

Data Preparation Tutorial

Version 5.7.0

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Index

1. Introduction	3
2. ENVI Preferences	3
3. SARscape Preferences	4
4. Processing	5
2.1. Sentinel Download.....	5
2.1.1. Sentinel-1 Multidownload.....	5
2.1.2. Sentinel Download auxiliary files	7
2.2. Data Import	9
2.3. DEM Extraction.....	11
2.4. Sample Selection	14
5. Batch Processing	18

1. Introduction

The aim of this document is to guide users to prepare SAR data to perform the most common SARscape processings.

This specific exercise considers how to download **Sentinel-1 data**¹ from online repository using a pre-selected area, how to import them and to extract the DEM that overlay the data (*Figure 1*). The data preparation steps are valid for the whole supported SARscape sensors, except for the downloading step, which is specific for Sentinel data.

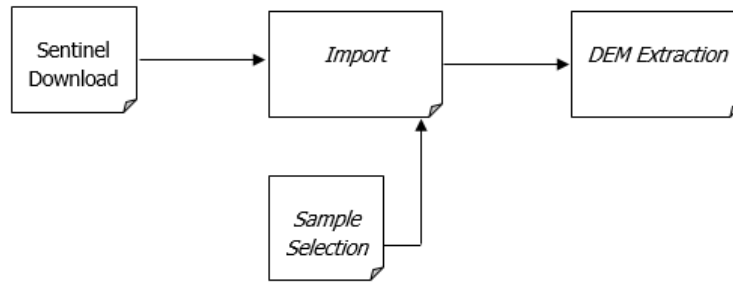


Figure 1 Data preparation scheme.

The main functionalities are quickly described. Information on how to complete the processing panels and the obtained results are provided in the description and in the figures as well.

Each practical step in this document is characterized by the symbol 

If the download cannot be performed, please use the data in the *Getting Started* folder on our FTP (<ftp.sarmap.ch>). Please, contact support@sarmap.ch to get login credentials, providing the full name of the license owner, the name of your institution and the license number.

The functionalities are referred to **SARscape version 5.7.0**, running under **ENVI 5.7.0 or ENVI 5.6.3** with a standard (GIS-like) interface installed on Windows 11, 64bit.

For other software functionalities, such as interferometry or interferometric stacking, the Reader is referred to dedicated tutorials. The tutorials and the datasets can be downloaded <http://www.sarmap.ch/wp/index.php/software/sarscape/>.

2. ENVI Preferences

To immediately have a quick access to the path in the dialog boxes, the ENVI Preferences should be set.

ENVI preferences are in File -> Preferences (*Figure 2*).

¹ The Sentinel satellites are owned by the European Union, in the framework of the Copernicus program. They have been developed and are operated by ESA (100% of the operations funding comes from the EU).

Select Directories and set ENVI Input, Output and Temporary directories.

Please note: these directories should be located on a local hard drive where you have read/write privileges. It is strongly recommended to do not choose USB or external drives as Input/Output or Temporary Directory, due to the large amount of data transfer.

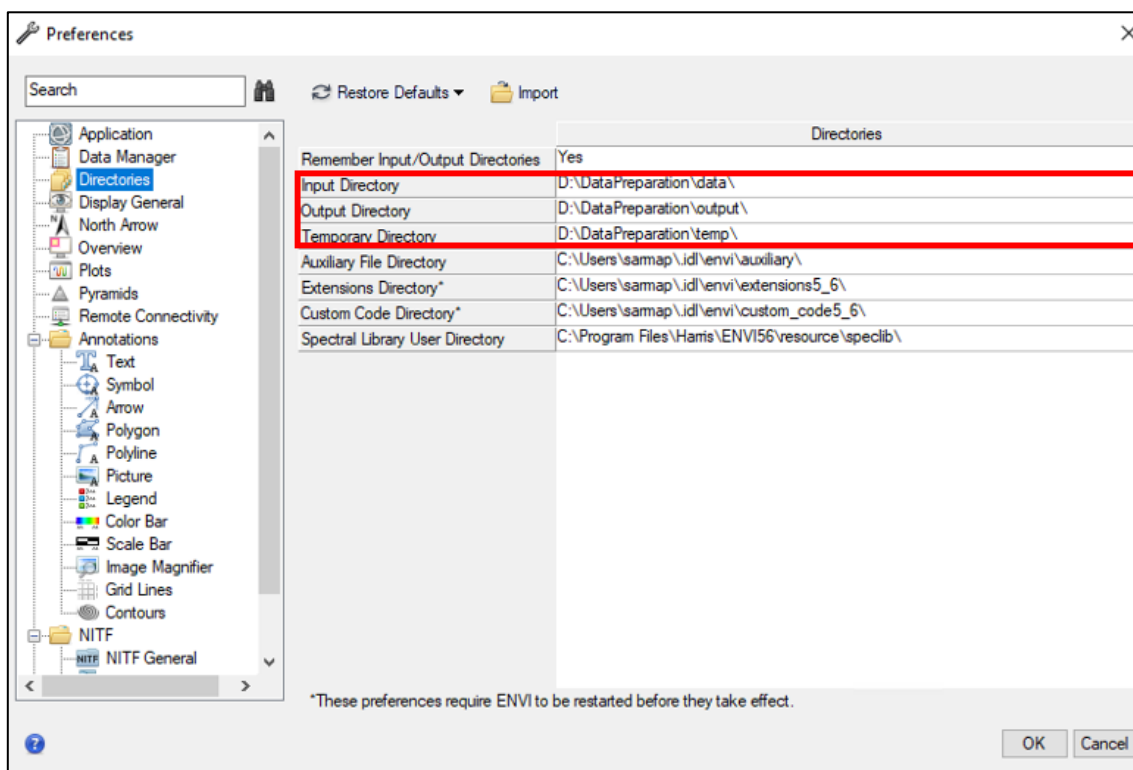


Figure 2 ENVI Preferences / Directories panel. Suggested Input/Output and temporary directories.

3. SARscape Preferences

The following steps show how to set both common and specific Preferences, how to change working directory, batch file name.

Click on the *Preference common* tool and select *Directories and batch file name* to set the **working directory** and **batch file name** in your local hard drive (Figure 3). It is strongly recommended to set integrated drives only as Input/Output or Temporary Directory, and to avoid the setting external drives. It is strongly recommended to do not choose USB or external drives as Input/Output or Temporary Directory, due to the large amount of data transfer.

On "*Directories and batch file name*" set a folder for Sentinel-1 orbit directory (Figure 3). **Note:** this folder requires at least 17 GB.

Click on the *Preference specific* tool and load the "*Sentinel TOPSAR (IW – EW)*" preferences. Please, make sure the Cartographic Grid Size is set to 15 m in the "*General parameters*" panel (Figure 4). This value is used to automatically estimate the correct multilooking factor.

Note: Setting the Quick Look Format to PNG to display geocoded results in Google Earth with transparent background.

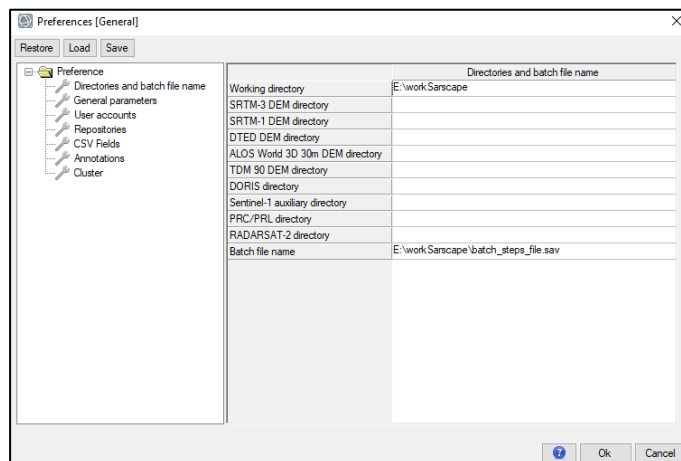


Figure 3: SARscape Preferences common panel.

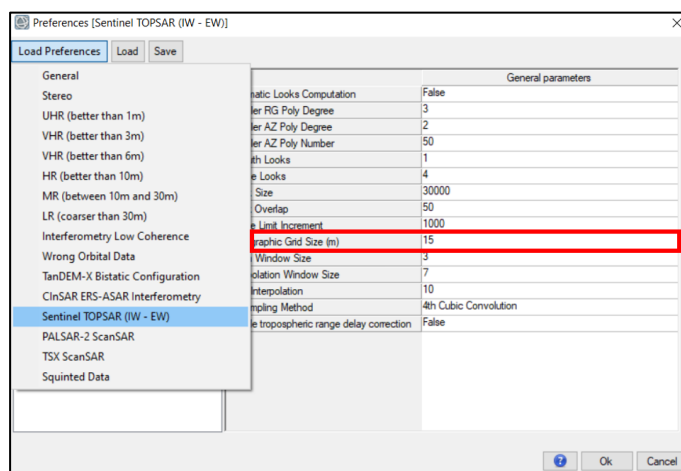


Figure 4: Preferences specific panel. "Load Preferences" button in the upper left part allows loading preferences set that can be chosen from a list. The Cartographic Grid Size set to 15 m. The user can modify and store (save button) his own set of preferences.

4. Processing

2.1. Sentinel Download

2.1.1. Sentinel-1 Multidownload

A query and download of Sentinel data from the Alaska SAR Facility - ASF- (<https://search.asf.alaska.edu>) and ESA scientific Hub (<https://scihub.copernicus.eu/dhus/>) must be performed using the Sentinel-1 Multidownload tool. The accounts with login credentials are required. The User accounts can be specified in the *Preferences Common* at the *User Accounts* session.

Please note you must obtain username and password by registering on the corresponding Sentinels Scientific Data Hub <https://scihub.copernicus.eu/dhus/> and/or Alaska SAR Facility - ASF - (<https://search.asf.alaska.edu>)

to download data. At least one account is mandatory for this step. A single image is around 4.5GB, the download depends on the connection speed.

- ✍ To start with the downloading, please open SARscape/Import Data/Sentinel MultiDownload in ENVI toolbox (Figure 5). The *Optional File* tab with the Geographical Region has to be specified including the AOI in shapefile format. A shapefile is provided with the Dataset tutorial.
- ✍ Fill the parameter tab as shown in Figure 6. If the credentials are available for just one provider, leave the unavailable corresponding credentials empty, or set to zero the corresponding concurrent downloads field.
- ✍ To keep track of the downloaded data the **Progress file name** must be set in the *Output Files*. The Progress file creates a list of needed files which fulfil the query created by the user using the provided parameters; checks if files reported in this list are already included in the Progress File (if provided).
- ✍ Store the downloaded data in the folder where the progress file has been set and unzip the downloaded compressed folder. We suggest setting the Unzip files to this directory to True, thus all the downloaded files will be unzipped in this directory. If this field is set to False, a manual unzipping procedure must be performed. It is suggested to use *Extract here* instead of *Extract in folder*, a long **path** is not recommended. The extracted files should be the following for an SLC product: *annotation* folder, *measurement* folder, *preview* folder, *support* folder, a **manifest.safe** file and a .pdf file. The Sentinel-1 import tool accepts as input file both the .zip folder and the manifest.safe file.
- ✍ Once the progress file name is set, click *Exec*. The window in Figure 7 should appear, it can be closed only once the download is completed. Please wait until the download is completed before continuing with the tutorial. During Sentinel-1 download, it is possible to use ENVI or SARscape.

Note: The AOI is provided with the dataset tutorial in shapefile format. SARscape also ingests kml files. However, if The Geographical Region is not available, SARscape allows to specify the coordinates of box (WEST, NORTH EAST, SOUTH) in the Parameters tab.

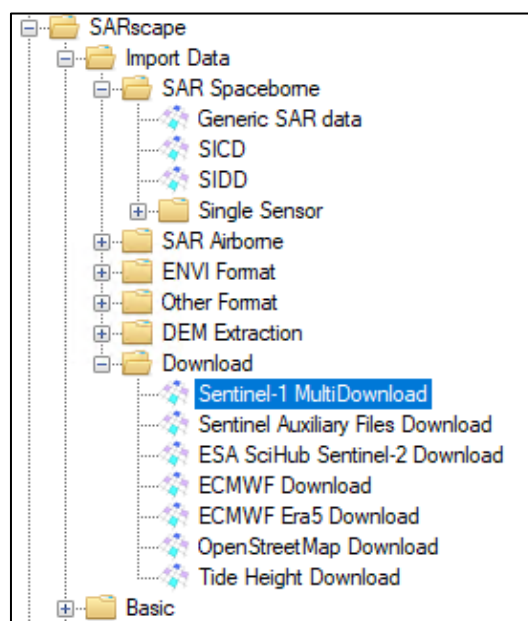


Figure 5 Sentinel MultiDownload Tool in ENVI toolbox.

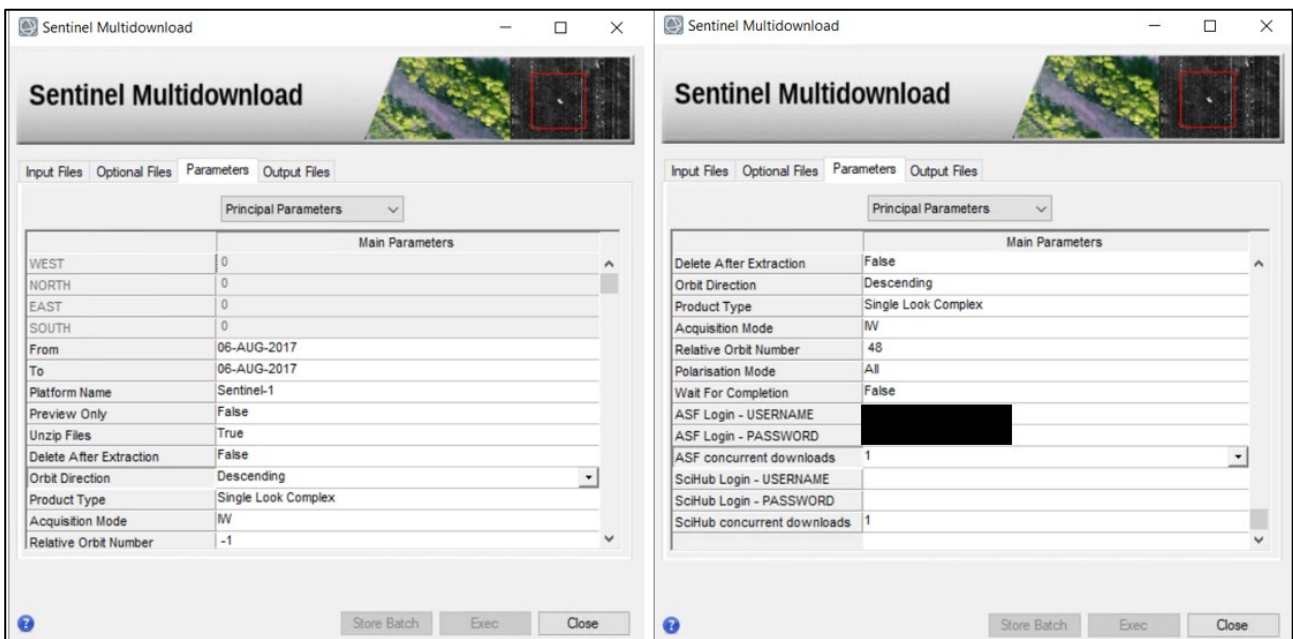


Figure 6 Principal Parameters for the download of one Sentinel IW SLC Data acquired over India on August 6th, 2017.

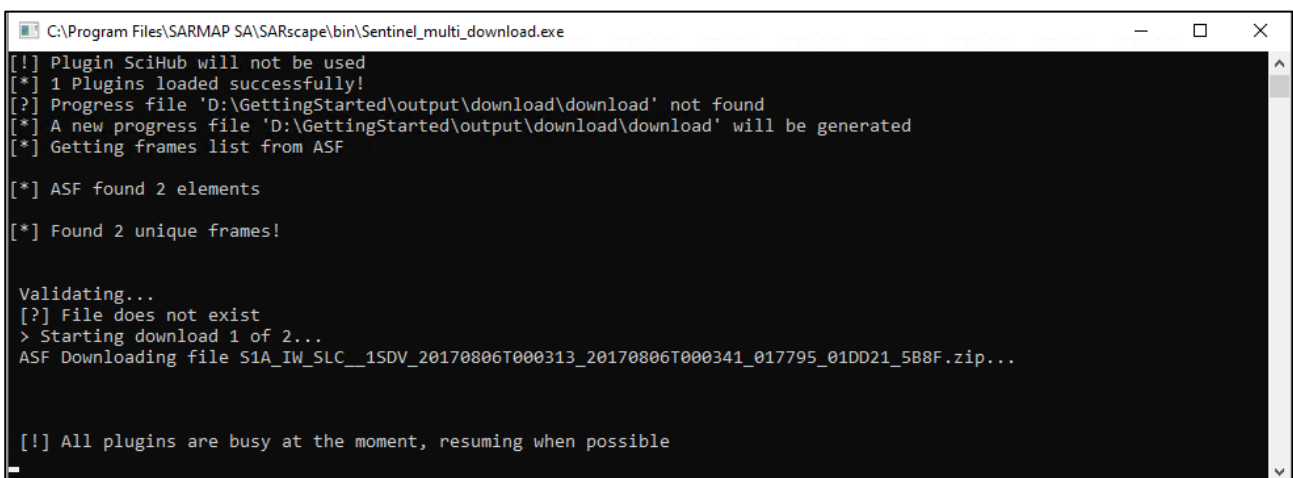


Figure 7 Download page for the files found by the Download Tool.

Progress File

Note: Never use the same Progress File for two concurrent downloads!

Note: Concurrent downloads: an account allows multiple downloads. Multiple different downloads can be launched with this tool, but it is imperative to use different progress files.

2.1.2. Sentinel Download auxiliary files

For **interferometry purposes** the presence of **precise orbit** is crucial.

SARscape automatically looks for the correct files located in the repository set in the common preferences (Sentinel-1 orbit directory, [Figure 8](#)). For this reason, before performing the Sentinel Download Auxiliary files tool, the proper orbit directory in the Preferences Common must be set.

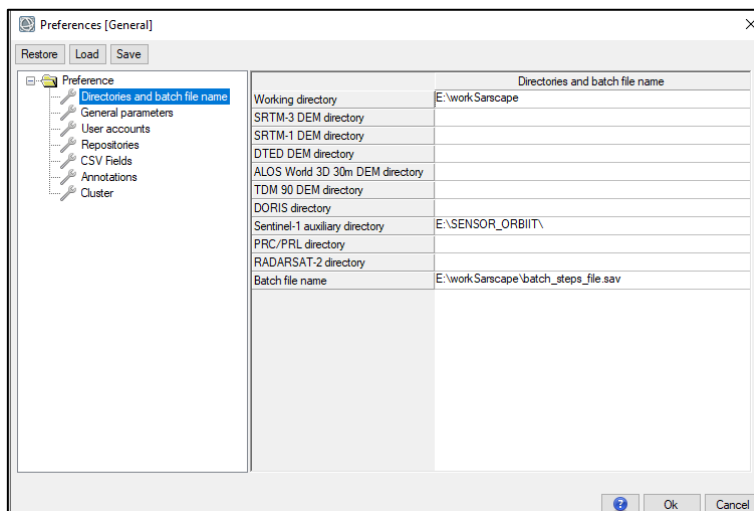


Figure 8 Sentinel-1 Directory settings in the Directories and batch file name menu of the Preferences Common.

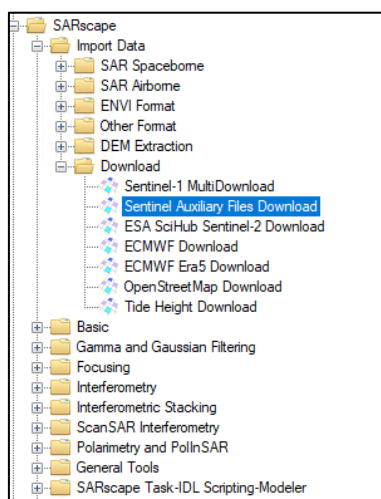


Figure 9 Sentinel Download Auxiliary files Tool in ENVI toolbox.

- ✍️ Open the Common Preferences tool, select the Directories and Batch File name, set the Sentinel-1 auxiliary directory as in [Figure 8](#).
- ✍️ Open the Sentinel Download auxiliary files, set the Download all the files parameter to *Full* and click *Exec*. A new window appears, and the download starts. During the download it is possible to continue using ENVI.

Tip: The downloaded orbit files can be kept for further processing with Sentinel-1 data. Just make sure to **update the repository** to cover the entire time span. A local/local network repository of the *Sentinel-1 Orbit Directory* and to update regularly using the *Sentinel Download Auxiliary Files* is suggested. **Please Note:** *Full* option must be set just the first time the tool is performed, the *Incremental* can be set once the repository is populated.

Note: If you are unable to download the files or you do not have internet access while you are performing this tutorial, please download the data in advance from our FTP site where you will find the acquisition used in this tutorial. Please contact us at support@sarmap.ch to get login credentials.

Note: If one or more orbit files required by the import step are missing, the Import tool perform a query for the missing files, store them in the working directory and delete them once they are imported.

2.2. Data Import

The purpose of the Data Import is to convert the data into **SARscape Data Format**. It is important to point out that it is mandatory to use **the SARscape *Import Data* tool to have the chance to process any data that was not created with SARscape.**

SARscape products consist of the following **data types**:

- **Binary *data*** (usually float, complex and byte) containing the data matrix (no extension is specified)
- Two ASCII header files containing ancillary information:
 - **.sml** file, containing all relevant information for the data processing.
 - **.hdr** file, corresponding to the ENVI header format. This enables the product compatibility within ENVI.

- ✍ As the previously downloaded data are SLC, open the Import Data/SAR Spaceborne/Generic SAR data.
- ✍ The unzipped files are in the folder defined in the Multidownload step. The .zip folder of the Sentinel-1 image has to be used as input in the *Input File List* as [Figure 10](#) (upper-left).
- ✍ Select the *AOI_Getting_Started.shp* file in the Optional Files tab to import and cut the bursts that covers the AOI ([Figure 10](#), upper-right). This reduces the import processing time and disk space needs.
- ✍ Leave the default parameters except for *the* Principal Parameters ([Figure 10](#), low-left). The power image is created. The *Rename the File Using Parameters* to True renames the output file name using the **sensor name**, the **track number**, the **date** and **time** of the acquisition, the geometry (Ascending/Descending) and the **polarization**. *Skip sample selection* has to set to False.
- ✍ On Output File List, click on the folder symbol to browse to the folder and change the output directory to a convenient one to store the imported data. It is strongly recommended to do not choose USB or external drives as Input/Output or Temporary Directory, due to the large amount of data transfer.
- ✍ Click Exec and wait the *End message*. Once the import is completed, in the output folder two **folders** (one for each polarization) **containing the bursts** are created. Outside the folders two **_slc_list file** are found (one for each polarization, each one with the associated .hdr and .sml files) containing information on the imported bursts.

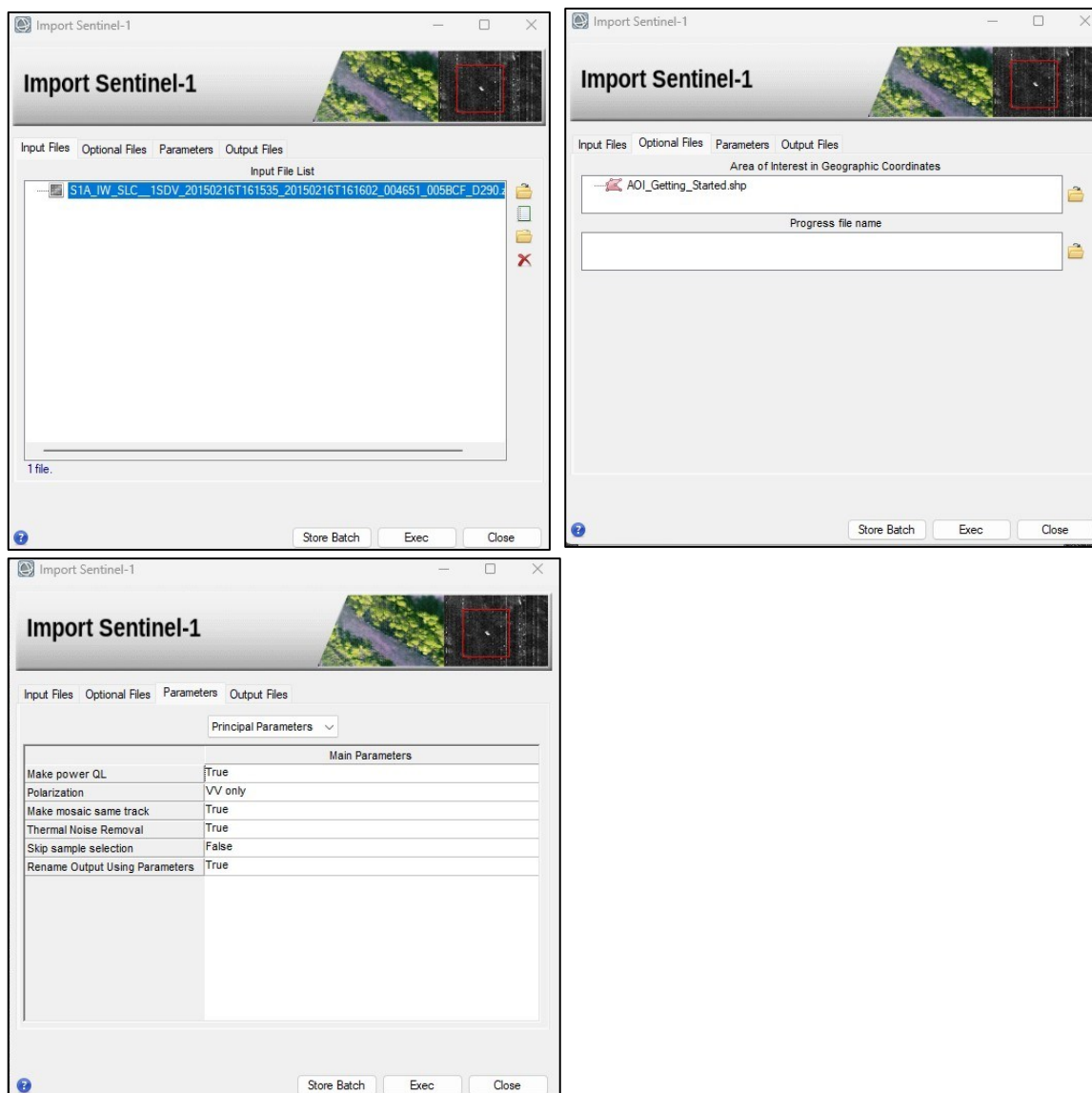


Figure 10: Import Sentinel-1 panel showing the Input Files tab. The .zip folder file is used as Input File for Sentinel Data whereas the Orbit Files are optional and not required in this example.

Sentinel-1 Tips

- Tip:** If consecutive frames acquired along the same track must be imported at the same time, please use the *Select File list...* option which requires a txt file. The text file can be created searching all the .zip folder in the directory containing all the SAR images, using *Copy as path* (shift+right click on the selected files) to copy the files in the .txt file. This avoids to manually insert each acquisition. Moreover, set the *Make Mosaic Same Track* to True to automatically mosaics these data.
- Tip:** If the AOI is not included in the Optional File tab all the bursts are imported. **The Sample selection paragraph provides more information on sampling data.**
- Tip:** The Import Data/SAR Spaceborne/Single Sensor/SENTINEL-1 specific tool allows simultaneously the import and cut step if the AOI is specified in the Optional File tab and the *Skip sample selection* must set to False in the Principal Parameters. The importing and cutting processes are available

only for Import Data/SAR Spaceborne/Generic SAR data and Import Data/SAR Spaceborne/Single Sensor/SENTINEL-1.

Tip: For **interferometric stacking processing**, importing only **co-polarized data** is suggested, as these are more suitable for interferometry. *Co-polarization only* option can be selected in the *Parameters* tab. With this option activate, the import time is halved.

Once the import processing is completed, the files in [Figure 11](#) are created in the selected output folder for each polarization.

Note: The **structure** of the imported file must be kept when moving the files. In particular, the **_slc_list (together with all ancillary files) must be in the same directory as the split_bursts folder** ([Figure 11](#)). In case of sensors other than Sentinel IW SLC, Palsar 2, ScanSAR and TSX ScanSAR, no subfolders are created. The _slc files and the associated .sml and .hdr files are created in the selected output directory.

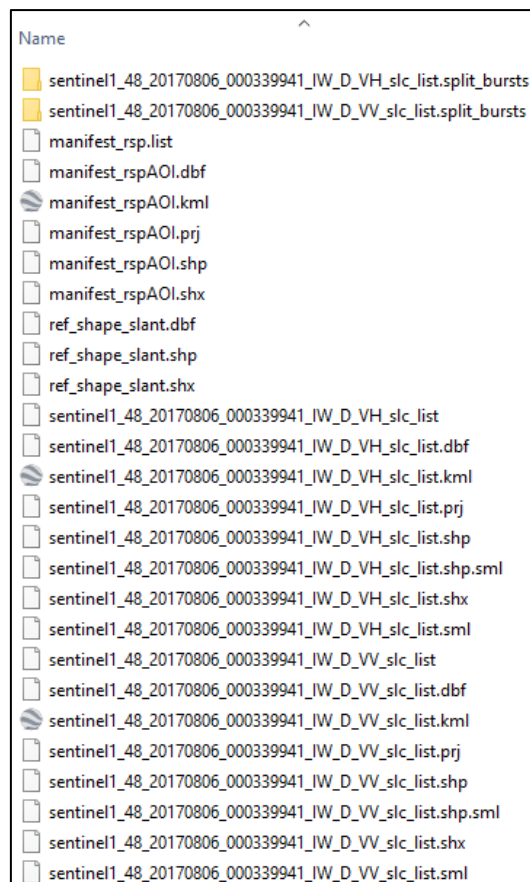


Figure 11 Imported files for both polarizations.

2.3. DEM Extraction

An accurate reference Digital Elevation Model (DEM), containing heights above a **reference ellipsoid**, improves the quality of several processing steps, such as geocoding, co-registration and interferometric phase flattening.

Currently, the DEMs that can be automatically downloaded from the Internet are the **SRTM3v4, TDM 90 and ALOS World 3D 30 m**. Other DEMs must be manually downloaded creating a local repository and the proper repository linked in the SARscape Preferences common. If the web server is online and no firewall blocks the internet connection, SARscape allows the user to automatically download and mosaic the tiles covering the area of interest.

- ✎ Open the DEM Extraction – SRTM3 Version 4 panel in SARscape/General Tools/DEM Extraction/SRTM-3 Version 4 and insert the previously imported `_slc_list` file in the *OPTIONAL Reference SR image* list in the *Input Files* Tab. It is possible to use both polarizations. Select the GEO-GLOBAL cartographic system as shows Figure 12 (left). Leave all the parameters as default and set the path of the output DEM file, the `SrtmV4_dem` is used as filename by default (Figure 12, right).
- ✎ Click *Exec*. Depending on your connection speed, the download can take up to several minutes. At the end of the processing the DEM is loaded in ENVI view (Figure 13).

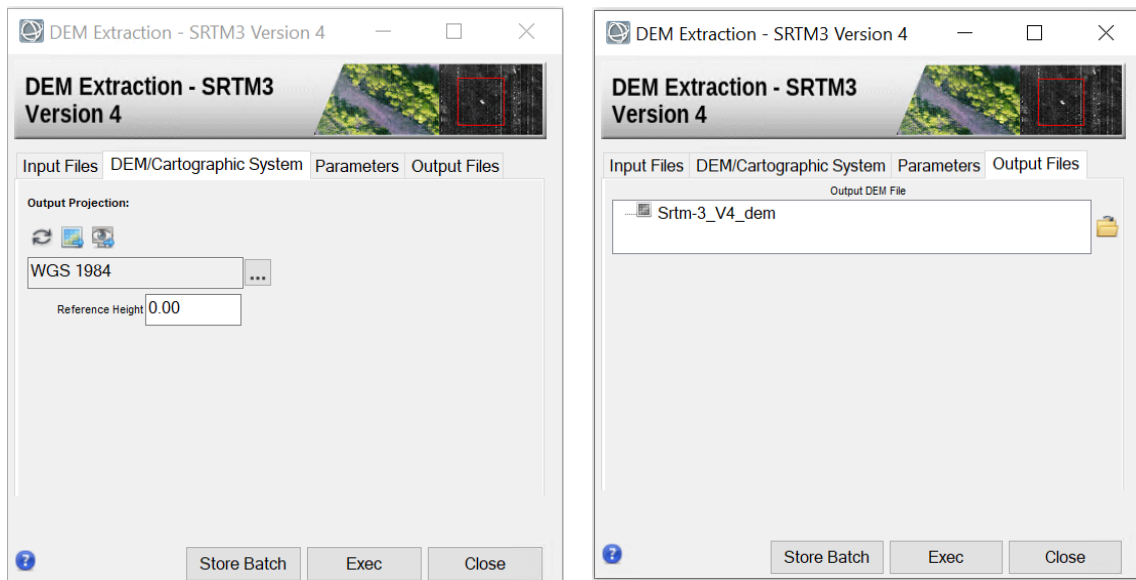


Figure 12 Input Files and DEM/Cartographic System tab in the DEM Extraction panel. Please select GEO-GLOBAL Output Files tab in the DEM Extraction panel (left). `SrtmV4_dem` as Output DEM File (right).

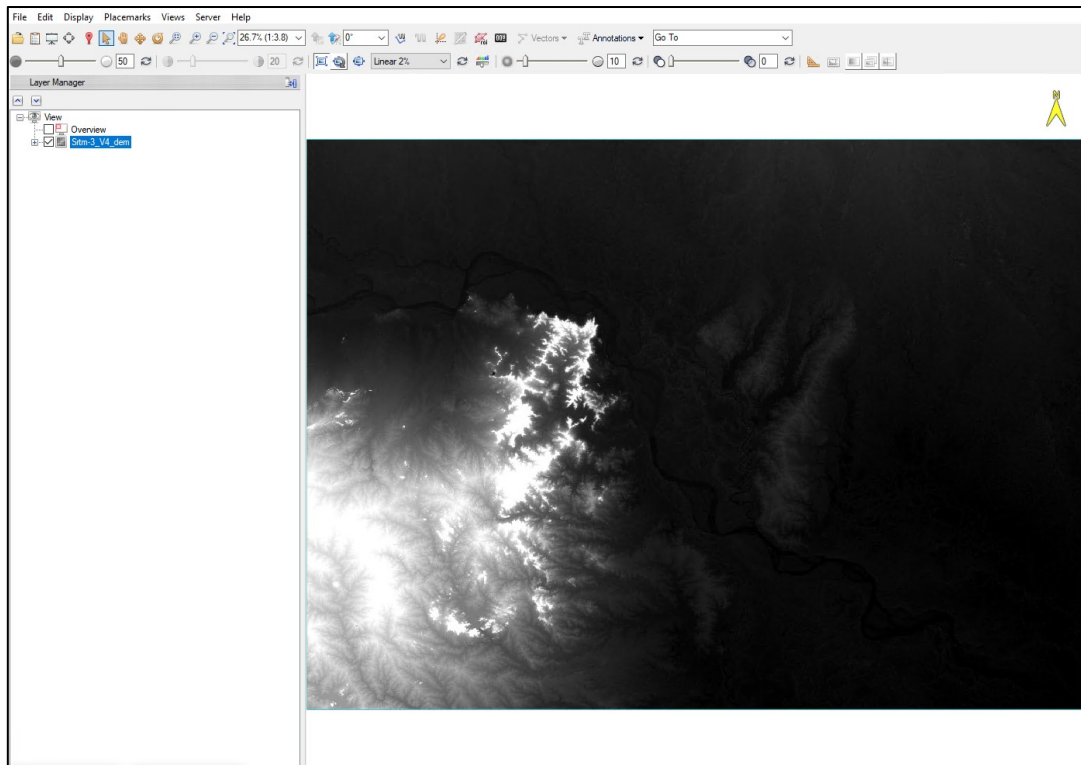


Figure 13 Downloaded SRTM DEM at the end of the DEM extraction process in ENVI view.

Note:

Tip: Download a **common reference DEM that covers all geometries and all sensors** to be used in the processing. The tool automatically downloads a DEM with an extension covering all input reference images.

Tip: If a **local repository of SRTM DEM** is available, the path can be set in the **SARscape Preferences common** as previously described. The software automatically looks first for data presence in this directory, if not included, it tries to download them via FTP.

If available, the user can import their own DEM. SARscape supports:

- TIFF format: Import Data/Generic Format/Tiff
- ENVI Format, Import Data/ENVI Format/Original ENVI Format (importing the DEM into ENVI first and saving it in ENVI format)
- Original SARscape Format: Import Data/ENVI Format/Original SARscape Format
- Generic Binary format: Import Data/Generic Format/Generic Binary/Binary Format.

Note: SRTM DEM is available only on land and between 60°N and 56°S of latitude and heights are above the EGM96 geoid. By default, the geoid component is subtracted during the DEM extraction, resulting in heights above the reference WGS-84 ellipsoid. **Users must consider that the DEM has to be referred to a reference ellipsoid.** For this reason, the geoid component must be subtracted, the specific tool General Tools/Cartographic Transformation/Geoid Component.

2.4. Sample Selection

The Import step performed through the Import Data/SAR Spaceborne/Generic SAR data automatically samples the data if an AOI is included in the Optional Files. This option is also valid for importing data using Import Data/SAR Spaceborne/Single Sensor/SENTINEL-1 tool. If the AOI is not included and the *Skip sample selection* is set to True, the full frame is imported. However, all the SARscape available Import tools for single sensors do not have the opportunity to automatically sample the data. For this reason, the Sample Selection is described below.

The Sample Selection allows creating a subset of an image (or a stack of images) to **reduce the image extent** based on an area of interest and consequentially to reduce the file size and processing time.

The interested region can be selected by:

- giving coordinates (geographic or SAR),
- selecting a .kml or .kmz file (Google Earth or Map format)
- selecting a Shapefile.

Depending on the source file types, two Sample Selection tools are available in SARscape General Tools:

- **Sample Selection SAR Geometry Data** This tool must be used if the selection has to be performed on data in **SAR geometry** (**_slc**, **_slc_list**, **_pwr**, **_gr**)
- **Sample Selection Geographic Data:** This tool must be used if the selection is to be performed on **geocoded data** (**_dem**, **_disp**, **_geo**, ...).

This processing considers the Sample Selection SAR Geometry Data.

The Import step is performed once again using Import Data/SAR Spaceborne/Single Sensor/SENTINEL-1 tool.

- ✎ Open the Import Data/SAR Spaceborne/Single Sensor/SENTINEL-1 tool.
- ✎ The unzipped downloaded files are in the folder defined in the Multidownload step. The .zip folder file must be used as input in the *Input File List*.
- ✎ Select *Make Power QL* to True. The power image is automatically created allowing to skip the Mooltilooking chapter.
- ✎ On Output File List, click on the folder symbol to browse to the folder and change the output directory to a convenient one to store the imported data (a directory different from the one used in the Generic SAR data import is suggested).
- ✎ Click Exec and wait the *End message*. Once the Import is completed, in the output folder two **folders** (one for each polarization) **containing the bursts** are created. Outside the folders you will find two **_slc_list file** (one for each polarization, each one with the associated .hdr and .sml files) containing information on the imported bursts.
- ✎ Open the *sentinel1_48_20170806_000338998_IW_D_VH_slc_pwr* image created in the Import step in the ENVI View.
- ✎ In the ENVI menu click on File > New > Vector Layer and give a name to the new vector layer and click OK. At this point it is possible to draw a shapefile; it is suggested to use the same region as the

one shown in this example, [Figure 14](#)). Right click and *Accept* to complete the editing. Right click on the shapefile in the layer manager and click on *Save As...* ([Figure 15](#)). If the shape is not perfectly rectangular, use the *Use Min and Max coordinates* flag in the Parameters to extend the area of interest ([Figure 16](#), left).

- ✎ Once the shapefile has been correctly created, open the *SARscape/General Tools/Sample Selections/Sample Selection SAR Geometry Data*. Fill in the *Input File List* field with the two *_pwr* images (one for each polarization).
- ✎ In the *Parameters* Tab, make sure that *Geographical Region* is set to False (as the shape was generated in slant geometry), the *Use Min and Max coordinates* flag was already set to True. The sample selection uses a perfect rectangular shape that exploits the minimum and maximum coordinates of the previously draw shapefile. Set the *Output file list*. **Note:** the suffix "*_cut*" is automatically added before the last extension name.
- ✎ Click *Exec*. Once the processing has ended, the two input files are shown in ENVI view ([Figure 17](#)).

Note: The DEM is mandatory in the *Optional Files* Tab if the Shapefile is created in geographic coordinates in order to avoid geolocation errors.

Note: If users want to perform a sample selection on a stack of data using a shapefile in SAR geometry, the shapefile must be referred to the first image of the sampling stack. Moreover, in the Sample Selection SAR Geometry, the *Principal Parameters Make Coregistration* must be set to True.

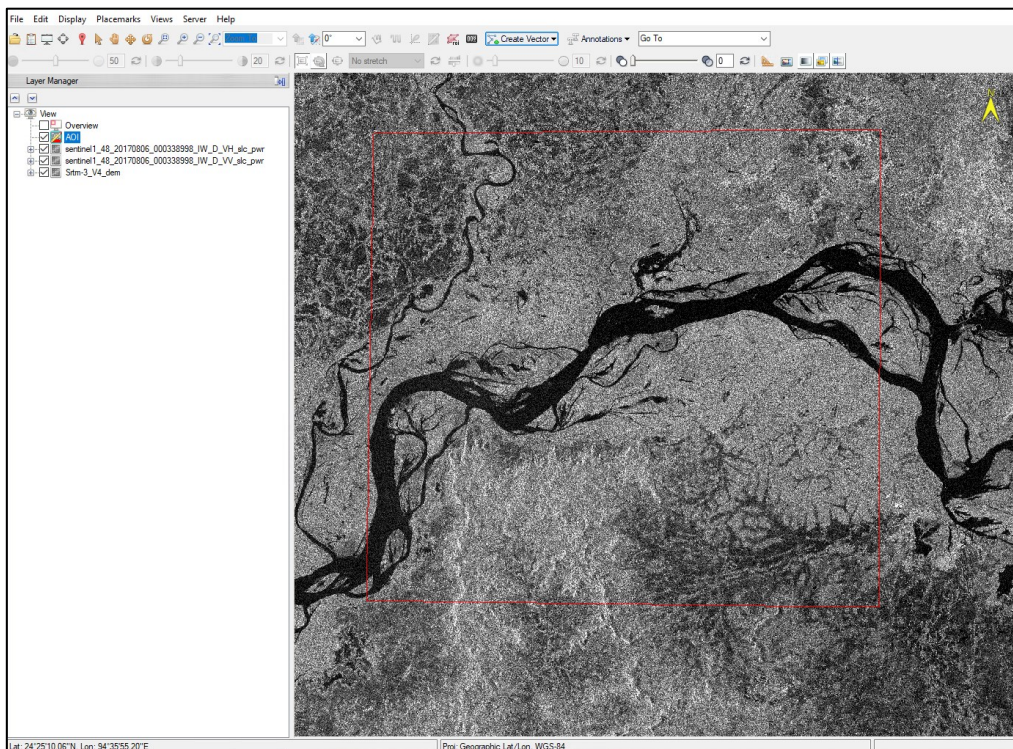


Figure 14 Polygon draw on *sentinel1_48_20170806_000338998_IW_D_VH_slc_pwr* image.

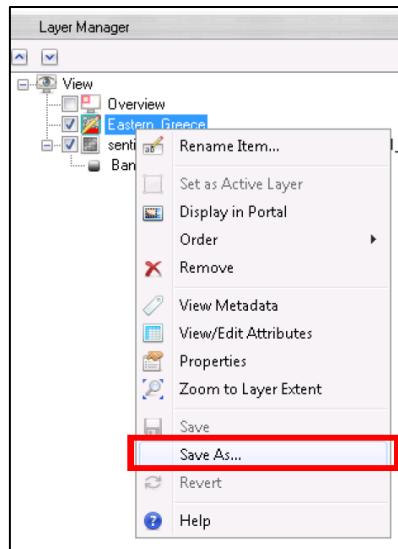


Figure 15 Right click on the Shapefile in ENVI Layer manager to save it to a convenient folder.

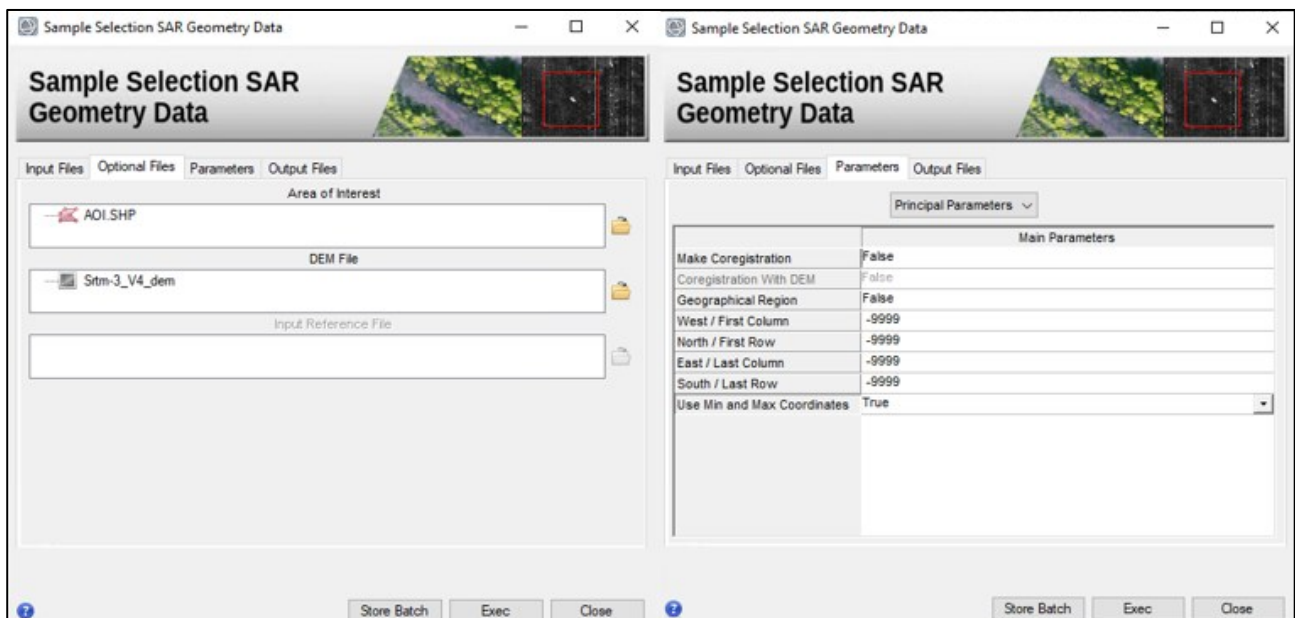


Figure 16 Area of Interest and DEM file in the Optional Files tab of Sample Selection panel (left); Parameters tab of the Sample Selection Tool (right).

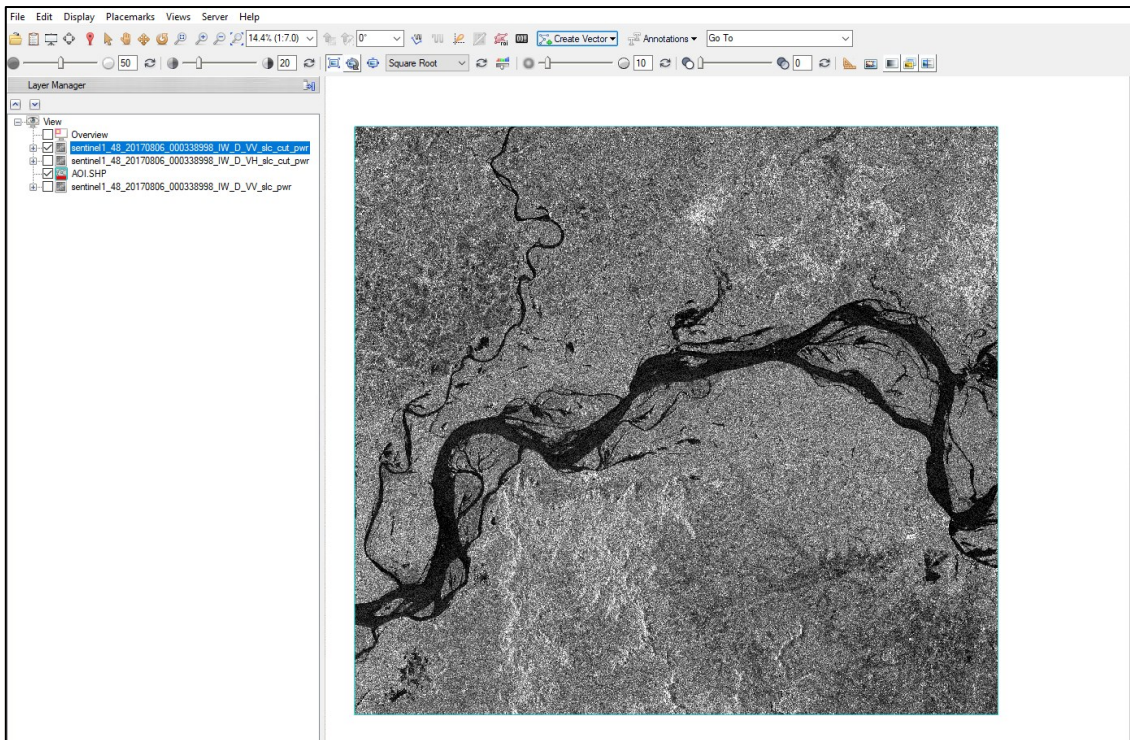


Figure 17 Sampled area opened in ENVI view after the Sample Selection.

The output image only contains the area of interest. The size is smaller in coverage and the disk size is reduced if compared to the full frame, the subsequent processing time is reduced as well.

5. Batch Processing

Each performed step can be store in batch mode by clicking the *Store Batch* button in the corresponding processing panel. Batch processing allows performing several checks and editing actions in the previously stored processing sequence.

The processing chain and corresponding format input described in the exercise above is shown (

Figure 18).

Once each step is stored and saved in the batch file as shown in the Preferences session, open the Batch Browser (Figure 20).

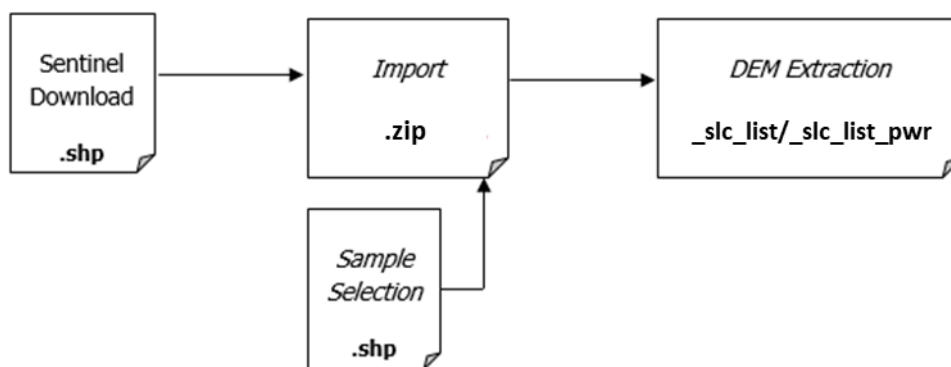


Figure 18 Workflow of the processing chain.

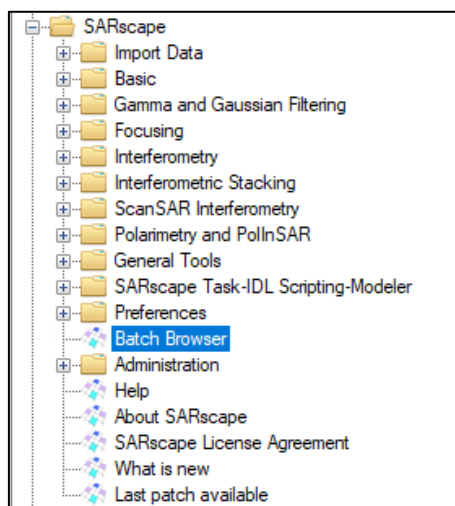


Figure 19 Batch Browser in Toolbox.

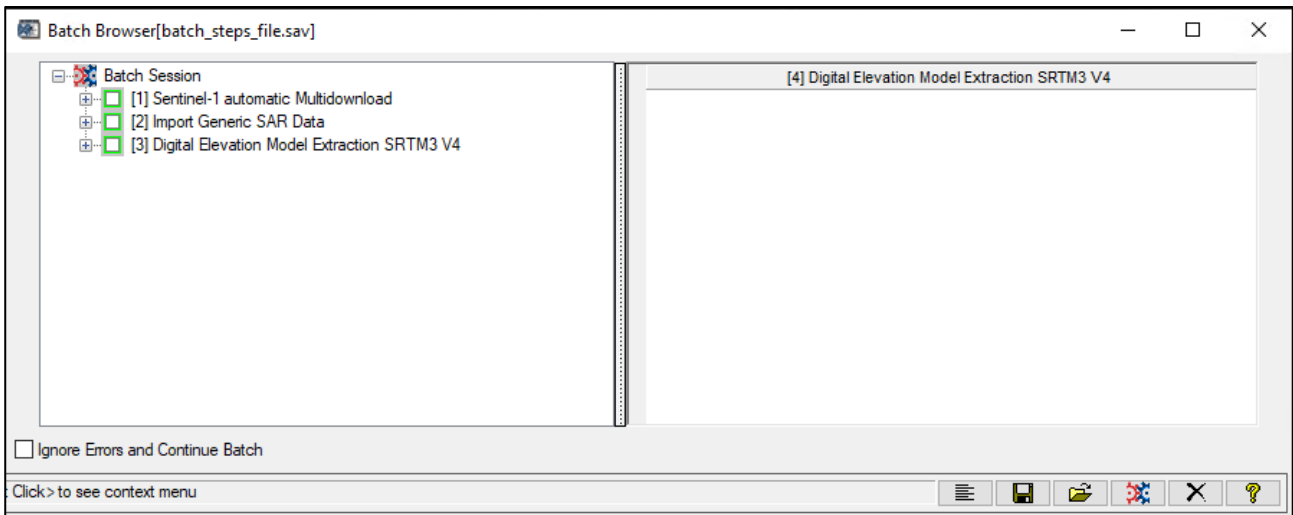


Figure 20 Batch Browser Window showing the steps performed in the tutorial. **Note:** in this example, the "Ignore Errors and Continue Batch" check is unchecked. Each process is dependent of the previous one, so in this case it makes no sense to continue the batch in case of errors.