

Student Guide

Tracking Change Over Time—Using MultiSpec to Interpret Satellite Imagery

1. Basics of RGB

Before we start opening and working with satellite images in MultiSpec, we need to understand more about how satellite sensors record images. All of the colors in a satellite image, similar to images on a television or computer monitor, are made up of a combination of red, green, and blue, or RGB for short.

The satellite sensors that captured the images you are studying record images in grayscale—each pixel is assigned a value of brightness on a scale from 0 to 255. Black is 0, and white is 255, and shades of gray are in between. (Landsat 8 uses values of brightness on a scale from 0 to 4,095!) These grayscale images are assigned the color red, green, or blue, which display the brightness of each of these colors. When we combine the three images, we get a false color image. With all of the possible combinations of red, green, and blue values, this provides for a display system capable of providing over a million different colors. Try this color slider to see how this works: http://www.calculatorcat.com/free_calculators/color_slider/rgb_hex_color_slider.phtml.



Color slider

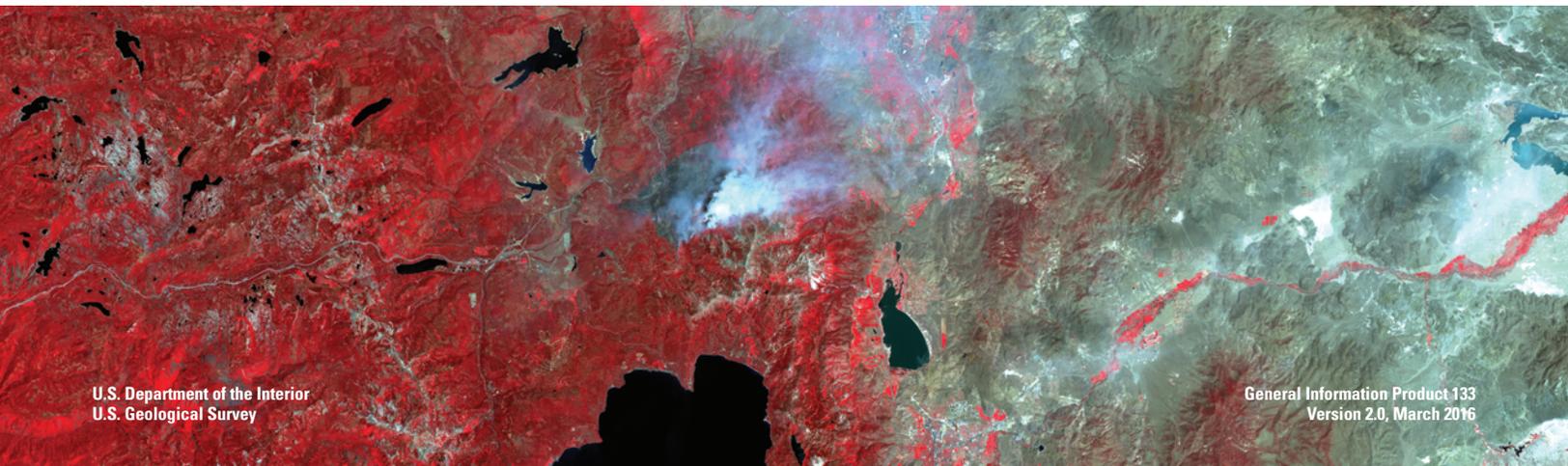
Stop and Check

- What happens when you set all three colors to the same value, such as 150?
- What happens when you make all three colors equal to 255?
- Try setting two of the colors to 255 and one to 0. In this color system, for example, red and green combine to make yellow. What other combinations do you notice?

2. Band Combinations

Landsats 7 and 8 collect several images at once. Each image shows a specific section of the electromagnetic spectrum, called a band. The two tables below show the bands that Landsats 5 and 7, and Landsat 8, collect.

Landsat 5, 7			
Band	Portion of Spectrum	Use	Wavelength (micrometers)
1	blue-green	Monitor sediment in water, map coral reefs, and water depth; can also be used to distinguish forest types	0.45–0.52
2	green	Monitor vegetation health, identify human-made structures	0.52–0.60
3	red	Help identify plant species; can help highlight barren lands, urban areas, and street patterns	0.63–0.69
4	near-infrared	Monitor vegetation (leafy plants reflect this band well)	0.76–0.90
5	mid-infrared	Measure vegetation moisture content and soil moisture	1.55–1.75
6	thermal infrared	Measure surface temperature, identify rock types; detect changes in ground temperature caused by moisture variation	10.4–12.5
7	mid-infrared	Monitor moisture content in soil and vegetation; identify minerals	2.08–2.35
8	panchromatic	Used to make images sharper	0.52–0.90



Landsat 8			
Band	Portion of Spectrum	Use	Wavelength (micrometers)
1	coastal aerosol	Coastal and aerosol studies	0.43–0.45
2	blue	Monitor sediment in water, distinguishing soil from vegetation and deciduous from coniferous vegetation	0.45–0.51
3	green	Emphasizes peak vegetation	0.53–0.59
4	red	Discriminates vegetation slopes	0.64–0.67
5	near-infrared	Monitor vegetation (leafy plants reflect this band well)	0.85–0.88
6	shortwave infrared 1	Discriminates moisture content of soil and vegetation, can see through thin clouds	1.57–1.65
7	shortwave infrared 2	Discriminates moisture content of soil and vegetation, can see through thin clouds	2.11–2.29
8	panchromatic	Used to make images sharper	0.50–0.68
9	cirrus	Detect cirrus clouds	1.36–1.38
10	thermal infrared 1	Estimates soil moisture	10.60–11.19
11	thermal infrared 2	Estimates soil moisture	11.50–12.51

Landsat 7 and Landsat 8 also use a panchromatic band. This band captures visible and infrared bands at 15-meter resolution and can be used to sharpen images from the other bands. We will not be dealing with the panchromatic band in this lesson.

Three of the bands are combined to form an image, each band assigned red, green, or blue in that order. Different band combinations reveal different details about the surface. In MultiSpec, you will be able to change the band combinations to help identify different features in satellite images.

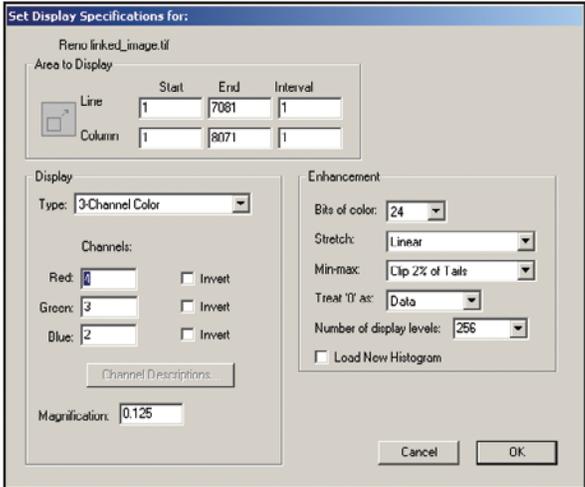
Here are some commonly used band combinations and what they reveal:

Landsat 5	Landsat 8	Landsat 7	Description
3,2,1	4,3,2		this band combination is the closest to natural color; used in urban studies and to detect sediment in water
4,3,2	5,4,3		actively growing vegetation = red urban areas = shades of light blue soils = dark to light brown
7,4,2	7,5,3		actively growing vegetation = bright green sparsely vegetated areas = oranges and browns urban areas = varying shades of magenta dry vegetation = orange barren soil = pink
4,5,1	5,6,2		healthy vegetation = reds, browns, oranges, and yellows soils = greens and browns urban areas = white, light blue, and gray
5,4,3	6,5,4		healthy vegetation = bright green soils = pale lavender

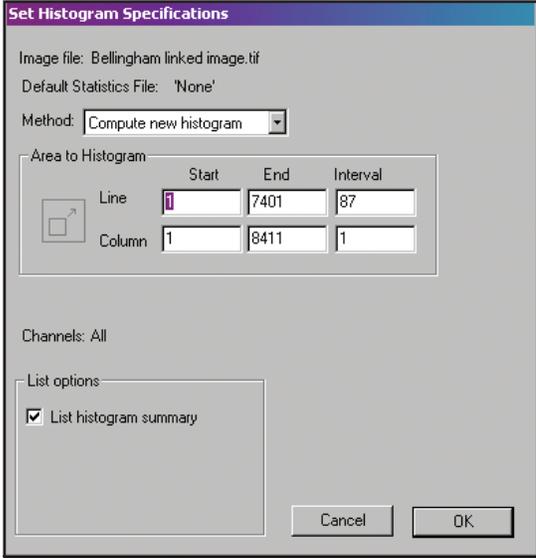
3. Working Your Way around MultiSpec



1. Launch MultiSpec
2. Open the Reno image, which is a Landsat 7 image
 - a. In the File menu, select “Open Image.”
 - b. In the Open dialogue box, locate the filename *Reno.tif* and click Open.
 - c. The “Set Display Specification for:” box will appear. The name of the image you opened will appear at the top of this box. Leave all of the defaults as they are and click OK.



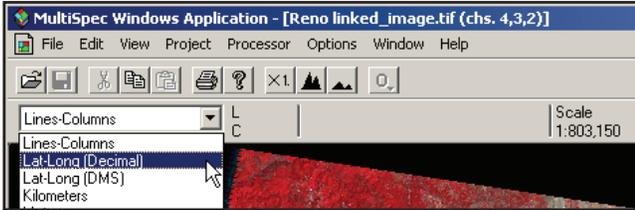
- d. The “Set Histogram Specifications” window appears; leave all of the default settings and click OK.



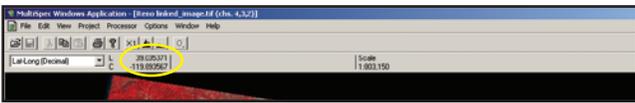
3. How to zoom (magnify the image)
 - a. Use the mountain buttons on the Tool Bar to zoom.



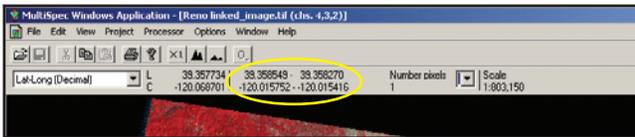
- b. The large mountains zoom in, and the small mountains zoom out.
 - c. Hold down the Ctrl key to zoom slower.
 - d. Click “X1.” to make the image 100% in size.
4. How to find a particular latitude-longitude (lat-long)
- a. In the Window menu, select “Show Coordinate View.”
 - b. In the drop-down menu at the upper left, change the units to “Lat-Long (Decimal).”



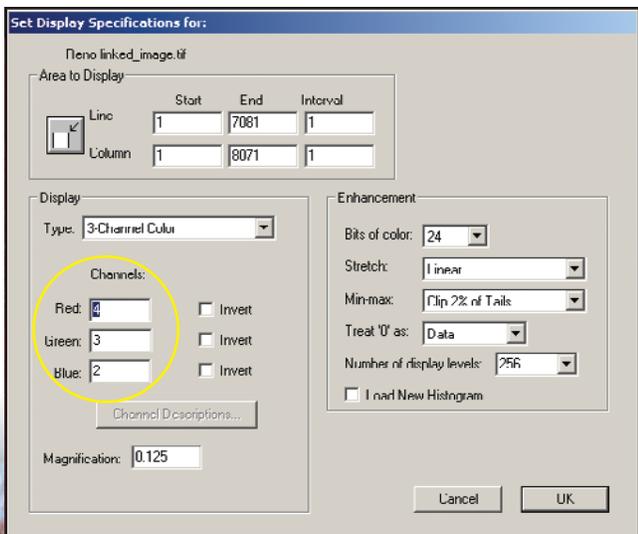
- c. Move the mouse around over the image. Notice how the numbers change.



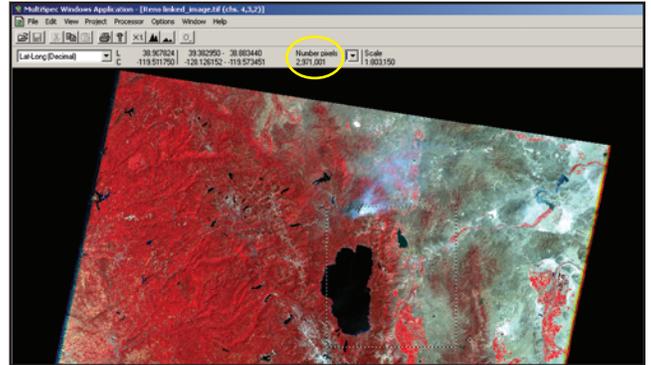
- d. Keep moving the mouse until you are at the latitude-longitude (lat-long) coordinates you want. A forest fire near Reno is at about 39.35° latitude, -120.00° longitude. Click once on the image when you are at these coordinates; you do not have to be too exact.
- e. Now notice that the lat-long numbers on the right stay locked.



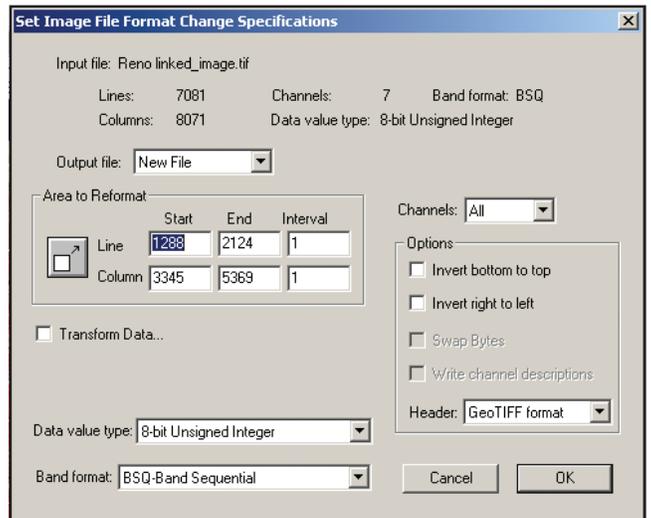
- f. Now you can zoom in on that lat-long and that point will stay in the center until you select another point.
5. How to change band combinations.
- a. In the Processor menu, select “Display Image.”
 - b. In the “Set Display Specifications for:” dialogue box, change the numbers under “Channels.”



- i. You will only be able to enter numbers 1–7 because there are 7 bands.
 - c. Click OK.
6. How to crop.
- a. Click and hold while dragging the mouse to choose a rectangular area to crop. Watch the number under “Number pixels” as you drag; this is the number of pixels that will be in the cropped image. An area less than 3,000,000 pixels should fit on most screens.



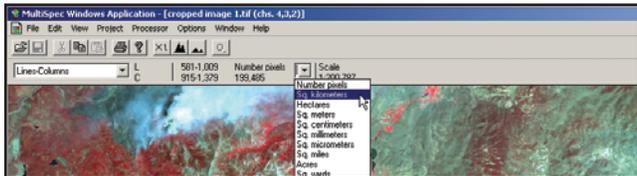
- b. In the Processor menu, choose “Reformat” and “Change Image File Format.”
- c. In the “Set Image File Format Change Specifications” window, leave all of the default settings.



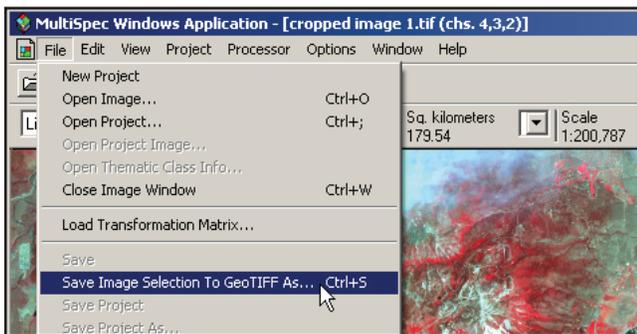
- d. Click OK.
- e. Choose where to save the new cropped image and give the image a filename, such as “cropped image 1.tif” (make sure the filename has “.tif” at the end). Click Save.
- f. Open the image you just cropped (see Step 2).
- i. In the “Set Display Specifications for:” window, you can choose the band combination you want to view, or just click OK.



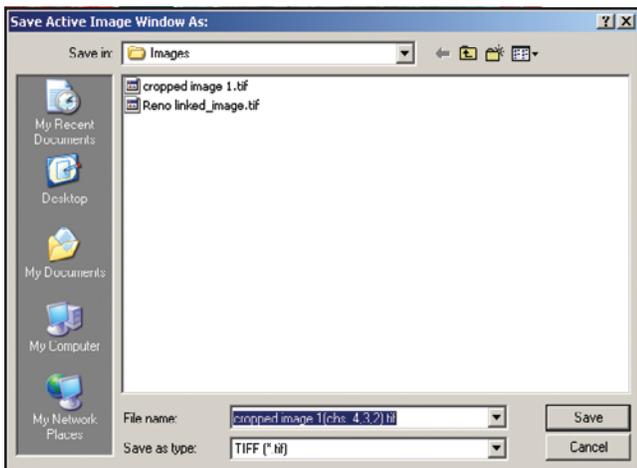
- ii. The “Set Histogram Specifications” window will appear next; leave all of the default settings and click OK.
 - g. Now it should be easier to see more detail in your image.
7. How to calculate area.
- a. In the Window menu, select “Show Coordinate View.”
 - b. Click and hold while dragging the mouse to choose a rectangular area.
 - c. Next to “Number pixels” is a drop-down menu. Use this to select “Sq. kilometers” or another unit.



- d. MultiSpec now displays how many square kilometers (or other unit) make up the area you selected.
8. How to save.
- a. In the file menu, select “Save Image to GeoTIFF As...”



- b. The “Save Active Image Window As:” window appears.
- c. The filename has the band combination added. Click Save.



4. Experiment with the Reno image

Use the MultiSpec instructions and the suggested band combinations to answer the following questions about the forest fire near Reno, NV.

- Look again at the table with the commonly used band combinations for Landsat 7. Which band combination shows most clearly the size of the area burned by the fire?
- Which commonly used band combination shows most clearly the extent of smoke?
- Of the following band combinations, which one allows you to filter through the smoke and observe land surface features? 7,5,3; 5,4,3; 7,4,1; 6,5,5; 4,2,1
- Of the following band combinations, which one shows where the fires were burning at the time of the image? 4,2,1; 6,5,5; 7,5,3; 6,3,6; 5,3,2
- Of the following band combinations, which ones best show the urban area in this image? 3,2,1; 5,4,1; 7,5,3
- Which commonly used band combination best shows agriculture and vegetation?
- Imagine you are a remote sensing specialist living and working in Reno, and you are studying satellite images of this fire. Because the images show a lot of smoke, you want to send out warnings to residents about air quality. What direction is the smoke blowing at the time of this image? How can you tell? Which, if any, residential areas need to be warned?
- Challenge: Estimate the area, in square kilometers, that has been burned by the forest fire in this image. (See Step 7 in the previous section.)

