National Institute for Space Research

TerraAmazon 7 - Digital Image Processing

Brazil

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Contents

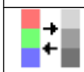
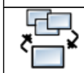
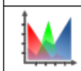
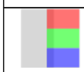
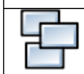
1 Digital Image Processing

1.1 Introduction

TerraAmazon is a GIS that provides many image processing functions that can be either used to assist in the classification of land usage or in any general purpose application. This document aims to provide instructions on how to use many of the Digital Image Processing functions available in TerraAmazon, which can be adapted to any project that requires image processing.

1.2 Image processing functions

The image processing functions available in TerraAmazon are shown in table 1.

Image Processing Tools	
Icon	Description
	A collection of **Arithmetic Operations** that can be performed on images.
	**Classification** methods used to detect patterns in image regions.
	**Clipping** operation. Used to crop regions of interest and create a new layer.
	**Cloud Detection**. Assists in cloud and shadow detection.
	**Color Transform**. Used to change the color system of a image.
	**Compose** and **Decompose**. Operations that compose a image with bands from different images or decompose an image in separate images.
	**Contrast**. Used to enhance the visual quality of the image.
	**Filtering**. Neighborhood operations that work with the values of the pixels.
	**Fusion**. Combines images with different spectral and spatial resolution.
	**Mixture Model**. Decomposes an image into fraction images.
	**Mosaic**. Used to create a mosaic from a set of images.

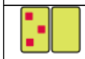
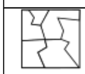
	**Principal Components Analysis**. Creates a set of decorrelated data bands whose energies are ranged in amplitude.
	**Post Classification**. Eliminates isolated points classified differently from their neighborhood.
	**Slicing**. Creates a color palette corresponding to the sliced image's histogram.
	**Rasterization**. Transforms vector data into an image where the pixel values are generated based on the grouping of an attribute.
	**Image registration**. Aligns two images, of the same area, acquired by the same/different sensors, at different times or from different viewpoints.
	**Segmentation**. Splits one image in several homogeneous regions.
	**Vectorization**. Converts an image into vector data, generating polygons based on similarity of the pixel values.

Table 1: Raster Processing Tools Description

1.2.1 Input and Output

1.2.1.1 Raster Selection

In many image processing functions, the first step is to choose which raster(s) will be used to perform the operation. The screen that is used to do that is shown at figure 1.

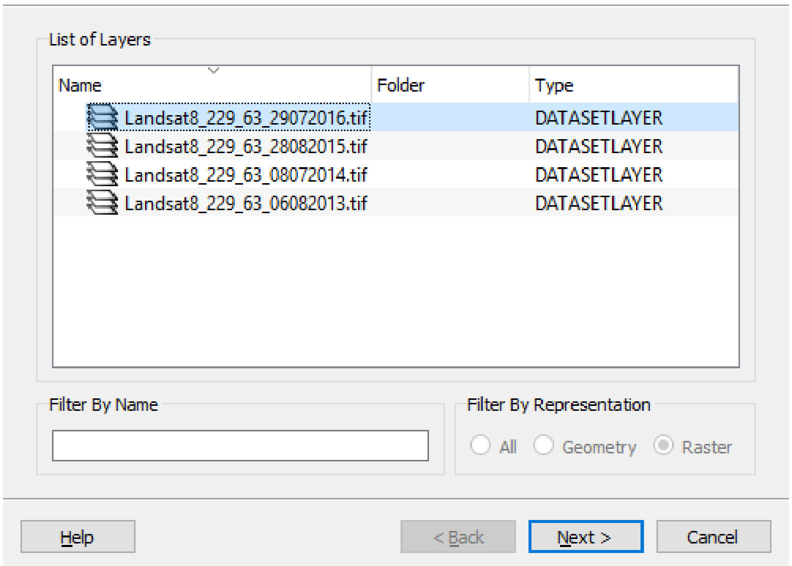


Figure 1: Raster Selection screen

The *List of Layers* section contains all the raster layers currently listed in the layer explorer. For the purposes of this tutorial the file Landsat8_229_63_29072016.tif, contained in the tutorial data, will be commonly used. Just click on the raster that you wish to use and then click the *Next* button to move on the next step.

1.2.1.2 Output definition

The screen shown at figure 2 is commonly used to generate the processing result. By clicking the button a dialog where you can choose the location and name of the output file will be shown. Filling it out returns you to the output screen, where you can click *Finish* button to generate the result. Optional parameters can be provided.

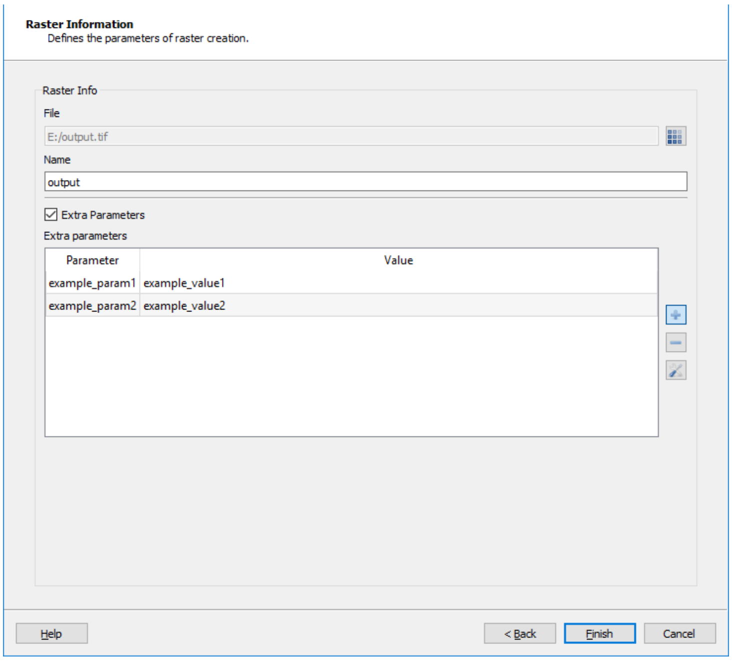


Figure 2: Output raster screen

1.2.2 Composition

The **Compose / Decompose bands** operations allows the user to compose a single raster with bands from different rasters and also decompose a raster in separate bands. It can be accessed through:

Processing -> Raster Processing -> Compose / Decompose bands

The raster selection screen will show up, refer to section 1.2.1.1 for how to use it, choosing the layer Landsat8_229_63_29072016.tif for the first step. Once the raster has been chosen, the screen shown at figure 3 will be shown.

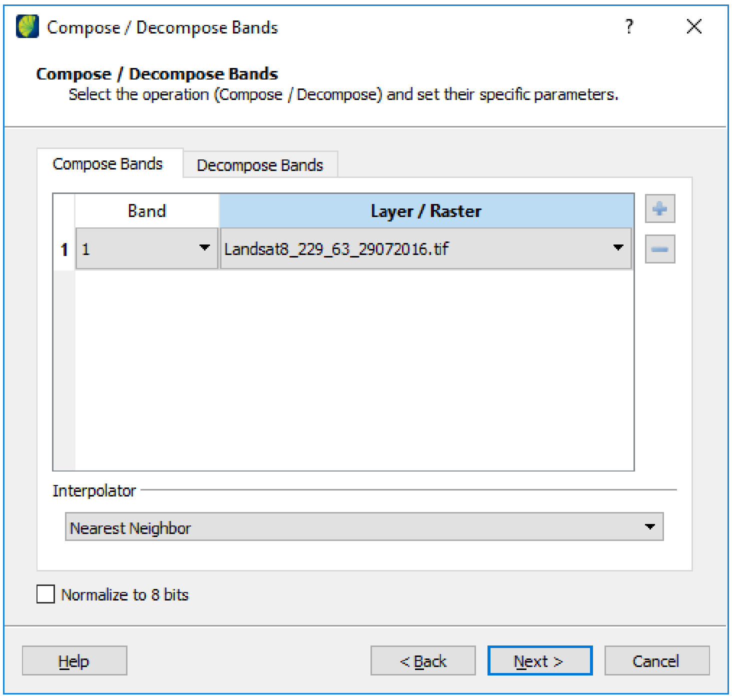


Figure 3: Raster Composition Screen

The first step is to decompose the layer, generating new raster files based on each band of the original. To do that, click on the *Decompose Bands* tab, and you will see the screen shown at figure 4.

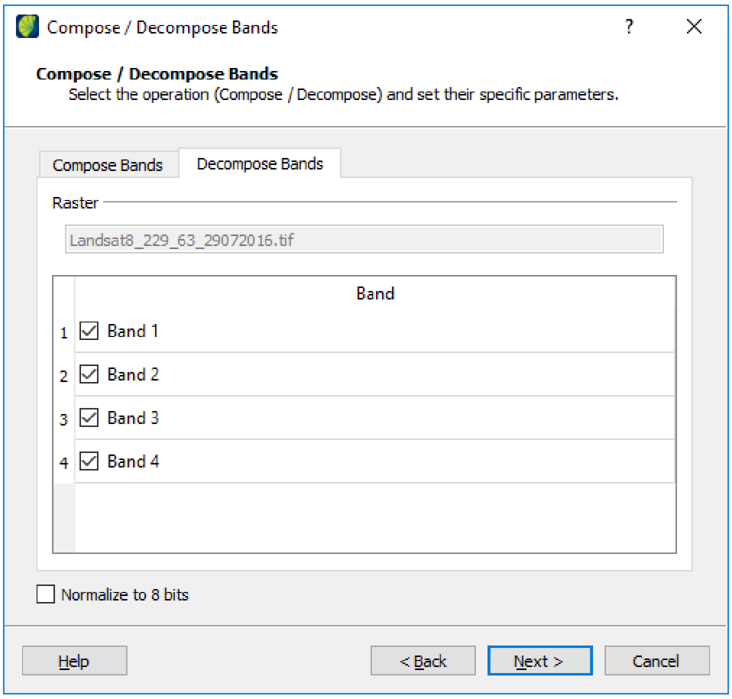


Figure 4: Raster Decomposition Screen

In this screen, you can choose which bands will generate output files. You can generate one file for each of the raster bands, so click *Next* and follow the instructions from section 1.2.1.2 to generate the result. New layers will be generated, like in figure 5.

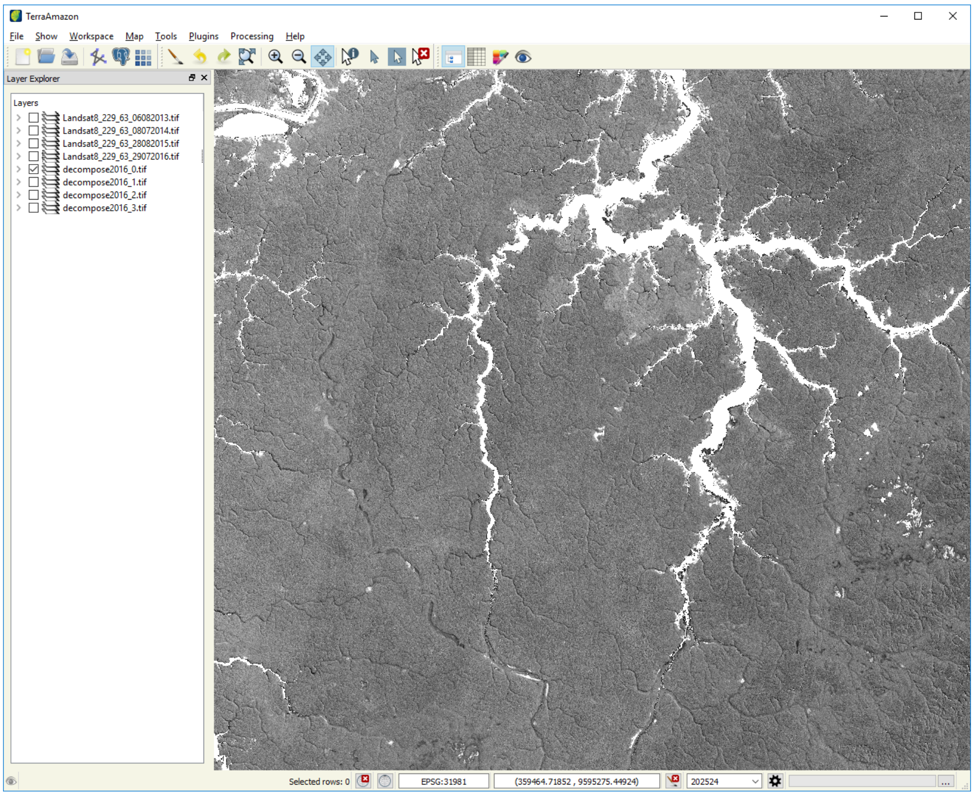


Figure 5: Raster decomposition result

To compose these individual files back to a single raster, access the composition function again and select the layers shown in figure 6 and click the *Next* button.

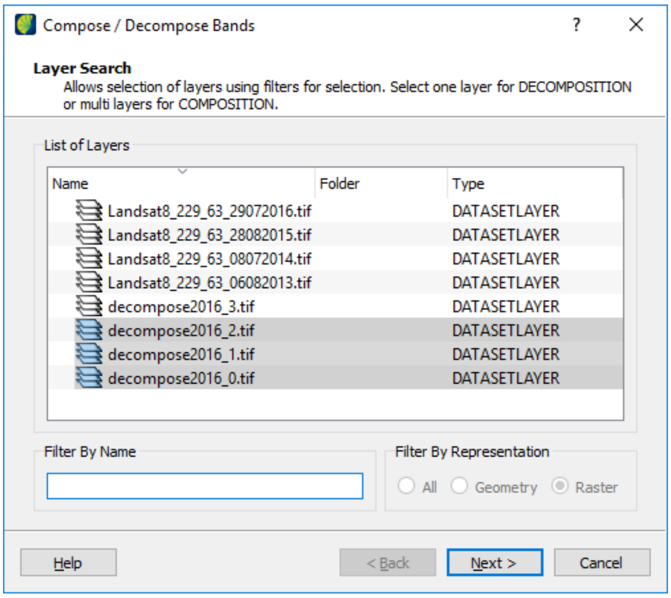


Figure 6: The rasters to be composed

The final step in the composition is to choose which band from each of the input rasters will be used to generate the composed raster. In this example, all the files used have a single band, so leave like shown in figure 7, click *Next* and follow the instruction from section 1.2.1.2 to generate the result, which should look like figure 8.

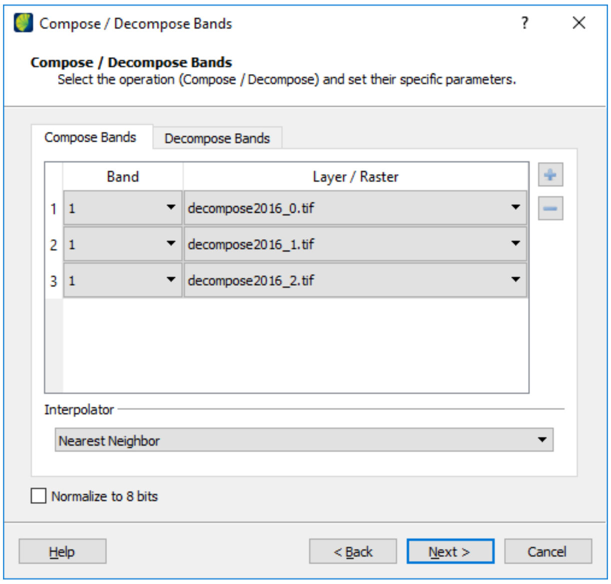


Figure 7: The bands that will be used to generate the result

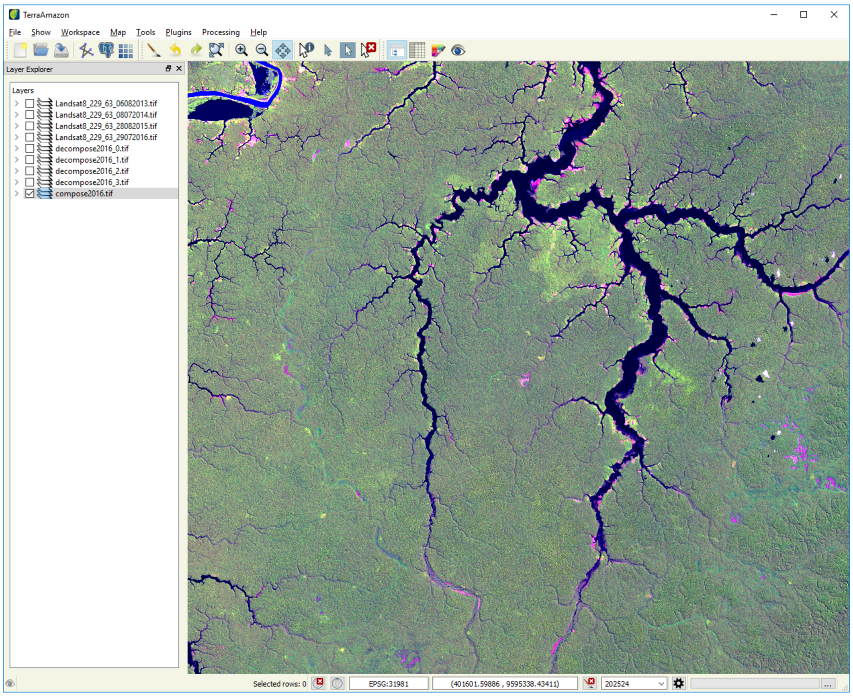


Figure 8: The composition result

1.2.3 Contrast

The **Contrast** operation is used to enhance the visual quality of the image represented by a raster file. To access the contrast interface, shown at figure 9, you must first select a raster layer in the *Layer Explorer*, choose the Landsat5TM_22963_23072008.tif raster for this example, then it can be accessed through:

Processing -> Raster Processing -> Contrast

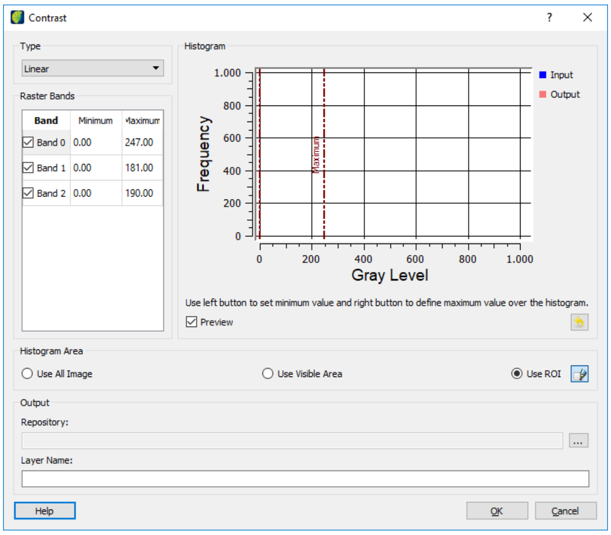


Figure 9: The contrast screen

For this example choose the *Linear* type. The *Histogram Area* section is where you select which area will be used as reference to do the contrast, choose *Use All Image* and the Histogram section will display the histogram of the image as shown in figure 10.

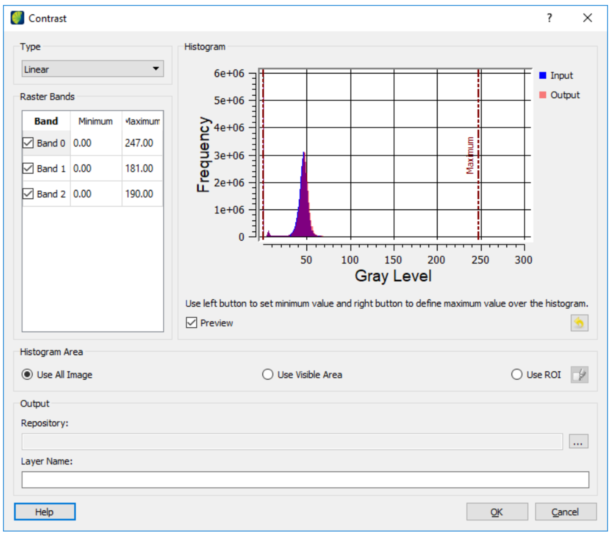


Figure 10: The contrast screen displaying the histogram

The linear function works using user-defined minimum and maximum values for the pixels in each band of the image. You can define these values by clicking on a band in the Raster Bands section, which will display that band's histogram, and then either manually type the minimum and maximum value or clicking in the histogram (left button for the minimum, right button for the maximum value). An example is shown at figure 11.

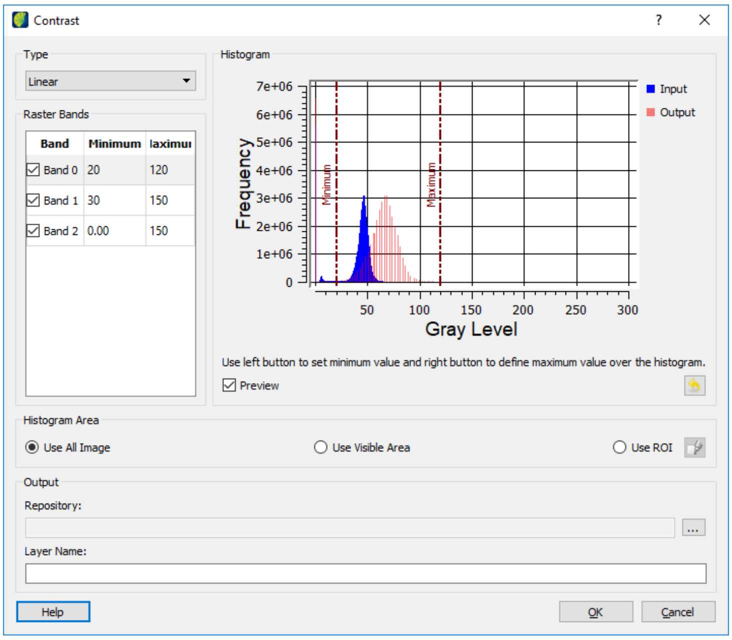


Figure 11: The adjustments to the contrast

Note that, as you make changes in these values, a preview of the contrast is applied in the layer being drawn, that helps to make fine adjustments until the contrast is satisfactory. Once you are done, click the ... button to define the location and name of the output file and then click *OK* to generate the new layer. A comparison of the result in this example is shown at figure 12.

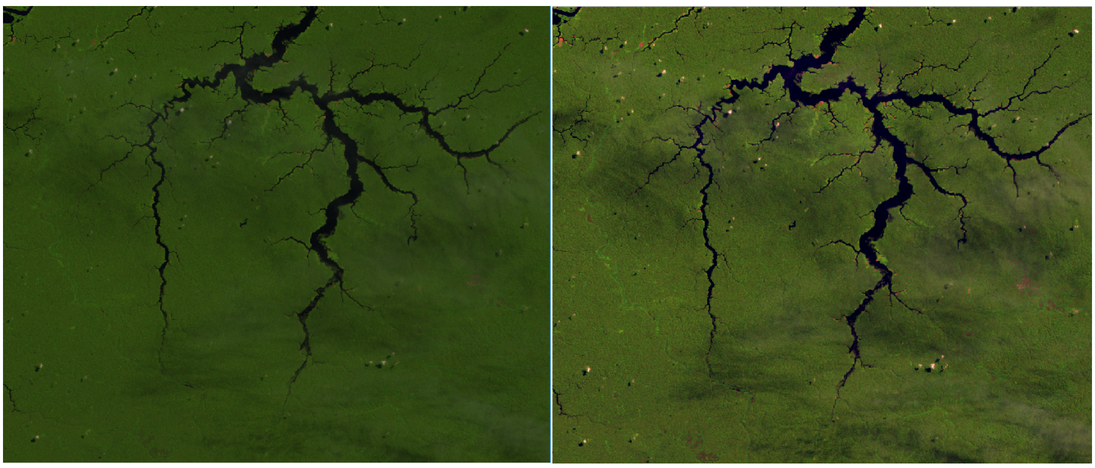


Figure 12: Image without contrast on the left, with contrast applied on the right

1.2.4 Mixture Model

The **Mixture Model** algorithms enable the decomposition of a raster into fraction images, where the value of the resultant pixels indicate the fraction of each target inside the pixel. It can be accessed through:

Processing -> Raster Processing -> Mixture Model

The layer selection screen will show up, refer to section 1.2.1.1 for how to use it and choose the layer Landsat8_229_63_29072016.tif. The screen at figure 13 will be shown.

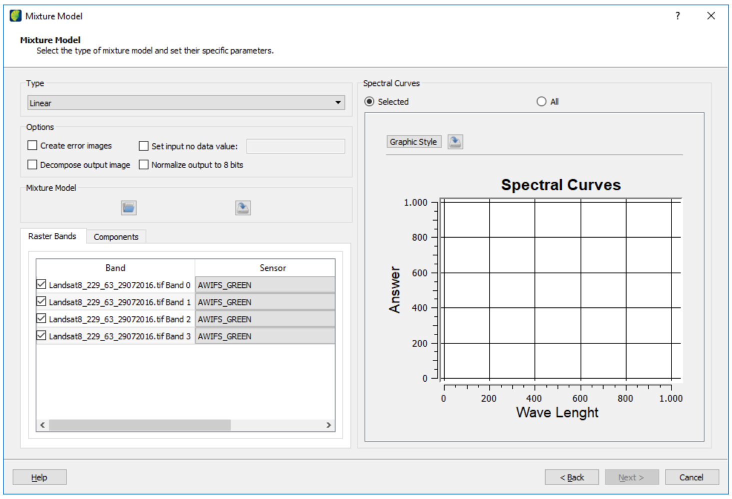


Figure 13: Mixture Model screen

The first step is to inform the sensor for each of the bands of the raster that will be used in the *Raster Bands* section, follow the example shown at figure 14.

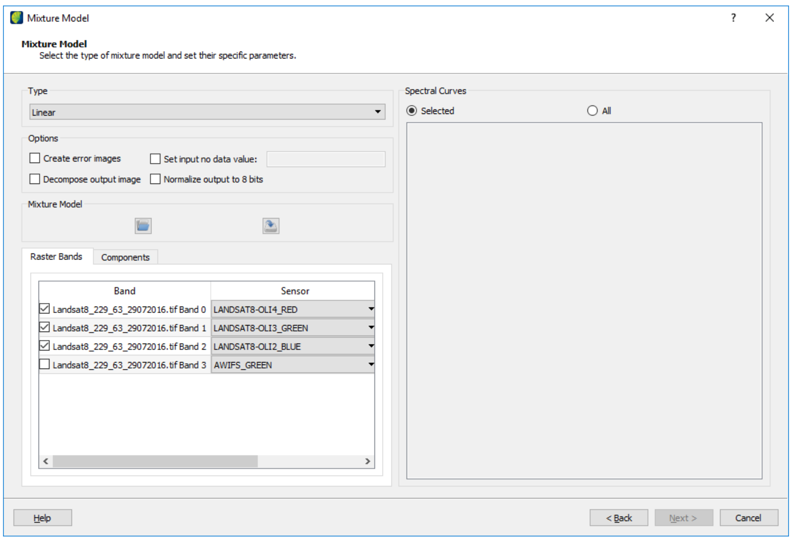


Figure 14: Defining the sensors for each bands

The next step is to click on the *Components* label. Then follow these steps:

1. Define a name for the sample in the *Component List*;
2. Define a color for the sample, using the color picker next to the name;
3. Click on the button, which activates the sample picker tool;
4. Click on a pixel of the image that represents the desired sample.

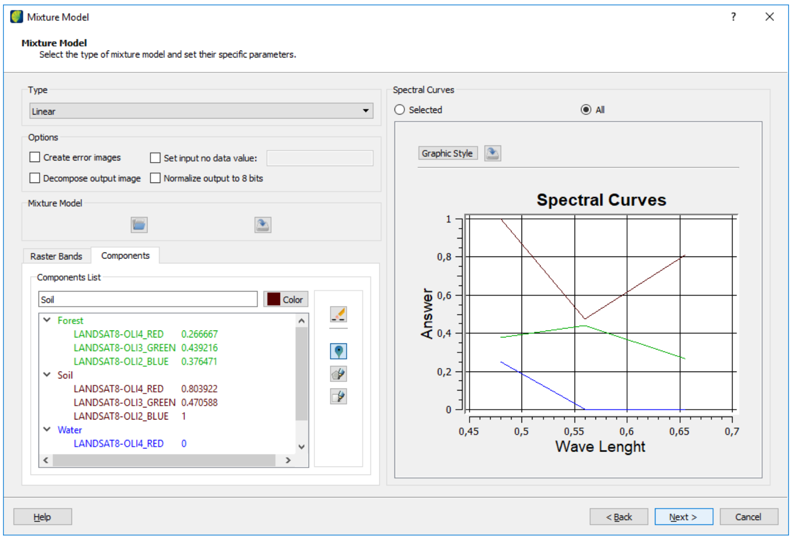


Figure 15: Defining the components for the Mixture Model

Once you've defined a few samples, click *Next* and follow the instructions at section 1.2.1.2 to define the output. A new layer will be generated, like shown in figure 16.

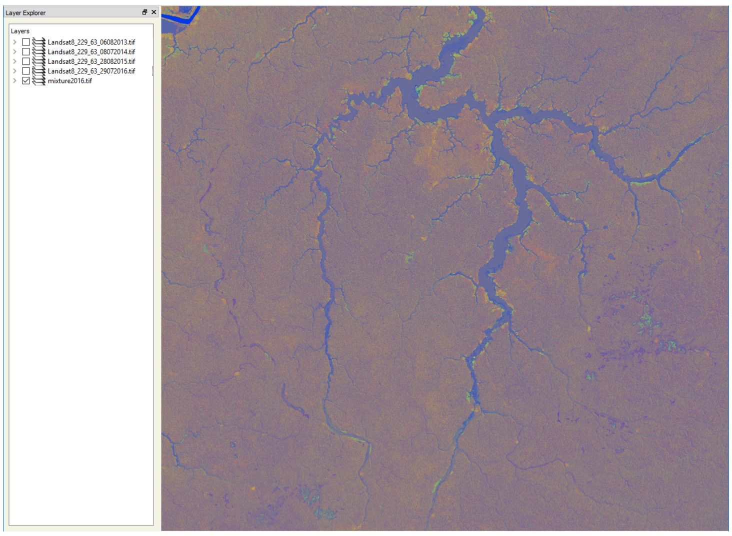


Figure 16: Mixture Model result

1.2.5 Segmentation

The **Segmenter** interface can be accessed through:

Processing -> Raster Processing -> Segmenter

It provides functions to segment a raster. The available methods are:

- **Region Growing:** Creates regions by merging similar neighboring pixels;
- **Based on Baatz and Shape:** Creates regions by merging similar neighboring pixels. Based on a user-defined scale and compactness.

The first screen that shows up is the layer selection screen, use the instructions from section 1.2.1.1 to select the layer Landsat8_229_63_29072016.tif and click *Next*. For this tutorial, only the *type* of the segmenter needs to be changed to Baatz. You can leave the parameters as shown at figure 17:

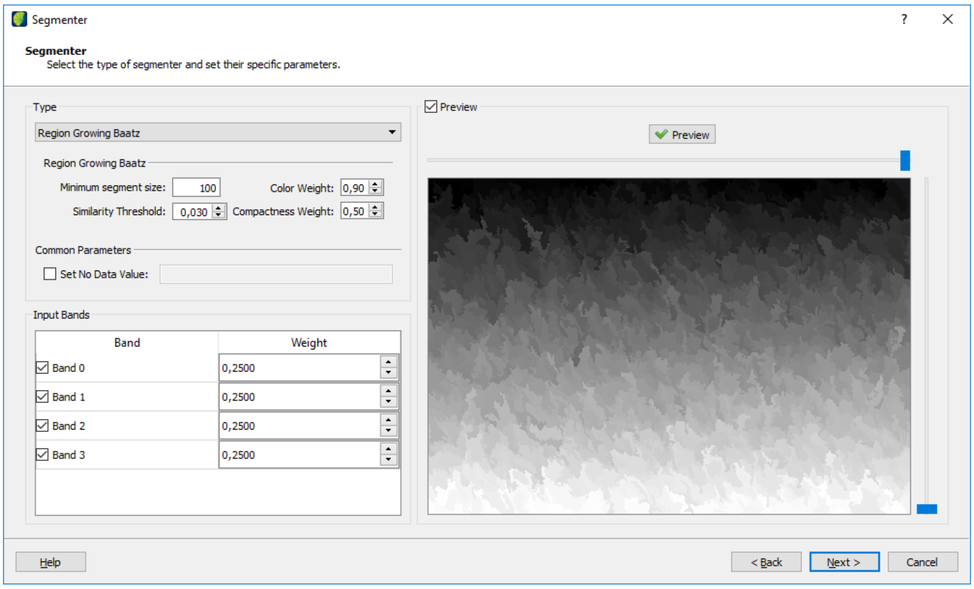


Figure 17: Defining the segmentation parameters

After defining the parameters, click *Next* and the screen shown at figure 18 will be shown. The only option that needs to be checked is the *Apply Vectorization* checkbox.

Once you are done, click *Next* and then use the instructions at section 1.2.1.2 to define the output file. A new layer will be generated in the layer explorer, click and hold on it with the left mouse button to drag it above the raster, then you can draw it like shown in figure 19.

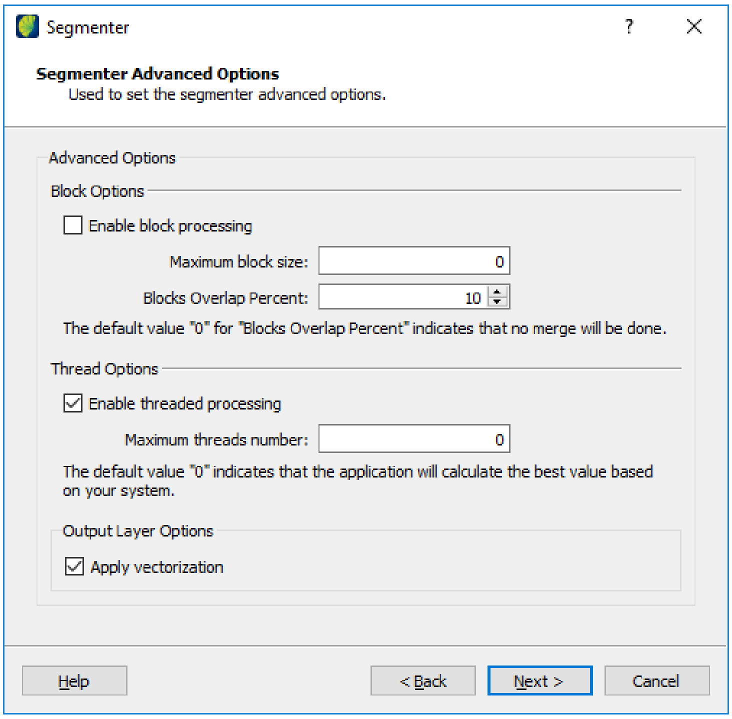


Figure 18: Defining advanced parameters - including vectorization

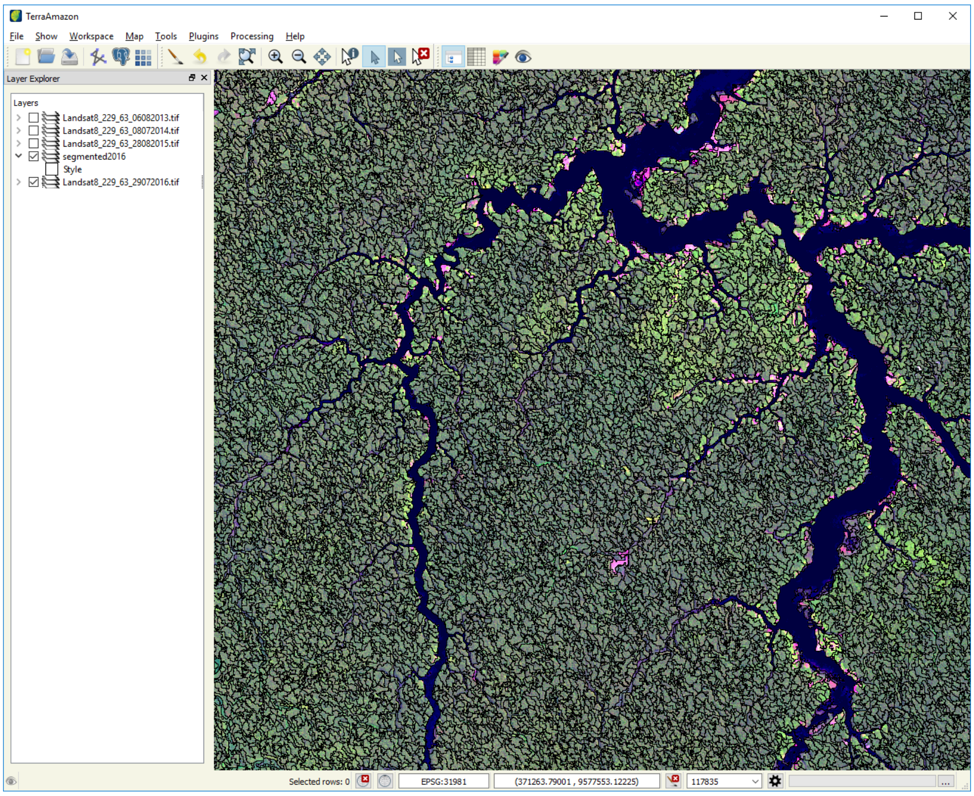


Figure 19: Segmentation result

1.2.6 Vectorization

The Vectorization operation converts raster data into vector data. This operation can be time consuming, so for this tutorial we will begin by clipping a raster file. Start by accessing the **Clipping** screen, shown at figure 20, through:

Processing -> Raster Processing -> Clipping

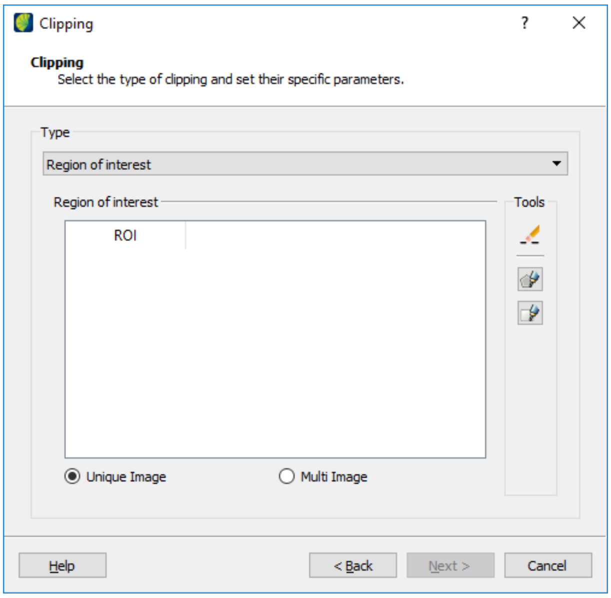


Figure 20: The clipping screen

Refer to section 1.2.1.1 if you need help choosing a layer. In this screen, click on the  button. Then click on the canvas and draw the region of interest, like in figure 21.

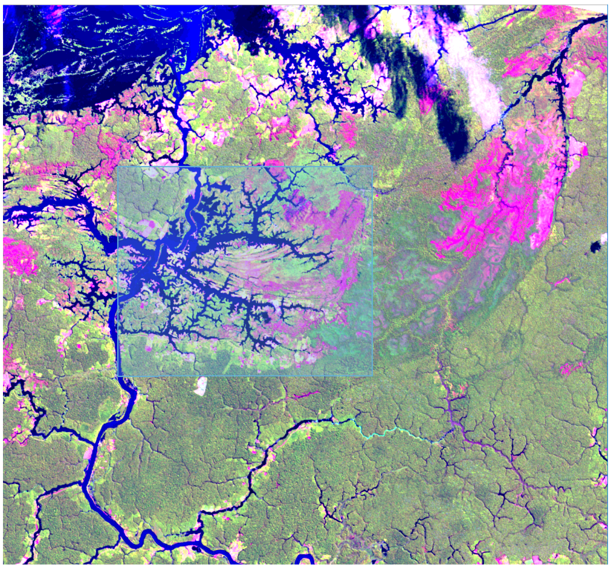


Figure 21: Creating a region of interest

After you have finished drawing a new item will be inserted in the *Region of Interest* list, like shown in figure 22, click *Next* and then use the instructions at section 1.2.1.2 to define the output file.

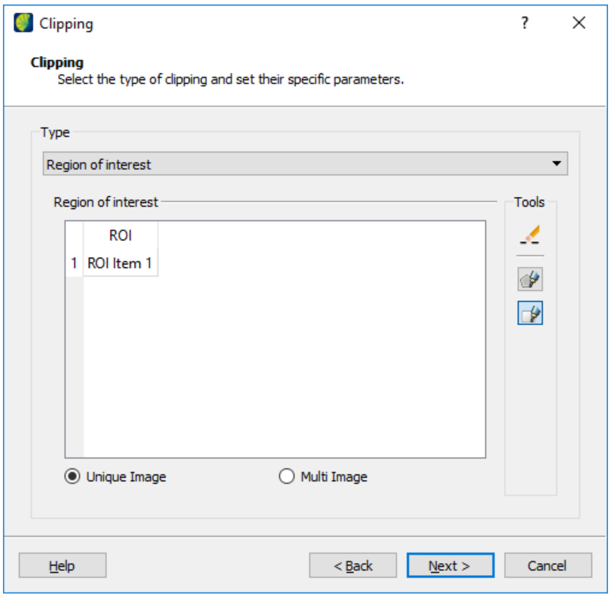


Figure 22: The region of interest has been created

Once the new layer has been created, you can use it for the vectorization function. Start by accessing it through:

Processing -> Raster Processing -> Vectorization

Use the instructions on section 1.2.1.1 to choose the clipped layer and you will see the screen shown at figure 23.

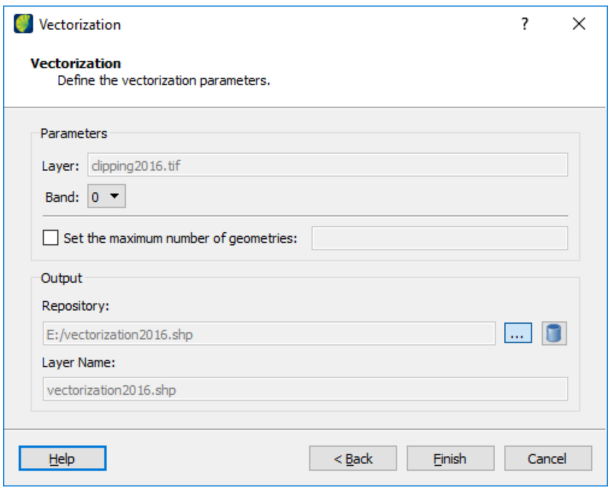


Figure 23: The vectorization screen

On this screen, click the ... button and define a name and location for the output file and click finish. Wait for the process to be over, the new layer will look like figure 24.

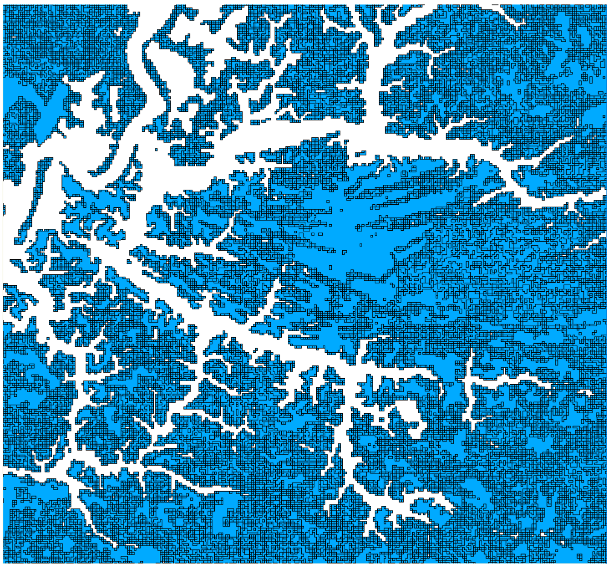


Figure 24: The vectorization result

1.2.7 Raster Slicing

The main use of image slicing is for visualization and interpretation of gray-scale events in an image of sequence of images. It can be accessed trough:

Processing -> Raster Processing -> Raster Slicing

The layer selection screen will show up, refer to section 1.2.1.1 for how to use it and choose the Landsat5TM_22963_23072008.tif. The screen at figure 25 will be shown.

Click the button and then click on the *Histogram* tag, that allows you to check histogram of the image and determine how the image should be sliced, like in figure 26.

Follow these steps to define the parameters that will generate the color palette:

1. Define the minimum and maximum values, 5 and 70 for example;
2. Define the number of steps (classes), like 10 for example;
3. Define the precision of the values, like 2 decimal places for example;
4. Define the color scheme, classification and Land Use 1 for example;
5. Click on the *Apply* button and you will see the color palette on the right;

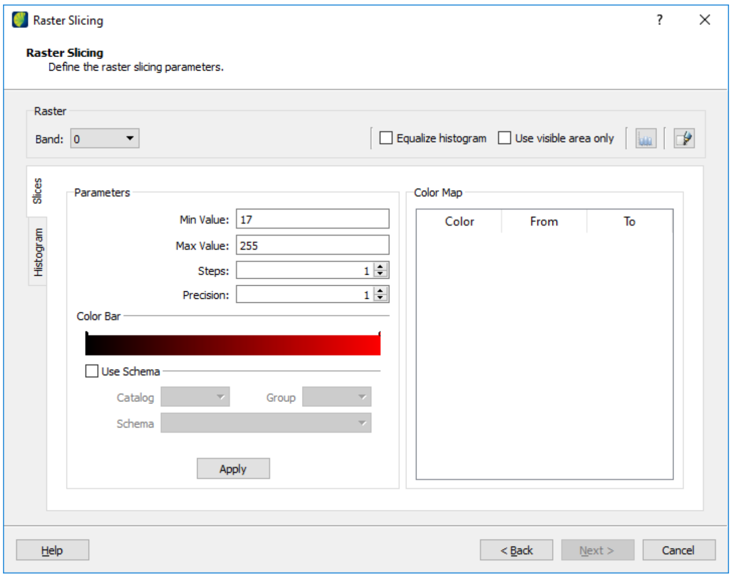


Figure 25: Raster Slicing screen

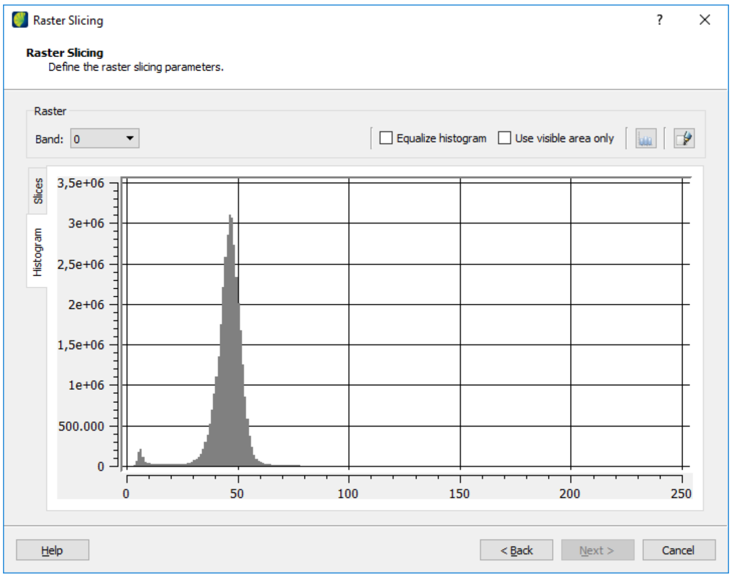


Figure 26: The histogram of the image

Once you are done, the screen should look like the example shown in figure 27, click *Next* and then use the instructions at section 1.2.1.2 to define the output file, the result should look like shown in figure 28.

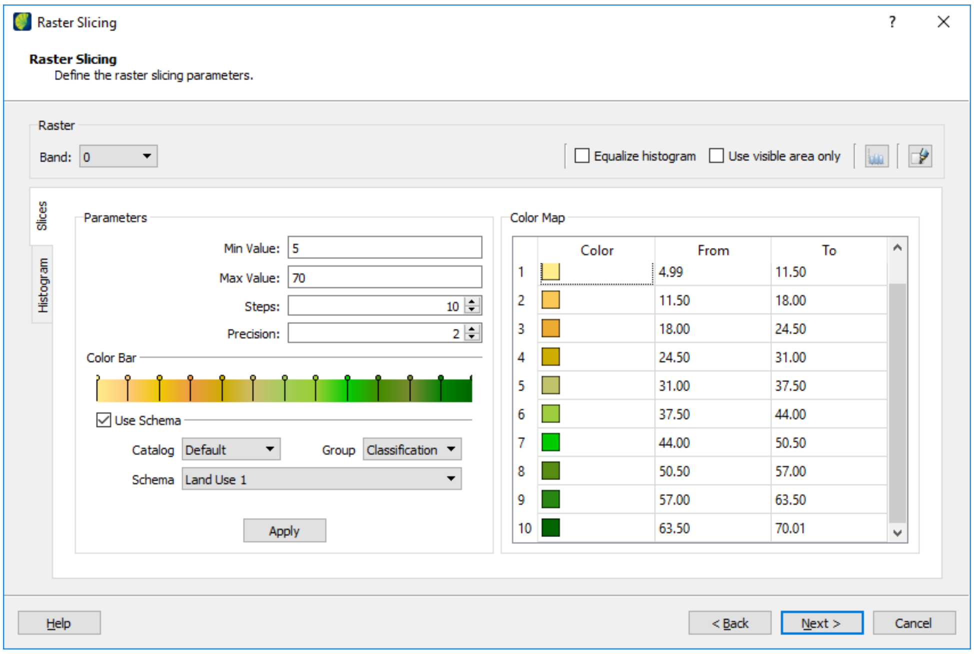


Figure 27: An example of the parameter configuration in the raster slicing screen

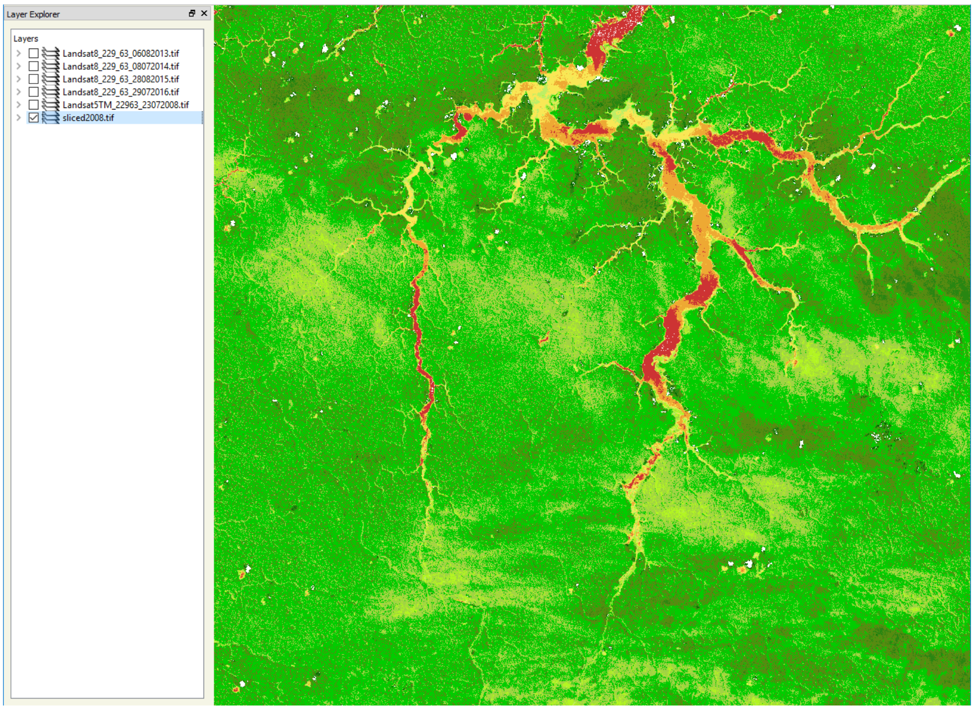


Figure 28: Raster slicing result

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