

ESA SNAP

Import of data into SNAP

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The goal of this document is to demonstrate how data collected, prepared or processed outside SNAP can be imported correctly. As there are many supported input data formats, this tutorial is not meant to be complete, but rather gives some advice on selected data types. It is possible that this tutorial will be extended by further input formats in the future.

General notes on loading data

There are two main ways of loading data into SNAP

1. **File > Open** (Figure 1 blue): You can use this to load products which were already processed in SNAP and stored in **BEAM DIMAP format**. This format is recommended during the processing of data in SNAP because it conserves all metadata of the original product which might be needed by the different tools. Furthermore, it stores a processing graph which lists all operations and their parameters which have been applied to a dataset as a kind of internal processing history. You can also open original or raw datasets with this option when you use the filter option to predefine the type of data you want to load (Figure 1 green box). However, this filter does not cover all data types which are supported by SNAP, so the second option is recommended for raw data.
2. **File > Import** (Figure 1 red): Depending on your choice a window will be opened which predefines the file type which is required to load a certain data format (for example *.xml*, *.hdr*, *.safe*, or *.zip*). In many cases it is possible to load the data as a subset, both spatially or by selecting a reduced number of bands (Figure 2 and Figure 3) to reduce the amount of data to be processed from the very beginning. Loading data via **File > Import** is recommended, because it grants that the correct file is selected during the import so that all metadata of the input are interpreted correctly by SNAP.

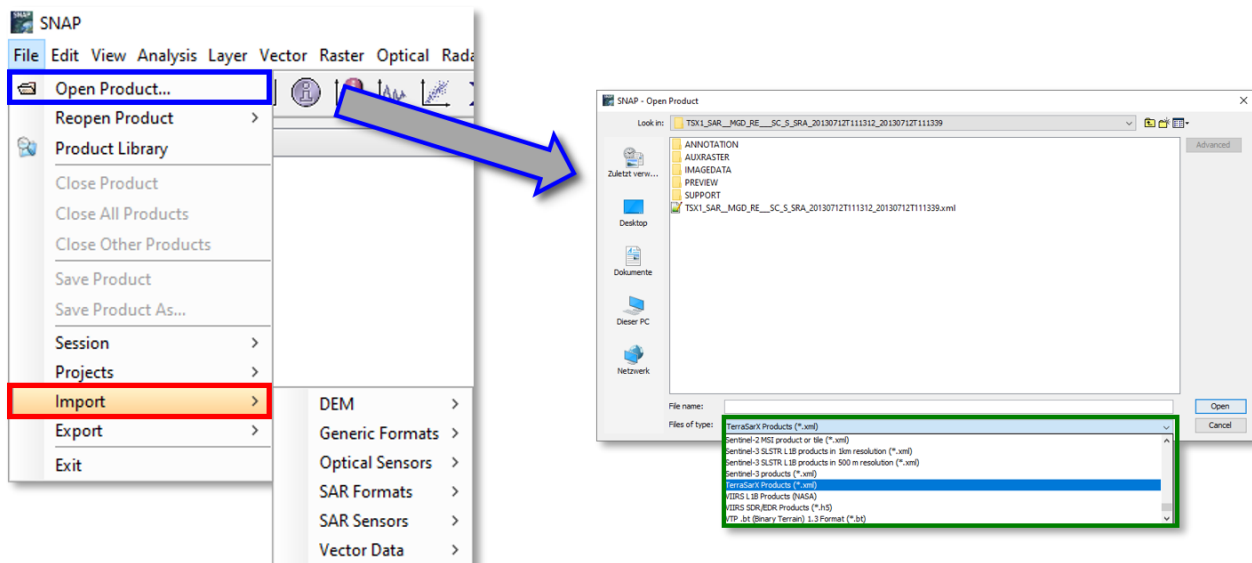


Figure 1: Ways to load raster data into SNAP

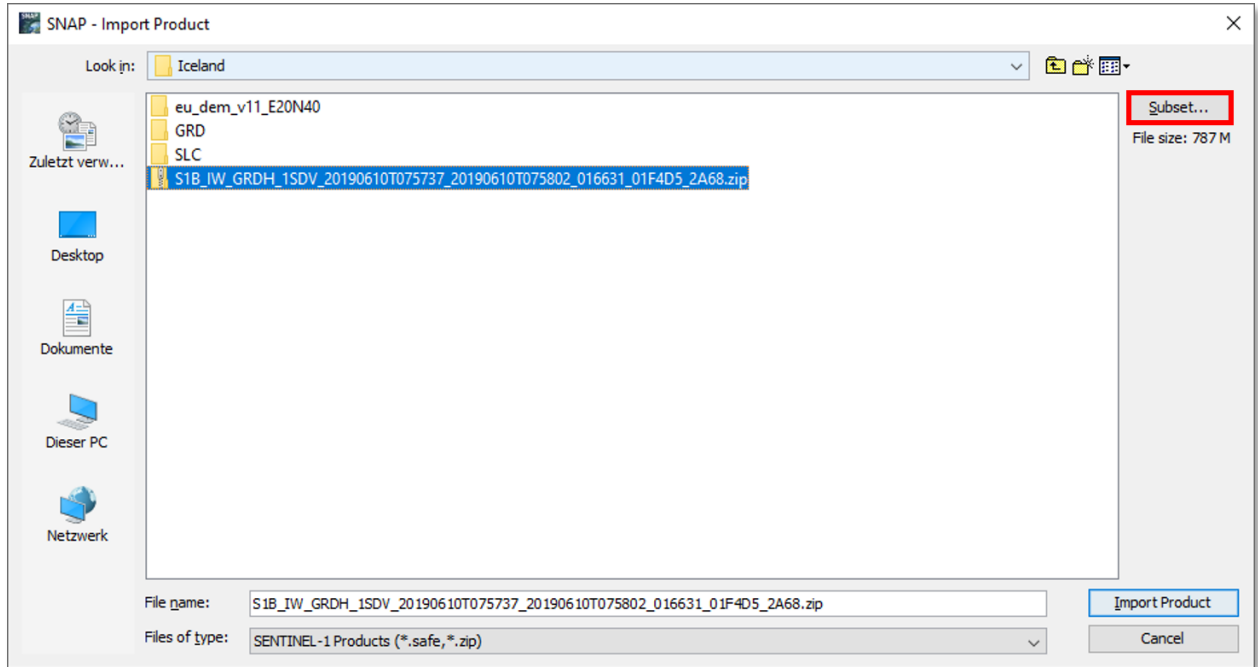


Figure 2: Loading a subset (here: Sentinel-1 GRD product)

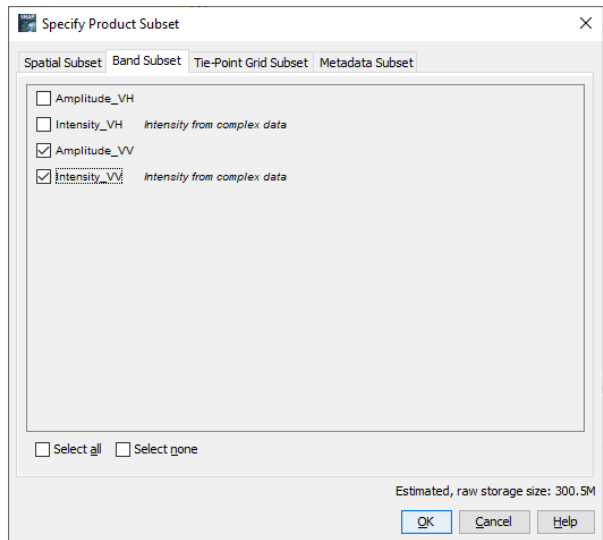
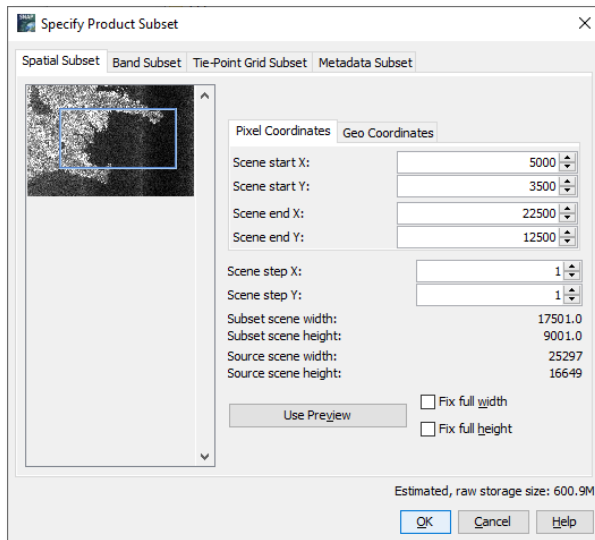








Figure 3: Spatial (left) and band subset (right)


Importing vector data

There are many purposes of adding vector data into SNAP:

- Location of specific features in raster bands (e.g. polygon of a forest area)
- Import of lines for the Profile Plot  tool
- Definition of a region of interest (ROI). Among others, polygons can be used to limit the analysis to a selection of pixels in the following tools and operators

-  Histogram
-  Profile Plot
-  Scatter Plot (example in Figure 10)
-  Correlative Plot
-  Statistics tool
- Classifications
- Principal component analysis

and many others. The principle is shortly explained in the following chapter. Please see the tutorial on [Synergetic use of S1 \(SAR\) and S2 \(optical\) data and use of analysis tools](#) for a detailed explanation of many of these tools.

- Import vectors to use them as masks in the Mask Manager 
- As training data for supervised classification or for the accuracy assessment (Examples are given in this tutorial [Land cover classification with Sentinel-1 GRD](#))

Important: **To load vector data, a raster product must be opened in SNAP** where the vector can be inserted. They are then displayed under Vector Data and stored as WKT files in the .data folder of the BEAM DIMAP product after you save the file (File > Save product).

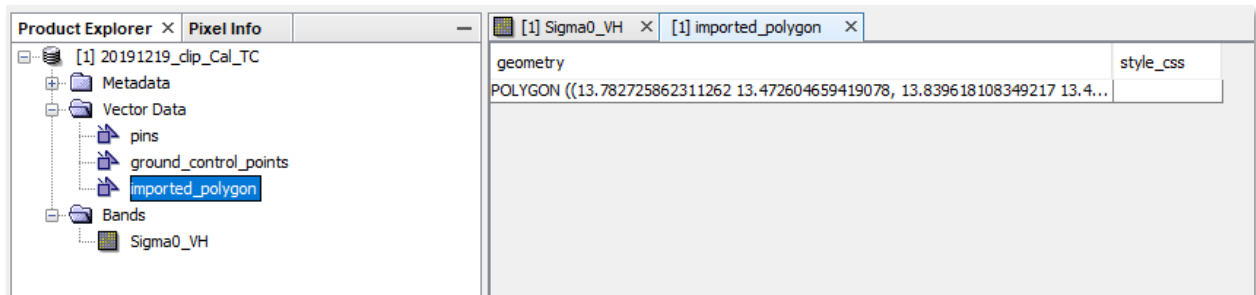


Figure 4: Storage of vectors in SNAP

The following methods of importing vector data will be shortly introduced in the following

- ESRI Shapefiles as ROIs
- ESRI Shapefiles as training data for supervised classification
- CSV data

ESRI Shapefiles as region of interest (ROI)

In the following example, a Sentinel-1 radar image (calibrated, speckle filtered, and terrain corrected), and a Sentinel-2 image of the island of Tenerife provided within the Copernicus Programme are used. Additionally, forest cover retrieved from [CLC 2018](#) is used as a polygon.

Important: **Shapefiles imported into SNAP should be stored in the same coordinate reference system as the raster product.** Otherwise, you might get an error message stating that the data was imported, but it is not spatially covering the raster data (Figure 5).

You can check the coordinate reference system which the raster was projected into by using the Geo-Coding tool (under Menu > Analysis; Figure 6, here: WGS84 [EPSG:4326] with latitudes and longitudes).

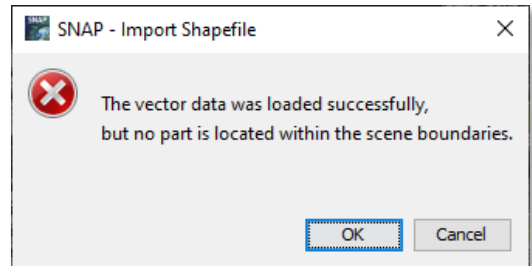


Figure 5: Error message when projections of vector and raster data differ

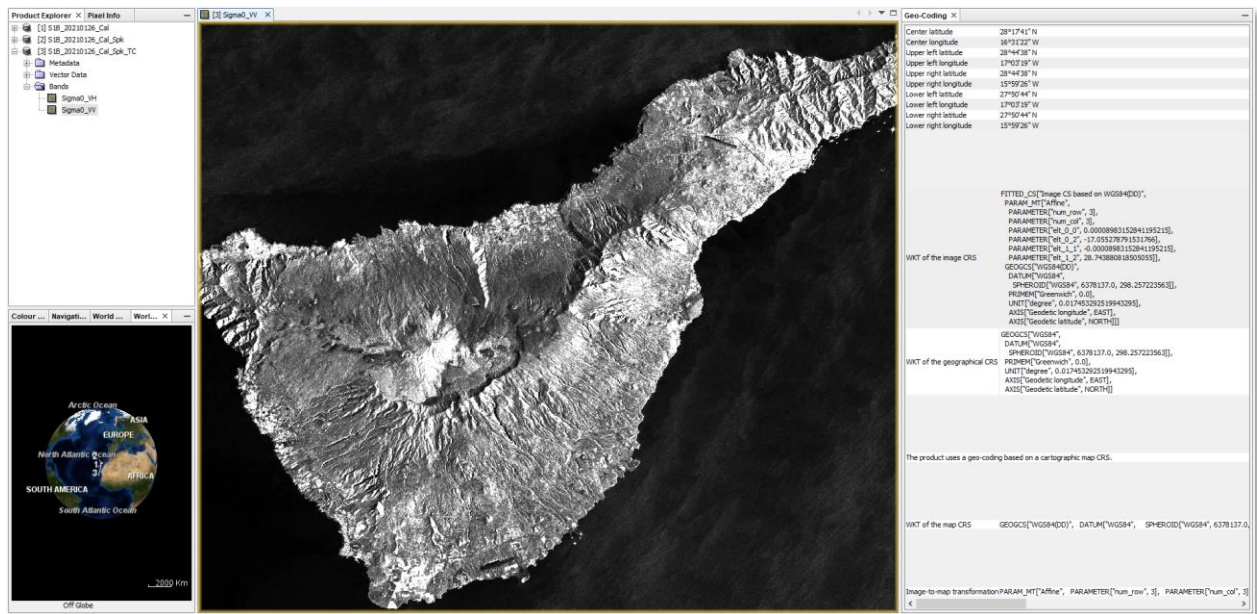


Figure 6: Loaded raster data and its projection displayed in the Geo-Coding window

Once you have opened a raster which matches with the spatial extent and the projection of the vector data, you can select from the *Menu > Vector > Import > ESRI Shapefile* (Figure 7).

Note: This option is greyed out when no raster products are loaded in SNAP.

A file dialogue will open which lets you select the *.shp file. Confirm with **Open**.

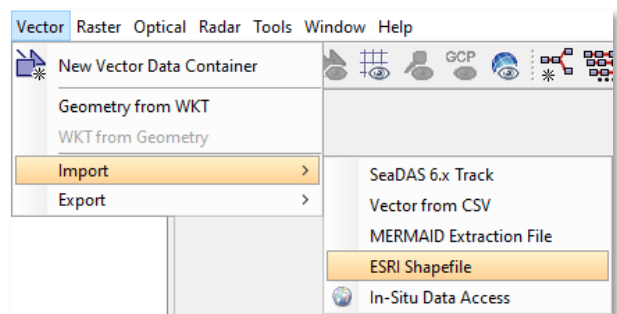


Figure 7: Loading ESRI Shapefiles

In case that the vector data consists of several polygons, another dialogue will pop up and ask you if you want to import them separately or as a single dataset (Figure 8). If you select **Yes**, the polygons will be grouped by an attribute and each group is added separately. If you select **No** all polygons will belong to the same group.

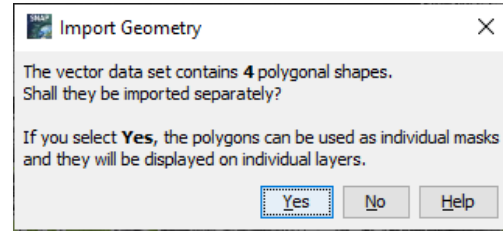


Figure 8: Import of multiple features

After confirmation with **No**, the data will be displayed on top of the raster (partially transparent) in a random color (Figure 9). You can use the *Layer Manager* to turn it on or off, and to change its style using the *Layer Editor*. If you want to keep the vector data permanently, select *File > Save Product*.

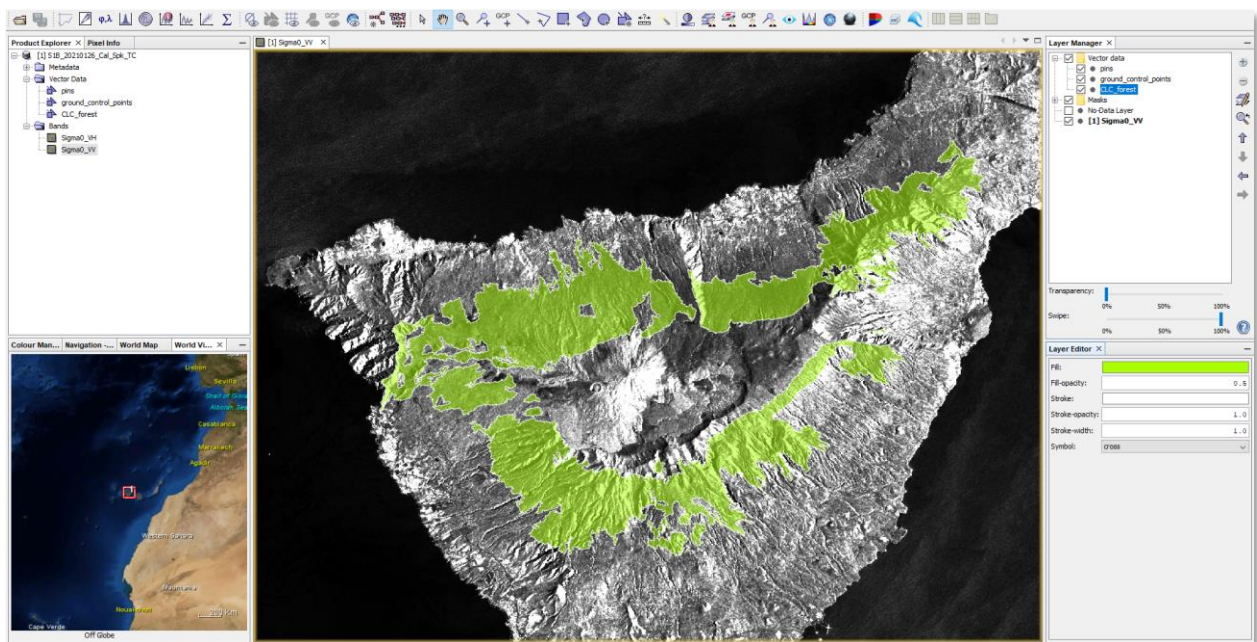


Figure 9: Polygon shapefile imported into SNAP

Once you have imported a polygon you can use it as Region of Interest (ROI) in several tools. As shown in Figure 10, the scatter plot was created based on the bands Sigma0_VV and Sigma0_VH but limited to the pixels covered by the imported vector CLC_forest (red rectangle).

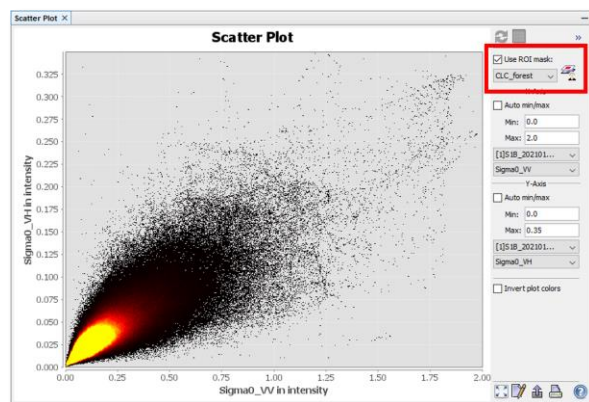


Figure 10: Scatter plot using a ROI

This allows to analyze certain parts of the image without the need for clipping.

Also, the area of each imported vector can be used as a mask in the *Mask Manager* for more advanced expressions.

ESRI Shapefiles as training data

To use external vector data for the training of supervised classification purposes in SNAP, an ESRI Shapefile is needed which contains a **text attribute** determining the class of a polygon. In the following example, this attribute is a string stored in the column `LC_name` (Figure 11). The attribute table may contain additional columns, SNAP will ask for the one which is used in the import.

However, it is important that each class (e.g. forest) is only represented by one line in the attribute table, even if it consists of several polygons. This can be achieved by a [dissolve](#) operation. Otherwise, each polygon will be imported as a single class (e.g. forest_1, forest_2) in the next step.



Figure 11: Training polygons in QGIS

Once the vector dataset is prepared, to load vectors into SNAP, a raster product has to be opened and selected in the **Product Explorer**. Then, you can navigate via the **Menu > Vector > Import > ESRI Shapefile** and select the shapefile (in this case it is named `CLC_2018_polygons_dissolve.shp`).

In this example, the shapefile consists of 15 classes (Figure 11). Upon selection of the file, SNAP opens a dialogue which asks if these classes should be imported as a single polygon or split by a text attribute. The drop-down menu (Figure 12, red box) allows you to select the correct attribute column (only text attributes can be used). We select `LC_Name` and confirm with **Yes**.

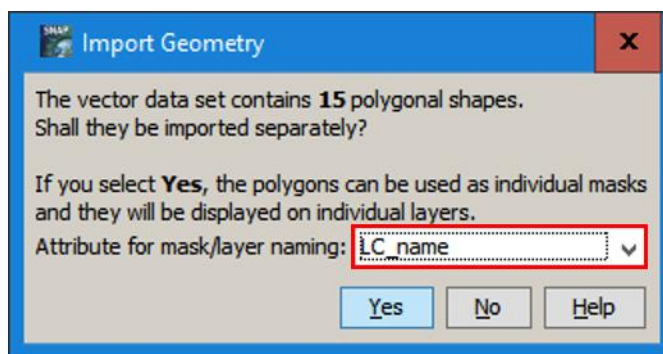


Figure 12: Import of classified polygons

The imported polygons will now be loaded into the raster product with each class belonging to a different entry in the *Vector Data* folder and each displayed in a different random color (Figure 13).

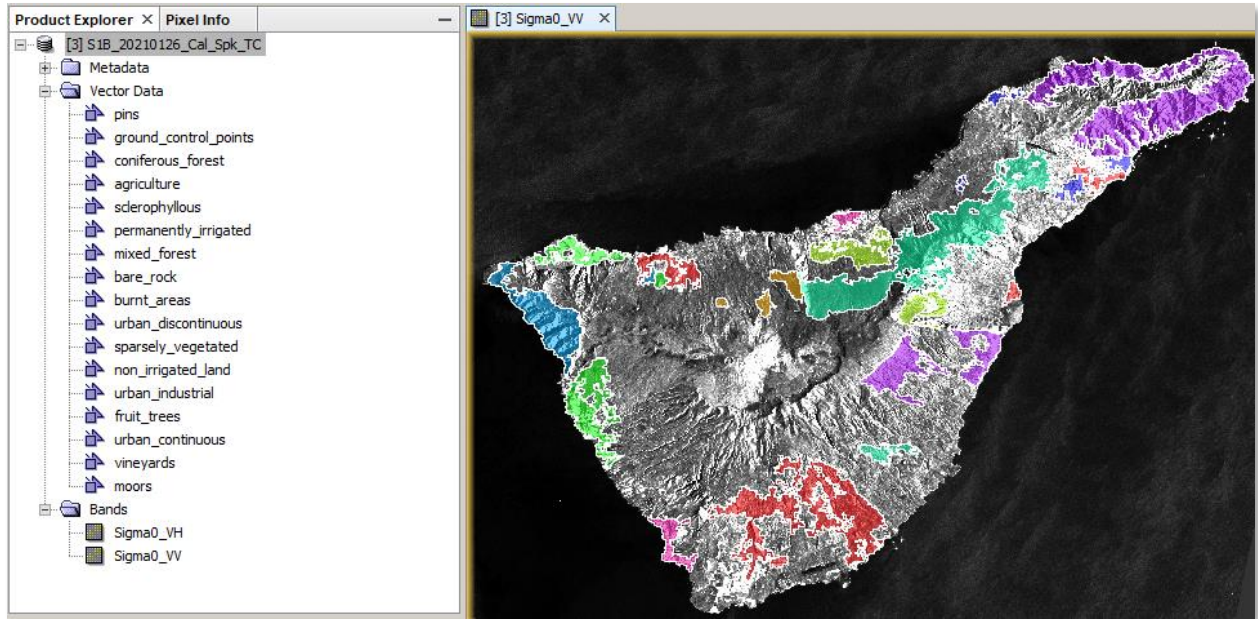


Figure 13: Imported classified polygons

In this format the imported class vectors can be used for training supervised classifiers as shown in Figure 14. They are found under *Menu > Raster > Classification > Supervised Classification*.

Note: Please be aware that a high number of classes also requires a large number of feature bands. It is not feasible (as shown in this example) to predict 15 classes based on two input bands (here: Sigma0_VV and Sigma0_VH). Especially the Random Forest classifier requires large numbers of both training vectors and feature bands to become effective.

To increase the number of raster features, you can calculate image textures or use images of different dates (e.g. images from the dry and wet season [\[tutorial\]](#)), or sensors (e.g. optical and SAR data [\[tutorial\]](#)).

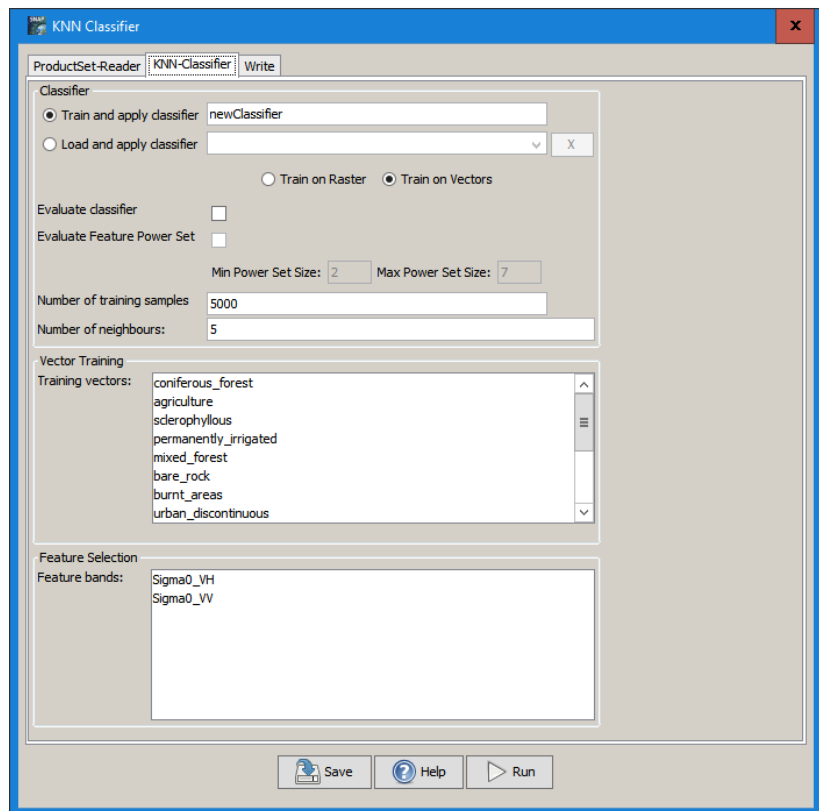


Figure 14: Usage of imported shapefiles for supervised classification

CSV files

CSV stands for comma separated value and is a common format for tabular data. It is a suitable format to store a series of points (including their attributes). However, csv data containing spatial information loaded into SNAP must fulfill certain conventions on content and formatting:

- **Tab separation:** The columns should be separated by a tabulator character (not a comma or semicolon). You can prepare your data in freely available programs, such as [Notepad++](#) and replace all commas by tabulators (search for , and replace by \t).
- **Header line:** The first line of the table should contain the names of the attributes. Two columns on the coordinates of the point must exist and be named lon and lat, longitude and latitude.
- **Number of columns:** The header line and the data below must have the same number of columns. Please check the data for invisible tabulators which might indicate the presence of another column.
- **Geometry (optional):** Advanced definitions of geometry types as used in databases are possible (e.g. 'geometry:Point', 'geometry:LineString', 'geometry:Polygon'). Examples are given in the Help section of SNAP under *Import and Export > Import Vector Data > CSV*.

An example of a simple CSV structure which can be imported into SNAP is given below.

```
# optional description
Point Longitude Latitude Name
pt_1 9.943068 43.09783 first
pt_2 10.458842 42.990147 second
pt_3 10.553919 42.664112 third
pt_4 10.302726 42.470406 fourth
pt_5 9.838505 42.601866 fifth
pt_6 9.656987 42.87649 sixth
pt_7 9.943068 43.09783 seventh
...
```

In this tutorial, data on trees from the [administration of Tenerife](#) is used. The first lines are shown below. Please note that because of the length of the coordinate attributes, the header descriptions are not horizontally aligned with the data columns (type is not above ABC, ABL...). This does not look nice but it is necessary so that each column is separated by exactly one tabulator.

```
lon lat type
-16.1536680930129 28.5252989881192 ABC
-16.1558792651145 28.5262766246275 ABC
-16.1553564297368 28.5255941346835 ABC
-16.1556519623649 28.5277503535452 ABL
-16.1556256702465 28.5276822534990 ABL
-16.1555989656586 28.5275229352706 ABL
-16.2723564024984 28.4844696842436 ABP
-16.2723604681660 28.4845284739826 ABP
...
```

The data is loaded via the *Menu > Vector > Import > Vector from CSV* and select the csv file (in this case it is named `trees_table.csv`). Upon confirmation, you will be asked about the reference system of the coordinates (Figure 15, left). As these are given in geographic coordinates, WGS84 is the correct choice. This step is especially crucial when your raster data was stored in UTM coordinates which are suggested as target CRS (but not correct). Confirm with OK. A second dialogue will ask you about the type of information where you can merge the points to lines, polygons or tracks (Figure 15, right). If you only want to import the data as points, select **Leave imported data unchanged** and confirm with OK. The data will be displayed on top of the raster (Figure 16). Depending on the number of points, this can take a while. The imported points can again be used in combination with analysis tools, e.g. the Statistics tool (Figure 17).

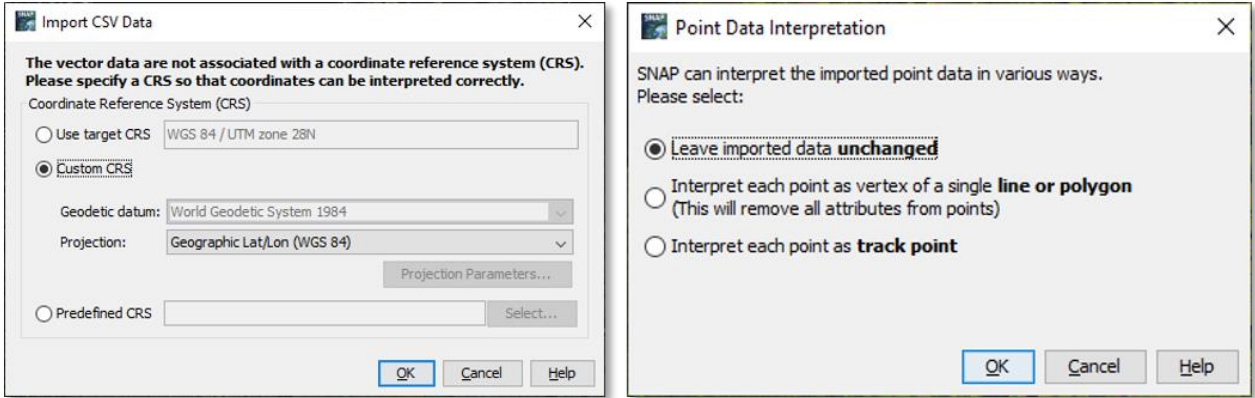


Figure 15: Import of CSV files

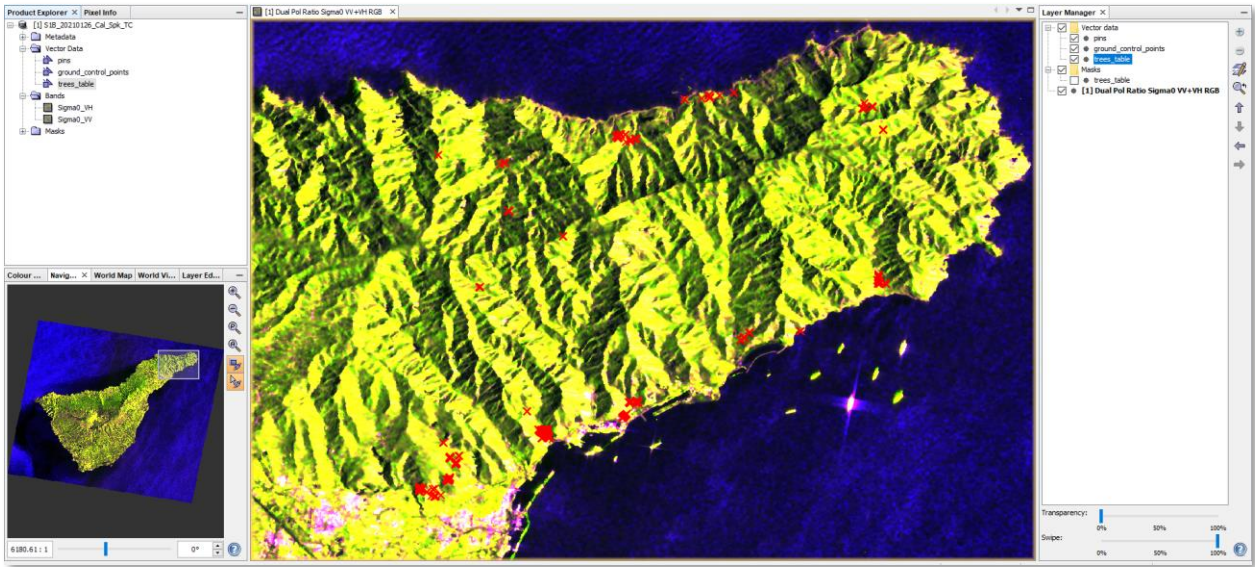


Figure 16: Points imported from CSV files

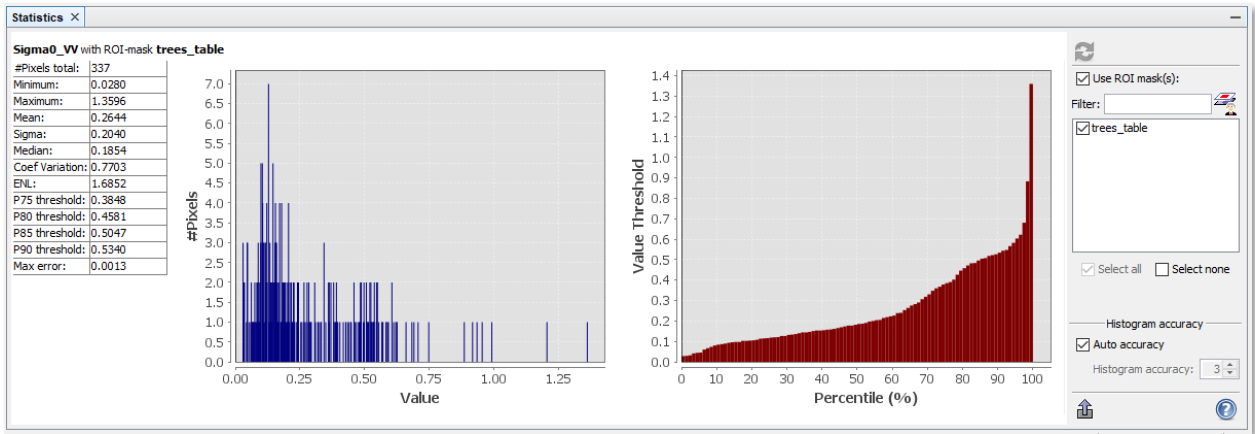




Figure 17: Statistics for the imported points

Spectral Signatures

A [spectral signature](#) is a tabular form of the reflectance of a certain material or surface over various wavelengths. It is mostly displayed as a line graph connecting the reflectivity values of single bands for a single pixel. It can be displayed interactively with the **Spectrum View** . Spectral signatures of various materials or surfaces are often collected in [spectral libraries](#).

Such signatures can be used as training data for the **Spectral Unmixing** tool which assigns a relative value of class abundance to each pixel based on the information of the input signatures [\[reference\]](#). However, the training signatures have to follow a specific formatting: The first column is named wavelength and contain the wavelength in nanometers. All other columns are separated by tabulators and contain the name and the reflectivity [0 – 1] of several surfaces at the corresponding wavelengths. An example is given in Figure 18. Again, the constant separation by tabulator characters might lead to visually misaligned columns, but this is not a problem.

The number and bandwidth of wavelengths depends on the source of the spectral signatures, but it should at least contain the bandwidths covered by the satellite (13 bands of Sentinel-2 in this example). This file structure can be saved as a .txt or .csv file and then loaded into the Spectral Unmixing tool (found under *Menu > Optical > Spectral Unmixing*) by the  button under *Endmembers*. Their signature is then shown in the plot on the bottom right as shown in Figure 19.

1	Wavelength	forest	soil	urban	water
2	443.0	0.0063	0.0348	0.2738	0.0195
3	490.0	0.0085	0.042	0.4608	0.0149
4	560.0	0.0201	0.0525	0.4972	0.0071
5	665.0	0.0154	0.0578	0.4908	5.0E-4
6	705.0	0.0506	0.0682	0.4159	7.0E-4
7	740.0	0.1547	0.0759	0.3747	1.0E-4
8	783.0	0.1897	0.0829	0.3685	4.0E-4
9	842.0	0.2056	0.0833	0.4568	1.0E-4
10	865.0	0.1975	0.083	0.364	1.0E-4
11	945.0	0.2174	0.0593	0.2371	1.0E-4
12	1610.0	0.0721	0.11711	0.3617	4.0E-4
13	2190.0	0.0305	0.1113	0.3266	0.0016

Figure 18: Spectral signature file

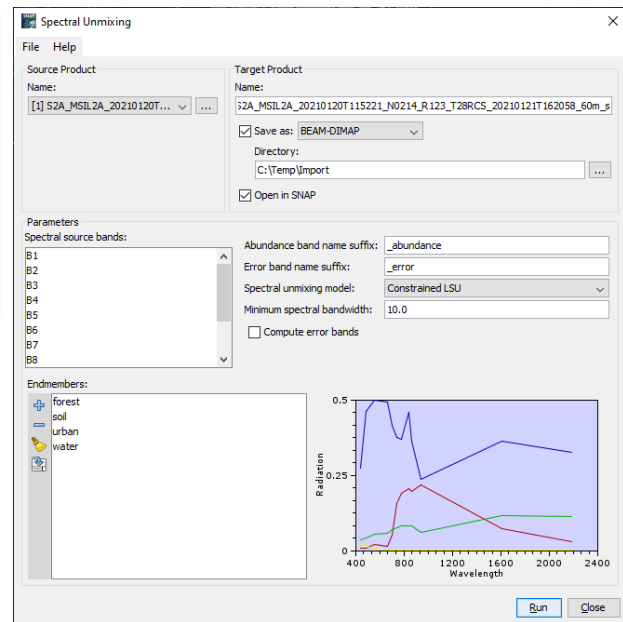





Figure 19: Spectral Unmixing with imported signatures

Hint: If you don't find the spectral signatures in open libraries or if you cannot measure them yourself using spectrometer devices, you can place pins  on representative pixels with large class probabilities (e.g. consisting of 100 % forest, water, or bare soil) using the **Pin Manager**  and then export the reflectance of these classes  to a .txt file. This txt file is ready to be used as endmember reference in the Spectral Unmixing tool.

Importing digital elevation and landcover data

Digital elevation models are used at many stages of geospatial analysis. They can be loaded into SNAP by right-clicking on a loaded product and selecting *Add Elevation Band* or *Add Land Cover Band*. This will open a list with datasets to choose from (Figure 20). Please note that not all datasets cover the entire world (e.g. SRTM does not cover high latitudes; AAFC only covers the state of Canada). As shown in the figure, a resampling method has to be selected which determines how the spatial resolution of the integrated data is adjusted to the one of the loaded raster (here: 10 m of Sentinel-1). Categorical data (land cover) require *NEAREST_NEIGHBOR* resampling while continuous data (elevation) can be resampled using *BILINEAR_INTERPOLATION*. After confirmation with **OK** the data is added to the list of bands, but only downloaded after the raster is displayed or used by another tool. Since SNAP version 8, the computation of slope and aspect (under *Menu > Raster > DEM Tools*) is also possible.

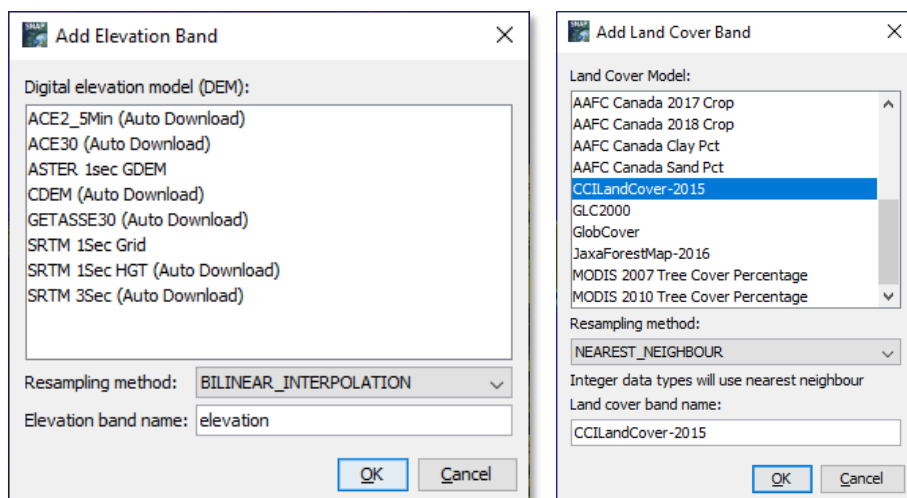


Figure 20: Automated download of DEM (left) and land cover data (right)

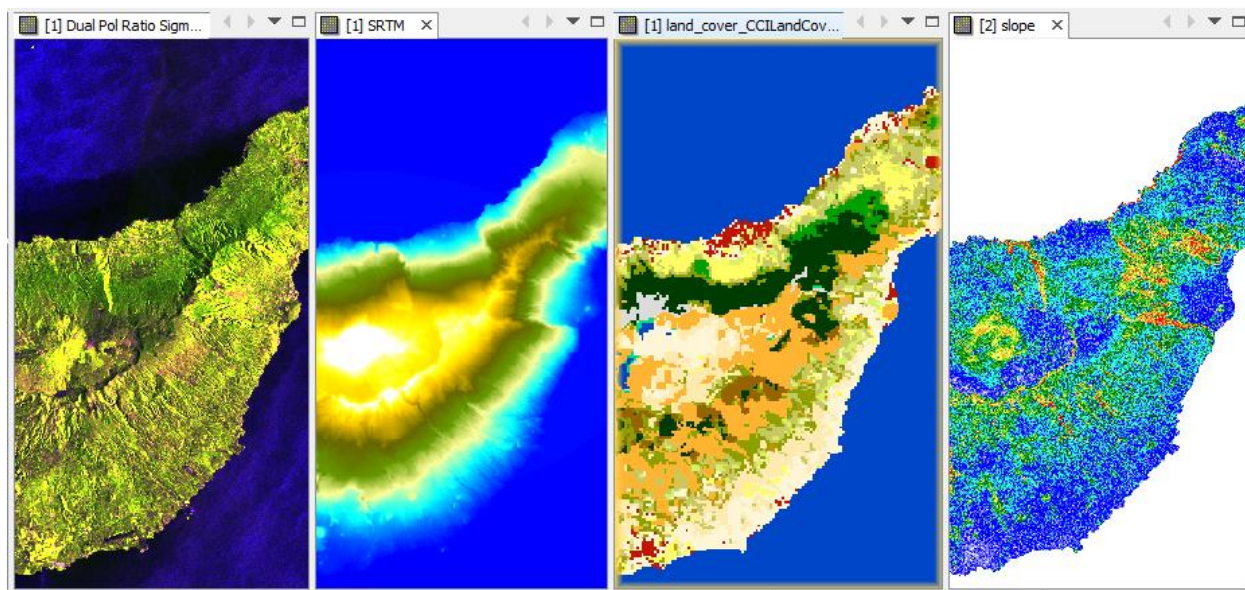


Figure 21: Radar data, DEM, land cover and slope

Importing Web Map Services

A Web Map Service ([WMS](#)) is a raster map (often computed from vector data) which can be loaded from a server and integrated into a software for spatial data. It is accessed using a service URL which denotes its location. Web Map Services are stored at servers by different providers. SNAP allows to integrate WMS as long as they are based on a common coordinate reference system and covering the area of a loaded data set. Some examples on working WMS:

Open Street Map data by [Terrestris](#):

- Color: <https://ows.terrestris.de/osm/service?>
- Grayscale: <https://ows.terrestris.de/osm-gray/service?>



A large range of base maps by the [German Aerospace Center](#)
<https://geoservice.dlr.de/eoc/basemap/wfs?>

- Base Map
- EU DEM
- Litem ap
- Bathymetry
- and many others, including most layers by [NaturalEarth](#)

Copernicus Marine Service

- Waves: <http://nrt.cmems-du.eu/thredds/wms/global-analysis-forecast-wav-001-027>
- Ocean Physics: <http://nrt.cmems-du.eu/thredds/wms/global-analysis-forecast-phy-001-024>
- Biogeochemical: <http://nrt.cmems-du.eu/thredds/wms/global-analysis-forecast-bio-001-028-daily>

Besides that, there are many Web Map Services with limited spatial coverage provided by local authorities, and also sites for the search for WMS exist, such as [GeoSeer](#), [Spatineo](#), or [data.gov](#).

We use a simple OpenStreetMap WMS for the example. First, a raster product has to be loaded and displayed. Then, the WMS can be added via the *Layer Manager*  by clicking on the  button. A new window will open where you select Image from **Web Map Server (WMS)** and confirm with **Next** (Figure 22). Enter the service URL (usually ending with `?`, Figure 23, left) and hit Enter to confirm, then proceed with **Next**. Depending on the contents, you will be given a list of layers to chose from (Figure 23, right). Select one and confirm with **Finish**.

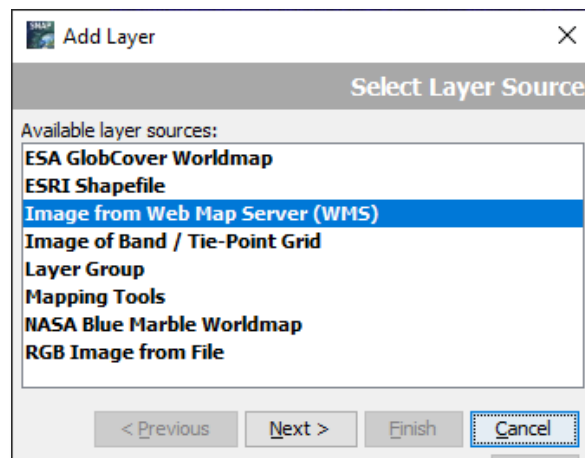


Figure 22: Adding a WMS via the Layer Manager

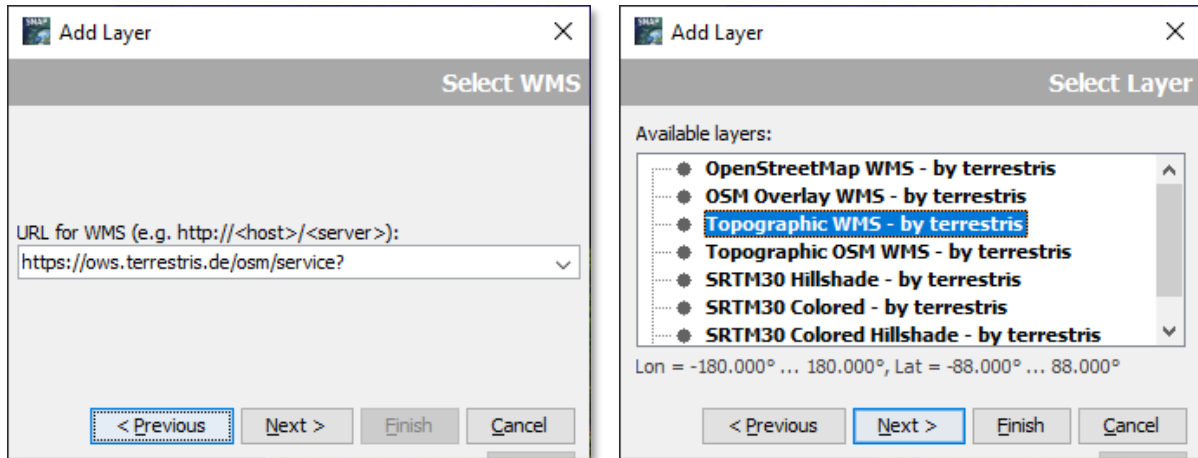


Figure 23: Specification of the WMS

SNAP will now establish a connection to the server and download the data as a raster. It will be then displayed in the main view and also added to the list of layers in the *Layer Manager* (Figure 24). Unlike WMS loaded into a Geographic Information System, the view will not update when you zoom in or navigate, so the loaded content is rather static. To visually combine or compare it with the underlying raster data, you can use the sliders at the bottom of the *Layer Manager* which allow you to swipe between both layers and define their transparency.

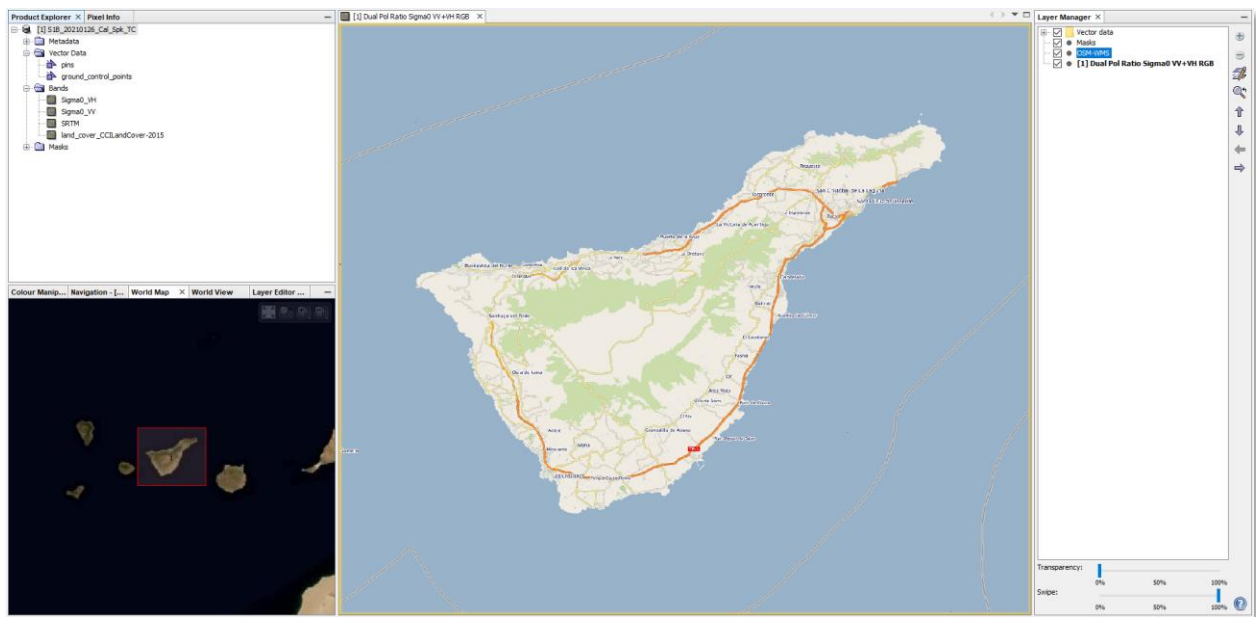


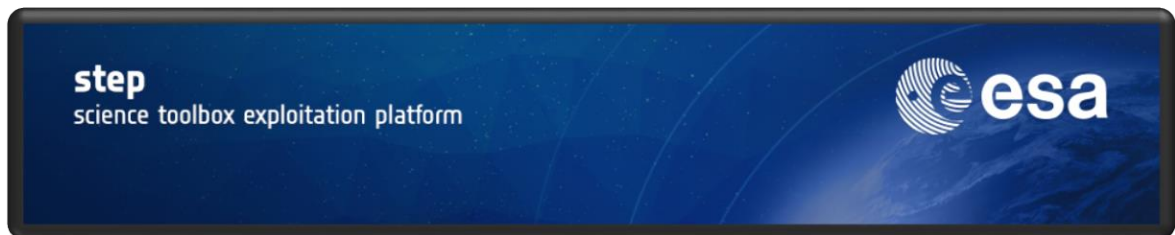
Figure 24: Open Street Map WMS loaded into SNAP

Note: All successfully loaded WMS will remain in the dropdown menu (Figure 23, left). This allows to quickly access them at later times without having to enter the service URL again.



For more tutorials visit the Sentinel Toolboxes website

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



Send comments to the SNAP Forum

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