Image Processing Lab Exercise #2:

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Introduction to Image Metadata, Stretching, Cursor Functions, and Spectral Profiles

Objectives:

- Understand how to open different image formats and header input files
- Learn to edit and define ENVI header files
- To introduce contrast stretching and other tools
- To understand and create spectral profiles and histograms

Data Used in this Lab

FlKeys.tif (Quickbird data in .tif format)
Boulder-ETM.dat (Enhanced Thematic Mapper+ data)
bldr_tm.dat (Thematic Mapper data)
qb_boulder_msi (Quickbird data)
new_zeal_wv2_sub.dat (WorldView 2 data)

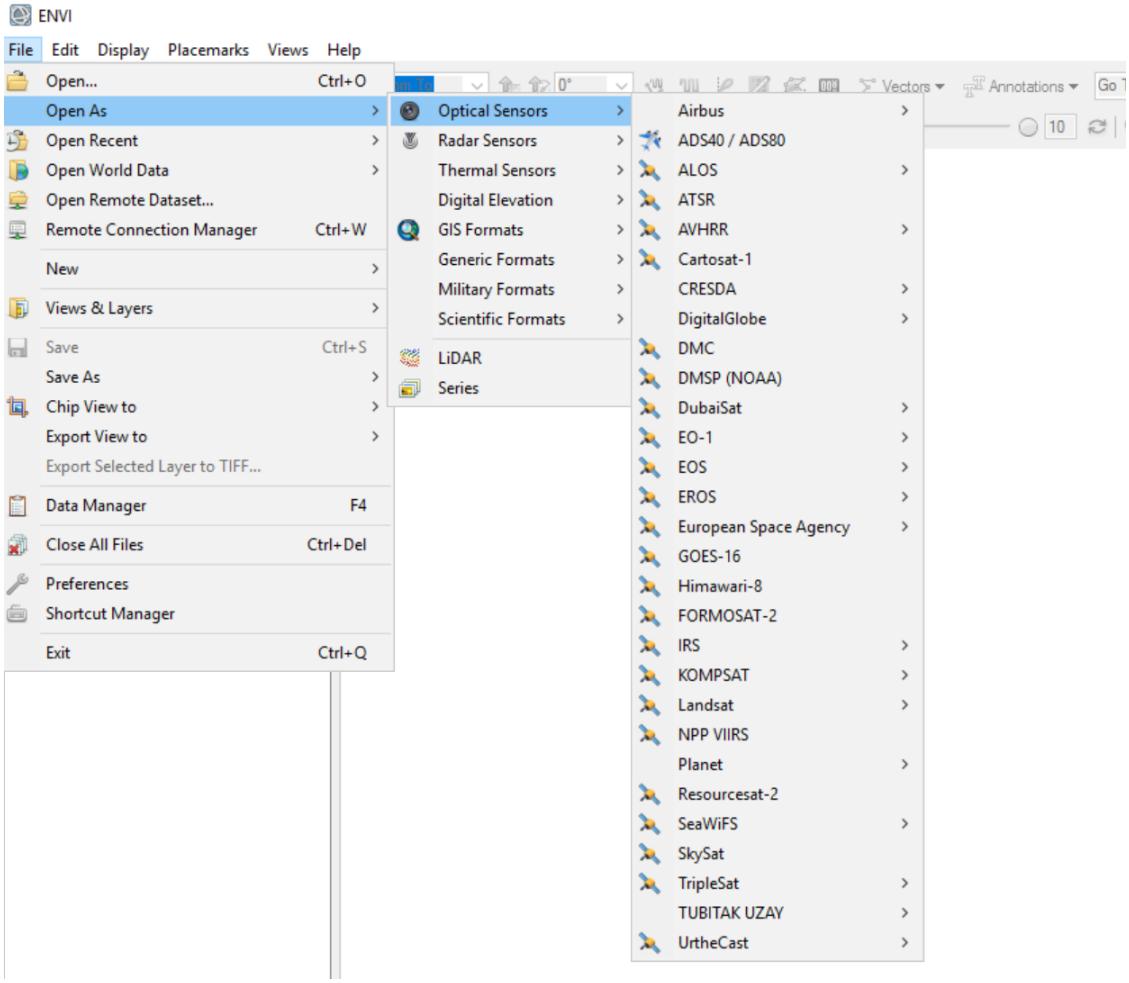
Background

A multi-spectral image can be organized and stored by ENVI in one of three basic formats: Band Interleaved by Pixel (BIP), Band Interleaved by Line (BIL), and Band Sequential (BSQ). ENVI adopted these three formats as its internal raster data format. The header file you will commonly see (.hdr) is an ASCII file. It contains the metadata about the image, often including the information about the number of rows (lines), the number of columns (samples), the radiometric resolution, map projection, and spatial resolution. The mean, standard deviation, minimum value, maximum value, and histogram of the image digital number are often used to characterize the digital images statistically. Another format file you may see is the .enp file, which is a "pyramid file" that also includes the metadata but also includes information about how the software will zoom in and out. Opening either one from ENVI will open the data. Note that if you open with the .enp file, the Data Manager window opens and requires you to set the R, G, and B bands. What happens when you open the .img, .tif, or no filename extension files? This is not a question to be answered, just tried.

Throughout these introductory labs feel free to play around in the ENVI environment. You cannot mess up! Even if you do something to corrupt the original data that you download (highly unlikely!) then you can download the data again from the original folder I provided. The best way to learn the setup and functionality of this RS software is to explore. There are numerous applications of ENVI that we cannot cover during the semester. By exploring and playing with the software you can start to learn some of these on your own. Later on, if you do not know how to do something, simply search on Google! Somewhere, somebody has had your problem, solved it, and posted it to the Web where it will be discoverable with a good search engine.

Part I: Image Formats

ENVI is one of several commonly used image processing packages. Others you may have heard of include ERDAS Imagine, ER Mapper, IDRISI, QGIS, MultiSpec, SPRING, or even packages in R or Python. Each of these software packages has its own strengths and weaknesses. Furthermore, there are hundreds of different formats for storing image data, which can often make working with remote sensing data difficult. ENVI uses a very flexible method for importing raster data that allows virtually any type of image data to be imported. ENVI can directly read native image data from almost all instruments currently or formerly flying. Open the **File: Open As…** link to see all of the alternatives (see screen below). This list is just the optical sensors, and many of these have additional formats available. Look at all the links to see all of your options. There is also a page in the ENVI help files ("Help" on the Menu Bar):
Help> Contents> Explore Data > Supported Data Types. Now is a good time to become acquainted with the ENVI help files. Look up the Supported Data Types help entry.

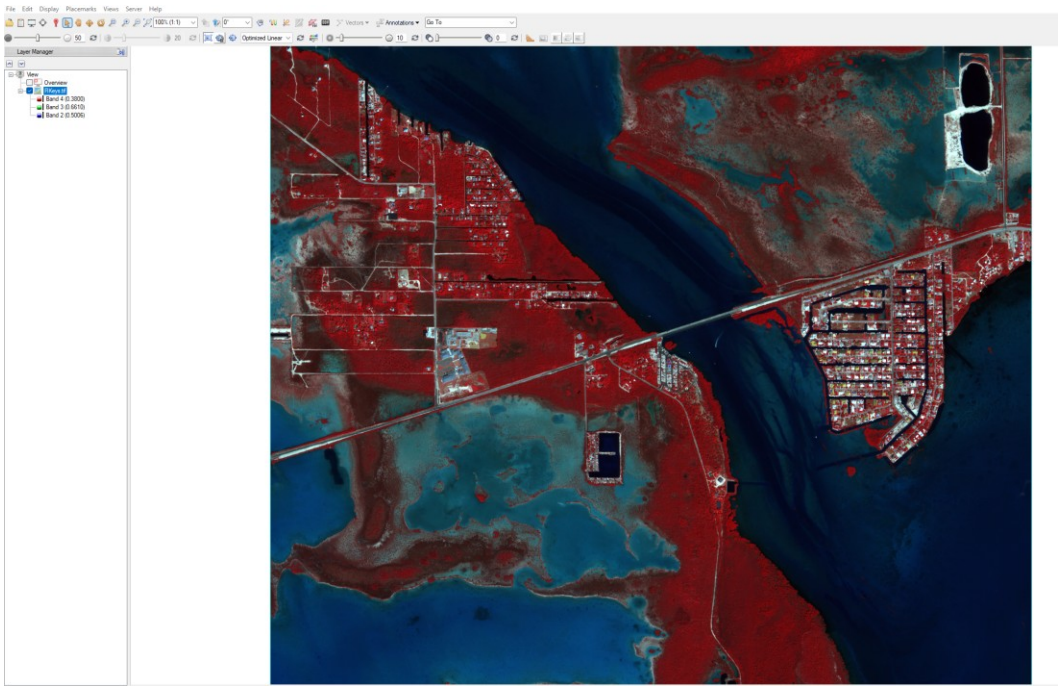


When one of these images is opened, it will appear on the screen very quickly. Also, when you move around, zoom in, or zoom out within the image, the display will update smoothly and rapidly. The reason for this is that ENVI uses pyramid files which are copies of the data file at various reduced resolutions. ENVI builds pyramid files the first time the data are opened. If ever asked if you want to build pyramids always say yes. This may require a bit more loading time but later work will be much quicker. Pyramids are used to speed image display by reducing the resampling required when displaying large portions of an image at low resolution. The following exercise will

walk you through reading an image into ENVI. This way of opening an image varies from the way in which we opened an image in the previous lab.

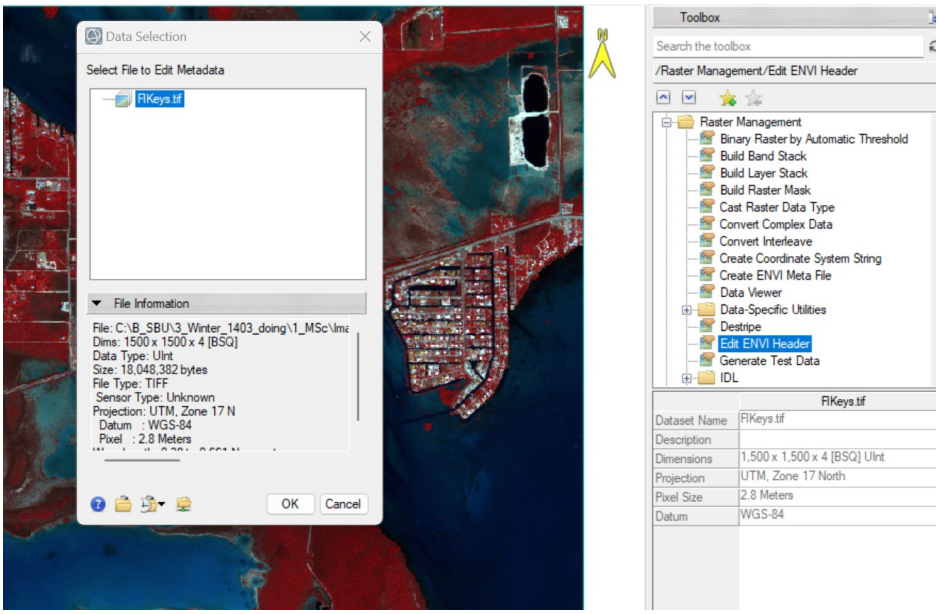
Opening an Image

1. From the ENVI menu bar, select **File --- Open** and navigate to the Lab 2 folder (this may be a good time to specify your Lab 2 Data folder as the input folder in the Preferences, and an output folder of your choice), *select FlKeys.tif.enp*, and click **Open**. Be patient! sometimes it takes a while to load these very large filed.

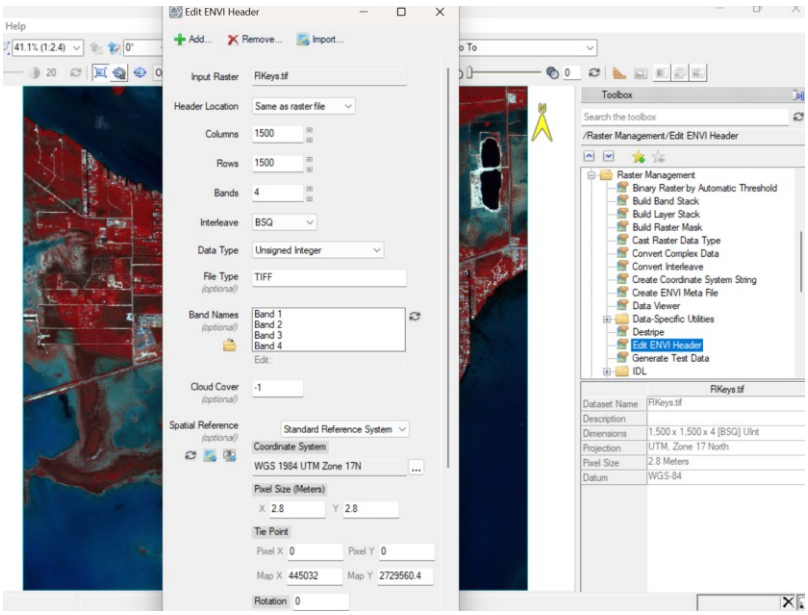


ENVI's numerous custom readers make it possible to read very complicated formats, such as the 10-bit compressed AVHRR Level 1B, RADARSAT, or TOPSAR data. In addition, ENVI can read formats from other vendors, such as Multi-Resolution Seamless Image Database (MrSID) or Enhanced Compressed Wavelet (ECW) images. When using one of the custom readers for file import, ENVI automatically extracts all of the information contained in the input file (from the .hdr file) and enters its image bands into the Available Bands List. In some cases, the image format being read includes not only the information required for reading the data itself but also ancillary information such as georeferencing data, wavelengths, or band names. You are not required to know any details about data files to import them into ENVI.

2. Once the image is fully displayed (and after **Zooming to Full Extent** ), expand **Raster Management** from the ENVI Toolbox, and double click on **Edit ENVI Header**.



3. In the Edit Header Input File dialog, click on the FlKey.tif under the **Select File to Edit Metadata**. The **Data Selection** window opens. Expand the **File Information** dropdown and note the dimensions, interleave, data type, and file size listed in the File Information panel. Click **OK**. The Edit ENVI Header dialog appears. *This exercise is continued in part II. Keep the Header Info dialog open.*



Part II: Opening, Understanding, and Editing the Header File

Image files stored in ENVI have an ENVI header file associated with them. This is true even for images that are stored in memory only or that are imported intro ENVI in their native format (without being converted into ENVI image format). The ENVI header file is a small ASCII file that

contains the basic information that ENVI must know in order to read the image data (number of samples, lines, and bands), and ancillary information (band names and wavelengths).

Editing an ENVI Header File

4. In the Header File dialog, examine the optional fields available. Some fields are only appropriate for special file types so they are unavailable (grayed out).

5. Scroll down to **Wavelengths**. The central wavelengths for the bands appear. Although they are already entered, you can practice editing them. First click on **Band 1**, then in the text edit window that appears type in 0.485 and hit the <Enter> key.

6. Band 2 is automatically selected. For Band 2 type in a value of **0.560** and hit the <Enter> key.

7. For Band 3 use a wavelength value of **0.660** and for Band 4, a value of **0.830**.

8. Click on the drop-down menu for **Wavelength Units** and change the alternatives to **Micrometers** if it is not. Then click **OK**.

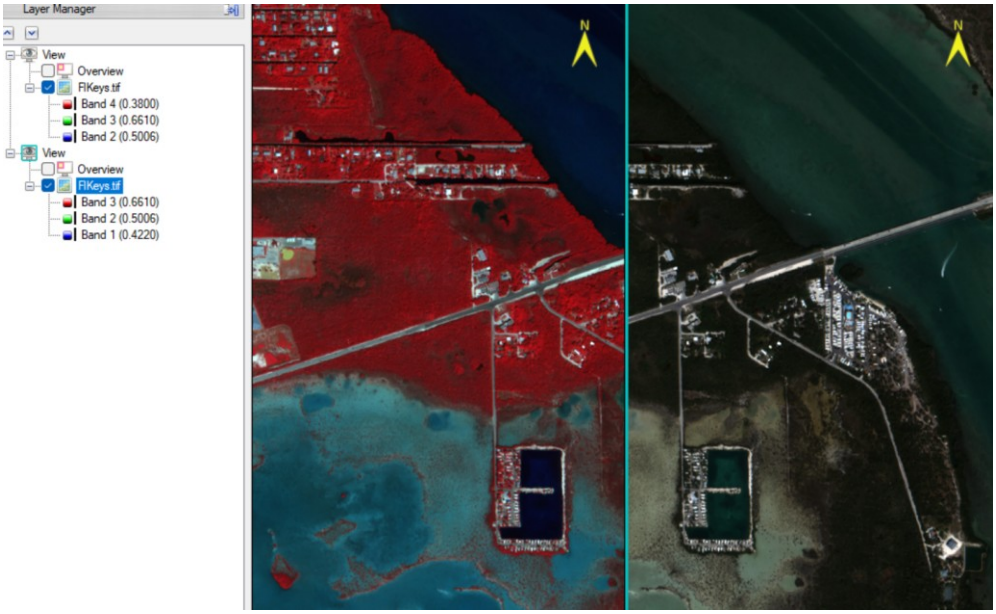
9. The **Spatial Reference** header field defines georeferencing information for the image by specifying the projection into which the image is geometrically corrected, as well as a reference pixel for which a map coordinate and pixel size are defined. The Map Information for the Florida Keys QuickBird image was filled out automatically by ENVI's custom QuickBird reader when the image was opened.

10. Click **OK** again to exit the Edit ENVI Header Info dialog.

11. In the Layer Manager all layers may automatically be removed, depending on how you have set your preferences. If they are not removed, right click on the **View** listing and select **Remove All Layers**

12. Open the FlKeys.tif file again and select or open the **Data Manager**. Create a color infrared composite (learned in lab 1). Select **Load Data.** If your preferences are already set to open data with a color infrared composite, then you don't have to do anything special.

13. Create a second composite in a **New View** (remember from Lab 1 using the **Views** commands) using the **Data Manager**. This time make a true color composite. Notice what you can see clearly in each image, and what seems to be obscured in each image



Now, remove all views including the images in the layer manager.

Part III: Visualizing Layers

Portals, Blend, Flicker, and Swipe help you compare two different layers. You can use these tools for comparing entire images or you can use them inside of a portal (you will learn this in the next step). **These tools are enabled only when you have two or more layers open in the Layer Manager, and when you display at least one layer in the display.**

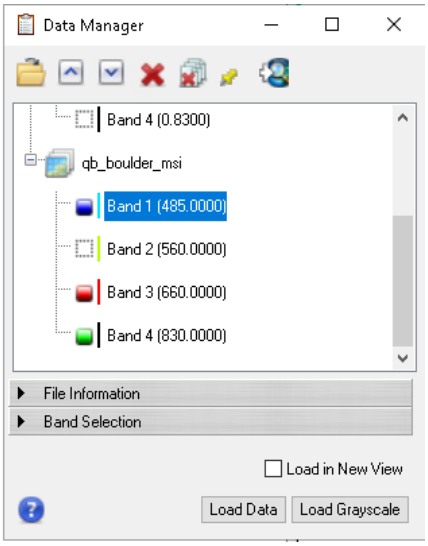
Open the qb_boulder_msi.enp image in a new window, then:

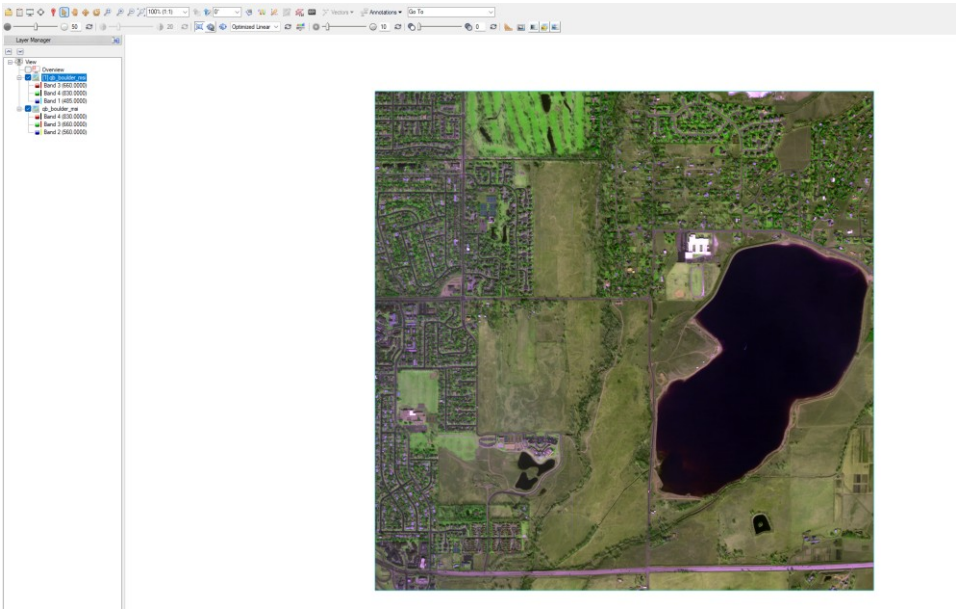
Portals, Swipe Blend, Flicker

A portal is a window inside the display that allows you to view a layer below. A portal is listed as a separate layer in the Layer Manager with a distinctive icon.

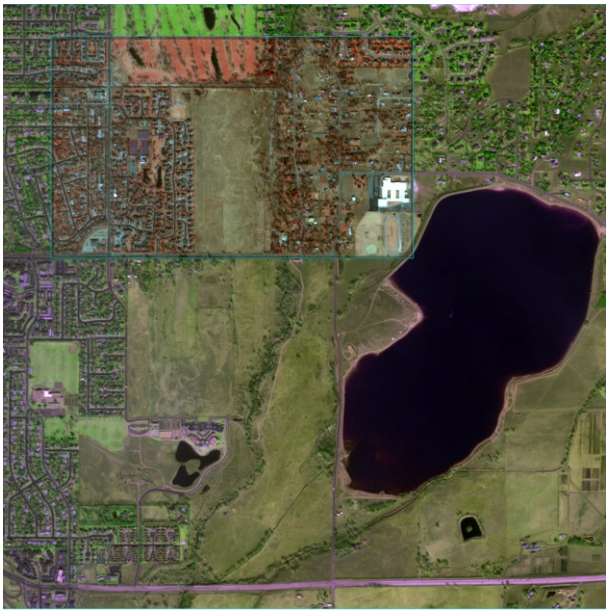
1. Right click the qb_boulder_msi composite images and select **Zoom to Full Layer Extent**. Be sure to turn the layers on.

2. Open the Data Manager icon  if the Data Manager is not already open. Use the Band Selection tool at the bottom of the Data Manager to choose bands for display. Click on Band 3 to load it as Red, click on Band 4 to display it as green, and click on Band 1 for Blue. Then click Load Data to display the selected bands as a new layer and close the Data Manager.





3. You will now see two images listed in the Layer Manager in the same view, and the Portal, Blend, Flicker, and Swipe icons  above the display are now selectable. Click the Portal button  on the toolbar. ENVI creates a Portal to display the lower layer, which is listed in the Layer Manager with the Portal icon. If you have more than two layers open and you want to see one of the lower layers in a Portal, right click on that layer in the Layer Manager and choose Display in Portal.



4. Click and drag inside the Portal to move it around the Image window.

5. Click and drag on a corner or side of the portal to resize it.

6. Click in the display to access the Pan tool . As you pan around the image notice that the Portal stays in one spot while the image moves behind it.

7. You can attach (or pin) the Portal to the image so that the Portal moves with the main image. Place your cursor inside of the Portal near the top to display the Portal toolbar.

8. Click the Pin button . The button changes to Unpin. Middle click and Pan around again. The Portal stays fixed to the image.

9. Place your cursor at the top inside of the Portal to display the Portal toolbar. Click the Unpin button on the Portal toolbar.

10. Click on the green arrowhead  at the top of the Portal. This starts Flicker. You can change the speed by clicking on the slower  or faster  buttons.

11. Click the Pause button  on the Portal toolbar to stop Flicker.

12. Right-click inside of the Portal and select **Blend**. This adjusts the transparency of the top image.

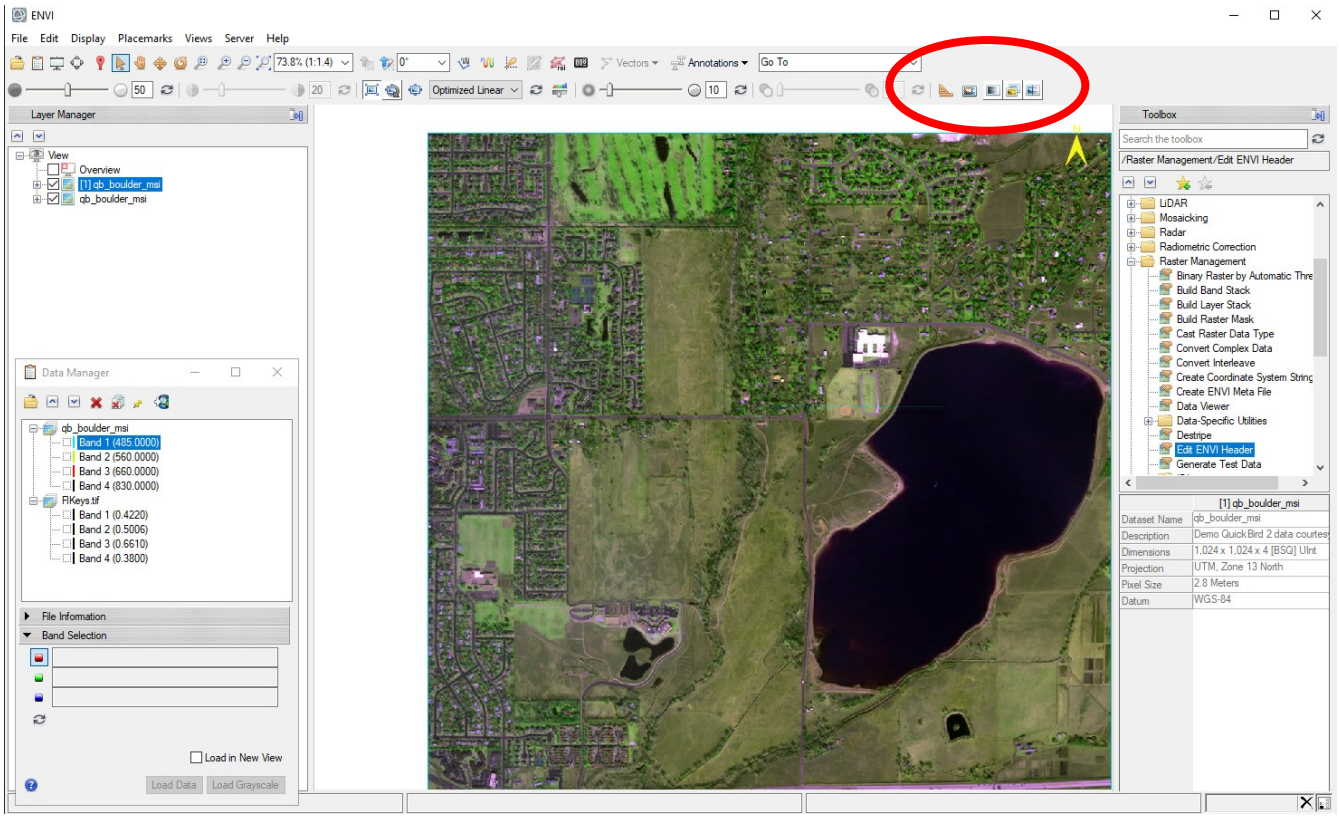
13. Right-click inside of the Portal and select Swipe. Swiping automatically begins between the two layers.

14. Click the Pause button  on the Portal toolbar to stop the swipe.

15. Close the Portal by either clicking on the x button  at the top of the Portal, right clicking on the Portal layer in the Layer Manager and choosing Remove, or right clicking in the Portal itself and choosing Close Portal.

16. Click on the View Flicker button  at the top of the ENVI interface. This opens a new Portal that covers the entire display. Right click in the display and choose Close View Portal.

NOTE: The swipe, flicker, and Blend functions can also be accessed in the toolbar outside of the portals. They work in the same way as the functions within the portal. The image below shows the ENVI screen. The large red ellipse covers the swipe, flicker, and blend tools. Notice that in this screen grab the buttons are active, this is because there are two images on the screen. When only one image is displayed the buttons are grayed out.



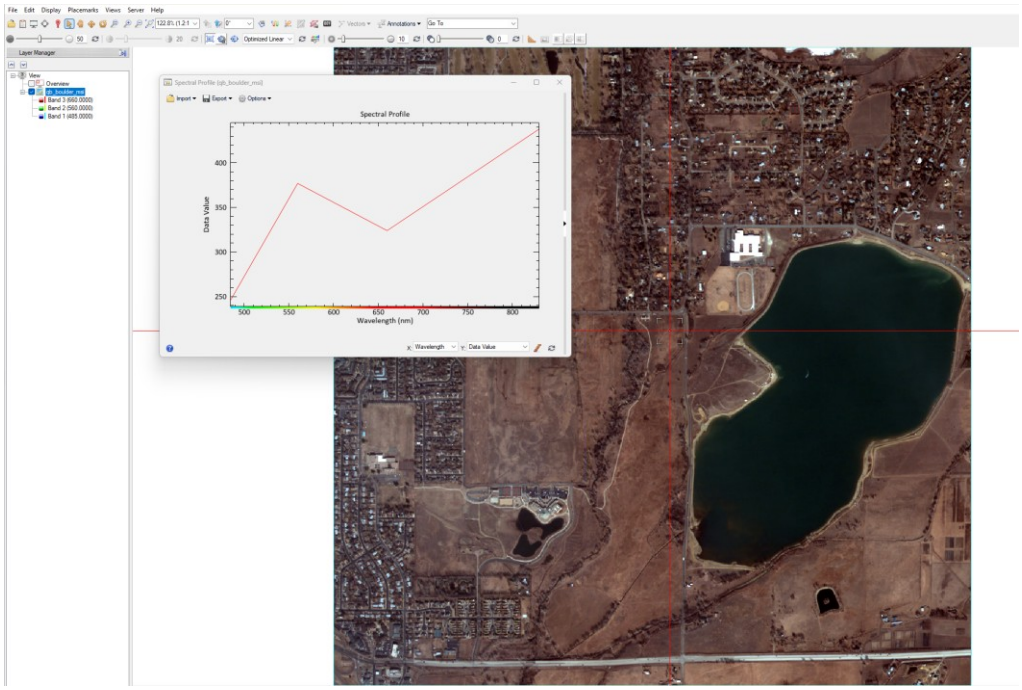
Part IV: Beyond Visual Interpretation

Spectral Profile

1. In this exercise we are going to use only the true color composite. If you do not use the correct band combination for this composite then your spectral profile will not look like the example below.

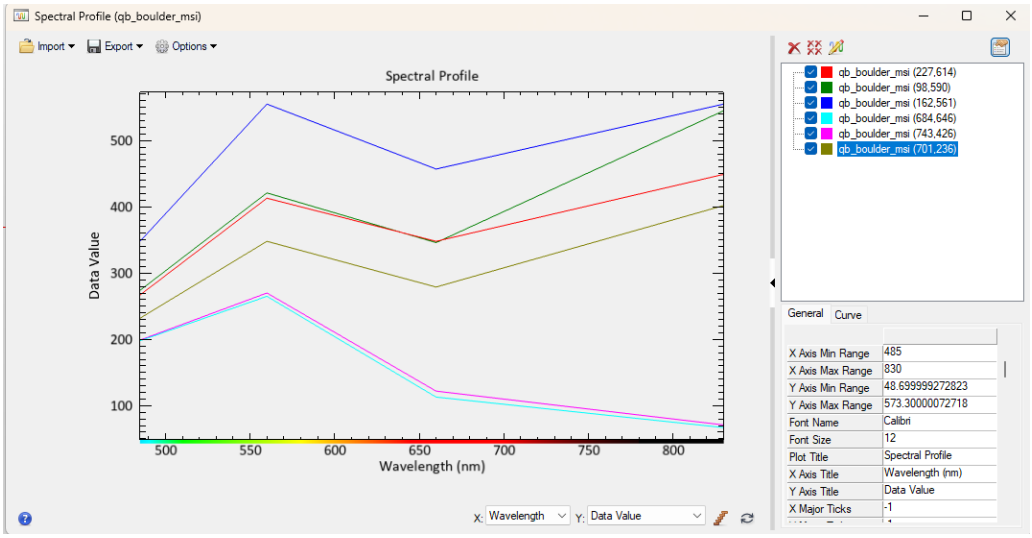
2. Be sure that the View with the qb_boulder_msi true-color composite is loaded in the Layer Manager (from the Lab 1: right click on the qb_boulder_msi name in the data manager and choose “Load True Color”):

3. From the ENVI menu bar, select **Display—Profile---Spectral**.... The Spectral Profile plot window appears along with the cross-hairs in the display. Click inside the display and drag your cursor around. The plot in the display updates to show the spectral profile for the pixel under your cursor.



4. Move your cursor into the plot and hold down the left mouse button. As you get near a specific band, the X (Wavelength) and Y (Brightness Value) values at that wavelength will be displayed in the lower left corner of the plot window.

5. Collect spectra in the plot by holding down the <Shift> key and clicking on different points in the image. Multiple spectra will be displayed in the Spectral Profile window. Collect spectra from different land cover types (including water) to see how they compare.



6. Click on the arrowhead ⏭ on the right side of plot window to show the plot key panel. All the spectra will be listed along with their pixel coordinates.

7. Right click in the plot and select Remove All Curves.

8. Close the Spectral Profile plot.

Histogram

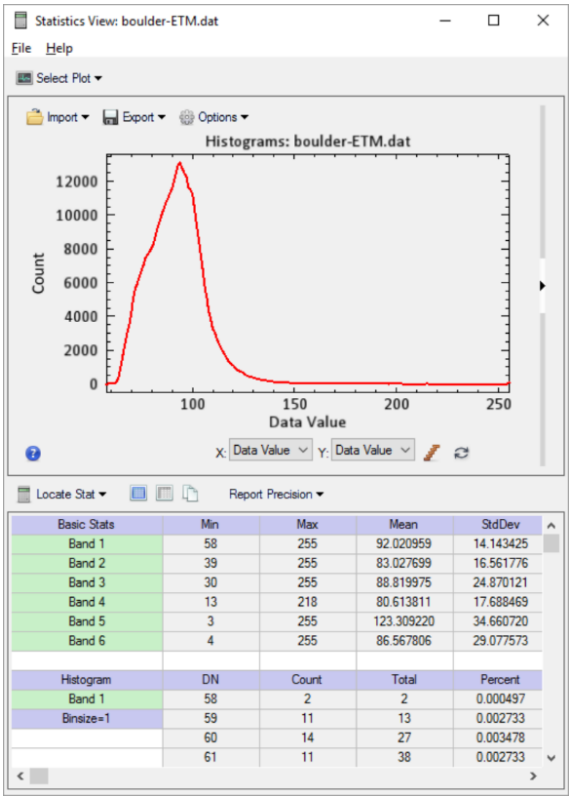
Creating a histogram of each band in an image is a common event to study the patterns across the landscape.

1. Open ENVI

2. Open the Boulder-ETM.dat file in the ENVI screen. Make sure that the image opens as a true color composite (3, 2, 1). If it does not use the Data Manager to create it. You may have to look up the ETM bands that correspond to the red, green, and blue bands of the electromagnetic spectrum

3. Right-click on the image name in the Layer Manager, and click on **Quick Stats**

4. Select any of the Histograms in the **Select Plot** dropdown menu. Make a histogram of EACH band (not just those in the RGB display). The output will look similar to the image to the right.

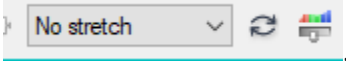


Note: The histogram output also shows you some basic descriptive statistics about each band in the image including Mean, Max, Min, and Standard Deviation. It also shows the actual numbers for the histogram if you scroll down.

Part V: Contrast Stretching

Contrast Stretching

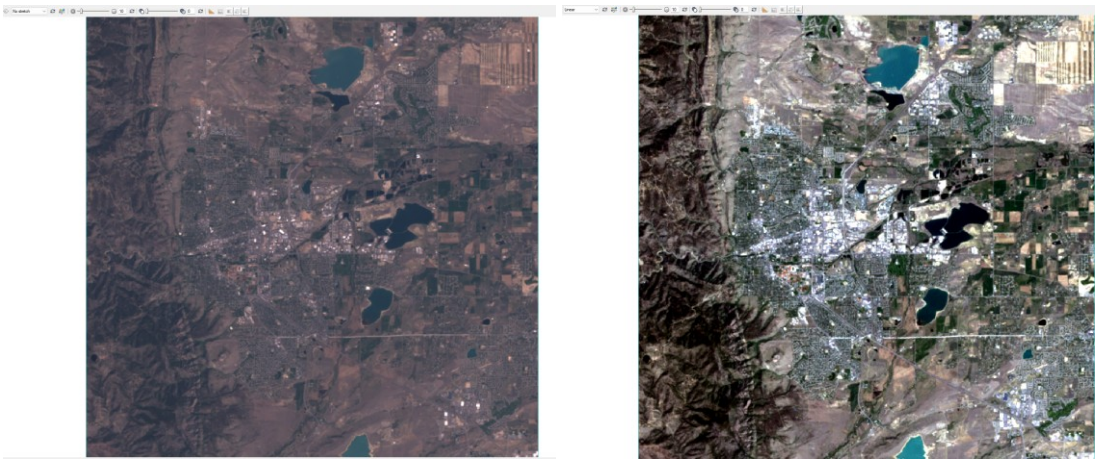
1. Keep the Boulder-ETM image open.

2. Experiment with different contrast stretches by selecting options from the drop-down list of standard stretches located in the middle of the top toolbar 

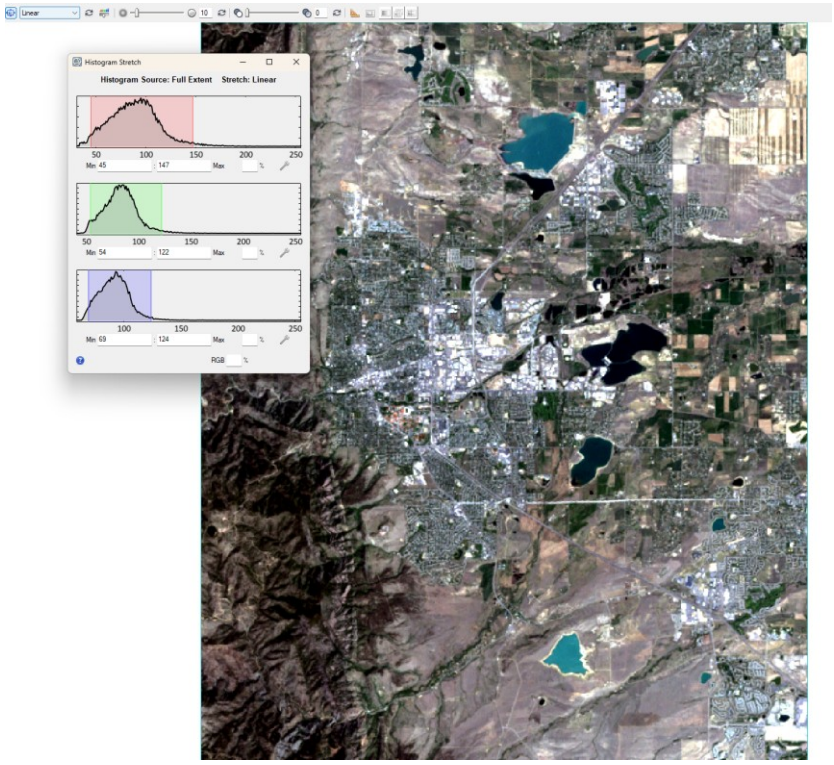
. Once this tool is selected, you can access different standard stretches.

The **Stretch on Full Extent**  and **Stretch on View Extent icons**  can be used to specify what part of the image is used to determine histogram statistics for the stretches. If you have multiple layers open, you can click on a specific layer to select it and have the sliders and contrast stretches operate on that layer. Click the **Reset Stretch Type** button

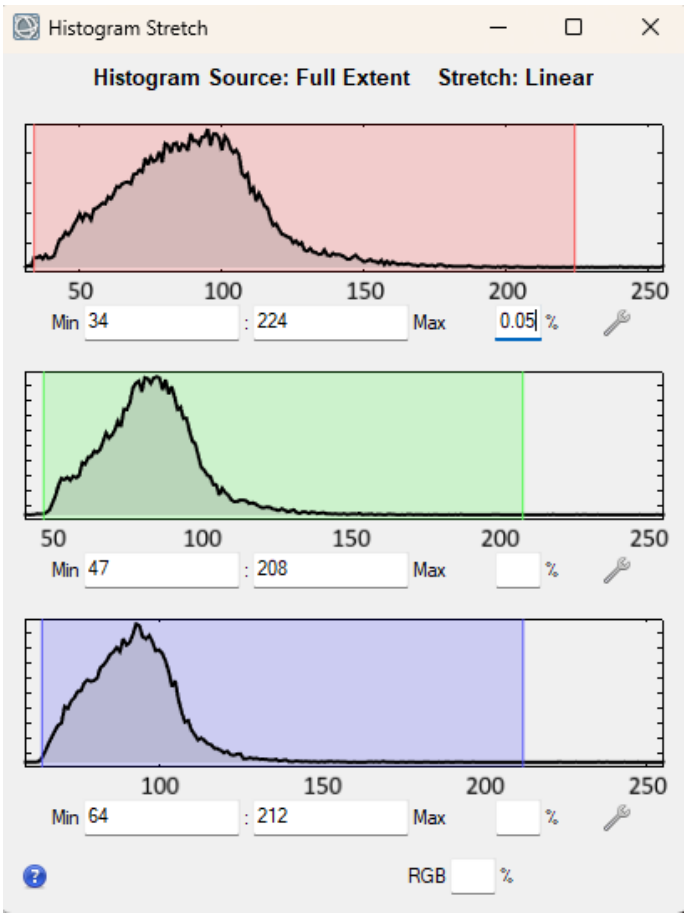
to return to the default. (Explore here!). See the image without stretch on the left and the image with linear stretch on the right below:



3. Access the custom Histogram Stretch by clicking on the icon. This tool is set to the pull-down window setting to start. Go through the options of the standard stretches again to see how they change the histogram stretch. For example the linear stretch gives:



4. Type in a value of **0.05** in the three **%** windows under the histograms and hit the <Enter> key. The display will update and the stretch type will become Linear. Try values of **0.5** and **1**.



5. Leave the Histogram Stretch window open and select **Gaussian** from the Stretch pull-down menu. For **Gaussian** type in a value of **0.10**. Try values of **0.5** and **1**. Click on the **Reset Dialog** button to go back to the default.

6. While in the custom stretch dialogue, you will see Min and Max values showing what data numbers (DN) values are set as upper and lower limits of the current stretch. If you are in Linear Stretch mode, typing in a Linear (Percent Value) will cause the Min and Max bars to shift. You can also move the Min and Max bars manually. This will automatically update the contrast stretch. If you move the bars to the end points, the Min and Max windows will show the minimum and maximum values for the data set. Experiment with the other bands that are displayed. When you are finished experimenting click on the Reset Dialog button to go back to the default. Close the Custom Stretch tool.

7. Click on the Mensuration tool . The Cursor Value tool will appear. Next click on the Polyline annotation button Polyline (in the center of the Tool Bar - it may already be selected) and click in the display to measure something of interest. Distances and headings between polyline nodes will be displayed in the Cursor Value dialog. If you want to keep the polyline, right click and choose **Accept**. If you wish to discard the polyline, right click and choose **Clear**. The Arrow annotation can also be used for calculating distance and heading. To clear all annotations still displayed, right click on the **New Annotation** layer in the Layer Manager and select **Remove**. Choose **No** to respond to the

question about saving the annotation. To clear a single annotation, right click on it and choose **Delete**. When finished with annotation click on the **Select** button , deselect the mensuration icon, and close the Cursor Value dialog.

Look at the view in which the boulder-ETM image has been added to the Layer Manager. Above the image bands, you will also see an "Overview" check box. This Overview provides a view of the full extent of the layers loaded into the display. To turn the Overview window on click in the check box for it in the Layer Manager Overview. If you have multiple views in the display, each view has its own Overview. The view box is a smaller, partially transparent window inside the Overview window that shows the extent of the image visible in the main display.

8. Increase or decrease the size of the View box by clicking and dragging a corner of that box. This will zoom in or out on the displayed. The View box adjusts shape to maintain the proper aspect ratio of the display.

9. Click inside of the View box and drag it to any location within the Overview window to dynamically update the Image window. Click outside of the View box in the Overview window to re-center the View box on the spot where you clicked.

10. Place your cursor in the display and note the information displayed in the Status bar at the bottom of the ENVI window. You will see Latitude and Longitude in one block, and map projection and datum in the next. One block does not show anything currently. Right click in that block and you will see that Security Banner is checked. There is no Security Banner data so nothing is displayed. You have the option to display anything on the list in any block during the current ENVI session. You can specify what you want for future ENVI sessions by changing ENVI Preferences. If a scene is not georeferenced you won't see any map information in the Status bar.

Note: The Status bar always displays information about the base layer in the Layer Manager. For information on any other layer use the Cursor Value tool.

11. The right-most segment of the Status bar is the Process Manager. It displays the process name and status for the oldest running process, along with an option to cancel the process by clicking the Cancel Process button  . When all processes finish, this segment becomes blank. As one or more processes are running, you can click the Process Description button  to display a window that shows the name and status of each process, and the name of the input images.

This is the end of this lab. Congratulations!