GEPL 4500/5500
Lab 4: Supervised Classification: Part I: Selecting Training Sets

Due: 4/6/04

This week we will work with your Landsat images and classify them using supervised classification.

There are a number of fundamental steps involved in supervised classification:
1. Establish the cover types to be classified in the image.
2. Establish spectral signatures for each cover type.
3. Build training sets (pixels that you can establish spectral signatures for, and that you have field, map, or photograph data to identify the cover classes or that you can easily identify in the image).
4. Use training data to determine the statistical model/probability model to be used in the classification.
5. Perform the classification (label each pixel as belonging to one of the ground cover types).
6. Develop thematic (class) maps or produce tabular output from the results of your classification.

Part 1: Spatial Orientation/Building Area Knowledge for Training Site Selection

Choose whether you will be classifying the August or October image.

Load an image that is in the GEPL 5500/lab4 folder. You will be classifying one of three images: Aug. 8, 2002, March 20, 2003 or Oct. 6, 2003 (which is a Landsat 5 image).

1. Looking at your image, try to identify 10 land cover types. Be wary of the dates of the satellite image. List your chosen land cover types. Choose areas that appear to be one specific cover type instead of a mixture of several. Also, try to choose the largest continuous areas in the image that are available for each cover type.

Remember: Given the USGS land-use and land cover classification system, the spatial resolution of ETM+ allows you to be able to discern Level I and potentially Level II cover types. Level I categories are urban or built-up, agriculture, rangeland, forestland, water, wetlands, barren land, tundra, and perennial snow or ice. You might find a few different water bodies, a few different crop areas, urban areas (residential, transportation--roads/airports), forested areas that look different spectrally. Wet fallow fields (bluish-gray in your images) will be darker than dry fallow fields. You may want to separate them into different classes.

Part 2: Preparing Your Training Sets
For your classification, you will use the Area of Interest (AOI) tool that is found on the viewer to define the training sets.

Define Training Sets/Signatures of Cover Types

Click on the **Classifier** icon from the Main icon panel → the classification menu will open. Select the **Signature Editor** → The Signature Editor will open.

Use AOI Tools to collect training areas and the signatures associated with them.

Select the **AOI|Tools** from the Viewer menu bar → the AOI Tool palette will display. Use any of the rectangle, oval or polygon AOI to select the training set for your first cover type. Once you have draw a bounding area, go to the Signature Editor, click on the Add Signature icon (plus with bent arrow) or select **Edit|Add** from the menu bar to add this AOI as a signature. You may need to use more than one AOI for each cover type to ensure that there are enough pixels available to derive the classification model. If you do, draw all of the AOI that you will need for that particular cover type. Then, use the combine AOI tool to link all of the AOI of that cover type together. Or, you can merge the signatures after you have added them to your signature editor by highlighting the two (or more) training sets on your signature editor and then clicking on **Edit → Merge**. You must then delete the two (or more) signatures that you just combined.

Change the name of your new training set (signature) to represent the cover type that it represents. You can do this by clicking on the Signature Name column in the Signature Editor.

You can also change the color of the signature and check the number of pixels in your sample under the Count category by clicking on the color column and choosing a new color.

Repeat the above procedure for the 10 cover types. Each training set should have approximately the same number of pixels.

***Save your training sets/signatures before moving on.

After you are finished defining your signatures, you may want to delete the AOI in the Viewer. Select **View|Arrange Layers** from the Viewer menu bar. → the Arrange Layers dialog will open. Right-hold on the AOI button and select **Delete Layer** to delete the layer and then click on Apply at the bottom of the dialog box. You will be asked if you want to save changes before closing. Click **No**.

Signature Statistics

Mean Plots and Histograms

Now, try out the various buttons on the Signature Editor icon menu. Play with the program a bit. Display histograms for all of the bands and signatures at the same time. View the mean plots (or spectral signature) for all of the training sets. It is located under **View** of the Signature editor.

2. Print out the mean plot with all 10 signatures on it. By studying the image mean plots and histograms, how well did you do at defining unique cover categories? Is there a lot of overlap? Which classes have a lot of overlap and in which bands do they have that overlap? Be specific about the classes and channels and the amount of separation

between each one. Print out the histogram for the band you believe shows the most separation and the band that you believe shows the least.

Classification Statistics
The statistics utility generates statistics for one cover type at a time. Put the “>” prompt next to the signature that you would like statistics for. In the Signature Editor, select **View|Statistics** or click on the Statistics icon (the summation button on the Signature Editor). → the Statistics dialog opens.

The Univariate statistics displays the minimum, maximum, mean, and standard deviation for each layer for the signature selected. The covariance matrix basically shows how the bands relate to one another. If the number is small, the values in those bands do not change much. If the numbers are large, the values vary a lot.

3. By studying the image statistics, which cover categories show larger variance (i.e. standard deviation) values? What do you think the implications of this will be for the spectral separability (the ability of the program to separate) of your cover types?

View Feature Space Images
The Feature Space image is a way to visualize the relationship between two channels in the image. This can help you understand how the classification model will separate out the classes that you choose.

Select **Feature|Create|Feature Space Layers** from the Signature Editor menu bar. → the Create Feature Space Images dialog will open. Enter the name of your Landsat image as the Input Raster Layer. Choose “Output to Viewer” so that the feature space will appear in a viewer without you having to find it. The lower part of the dialog box gives the different combinations of channels that you can compare. Try out a couple of them.   After selecting the band combination that you desire, click **OK**. Make a note of which channel is on the x-axis and which is on the y-axis. When the process is finished, the Feature Space image will open in a Viewer.

4. Which two-channel combination produces the best separation? Print out this Feature Space image. **Before you move on, draw in areas (ellipses) that you think represent your cover categories. *****

You can link the cursor between the image and feature space by selecting **Feature|View|Linked Cursors** from the Signature Editor in order to see what cover types relate to which part of the Feature Space Image. → the Linked Cursors dialog opens. Click on select Feature Space to make the Feature Space you have open active. Make sure that the Feature Space viewer is the correct one. Click on **link** and then **close**. Now, you can drag the inquire cursor around in the Viewer and see how the image and the feature space relate.

You could add signatures directly from the Feature Space Image if you would like. We will not do this in this class.

Use of Signature Objects dialog.
The computer will show you the cover types on your feature space image. Select **Feature|Objects** from the Signature Editor dialog box. → the Signature Objects dialog opens. In the Signature Editor, select the signature that you are interested in and Shift-click to include multiple cover types. Confirm that the correct Viewer number is in the Signature Objects dialog box. Enable the **label** check box, select a standard deviation of 2 and click **OK**. The Feature Space Image Viewer will pop up and ellipses will mark the location of the cover type in the Feature Space. Note if the cover types that you have chosen overlap much.

5. Print out the Feature Space Image with the signature object ellipses.

Signature Separability
The signature separability utility tells you the statistical distance between your classes. This will allow you to determine if the signatures are different enough from each other for a good classification. Unselect any signatures that you may have selected in your Signature Editor. To do this, right-click and hold, then choose select none. Select **Evaluate|Separability** → the Signature Separability dialog opens. Choose 7 as the Layers Per Combination (the default). Select the Transformed Divergence distance measure and click **OK**. A file with the separabilities will open. It will show how the signatures compare to one another so you can check for classes that are spectrally too close together. The transformed divergence will range from 0 to 2000. 0 means that the signatures cannot be distinguished at all while 2000 means that they are completely separate.

6. Are any of your classes very close together? Which ones are they? Attach a copy of your separability test to your lab.

Performing the Classification
Once you are satisfied with your training sets it is finally time to perform your classification.

Open the **Signature Editor** from the Classification dialog box.

Change the colors of the classes to what you want them to be before you perform the classification. If you have two classes that are very similar, you may want to have them have two very different colors so you can distinguish them easily.

In the Signature Editor select all or none of the signatures. If you select none, all will be used. Select **Classify|Supervised** from the Signature Editor menu bar.

Enter the output file making sure that you have the right output directory**. Click on the distance file because we want to make a distance file**. The distance file contains information about the statistical properties of each pixel. Basically, it is a measure of the numerical distance to the mean for the class that the pixel was identified as. Enter the name of the distance file in the box below the check box. Make sure that you specify the correct directory. Click on **Attributes Options** → the Signature

Statistics dialog opens. Click on Minimum, Maximum, Mean and Std. Dev. and then Close.

In the Non-parametric Rule window – highlight None. We are not using non-parametric training sets.

In the Parametric Rule window – highlight Maximum Likelihood. Maximum likelihood is the statistical function we talked about in class.

Then click **OK** to start the classification. → A job status box will pop up.

Open the classified image in a new Viewer window. You can change the color of each class by selecting Raster|Attributes from the Viewer menu. Left-click on the box in the Color column for the cover type that you would like to change. You may need to do this to distinguish some covers that are closely located.

7. Print out a color copy of your image. You will need to put a legend on your image.

8. Are there any gross errors that you see right off of the bat? What are they?
For example, I had a pavement category when I did my classification. Any water that had a high concentration of sediment was classified as pavement, oops!

Use the swipe and flicker utilities to compare your classified image to the false color image. Under Raster → Attribute you can see what colors represent what class.

9. Would having more classes help/hurt your classification? Why?

10. Be prepared to compare your classification to others in class on April 11. Having the images from different times of the year and from two different satellites, Landsat 5 and 7, should make different classifications.

Assessing the accuracy of your work is very important to demonstrate to others that you have done good work. It is a way to quantify your classification. Although there are problems with reporting your accuracy, i.e. it is easy to show positive results, we will go through the process because it will be important if you do remote sensing work in the future.

Qualitative Analysis: You can take a first cut through your analysis by just looking at the image and determining if there are errors that are easily apparent.

1. What class has the most errors in classification either of omission or commission? Which one has the least?

Quantitative Analysis:
You will use the stratified random point generator to get 50 random points for your accuracy assessment. We really want 50 random points for each class for a total of 400 points but your lab would take too long if you did that. There are several sources of information that will help you validate your classification: The original Landsat 7 image,

aerial photographs, and your personal knowledge of the area will be used to validate the classification. Or, use Terraserver http://terraserver.microsoft.com/default.aspx Another approach to validating classifications is to visit sites with a GPS unit. This would also be too time consuming for this class.

Have your classified image in a Viewer. Click on the **Classifier** icon from the Erdas Main Menu. Select **Accuracy Assessment** → the Accuracy Assessment viewer opens. This viewer allows you to compare the class of pixels in your image to the class you pick from your reference image (i.e. aerial photograph, false color image, etc.). In the Accuracy Assessment viewer, select **File|Open** and open the classified image.

In the Accuracy Assessment viewer, select **View|Select Viewer** and then click on the viewer with your classified image in it.

Generate the Random Points
In the Accuracy Assessment viewer, select **Edit|Create/Add Random Points** → the Add Random Points dialog opens. Choose 50 stratified random points and then choose a minimum of 4 points for each class and click OK. You don't have to worry about the number of counts. → a list of points will appear in the Accuracy Assessment CellArray. In the Accuracy Assessment viewer, select **View|Show All**. Now select **View|Change Colors**. In the Change Colors dialog, set the Points with no reference and the Points with reference to colors that will show up best for you. Click on **Edit/Show class values** to get the classes from the image.

Now, enter your best guess of the classes in the Reference column of the Accuracy Assessment CellArray using the original Landsat image and aerial photographs. As you enter the value for each point, it will turn from white to yellow. Open the **Report|Options** to check the Error Matrix Accuracy Totals and the Kappa Statistics. Select the Report|Accuracy Report and the Report|Cell Report to generate information about the classification. The reports will appear in the text editors. You can save the reports and print them out. Given the data the you have entered, generate an Error Matrix similar to the one shown on page 248 of your textbook.

2. Print out the Accuracy Report which includes the error matrix and the Cell Report for your classification.

3. What is the overall accuracy of your classification?

4. Should you redo any of the classes? List them.

5. How can you improve upon your classification? i.e. by using other images or other classification techniques. I would like some detail here. Please read the sections in the book to get some ideas.