

# **Change Detection and Analysis**

## **ERDAS Imagine 2016**

Description: In this lesson we will use tools available in Imagine to identify the condition of vegetated areas. We will also work with two approaches to change detection.

## Outline of Lab

In this lab we will look at two types of change detection. *Image Differencing* uses the original images and compares each pixel to produce a new image. *Thematic Change* is a post-classification method that compares two classification maps. For either method, it is important to ensure that the images used cover the same geographic extent and are from the same time period.

## Images

The images for 1991 and 1998 include Landsat TM bands 4 (NIR), 3 (red) and 2 (green). If Imagine loads the image bands as 2,3,4 by default – you can change the bands to 4,3,2 (R,G,B).

These images cover an area equal to two DOQs, or the south ½ of a 7½ minute topo quad (Lake Elmo). The area is located southeast of the I-94 and I-494 intersection in Washington, County, MN.

Familiarize yourself with the image by viewing each image and studying its features.

### Set Up:

1. Log onto the computers as usual and start Imagine.
2. At the viewer window, from the **File** menu choose **Open > Raster Layer** or the open layer. 
3. Download and unzip the data files for the lab from Moodle or navigate to the **Lab09** folder on the G drive. Recall that you can load all the images at once in a single viewer if you click on the Raster options tab and uncheck Clear display.
4. Add the following data layers to your map: Elmo-South, Elmo-91 and Elmo-98.
5. Assign Landsat bands 4-3-2, respectively to Red, Green and Blue for each Elmo-91 and Elmo-98.

*Similar to ArcMAP, you can also open multiple files by select on two or more files in the browser window and selection them with a shift-enter*

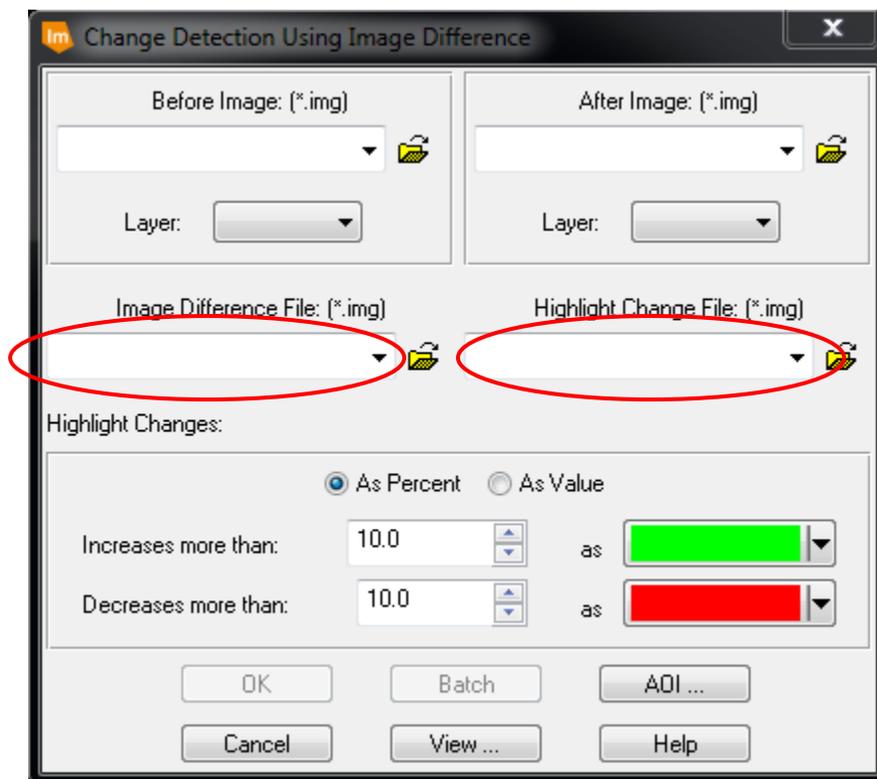
Orient yourself with the landscape: Hwy I-494 runs diagonally across the northwest corner, agricultural fields are generally in the southern and eastern parts, development is close to the roads. There is a linearly shaped wetland running southeast from the upper part of I-494, and 7 fairly large lakes. With the Landsat image colors as specified above, Dark red areas are forest; bright red and pink areas are crops, pasture or grasses; green areas may be fields that are bare, have been cut, or dry grass; wetlands are generally a mix of dark greens, purples and reds; aquas are bare surfaces such as bare soils, pavement and rooftops. Open the corresponding **1991 DOQ (elmo-south.img)** and compare it to the **Elmo-1991** image to get a feel for the differences in resolution between the two types of imagery. Then look at the 1998 image and see if you can tell visually how the landscape might have changed over time.

## Change Detection

There are two ways we can look at change. First, by finding the changes in pixel values of the original images (**Image Difference**), reported either as a percent of the value or the difference between values. Second, by finding the amount of change between *categorized thematic* files of the two images (**Thematic Change**). We will start with using Image Difference to detect change between the two years; then we will classify the images from each year and use Thematic Change. Finally, we can tabulate and summarize the results.

### Image Difference

Image Difference operates on continuous data (raster). The pixel values from the “after theme” (**Elmo-98**) are subtracted from the values of the “before theme” (**Elmo-91**), for example.



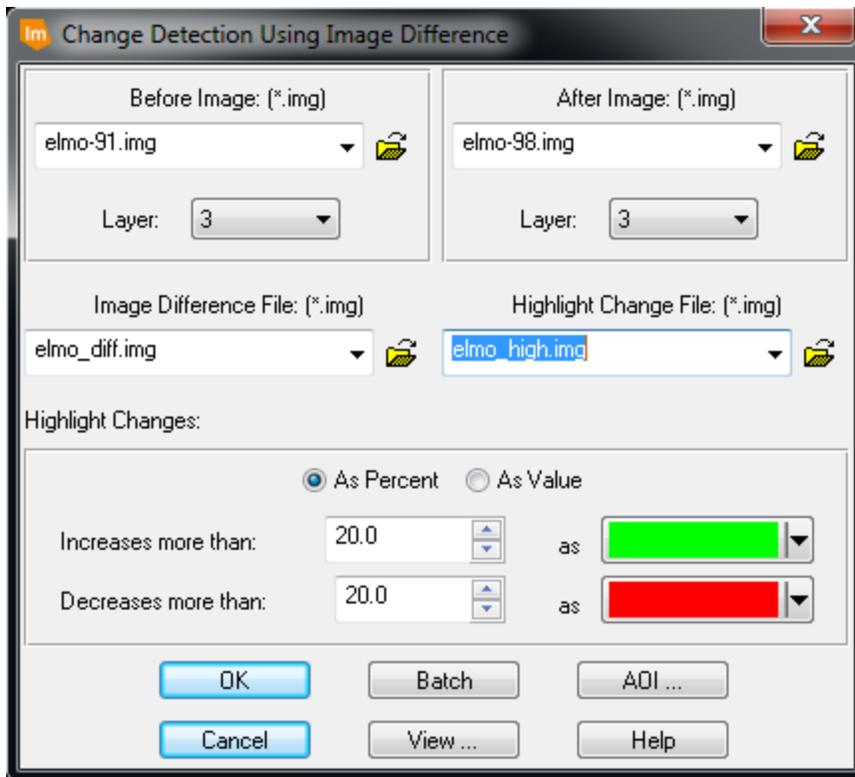
You will need to enter file names to be created on your student drive for the two output files circled in red above. With *Image Difference*, change is measured as brightness, either as a percentage or a direct value. The output will be two files: The *Difference* file will be continuous data showing change by pixel. Darker pixels indicate less change and lighter pixels indicate greater change. The *Highlight Changes* file creates a thematic layer with 5 classes: Background, Decreased, Some Decrease, Unchanged, Some Increase, and Increased.

1. In the **Raster** tab, **Change Detection** group, click the drop down under **Change Detection Tools** and select **Image Difference** to see the above window. (Hint: If Image Difference isn't there, find it using the Help search)
2. Enter your before and after images from the Lab 09 folder
3. Select **layer 3** for each file in question. This analyzes only the NIR band. (the image is stacked such that Layer 1 = Green, Layer 2 = Red and Layer 3 = NIR)
4. Create a file in your designated place for the Image Difference File.
5. Create a file in your designated place for the Highlight Change File.
6. Select the **As Percent** radio button.
7. Type in a % value for the two bottom boxes (threshold). You can also change the color of the change boxes.

How much do you think the area will have changed in seven years? You may want to start with a 20% (threshold value), view the output, and repeat with another value. The amount you enter may depend on your own interests, i.e. is there a change in vegetation vigor (small value) or is the change significant (vegetation to pavement)?

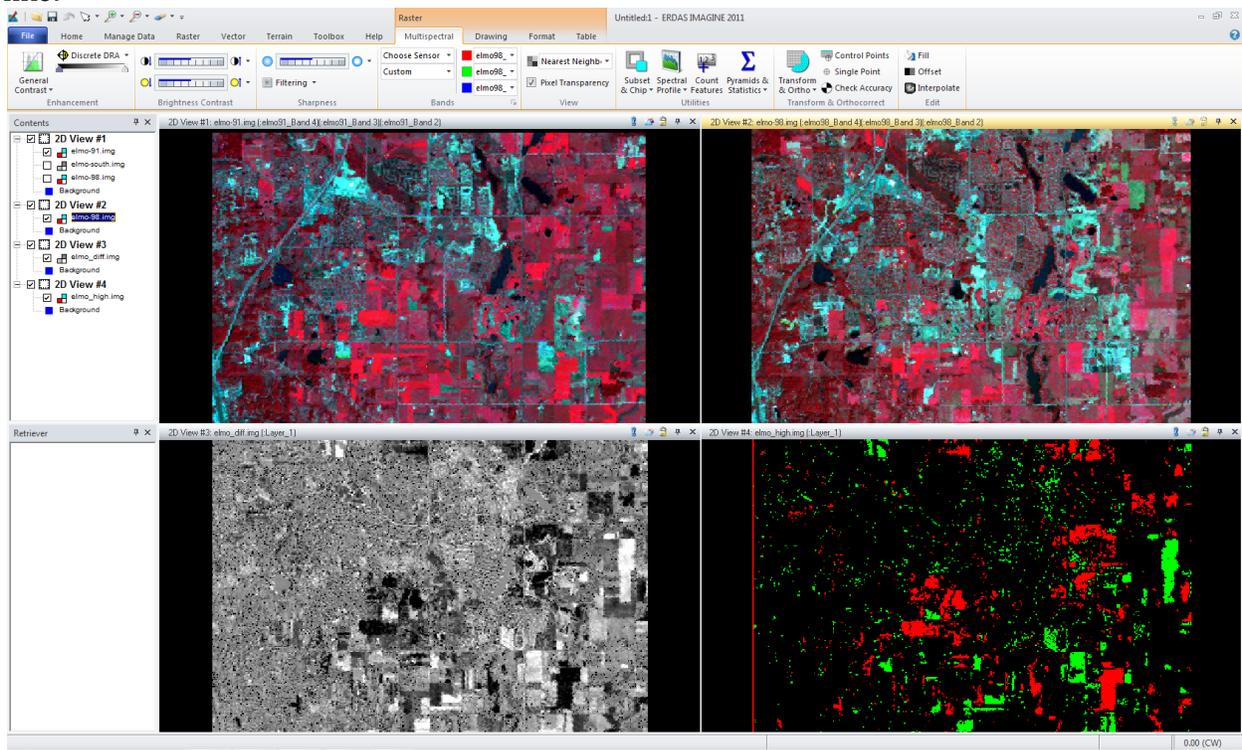
In the *Image Difference* file, an increase in brightness of layer 3 (NIR) usually implies that the amount of vegetation has increased, or has gone from forest to grass (*think about why that might be*). The *Highlight change file* shows the image with five classes, but only the increases and decreases above and below the specified threshold have been colored.

If you did several analyses using different values or percents, these themes can be overlaid such that the theme with larger areas is on the bottom, and the theme with smallest classes is on top. This will produce an image on the screen that appears to have some gradation by percentage. The >20% change areas in general will be contained within the larger >10% areas, or might be the same area. Your final filled out screen might look something like:



Click **OK** to run the process.

If you load all 4 images into 2D Views and Fit to Frame... your screen will look something like:



Although we will not do it this lab, the next step you might try in change detection analysis is to carry out a classification of the change image itself.

## Thematic Change

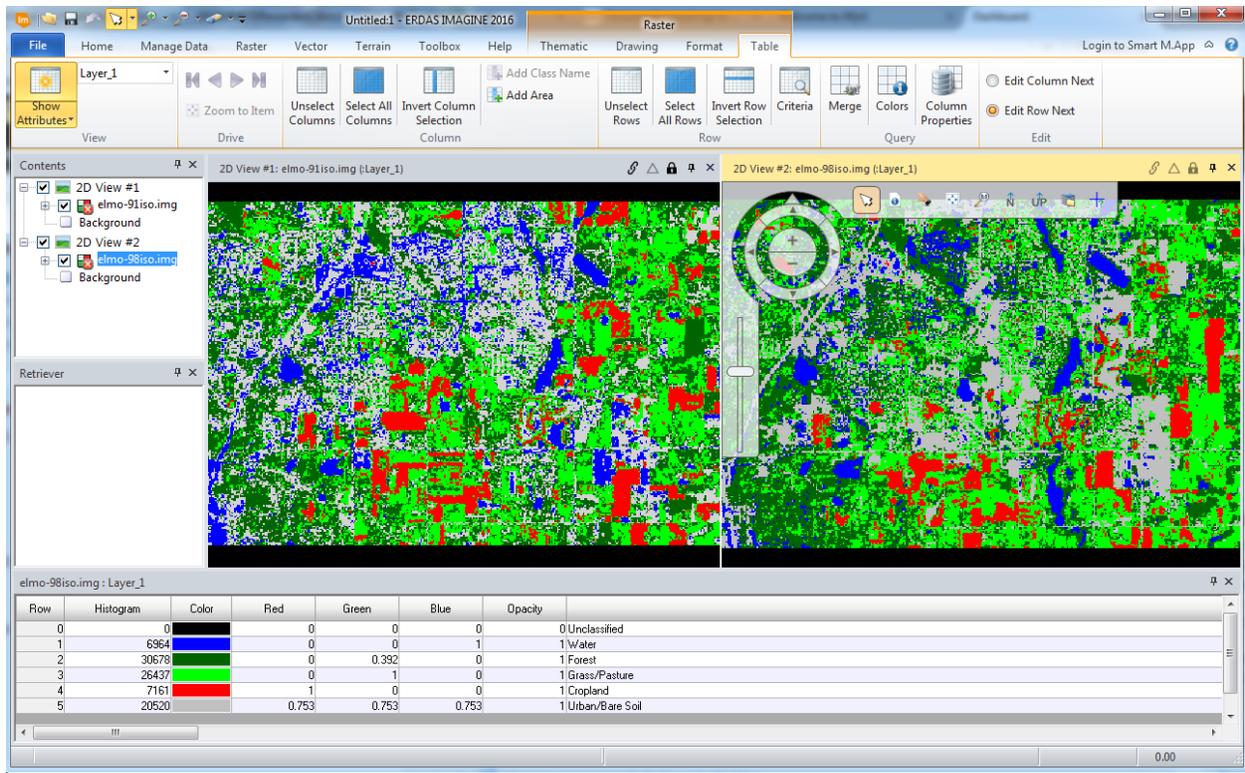
As its name implies, **Thematic Change** operates on thematic images that are classifications of raster images. After an unsupervised classification we can perform a **Thematic Change**. The image produced analyzes the amount and direction of change. This method is often referred to as Post-classification Comparison; one of its advantages is that it provides “from-to” information about what classes changed.

Your first step is to follow the process for unsupervised classification in a previous Lab and classify the 1998 and 1991 Lake Elmo images. Save the outputs to your personal space.

Use a convergence threshold of 0.98 and 15 maximum iterations. Choose the principal axis under initializing options instead of the diagonal. You may even want to try to color your output BEFORE creating the output file. Use five classes as follows:

- Forest
- Grass/Pasture
- Cropland
- Urban/Bare Soil
- Water

Once you have classified your images, give your output images good contrasting colors between the categories if you feel that the provided colors are too difficult to work with (example: green, tan, orange, grey, and blue, for the respective classes above). As a reminder, go to the **Raster** group, **Table** tab, click **Show Attributes**.

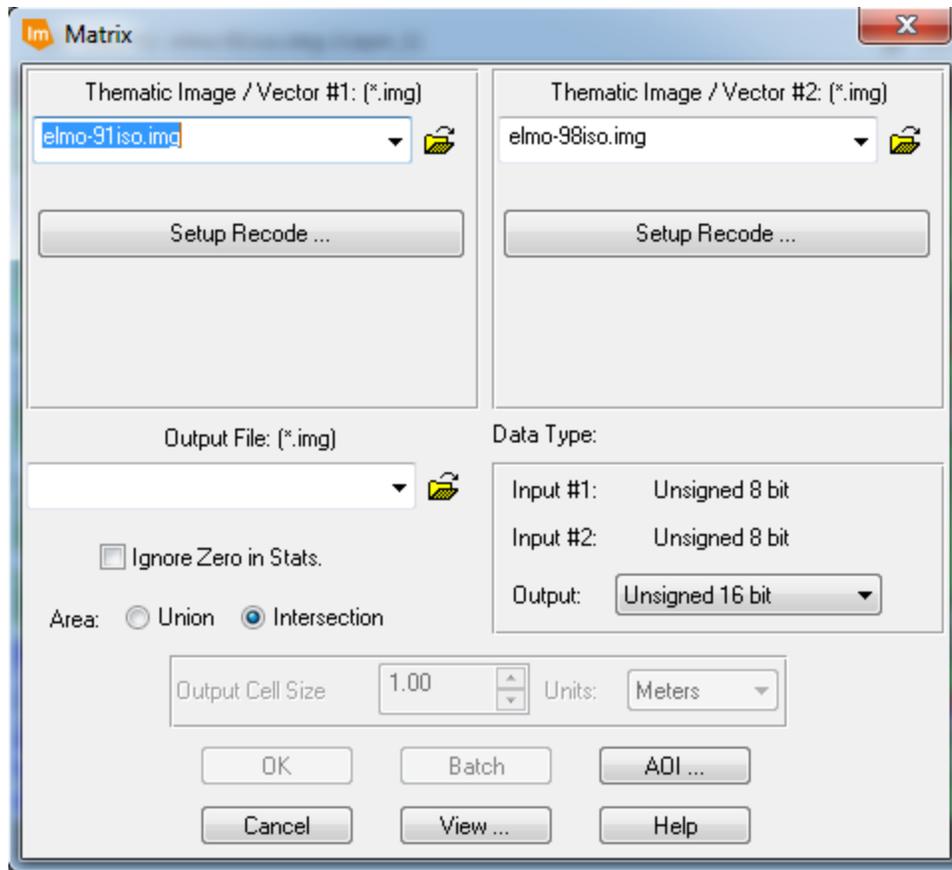


Now we can examine the classified thematic images by comparing their histograms. Can you readily see the differences between the number of pixels in each class for each year? You can remove these layers now but remember to save your raster edits.

## Summarize Areas

To further analyze thematic changes, there are some utilities within ERDAS Imagine to help you. The Matrix Union function will create a matrix from two input thematic rasters. To open this dialog, go to the **Raster** tab, **Raster GIS** group, click the drop down below **Thematic** and select **Matrix Union**.

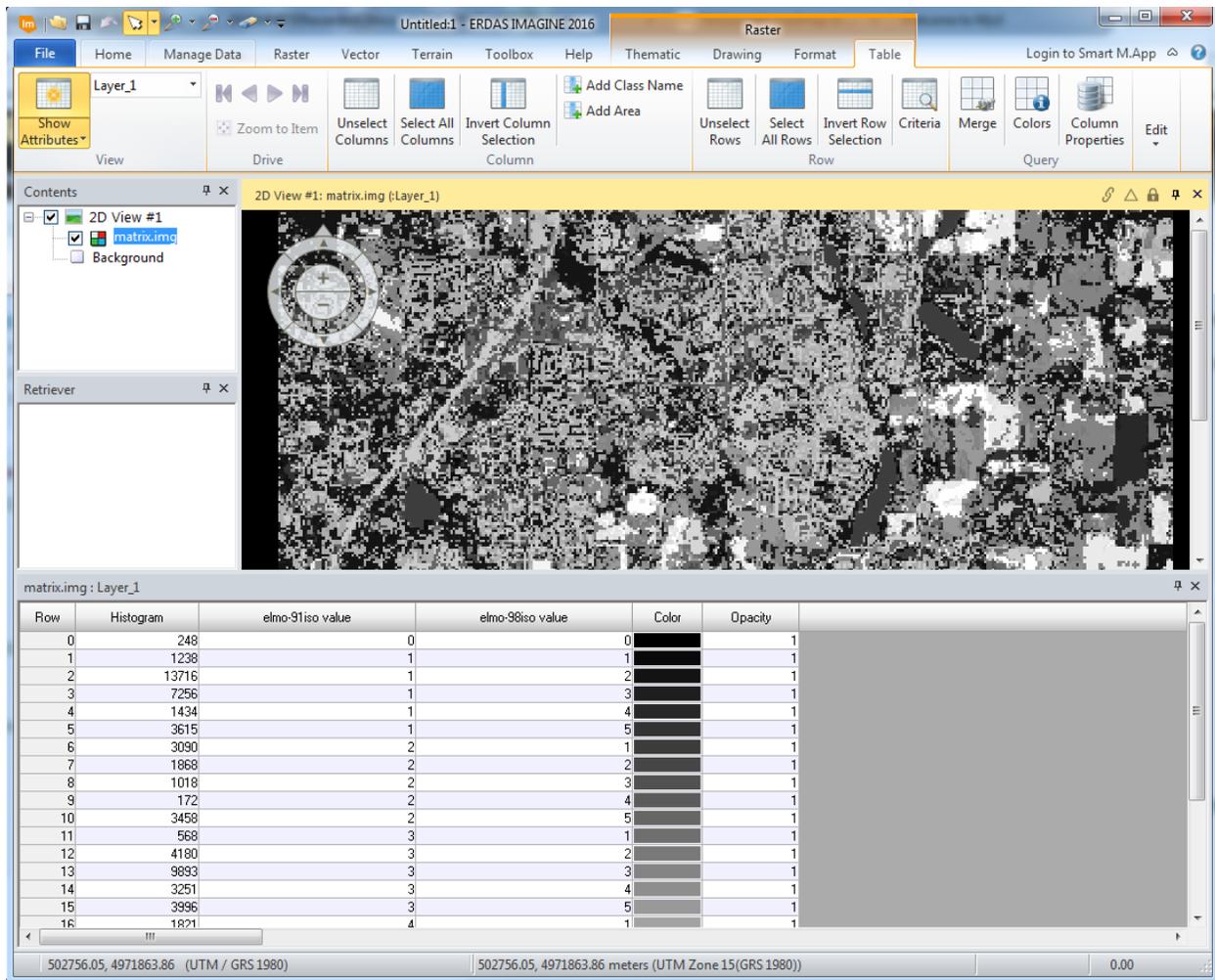
Use this utility to create an output file that contains a matrix of class possibilities between the thematic classifications. This will create a file of 25 classes, which is the product of 5 classes from each post-classification.



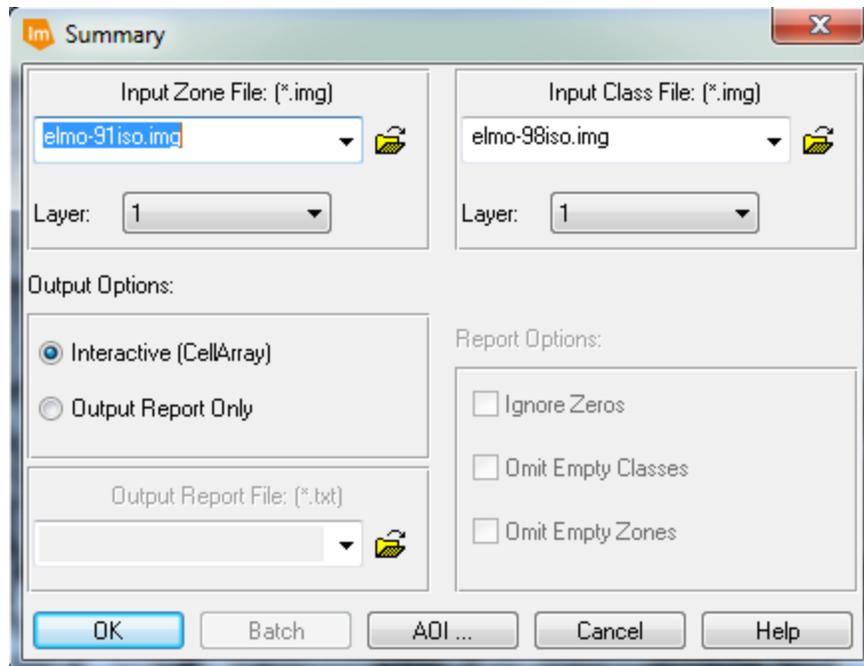
Set the Thematic Image #1 to your 1991 unsupervised classification and Thematic Image #2 to your 1998 unsupervised classification. Store an output file to your personal space. Accept the defaults for Setup Recode and Data Type and click **OK**.

Open your matrix image in a new viewer to see how the pixels change between the years and what class they changed to (classes are designated as a class number - consider writing your class codes down so you can more easily translate). The inquire cursor will help you rapidly see how an individual pixel changed and to what value (expand the window so you can see all of the columns).

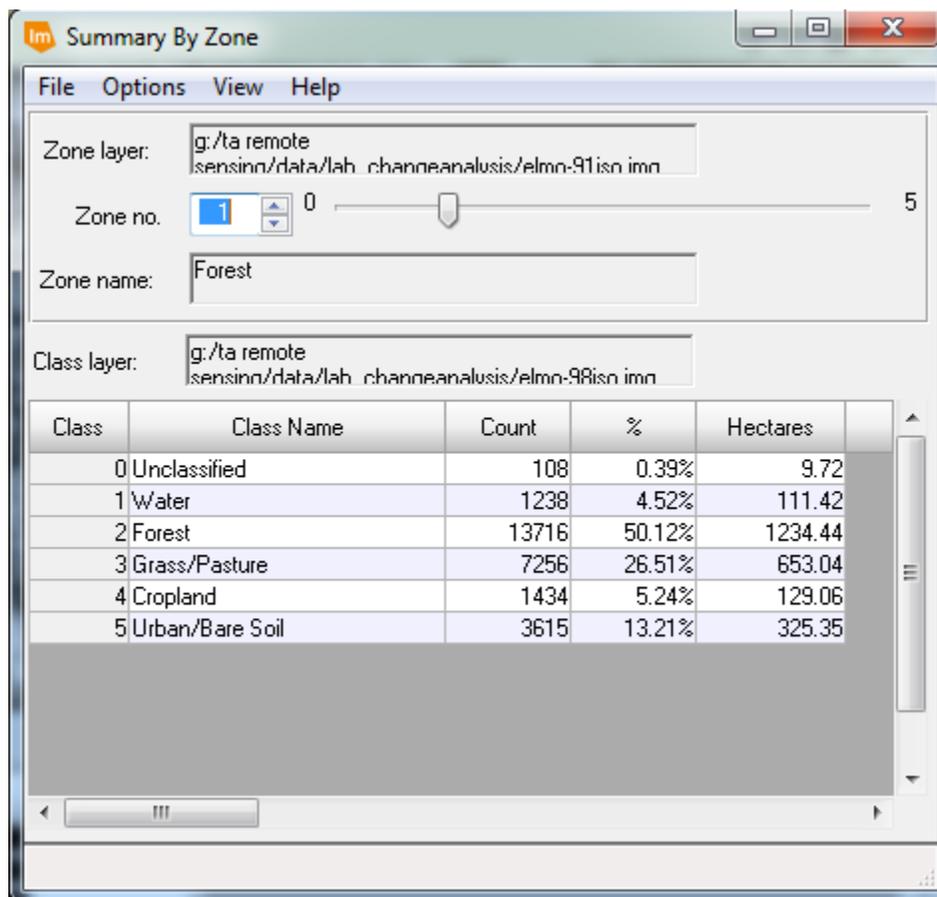
The matrix in this case produces a thematic layer containing a separate class for every coincidence of classes between two layers. The output can be described with a matrix diagram, but this overlapping information can also be seen in the attribute table as below (recall how to open the attribute editor). There should be 25 rows in the table. Why? The output classes are assigned according to the coincidence of any two input classes. Select a changed class and highlight it in your change map.



If you know the pixel size of your image (resolution) can you calculate the area of change for any given class? That would take a lot of manual work to get at the answer, given all of the combinations of change. To make this a bit easier, we can use a **Summary by Zone**. Go to the **Raster** tab, **Raster GIS** group, click the drop down below **Thematic** and select **Summary Report of Matrix**. In this case, the Input Zone file is the 1991 classification and the Input class file is the 1998 classification. Click OK to run the summary:



After processing the following summary dialog will open



This function produces “cross-tabulation” statistics useful in making a comparison of class value areas between two thematic layers. It shows the number of common points or cells, number of acres (hectares or square miles) and percentages of cells in common. The output produces information for each “zone theme” in a table. This table can now be saved for later use. Once the **Summary by Zone** opens, choose **File > Report**. An editor opens and this can be saved as an ASCII text file. This file can also be imported into various spreadsheet applications for further analysis if you desire.

### Lesson Outcomes

By completing this lesson, you should be able to

1. Apply **Image Difference** to two images, and interpret how areas have changed.
2. Apply **Thematic Change** to two images and be able to identify changed areas.
3. Use the matrix and summary tools to summarize the changes.