Name: ________________________

Remote Sensing of the Environment
GEOG/GEOL 4093/5093
Fall Semester 2009

Lab Exercise #10: 11/12/2009
Due: 11/19/2009

Cryospheric Applications of Remote Sensing

Launch Internet Explorer and type *\\nyx\rs4093* into address bar and hit enter, that takes you to the remote sensing class folder "*rs4093*" in CIRES server. Copy the folder "*Lab_9*" to "*C:*" drive (even though this is Lab 10).

One important application of remote sensing is the classification of land cover types. In this lab you will get a small sample of image classification techniques and their application to snow and ice.

Begin by displaying a 5,4,3 RGB composite of the image **C:\Lab_9\quel_1992_tm_dark_obj**. This is a subset of a Landsat TM image covering the Quelccaya (pronounced "kwel-KĪ-ah") ice cap in southern Peru. In this band combination, the bedrock will appear reddish and the ice cap will appear cyan to blue. For more background information, see: **http://pubs.usgs.gov/prof/p1386i/peru/orient.html#VILC**

1. What color does vegetation appear in this band combination? What about water (1)?

There are a number of techniques for classifying an image. These techniques are generally broken down into two major categories, **supervised** classification techniques and **unsupervised** classification techniques. In supervised techniques, the user will provide the system with some information regarding either the land cover of the image or the spectral signature of different land covers. The system will then apply the known spectral information to the rest of the image and determine a class for some or all pixels. Unsupervised techniques, on the other hand, do not require any *a priori* knowledge of the area. Instead, the system analyzes the spectra of every pixel and groups them into clusters. These clusters serve as classes and the user is left to determine what land cover classes correspond to each cluster.

Part I: Supervised Techniques

Here you will use the familiar ROI tool to define some land cover classes. You will then use several supervised techniques to classify ice and snow in the image.

From the main ENVI menu, under Basic Tools, choose the ROI tool and begin drawing a new polygon that encloses an area that you are confident is purely ice or snow (not a mix with other land covers). Close the polygon by right clicking inside of it twice. Create new ROIs for water, vegetation and bedrock. Try to choose homogeneous areas. Refer to the figure attached for sample locations of each of these cover types.

Once you have created four ROIs, choose "Select All" and then click "Stats". This should calculate and plot mean spectra for each of the regions.

2. Look at the spectral plot for the different surfaces, especially the snow/ice and bedrock regions. What information is being shown on the x and y axes, or in other words, what is this plot showing you (2)?

3. Sketch (do not print) and label the spectral curves of each material (2).

Right-click in the spectral plot window to display a legend (key). Leave this window where you can easily see it.

In order to understand how the classification schemes work, it is important to understand how spectra are treated in ENVI. Each pixel or set of pixels has six dimensions since the image has six spectral bands (the thermal band is not used here). ENVI treats each pixel or set of pixels as a vector in 6-dimensional space. So, each spectrum that you have plotted can be thought of as vectors.

The first classification scheme that we will explore is called the Spectral Angle Mapper (SAM). The SAM technique determines the similarity of the 6-dimensional angle of each pixel vector to the reference spectra that you will provide.

From the main ENVI toolbar choose Classification > Supervised > Spectral Angle Mapper. Choose the image and click OK. One at a time, click on the center of each legend label in your spectral plot window and drag and drop the label into the white box in the "Endmember Collection" window that just opened. Each label should appear in the white box.

Once you have collected and selected all four spectra, click *Apply*. Keep the default angle of 0.10 radians. Change the output to Memory. DO NOT save a rule image. Click *OK*. Display the resulting image in a new display.

4. What areas are classified as ice and snow? What areas are missed? Why do you think you got this pattern? Find a way to calculate the area of the ice and snow and give it in km^2 (4).

Return to the Endmember Collection window. Click *Apply* again. Use the same parameters, but change the angle to 0.35 radians. Display the resulting image.

5. What are you actually doing when you change the angle to 0.35 radians? Draw a sketch of this. What effects did changing the angle have on the classification? Is this a better classification of ice? What areas are still missed (3)?

In the Endmember Collection window, change the algorithm to *Minimum Distance*. This classification scheme calculates the Euclidean distance from each image pixel to the mean vectors of each class that you provided. The endmembers should already be loaded. Click *Apply*. Again, choose Memory as the output and do not output a rule image. Enter 100 as the max distance. (You can experiment with other ½-widths). Display the resulting image in a new window. Link all open windows and compare the classifications.

6. How does the minimum distance algorithm perform compared to the SAM algorithm? Where does it do better? Where does it do worse (2)?

7. Does the Minimum Distance or the SAM algorithm classify more pixels as vegetation (2)?

Change the algorithm to *Parallelepiped*. This is a very simple classification technique. You can read about it in the ENVI online help. Choose 100 as the half-width.

8. How does the simple Parallelepiped algorithm compare to the other two classification schemes (2)?

9. Which of these supervised techniques seems to do the best job in classifying ice and snow in this image (2)?

10. Do any of the algorithms correctly classify all of the ice and snow in the image? Why do you think this is so (2)?

If you haven't already, close all of the resulting memory images from the supervised techniques and the Endmember Collection and ROI windows.

Part II: Unsupervised Techniques

Under Classifications > Unsupervised, choose Isodata. The Isodata classification determines general spectral clusters and lumps them into classes. It then calculates the mean of each class and iteratively clusters the remaining pixels into one of those classes based on minimum distance techniques. Then, during each iteration, means are recalculated and all pixels are reclassified with respect to the new means.

Change the maximum iterations to 3 and output the results to memory. Be patient. This may take several minutes to calculate.

The resulting image may have up to 10 different classes (unless you specified another number for the maximum classes parameter). More than one of these classes may correspond to ice. To clarify the image and to assess the performance of this algorithm, choose Tools > Color Mapping > Class Color Mapping. Go through each class and change its color to black (slide all sliders to zero) if it does not appear to correspond to ice cover. Choose *Save Changes* from the *Options* menu.

11. How did the unsupervised technique perform? How does it compare to the supervised techniques? What is the area of ice, and what is this difference compared to the Spectral Angle Mapper (0.35 radians) approach? Discuss the differences between supervised and unsupervised techniques and output (4).

12. Which technique seems to be better at classifying ice? What is the take home message about using these classification systems? Are the values you have generated representative of the ice area according to the USGS report (4)?

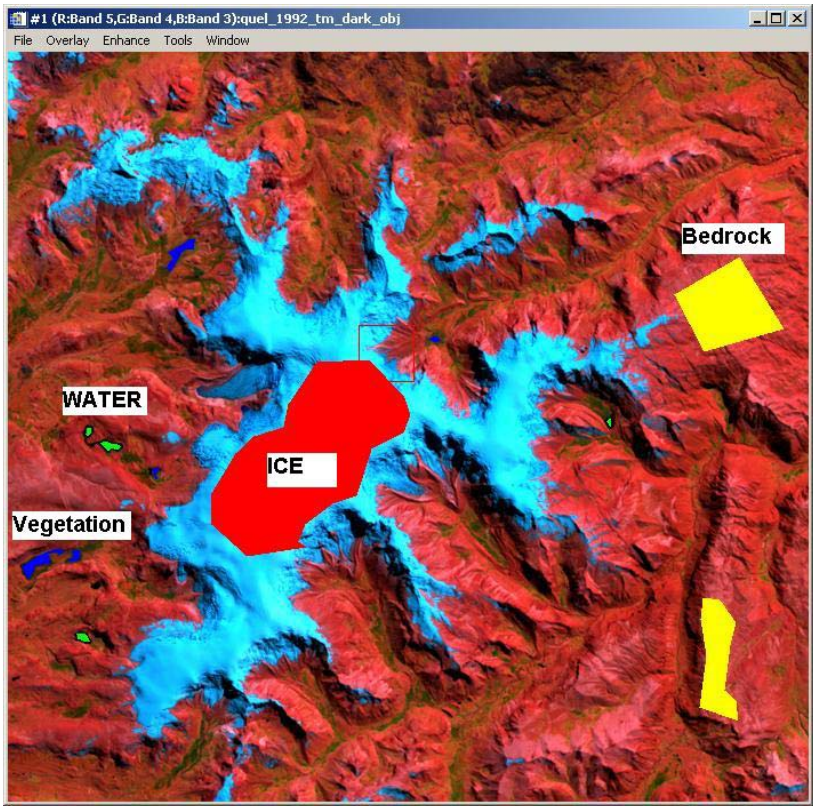

Figure 1: Location of possible spectral sample training sites.