QGIS Semiautomatic Classification

Download and install QGIS

Open terminal window or command line prompt

- Type pip3 install matplotlib
- After you install the matplotlib module in python then
  - Type pip3 install scipy

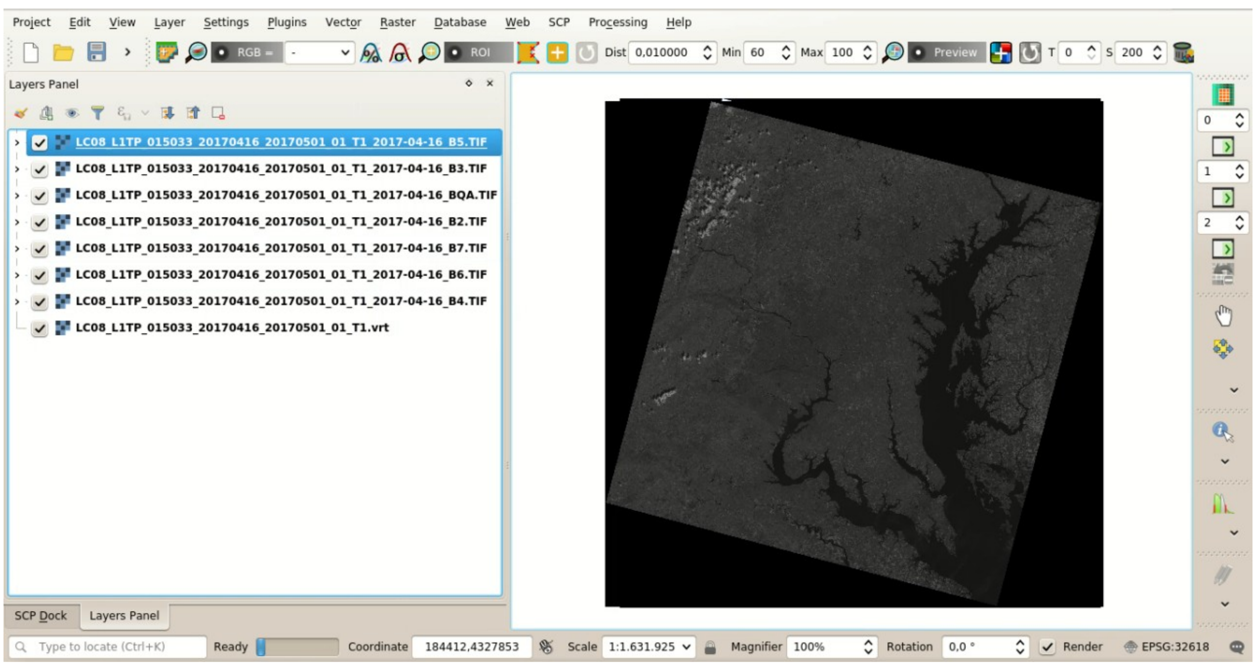
Open QGIS (see if the plugin loads)

Download the sample data:
https://docs.google.com/uc?id=18CXceeQrjxQoM5Z80kvlvdTI4SmVBDZn
http://bit.ly/2WWDA5A

https://fromgistors.blogspot.com/2018/02/basic-tutorial-1.html

For the purpose of this tutorial, uncheck the option Preprocess images (you should usually leave this checked) because we are going to preprocess the image in Convert Data to Surface Reflectance. To start the image download, click the button RUN and select a directory where bands are saved. The download could last a few minutes according to your internet connection speed. The download progress is displayed in a bar.

TIP : The option Only if preview in Layers allows for downloading only images in the result table which are loaded as previews in the map. If this option is unchecked, all the products in the list are downloaded.
After the download, all the bands are automatically loaded in the map.

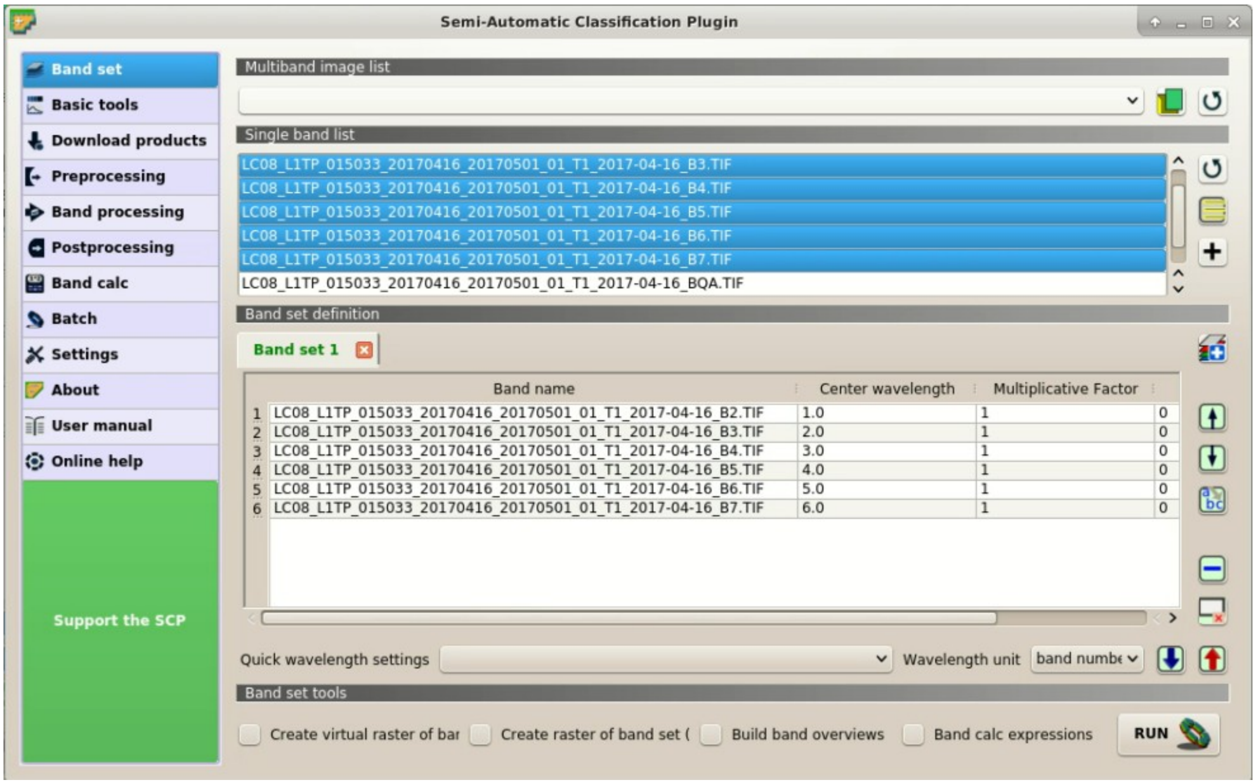


Download of Landsat bands

2. Clip the Data

For for limiting the study area (and reducing the processing time) we can clip the image.First, we need to define a Band set containing the bands to be clipped. Open the tab Band set clicking the button in the SCP menu or the SCP dock.

Click the button to refresh the layer list, and select the bands: 2, 3, 4, 5, 6, and 7; then click to add selected rasters to the Band set 1.

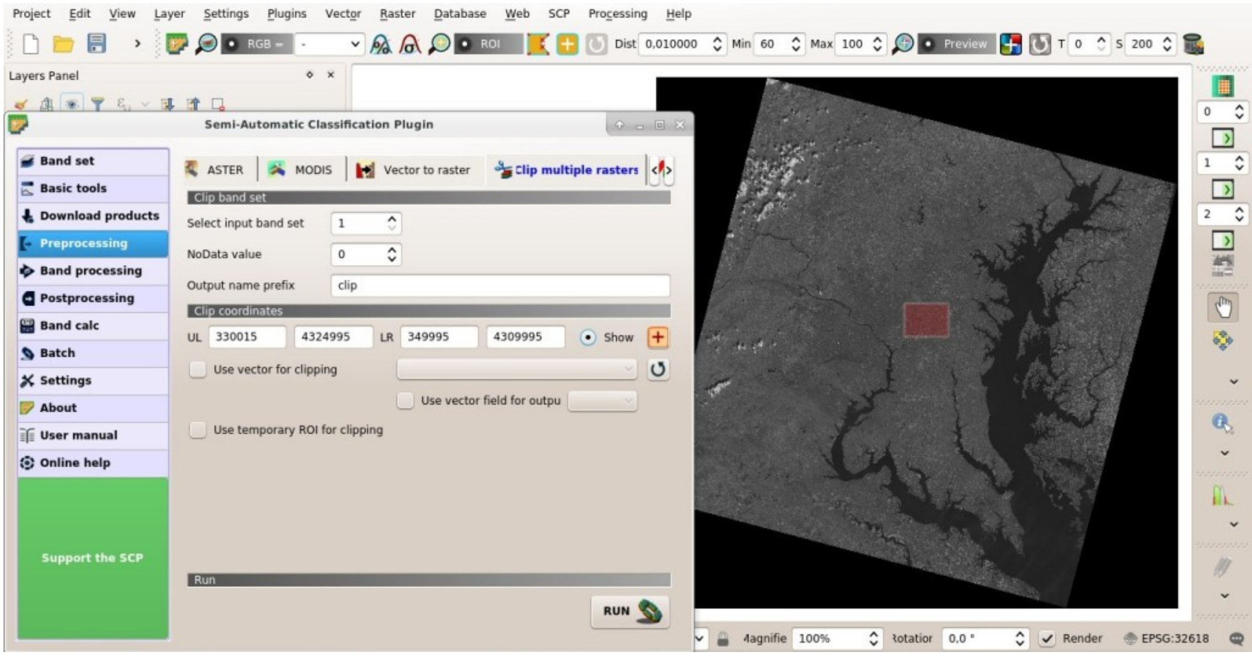


Band set for clipping

In Preprocessing open the tab Clip multiple rasters. We are going to clip the Band set 1 which contains Landsat bands.

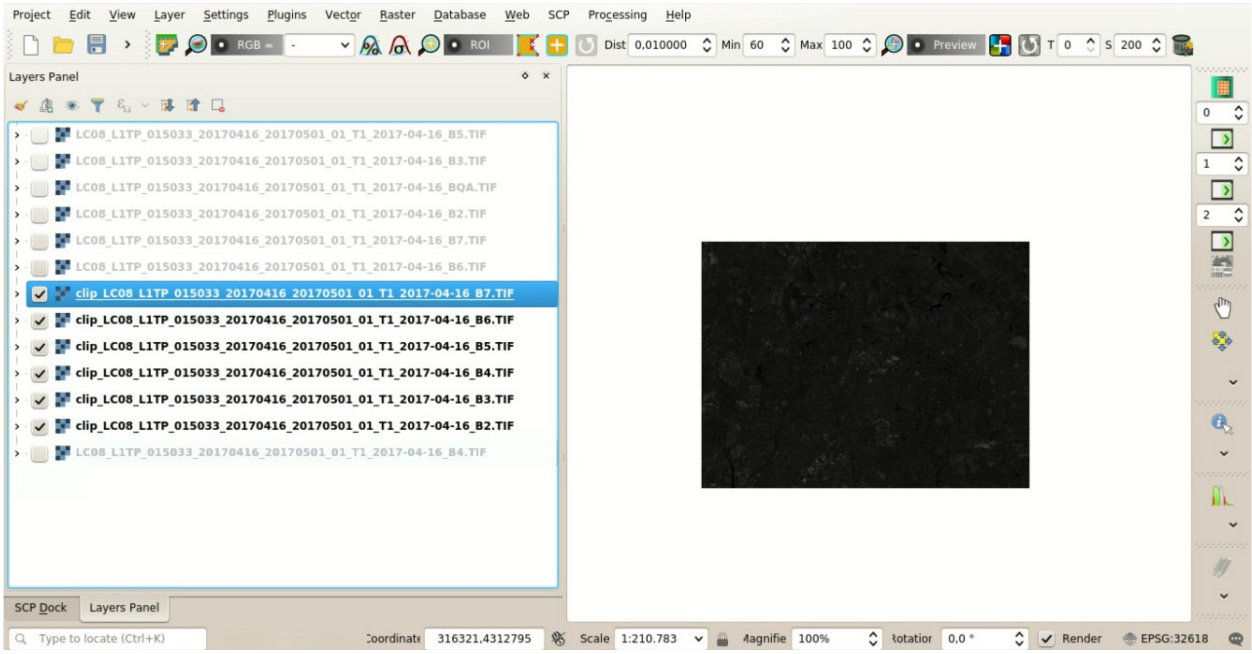
Click the button and select an area such as the following image (left click in the map for the UL point and right click in the map for the LR point), or enter the following values:

- UL: 330015 / 4324995
- LR: 349995 / 4309995



Clip area

Click the button RUN  and select a directory where clipped bands are saved. New files will be created with the file name prefix defined in Output name prefix. When the process is completed, clipped rasters are loaded and displayed.



Clipped bands

3. Convert Data to Surface Reflectance

Conversion to reflectance (see) can be performed automatically. The metadata file (a .txt file whose name contains MTL) downloaded with the images contains the required information for the conversion. Read for information about the and .

In order to convert bands to reflectance, open the Preprocessing clicking the button in the SCP menu or the SCP dock, and select the tab Landsat.

Click the button Directory containing Landsat bands and select the directory of clipped Landsat bands. The list of bands is automatically loaded in the table Metadata.

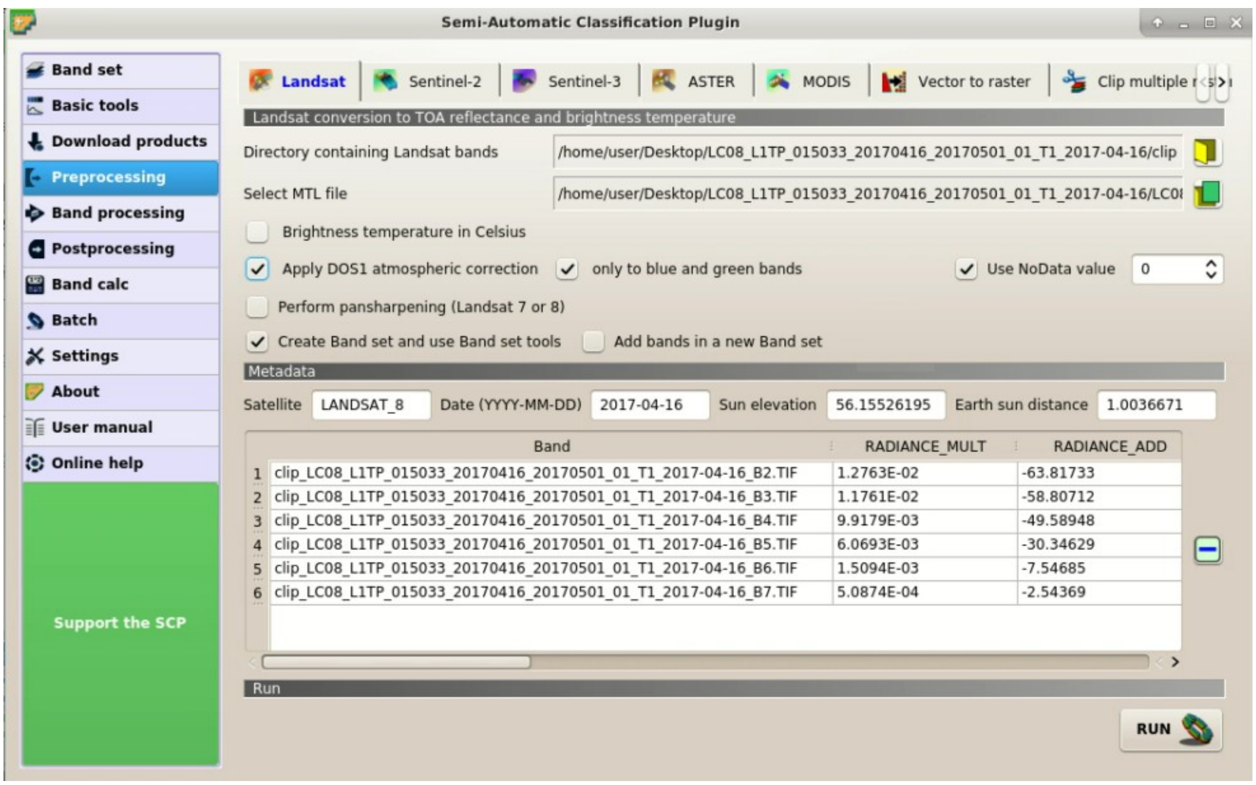
Click the button Select MTL file and select the metadata file `LC08_L1TP_015033_20170416_20170501_01_T1_MTL.txt` from the directory of downloaded Landsat images. Metadata information is added to the table Metadata.
In order to calculate Surface Reflectance we are going to apply the DOS1

Correction; therefore, enable the option  Apply DOS1 atmospheric correction.

TIP : In general, it is recommended to perform the DOS1 atmospheric correction for the entire image (before clipping the image) in order to improve the calculation of parameters based on the image.

For the purpose of this tutorial, uncheck the option  Create Band set and use Band set tools because we are going to define this in the following step Define the Band set and create the Training Input File.

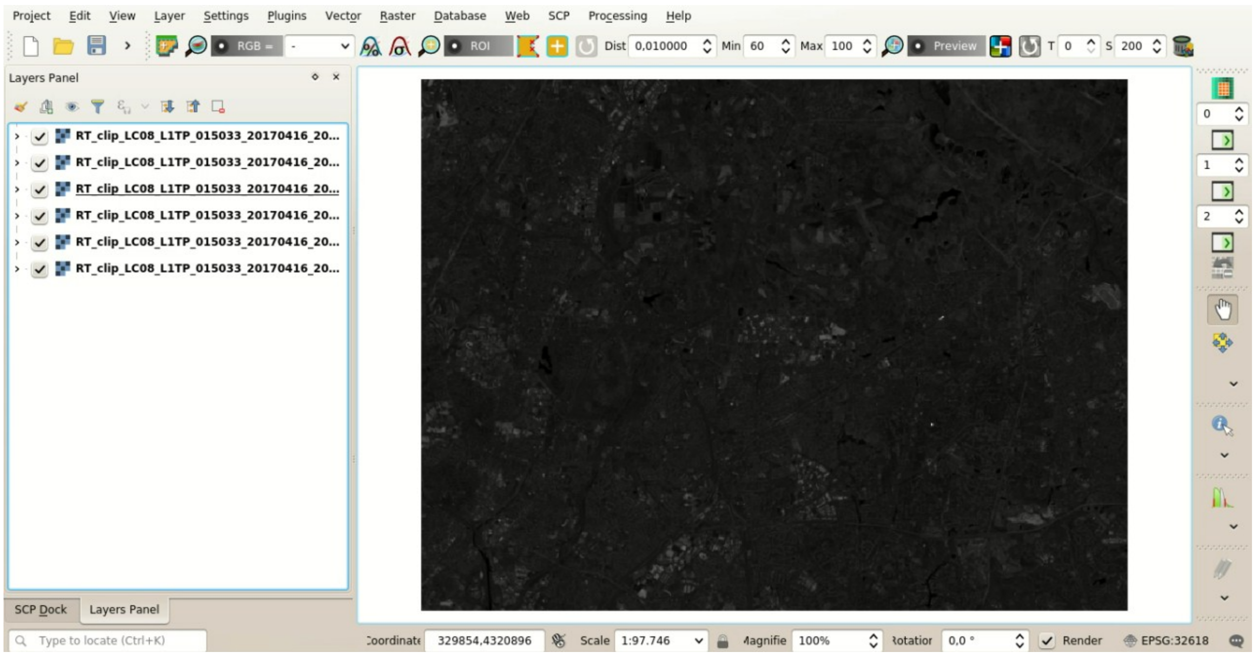
In order to start the conversion process, click the button RUN  and select the directory where converted bands are saved.



Landsat 8 conversion to reflectance

After a few minutes, converted bands are loaded and displayed (file name beginning with `RT_`). If  Play sound when finished is checked

in Classification process settings, a sound is played when the process is finished.
We can remove all the bands loaded in QGIS layers except the ones whose name begin with `RT_`.



Converted Landsat 8 bands

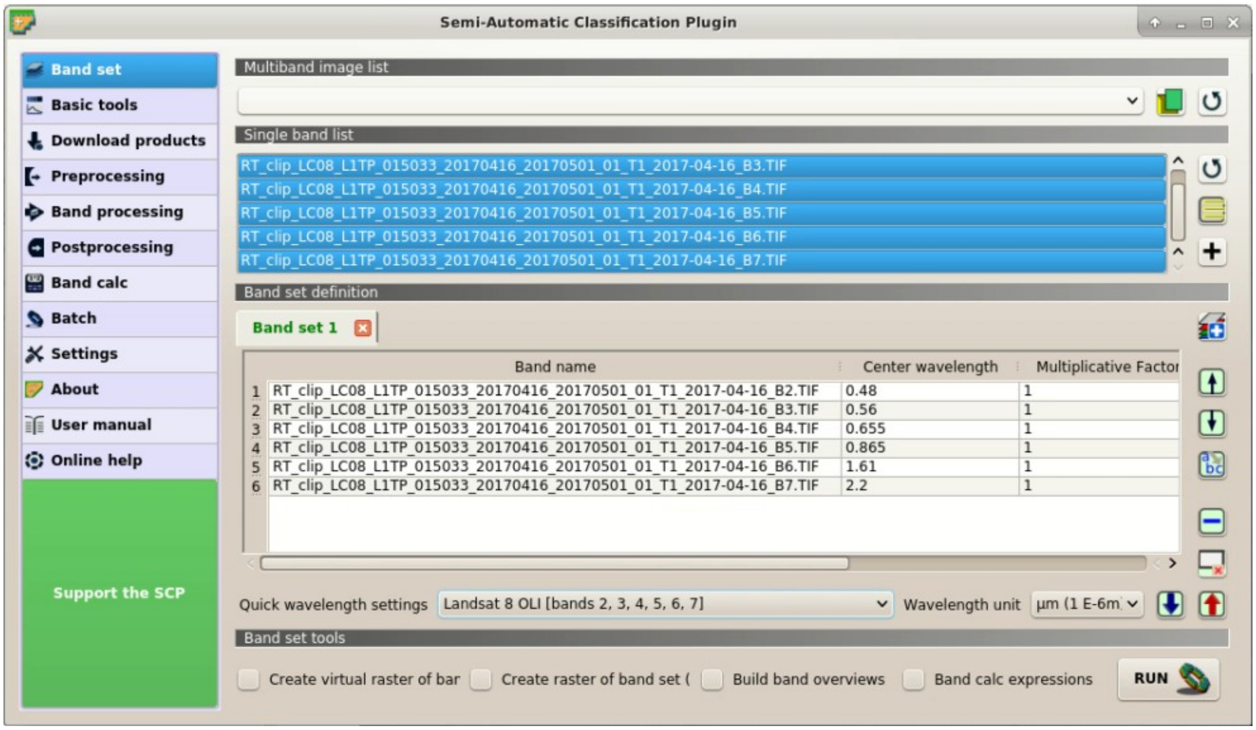
4. Define the Band set and create the Training Input File

Now we need to define the Band set which is the input image for SCP. Open the tab Band set clicking the button in the SCP menu or the SCP dock.

In Band set definition click the button to clear all the bands from active band set created during the previous steps.

Click the button to refresh the layer list, and select all the converted bands; then click to add selected rasters to the Band set.
In the table Band set definition order the band names in ascending order (click to sort bands by name automatically). Finally, select Landsat 8 OLI from the list Quick wavelength settings, in order to set automatically

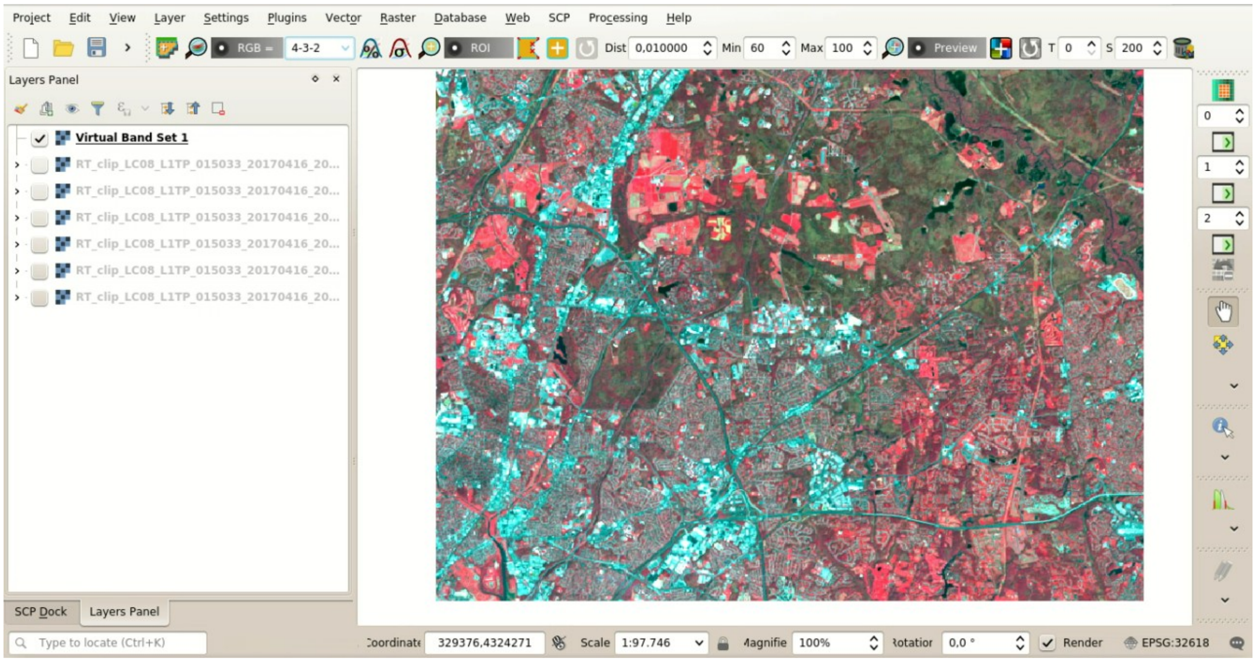
the Center wavelength of each band and the Wavelength unit (required for spectral signature calculation).



Definition of a band set

We can display a Color Composite of bands: Near-Infrared, Red, and Green: in the Working toolbar, click the list RGB= and select the item `4-3-2` (corresponding to the band numbers in Band set). You can see that image colors in the map change according to the selected bands, and vegetation is highlighted in red (if the item `3-2-1` was selected, natural colors would be displayed).

TIP : If a Band set is defined, a temporary virtual raster (named `Virtual Band Set 1`) is created automatically, which allows for the display of Color Composite. In order to speed up the visualization, you can show only the virtual raster and hide all the layers in the QGIS Layers.



Color composite RGB=4-3-2

Now we need to create the Training input in order to collect Training Areas (ROIs) and calculate the Spectral Signature thereof (which are used in classification).

In the SCP dock select the tab Training input and click the button  to create the Training input (define a name such as `training.scp`). The path of the file is displayed and a vector is added to QGIS layers with the same name as the Training input (in order to prevent data loss, you should not edit this layer using QGIS functions).

Definition of Training input in SCP

5. Create the ROIs

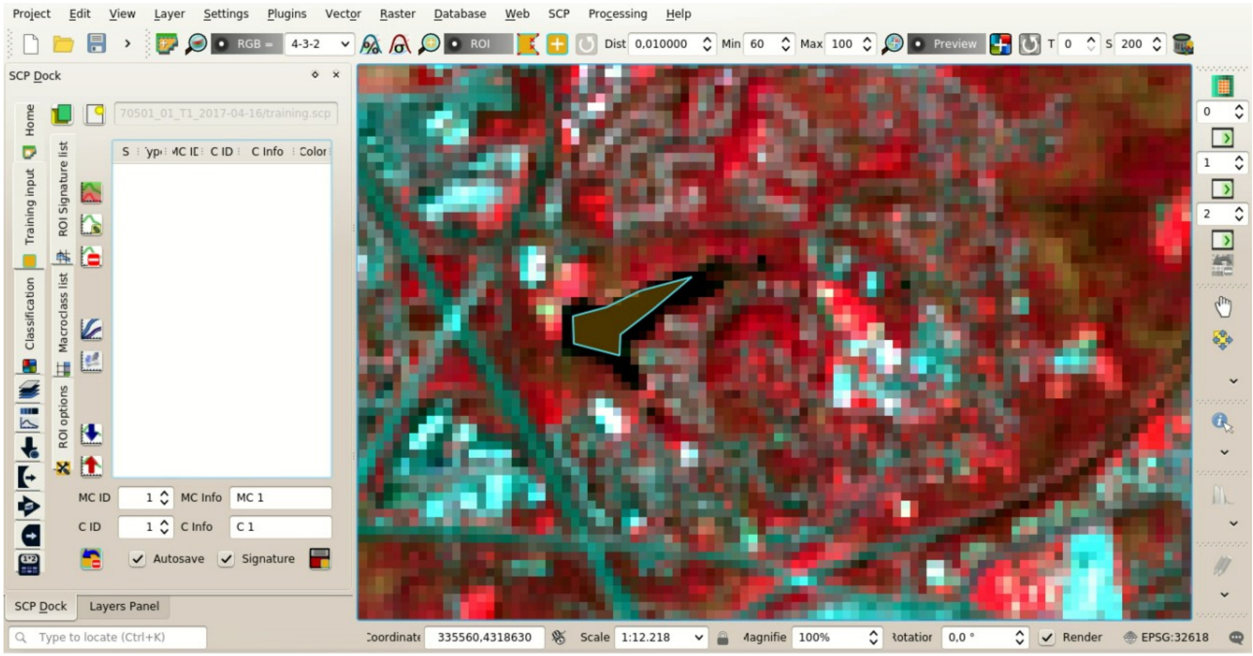
We are going to create ROIs defining the Classes and Macroclasses. Each ROI is identified by a Class ID (i.e. C ID), and each ROI is assigned to a land cover class through a Macroclass ID (i.e. MC ID).
Macroclasses are composed of several materials having different spectral signatures; in order to achieve good classification results we should separate spectral signatures of different materials, even if belonging to the same macroclass. Thus, we are going to create several ROIs for each macroclass (setting the same MC ID, but assigning a different C ID to every ROI).
We are going to used the Macroclass IDs defined in the following table.

Macroclasses

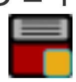
Macroclass name	**Macroclass ID**
Water	1
Built-up	2
Vegetation	3
Bare soil (low vegetation)	4

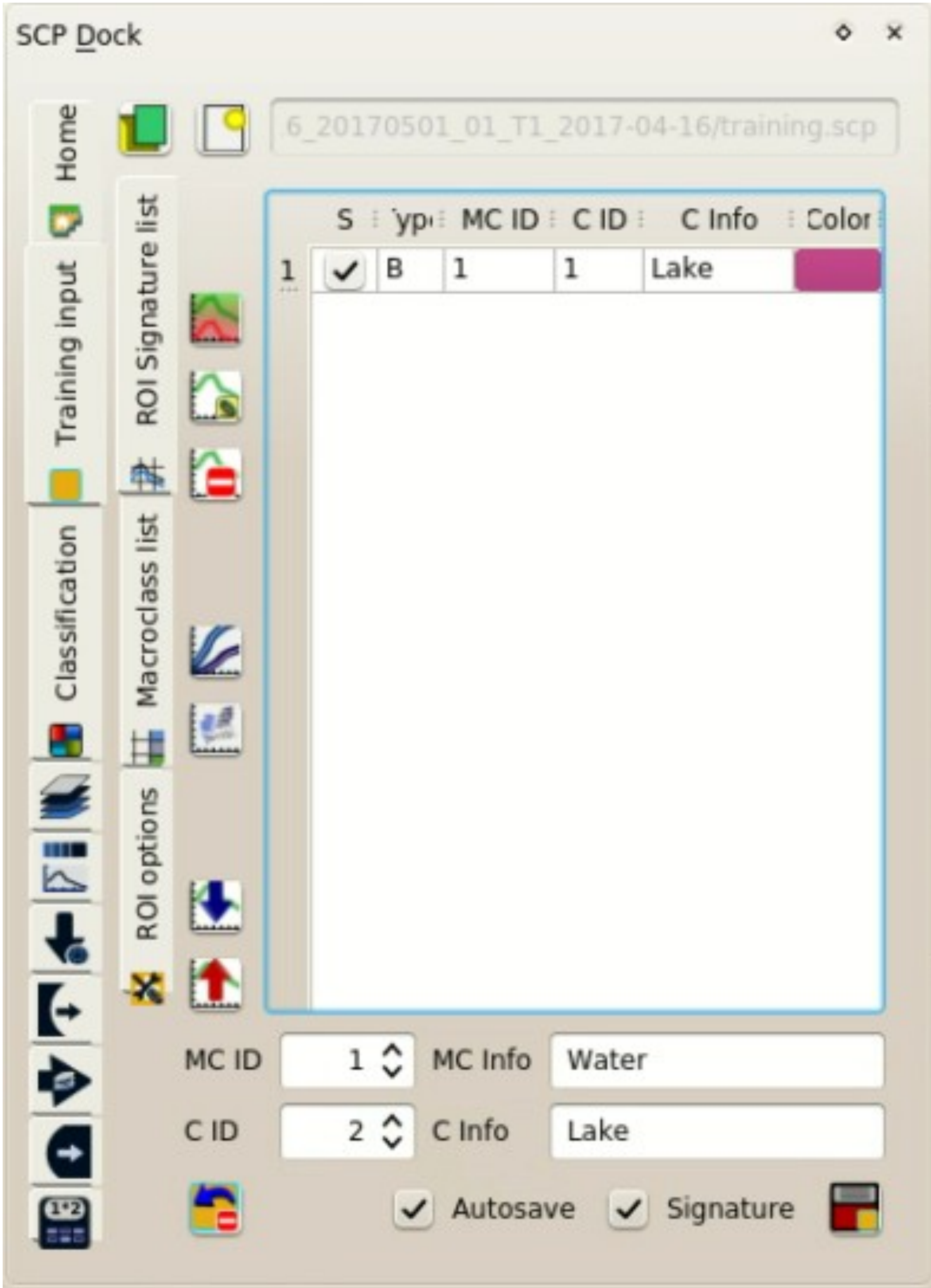
ROIs can be created by manually drawing a polygon or with an automatic region growing algorithm.
Zoom in the map over the dark area in the upper right corner of the image which is a water body. In order to create manually a ROI inside the dark area, click the button  in the Working toolbar. Left click on the map to define the ROI vertices and right click to define the last vertex closing the polygon. An orange semi-transparent polygon is displayed over the image, which is a temporary polygon (i.e. it is not saved in the Training input).

TIP : You can draw temporary polygons (the previous one will be overridden) until the shape covers the intended area.



A temporary ROI created manually

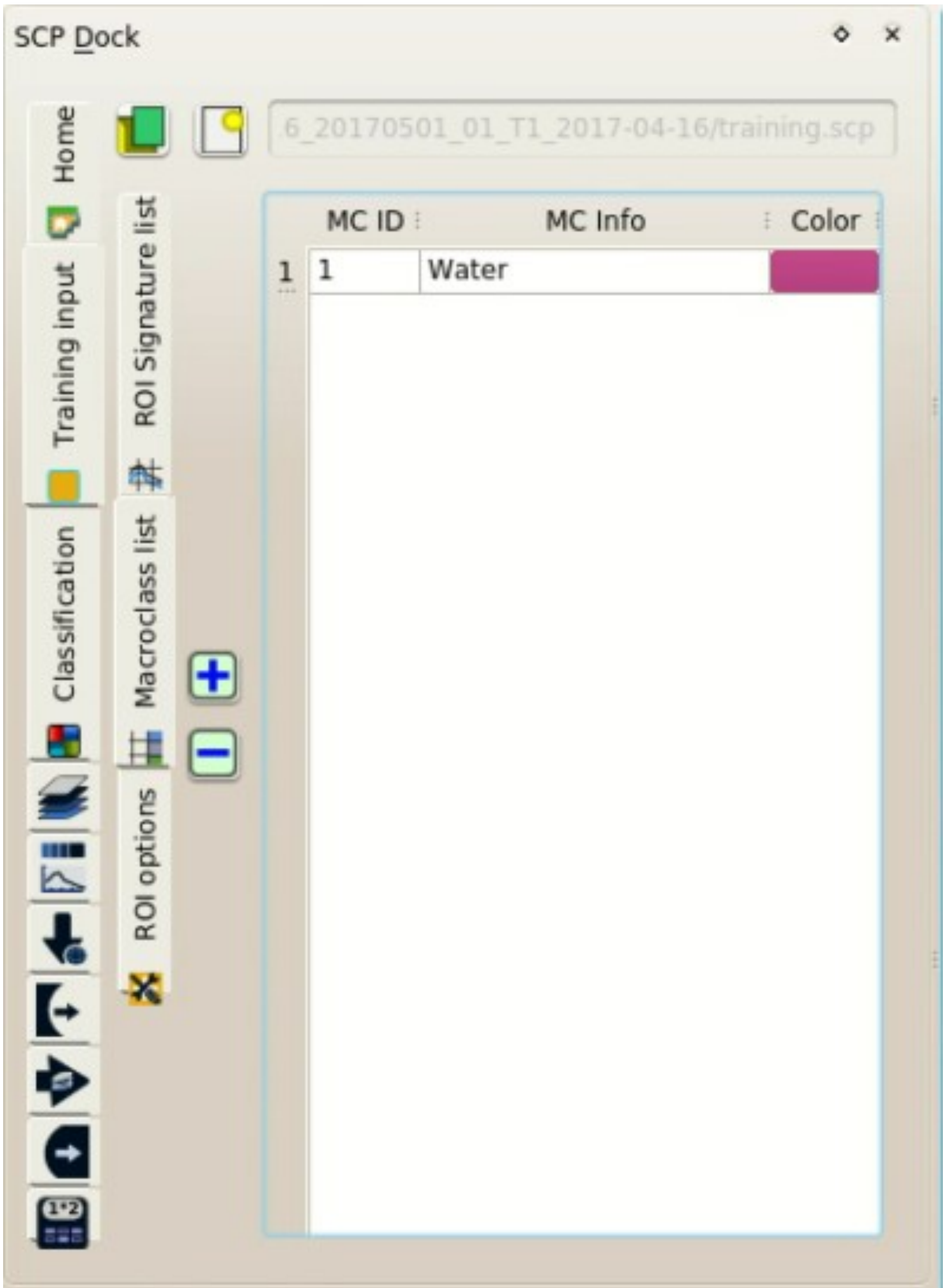
If the shape of the temporary polygon is good we can save it to the Training input.
Open the Training input to define the Classes and Macroclasses . In the ROI Signature list set MC ID = 1 and MC Info = `Water`; also set C ID = 1 and C Info = `Lake`. Now click  to save the ROI in the Training input.
After a few seconds, the ROI is listed in the ROI Signature list and the spectral signature is calculated (because  Signature was checked).



The ROI saved in the Training input

As you can see, the C ID in ROI Signature list is automatically increased by 1. Saved ROI is displayed as a dark polygon in the map and the temporary ROI is removed. Also, in the ROI Signature list you can notice that the Type is B, meaning that the ROI spectral signature was calculated and saved in the Training input.

You can also see in the tab Macroclasses that the first macroclass has been added to the table Macroclasses .

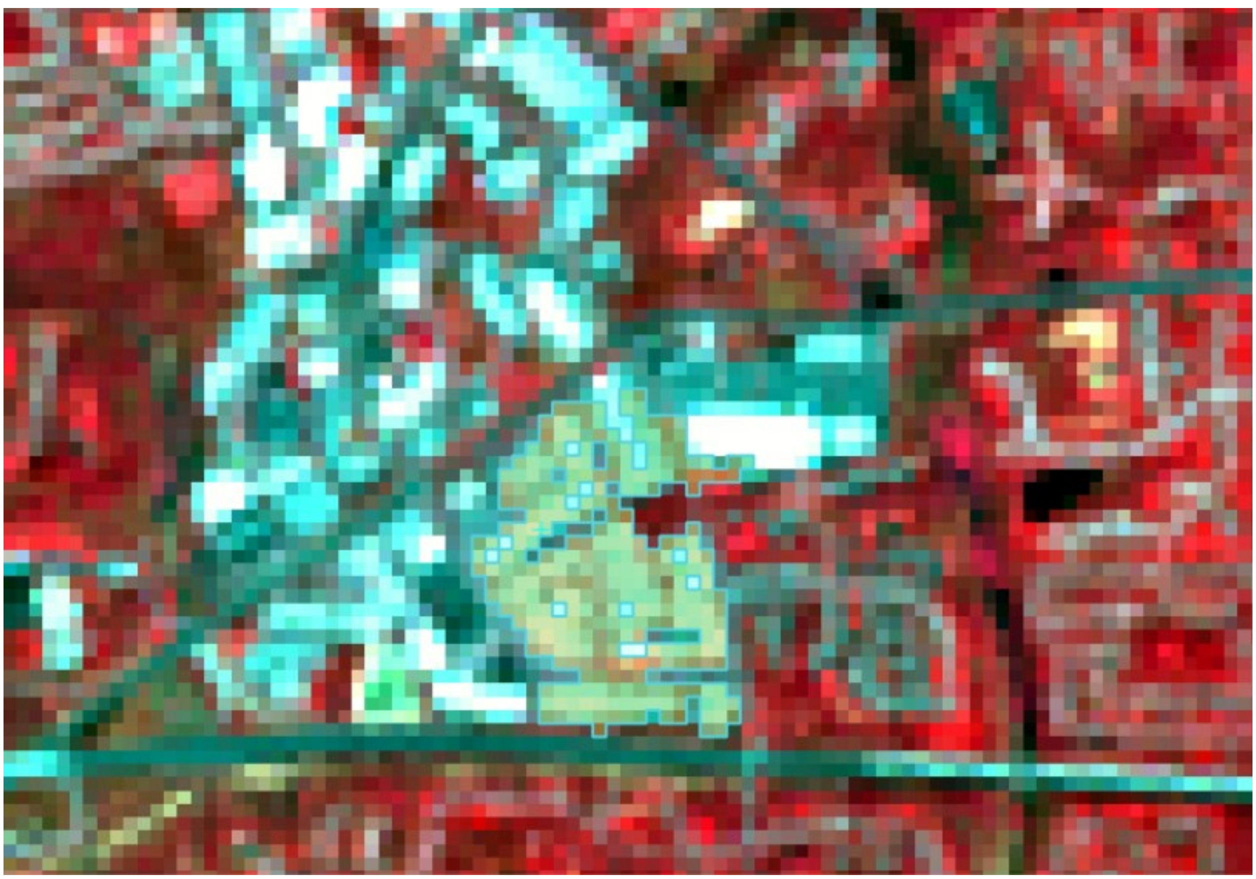


Macroclasses

Now we are going to create a second ROI for the built-up class using the automatic region growing algorithm. Zoom in the lower region of the image.

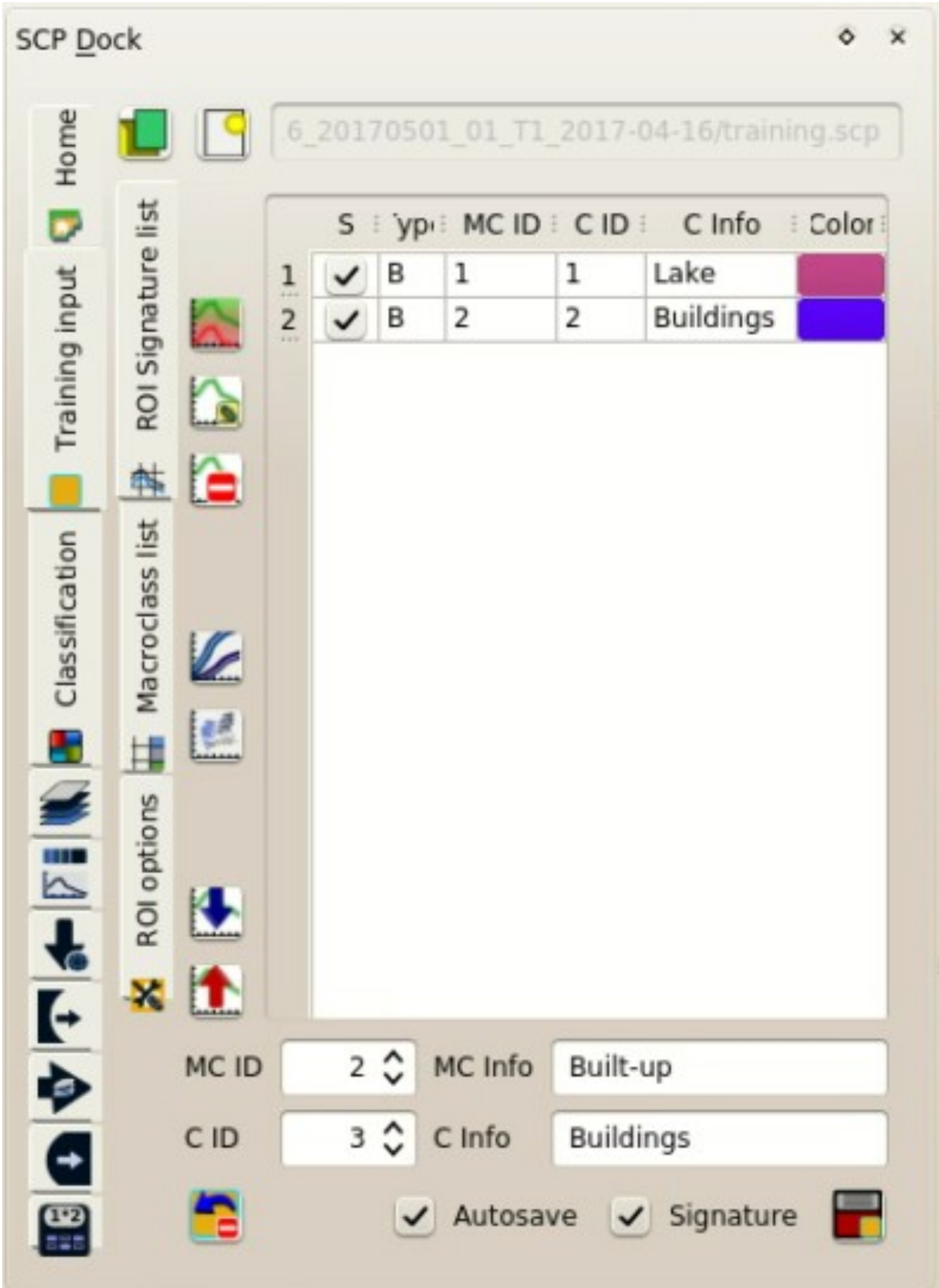
In Working toolbar set the Dist value to 0.08 . Click the button  in the Working toolbar and click over the purple area of the map. After a while the orange semi-transparent polygon is displayed over the image.

TIP : Dist value should be set according to the range of pixel values; in general, increasing this value creates larger ROIs.



A temporary ROI created with the automatic region growing algorithm

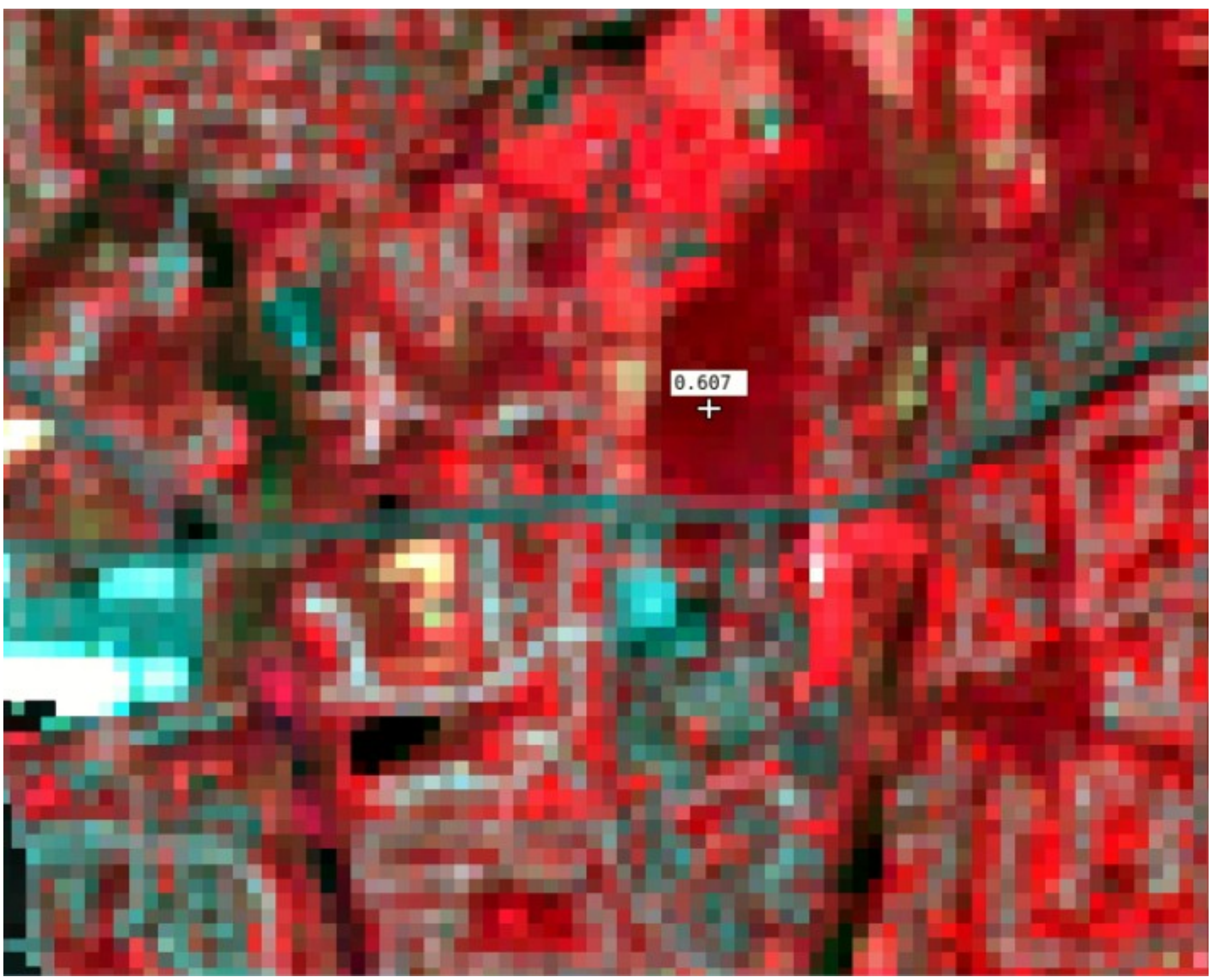
In the ROI Signature list set MC ID = 2 and MC Info = `Built-up` ; also set C ID = 2 (it should be already set) and C Info = `Buildings`.



The ROI saved in the Training input

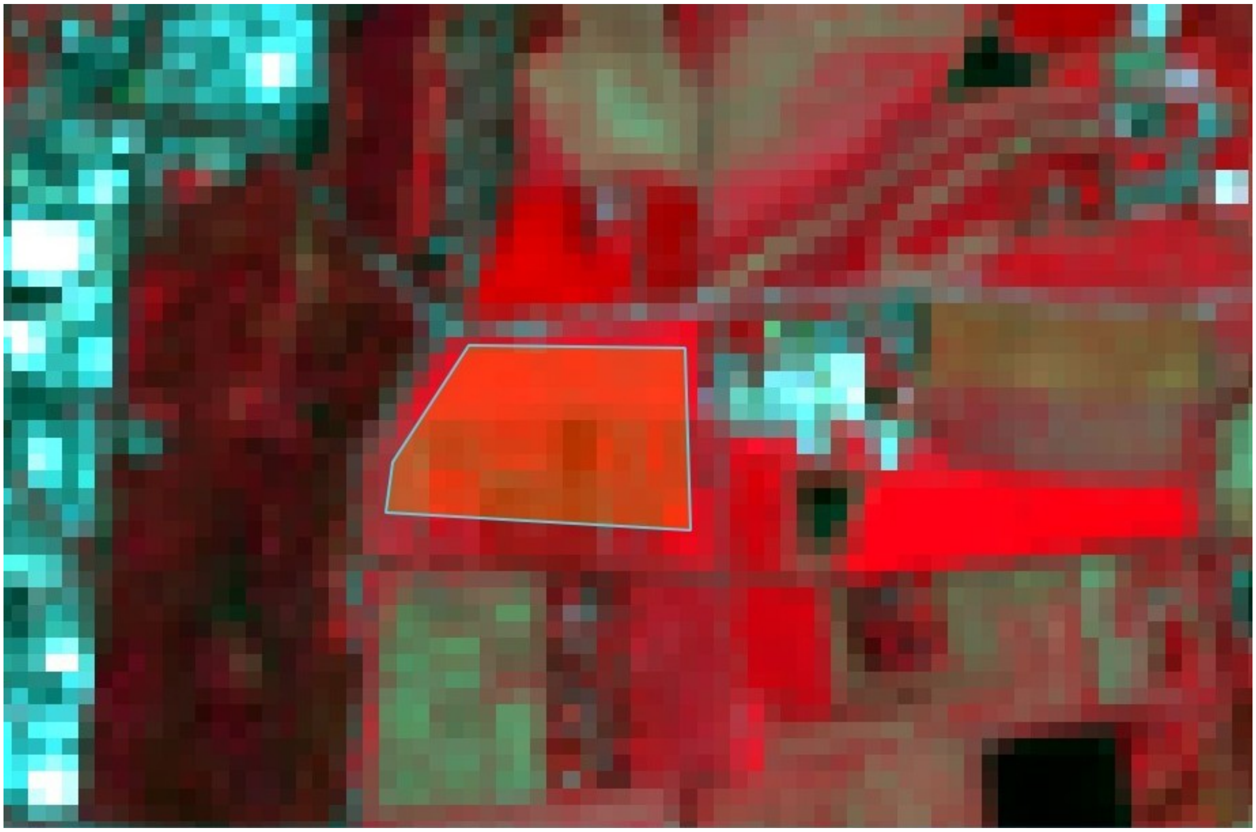
Again, the C ID in ROI Signature list is automatically increased by 1.

After clicking the button in the Working toolbar you should notice that the cursor in the map displays a value changing over the image. This is the NDVI value of the pixel beneath the cursor (NDVI is displayed because the function Display is checked in Training input). The NDVI value can be useful for identifying spectrally pure pixels, in fact vegetation has higher NDVI values than soil.
For instance, move the mouse over a vegetation area and left click to create a ROI when you see a local maximum value. This way, the created ROI and the spectral signature thereof will be particularly representative of healthy vegetation.



NDVI value of vegetation pixel displayed in the map. Color composite RGB = 4-3-2

Create a ROI for the class `Vegetation` (red pixels in color composite `RGB=4-3-2`) and a ROI for the class `Bare soil (low vegetation)` (green pixels in color composite `RGB=4-3-2`) following the same steps described previously. The following images show a few examples of these classes identified in the map.



Vegetation. Color composite RGB = 4-3-2

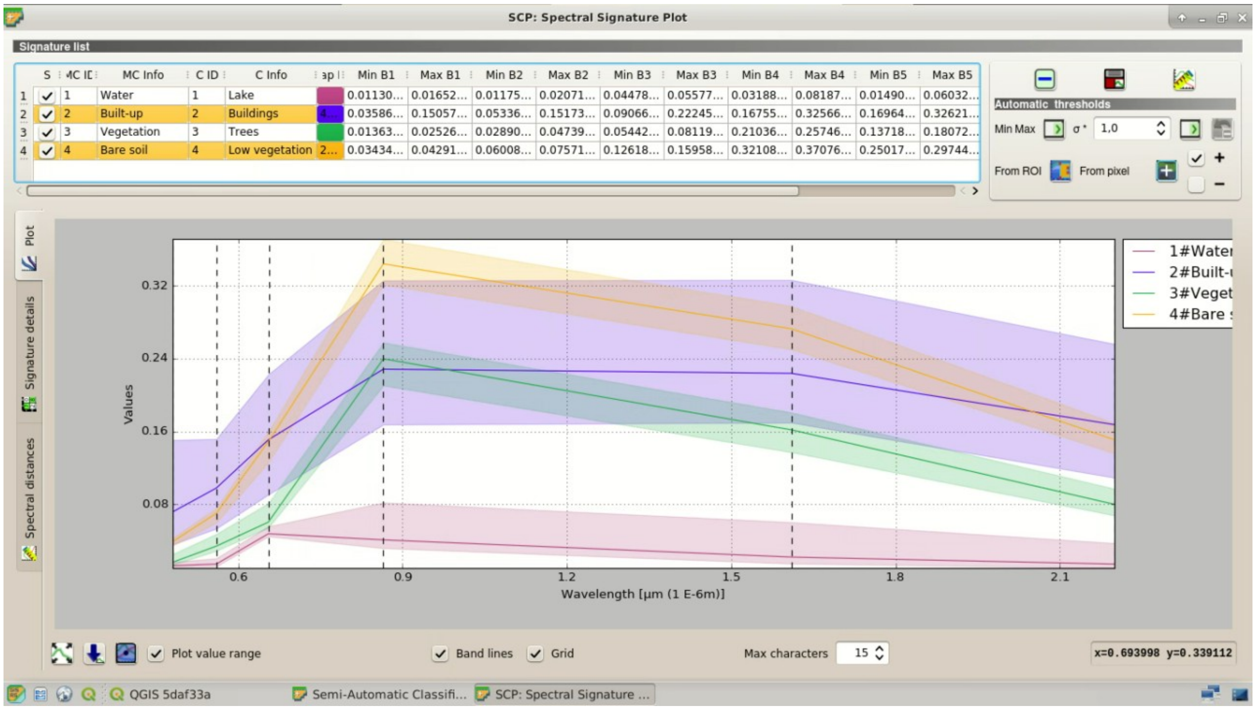
Bare soil (low vegetation). Color composite RGB = 4-3-2

6. Assess the Spectral Signatures

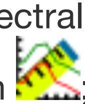
Spectral signatures are used by Classification Algorithms for labelling image pixels. Different materials may have similar spectral signatures (especially considering multispectral images) such as built-up and soil. If spectral signatures used for classification are too similar, pixels could be misclassified because the algorithm is unable to discriminate correctly those signatures. Thus, it is useful to assess the Spectral Distance of signatures to find similar spectral signatures that must be removed. Of course the concept of distance vary according to the algorithm used for classification.

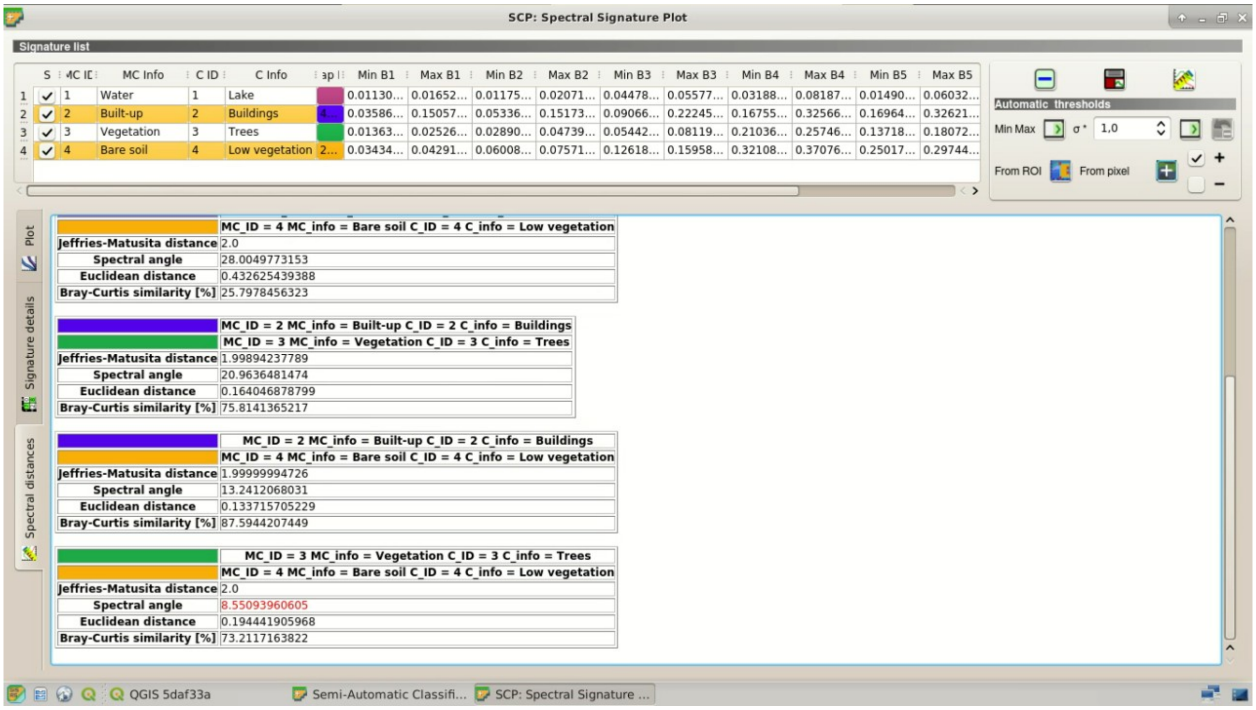
One can simply assess spectral signature similarity by displaying a signature plot. In order to display the signature plot, in the ROI Signature list highlight two or more spectral signatures (with click in the table), then click the button . The Spectral Signature Plot is displayed in a new window. Move and zoom inside the Plot to see if signatures are similar (i.e. very close). Double click the

color in the Plot Signature list to change the line color in the plot.
We can see in the following figure a signature plot of different materials.



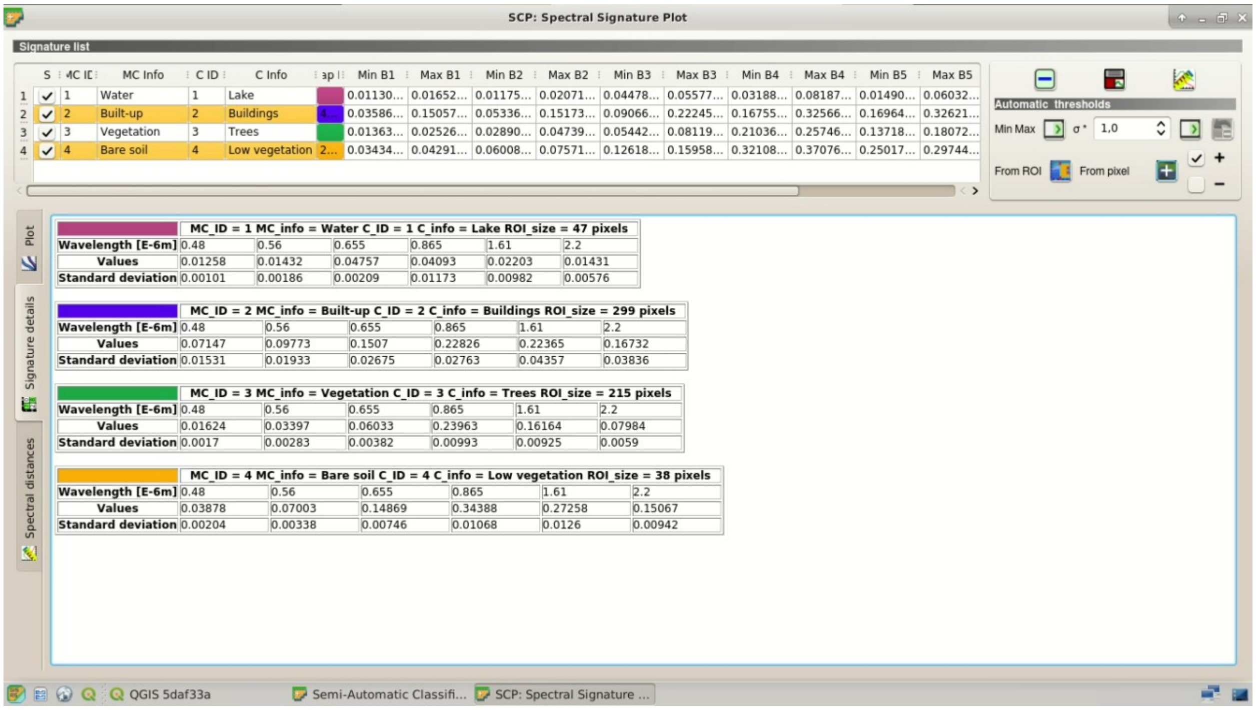
Spectral plot

In the plot we can see the line of each signature (with the color defined in the ROI Signature list), and the spectral range (minimum and maximum) of each band (i.e. the semi-transparent area colored like the signature line). The larger is the semi-transparent area of a signature, the higher is the standard deviation, and therefore the heterogeneity of pixels that composed that signature. Spectral similarity between spectral signatures is highlighted in orange in the Plot Signature list.
Additionally, we can calculate the spectral distances of signatures (for more information see Spectral Distance). Highlight two or more spectral signatures with click in the table Plot Signature list, then click the button ; distances will be calculated for each pair of signatures. Now open the tab Spectral distances; we can notice that similarity between signatures vary according to considered algorithm.



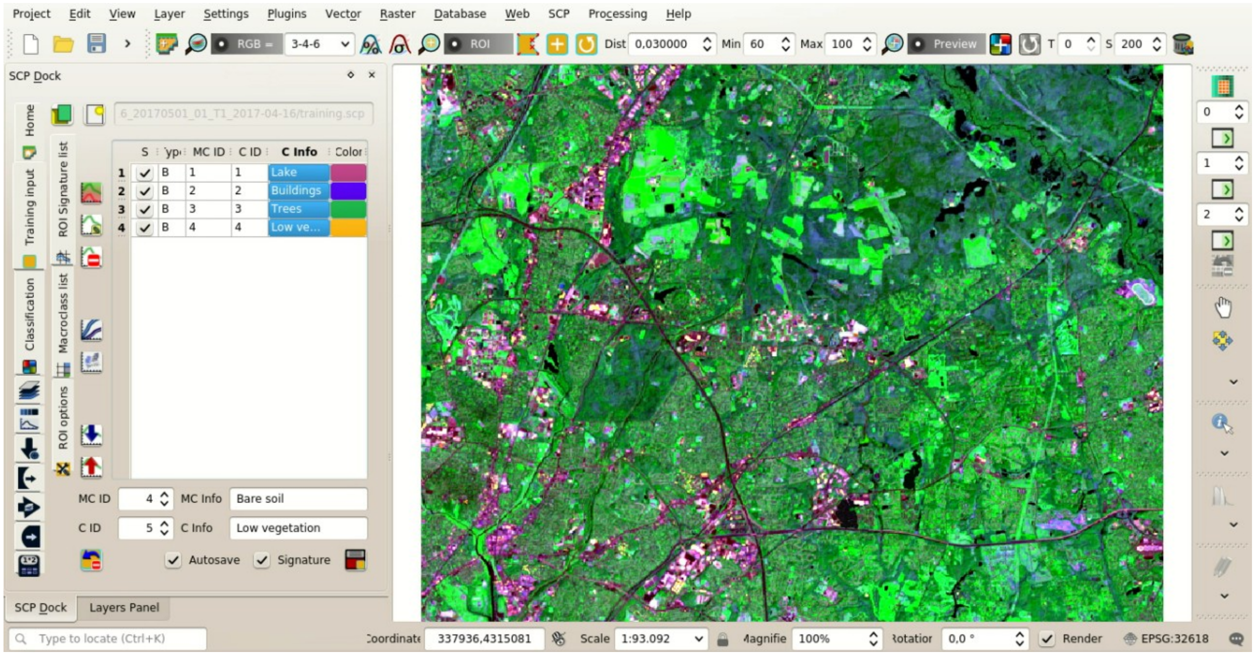
Spectral distances

For instance, two signatures can be very similar for Spectral Angle Mapping (very low Spectral Angle), but quite distant for the Maximum Likelihood (Jeffries-Matusita Distance value near 2). The similarity of signatures is affected by the similarity of materials (in relation to the number of spectral bands available); also, the way we create ROIs influences the signatures. Spectral signature values, standard deviation and other details such as the number of ROI pixels are displayed in the Signature details.



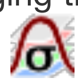
Spectral signature values

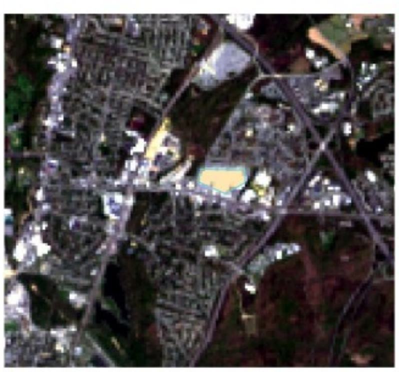
We need to create several ROIs (i.e. spectral signatures) for each macroclass (repeating the steps in Create the ROIs), assigning a unique C ID to each spectral signature, and assess the spectral distance thereof in order to avoid the overlap of spectral signatures belonging to different macroclasses.
In the list RGB= of the Working toolbar type `3-4-6` (you can also use the tool RGB list). Using this color composite, urban areas are purple and vegetation is green. You can notice that this color composite `RGB = 3-4-6`highlights roads more than natural color (`RGB = 3-2-1`).



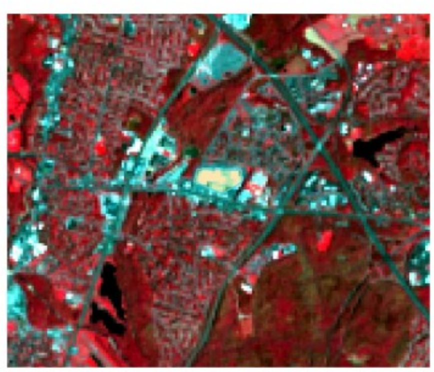
Color composite RGB = 3-4-6

The following examples display a few RGB color composites of Landsat images.

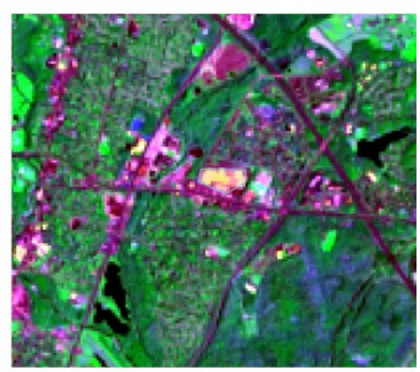
TIP : Change frequently the Color Composite in order to clearly identify the materials at the ground; use the mouse wheel on the list RGB= of the Working toolbar for changing the color composite rapidly; also use the buttons  and  for better displaying the Input image (i.e. image stretching).



RGB = 3-2-1



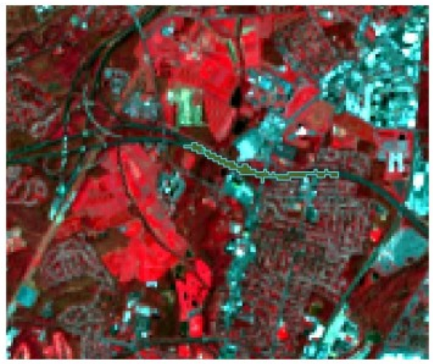
RGB = 4-3-2



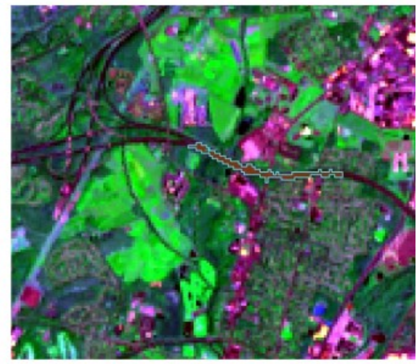
RGB = 3-4-6

Built-up ROI: large buildings

RGB = 3-2-1



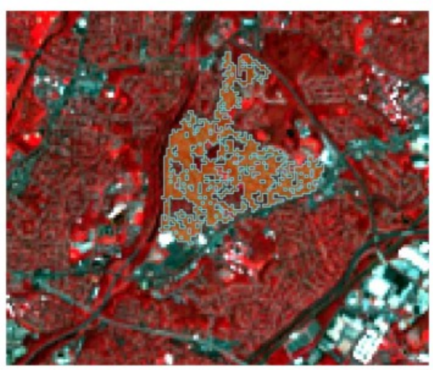
RGB = 4-3-2



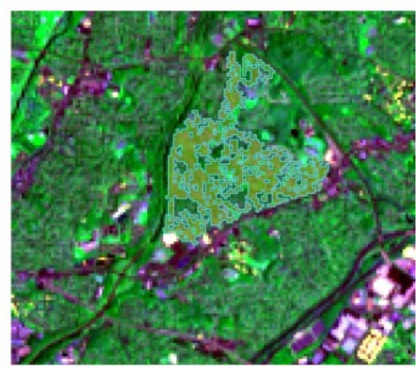
RGB = 3-4-6

Built-up ROI: road

RGB = 3-2-1

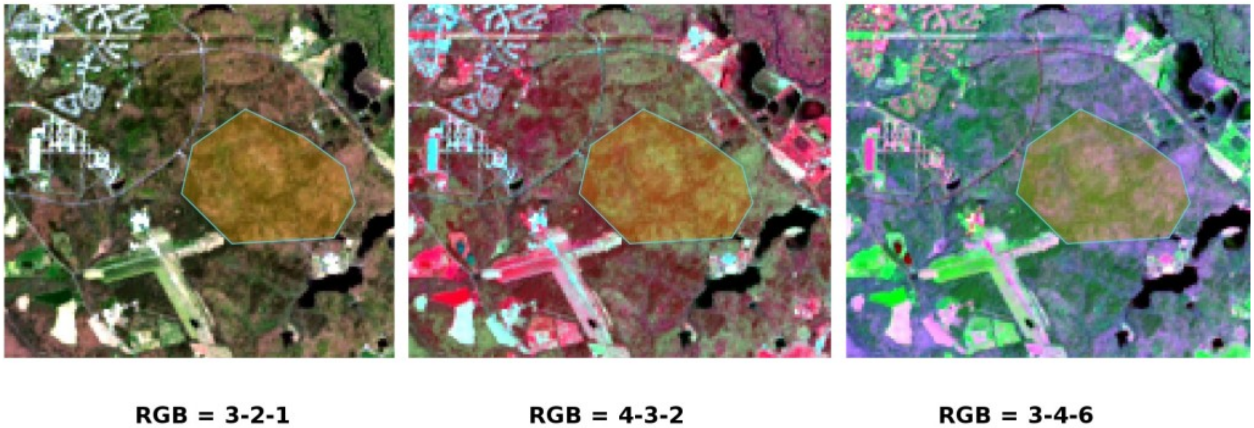


RGB = 4-3-2

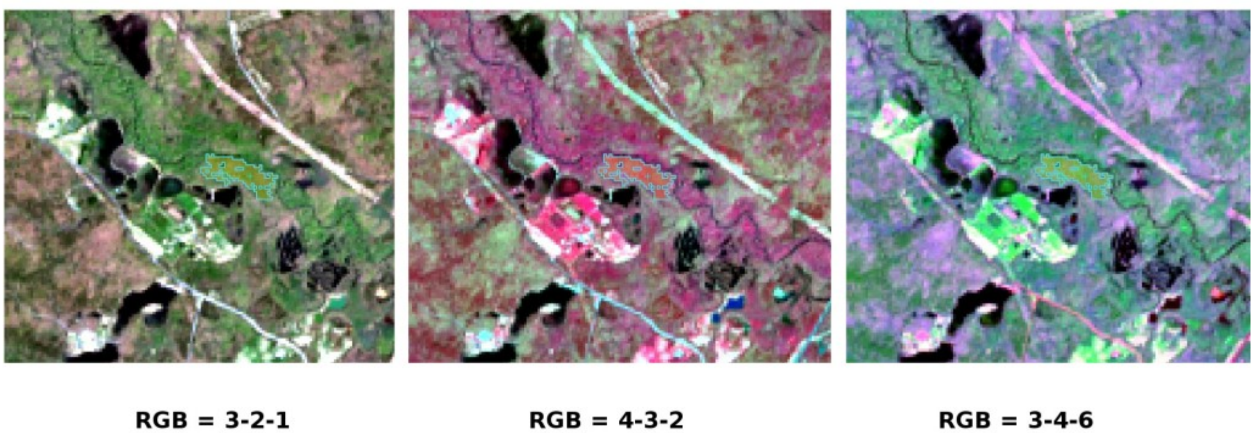


RGB = 3-4-6

Built-up ROI: buildings, narrow roads



Vegetation ROI: deciduous trees



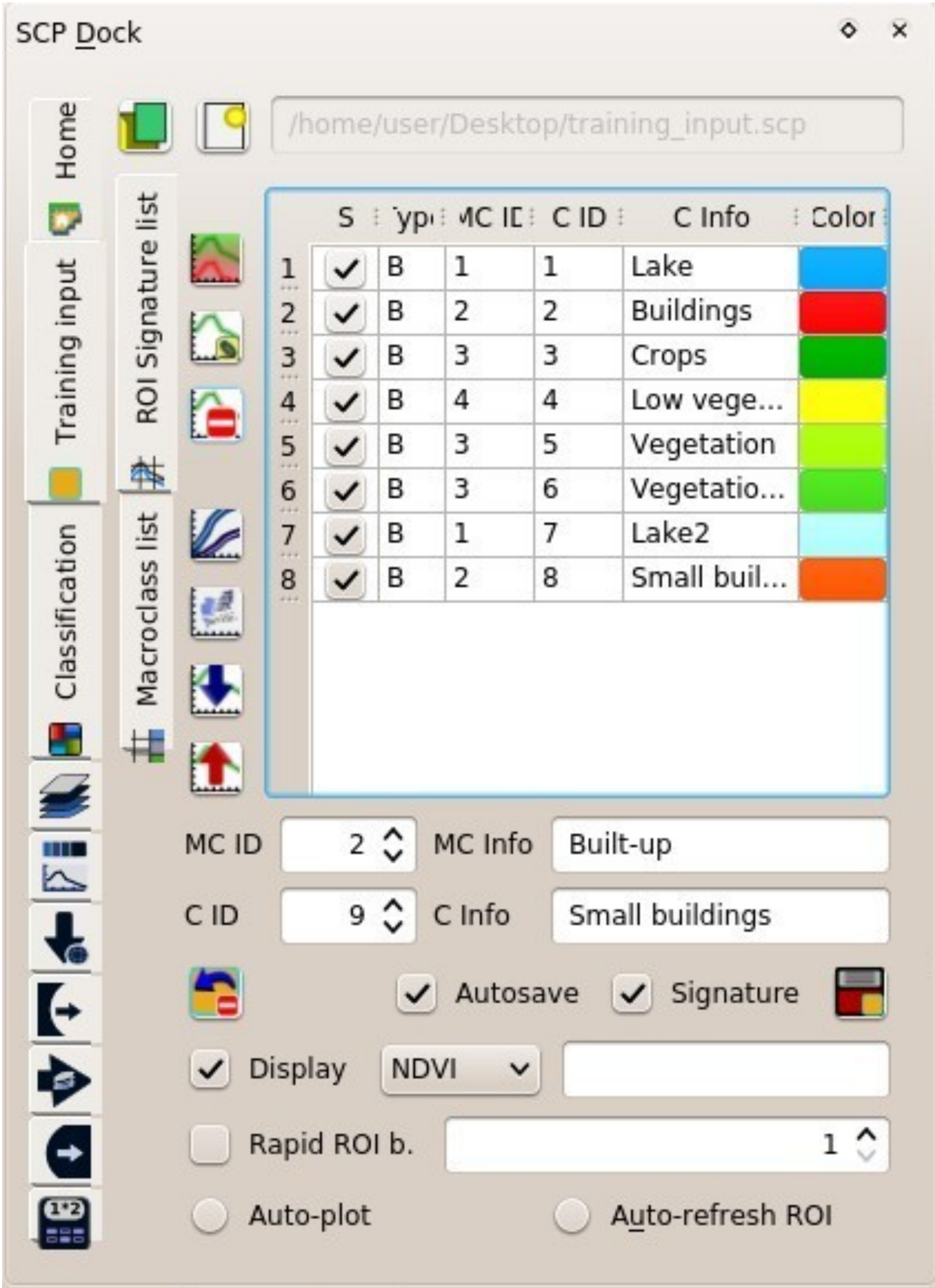
Vegetation ROI: riparian vegetation

It is worth mentioning that you can show or hide the temporary ROI clicking the button ROI in Working toolbar.

TIP : Install the plugin QuickMapServices in QGIS, and add a map (e.g. OpenStreetMap) in order to facilitate the identification of ROIs using high resolution data.

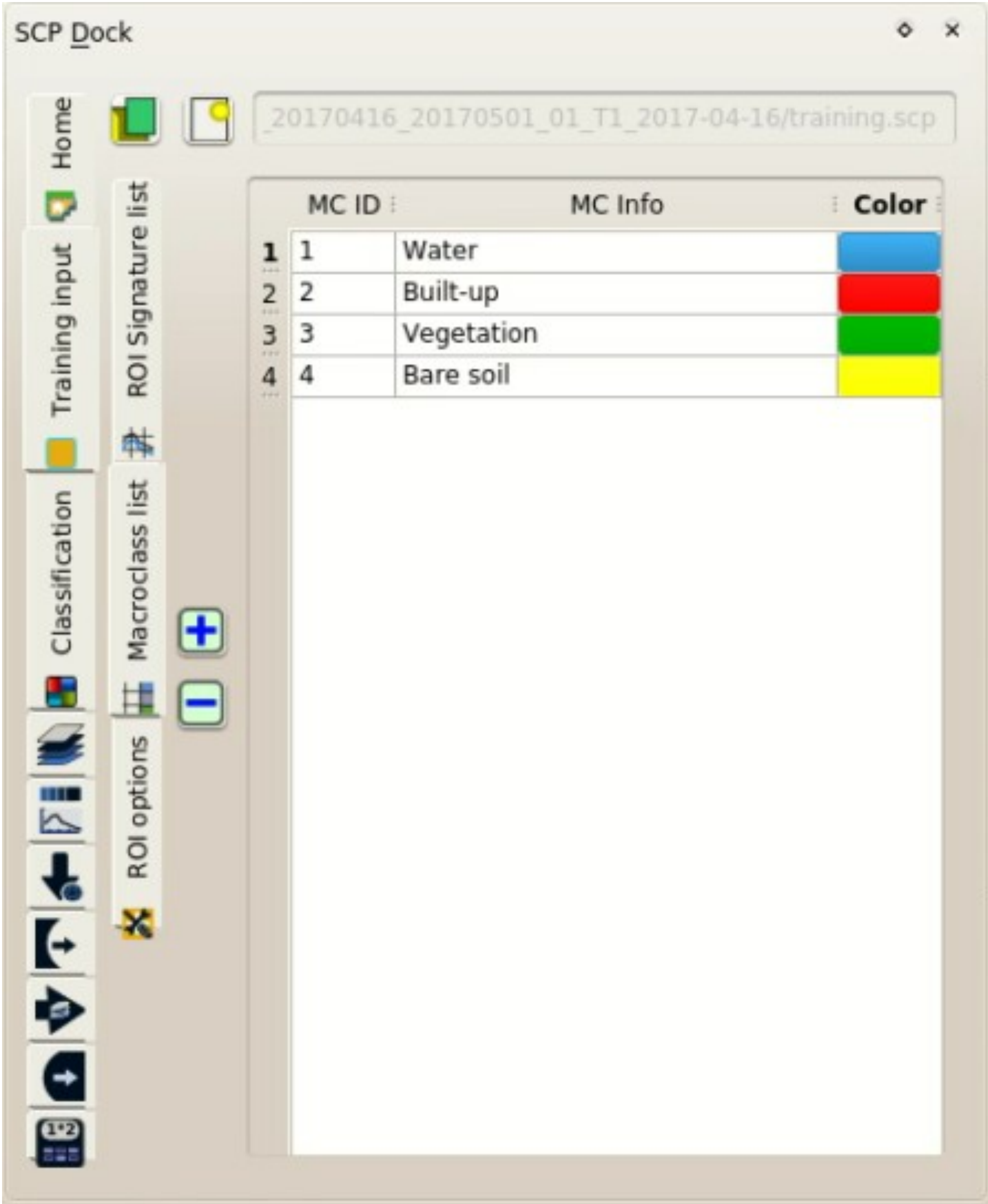
7. Create a Classification Preview

The classification process is based on collected ROIs (and spectral signatures thereof). It is useful to create a Classification preview in order to assess the results (influenced by spectral signatures) before the final classification. In case the results are not good, we can collect more ROIs to better classify land cover.
Before running a classification (or a preview), set the color of land cover classes that will be displayed in the classification raster. In the ROI Signature list, double click the color (in the column Color) of each ROI to choose a representative color of each class.



Definition of class colors

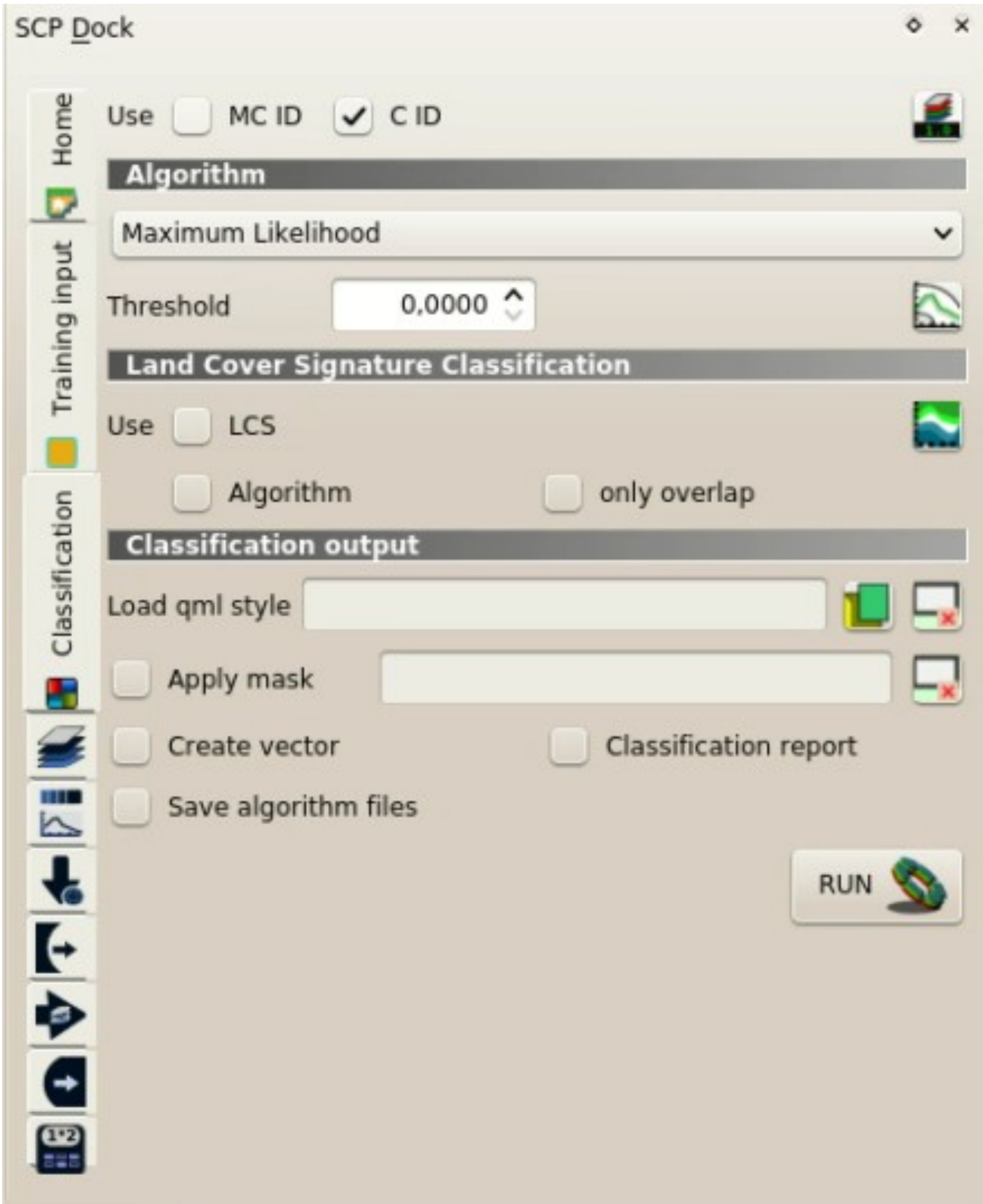
Also, we need to set the color for macroclasses in table Macroclasses.



Definition of macroclass colors

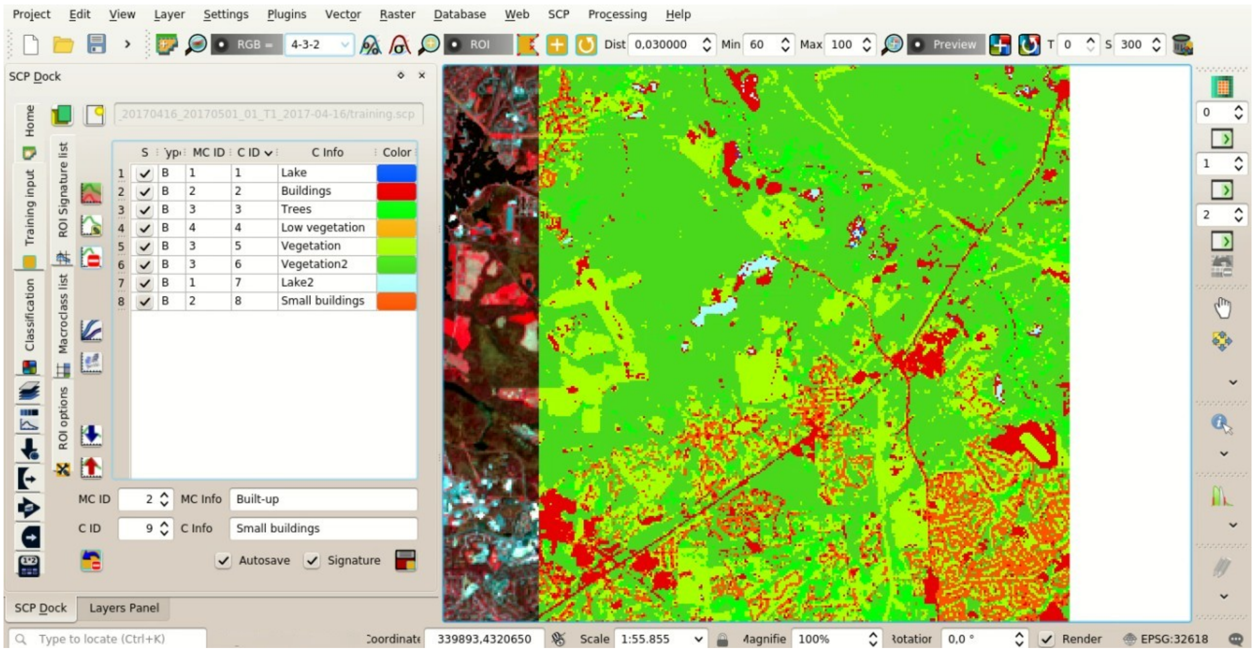
Now we need to select the classification algorithm. In this tutorial we are going to use the Maximum Likelihood.
Open the Classification to set the use of classes or macroclasses.

Check Use C ID and in Algorithm select the Maximum Likelihood.



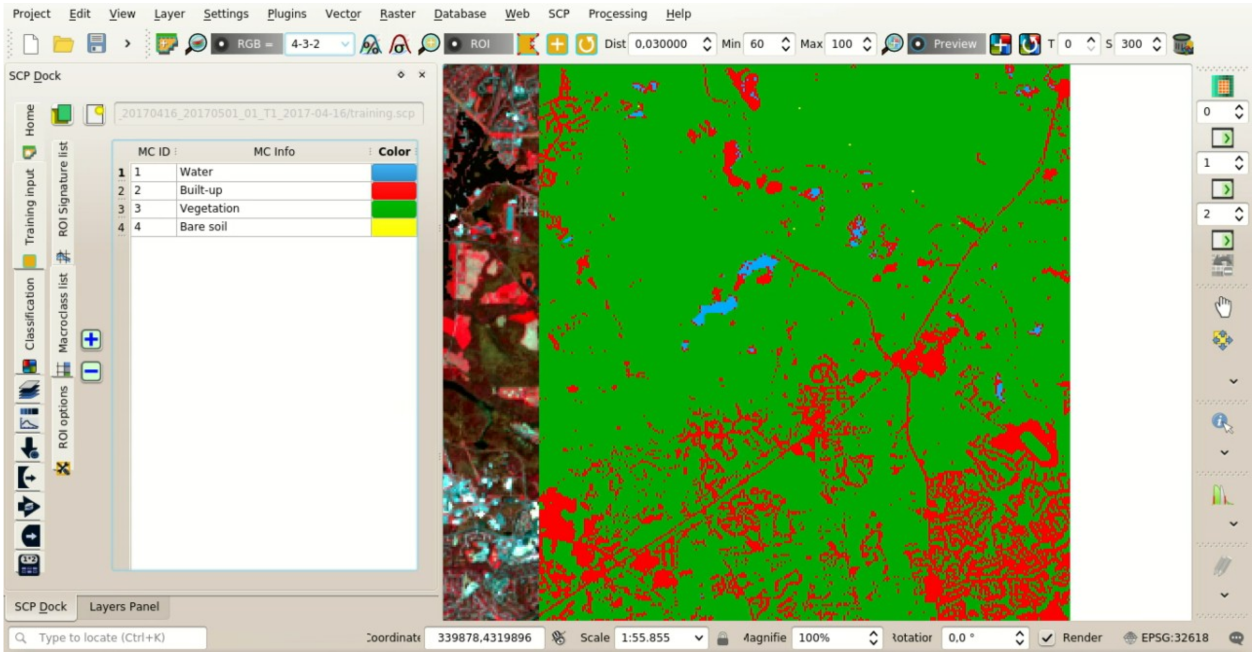
Setting the algorithm and using C ID

In Classification preview set Size = 300; click the button  and then left click a point of the image in the map. The classification process should be rapid, and the result is a classified square centered in clicked point.



Classification preview displayed over the image using C ID

Previews are temporary rasters (deleted after QGIS is closed) placed in a group named Class_temp_group in the QGIS panel Layers. Now in Classification check Use  MC ID and click the button  in Classification preview.



Classification preview displayed over the image using MC ID

We can see that now there are only 4 colors representing the macroclasses.

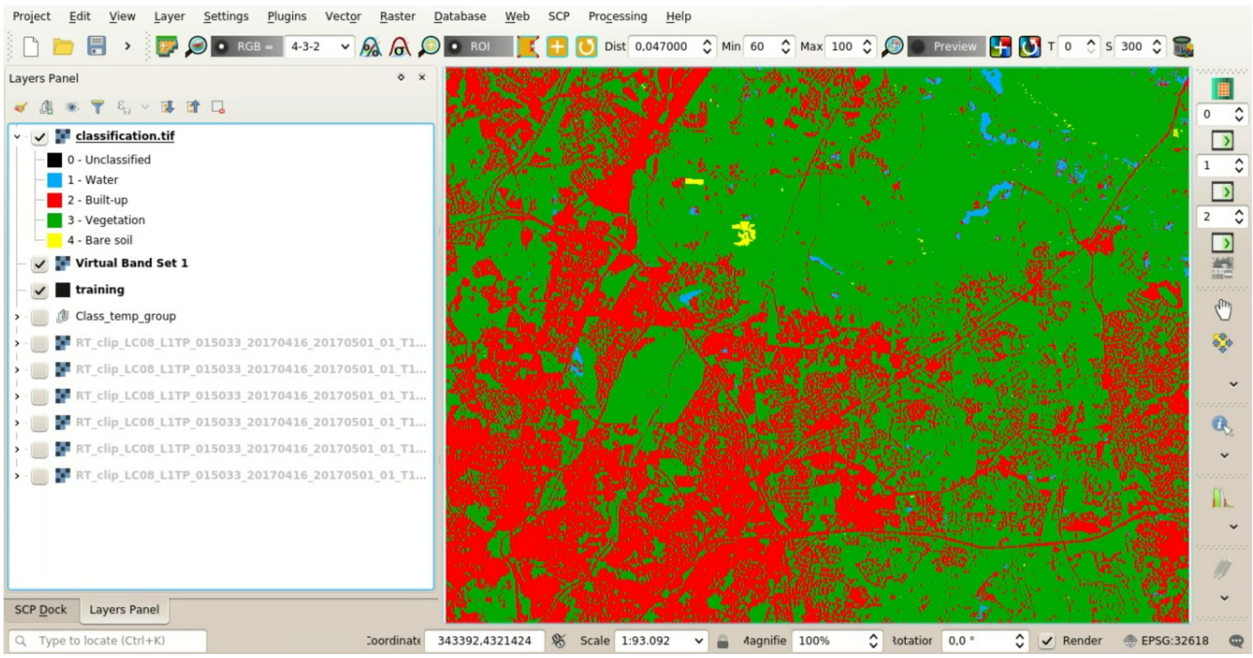
TIP : When loading a previously saved QGIS project, a message could ask to handle missing layers, which are temporary layers that SCP creates during each session and are deleted afterwards; you can click Cancel and ignore these layers; also, you can delete these temporary layers clicking the button  in Working toolbar.

In general, it is good to perform a classification preview every time a ROI (or a spectral signature) is added to the ROI Signature list. Therefore, the phases Create the ROIs and Create a Classification Preview should be iterative and concurrent processes.

8. Create the Classification Output

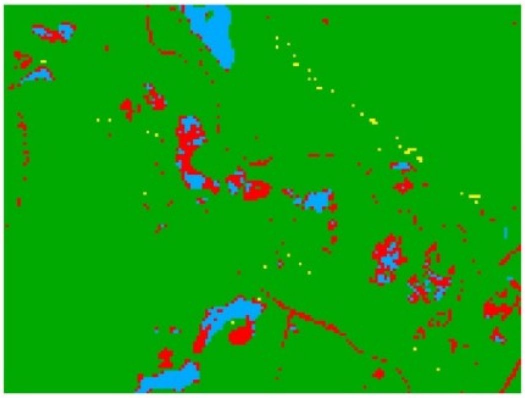
Assuming that the results of classification previews were good (i.e. pixels are assigned to the correct class defined in the ROI Signature list), we can perform the actual land cover classification of the whole image.

In Classification check Use MC ID. In the Classification output click the button and define the path of the classification output, which is a raster file (.tif). If Play sound when finished is checked in Classification process settings, a sound is played when the process is finished.



Result of the land cover classification

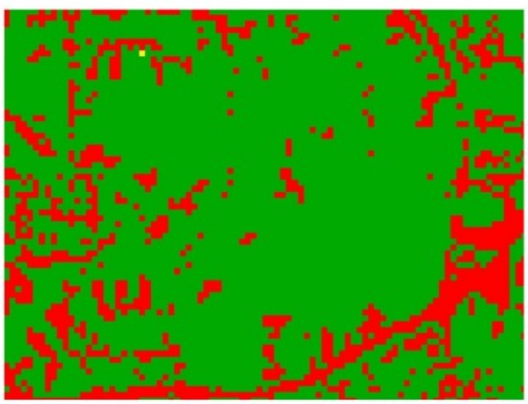
Well done! You have just performed your first land cover classification. However, you can see that there are several classification errors, because the number of ROIs (spectral signatures) is insufficient.



Classification

RGB = 3-2-1

Example of error: Water bodies classified as Built-up



Classification

RGB = 3-2-1

Example of error: Built-up classified as vegetation