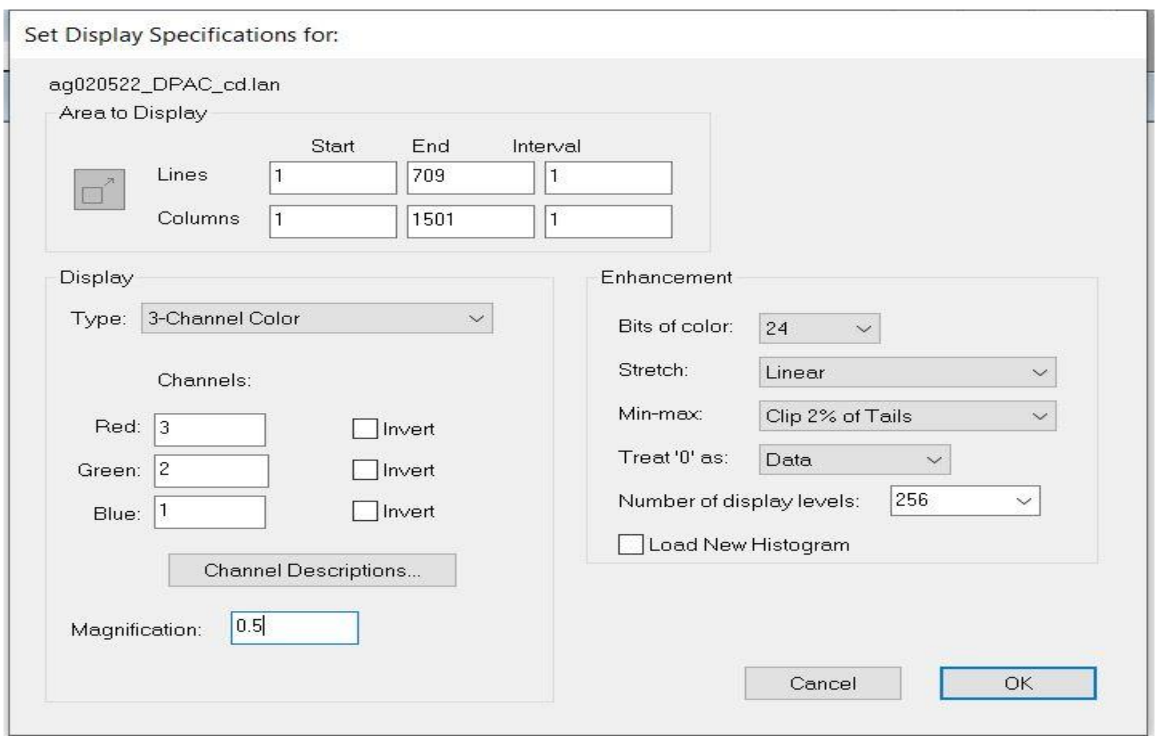
Practice 1: Display and Inspection of Image Data

Requirements: MultiSpec application and image titled "ag020522_DPAC_cd.lan".

In this tutorial, we will display an aircraft image of a portion of the Davis Purdue Agriculture Center in Randolf County, Indiana and view the data in several ways using MultiSpec.

Steps:

1. First started MultiSpec using the icon on the desktop or from MultiSpec in the Startup Menu.
2. From the File menu we chose Open Image. . .. A dialog box will open to allow one to select the data file one wishes to use.
3. We selected ag020522_DPAC_cd.lan in the Tutorial1 folder and Opened. This is a segment (709 lines x 1501 columns of pixels) of a 3-channel image of DPAC collected on May 22, 2002. Next a dialog box will appear to allow one to choose among various options for the image display approximating Color Infrared film.



By default, the area designated for display is the whole scene and the 3-

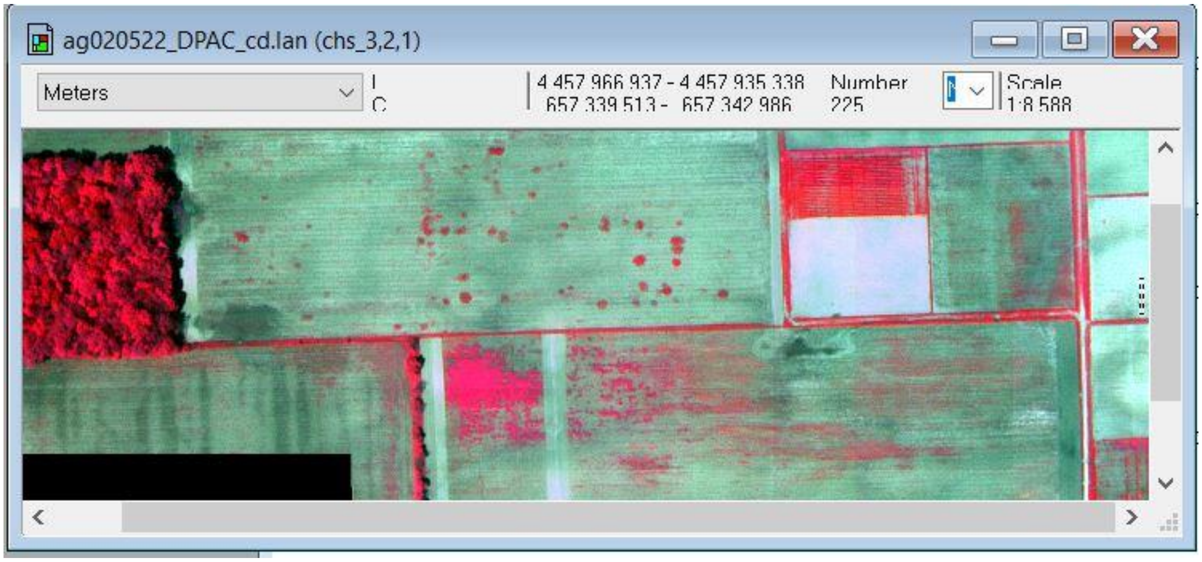
Channel Color Display Type is selected. The default settings call for the Red screen color to be derived from band 3, Green from band 2 and Blue from band 1. These particular choices will cause the screen image to be in a 3-color format

4. Selected Ok.
5. The image of the data appeared. Just above the image window in the toolbar there are two small boxes with large and small “mountains”. These are image zooming buttons allowing one to zoom in (large mountain) or out (small mountain) from the current image scale. Just to the left of the image zooming buttons is another button which shows X 1 in grayed form. This button allows one to go to X1 magnification directly. The current zoom magnification is displayed along the bottom of the MultiSpec application window in the box labeled “Zoom=”.

   Some other options are to hold the ‘Ctrl’ key down while zooming to change the zoom step factor to 0.1 instead of 1. In other words, the zoom factor will change from 1.0 to 1.1 to 1.2 etc. instead of 1, 2, 3, etc. We can make a selection within the image by left click-hold in the image window, drag to select a rectangle, and then releasing the left mouse button. If a selected area exists in the image, any zooming will be centered on the selected area if possible. Cleared selection using the “Delete” key.
6. Next step we viewed a side-by-side channel display for data quality inspection. From the Processor menu, select Display Image… to bring up the display dialog box. Then select Display Type “Side-by-Side Channels”, and select OK to display all three channels in the image side by side.

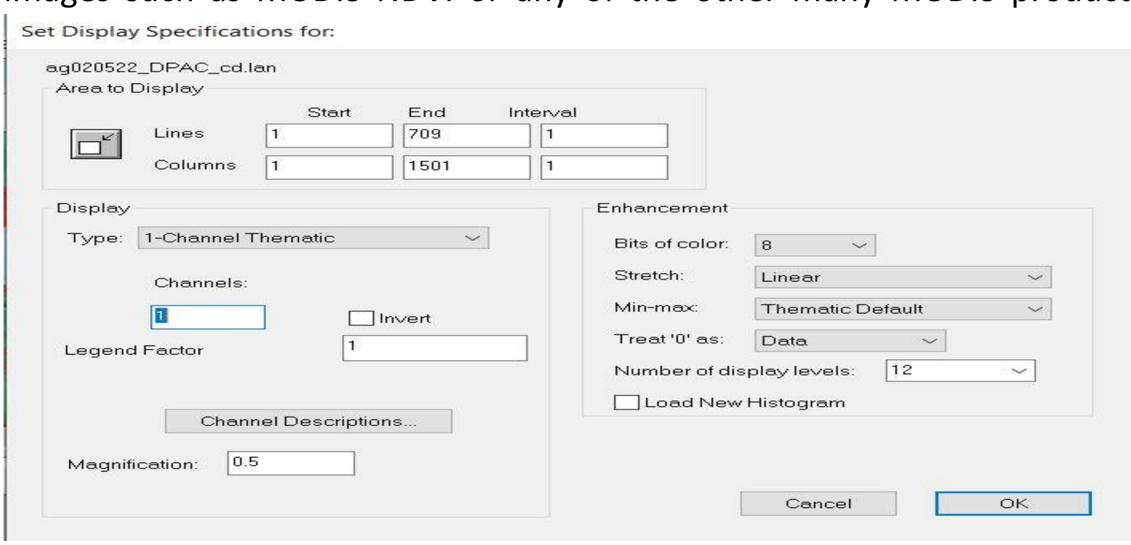
The above image window displayed (after zooming out) which shows all three channels displayed side-by-side. The vegetation areas in channel 3 are brighter than the same areas in channels 1 and 2.

7. Coordinate View: We can also display a “coordinate view” along the top of the image to present the cursor (mouse) location and selected areas in the image. We did this, select the View->Coordinate View in the menu item.

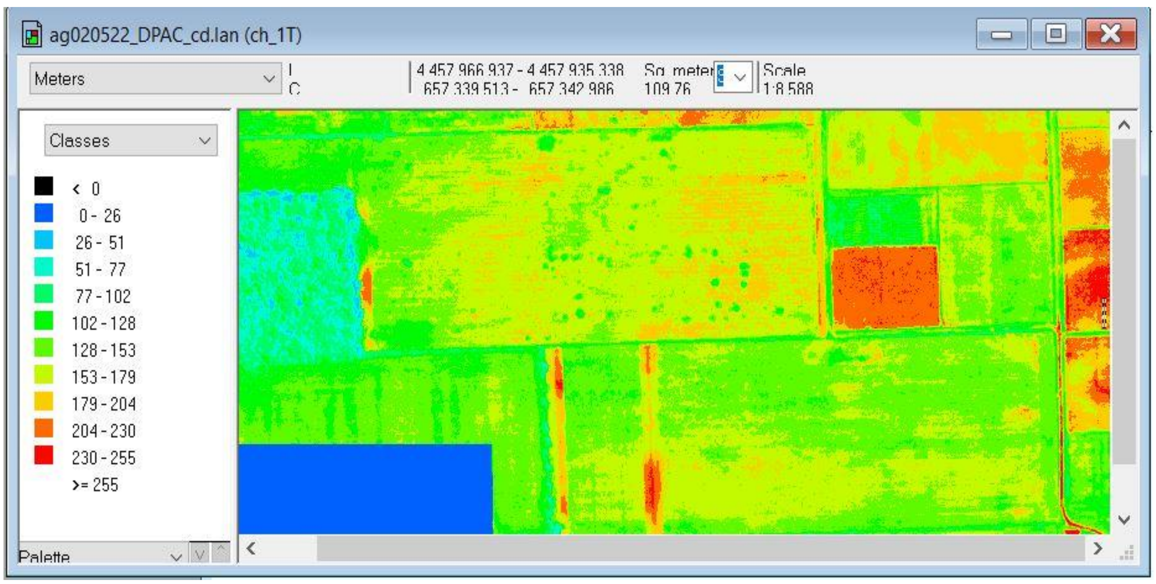


If map coordinate information exists for the image, we can display the coordinates as map units. We Used the popup menu on the left side of the coordinate view to select the map units. The area of the selection can be displayed as the number of pixels or in units of acres, hectares etc using the popup button to the left of “Scale”. The scale of the image also displayed.

8. The 1-channel Thematic display type is useful to display "product" type images such as MODIS NDVI or any of the other many MODIS products.



The data values are grouped into the desired number of levels and a legend is displayed to the left of the image indicating which palette colors are associated with each range of data. (See illustration below.) We can also enter a factor to multiply the data values displayed in the legend by to reflect the actual measurement unit. Sometimes the data value may be the measurement value times 100 or 1000. We can use the Min/Max User Specified dialog box item to set the min and max values for the range of data to be displayed. Black is the default color for data values less than the minimum and white is the default color for values greater than the maximum.



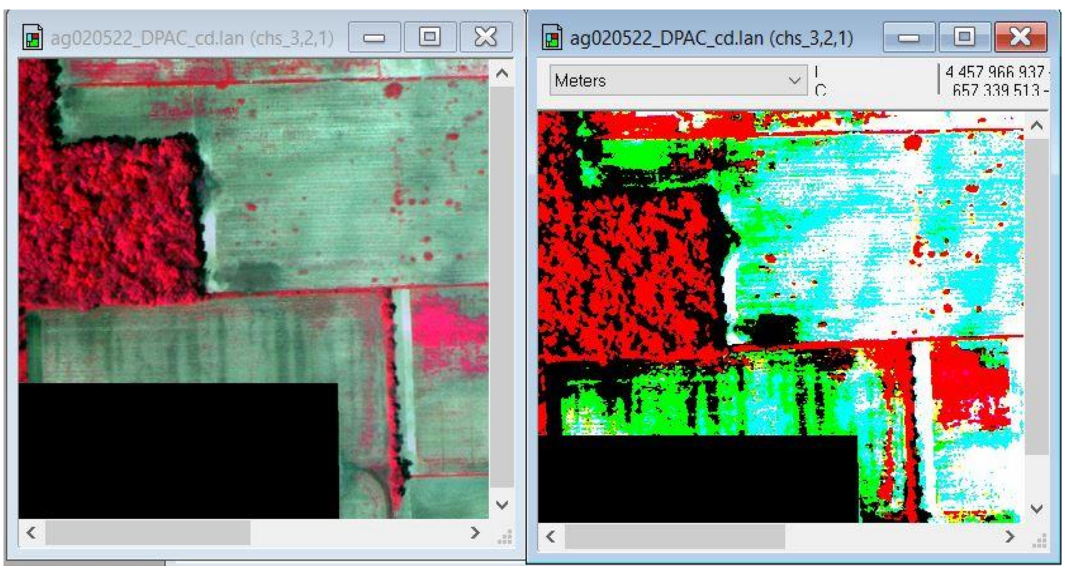
Practice 2: Image Enhancement

Requirements: MultiSpec application and image titled “ag020522_DPAC_cd.lan”.

We can control the enhancement of the image in the multispectral image window by setting five different options in the Enhancement portion of the Display Specifications dialog box including Bits of color, Stretch, Min-maxes, Treat ‘0’ as and Display levels per channel.

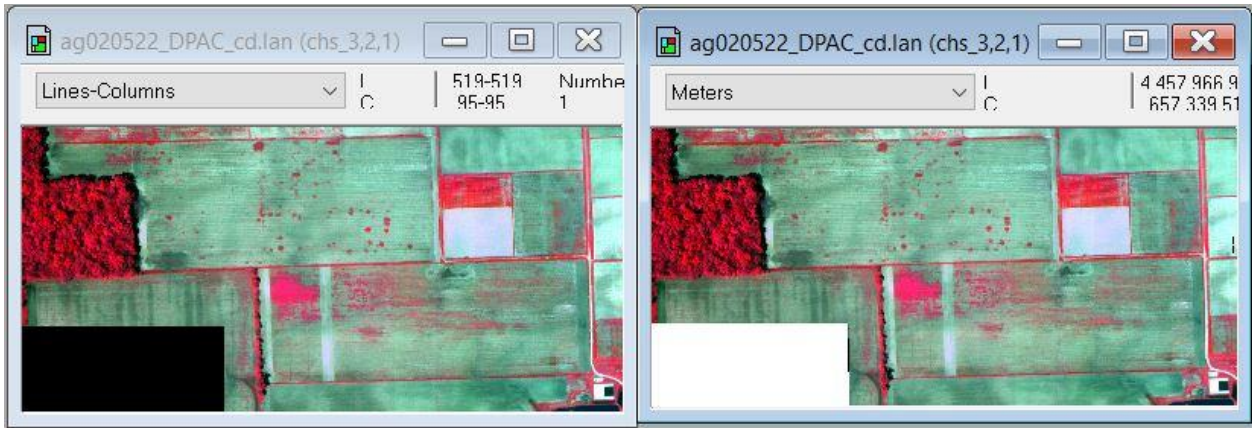
Steps:

1. The “Bits of color” default is 24 and the “Display levels per channel” default is 256 for all monitors now days for the maximum number of colors possible. We can adjust to lower values if one wishes to see what the affects are. The figure below illustrates 256 display levels per channel (millions of colors) on the left and 2 display levels per channel (8 colors) on the right.



2. The Treat ‘0’ as data setting causes 0 values to be displayed as black. However, if 0’s actually represent background or ‘no data’, one may want to select the background option to cause 0’s in all channels to be displayed

as white. The figure below illustrates 0's treated as black on the left and 0's as white on the right.



3. The Stretch and Min-maxes are usually the options used to enhance different parts of the image. They control the process by which each possible data value in the image data is assigned to all possible display levels. There are three choices for Stretch: Linear, Equal Area and Gaussian. In the case of Linear Stretch, gray scale intervals are equally spaced over the data range, while the Equal Area Stretch choice causes them to be set so that each interval represents about the same number of pixels. Though nonlinear, the equal area stretch will provide maximum contrast. The Gaussian selection causes the distribution of the number of pixels assigned to the gray scale intervals to represent a Gaussian curve.

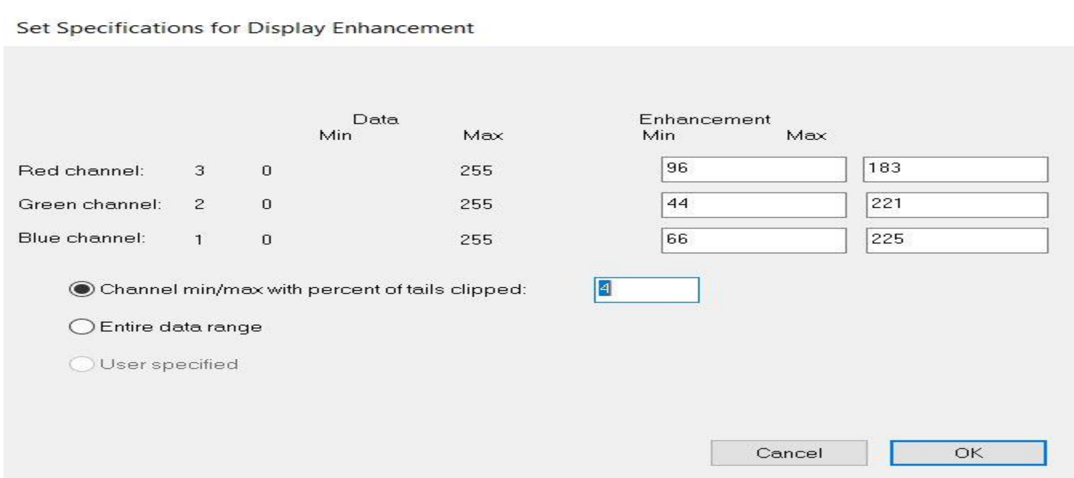
Linear, equal area and Gaussian stretches are illustrated in figure above left to right.

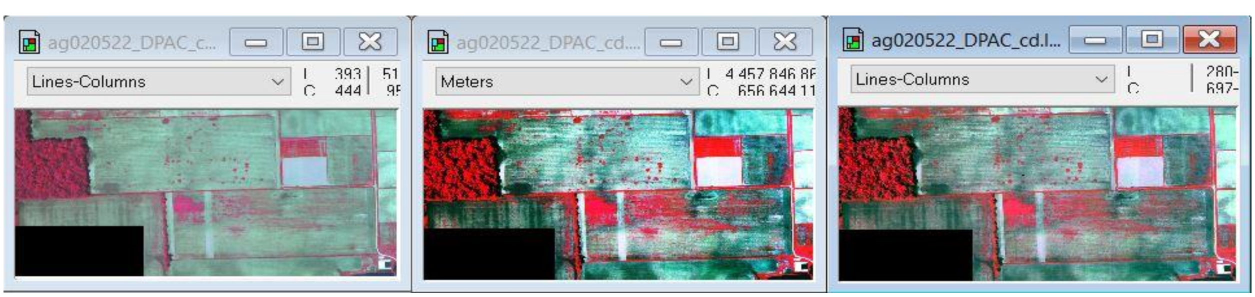
4. The Min-maxes option allows us to select the beginning and end data values of the image histogram to be used for assigning the pixels in the gray scale intervals defined by the Stretch option. The "Entire Range" choice for this

option would cause lowest data value possible in the image, 0 for 8-bit unsigned data, to be the first data value displayed for lowest display value (black) and 255 to be the last data value displayed for the highest display value (white). However, if the actual range of the data is only 50 to 150, then the data will only be represented by grays not black to white; there will not be much contrast in the image.

The 2 Percent Tails Clipped choice will cause the selected begin and end range of data values for a given channel to represent those data values in which 2 percent of them in the histogram are outside of the selected range. The intent of this choice is to reduce the chance that a small number of extreme outlier data values in the image will unduly influence the display enhancement. This choice usually results in a display of the data that has better contrast over all.

Selection of the Specify Min-Max... choice presents a dialog box (illustrated below) to allow us to set percent of tails clipped to be something other than 2%. We can also set our own min-max values to stretch the gray levels across. The actual data min and max values computed from the histogram are included in the dialog box.





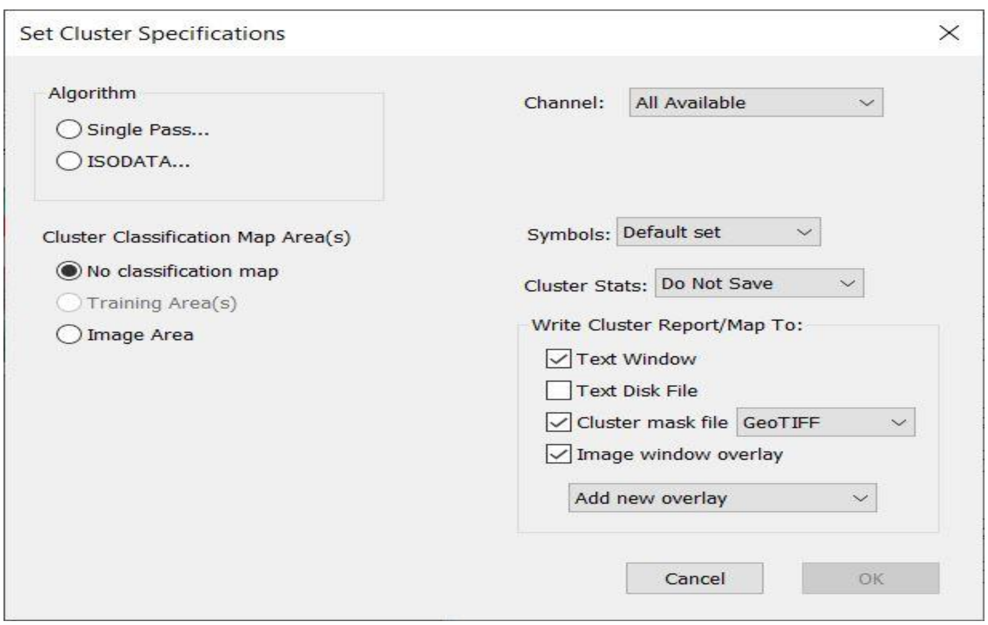
Practice 3: Unsupervised Classification (Cluster Analysis)

Requirements: MultiSpec application and image titled “ag020522_DPAC_cd.lan”.

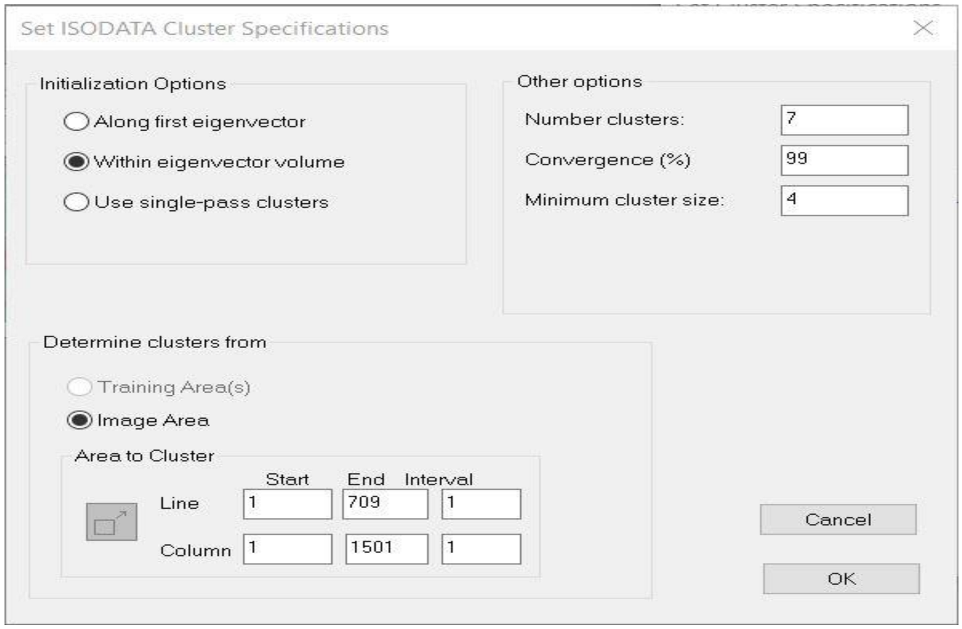
Two Clustering algorithms are available in MultiSpec. They are useful in grouping similar pixels in the image into clusters or categories. One algorithm implemented is a simple one-pass type. The second is an iterative type called ISODATA. We used the ISODATA algorithm for this practise.

Steps:

1. From the Processor menu, selected Cluster… to bring up the cluster specifications dialog box. Selected “Do Not Save” in the Cluster Stats: popup menu. Selected “Cluster mask file” and selected “Image window overlay” under the “Write Cluster Report/Map To” group. This caused a cluster map created as a thematic image disk file and displayed as an overlay on the multispectral image window.

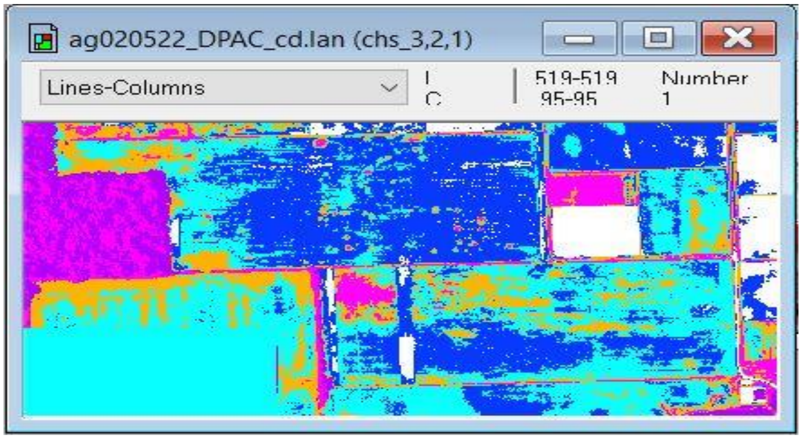


2. Then selected “ISODATA…” This will cause the ISODATA Specifications dialog box displayed. Entered 7 for the number of clusters, 100 for the convergence percentage and set the line and column intervals to 1 and then selected OK.

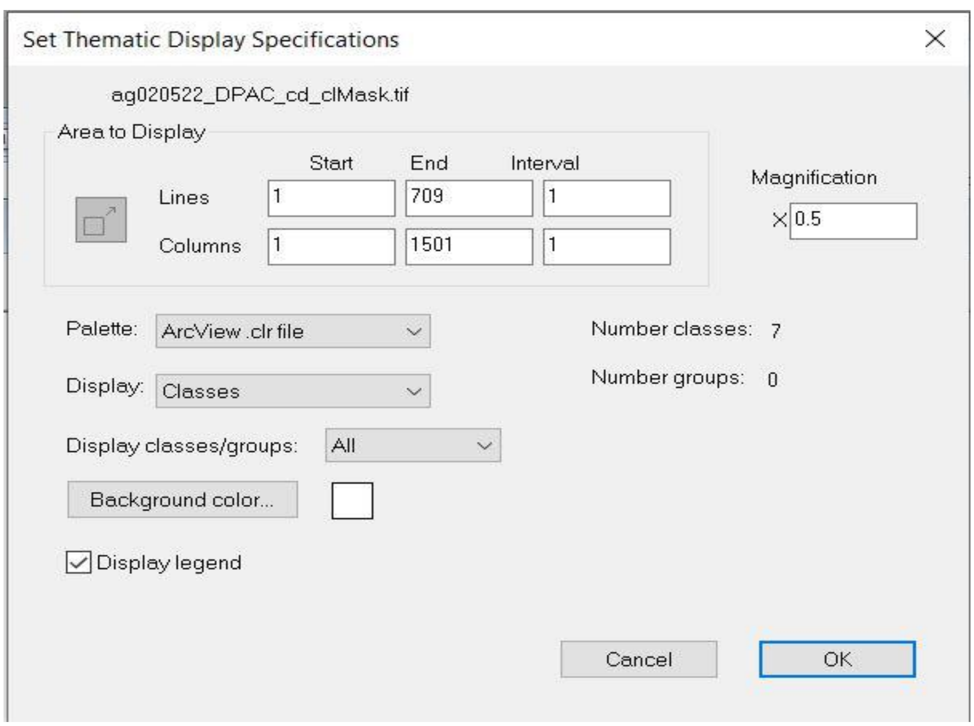


3. We are now back to the Cluster Specifications dialog box. Selected OK to closed this dialog box and started the clustering operation.

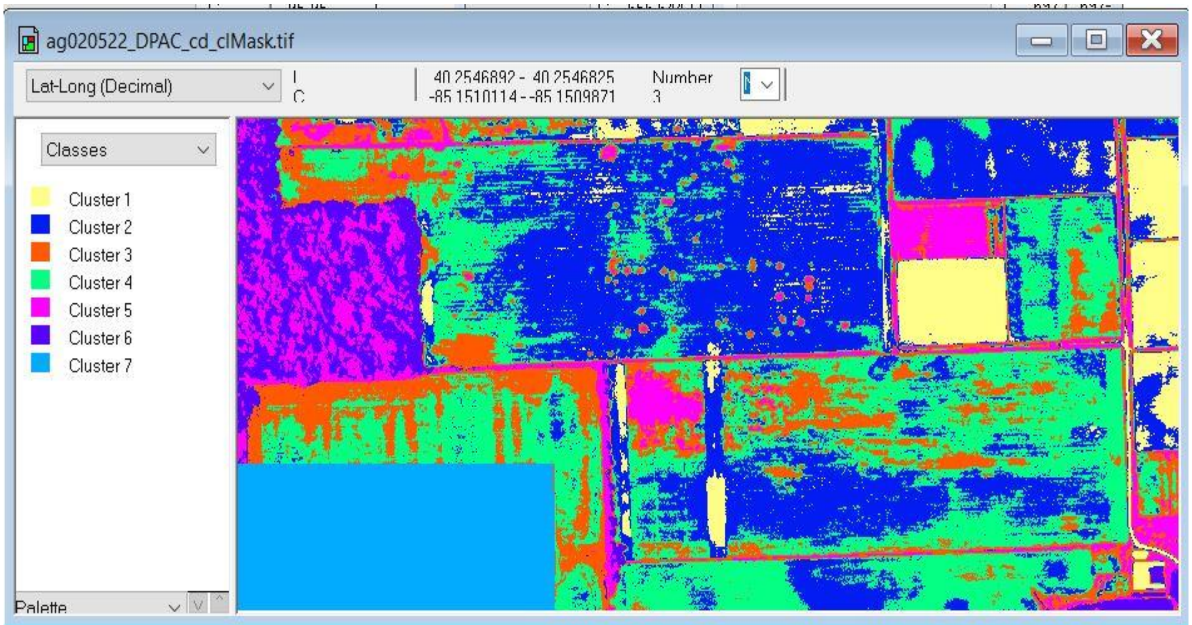
   We were prompted to enter a name for the cluster map disk file and where to save the file. Just used the defaults by selecting OK in the Saved Cluster Map dialog box. A cluster map will now be created with around 7 classes in an unsupervised manner. We noticed the colors change in the image window as the pixels are sorted into cluster classes during each iteration. After the final iteration, a thematic image file with a map of the cluster classes was saved to disk. The text output for the cluster operation was at the end of text output window. The information includes the mean values for each of the channels for each cluster for both the intial condition and the ending condition. If the map information is available for the image, the final area for each cluster is listed in the units specified in the coordinate view for the image window. Usually the convergence is set for a little less than 100 so that the process does not take too long to complete. We used 100 in this example so that you have a chance to watch the pixels change cluster classes which illustrates the nature of the ISODATA algorithm. The cluster map overlay on the multispectral image window will look similar to the following. We can turn the overlay on and off by using the "Red O" popup menu button in the toolbar to the right of the "small mountain" zoom button.



4. Now opend the cluster map thematic image file. This will be the same image as is shown in the overlay above .
   From the File menu, selected Open Image… to bring up the open image dialog box. We had to change the "Files of type" popup to Thematic Files. Then selected "ag020522_DPAC_cd_clMask.tif" and then selected OK.
   The Thematic Display Specifications dialog box to the right was displayed. The default settings are fine; selected "OK" in the Display Thematic Image dialog box. This opened a thematic image window.



5. The cluster class legend is on the left in the thematic image window below.



6. Compared the Cluster map with the original image window. clusters that represent trees, sparse vegetation, thicker vegetation, different soil colors and shadows. There are several things we can do to evaluate the image. we can move the cursor over a color chip, hold the shift key down (cursor will change to an open eye) and click the left mouse button down and up to cause the colors for that class to blink off and on (alternate between white and the color). If we hold down both the shift and ctrl keys and then clicked the left mouse button down and up, then all of the other classes blinked off and on. These procedures are helpful in understanding the extent of the classes in the image. we can also change the class color by double clicking on the color chip. we can change the cluster class names by double clicking on the name to the right of the color chip. (The list of interpreted cluster names that I come up with are: Light soil, Medium colored soil, Sparse vegetation (weeds), Dark soil, Dense vegetation (trees, wheat, weeds), Shadowed trees, Image blank

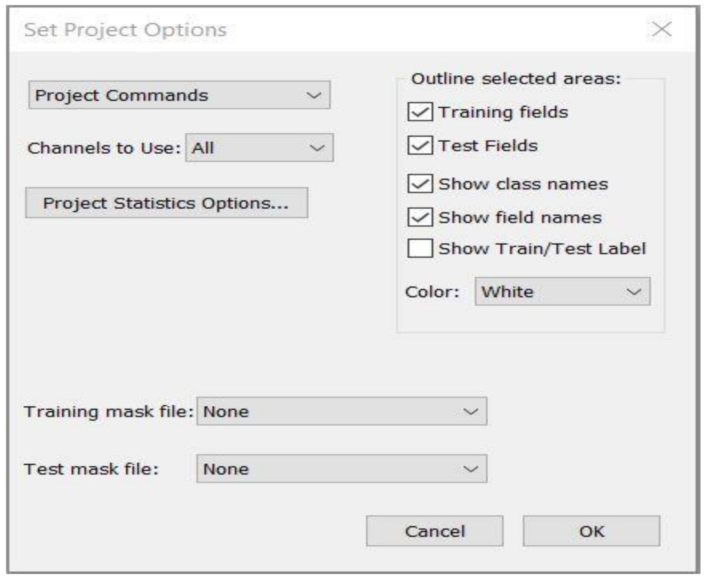
Practice 4: Supervised Classification - Select Training Fields

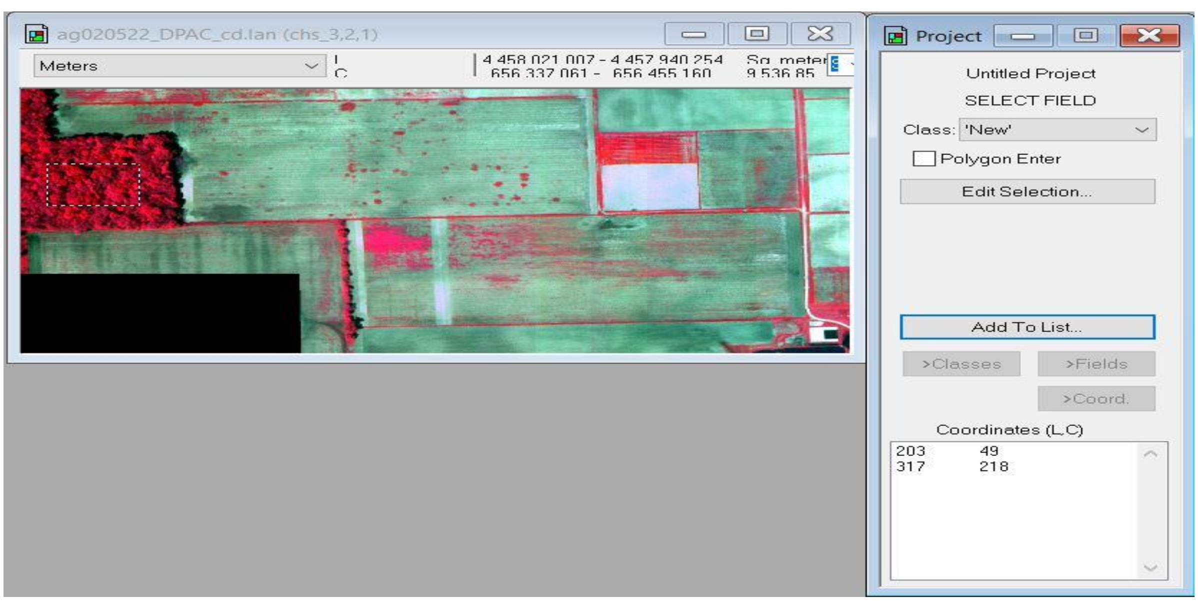
Requirements: MultiSpec application and image titled “ag020522_DPAC_cd.lan”.

We can also do a supervised classification by selecting training areas for specified classes from known areas.

Select Training Fields

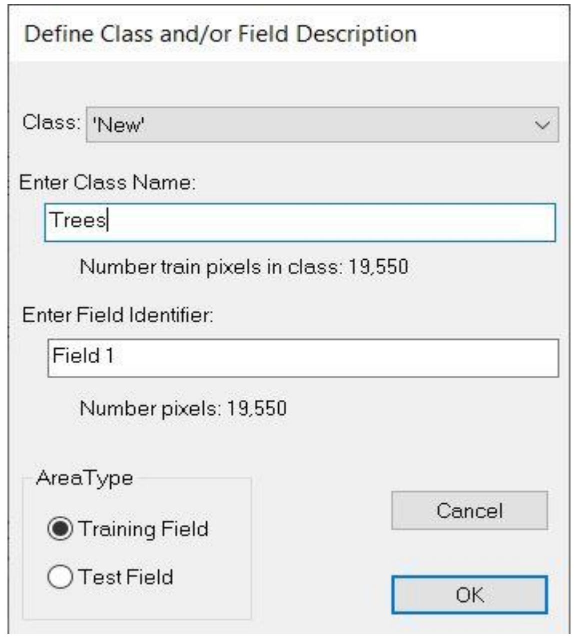
1. If a project window is open, from the Window menu, select Project, and then double click in the upper left to close the current project and project window. We may have been created during the cluster analysis.
2. Now we selected training fields. From the Processor menu selected Statistics and selected OK in the Set Project Options dialog box. (The default settings for this tutorial are satisfactory.) A new window labeled Project appeared to the right of the screen that used in a moment. To select training fields for each class, we simply "drag" a rectangular area on the image (or, with polygon



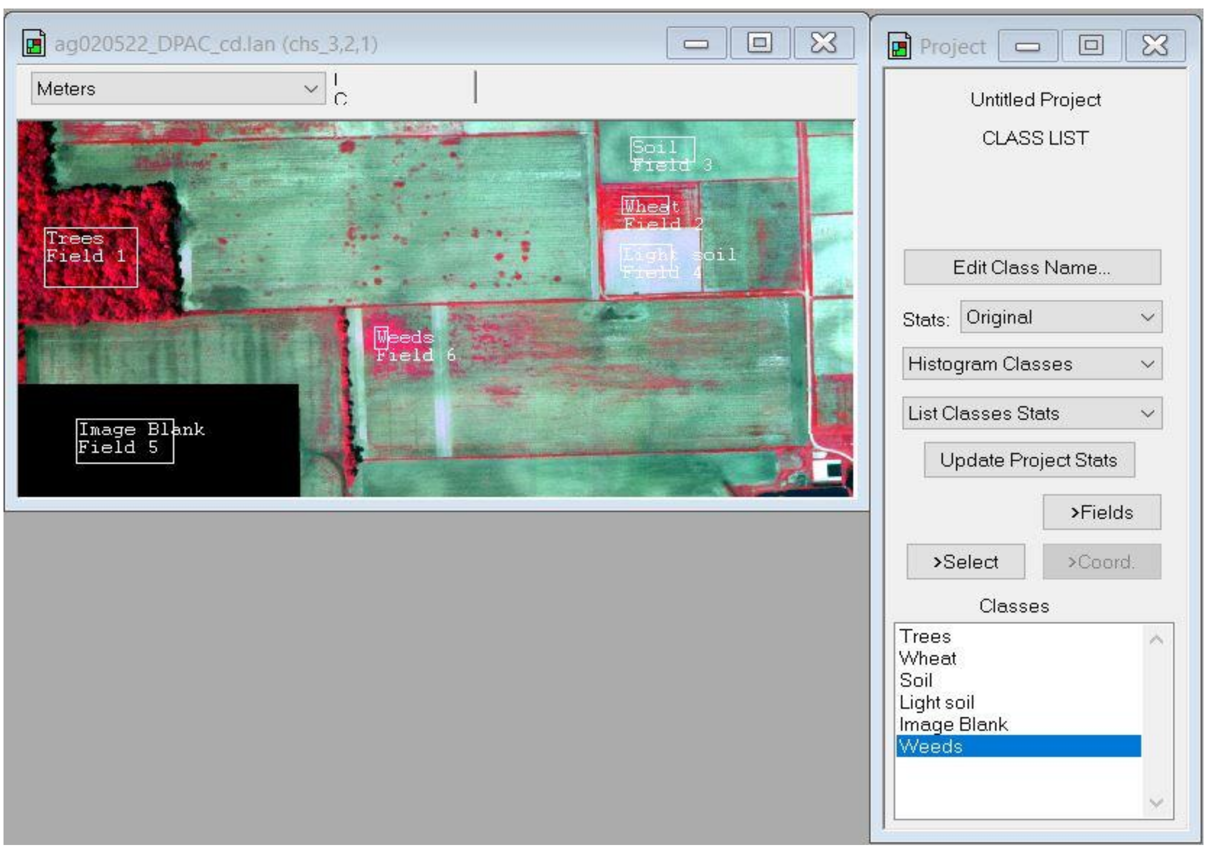


option selected, clicked on the corners of the desired polygon), and then "Added that field to the list."

3. Selected the Add to list button. A dialog box appeared to allow us to name the class and give the field a special designation, as desired. Thus, Typed Trees into the Class Name box and then selected OK.



4. Since there was only one training field for this class, we were ready to select the training for the second training class. Thus next, Drag across the second training field in the Image Window shown below for Wheat. Selected the Add to list button in the Project window. Selected the training areas for the rest of the six classes – Image blank, Weeds, Soil, Light soil.



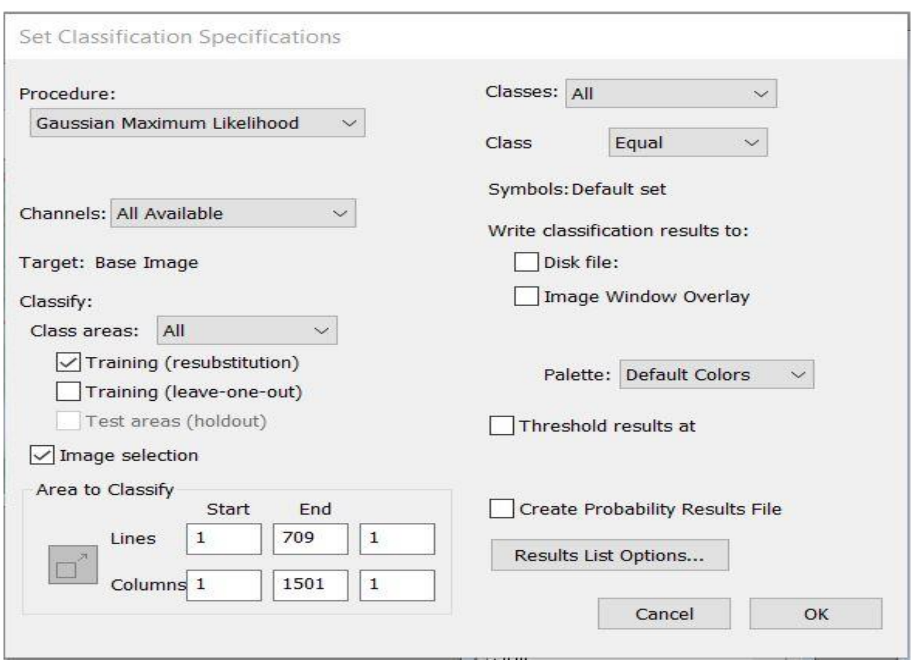
The Project Window can have four different modes – the Select training field mode, the Class list mode, the Field list mode and the Coordinate list mode. The modes are controlled by four buttons just above the list box at the bottom of the Project Window. The “>Select” button causes the Project window to be in the select mode. The “>Classes” button causes the Project classes to be displayed. The “>Fields” button causes the fields for the selected class to be displayed. The “>Coord.” button causes the coordinates for the selected field to be displayed.

We can delete a class by selecting the class in the class list and then selecting “Cut Class” in the Edit menu. We can also do the same for deleting a specific field.

We can also use polygonal type fields to define training classes. To do this, we have to select the “Polygon Enter” checkbox in the Project Window when in Select mode. We have to click in the image window to define each corner of the polygon. Then to double click on the last point. To turn the polygon type selection off, just select the “Polygon Enter” checkbox to deselect it.

Classification

1. From the Processor menu selected Classify…. In the Set Classification Specifications dialog box which appears, selected the √ near Image Selection under Classify to de-select it since, during this pass, it was desired to classify only the training fields in order to obtain an initial estimate of the quality of the class definition and training.



Since the other default options are satisfactory, selected OK and then Updated to the "Update Project Statistics" dialog box to begin the classification.

The classification completed momentarily.

2. From the Window menu selected Text Output, to bring the text window forward and make it active, since it contains the classification results. The “TRAINING CLASS PERFORMANCE (Resubstitution Method)” table tabulates how the pixels of each field and class were classified. There should be nearly 100% accuracy on the training fields. If the Reference Accuracy is particularly low (say less than 50%) for a class, then the training pixels for that class should be reexamined and new training pixels selected.

Classification of Training Fields

TRAINING CLASS PERFORMANCE (Resubstitution Method)

Project Class Name	Class Number	Reference Accuracy+ (%)	Number Samples	1 Trees	2 Wheat	3 Soil	4 Light soil	5 Image Blank	6 Weeds
				Number of Samples in Class					
Trees	1	98.3	19550	19212	308	0	0	0	30
Wheat	2	98.9	2890	33	2857	0	0	0	0
Soil	3	100.0	5520	0	0	5520	0	0	0
Light soil	4	100.0	4600	0	0	0	4600	0	0
Image Blank	5	100.0	14700	0	0	0	0	14700	0
Weeds	6	98.5	1008	3	12	0	0	0	993
	TOTAL		48268	19248	3177	5520	4600	14700	1023
	Reliability Accuracy (%)*			99.8	89.9	100.0	100.0	100.0	97.1

OVERALL CLASS PERFORMANCE (47882 / 48268) = 99.2%
Kappa Statistic (X100) = 98.9%. Kappa Variance = 0.000000.

+ (100 - percent omission error); also called producer's accuracy.
* (100 - percent commission error); also called user's accuracy.

3. Assuming satisfactory results, we are ready to classify the whole area. From the Processor menu choosen Classify…

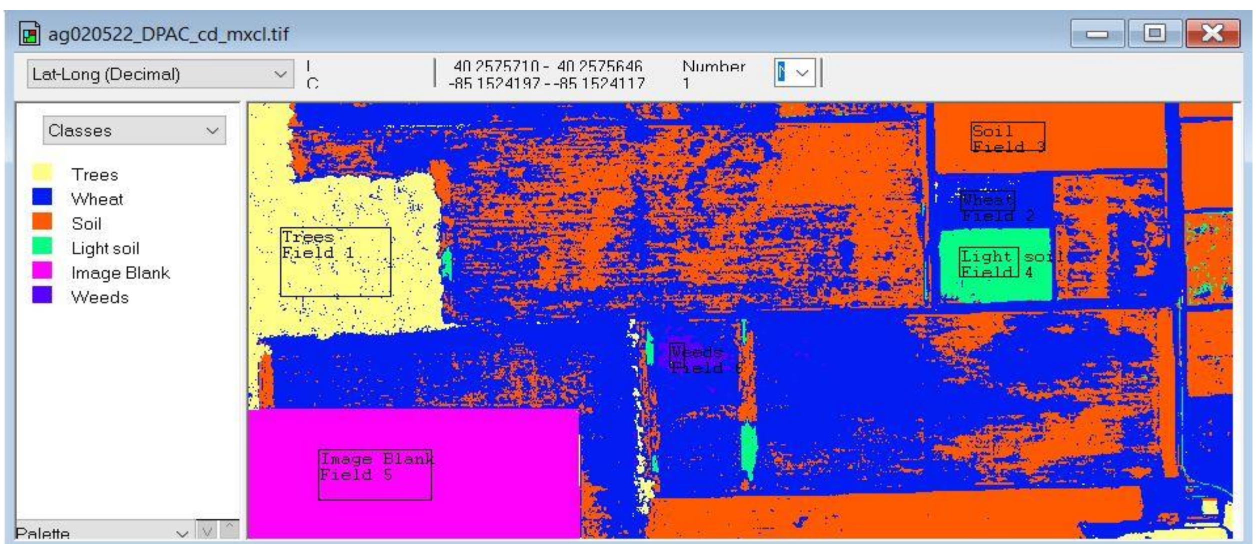
   Under Areas to Classify de-selected Training (resubstitution) by selecting the √ by it, and,
   Selected Image selection. Made sure that the entire area of the image is to be classified (lines 1-709 and columns 1-1501). Selected the square button, if activated, to the left of lines and columns, to force all lines and columns in the image to be used.
   Also selected Disk File under Write classification results to: so that a disk file for later use will be created.

We can also select Image Window Overlay to cause the classification to be displayed as an overlay on the multispectral image window if you wish to.
Also selected the Create Probability Results File checkbox so that a classification probability map will be saved to a disk file.
Then selected OK.
Selected Save in the dialog box that follows regarding a file name for the results. We used the default name and location for the output classification file and for the probability map file.
As soon as the classification was completed, we saw a summary of the results displayed in the text window.

4. Saved the project using the File–>Save Project menu item. That was presented with a dialog box to enter the name (or use the default name). The training and test areas that you selected will be saved. We can open this file up at a later time to continue your analyses.

View Classification Map

1. Now opened the classified image named “ag020522_DPAC_cd.gis”.

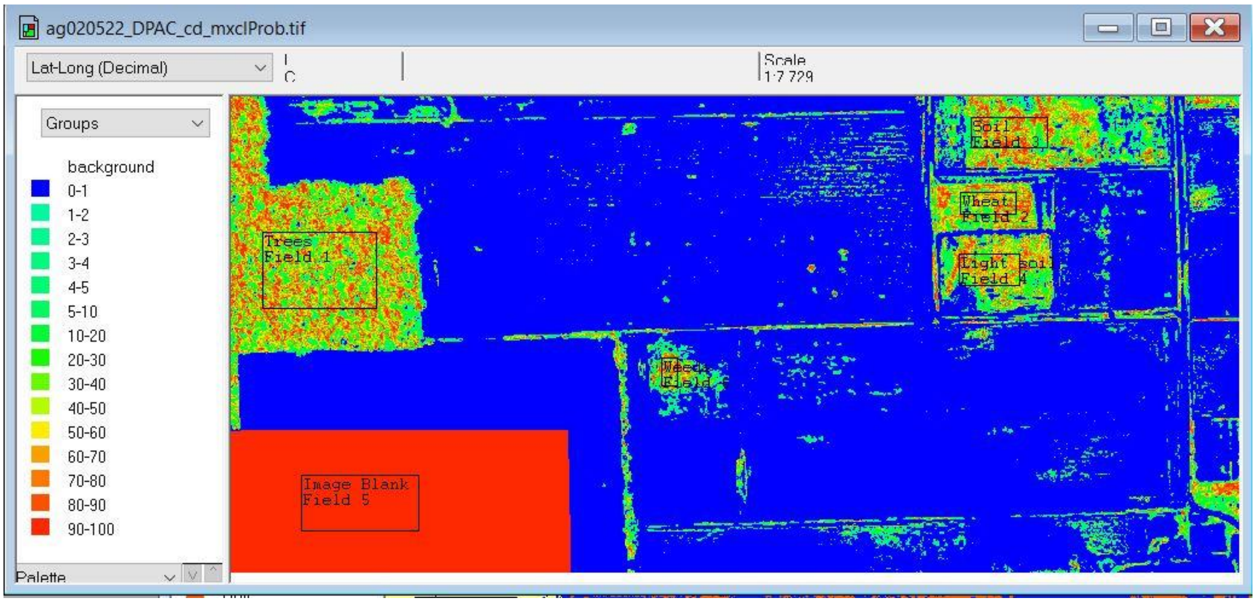


2. After displaying the classified image “ag020522_DPAC_cd.gis”, from the Project menu, selected Add as Associated Image to cause the training field outlines to be drawn on the image. we can change the field outline color to black using the Processor->Statistics… menu item and selecting “Black” in the Color popup under the “Outline selected areas:” group.

Classification Probability Map

We can view the classification probability map to evaluate which portions of the image have lower and higher probabilities of being classified correctly. There may be other classes in the image that our training fields do not adequately represent.

1. Opened the probability map named “ag020522_DPAC_cdProb.gis”



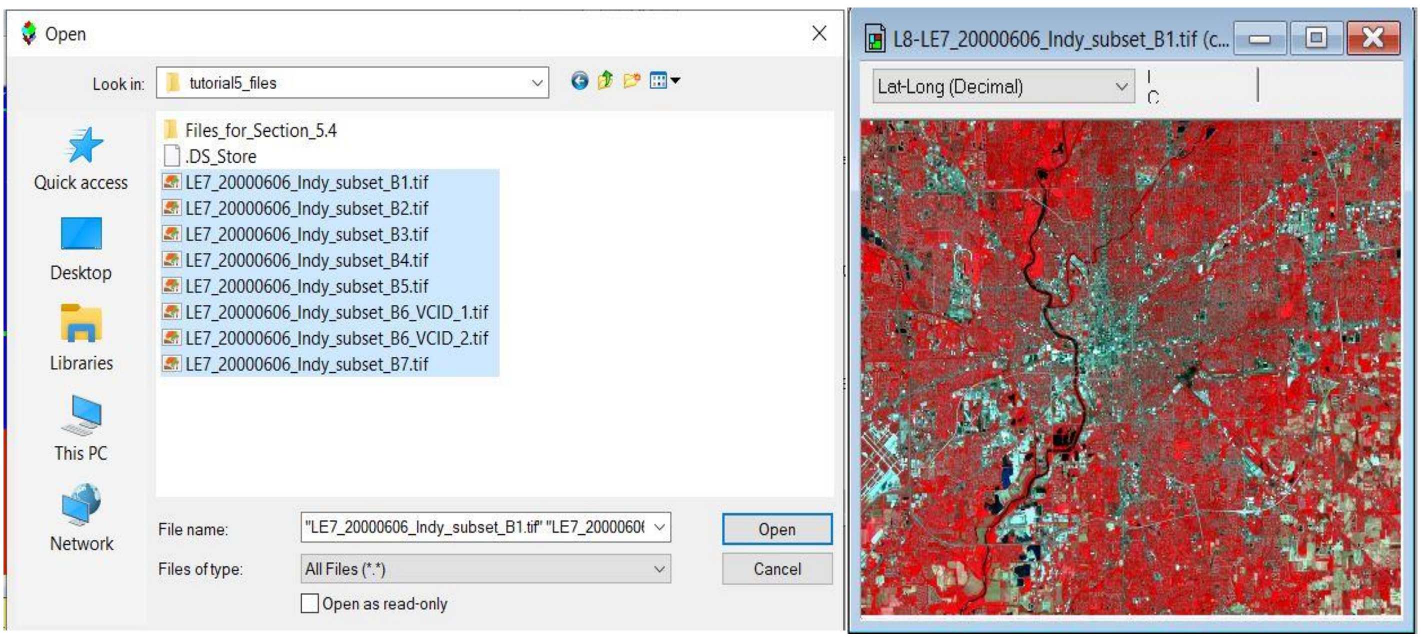
Yellow to red colors represent a high probability of being correct. These pixels are very close to our training pixels for the classified class. Dark green to blues represent a low probability of being correct. These pixels are very far from the training pixels for all of the classes. The classified image though may still represent the area well enough for our purposes. For our classification, we could probably do a better job of separating out the sparse weeds from the wheat. There are probably more than the six classes that we selected than can be separated successfully.

Practice 5: Combining Separate Image Files into a Single Multispectral Image File

Requirements: MultiSpec application and images titled "LE7_20000606_Indy _sub set_Bn.tif"

Problem 1: Multiple selection approach: For this approach, we selected all of the images to be linked at one time in the Open Image File dialog box before selecting the Open button.

1. Selected the File->Open Image… menu item. Then selected the images to be linked as illustrated in the figure below. Then selected the Open button. The "Display Multispectral Image" dialog box was presented to allow us to display the image representing the linked image files.

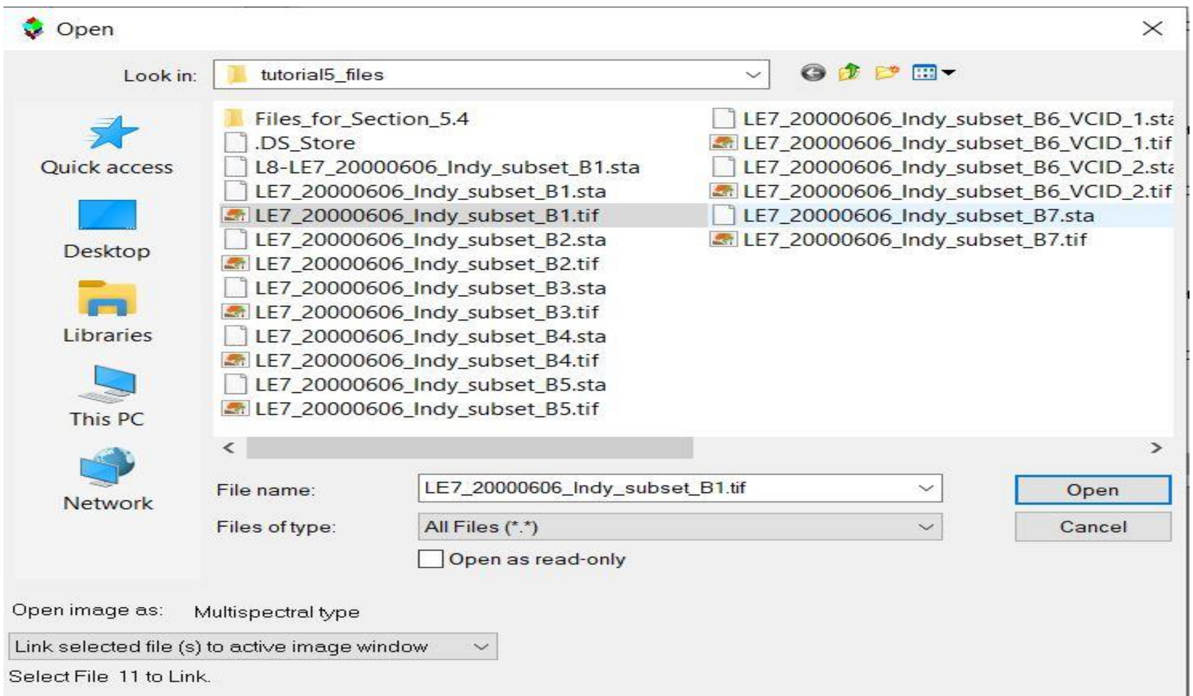


Problem 2: Single selection approach: This approach involves selecting the images to be linked one at a time within the Open Image File dialog box. It is useful if one needs to link the image files in a different order than they are listed in the dialog box or in the way that MultiSpec orders the Landsat data files downloaded from the standard EROS Center. (MultiSpec orders the image files in wavelength order.)

1. Opened the first multispectral image as one normally would using the File->Open Image… menu item. The "Display Multispectral Image" dialog box will be presented to allow one to display the selected image. We may

display the image or just cancel the dialog box. A blank multispectral image window will continue to be displayed. This will become the “active” image window that represents the first image file that will be used in the next steps.

2. To link an additional image disk file to the active image window, used the File->Open Image… menu item again. Changed popup menu in the lower-left portion of the dialog box displaying “Do not link” to “Link selected file(s) to active image window”. Then select the 2nd image file (such as band 2 illustrated in the figure below) to be linked to the active image window. As long as Cancel is not selected, the open image dialog box will automatically

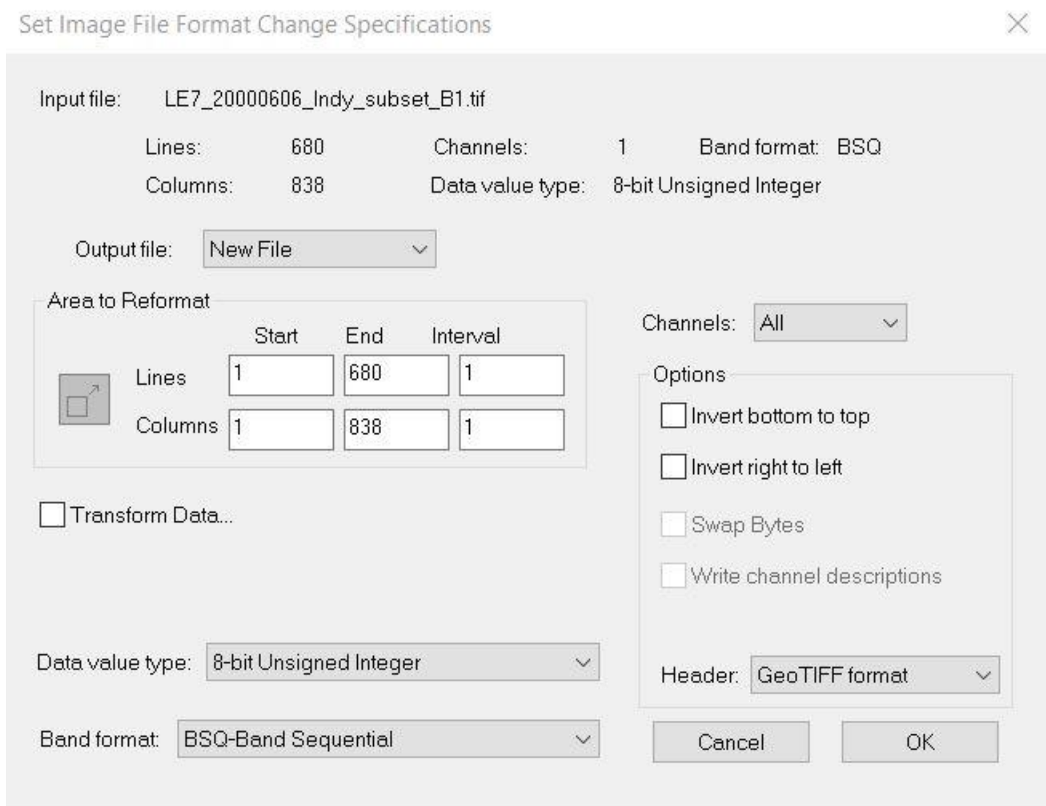


be displayed to allow the user to link additional image files to the active image window. The title for the open image dialog box will indicate the number of files that will be linked with the selection to be made. Also the name of the image window is prefaced with 'Ln-' where n is the number of files that are linked for that image window.

3. Selected ‘Cancel’ after all desired image files have been linked.
4. After linking the separate disk files together, we can run the Display Image, Histogram, List Data, Principal Components, and Reformat processors on the

"logically linked" image. We cannot use this "logically linked" image as a base image for a Project

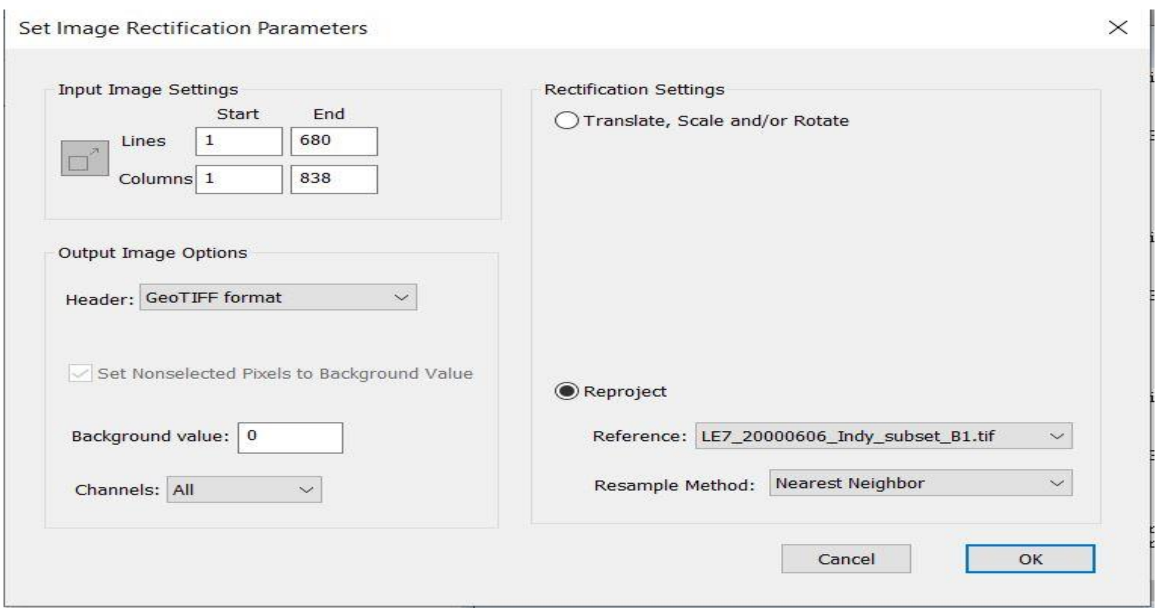
Problem 3: Combining Files into a Single New File: Used the Reformat->Change Image File Format… menu item to create a new disk file that contains all the channels included in the "logically linked" image files. The default options are usually sufficient but we can change them as desired. If the map projection information is known for the image and included with the input images, the GeoTIFF format is a good Header option to use to keep that information with the new image file.



After selecting "OK", we had the opportunity to name the file before it is created or use the default name provided. This new file can then be used as a base image for a project.

Problem 4: Handling Differing Spatial Resolutions: The thermal channel for many older Landsat data sets may be at a different spatial sampling than that for the reflective channels. We cannot link the thermal channels without first creating a new thermal image file that has the same spatial sampling as that for the reflective channels. We can do this with a couple of additional steps using the Processor–>Reformat–>Rectify Image… menu item in MultiSpec. The following steps are specifically for Landsat 7 thermal data. They can be modified for other kinds of images.

1. Opened band 1 (LE7_20000606_Indy_subset_B1.tif) from the set of multispectral images to be linked using the File–>Open Image… menu item. The “Display Multispectral Image” dialog box was presented to allow one to display the selected image. We may display the image or just cancel the dialog box. A blank multispectral image window will continue to be displayed.
2. Opened the first thermal band (LE7_20000606_Indy_subset_B61.tif).
3. Made sure the image window for the thermal channel is the active image window and then select the Processor–>Reformat–>Rectify image… menu item. Select “Reproject” in the Rectification Settings group in the “Set Image Rectification Parameters” dialog box as illustrated in the figure below. Also verified that “LE7_20000606_Indy_subset_B1.tif” is the reference image.



4. Selected OK and entered the name for the new rectified thermal image (LE7_20000606_Indy_subset_B61_30m.tif). A new thermal image was created such that it contains a thermal value that matches the location for each pixel in the reference image using nearest neighbor as the sampling scheme.

5. Closed the first thermal image window and opened the second thermal band (LE7_20000606_Indy_subset_B62.tif). Followed the same procedure used above to create “LE7_20000606_Indy_subset_B62_30m.tif”.

#ASTER HDF Files. MultiSpec will automatically link the ASTER channel sets 1, 2 and 3N (VNIR) together if any one of these data sets is selected in the hdf file. The same is true for the SWIR set of channels (4-9) and the TIR set of channels (10-14).

#FAST-L7A Format. MultiSpec will automatically link all bands in the FAST-L7A formatted group identified in the header if a one selects the header file such as …HRF.FST for reflective data (bands 1-5 & 7) and HTM.FST for thermal data (bands 61 & 61).

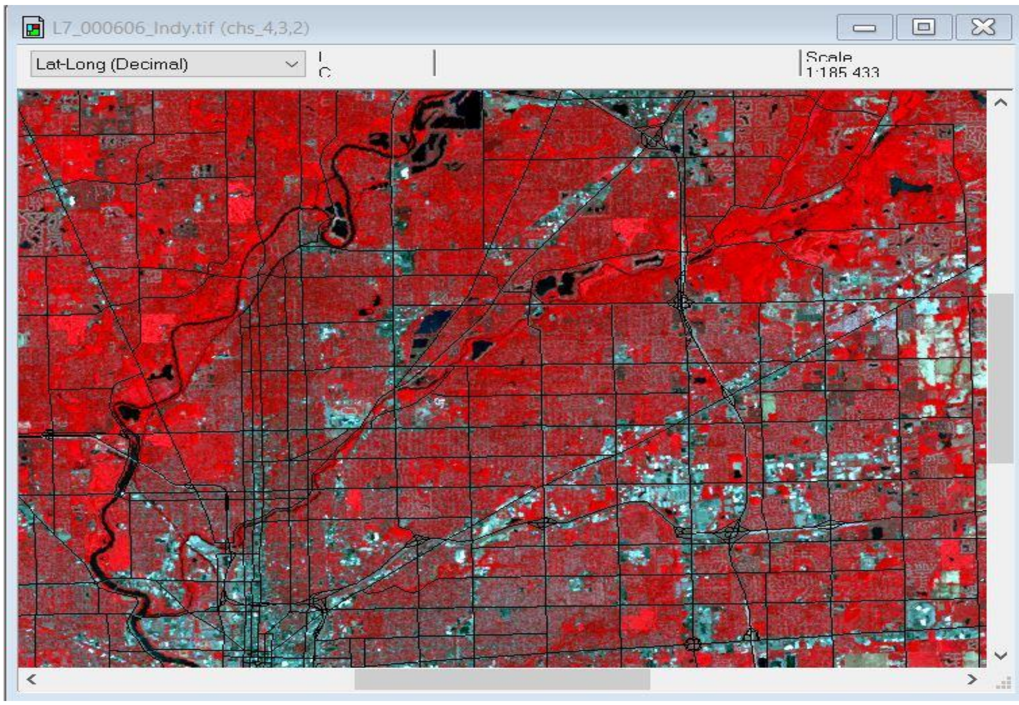
Practice 6: Overlay Shape Files on Image Window

Requirements: MultiSpec application and images titled “L7_000606_Indy.tif” & inrds.shp.

We can open ArcView Shape files (as long as an image window is opened first). A popup menu button will appear in the lower left of the Macintosh Image Window to allow one to turn the display of the shape file overlay(s) on and off. The popup menu button for the Windows version is next to the zoom buttons in the toolbar. The shape file will only be added to the active image window.

1. Display the L7_000606_Indy.tif image file in a multispectral image window using the File–>Open Image… menu command. You can display the image using any band combination that we wish.
2. Used the File–>Open Image… menu command to open a shape file such as inrds.shp in the IN_themes folder. We may need to change the filter (Files of types) in the open image dialog box to Shape or All. The shape file will be overlaid onto the image window as illustrated above with black lines.
   MultiSpec automatically converted lat-long shape files to respective map coordinates for images in Albers Equal Area, Cylindrical Equal Area, Equirectangular, Lambert Azimuthal Equal Area, Transverse Mercator, Orthographic, Sinusoidal and UTM map projections. MultiSpec first assumes

the shape file is in the same units as the map projection. If there is no overlap, MultiSpec checks if the input shape file units are within the range possible for decimal latitude-longitude degrees. If so, MultiSpec assumes the shape file is in lat-long units and converts them to map projection units. If the converted shape file values overlap with the image, then the shape file is overlaid onto the image. If a shape file has been converted, _ltom is appended to the shape file name in the overlay list for the window.



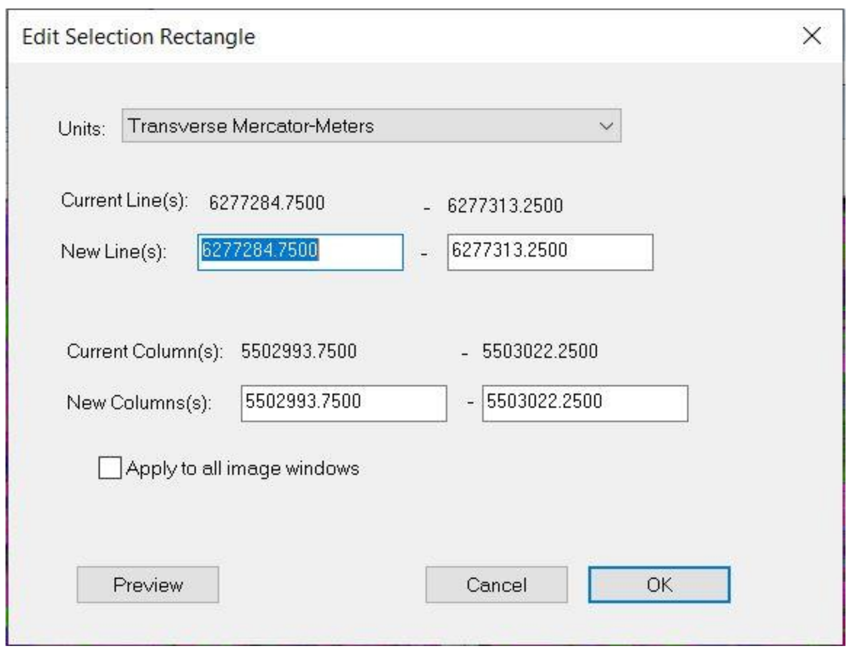
3. We can obtain a dialog box for editing the vector line width and color in the Windows version by holding the shift key down before selecting the Overlay menu button with the left mouse button and then select the shape file overlay to be edited. Now follows the overlay name indicating that a dialog box will be displayed.
   Changed the color of the shape files lines that have been drawn to white with a thickness of 2.
4. We can use the Edit->Clear Overlay menu item to remove the selected shape file from memory. The list of shape files in this list will include all shape files drawn in all open image windows. If one also has an image in geometric (lat-long) projection, shape files on these images will be treated as a separate shape files in the Edit–>Clear Overlay list

Practice 7: Selecting Areas and the Coordinate View

Requirements: MultiSpec application and pampas_xxx.img image files

We can make selections of areas within an image using line-column, map or latitude-longitude units. The map and latitude-longitude units are only available for images where the required map projection information is available. Currently, MultiSpec can handle selections in latitude-longitude for image in geometric (latitude-longitude) and UTM, Transverse Mercator, Albers Conical Equal Area, Cylindrical Equal Area, Lambert Azimuthal Equal Area, Sinusoidal, Orthographic, Krovak and a few State Plane map projections.

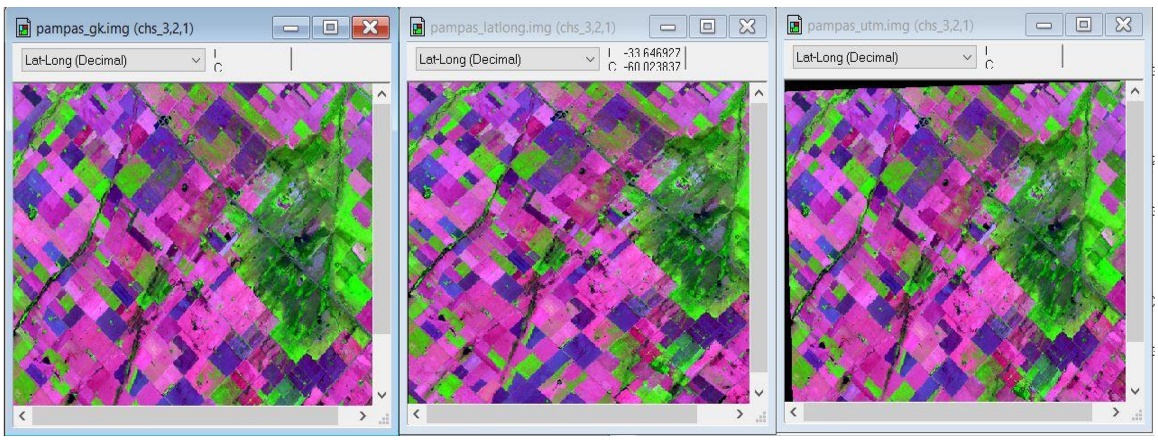
1. We can use the Edit–>Selection Rectangle menu item to do this. A checkbox was available to allow one to apply the selection to all open image windows. If the selections are being made in line-column units we can turn off the option to take into account the start line and column of the images. If the units being used are map or latitude-longitude units then the same area will be defined as well as possible across all image windows even if the pixel sizes are different.



2. Similar capability to the Edit->Selection Rectangle menu item above, is also available using the coordinate views of the images and the mouse cursor. If we make a selection in an image window with the coordinate view in lines/column units and hold the control key down when making selections, the same line and column selection will be made if possible in all open image windows.

If the coordinate view is in latitude-longitude units, the same latitude-longitude will be selected in all open image windows that contain the map projection information (which makes this possible). The same is true when selecting in map units of meters, etc.

The pampas_gk.img (Transverse Mercator), pampas_latlong.img (Latitude-Longitude) and pampas_utm.img (UTM) files can be used to illustrate these features. The figure below illustrates the result of a latitude-longitude selection in one image that was copied to the other open image windows when the control key was used in making the selection.



Practice 8: Creating Vegetation Indices Images

Requirements: MultiSpec application and ag020522_DPAC_cd.lan

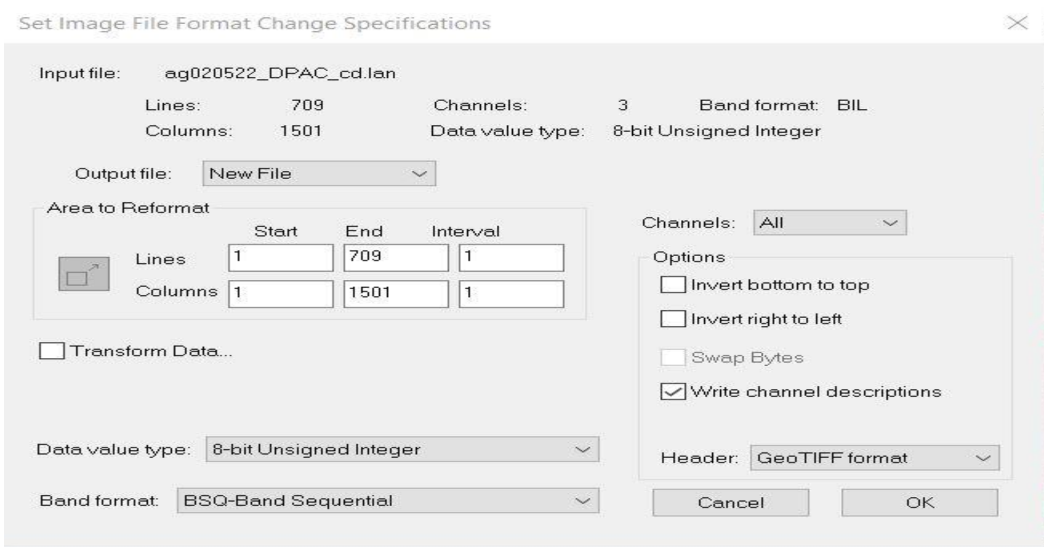
We can create images that represent algebraic combinations of the original channels of an image to try to enhance the image. This technique is used to enhance the vegetation or mineral variations in the image. One example is the Normalized Vegetation Index (NDVI) image. These images represent an algebraic combination of the red and near infrared bands to represent the amount of green vegetation in the image.The formula is:

$$NDVI = (NIR - Red)/(NIR + Red)$$

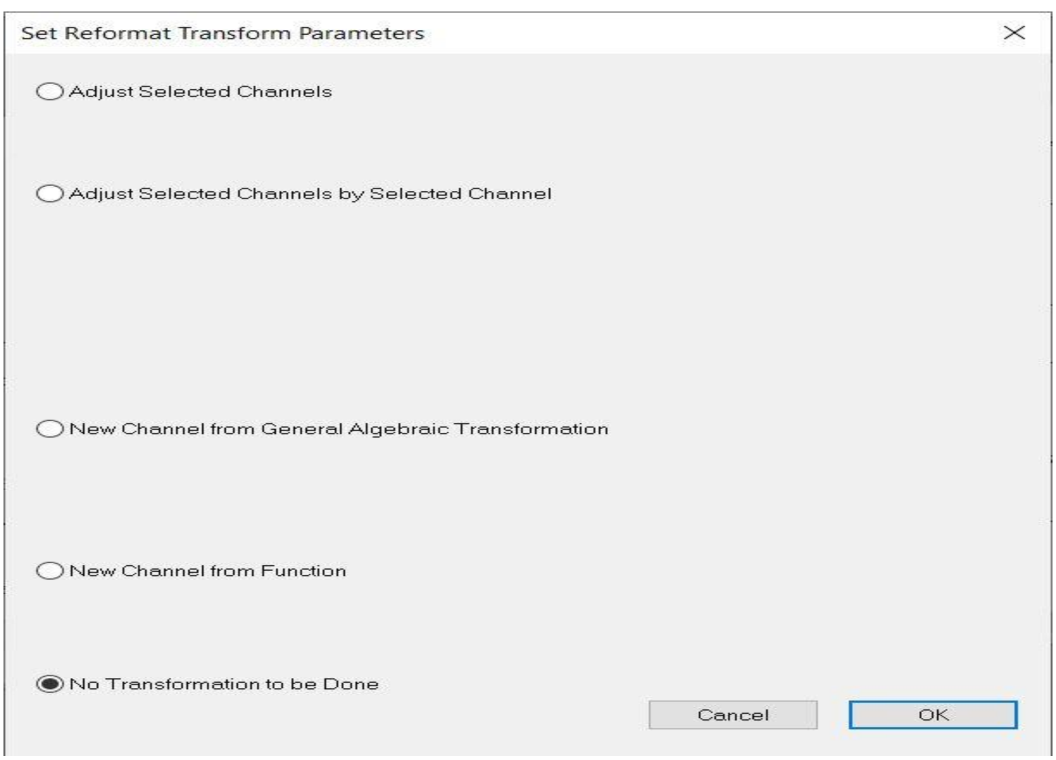
Where NIR represents the Near Infrared channel or band and Red represents the red channel or band. This formula results in a value that nominally varies between -1 (usually water) to +1 (strongest vegetation growth).

At first “ag020522_DPAC_cd.lan” was opened. Also clear any selections in the image window by striking the “Delete Key”

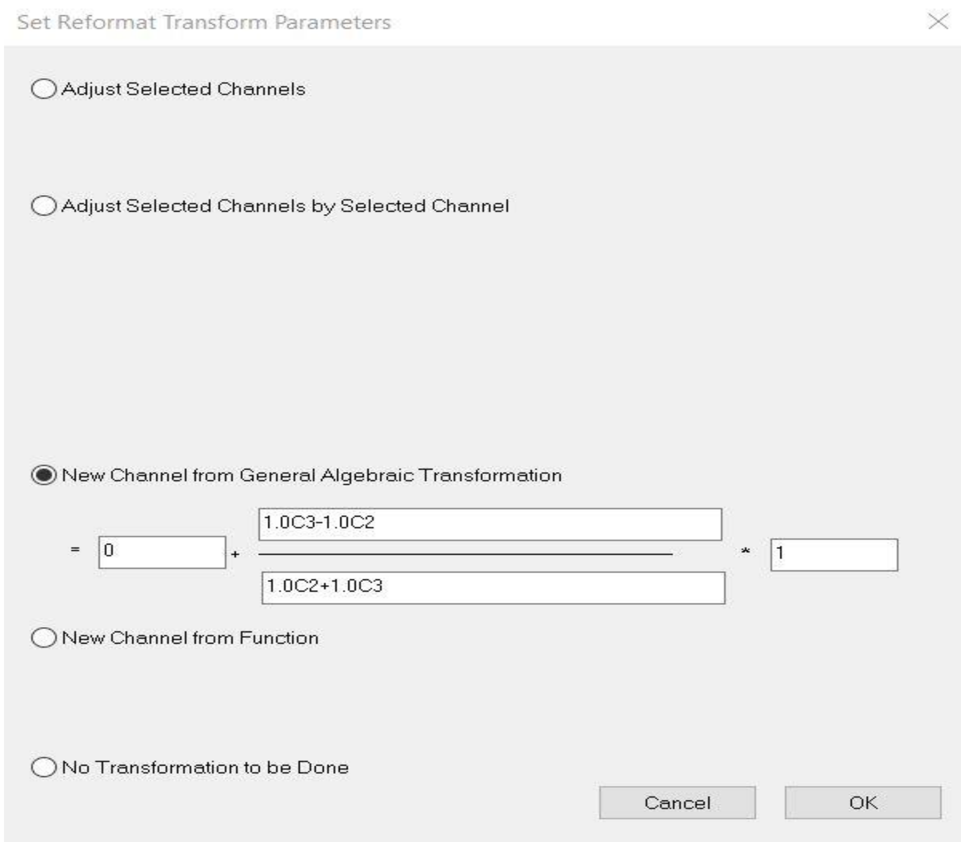
1. From the Processor menu, selected Reformat->Change Image File Format… to bring up the Image File Format Change Options dialog box.



2. Selected the “Transform Data…” checkbox. This caused the “Set Reformat Transform Parameters” dialog box to be displayed.



3. Then selected “New Channel from General Algebraic Transformation” This caused the window below to be displayed.



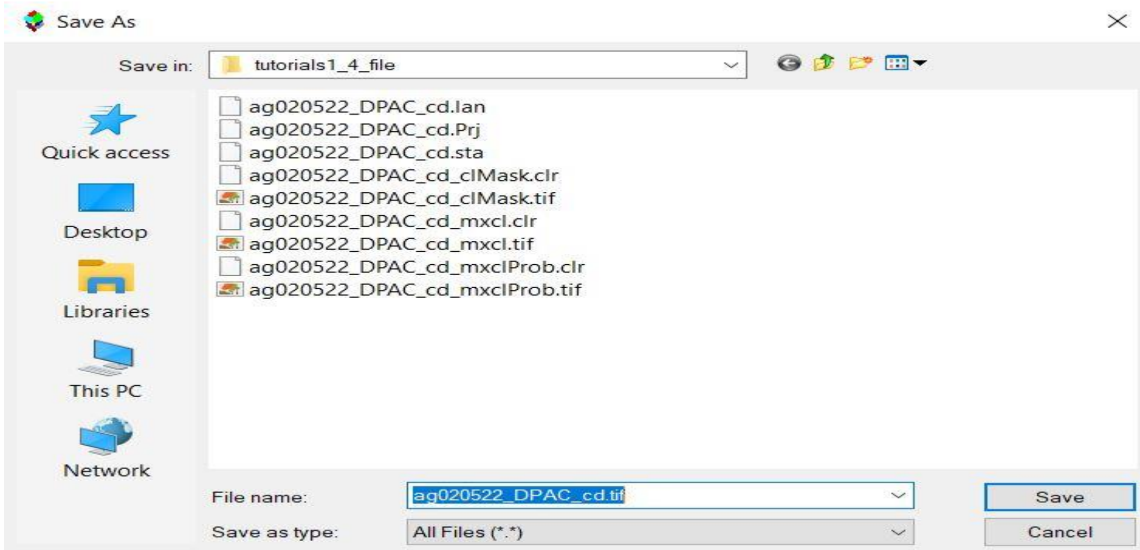
4. the ag020522_DPAC_cd.lan image file in which the red band is channel 2 and the near-infrared band is channel 3. Therefore to create a NDVI image for this image as defined in the introduction for this tutorial the equation (algebraic combination) will look like:

$$NDVI = 0+(1.0C3 - 1.0C2)/(1.0C2 + 1.0C3)*1$$

   Then selected OK to accept the defined algebraic transformation. This closed the “Set Reformat Transform Parameters dialog box and brought the “Image File Format Change Options” dialog box back to the top.

5. In the “Image File Format Change Options” dialog box, selected “32-bit Real” in the Data value type popup menu. Then selected OK to close this dialog box and started the processing to create the NDVI image file. The “Save New Image File As” dialog box appeared, as given below, to allow one to enter the

desired file name. Then select "Save". The new NDVI image file was written to the disk at the requested location.

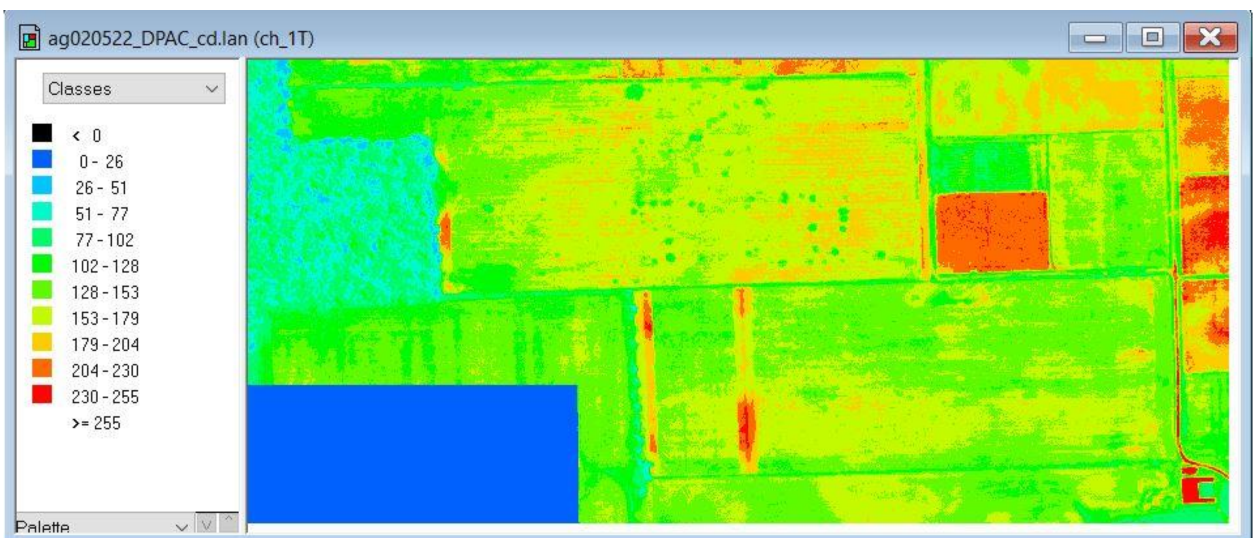


Checked the log output in the text window for this operation to verify that the creation of the NDVI image went well. The log output was

```
Reformat: Change Image File Format  01-06-2020  06:45:53 (MultiSpecWin64_2019.12.20)

  Input Parameters:

    Image file = 'ag020522_DPAC_cd.lan'
    Create transformed channel image
    = 0.000000 + (1.0C3-1.0C2)/(1.0C2+1.0C3) * 1.000000
     Lines 1 to 709 by 1.  Columns 1 to 1501 by 1

    Channels used:
        2: 0.635-0.705 um
        3: 0.7365-0.8635 um

  Output Information:

    New output image file name: 'ag020522_DPAC_cd.tif'
    File format:                GeoTIFF
    Image type:                 Multispectral
    Band interleave format:     BSQ
    Data type:                  Real
    Swap bytes:                 No
    Signed data:                Yes
    Number of lines:                      709
    Number of columns:                   1501
    Number of channels:                     1
    Number of bytes:                        4
    Number of bits:                        32
    Number of header bytes:               614
    Number of pre-line bytes:               0
    Number of post-line bytes:              0
    Number of pre-channel bytes:            0
    Number of post-channel bytes:           0
    Line start:                             1
    Column start:                           1

    -1 is lowest calculated value
    3.40282e+38 is highest calculated value
    0 data values saturated at low end: -3.40282e+38
    106,907 data values saturated at high end: 3.40282e+38

  0 CPU seconds for reformatting.  01-06-2020  06:48:14
  --------------------------------------------------
```

6. We can now display the resulting image as either a 1-channel gray scale type image or as a 1-channel thematic type as show below.

1-channel type display of the resulting NDVI image



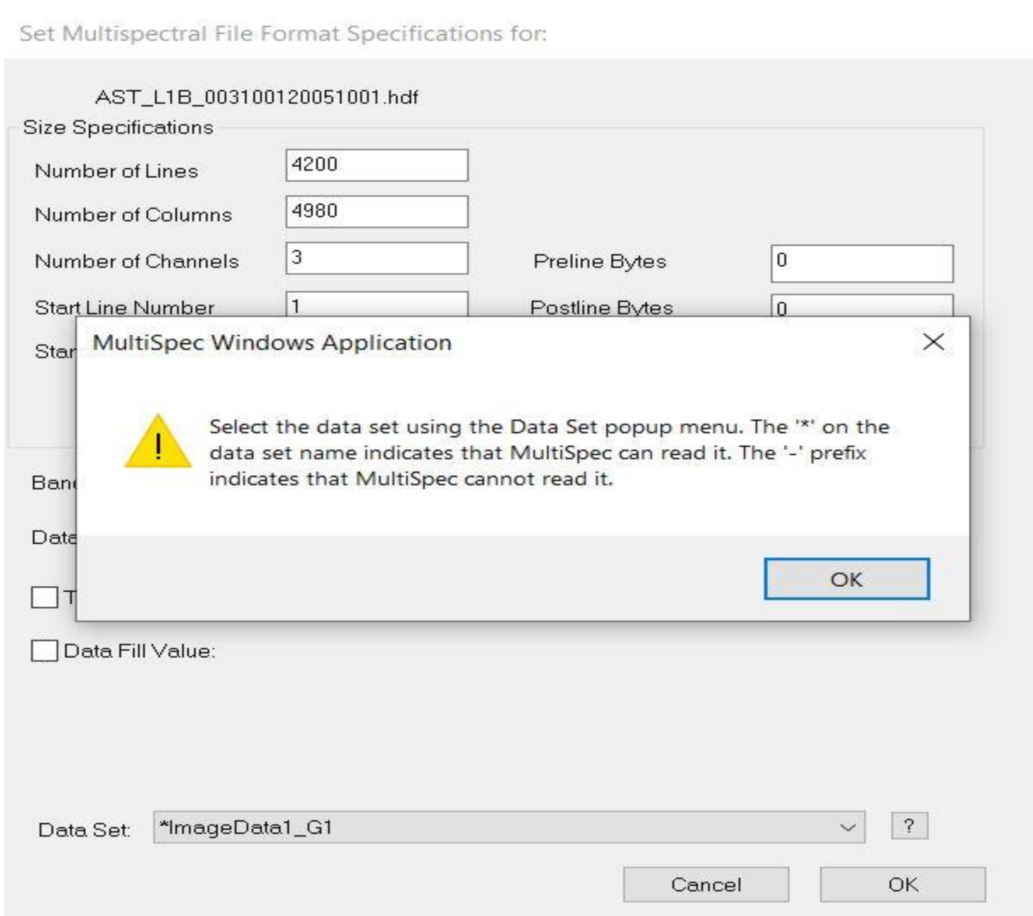
1-channel thematic display of the resulting NDVI image

Practice 9: Handling HDF Formatted Image Files

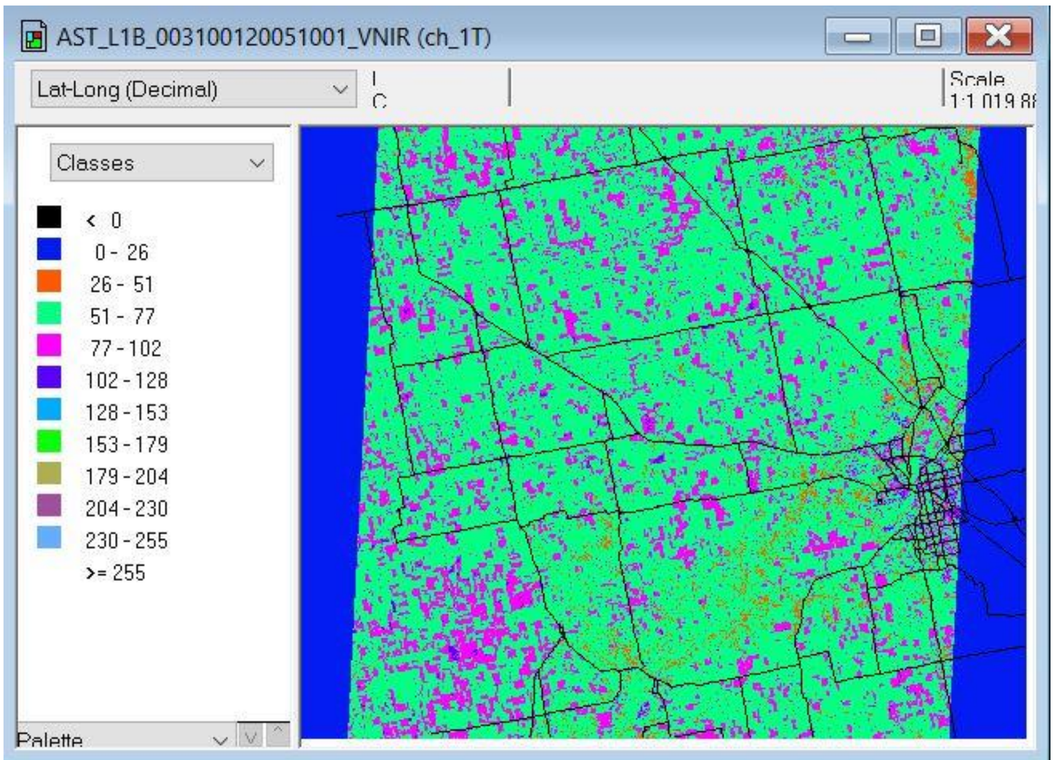
Requirements: MultiSpec application and AST_L1B_003100120051001.hdf

Hierarchical Data Format (HDF) is a data file format designed by the National Center for Supercomputing Applications (NCSA) to assist users in the storage and manipulation of scientific data across diverse operating systems and machines. HDF supports a variety of data types: scientific data arrays, tables, and text annotations, as well as several types of raster images and their associated color palettes. There are two different varieties of HDF, one known as HDF4 and the newer one called HDF5. HDF5 can handle very large file sizes among other improvements. MultiSpec currently can handle HDF4 formatted files.

1. From the File menu, selected Open Image A dialog box will open to allow one to select the image data file one wishes to use. Selected AST_L1B_003100120051001.hdf. Then The "Set Multispectral File Format Specifications" dialog box appeared if there was more than one data set in the file.



2. Clicked ok the selected ImageData1_G1 data set.
3. Selected the "OK" button. The 'Multispectral Display Specifications" dialog box then appeared to allow us to display the image just like that from any other image file. The default channel combination display of this image will appear as below.



Practice 10: Visualizing Growing Degree Day (GDD) Images

Requirements: MultiSpec application and "gdd_2012_accumulated.tif" image and "STATES.SHP" shape file

This Problem illustrates how MultiSpec can be used for handling and analysis of general geospatial images. The image data used in this example is not multispectral data collected by a satellite or aircraft or the results of analysis of those data rather it is a geospatial image derived from gridded data obtained from the Applied Climate Information System (ACIS); the data is derived from measurements collected by many weather stations

Problem 1: Growing Degree Day (GDD) Data : Growing Degree Days (GDD), also called Growing Degree Units (GDUs), are a heuristic tool in phenology. GDD are a measure of heat accumulation used by horticulturists, gardeners, and farmers to predict plant and pest development rates such as the date that a flower will bloom or a crop reach maturity. Growing degree days take aspects of local weather into account and allow farmers to predict the plants' pace toward maturity. The general formula for GDD is given below:

$$GDD = (\max(T)+\min(T))/2-\text{base}(T)$$

GDDs are calculated by taking the average of the daily maximum and minimum temperatures compared to a base temperature.

GDD's for layers 1, 2 and 3 are calculated as:

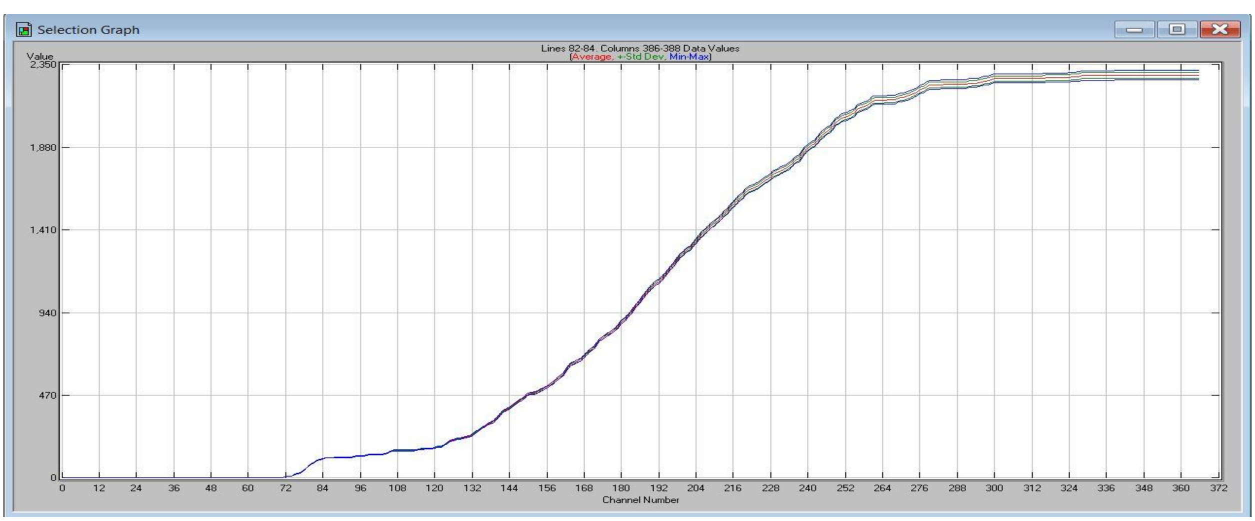
Layer 1 = GDD's for day 1

Layer 2 = GDD's for day 1 + GDD's for day 2

Layer 3 = GDD's for day 1 + GDD's for day 2 + GDD's for day 3

Problem 2: Plot Accumulated GDDs Data per Day for a Selected Year

1. Opened "gdd_2012_accumulated.tif".
2. Selected a point in the grayscale image by clicking on the desired location. After going to Windows option in MultiSpec main menu and selected Selection Graph. A plot of the accumulated GDD vs. day of year was displayed showing the amount of GDD accumulated through time (days of year) for to the selected location.



Problem 3: View an "Animation" of how the GDDs accumulate during the year.

We can view an animation of the daily accumulations with a few fairly simple steps.

1. Opened gdd_2012_accumulated.tif
2. Selected 1-Channel Thematic for the Display Type, Selected User Specified for the Enhancement Min/Max.
3. In the "Set Specifications for Display Enhancement" dialog box, set Min value to 0 and Max value to 5500. Then close the Enhancement dialog box by selecting OK.
4. Entered 24 for the number of display levels. Then Selected OK to close the "Multispectral Display" dialog box. Added State Shape file overlay on the image