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National Institute of Hydrology

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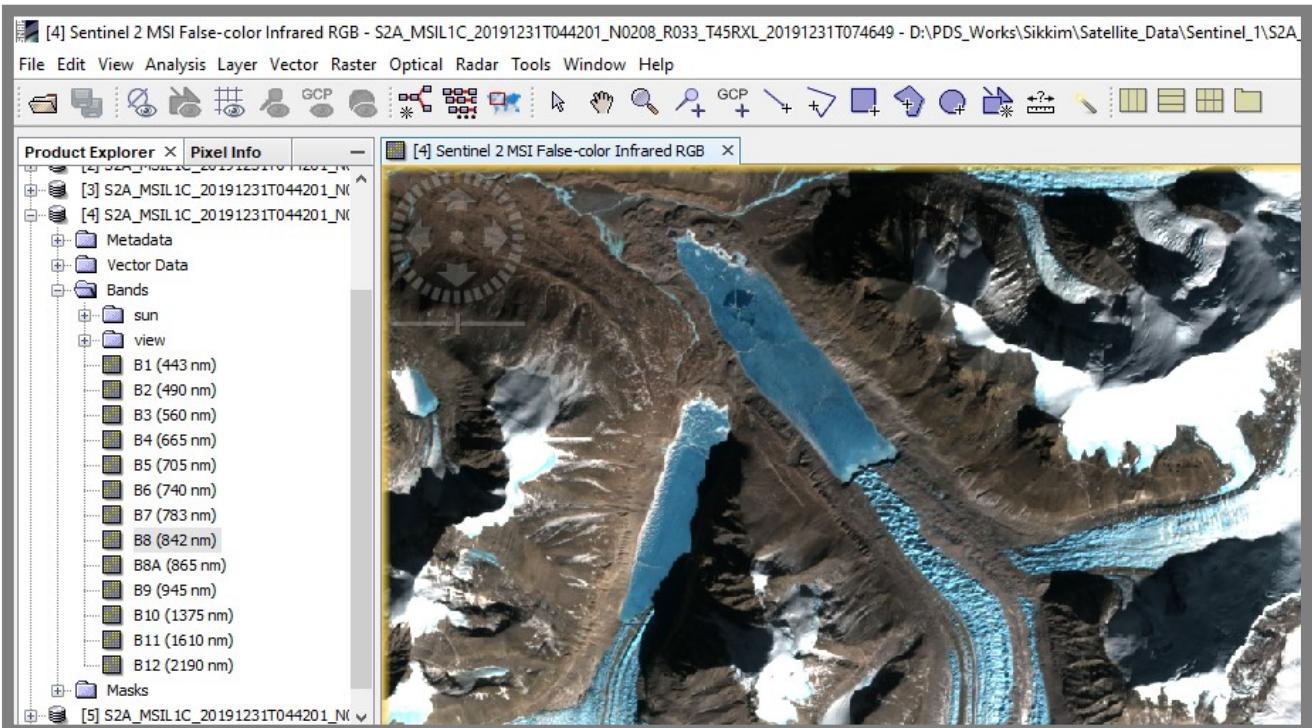


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Tutorial in SNAP Desktop for Sentinel 2 Data Pre Processing Applications - GNU GPL Environment



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:

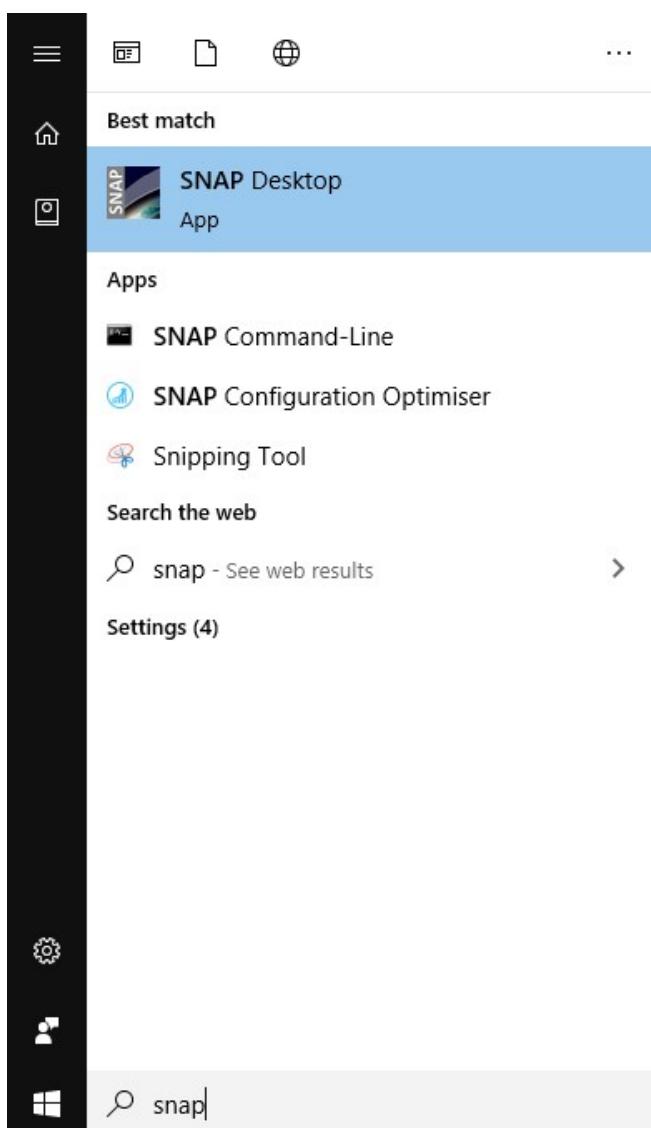
Concern expert is the solely responsible for any issues while doing this tutorial. Neither the working organization nor the ESA Sentinel Team responsible for the issues found in this tutorial.

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.

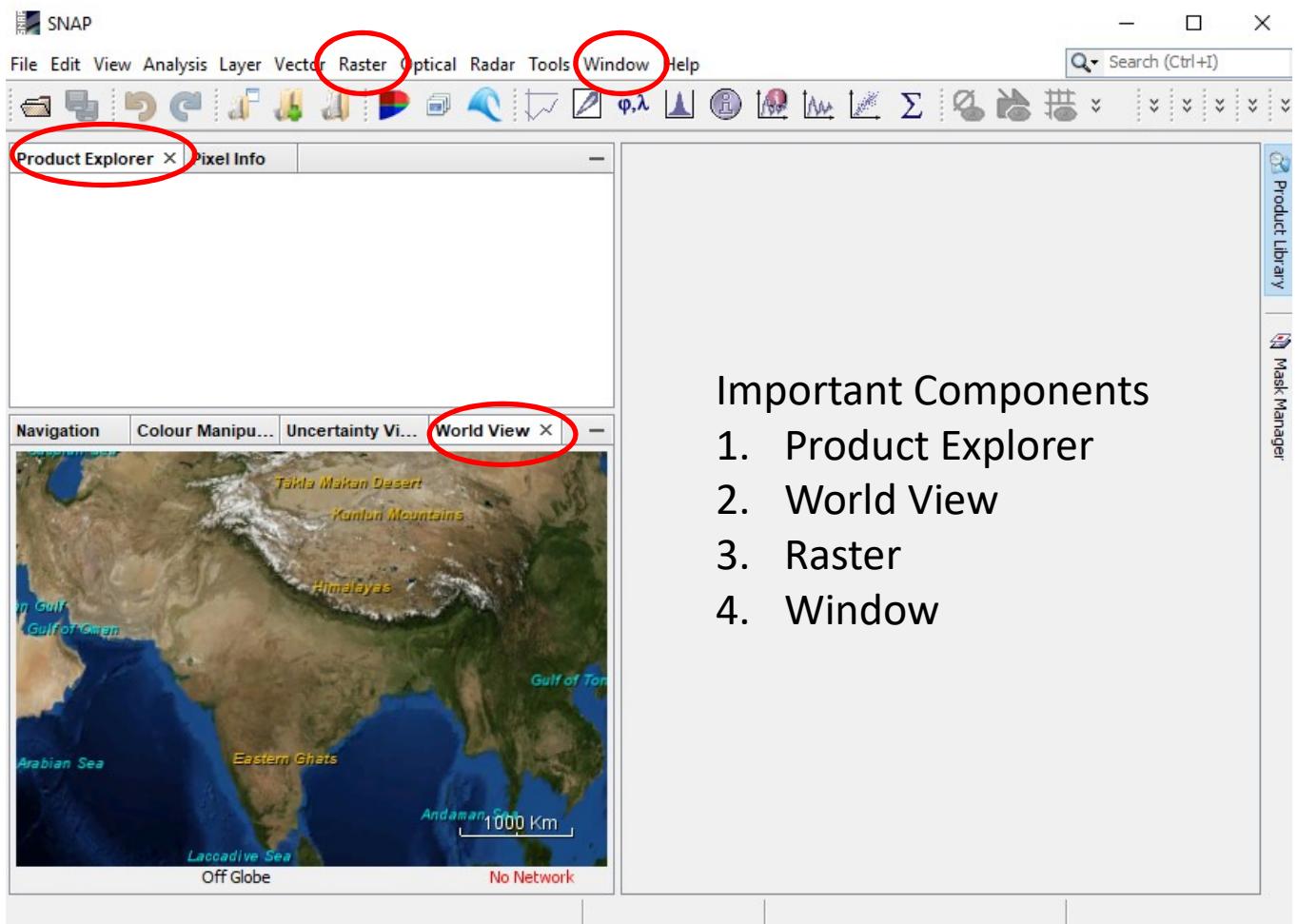
Tutorial topics included:

- 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:

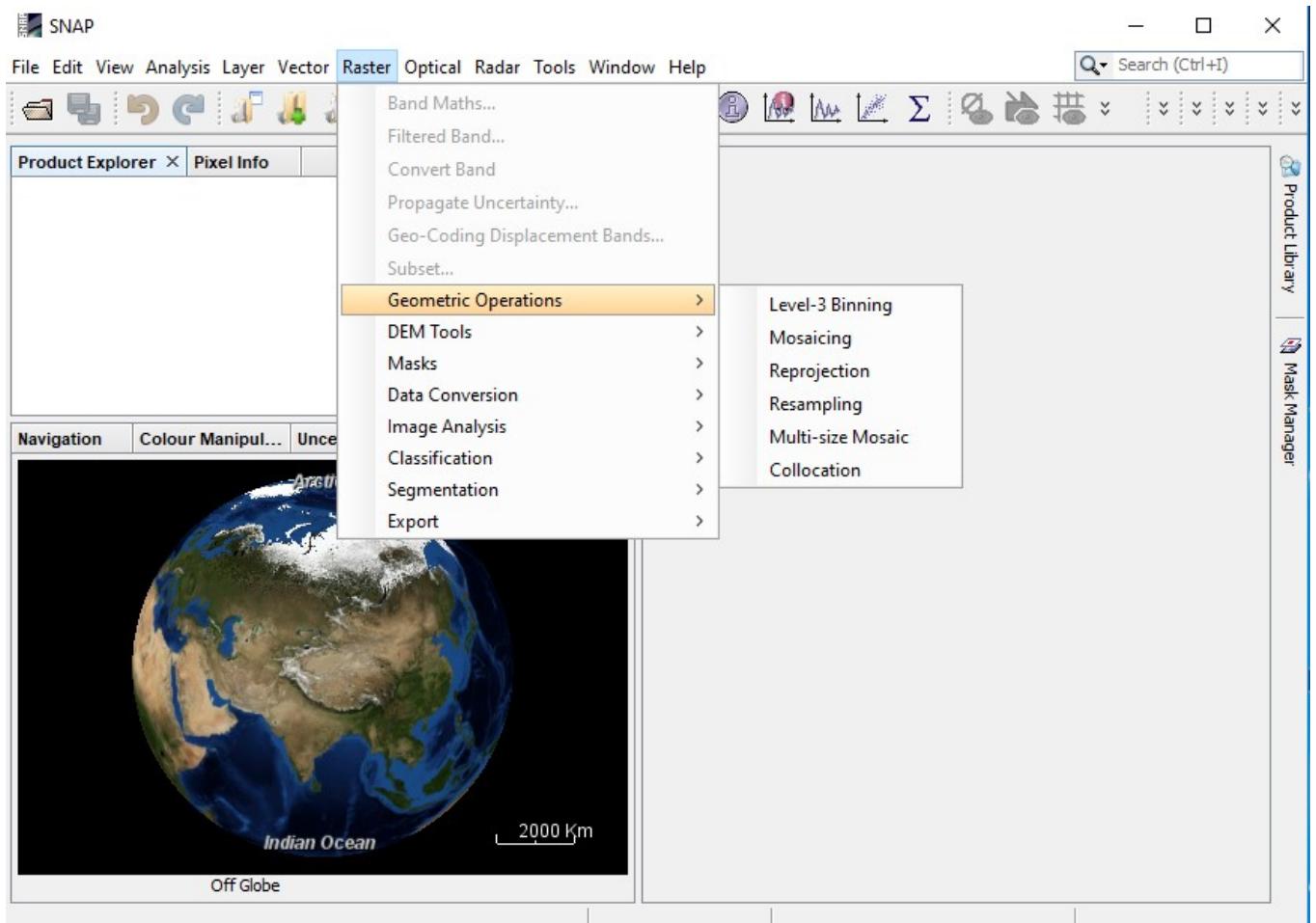
- Download Sentinel 2 Data required for your Area of Study via SCIHUB/Earth Explorer
- Unzip Sentinel 2 Data shows .SAFE Extension
- Open Sentinel Tool Box SNAP 6.0 or higher
- Drag and Drop Data in Product Explorer



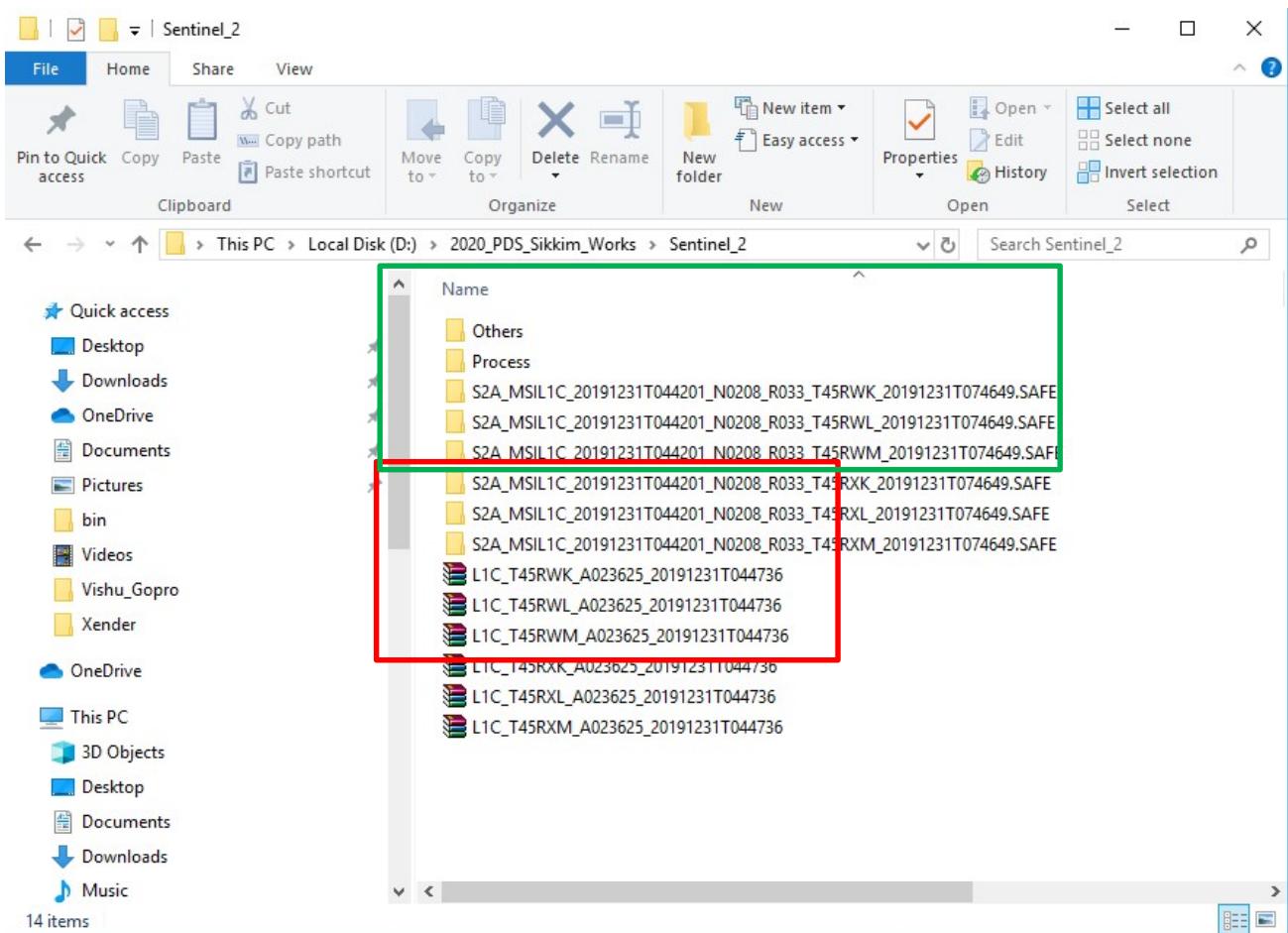
Important Components

1. Product Explorer
2. World View
3. Raster
4. Window

1. SNAP Desktop tool looks like picture shown above

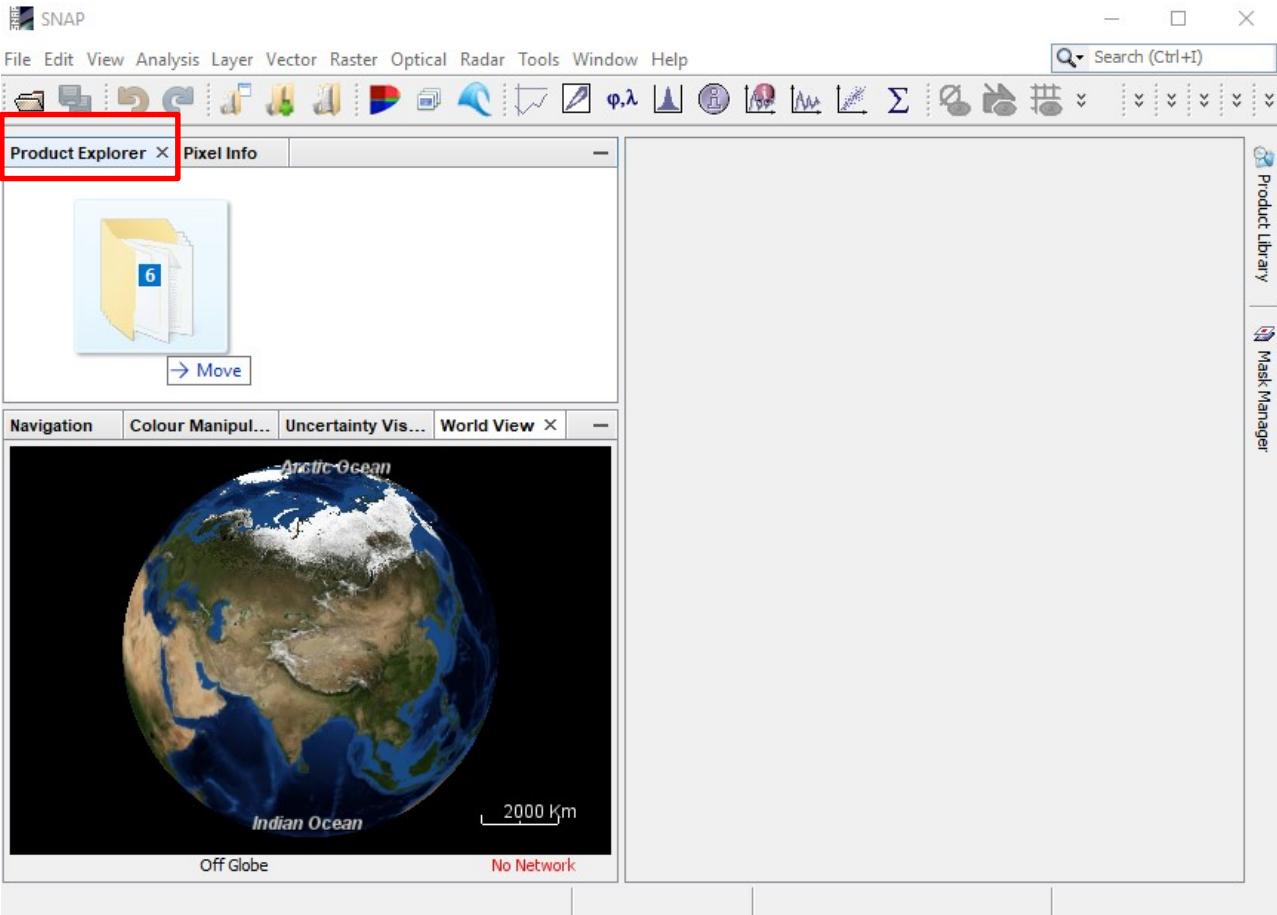


2. Geometric operations are main pre-processing essentials

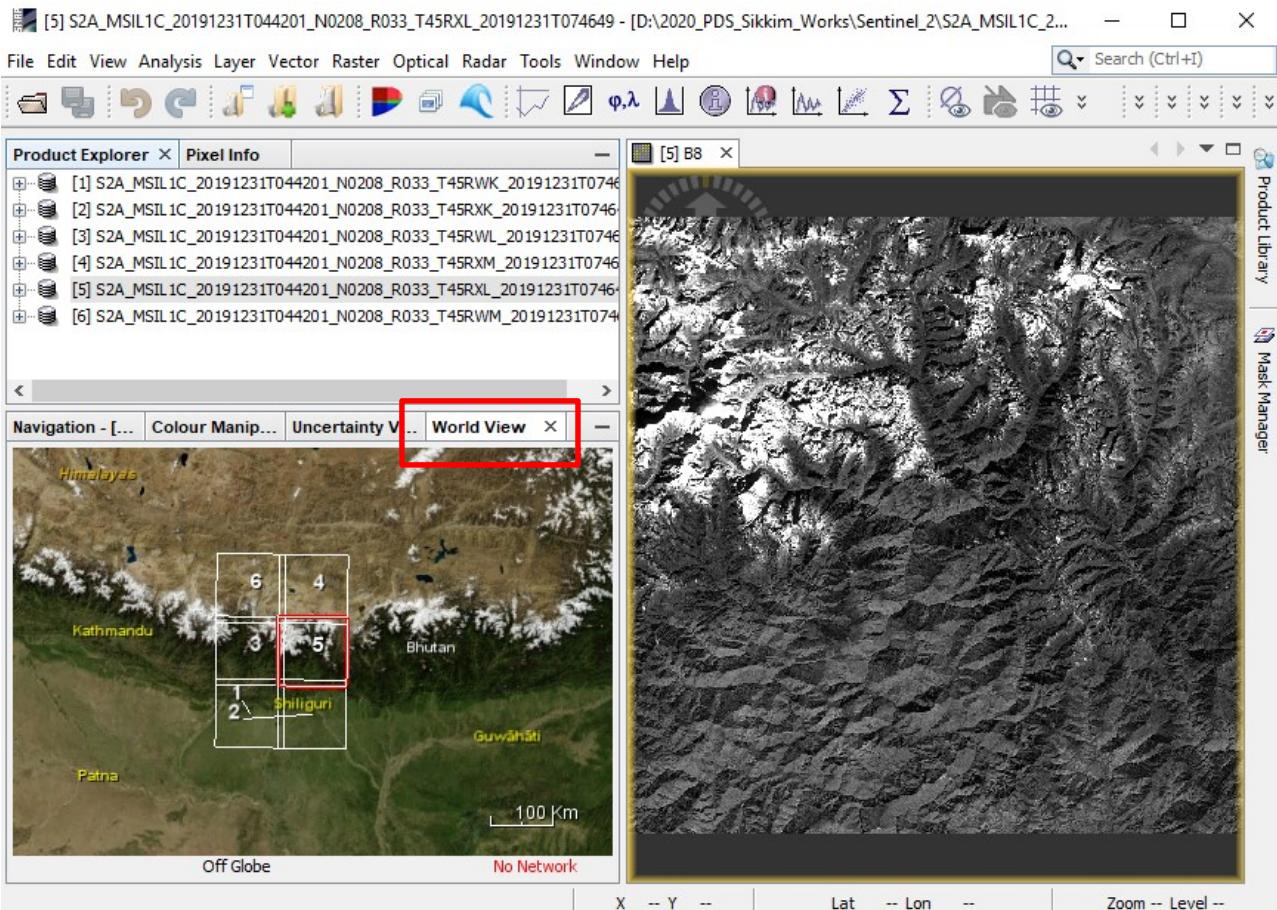


1. Red Box showing the zip files downloaded from the Earth Explorer
2. Green box showing the extracted data in .safe format.
3. The Data needs to be pre processed to get the geocoded output in the form of .tif, .img or .hdr format
4. The .SAFE folders can be directly dragged ad dropped in the product 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

Help

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Find: sentinel 2

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- 8 SNAP S2REP - Algorithm Specification
- 4 SNAP Data Processors - Algorithm Spec
- 3 Thematic Land Processing
- 3 SNAP NDI45 - Algorithm Specification
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- 5 Help - Wind Field Estimation
- 5 SNAP MSAVI2 - Algorithm Specificatio
- 5 Help - Sentinel-1
- 5 Binning Operator

Import Sentinel-2 Products

This option allows to import **Sentinel-2** products.

SENTINEL-2 is a wide-swath, high-resolution, multi-spectral imaging mission, supporting Copernicus Land Monitoring studies, including the monitoring of vegetation, soil and water cover, as well as observation of inland waterways and coastal areas.

The **SENTINEL-2** Multispectral Instrument (MSI) sample 13 spectral bands: four bands at 10 metres, six bands at 20 metres and three bands at 60 metres spatial resolution.

[See Sentinel-2 MSI Overview](#)

Band Number	Spatial Resolution (m)	Central Wavelength (nm)	Bandwidth (nm)	Reference Radiance (W m ⁻² sr ⁻¹ um ⁻¹)	SNR @ Lref
1	60	443	20	129	129
2	10	490	65	128	154
3	10	560	35	128	168
4	10	665	30	108	142
5	20	705	15	74.5	117
6	20	740	15	68	89
7	20	783	20	67	105
8	10	842	115	103	172
8A	20	865	20	52.5	72
9	60	945	20	9	114
10	60	1375	30	6	50
11	20	1610	90	4	100
12	20	2190	180	1.5	100

[See Sentinel-2 User Handbook](#)

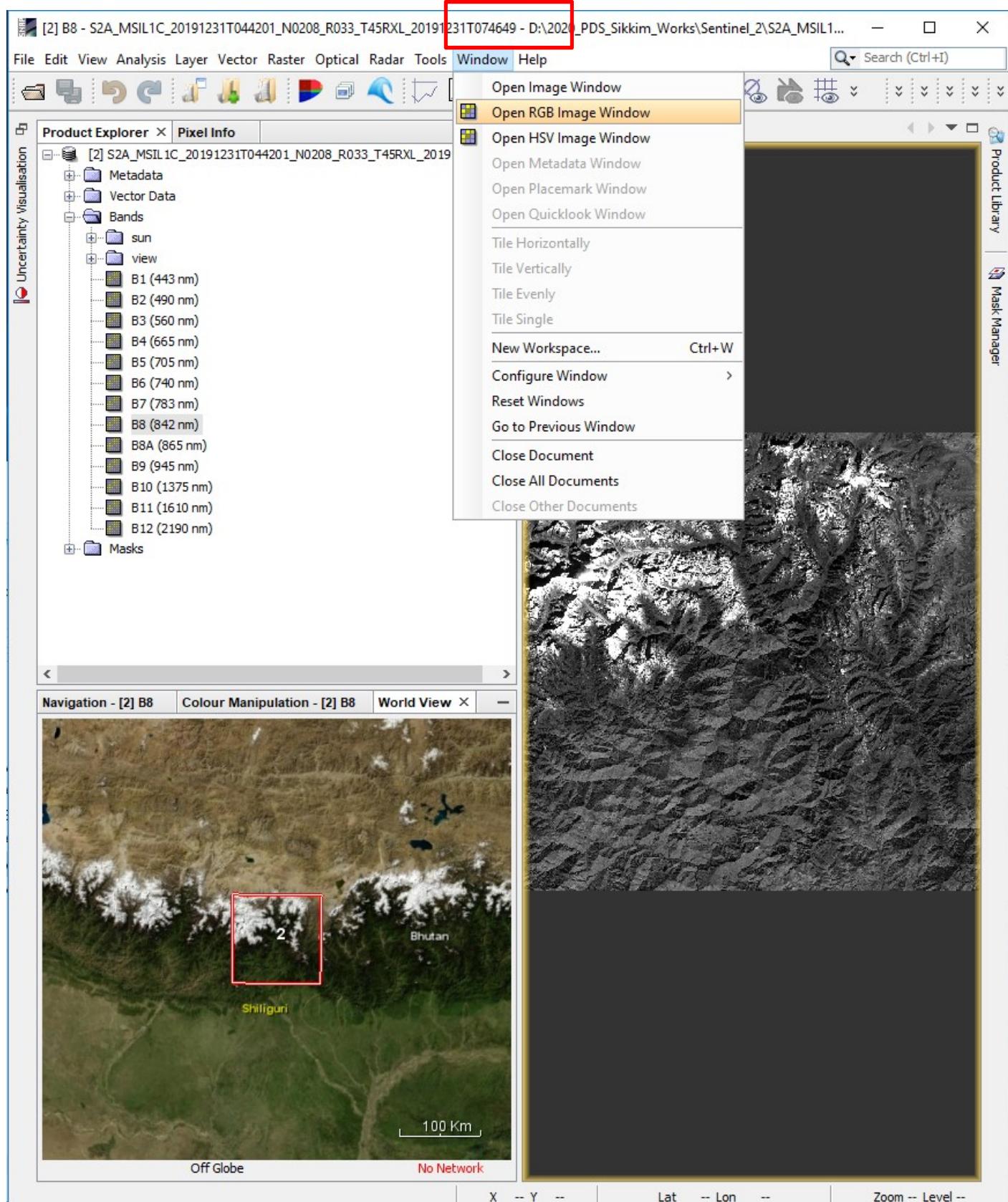
Supported products:

The supported **Sentinel-2** product types are:

- Level-1B: Top of atmosphere radiances in sensor geometry.
- Level-1C: Top of atmosphere reflectances in fixed cartographic geometry.
- Level-2A: Bottom of atmosphere reflectances in cartographic geometry generated by Sen2Cor
- Level-3: Multi temporal cloud-free synthesis generated by Sen2Three from a set of L2A products

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



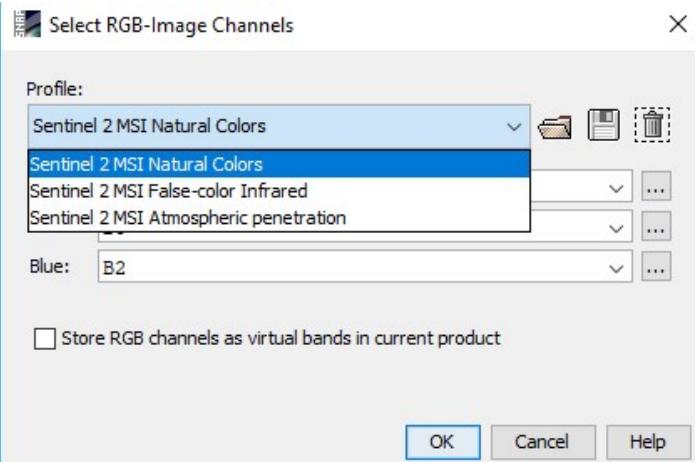
Before Resampling:

(3 RGB Channels)

1. MSI Natural Colors

2. MSI False Color IR

3. MSI Atmospheric penetration



[2] Sentinel 2 MSI Natural Colors RGB - S2A_MSIL1C_20191231T044201_N0208_R033_T45RXL_20191231T074649 - D:\2020_PDS_Sikki...

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

Search (Ctrl+I)

Product Explorer X Pixel Info

Uncertainty visualisation

[2] S2A_MSIL1C_20191231T044201_N0208_R033_T45RXL_20191231T074649

- Metadata
- Vector Data
- Bands
 - sun
 - view
 - B1 (443 nm)
 - B2 (490 nm)
 - B3 (560 nm)
 - B4 (665 nm)
 - B5 (705 nm)
 - B6 (740 nm)
 - B7 (783 nm)
 - B8 (842 nm)
 - B8A (865 nm)
 - B9 (945 nm)
 - B10 (1375 nm)
 - B11 (1610 nm)
 - B12 (2190 nm)
- Masks

[3] S2A_MSIL1C_20191231T044201_N0208_R033_T45RXL_20191231T074649

Navigation - [2] RGB Colour Manipulation - [2] ... World View X

Shilliguri

Bhutan

100 Km

Off Globe No Network

[2] Sentinel 2 MSI False-color Infrared RGB

[2] Sentinel 2 MSI Natural Colors RGB

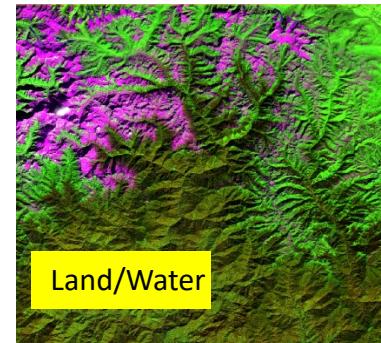
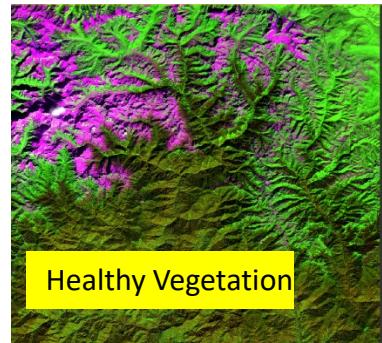
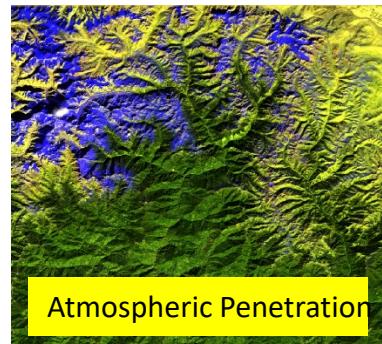
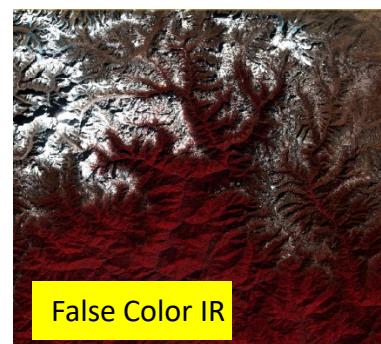
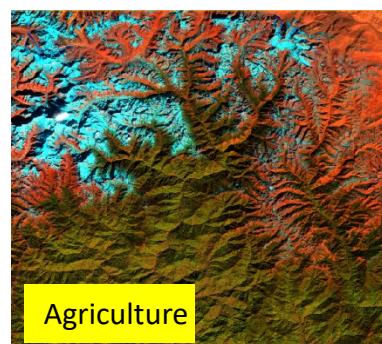
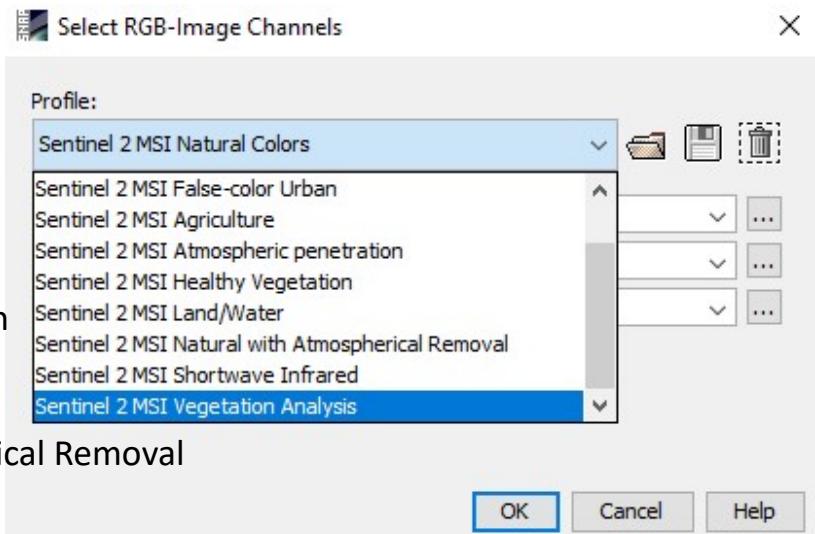
X -- Y -- Lat -- Lon -- Zoom -- Level --

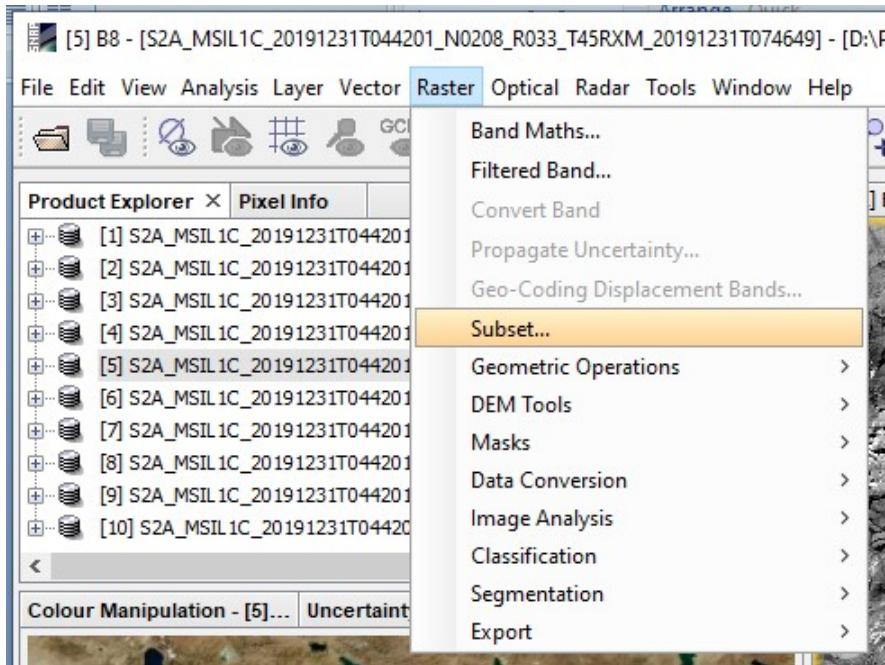
Product Library Mask Manager

After Resampling:

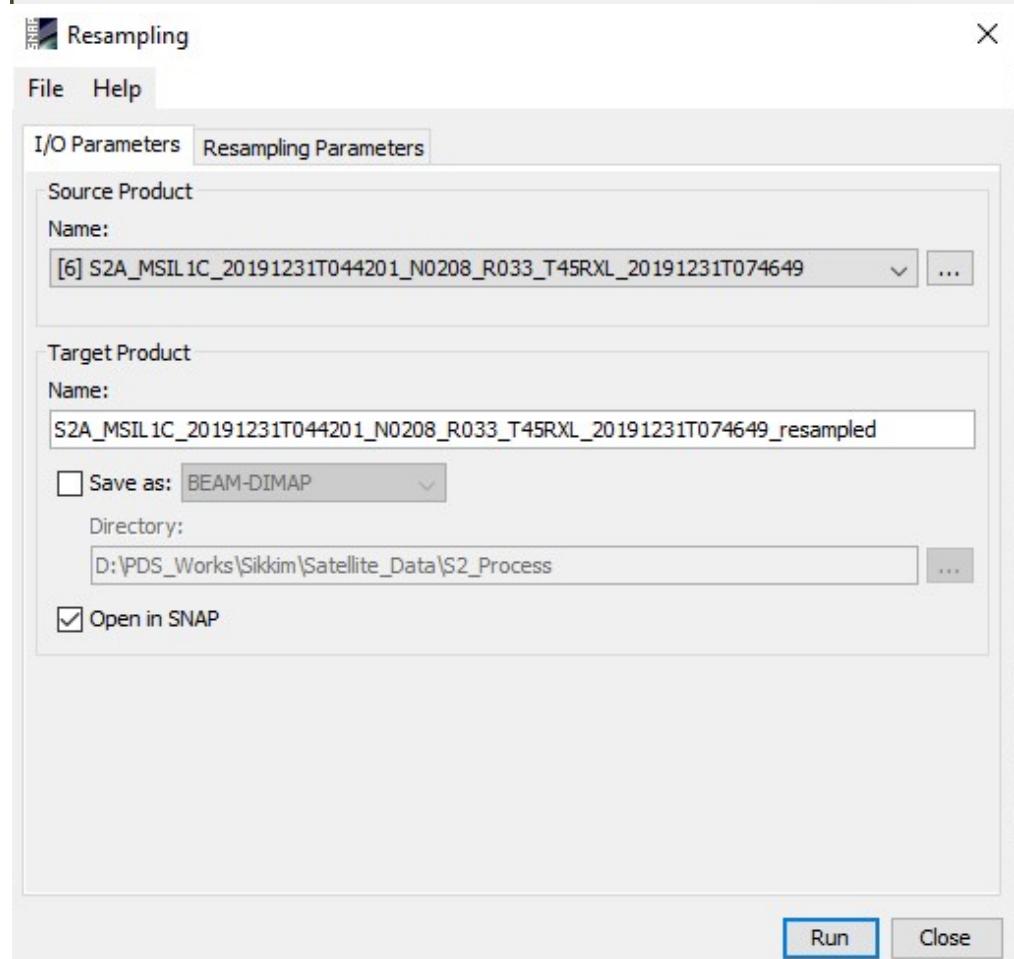
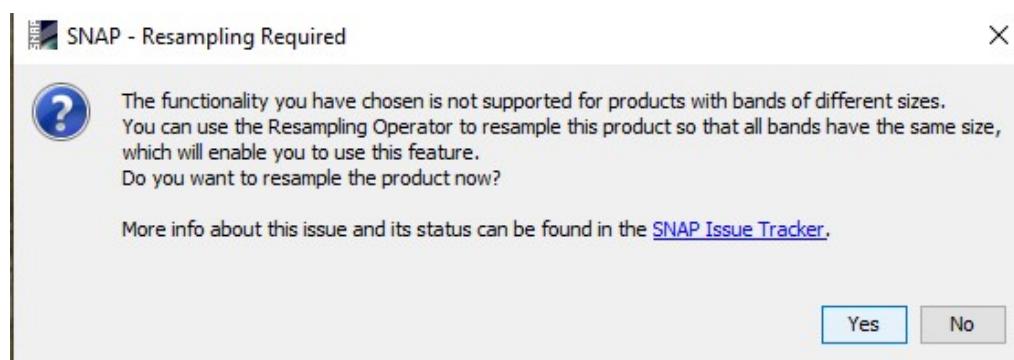
(10 RGB Channels)

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 Atmospheric Removal
9. MSI Shortwave Infrared
10. MSI Vegetation Analysis

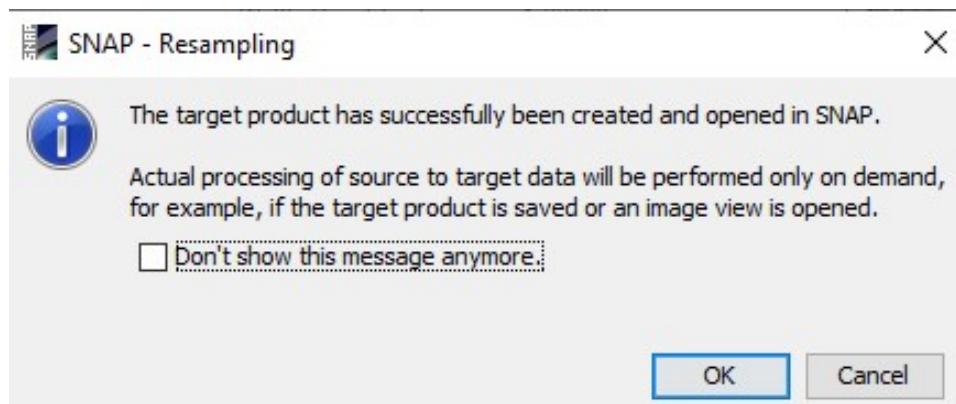
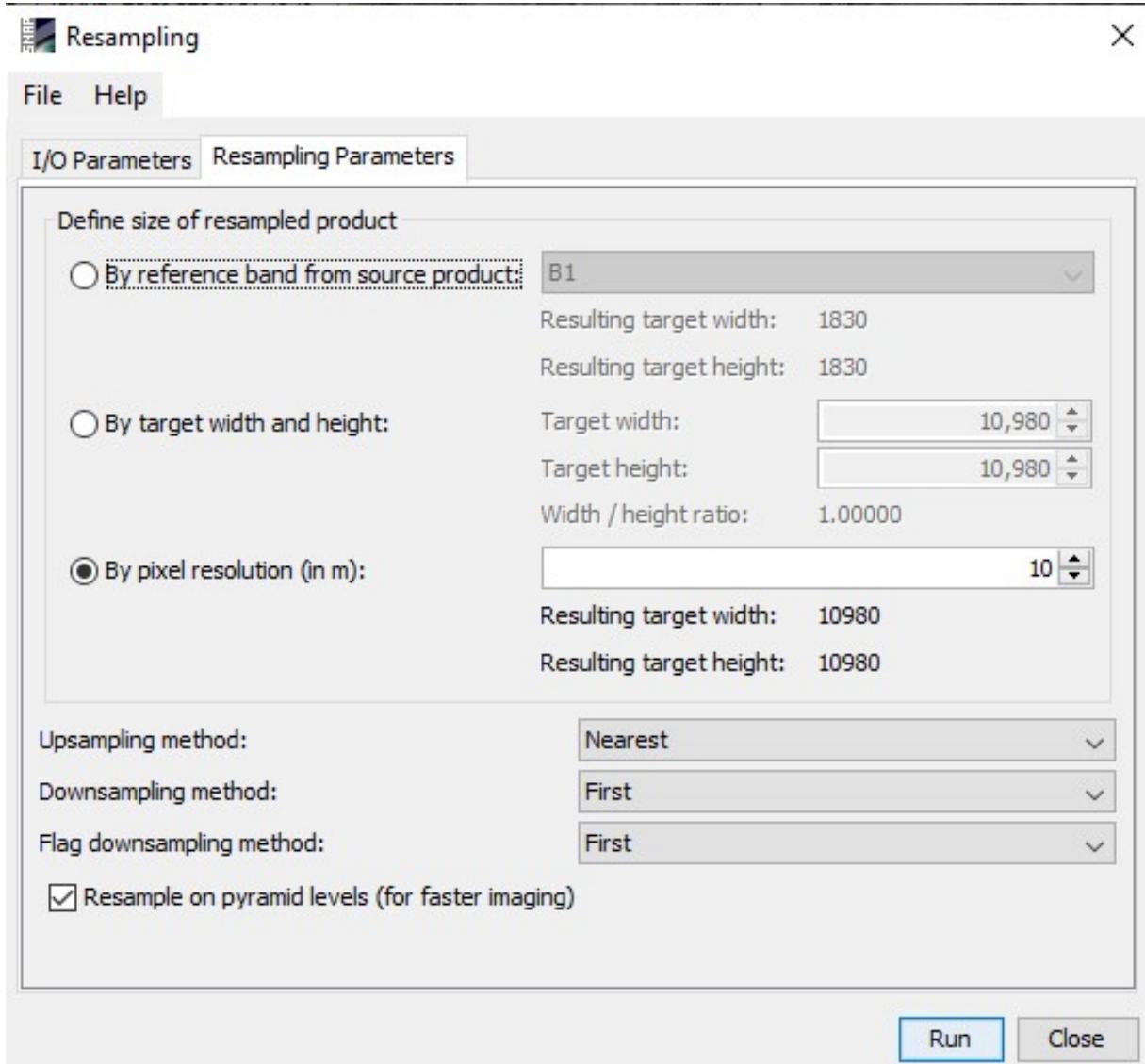




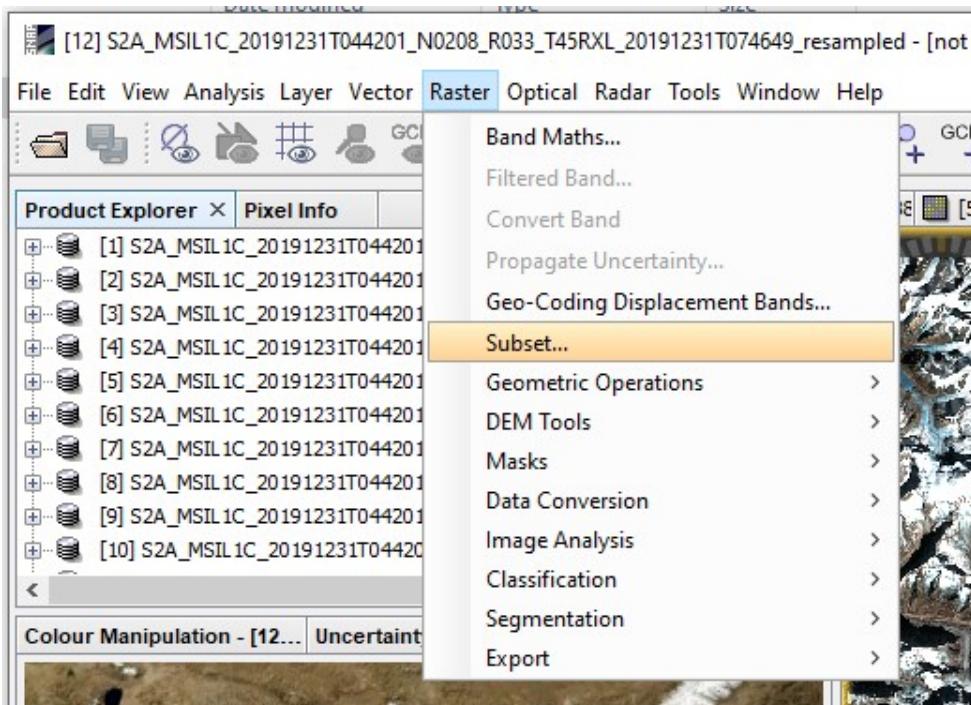
- Go to Raster -> Subset (Image 1)
- A dialogue box shows you need to **Resample this product** as shown in Image 2
- Click Yes, **Resampling Operator** opens as shown in Image 3



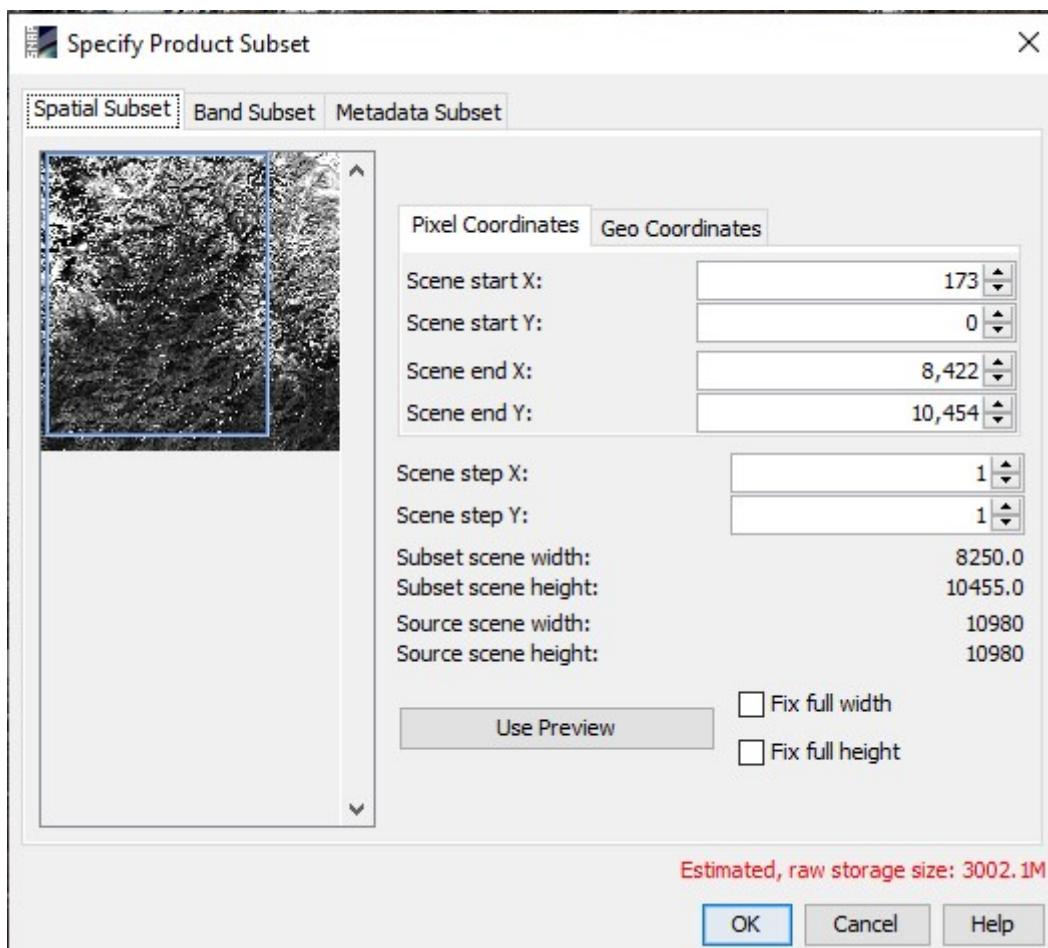
- **I/O Parameters** are taken by default for the image opened in the window (refer. **Slide 10, Image 3**)
- Please set **Pixel resolution** (in m) in the resampling parameters
- Applicable resampling resolutions **10, 20 & 60 m**, which depends upon the user need and system ability of representing 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.



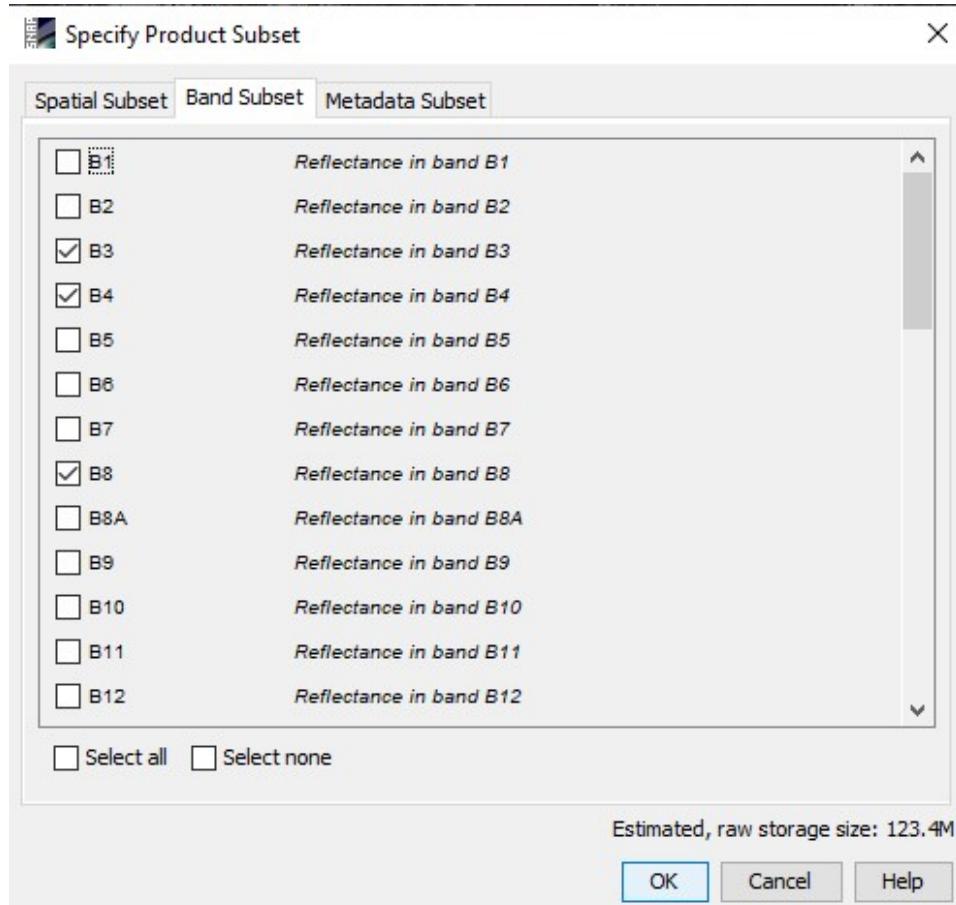
Click on Raster -> Subset to do spatial as well as spectral subsets



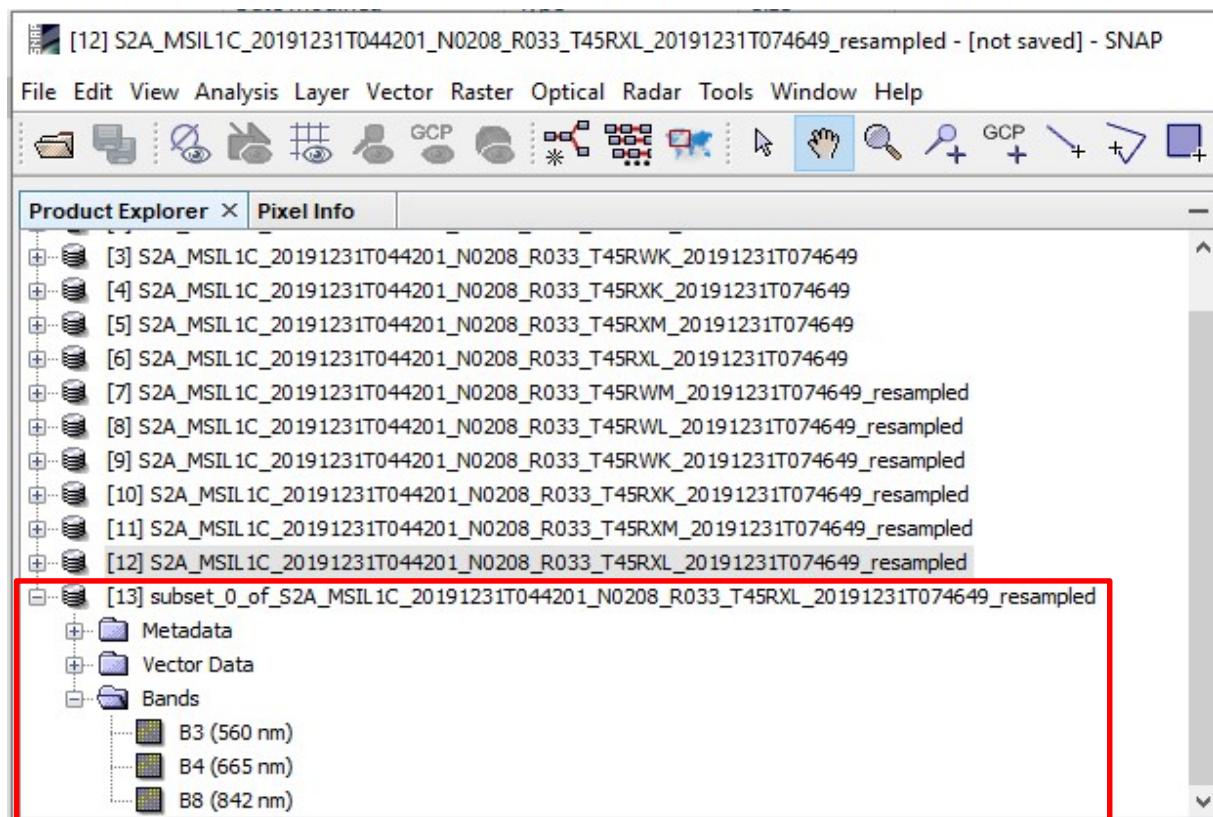
- Product Subset Dialogue box opens as shown below
- Check Fix full width, Fix full height checkbox if there is no need of Spatial subset.
- If you wish to subset Use Preview and alter the blue box from preview

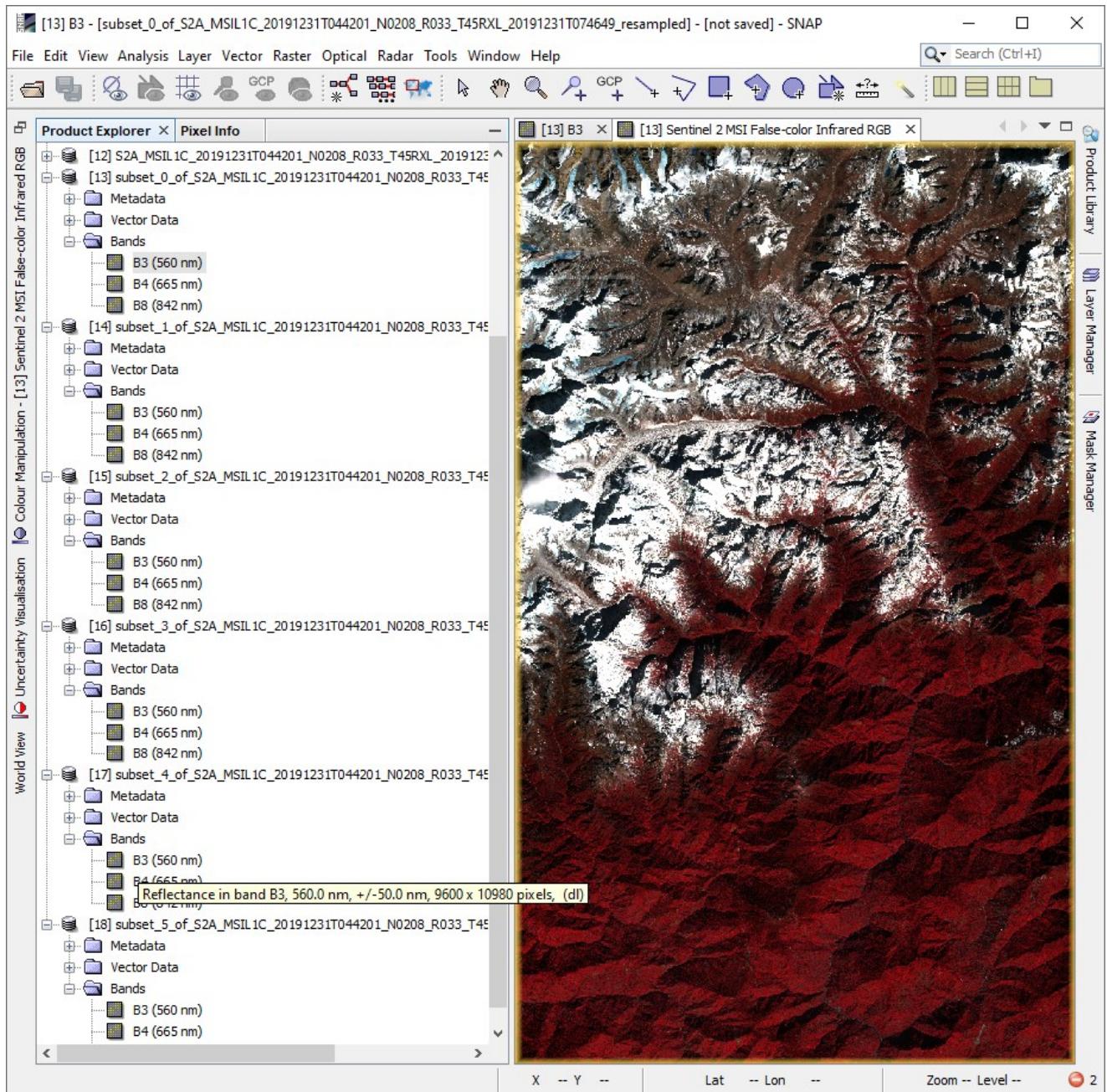


Check only required bands for Band subset, then click OK



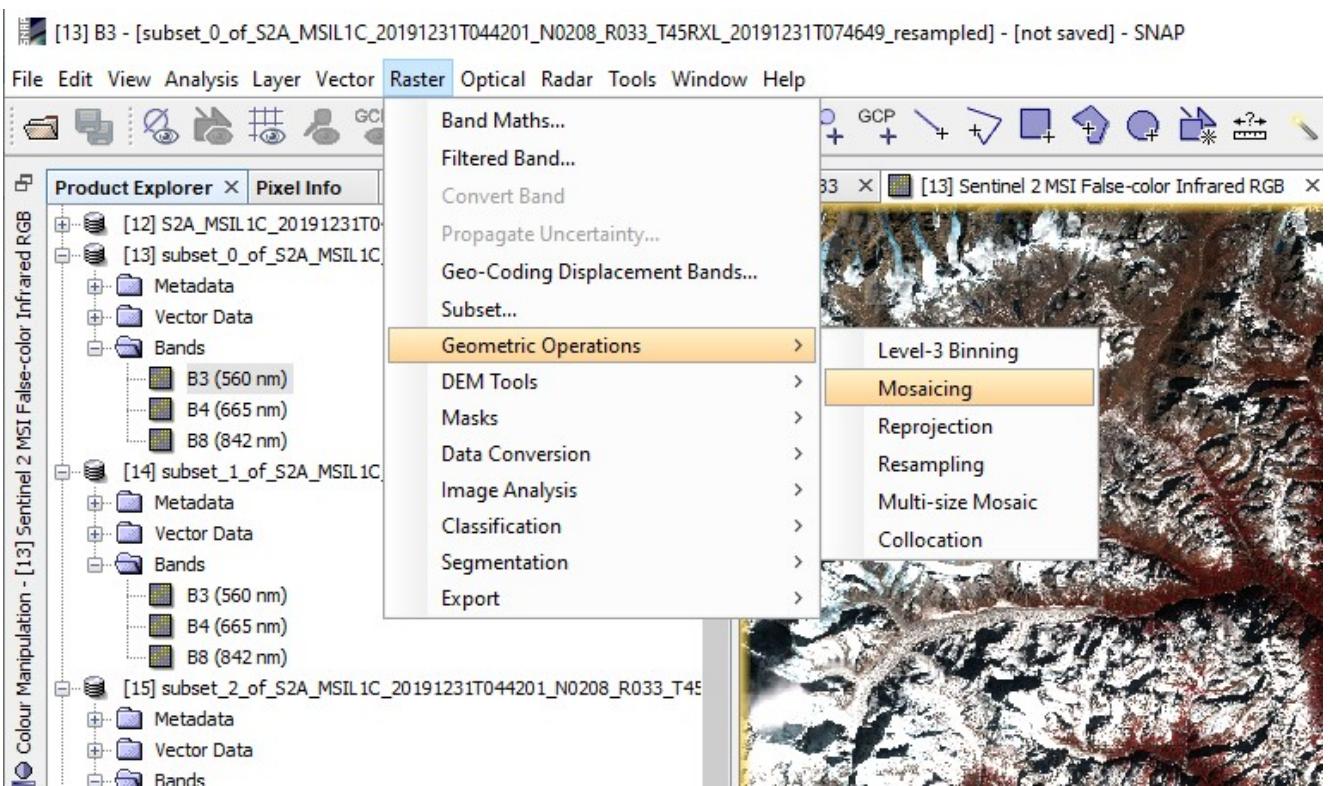
Subseted Image will show only the bands selected, this will reduce the size and operation time in the further processes. **Write the image** before mosaic operation



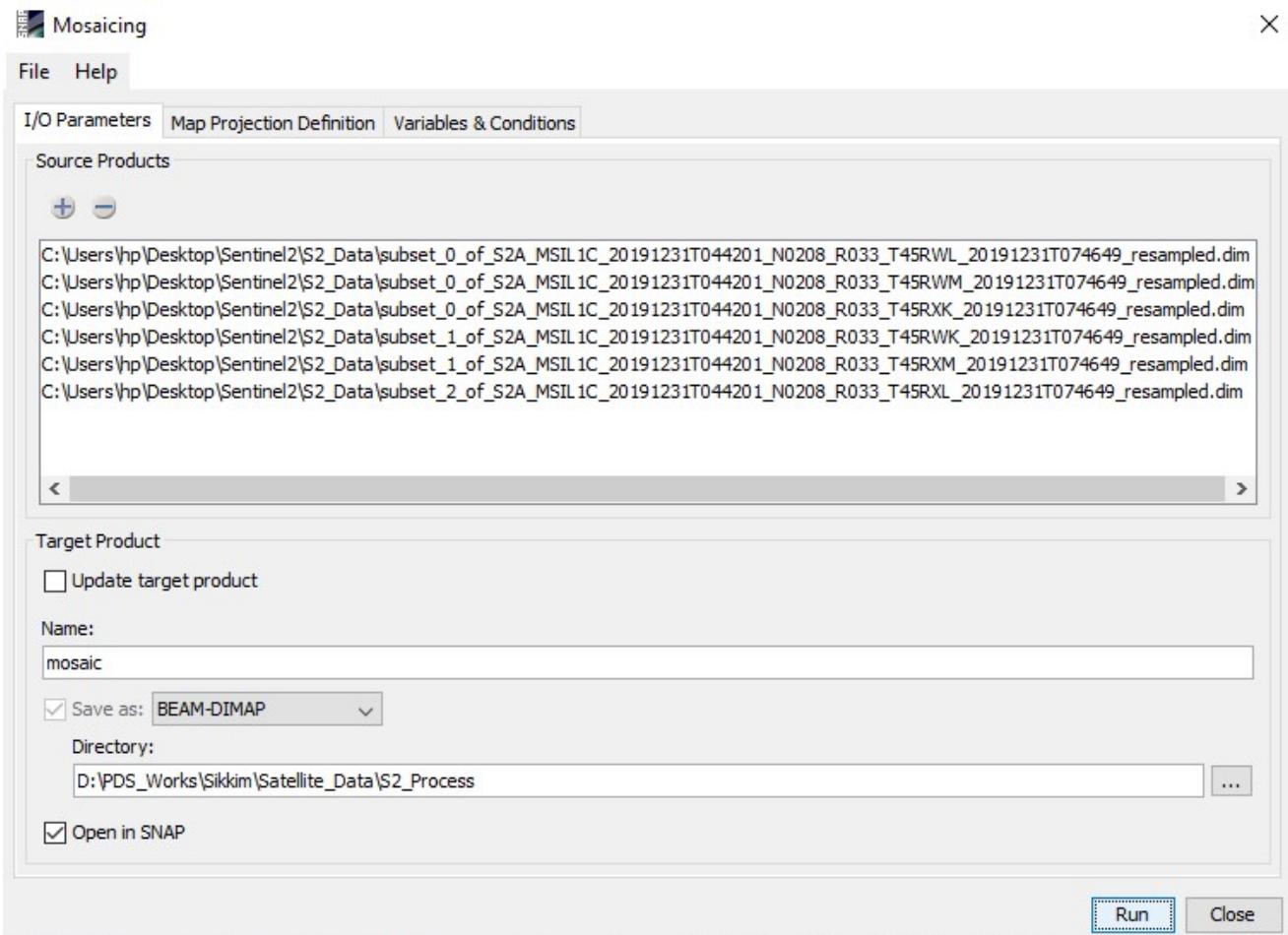


- Subsequently Resample and subset all the images required for the study area
- Click File -> Save Product to save all the subseted image
- Note: Corresponding Subseted image is needed to be opened in the window to save the product

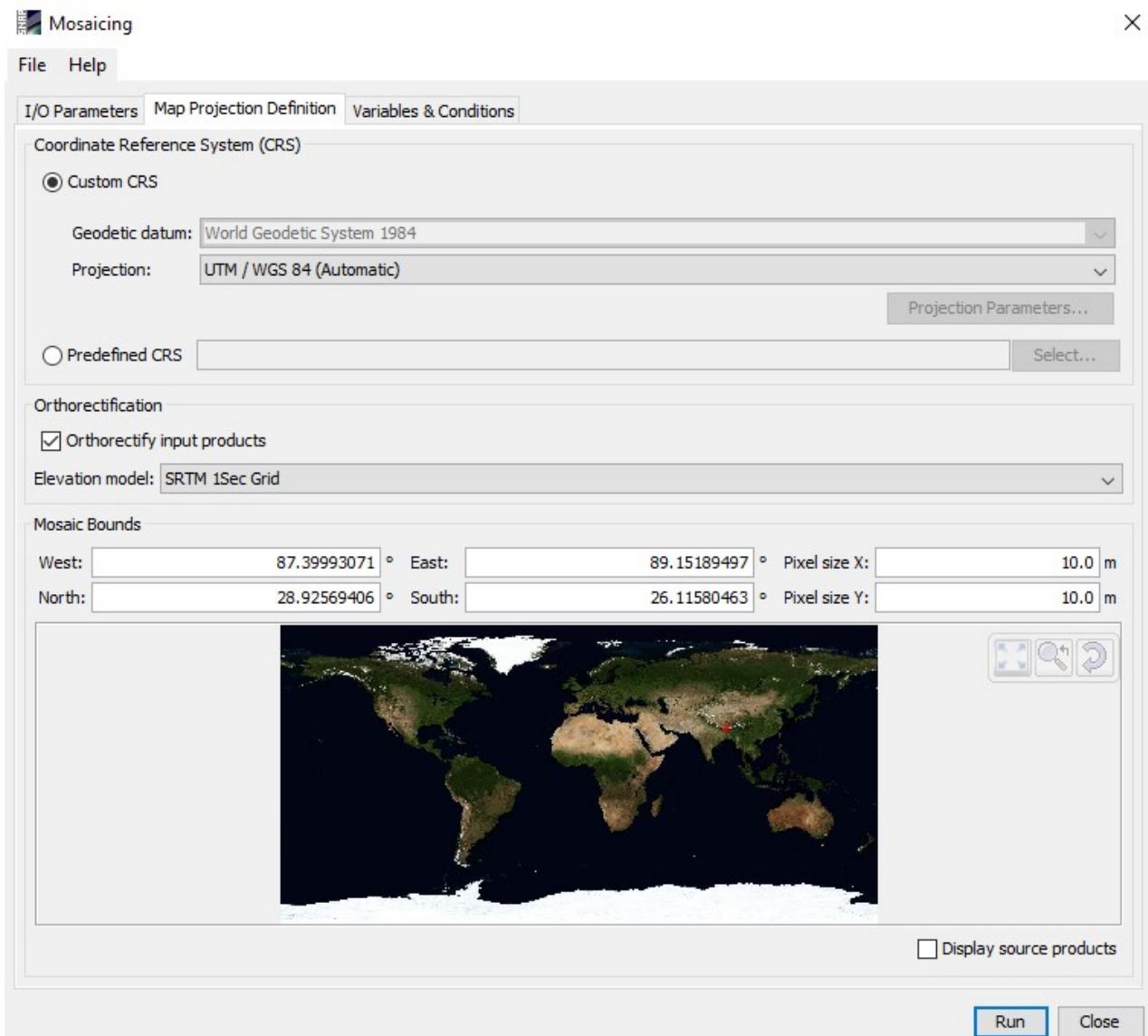
Click Raster -> Geometric Operations -> Mosaicking to do mosaic image

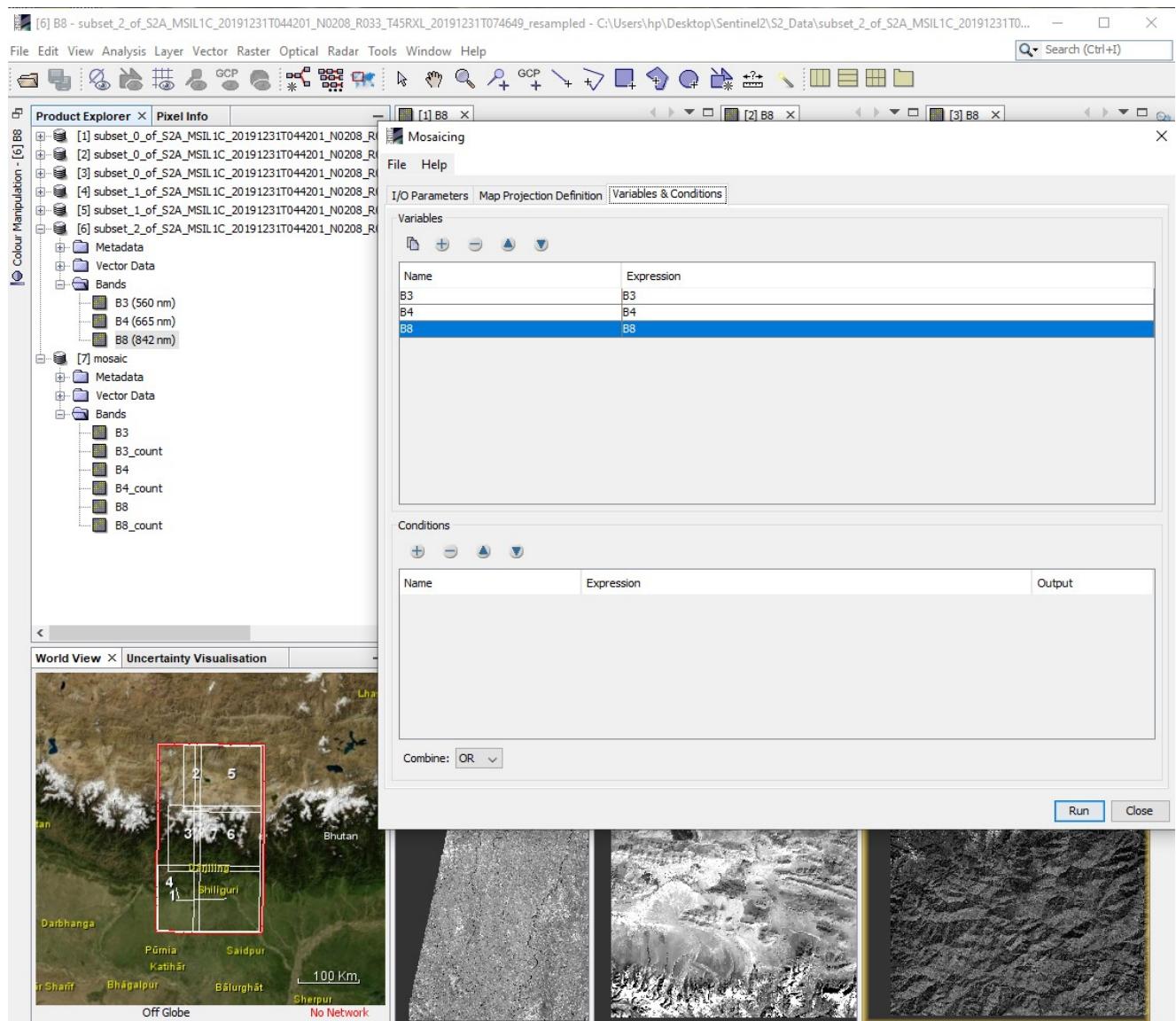


Open all the images from the I/O Parameters, & Go to Map Projection Definition



- 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





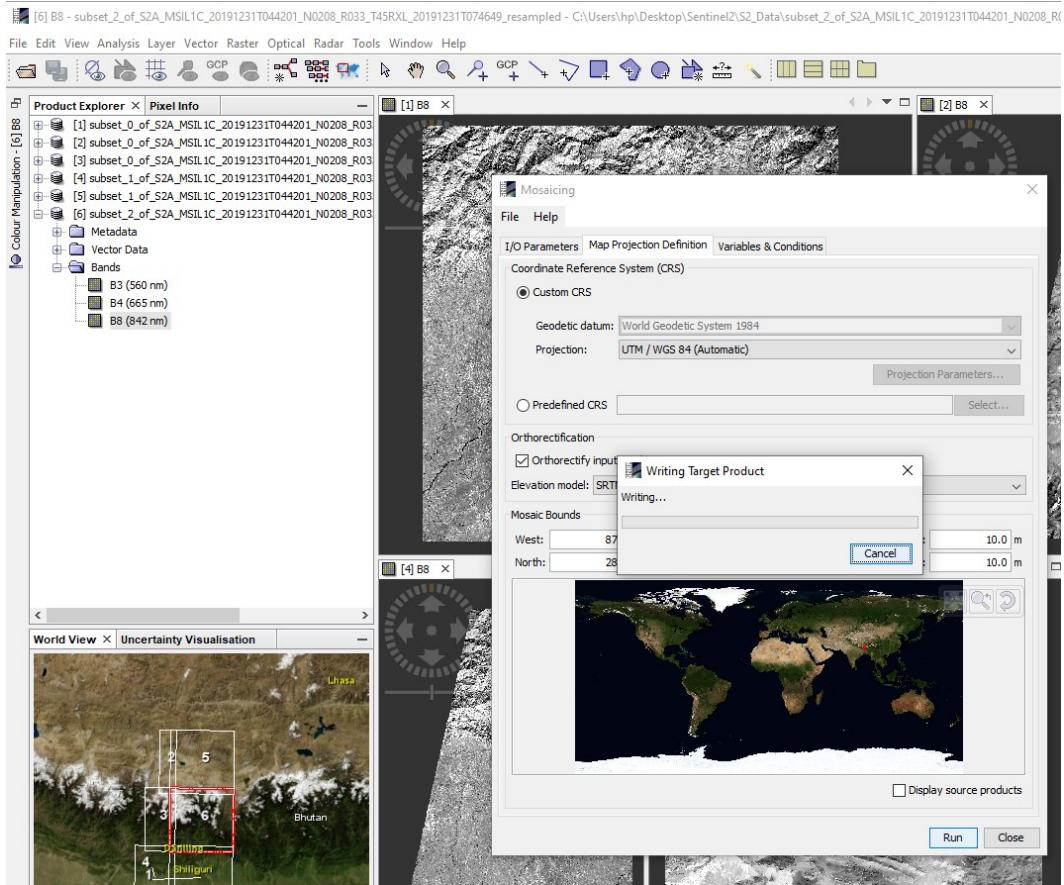
I/O Parameters | Map Projection Definition | Variables & Conditions

Variables

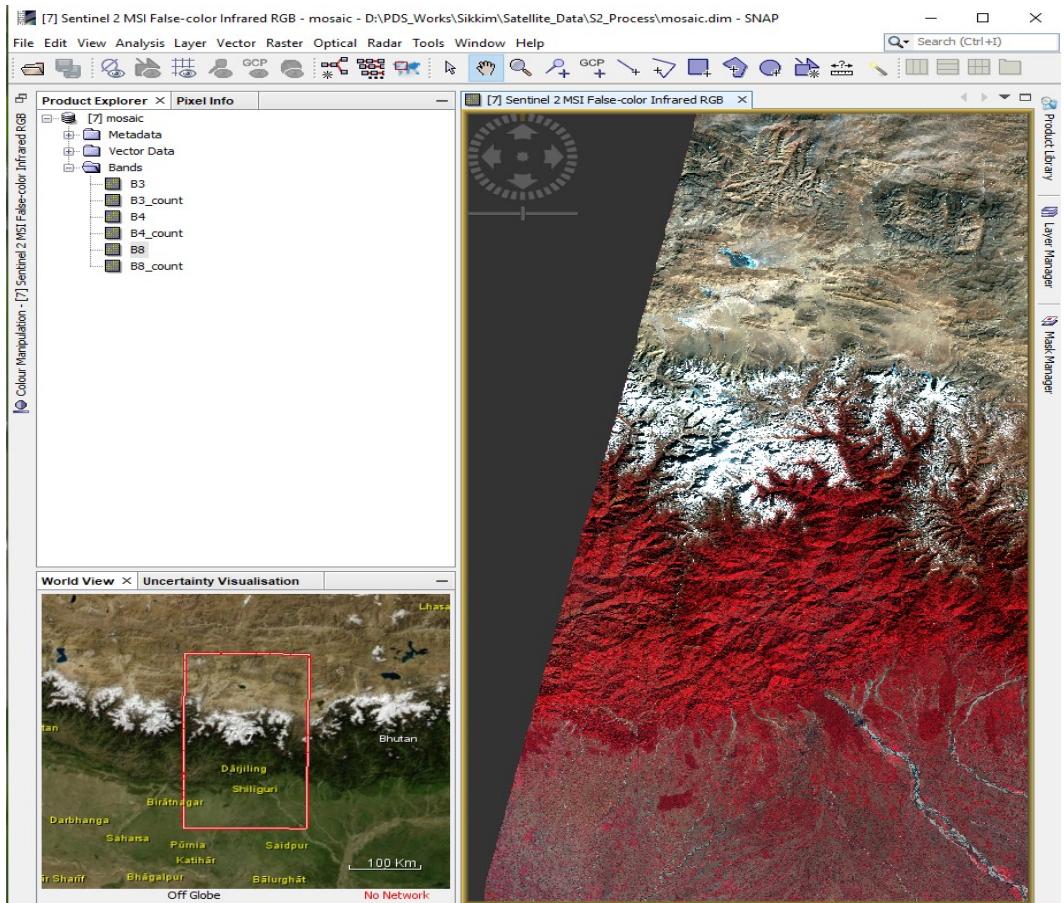
Name	Expression
B3	B3
B4	B4
B8	B8

- 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.

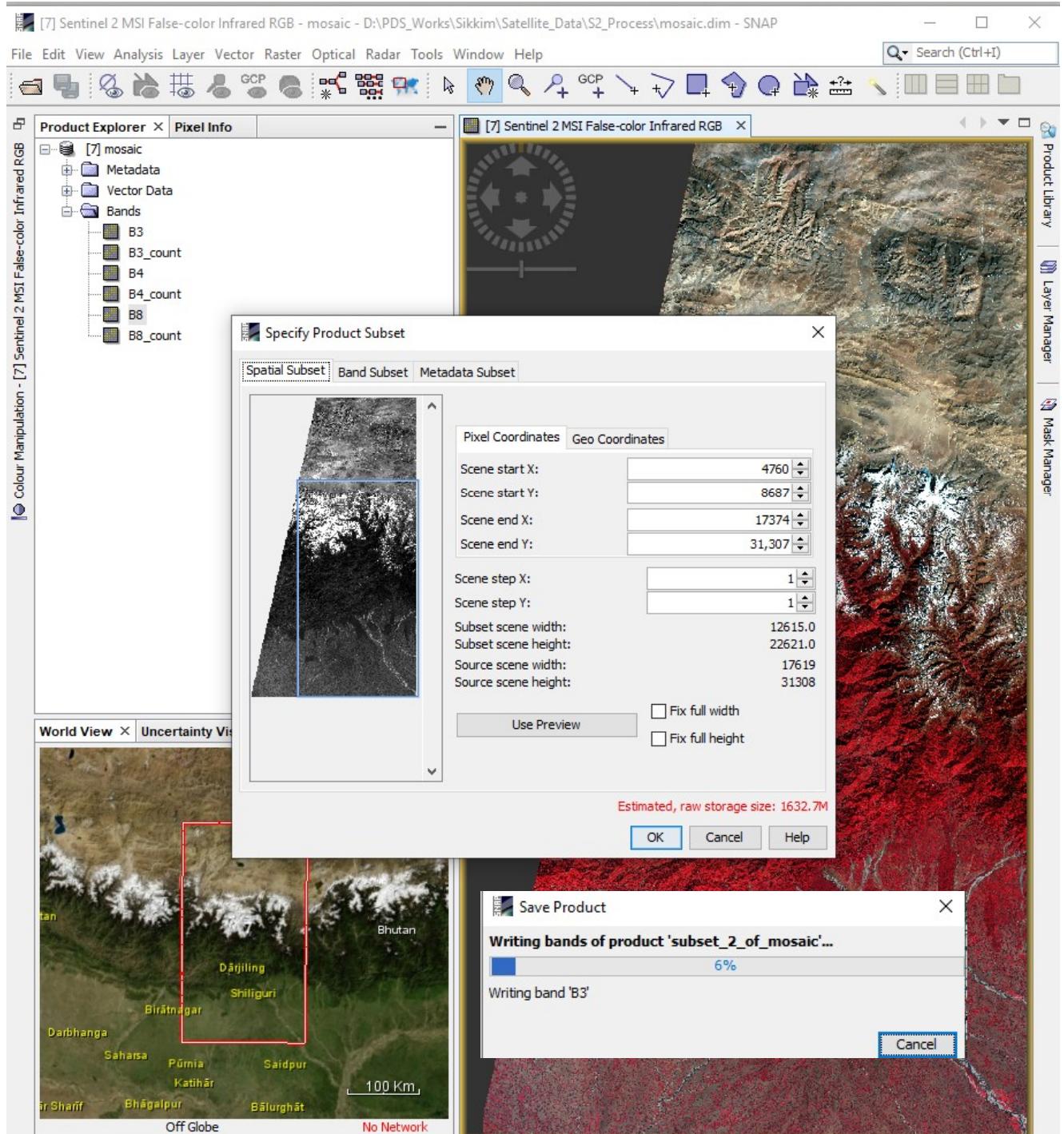
It Shows Writing Target product while processing the product



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 done accordingly based on the need as shown in the preview, it shows the estimated Raw Storage capacity
- Once it is Subsets, 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.

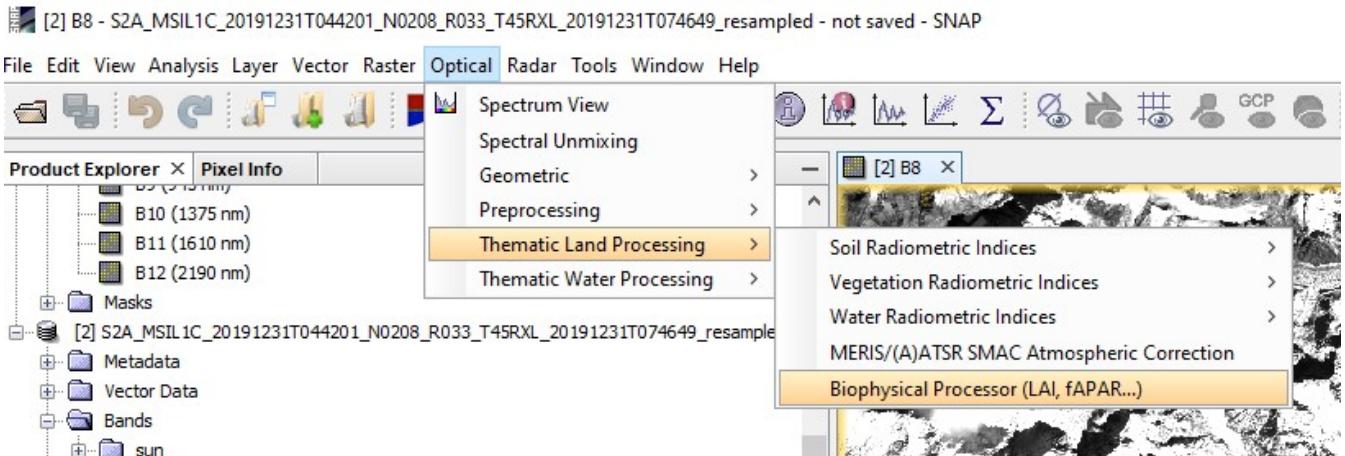


SNAP Desktop is a powerful tool for various land & Water Related Applications listed below are some:

- **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 Processor (LAI, Chlorophyll, Canopy Water, FAPAR etc.,)



Help

Biophysical Processor Overview

The Biophysical Processor computes Level-2B Biophysical products from Sentinel-2 reflectances. From top-of-canopy normalized reflectance data, it derives a set of biophysical variables, namely :

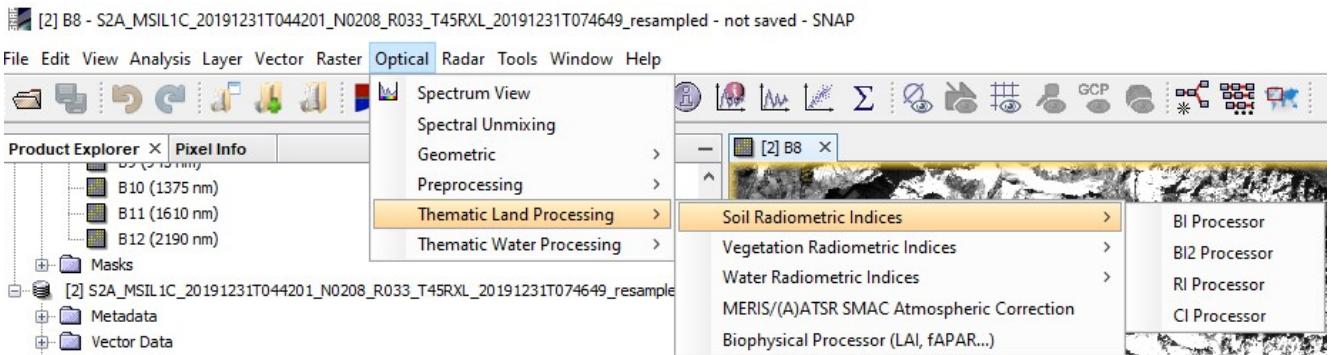
- LAI : Leaf Area Index
- FAPAR : Fraction of Absorbed Photosynthetically Active Radiation
- FCOVER : Fraction of vegetation cover
- Cab : Chlorophyll content in the leaf
- CW : Canopy Water Content

The S2 SNAP Toolbox biophysical variable retrieval algorithm is based on specific radiative transfer models associated with strong assumptions, particularly regarding canopy architecture (turbid medium model). All the variables derived from such algorithms should be seen as effective, i.e. the variables that would correspond to the measured satellite signal reflected by a canopy verifying all the assumptions made through the radiative transfer models. Depending on the variable, this may lead to differences with ground values that may be accessed from field measurements.

Furthermore, the algorithm is "generic", i.e. it should apply to any type of vegetation with reasonable performances. However, to better match the specificities of given canopies, either simple correction could be calibrated, or more specific algorithm could be developed.

One strong assumption embedded in any single pixel retrieval algorithm as this one, is that the pixel targeted belongs to a landscape patch presenting enough homogeneity (at the pixel scale) preventing unexpected loss or gain of radiation fluxes. For forests with large crowns, or any pixel showing strong heterogeneity such as pixels at the intersection between two different vegetation patches, results may be uncertain. This applied also to pixels where the neighbouring ones are very different. Specific algorithms should be developed to detect such situations and possibly propose alternative retrieval methods.

Radiometric Indices (Soil, Water & Vegetation)



The screenshot shows the Sentinel-2 Toolbox interface. On the left, a tree view lists various processing operators and index definitions, including Reflectance to Radiance, Masking, Idepix Classification of Pixels (Sentinel-2), Radiance-to-Reflectance Processor, Thematic Land Processing, and a detailed list of Radiometric Indices. The 'Radiometric Indices Complete List' is currently selected. On the right, a detailed configuration dialog for the REIP (Remote Index Processing) operator is shown. It has tabs for I/O Parameters and Processing Parameters. Under I/O Parameters, Resample Type is set to 'Highest resolution' and Upsampling method is 'Bicubic'. Under Processing Parameters, various bands are selected for resampling. A table on the right provides descriptions for parameters like Resample Type, Upsampling Method, Downsampling Method, and Bx factor. A note at the bottom of the dialog states: 'In case of bands with different resolutions are employed, a message is displayed at the bottom of the window, as it can be seen on the above figure.'

Parameter	Description
Resample Type	In case when the bands involved in the calculus are not of the same resolution, this represents the choice of resampling the bands: either use the lowest resolution band as reference, or the highest resolution one.
Upsampling Method	If the resampling will be done for the highest resolution band, this is the method used for upsampling lower resolution bands. Can be one of: Nearest neighbour, Bilinear, Bicubic .
Downsampling Method	If the resampling will be done for the lowest resolution band, this is the method used for downsampling higher resolution bands. Can be one of: First, Min, Max, Mean, Median .
[Bx] factor	The weight given to the [Bx] band pixel value.
[Bx]	The selected band [Bx]

Image Processing & Classifiers

The screenshot shows the QGIS interface with the Raster menu selected. The Product Explorer panel displays a project structure with various layers and bands. The Raster menu is expanded, showing options like Band Maths..., Filtered Band..., Convert Band, etc. Below the Raster menu, the Help window is open to the "Support Vector Machine Classification" topic. The left sidebar of the Help window shows a tree view of available topics, with the SVM section under the Classification category highlighted.

Support Vector Machine Classification

[Supervised Classification](#)

A Support Vector Machine (SVM) is a classification and regression technique based on statistical learning theory that has been proved very effective in solving complex classification problems in many different application domains. The success of SVMs is due to the important properties of this approach, which integrated with the effectiveness of the classification procedure and the elegance of the theoretical developments, result in a very solid classification methodology in many different remote sensing data analyses domains.

SVM focuses classification decisions on the boundary between classes and not on mean and variances of classes. The SVM attempts to divide the feature space using a hyperplane such that each class will reside entirely on its own side of the plane. Using a kernel function, SVMs map the input space of independent variables to a higher dimensional space where complex nonlinear decision boundaries between classes become linear. Popular kernel functions include linear, polynomial, radial basis, and sigmoid. SVM Regression is used to define a real-valued output function given the independent input variables. SVM Regression applies the concept of a ϵ -insensitive loss function that ignores point errors within a distance of ϵ from the true value by weighting them with zero. The solution is obtained through a small subset of training points and the support vectors (vectors from points nearest to decision boundary) contain all the required information to define the function and results in extremely efficient algorithms.

All input parameters should be scaled to have zero mean and unit variance before training.

Classification accuracy can be measured using stratified 10-fold cross-validation wherein the data are randomly split into ten

Create, Add & Edit Vector Layers through Layer Manager

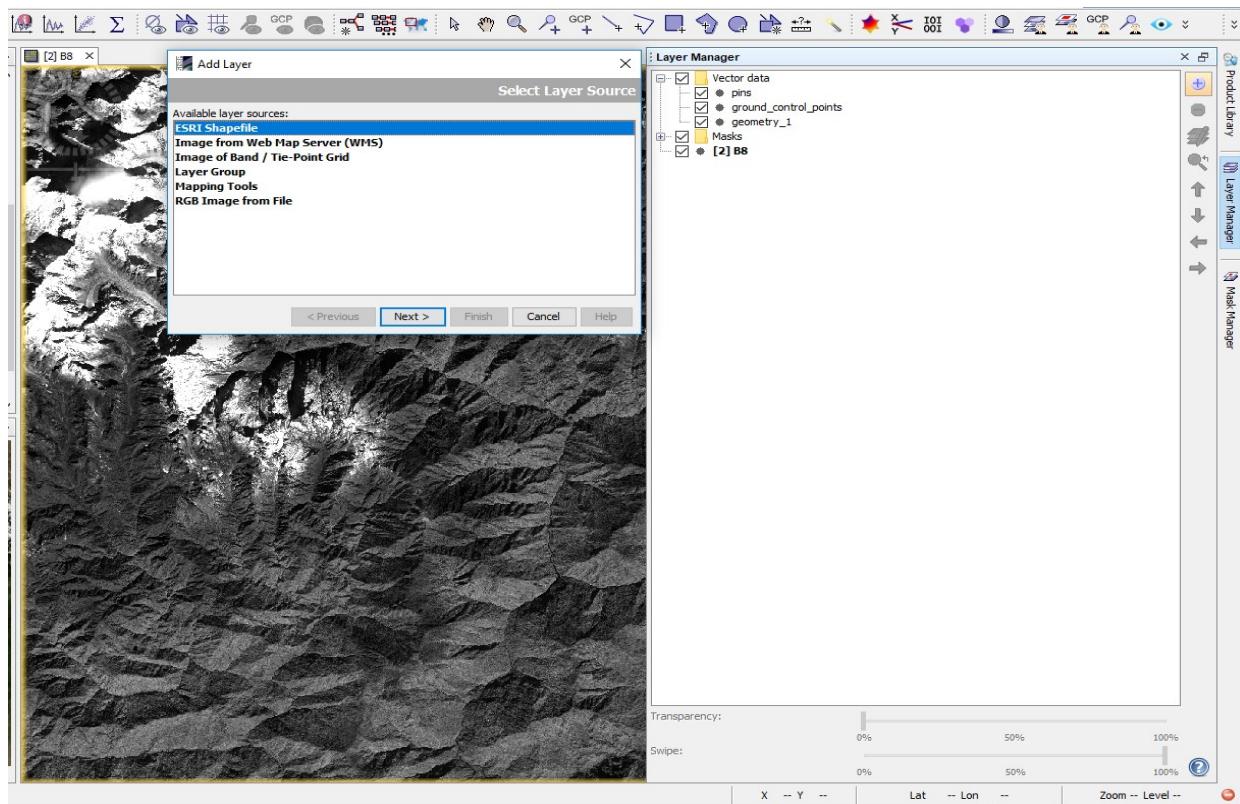
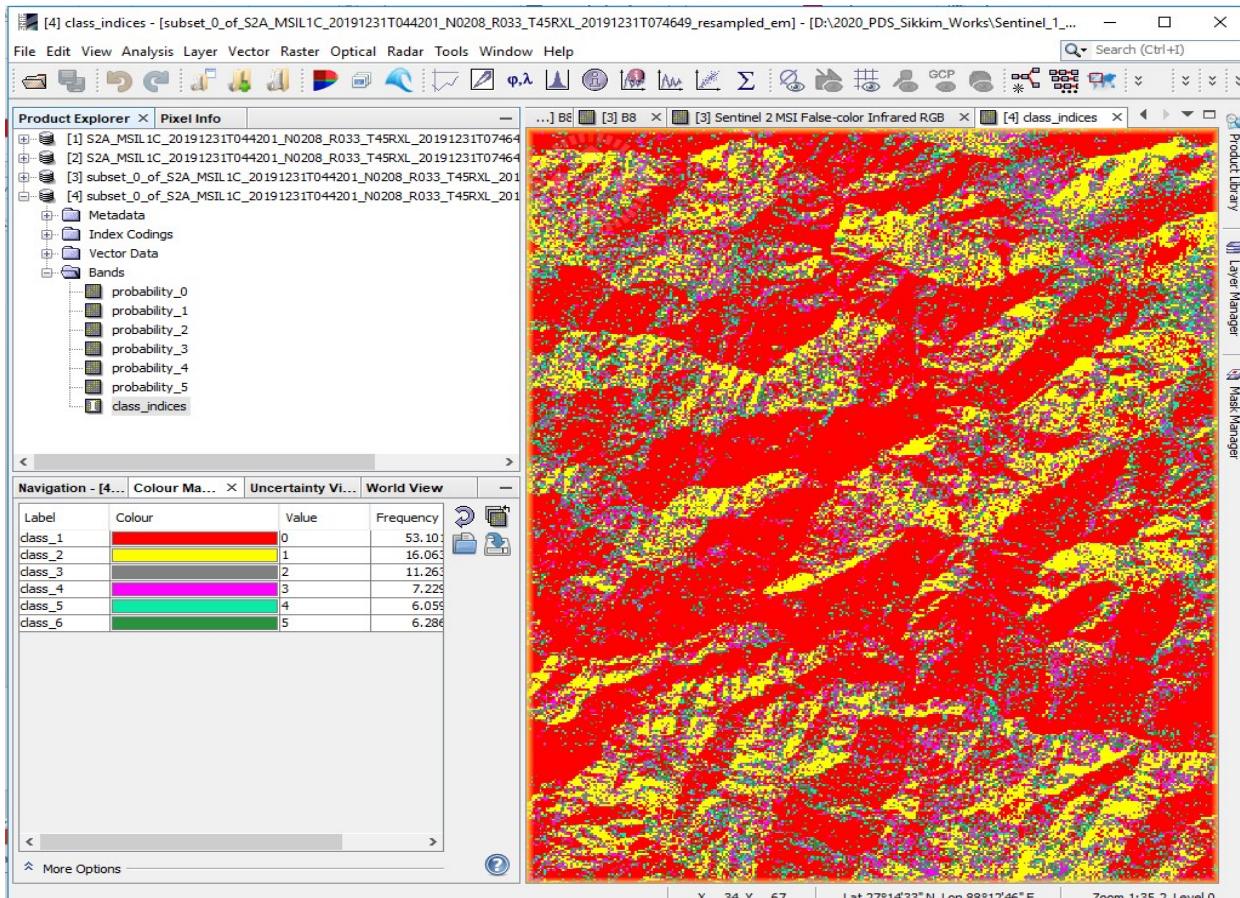
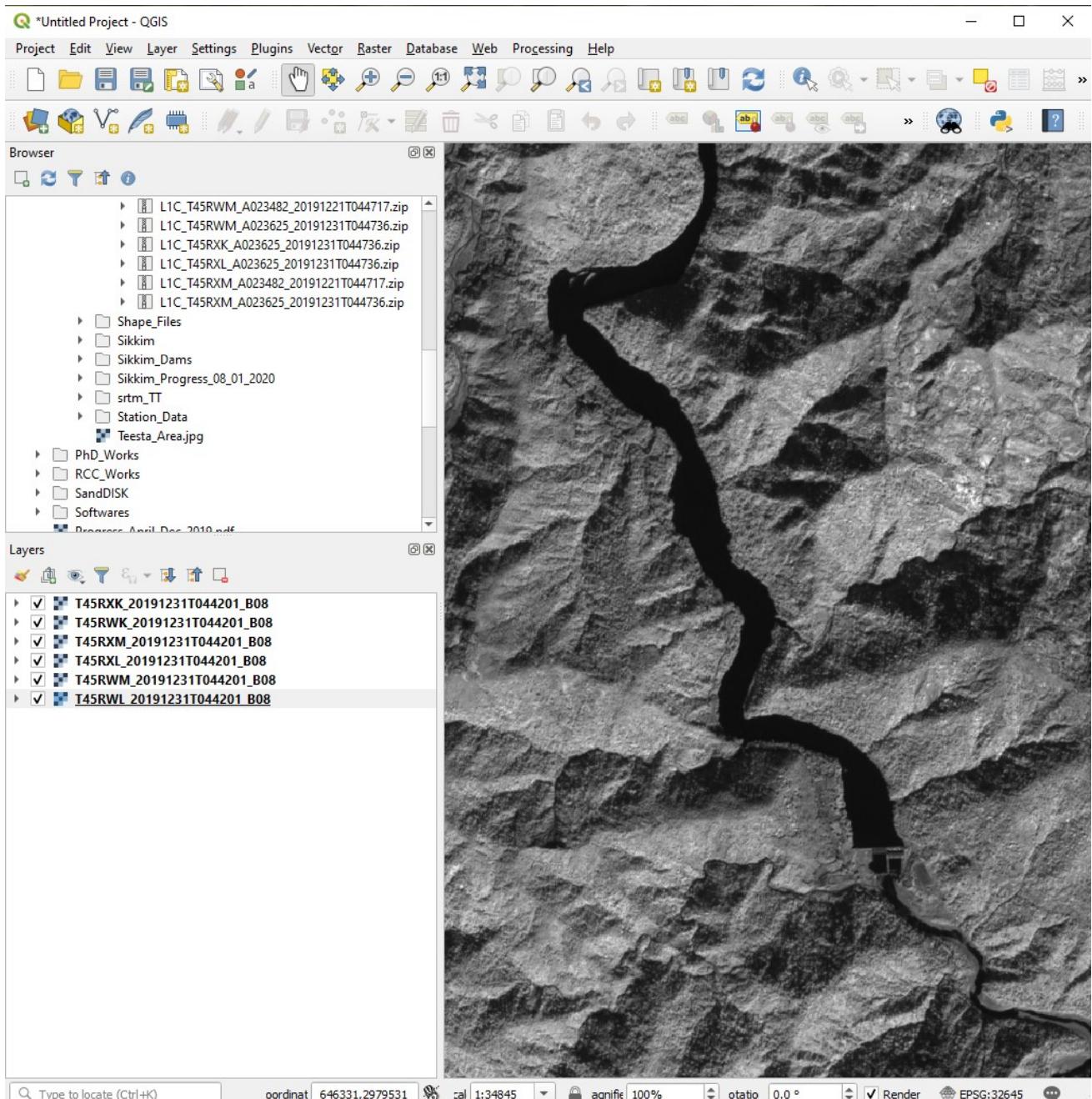


Image Classification



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

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SNAP Download

Here you can download the latest installers for SNAP and the Sentinel Toolboxes.

Data provision is available to all users via the [Sentinel Data Hub](#).

Current Version

The current version is **7.0.0** (22.07.2019 13:30 UTC).

For detailed information about changes made for this release please have a look at the release notes of the different projects: [SNAP](#), [S1TBX](#), [S2TBX](#), [S3TBX](#), [SMOS Box](#), [PROBA-V Toolbox](#)

We offer three different installers for your convenience. Choose the one from the following table which suits your needs. During the installation process, each toolbox can be excluded from the installation. Toolboxes which are not initially installed via the installer can be later downloaded and installed using the plugin manager. Please note that SNAP and the individual Sentinel Toolboxes also support numerous sensors other than Sentinel.

	Windows 64-Bit	Windows 32-Bit	Mac OS X	Unix 64-bit
Sentinel Toolboxes	These installers contain the Sentinel-1 , Sentinel-2 , Sentinel-3 Toolboxes			
	Download	Download	Download	Download
SMOS Toolbox	These installer contains only the SMOS Toolbox . Download also the Format Conversion Tool (Earth Explorer to NetCDF) and the user manual .			
	Download	Download	Download	Download
All Toolboxes	These installers contain the Sentinel-1 , Sentinel-2 , Sentinel-3 Toolboxes, SMOS and PROBA-V Toolbox			
	Download	Download	Download	Download

step.esa.int/downloads/7.0/installers/esa-snap_all_windows-x64_7_0.exe

installation you can follow this

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Sentinel 2 Data Download from SCIHUB

The screenshot shows the Copernicus Open Access Hub search interface. On the left, there are three search boxes for "Satellite Platform", "Product Type", and "Collection". Under "Satellite Platform", "Mission: Sentinel-2" is selected. Under "Product Type", "S2MSI1C" is selected. Under "Collection", "Polarisation" and "Sensor Mode" are dropdown menus. Below these are dropdown menus for "Relative Orbit Number (from 1 to 175)" and "Cloud Cover % (e.g. [0 TO 9.4])". There are also checkboxes for "Mission: Sentinel-2" and "Mission: Sentinel-3". At the bottom left, it shows "Lat Lon: 24.16, 90.41". On the right, a map of South Asia is displayed with a yellow rectangular area highlighting a region around Kathmandu, Nepal. The map includes labels for various cities like Lhasa, Shigatse, Gyegu, Golmud, Delingha, Dibrugarh, Jorhat, Guwahati, Myitkyina, and Rangoon. A legend at the bottom right indicates "Open Street [Data © OpenStreetMap contributors, Referring to MapServer and EOX]."

QGIS Software Download

Screenshot of a web browser showing the QGIS download page (<https://qgis.org/en/site/forusers/download.html>). The page displays download links for Windows, categorized by installer type.

Download for Windows

QGIS in OSGeo4W:

-  [OSGeo4W Network Installer \(64 bit\)](#)
-  [OSGeo4W Network Installer \(32 bit\)](#)

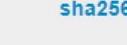
In the installer choose **Desktop Express Install** and select **QGIS** to install the *latest release*.
To get the *long term release* (that is not also the latest release) choose **Advanced Install** and select **qgis-ltr-full**
To get the *bleeding-edge development build* choose **Advanced Install** and select **qgis-dev-full**

Standalone installers from OSGeo4W packages

Latest release (richest on features):

-  [QGIS Standalone Installer Version 3.10 \(64 bit\)](#)
-  [sha256](#)
-  [QGIS Standalone Installer Version 3.10 \(32 bit\)](#)
-  [sha256](#)

Long term release repository (most stable):

-  [QGIS Standalone Installer Version 3.4 \(64 bit\)](#)
-  [sha256](#)
-  [QGIS Standalone Installer Version 3.4 \(32 bit\)](#)
-  [sha256](#)

The link for the 64-bit version of the QGIS Standalone Installer Version 3.4 is highlighted with a red box.

https://qgis.org/downloads/QGIS-OSGeo4W-3.4.15-1-Setup-x86_64.exe

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**

Sentinel 2 Data Download from Earth Explorer

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2. Select Your Data Set(s)

Check the boxes for the data set(s) you want to search. When done selecting data set(s), click the *Additional Criteria* or *Results* buttons below. Click the plus sign next to the category name to show a list of data sets.

Use Data Set Prefilter ([What's This?](#))

Data Set Search:

Data Set Message

UPDATE (February 8, 2018): USGS is now distributing Level-1C Sentinel-2B products. Both Sentinel-2A and -2B products are combined under the Sentinel-2 collection on the Data Sets tab. On the Additional Criteria tab, a *Platform* filter gives users the ability to select either or both satellite platforms.

USER NOTICE: Sentinel-2 Products from USGS
The Sentinel-2 data were acquired, processed, and generated by the European Space Agency (ESA) and repackaged by USGS into tile-based bundles. For more information on the available Sentinel-2 products and distribution from USGS, please visit: <http://eros.usgs.gov/sentinel-2>.

All Sentinel-2 data products are provided under the terms and conditions prescribed by the European Commission's Copernicus Programme. For detailed information on data policy, appropriate usage, and citation of Sentinel data, click on this link: https://ita.cr.usgs.gov/sites/default/files/Sentinel_Data_Terms_and_Conditions.pdf

IMPORTANT: The USGS Sentinel-2 archive is a partial representation of all available acquisitions from ESA. Users should expect a delay before ESA's acquisitions become available on EarthExplorer. For detailed information on the Sentinel-2 mission and data access available from ESA, please visit: <https://sentinel.esa.int/web/sentinel/missions/sentinel-2>

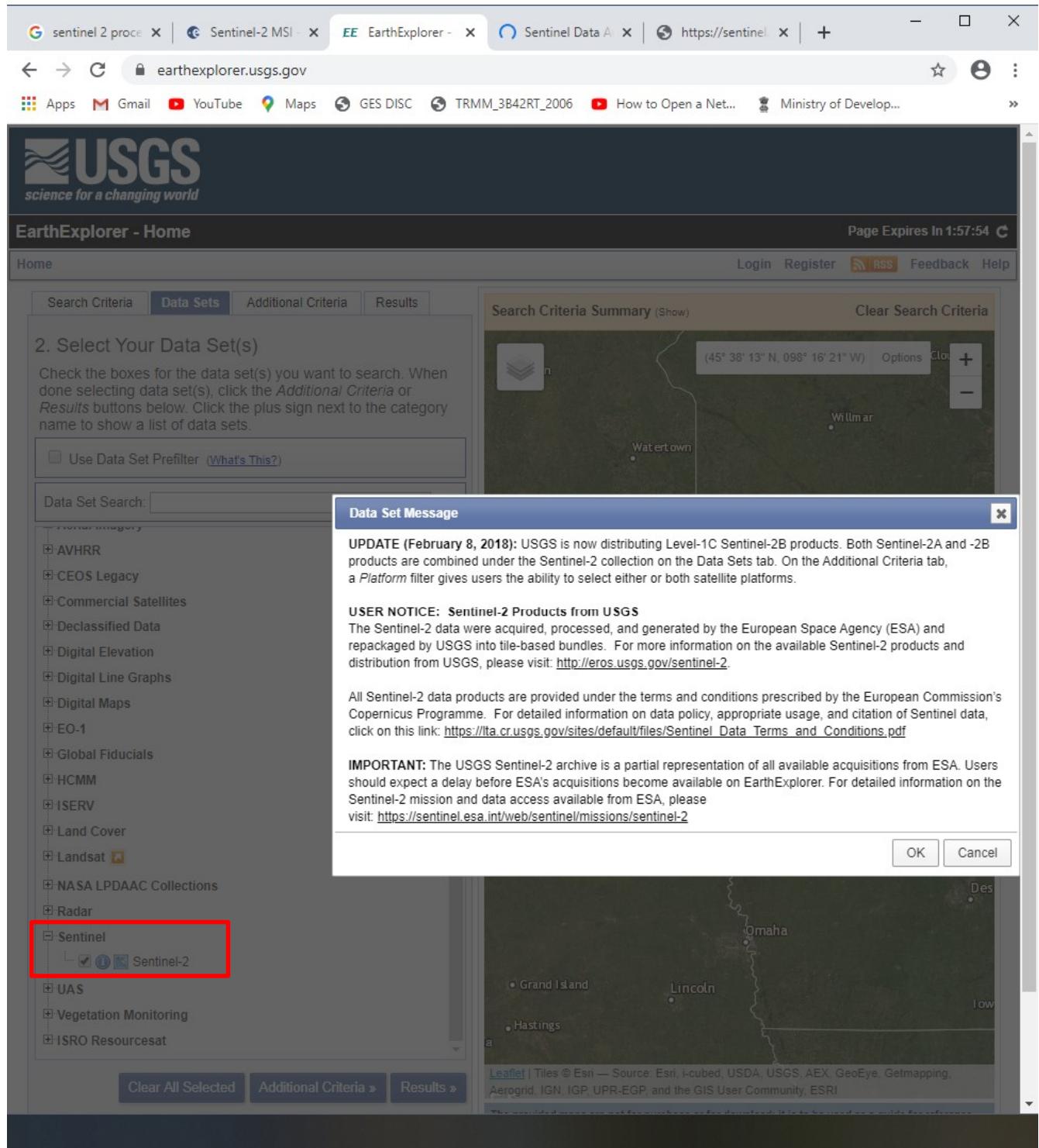
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Sentinel-2

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EO-1
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ISERV
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Radar
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ISRO Resourcesat

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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, L1A, L1B, L1C) generated by the Sentinel-2 Ground Segment, their access, and links to the generation of Level-2A data using the Sentinel-2 Toolbox
- [Calibration and Validation](#)
Calibration and Validation (Calval) 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.

[Appendices](#)

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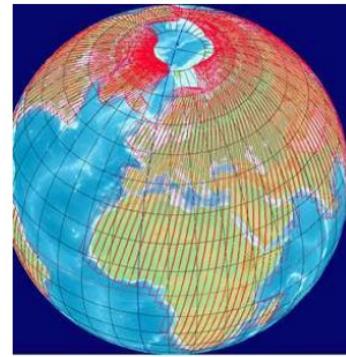


Figure 22: Modelled Sentinel-2 Coverage

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

European Commission

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Date 24/07/2015 Issue 1 Rev 2

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



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