MultiSpec Tutorial: Creating Vegetation Indices Images

Requirements: MultiSpec application and ag020522_DPAC_cd.lan.

One 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:

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

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).

To start this tutorial, be sure that the "ag020522_DPAC_cd.lan" image that was used in tutorial 1 is open and represents the top-most image window in MultiSpec. Also clear any selections in the image window by striking the "Delete Key"

8.1   From the *Processor* menu, select *Reformat->Change Image File Format…* to bring up the Image File Format Change Options dialog box.
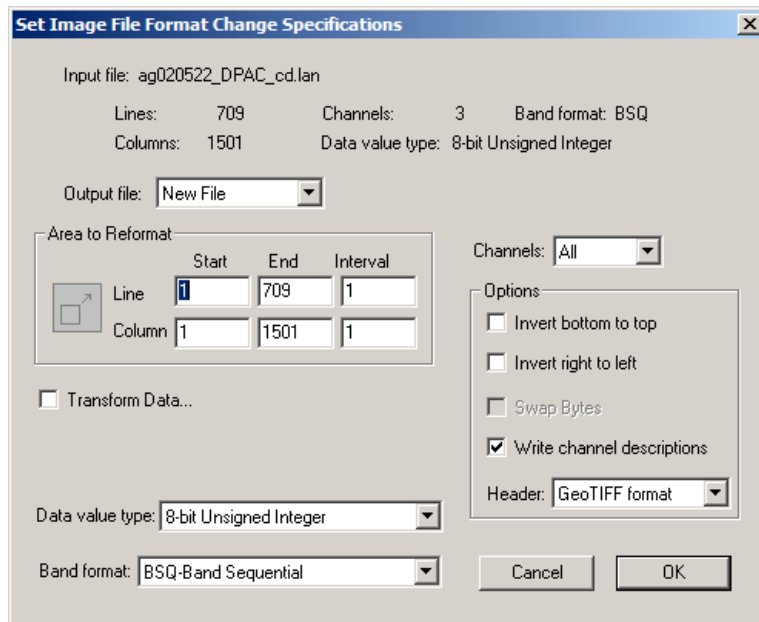
8.2   Select the "Transform Data…" checkbox. This will cause the "Set Reformat Transform Parameters" dialog box to be displayed.
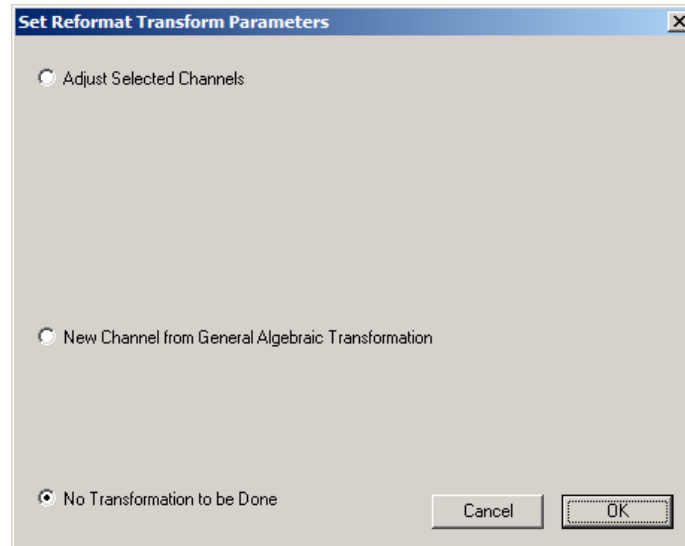
8.3   Then select "New Channel from General Algebraic Transformation" This will cause the window below to be displayed.
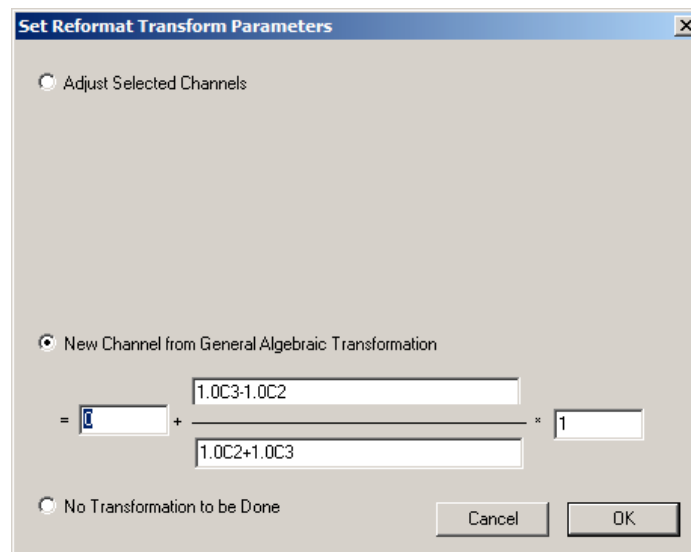

The editable boxes in the above window allow one to define an algebraic combination of the original input channels to create a new channel such as NDVI. The transformation is in the form of $= \text{offset} + (a_0 + a_1C_1 + a_2C_2 + ...)/(b_0 + b_1C_1 + b_2C_2 + ...) * \text{factor}$; where offset, factor, a_0, a_1, b_0, b_1, ... are real constants which can be positive or negative and C_1, C_2, ...C_n represent the channel number to be used. Both 'c' or 'C' can be used. The number of constant*Channel value (e.g. a_1C_1) combinations in either the numerator or the denominator is limited to the number of channels in the active image file plus 1. Also the number of characters in the numerator and denominator is limited to 255. Note that one can create only one new channel at a time.

8.4   This tutorial is based on 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:

$$NDVI = 0 + \frac{1.0C3 - 1.0C2}{1.0C2 + 1.0C3} * 1$$

After entering the values needed to compute a new channel representing NDVI, the Transform Parameters dialog box will look like:
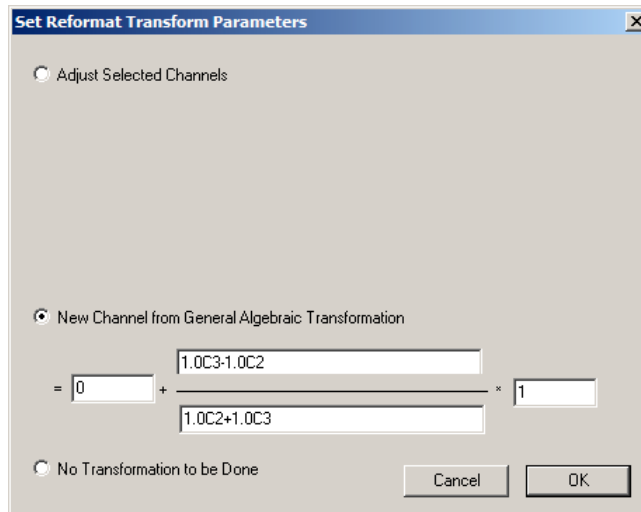

Since the real constants a1, a2, b1, b2 are 1.0, one can also enter the transformation as illustrated by the dialog box below.
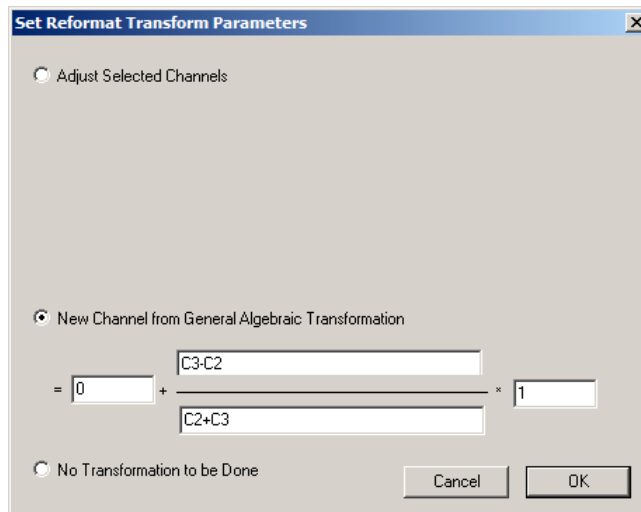
Then select **OK** to accept the defined algebraic transformation. This will close the "Set Reformat Transform Parameters dialog box and bring the "Image File Format Change Options" dialog box back to the top.

8.5   In the "Image File Format Change Options" dialog box, select "32-bit Real" in the Data value type popup menu.
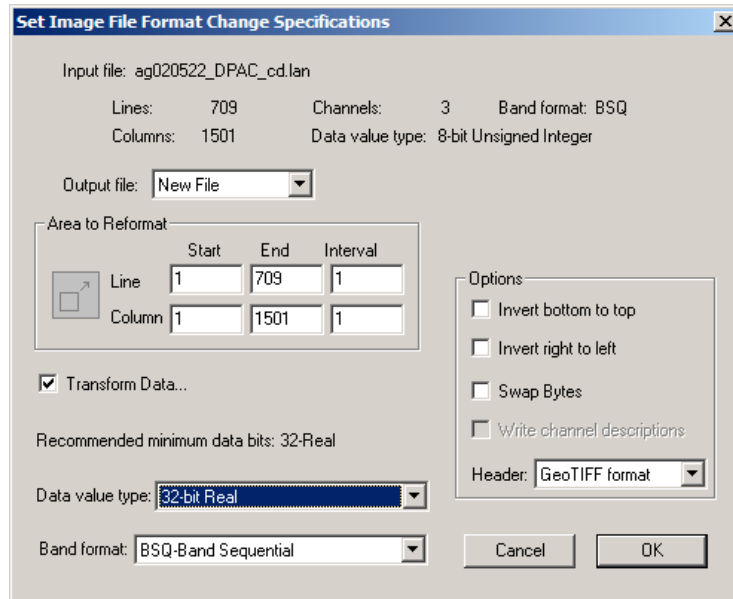
Note that requesting the output data values to be real numbers is important since the resulting data values nominally range between -1 and +1.

If the output data values are converted to signed integer values, one will end up with only -1's, 0's, or 1's or if to unsigned integer values, one will end up with only 0's and 1's.

8.6   Select **OK** to close this dialog box and start the processing to create the NDVI image file. The "Save New Image File As" dialog box will now appear, as given below, to allow one to enter the desired file name. Then select "**Save**". The new NDVI image file will be written to the disk at the requested location.
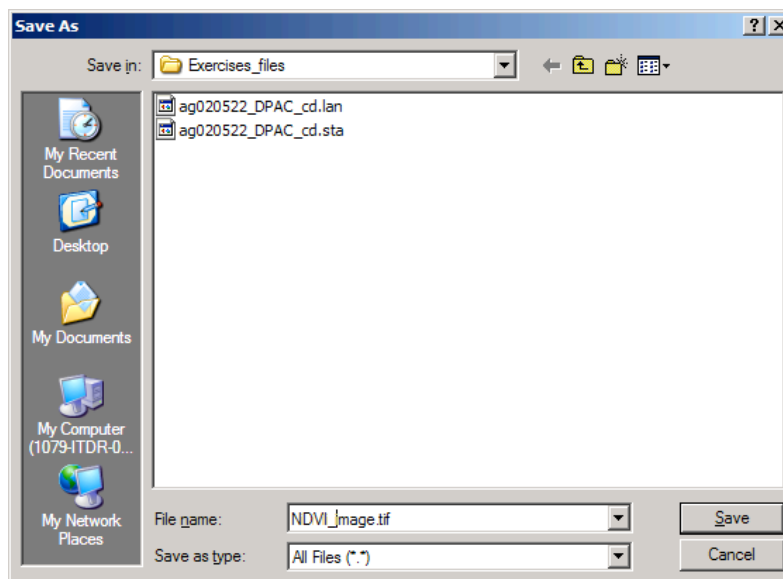
Check the log output in the text window for this operation to verify that the creation of the NDVI image went well. The log output should be similar to the following:

```
Reformat: Change Image File Format  06-28-2010  14:04:15
(MultiSpecWin32_6.28.2010)

  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: 'NDVI_image.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:           548
    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+038 is highest calculated value
    0 data values saturated at low end: -3.40282e+038
    106,907 data values saturated at high end: 3.40282e+038

  1 CPU seconds for reformatting.  06-28-2010  14:04:31
```

One should verify that the transformation equation used is as you expected. One should also check the lowest and highest calculated value to verify that these values make sense. One should also verify that the number of pixels saturated at the low and high ends are 0 or at least a very small portion of the total number of data values in the image. For this image, the highest calculated value is very high … the maximum possible 32-bit real number which seems a little strange. On checking though one will find that these 106,907 high values represent the calculated NDVI for the portion of the scene (lower left) which contain missing data (all 0's); a limit value for these pixels make sense.

NOTE:

A large number of saturated data values may indicate that the data output type needs to be changed from integer to real. A very small range in data from the lowest to highest data value may also indicate that one needs to change the data type from integer to real or one needs to provide scaling and offset values to adjust the range of the output data values for better precision.

For example if one used 8-bit unsigned integer as the data type to create an NDVI image from ag020522_DPAC_cd.lan, the NDVI image will have over 900,000 '0' data values and 33,000 '1' data values. This image will not be very useful. However if one changes the gain value in the transformation from 1 to 100 and uses 8-bit signed integer, one will end up with a data range of -100 to 127. The variation in the NDVI values are spread across a nearly the entire range possible for an 8-bit signed integer data value. One will just need to keep in mind that an image value of 100 represents an actual NDVI value of 1.

8.7   One 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. See Tutorial 1 for steps to do this if needed.
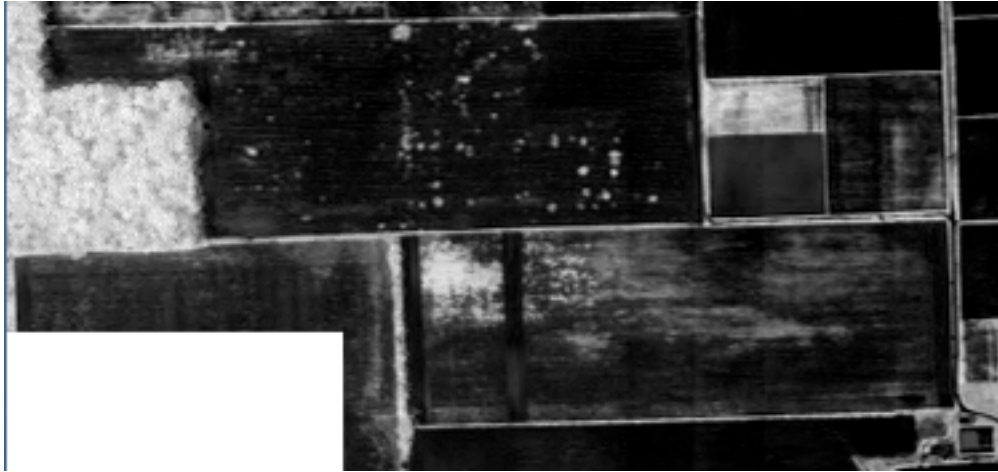
1-channel type display of the resulting NDVI image. High NDVI values which represent significant amounts of green vegetation are illustrated by light tones. Bare soil is represented by darker tones.
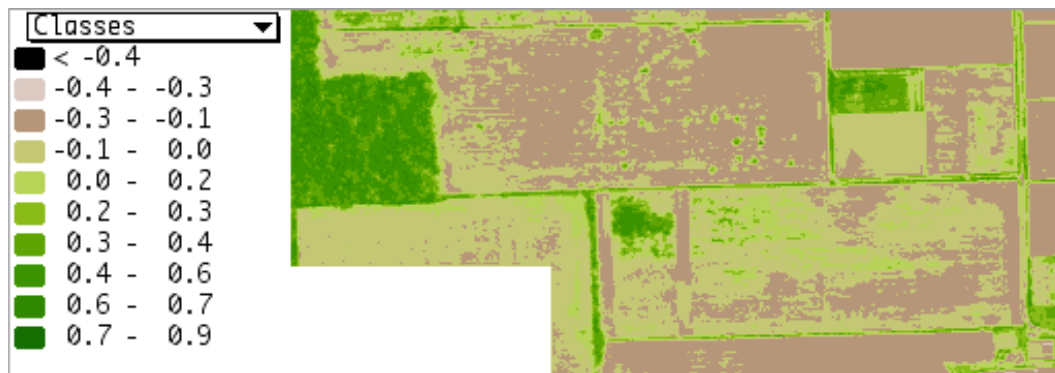
1-channel thematic display of the resulting NDVI image using the MODIS NDVI palette. The legend on the left relate the color tones with the NDVI values.

Concluding Remarks

There are many other operations that one can do with MultiSpec. See other tutorials or the MultiSpec Introduction at the MultiSpec web site for more information. The MultiSpec web site is: https://engineering.purdue.edu/~biehl/MultiSpec/. Or contact Larry Biehl at biehl@purdue.edu with questions.