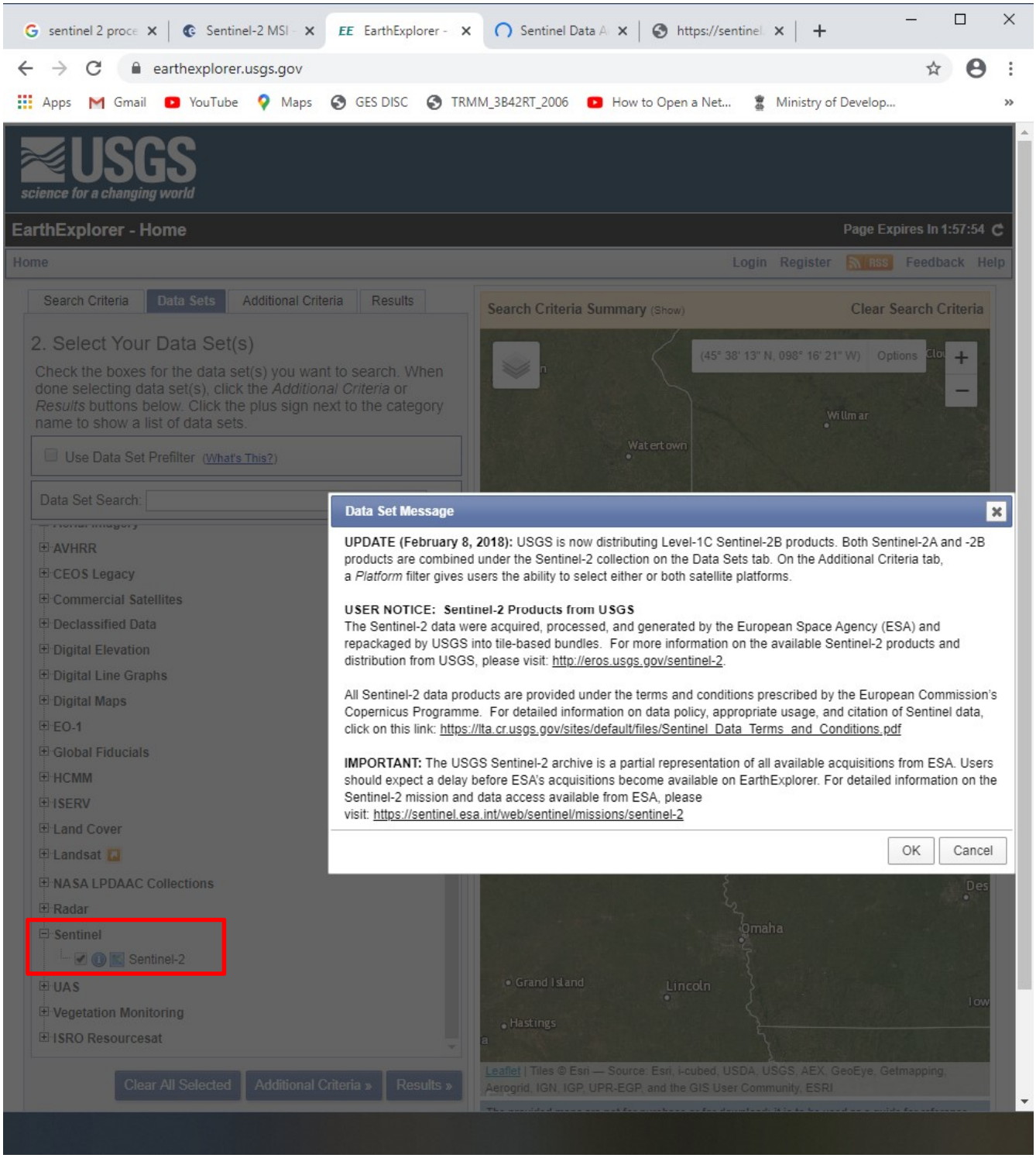

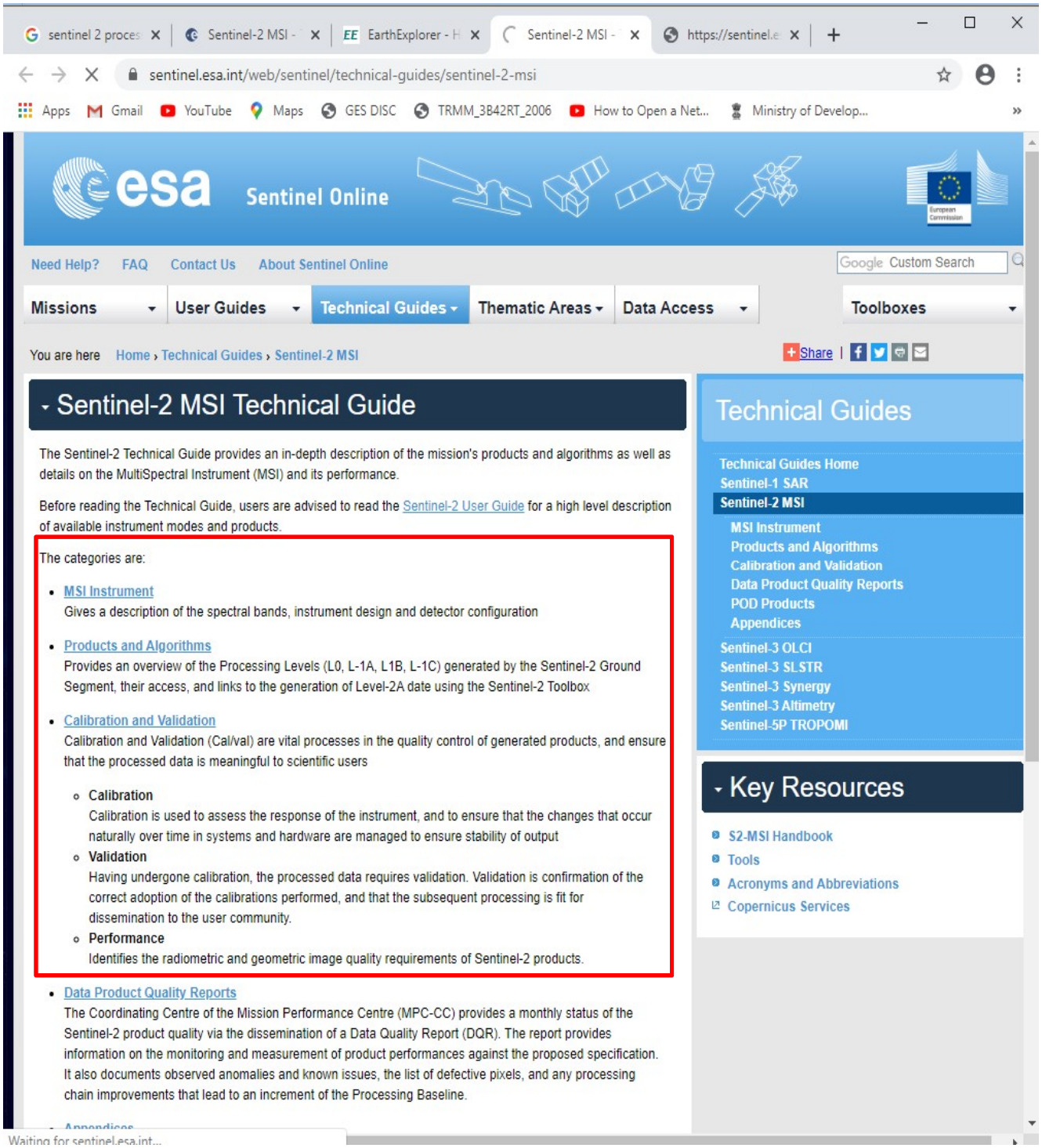
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Sentinel-2 MSI Technical Guide
The Sentinel-2 Technical Guide provides an in-depth description of the mission's products and algorithms as well as details on the MultiSpectral Instrument (MSI) and its performance.
Before reading the Technical Guide, users are advised to read the Sentinel-2 User Guide for a high level description of available instrument modes and products.
The categories are:
MSI Instrument
Gives a description of the spectral bands, instrument design and detector configuration
Products and Algorithms
Provides an overview of the Processing Levels (L0, L-1A, L1B, L-1C) generated by the Sentinel-2 Ground Segment, their access, and links to the generation of Level-2A date using the Sentinel-2 Toolbox
Calibration and Validation
Calibration and Validation (Cal/val) are vital processes in the quality control of generated products, and ensure that the processed data is meaningful to scientific users
Calibration
Calibration is used to assess the response of the instrument, and to ensure that the changes that occur naturally over time in systems and hardware are managed to ensure stability of output
Validation
Having undergone calibration, the processed data requires validation. Validation is confirmation of the correct adoption of the calibrations performed, and that the subsequent processing is fit for dissemination to the user community.
Performance
Identifies the radiometric and geometric image quality requirements of Sentinel-2 products.
Data Product Quality Reports
The Coordinating Centre of the Mission Performance Centre (MPC-CC) provides a monthly status of the Sentinel-2 product quality via the dissemination of a Data Quality Report (DQR). The report provides information on the monitoring and measurement of product performances against the proposed specification. It also documents observed anomalies and known issues, the list of defective pixels, and any processing chain improvements that lead to an increment of the Processing Baseline.
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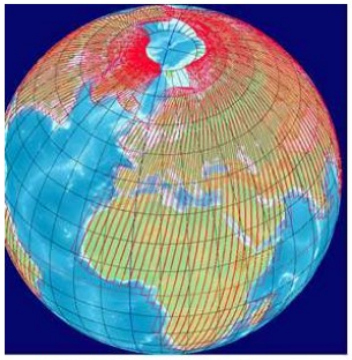

Figure 22: Modelled Sentinel-2 Coverage

ESA Standard Document | https://scihub.copernicus.eu

sentinel.esa.int/documents/247904/685211/Sentinel-2_User_Handbook

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SENTINEL-2 User Handbook

Table of contents:

1.12.2 Radiometric Resolutions

SENTINEL-2 data are acquired on 13 spectral bands in the VNIR and SWIR:

- four bands at 10 m: 490 nm (B2), 560 nm (B3), 665 nm (B4), 842 nm (B8)
- six bands at 20 m: 705 nm (B5), 740 nm (B6), 783 nm (B7), 865 nm (B8a), 1 610 nm (B11), 2 190 nm (B12)
- three bands at 60 m: 443 nm (B1), 945 nm (B9) and 1 375 nm (B10).

Radiometric resolution is the capacity of the instrument to distinguish differences in light intensity or reflectance. The greater the radiometric resolution, the more accurate the sensed image will be.

Radiometric resolution is routinely expressed as a bit number, typically in the range of 8 to 16 bits. The radiometric resolution of the MSI instrument is 12 bit, enabling the image to be acquired over a range of 0 to 4 095 potential light intensity values. The radiometric accuracy is less than 5% (goal 3%). Radiometric resolution is also dependent upon the Signal to Noise Ratio (SNR) of the detector.

Table 3:10 m Spatial Resolution Bands and associated Signal to Noise ratio (SNR)

Band number	Central wavelength (nm)	Bandwidth (nm)	Lref (reference radiance) (W m−2 sr−1 µm−1)	SNR @ Lref
2	490	65	128	154
3	560	35	128	168
4	665	30	108	142
8	842	115	103	172

Table 4:20 metre Spatial Resolution Bands and associated Signal to Noise ratio (SNR)

Band number	Central wavelength (nm)	Bandwidth (nm)	Lref (reference radiance) (W m−2 sr−1 µm−1)	SNR @ Lref
5	705	15	74.5	117
6	740	15	68	89
7	783	20	67	105
8b	865	20	52.5	72
11	1 610	90	4	100
12	2 190	180	1.5	100

Table 5:60 metre Spatial Resolution Bands and associated Signal to Noise ratio (SNR)

Band number	Central wavelength (nm)	Bandwidth (nm)	Lref (W m−2 sr−1 µm−1)	SNR @ Lref
1	443	20	129	129
9	945	20	9	114
10	1 375	30	6	50