SKYWATCH

esa

ESA SNAP

Export of products from SNAP

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Exporting of data from SNAP

The goal of this document is to demonstrate how data processed in SNAP can be used in other software for image processing or geospatial analysis, such as ArcGIS or QGIS.
This is required, whenever processing tools or algorithms are required which are not covered by SNAP. However, there are a number of important things to consider for the selection of a suitable data export.

Export to GeoTiff

Selection of data

Raster bands or entire stacks can be exported to the GeoTiff fomat, a widely used standard which stores both raster values and the geocoding of data. Once a raster product is loaded and displayed in SNAP, this can be done via the menu:

```
File > Export > GeoTIFF
```

The subsequent dialogue allows to define the spatial extent and the desired bands as shown in Figure 1. Especially when you work with Copernicus data, make sure to only select the bands you really need, because many of the mask layers and quality indicators are included unless you de-select them in the *Band Subset* tab (right side). You will see how the size of the target product changes when you include or exclude certain bands. Confirm with **OK** and **Export Product** to start the conversion to GeoTiff.

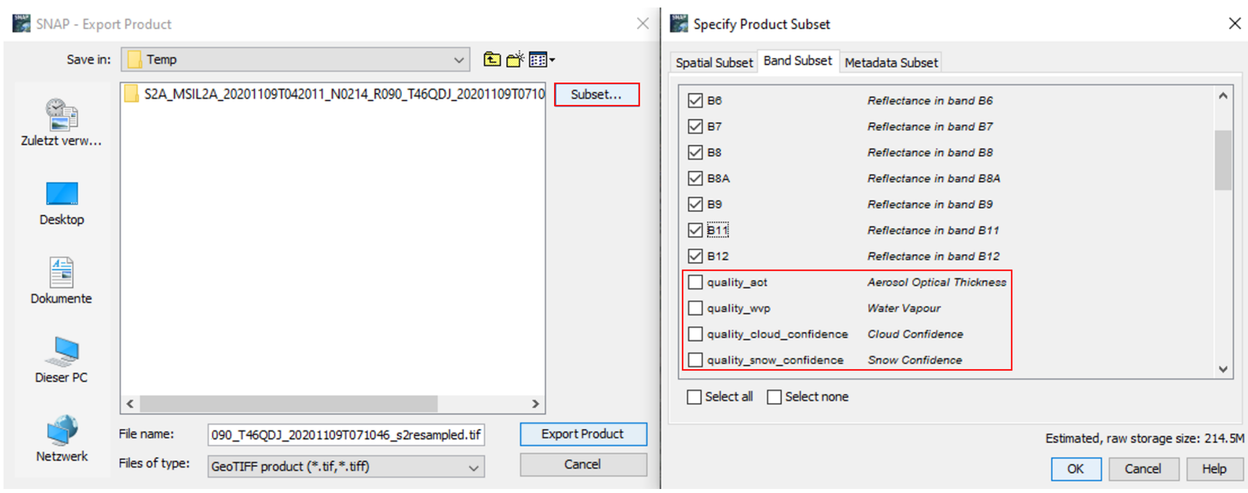


Figure 1: Export of a Sentinel-2 raster stack

Things to note

- The file size of a GeoTiff raster stack is larger than the sum of img rasters contained in the BEAM DIMAP product. This maybe of relevance when working with large file volumes. Alternatives are given in chapter “Direct use of BEAM DIMAP products”.
- Many of the metadata used in SNAP are not read from the GeoTiff when it is loaded in another software. This is especially important for Sentinel-2 data (illustrated in Figure 2)
- The data type of the raster might change during the export (e.g. from *Float 32 bit* to *Integer 16 bit*). Your raster values will change accordingly. This is important when you work with spectral signatures or thresholds because they might not be the same after the export.

These points also apply to other formats, such as ENVI, HDF5, or JP2000.

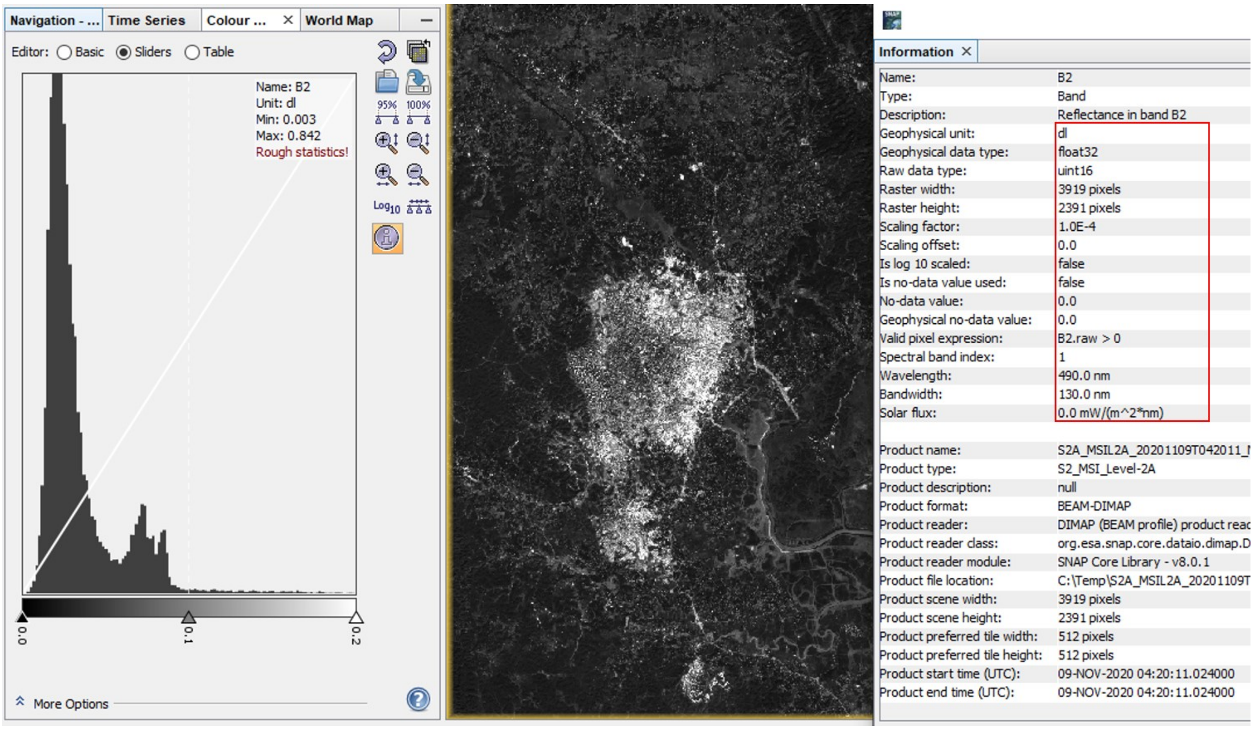


Figure 2: Sentinel-2 metadata in SNAP

As shown in Figure 2, Sentinel-2 data is physically stored as **16 bit Integer** (full numbers), but displayed as **32 bit Float** (reflectance in decimal numbers, ranging between 0 and 1 in theory, see the histogram), because SNAP applies the Scaling factor of 1.0E4 (=10.000) to the data. This might also apply for the wavelength (required for the *Spectrum View*), the *Valid Pixel Expression* (excludes invalid pixels) and others are not part of the exported GeoTIFF when it is opened in another software. The same applies for the contrast selected in the *Color Manipulation* window or the order of bands of an RGB view.

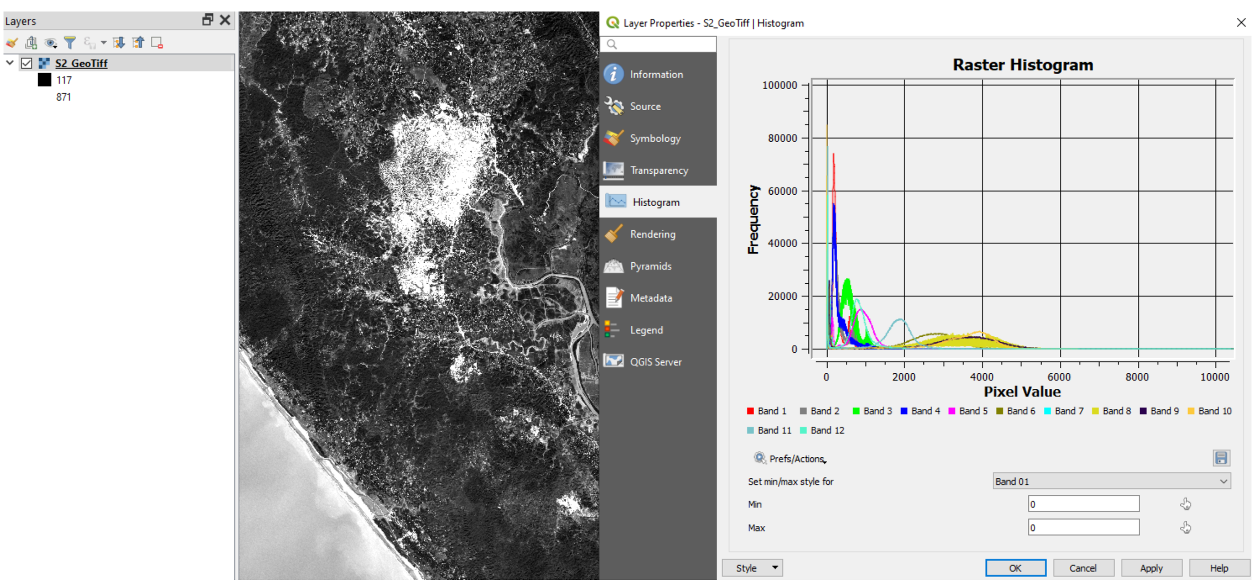


Figure 3: Sentinel-2 data exported as GeoTiff and opened in QGIS

As shown in Figure 3, the exported GeoTIFF opened in QGIS is interpreted as 16 bit Integer and all bands range between 0 and 10.000. To get the reflectance values as displayed in SNAP, the *Scaling factor* as shown in the band's Information window (Figure 2) has to be applied manually, for example by dividing the raster values by 10.000 in the raster calculator.

Notes on contrast

Software packages handle the display of raster values differently. SNAP automatically stretches colors over 95% of the value range of a band ( ), but this might not be the case in QGIS or ArcMap. To get good visual contrasts in QGIS, open the Layer Properties under *Symbology*. Select "Stretch to MinMax" and select "Cumulative count cut" as under *Min / Max Value Settings* (Figure 4). The same applies for ArcGIS which uses a similar percent clip as SNAP (Figure 5), but also not as a default setting. Without these settings the image can appear rather dark. However, it is important to understand, that these enhancements do not affect the pixel values of the raster, but only change which colors are assigned to them for display.

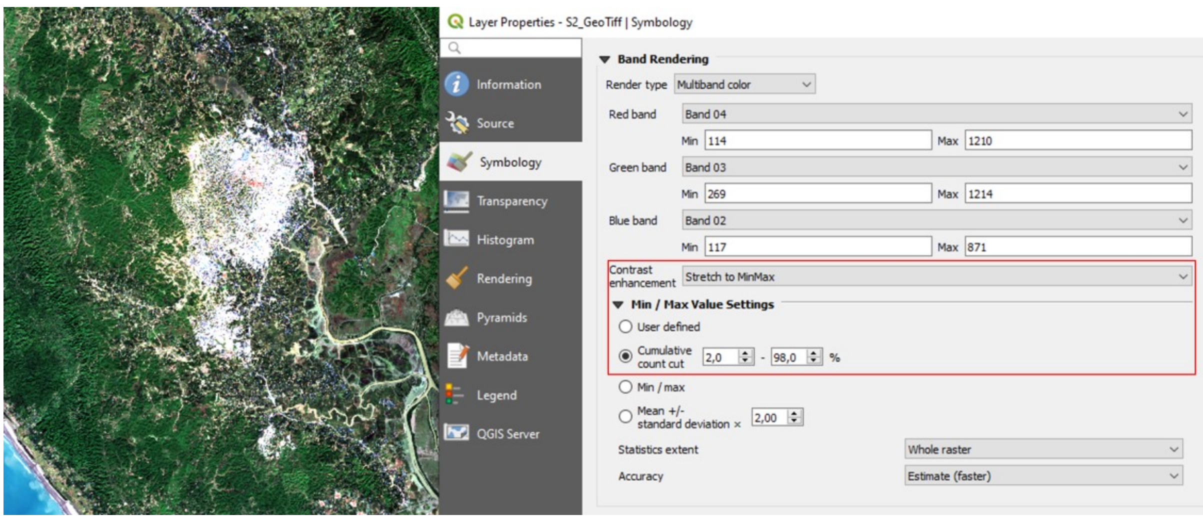


Figure 4: Visual contrast adjustment in QGIS

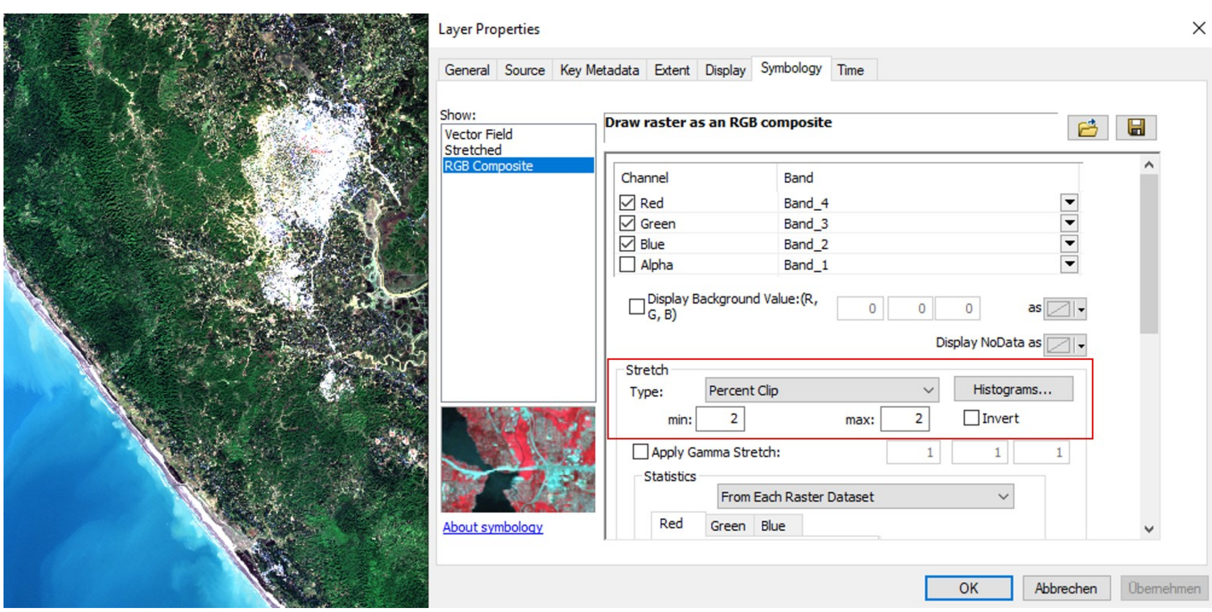


Figure 5: Visual contrast adjustment in ArcGIS

Export to CSV

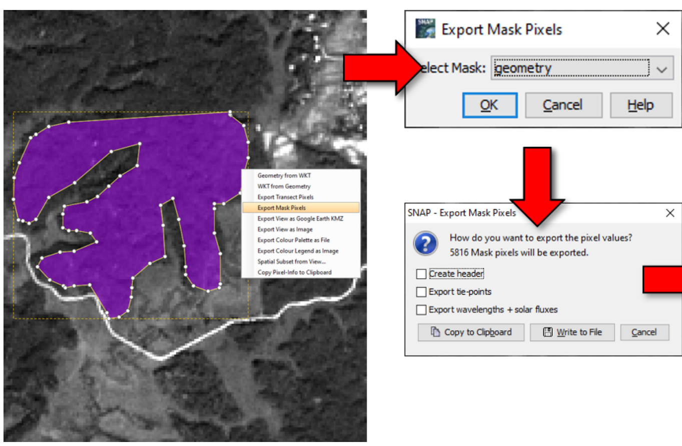
Whenever pixel values of images or regions of interest are required for statistical analysis, the CSV export is an option. It can be found in the menu under

```
File > Export > GeoTIFF
```

and writes a list of all pixels of one or multiple bands (allows the same selection of subset area and bands as in Figure 1) to a text file, as well as their x and y coordinates. This requires an immense amount of data and is mostly not necessary, because there are tools which allow more specific export.

Export of pixels within a polygon

If only statistics of a certain area of the image are required, a polygon can be digitized, and the values underneath are exported by right-clicking > **Export Mask Pixels**. In the next dialogue, the mask of interest (here *geometry*) has to be selected and in the last step, additional options, such as headers or tie-points (only required if you know that you need them) can be set. After clicking **Write to File** a text file is created which contains the x and y position of a pixel, their coordinates, as well as the pixel values of the different bands (Figure 6). This allows a systematic evaluation of the pixel values outside SNAP, for example in MS Excel (Figure 7). A detailed description on how to load tabular data stored as text into Excel is given here.



Pixel-X	Pixel-Y	Longitude	Latitude	B1	B2	B3	B4	B5	B6	B7	B8
1880.5	948.5	92.21832792409057	21.193426371778358	0.0203	0.0209						
1881.5	948.5	92.21842425945812	21.193426817373894	0.0205	0.021						
1882.5	948.5	92.21852059482818	21.19342726291452	0.0207	0.0208						
1883.5	948.5	92.21861693020074	21.19342770840024	0.0209	0.0205						
1884.5	948.5	92.2187132655758	21.19342815383105	0.0209	0.0205						
1864.5	949.5	92.21678703465197	21.193328888838945	0.0191	0.0175						
1865.5	949.5	92.21688336992078	21.19332933531092	0.0191	0.0204						
1866.5	949.5	92.21697970519209	21.19332978172798	0.019	0.0183						
1867.5	949.5	92.21707604046593	21.19333022809014	0.019	0.02						
1868.5	949.5	92.21717237574228	21.193330674397387	0.019	0.0192						
1869.5	949.5	92.21726871102113	21.19333112064973	0.019	0.0178						
1870.5	949.5	92.21736504630252	21.19333156684716	0.019	0.0189						
1871.5	949.5	92.21746138158639	21.19333201298969	0.019	0.0208						
1872.5	949.5	92.21755771687279	21.193332459077308	0.0191	0.0233						
1873.5	949.5	92.2176540521617	21.19333290511002	0.0193	0.0208						
1874.5	949.5	92.21775038745312	21.19333335108783	0.0195	0.0211						
75.5	949.5	92.21784672274704	21.193333797010727	0.0196	0.0196						
1876.5	949.5	92.2179430580435	21.193334242878716	0.0198	0.0222						
1877.5	949.5	92.21803939334245	21.193334688691806	0.02	0.0206						
1878.5	949.5	92.21813572864393	21.19333513444998	0.0202	0.0231						
1879.5	949.5	92.21823206394791	21.19333558015325	0.0204	0.0214						
1880.5	949.5	92.2183283992544	21.19333602580161	0.0206	0.021						
1881.5	949.5	92.21842473456341	21.193336471395067	0.0208	0.019						
1882.5	949.5	92.21852106987491	21.193336916933614	0.0209	0.0212						
1883.5	949.5	92.21861740518894	21.193337362417253	0.0212	0.0204						
1884.5	949.5	92.21871374050545	21.19333780784599	0.0211	0.0182						
1849.5	950.5	92.21534248289812	21.19323183925736	0.0205	0.0176						

Figure 6: Export of Mask pixels to CSV

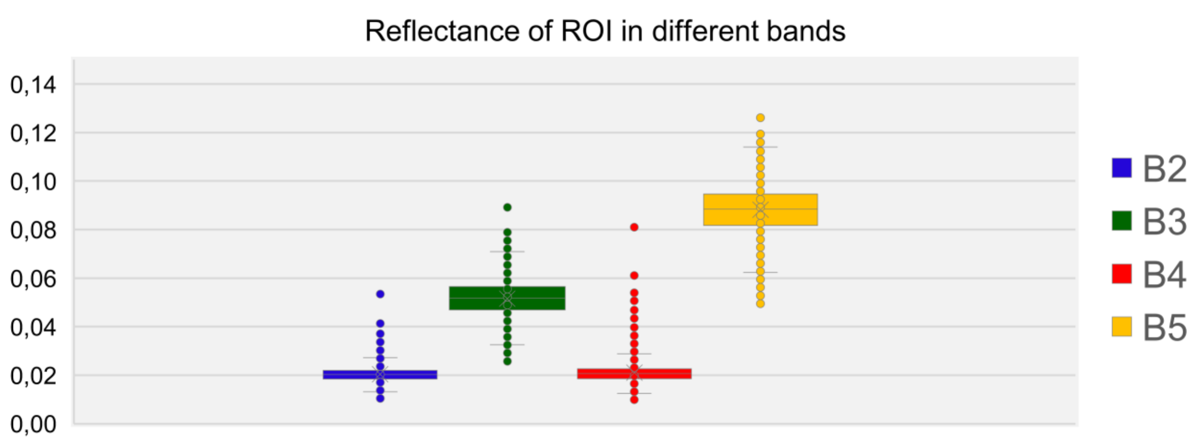


Figure 7: Box plots for selected bands under the digitized polygon

Pin Manager

The *Pin Manger* is a useful tool to export values of selected pixels for systematic comparison. After digitizing pins (and optionally assigning class names and colors), the raster values can be extracted with the filter icon **Filter pixel data to be displayed in table**. The bands are then added as columns as shown in Figure 8 which can then be exported with **Export selected data to text file**.

An example of the file structure of the exported pixel values is shown in Figure 9. Please note that the data is separated by tabulators, so the headers might not look aligned with their columns in a simple text editor, but the structure allows the clean ingestion in statistic programs, such as MS Excel, SPSS or Orange. If the data was labelled, classifiers can be trained based on the table, for example by searching ideal thresholds to separate the classes based on the selected bands (an example is given here). Note that it might be necessary to remove the first 6 lines so that the first line is the header of the column (starting with "Name").

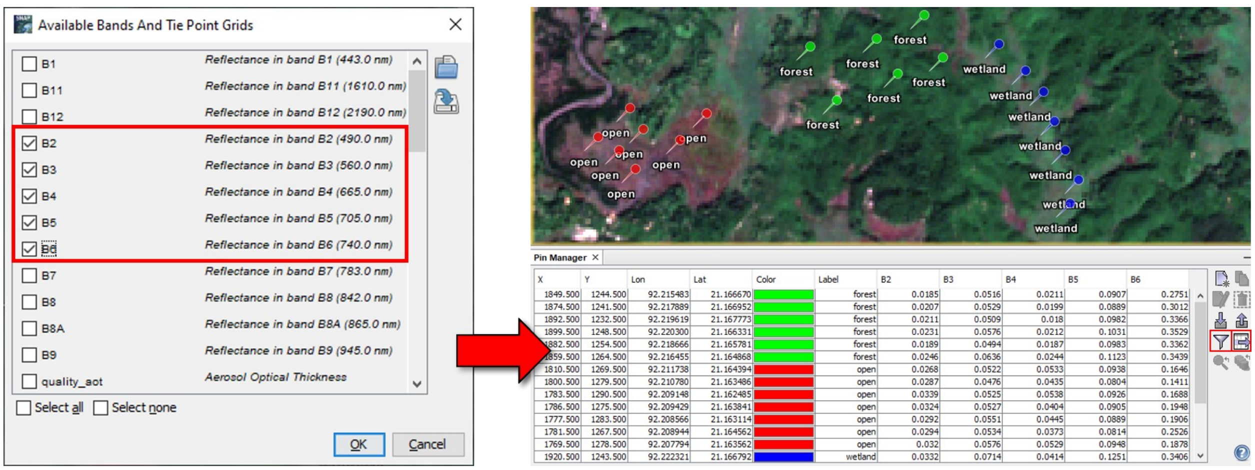


Figure 8: Extraction of pixel values under pins

```
# SNAP pin export table
#
# Product:  S2A_MSIL2A_20201109T042011_N0214_R090_T46QDJ_20201109T071046_s2resampled
# Created on:   Sat Dec 12 15:46:57 CET 2020

# Wavelength:                         490.0   560.0   665.0   705.0   740.0
Name    X   Y   Lon Lat Color   Label   Desc    B2  B3  B4  B5  B6
pin_1   1849.5  1244.5  92.21548260467831   21.166670098498034  java.awt.Color[r=0,g=255,b=0]   forest      0.0185  0.0516  0.0211  0.0907  0.2751
pin_2   1874.5  1241.5  92.21788913044091   21.1669522878081    java.awt.Color[r=0,g=255,b=0]   forest      0.0207  0.0529  0.0199  0.0889  0.3012
pin_3   1892.5  1232.5  92.21961859497848   21.167773411643594  java.awt.Color[r=0,g=255,b=0]   forest      0.0211  0.0509  0.018   0.0982  0.3366
pin_4   1899.5  1248.5  92.22030039966079   21.16633098011817   java.awt.Color[r=0,g=255,b=0]   forest      0.0231  0.0576  0.0212  0.1031  0.3529
pin_5   1882.5  1254.5  92.21866584206288   21.16578134725746   java.awt.Color[r=0,g=255,b=0]   forest      0.0189  0.0494  0.0187  0.0983  0.3362
pin_6   1859.5  1264.5  92.21645529702366   21.16486763821566   java.awt.Color[r=0,g=255,b=0]   forest      0.0246  0.0636  0.0244  0.1123  0.3439
pin_18  1810.5  1269.5  92.21173816774166   21.16439398192508   java.awt.Color[r=255,g=0,b=0]   open        0.0268  0.0522  0.0533  0.0938  0.1646
pin_19  1800.5  1279.5  92.21077979396993   21.1634860299762    java.awt.Color[r=255,g=0,b=0]   open        0.0287  0.0476  0.0435  0.0804  0.1411
pin_21  1783.5  1290.5  92.20914770557421   21.16248457648024   java.awt.Color[r=255,g=0,b=0]   open        0.0339  0.0525  0.0538  0.0926  0.1688
pin_22  1786.5  1275.5  92.20942945364452   21.163841118511915  java.awt.Color[r=255,g=0,b=0]   open        0.0324  0.0527  0.0404  0.0905  0.1948
pin_23  1777.5  1283.5  92.20856645257149   21.163114296750656  java.awt.Color[r=255,g=0,b=0]   open        0.0292  0.0551  0.0445  0.0889  0.1906
pin_24  1781.5  1267.5  92.20894403254357   21.164561636015677  java.awt.Color[r=255,g=0,b=0]   open        0.0294  0.0534  0.0373  0.0814  0.2526
pin_25  1769.5  1278.5  92.20779352447636   21.16356242074949   java.awt.Color[r=255,g=0,b=0]   open        0.032   0.0576  0.0529  0.0948  0.1878
pin_14  1920.5  1243.5  92.22232071495296   21.16679202288802   java.awt.Color[r=0,g=0,b=255]   wetland     0.0332  0.0714  0.0414  0.1251  0.3406
pin_15  1930.5  1253.5  92.22328861206205   21.165892984590606  java.awt.Color[r=0,g=0,b=255]   wetland     0.0321  0.0662  0.0375  0.1173  0.2992
pin_16  1937.5  1261.5  92.22396604132      21.16517330781741   java.awt.Color[r=0,g=0,b=255]   wetland     0.0289  0.0679  0.0371  0.1166  0.324
pin_17  1941.5  1272.5  92.224357051755 2   21.164181264225427  java.awt.Color[r=0,g=0,b=255]   wetland     0.0329  0.0673  0.039   0.118   0.3294
pin_20  1945.5  1283.5  92.22474749397381   21.163189219456928  java.awt.Color[r=0,g=0,b=255]   wetland     0.0296  0.0692  0.0318  0.1201  0.358
pin_26  1950.5  1294.5  92.22523424608963   21.16219761460616   java.awt.Color[r=0,g=0,b=255]   wetland     0.0296  0.0637  0.0402  0.1183  0.309
pin 27  1947.5  1303.5  92.2249495335266    21.161383173050517  java.awt.Color[r=0,g=0,b=255]   wetland     0.0302  0.0716  0.0338  0.1237  0.3652
```

Figure 9: Exported table of pixel values under pins

Export to Google Earth

Google Earth is a freely available software to visualize spatial information on satellite image backgrounds. Vector data is loaded as kml (Keyhole Markup Language) files. SNAP supports the export to Google Earth by using the KMZ format which additionally allows the storage of raster information. These can be shared to people which are not familiar with geographic information systems (GIS), but still want to allocate the produced image product and interpret it based on the underlying satellite image information. This can be done by opening a band or RGB image and selecting

```
File > Export > Other > View as Google Earth KMZ
```

The following points are important here:

- The data must be projected in WGS84 (not UTM or other coordinate reference systems). Select Raster > Geometric > Reprojection if your data does not have the requested projection.
- The current image view is exported as it is displayed. That means the zoom and extent, as well as color adjustments have to be defined in advance.
- There is an upper size limit of 2 GB and the export fails if this file size is exceeded. To avoid this, resampling to a lower resolution is recommended before exporting, also zooming to the smallest area necessary.
- For some graphic cards, the kmz is only displayed in Google Earth when zooming very close to the data. Check the *3D View* options of Google Earth to test if changes of the *Graphics Mode* or *Antialiasing* help to avoid this.

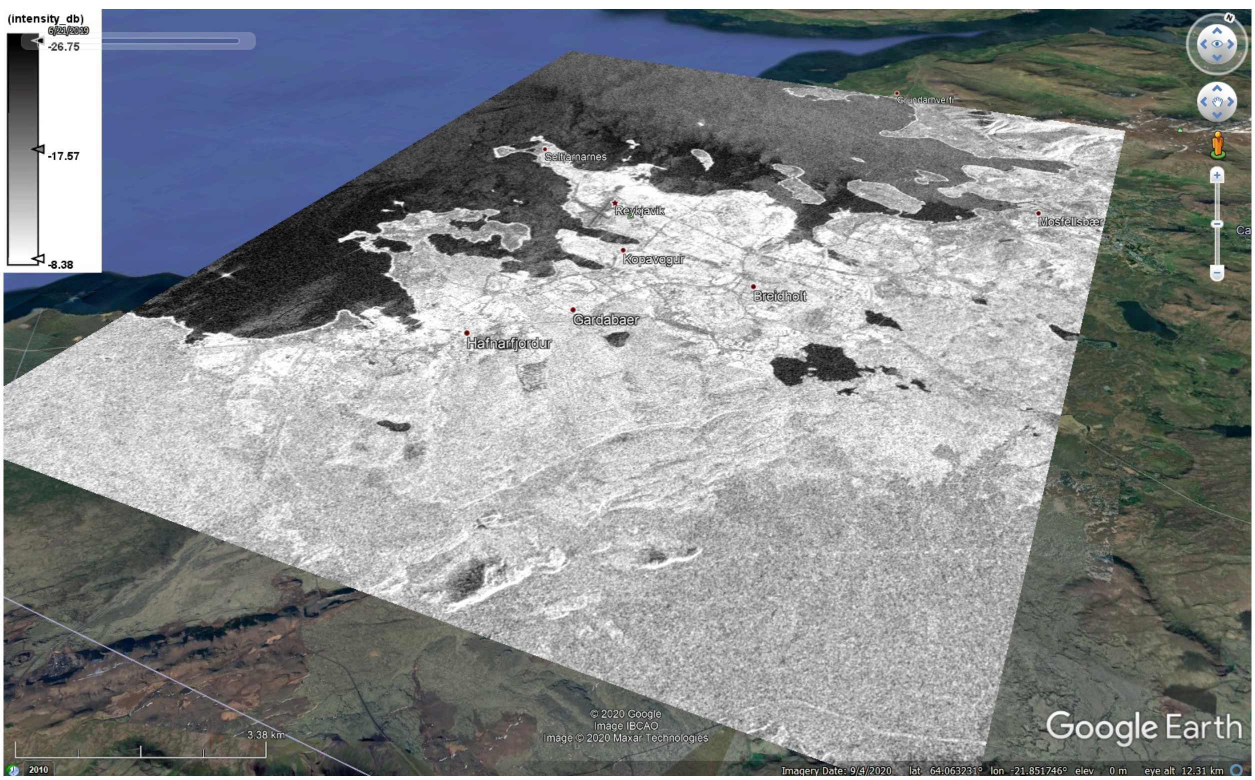
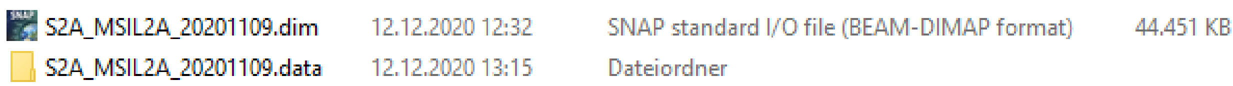


Figure 10: Radar image exported to Google Earth

Direct use of BEAM DIMAP products

In many cases, it is not necessary to export raster data to another format, because the BEAM DIMAP format is compatible with many other programs and can directly be loaded into QGIS, ArcGIS or others. This not only reduces the chance for errors which occur during the conversion, but also avoids the writing of large files with the same information content.
Each BEAM DIMAP product which was written in SNAP consists of two parts – a .dim file and a .data folder. Both have the same name and must be stored inside the same directory, so SNAP reads them as one product.



- **.dim** file: xml structure containing all metadata of the original product, such as sensor name, acquisition date, but also all the processing history in SNAP (including all applied tools and selected parameters) is stored in here.
- **.data** folder: Depending on the product this folder contains the following elements:
  - **vector_data** folder: If you digitized or imported vectors in SNAP, they are stored in here
  - **tie-point grids** folder: If the product contains tie-point grids, they are stored inside this folder
  - **.img** files of each raster band belonging to the product
  - **.hdr** files of each raster band, storing header information (product name, rows, columns, file type, data type, storage type, band name, coordinate reference, wavelength, etc.)

The .img files are ENVI compatible and can be directly loaded into QGIS or ArcMap. As shown in Figure 11, each band of the raster product is stored as an img file of the same name as displayed in SNAP.

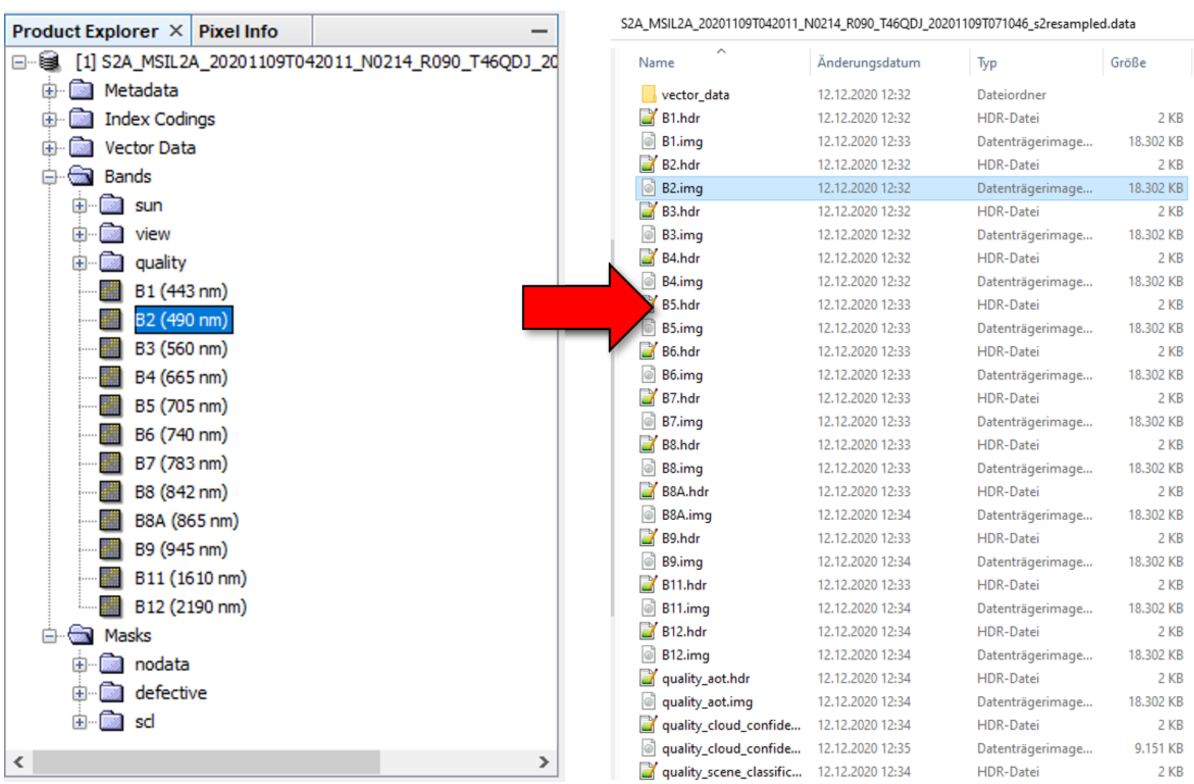


Figure 11: Bands in SNAP (left) Files inside the .data folder of the BEAM DIMAP product (right)

As shown in Figure 12, the .img files can be loaded and displayed in QGIS or ArcGIS without exporting into a different file format. However, the contrast (see chapter “Notes on contrast”) has to be set accordingly.

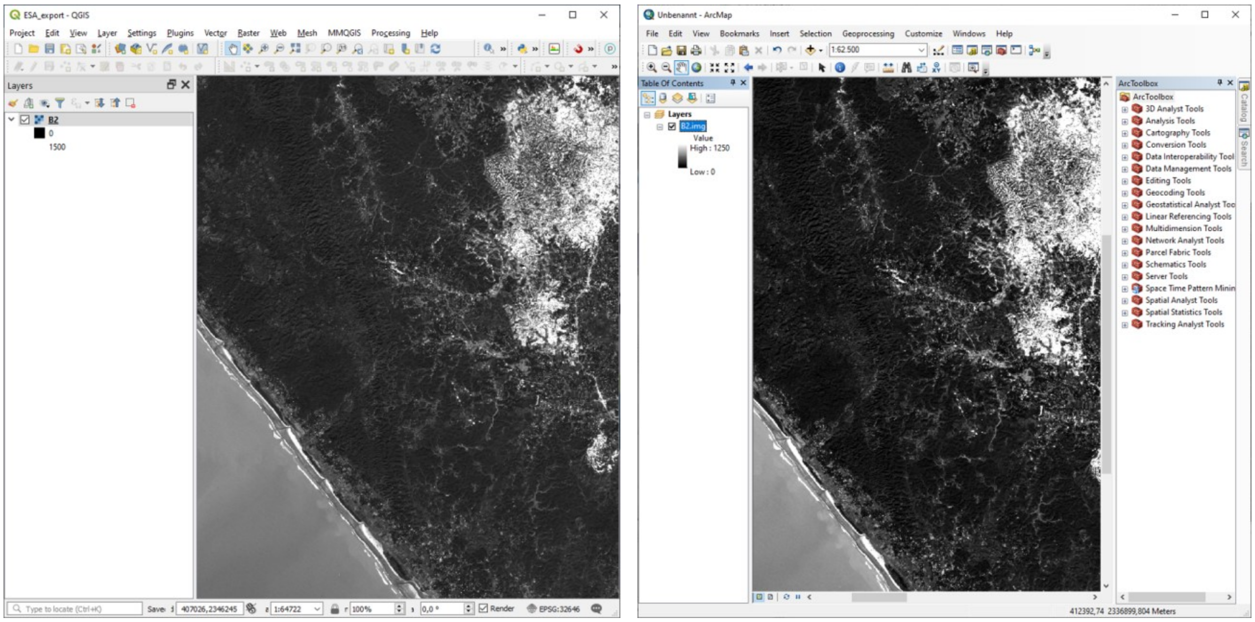


Figure 12: img file of Band 2 of aSentinel-2 product loaded into QGIS (left) and ArcGIS (right)

As all raster bands are stored separately in the .data folder, a stack can be created with

- Menu >Raster > Miscellaneous > Merge (QGIS)
- Toolbox > Data Management Tools > Raster > Raster Processing > Composite Bands (ArcGIS). An example is given in Figure 14.

In case of thematic raster products, such as classifications, the name of the file in the .data folder is either LabelledClasses.img or class_indices.img. Again, colors defined in SNAP are not exported with the data. When it is loaded in QGIS or ArcGIS, it is displayed as a continuous greyscale raster by default, so the symbology has to be changed to “Paletted/Unique values” (QGIS, left) or “Unique” (ArcGIS, right) as shown in Figure 13. This allows to define individual colors for each pixel value, as shown in Figure 15.

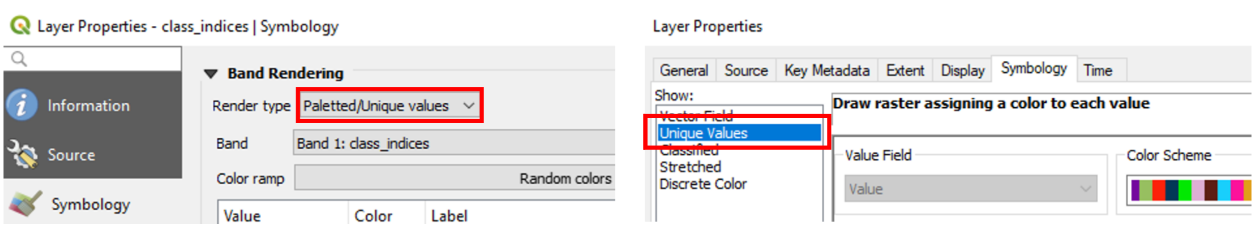


Figure 13: Assignment of discrete colors to raster values

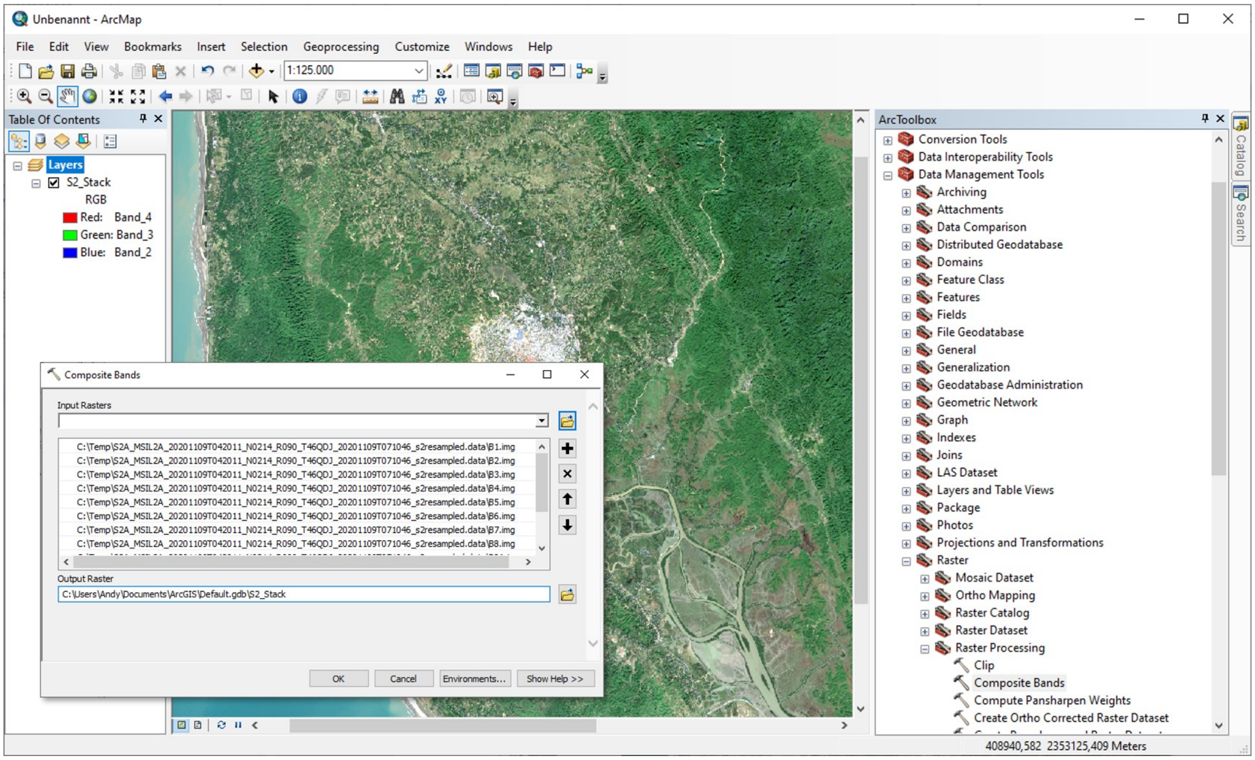


Figure 14: Creation of a raster stack from img files

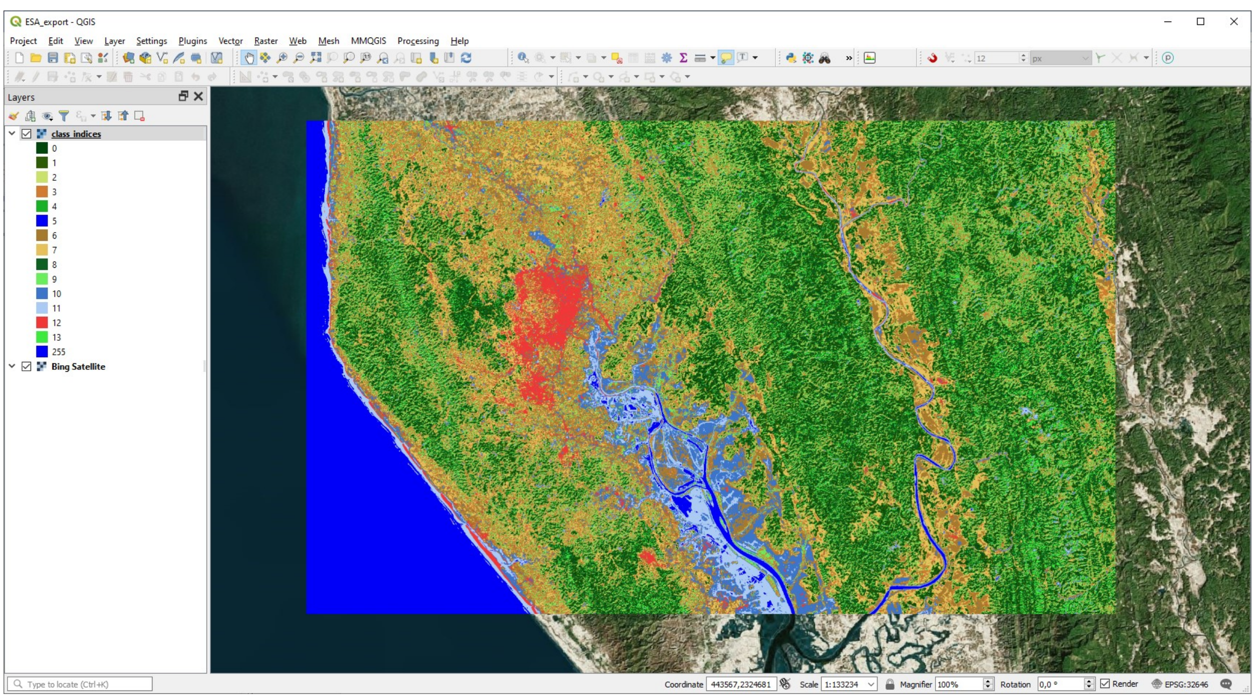


Figure 15: Display of classified data in QGIS

For more tutorials visit the Sentinel Toolboxes website

http://step.esa.int/main/doc/tutorials/

Send comments to the SNAP Forum

http://forum.step.esa.int/