National Institute for Space Research



TerraAmazon 7 - Digital Image Processing

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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.						
00	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.						



Ø	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.
\mathbf{x}	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.
X	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.

ilter By Name	Filter By	Representation O Geometry Raster
Landsat8 229 63 06082013.tif		DATASETLAYER
E Landsat8_229_63_08072014.tif		DATASETLAYER
E Landsat8_229_63_28082015.tif		DATASETLAYER
🗮 Landsat8_229_63_29072016.tif		DATASETLAYER
Name	Folder	туре

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.

Pacter Info			
File			
E:/output.tif			
Name			
output			
Extra Parameter	5		
Extra parameters			
Parameter		Value	
example_param1	example_value1		
example_param2	example_value2		
			1

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.



0	Cor Com	mpose / Decor pose / Decon Select the opera	mpos npose ation (e Bands e Bands Compose / Decom	pose) and set their s	pecific parameter	?	×
	Со	mpose Bands	Dec	compose Bands				
		Band			Layer / Raster		+	
	1	1	-	Landsat8_229_6	3_29072016.tif		-	
	Int	erpolator						_
		Nearest Neighbo	or				•	
		ormanize to o bit						
	He	elp			< <u>B</u> ack	Next >	Cano	el

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.

Rast	
	ter
La	andsat8_229_63_29072016.tif
	Band
1	☑ Band 1
2	Band 2
3	Band 3
4 6	☑ Band 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.

ayer Search				
Allows selection of layers using filters to or multi layers for COMPOSITION	for selection.	Select or	ne layer for DECO	MPOSITIC
List of Layers				
Name	Folder		Туре	
🗟 Landsat8_229_63_29072016.ti	f		DATASETLAYER	2
🗧 🔁 Landsat8_229_63_28082015.ti	f		DATASETLAYER	2
🔁 Landsat8_229_63_08072014.ti	f		DATASETLAYER	2
🗧 🔁 Landsat8_229_63_06082013.ti	f		DATASETLAYER	2
decompose2016_3.tif			DATASETLAYER	2
🔁 decompose2016_2.tif			DATASETLAYER	2
🔁 decompose2016_1.tif			DATASETLAYER	2
😫 decompose2016_0.tif			DATASETLAYER	R
Filter By Name		Filter B		
		ritter by	Representation	
			O Geometry	Raster

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.

	Band	Layer / Raster
1	1	decompose2016_0.tif 🔹 🖃
2	1 •	decompose2016_1.tif
3	1 .	decompose2016_2.tif ▼
nte	erpolator	

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.

Mixture Model	? ×
Select the type of mixture model and set their specific parameters. Type Linear Options	Spectral Curves © Selected All
Create error meges Extraction data value: Create error meges Hormalze output to 8 bits Moture Model	Spectral Curves
Band Sensor 2 Landsat6.229, 53,20070016.4f Band 0 AV/P5_GREEN 2 Landsat6.229,53,20070016.4f Band 1 AV/P5_GREEN 2 Landsat8.229,53,20070016.4f Band 2 AV/P5_GREEN 2 Landsat8.229,53,20070016.4f Band 2 AV/P5_GREEN 2 Landsat8.229,53,20070016.4f Band 2 AV/P5_GREEN	
٢	0 200 400 600 800 1.000 Wave Lenght
Help	< Back Mext > Cancel

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.

Linear Iptions Create err Decompos	or images 📄 Set input no e output image 📄 Normalize o	o data value:	•	Selected	() All	
ptions] Create err] Decompos	or images Set input no e output image Normalize o	data value:				
Create err	or images Set input no e output image Normalize o	o data value:				
Decompos	e output image 🗌 Normalize o	utput to 9 bits				
ivture Model						
vture Model						
laster Bands	Components					
	Band	Sensor				
Landsat	8_229_63_29072016.tif Band 0	LANDSAT8-OLI4_RED	-			
🗹 Landsat	8_229_63_29072016.tif Band 1	LANDSAT8-OLI3_GREEN	-			
Landsat	8_229_63_29072016.tif Band 2	LANDSAT8-OLI2_BLUE	-			
Landsat	8_229_63_29072016.tif Band 3	AWIFS_GREEN	-			

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 \checkmark 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:

🌍 Segmenter			?	×
Segmenter Select the type of segmenter and	d set their specific parameters.			
Type		Preview		
Region Growing Baatz	•	V Preview		
Region Growing Baatz				
Minimum segment size:	100 Color Weight: 0,90 🜩	영상 지수는 것이 아파 관계에 가지 않는 것이 아파 것이 하는 것이 같아.	Ē	
Similarity Threshold: 0,0	30 🗘 Compactness Weight: 0,50 🗘			
Common Parameters				
Set No Data Value:				
Input Bande				
Band	Weight	이는 것을 만큼 못 없는 것이 가지도 않지?		
Band 0	0,2500			
Band 1	0,2500			
Band 2	0,2500			
Band 3	0,2500		2	
		비 해외에서 잘 즐기가 사람을 사용하는 것을 수 있다.		
				_
Help		< <u>B</u> ack <u>N</u> ext >	Cano	el

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.





Segmenter	?	×
Segmenter Advanced Options Used to set the segmenter advanced options.		
Advanced Options		
Block Options		_
Enable block processing		
Maximum block size: 0		
Blocks Overlap Percent: 10 🚖		
The default value "0" for "Blocks Overlap Percent" indicates that no merge	will be done.	
Thread Options		_
☑ Enable threaded processing		
Maximum threads number: 0		
The default value "0" indicates that the application will calculate the best value on your system.	alue based	
Output Layer Options		
Apply vectorization		
Help < Back Next >	Cano	el

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

Clipping		?
lipping Select the type of clipping a	nd set their specific parameters.	
Туре		
Region of interest		-
Region of interest		Tools
ROI		<u>~</u> Ø
Unique Image	🔿 Multi Image	
Help	< Back N	evt > Cancel

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 \checkmark 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.

Clippin	ng			?	Х
Sele	ect the type of clipping and	set their specific parameters.			
Type	n of interest			•	•
Regi	on of interest			Tools	
1	ROI ROI Item 1			<u>~</u>	
۲	Unique Image	🔿 Multi Image			
<u>H</u> elp		< <u>B</u> ack	Next >	Canc	el

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.

Vectorization			?	×
Vectorization Define the vectorization parameters.				
Parameters				
Layer: dipping2016.tif				
Band: 0 🔻				
Set the maximum number of geometries:				
Qutnut				
Repository:				
E:/vectorization2016.shp			[
Layer Name:				
vectorization2016.shp				
Help	< Back	Finish	Cano	al
Teb	< Educ	- Linsin	Cane	

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;



Raste Band:	r 0 ~		Eq	ualize histogram	Use visible a	rea only	1
Slices	Parameters			Color Map			
=	Min Value	2: 17		Color	From	То	
ograr	Max Value	255					
Histo	Step	s:	1 🗘				
	Precision	1:	1 🗘				
	Color Bar						
	Use Schema						
	Catalog	Group	~				
	Schema		~				
		haalu					

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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