ANTH 583 – GIS and Imagery Analysis
Project 4

This project is designed for you to demonstrate *Imagery Analysis.* *You will employ the following skills:*
1) Qualitative and Quantitative Pattern Analysis
2) Greyscale and Multi-Band Image Analysis
3) Image Classification

Background

We will work with drone and satellite imagery from Calabria, southern Italy. This includes high-resolution drone photos (in file “Calabria_imagery.zip”) and a multi-band, but coarser Landsat Satellite image (in file UTMwgs84_z33n.zip”). You will use GIMP to conduct a qualitative pattern analysis of the drone imagery, and you will use GRASS to undertake quantitative analyses of the Landsat imagery.

Follow the “best practices” for naming your images and raster maps, as we have discussed in the past. Use descriptive names that tell you what information is contained in the raster map. Do not use spaces or dashes (“-”) in map names. You may use underscores (“_”) instead.

Part 1: Qualitative pattern analysis (NOTE: The tutorial video shows different imagery, but the workflow is the same)

1) You will use GIMP to enhance an area of interest in one of the drone images of Calabria, southern Italy.

2) Identify an area of interest on the image by zooming and panning. It should be an area with some archaeological or land-use features you would like to enhance

3) Use the zoom tool and the rectangle select tool to create an appropriate cropped image, if necessary. This will be your base image for the analysis.

3) Conduct TWO different workflows to enhance the area of interest. Use any combination of the enhancement techniques we have covered (e.g., colors, contrast, levels, curves, thresholding, edge-detect, sharpening, blurring, dilate/erode, etc.). Be sure to DOCUMENT your workflow for each enhancement. Save the two final images to jpeg’s or png’s.

Part 2: Multiband image analysis

1) You will use GRASS GIS for this part of the analysis. Download and unzip the “UTMwgs84_z33n” GRASS location and the file labeled “p188r034_7t19990926.met”. Start GRASS and create a new mapset called “Project4” in this location the startup dialog.

2) The mapset contains a single Landsat 7 tile that I have cropped to the southern tip of Calabria, southern Italy. This “single” tile actually consists of 8 different “bands”, each separated as a different raster map in GRASS, and numbered sequentially (but you will have to rename these, watch the video). Study the first table below to understand what wavelengths of light the different “bands” represent, and what these wavelengths can inform us about. Display each band in GRASS, and examine the tonal patterning in each image with this information in mind.

3) Be sure to update your region settings as you work. Initially, it may be easiest to right click one of the bands in the layer manager, and “set location to match this raster map.” This will ensure the bounds and resolution of the current working region will match your Landsat tiles. Using the zoom and pan

tools, hone in on an area that seems to have some interesting patterning (e.g., irrigated fields, natural vegetation, erosive channels, landscape features, urban areas, etc.). Once you are happy with an area, use the tools in the map display to set the computational region extents to match the current zoom. Save out an image of the "Panchromatic" band 8 to an file using the tool on the map display window.

4) Looking at the second table below, use *d.rgb* (easily accessed through the layer manager) to create a "Natural Color" RGB image using the visible light bands. You may need to adjust the colors with *i.colors.enhance*, or by using *r.colors* on each individual band to set a histogram equalized grey color scheme. Save the Natural Color RGB image out to an image file.

5) Add another rgb map layer with *d.rgb* and experiment with other color band combinations to make a "False Color" image that highlights different features. Save out at least one false color image out to an image file.

6) Use *i.vi* to create a "Normalized Difference Vegetation Index" map of you area. Again, save out the image to an image file. You should include a legend with this map. Remember, NDVI maps are scaled between -1 and 1. Values close to -1 are likely water or rock. Values close to 1 are likely healthy vegetation,a nd values close to 0 (but positive) are likely unhealthy vegetation.

Landsat 7 Spectral Bands

Band	Wavelength	Useful for mapping
Band 1 - Blue	0.45 - 0.52	Bathymetric mapping, distinguishing soil from vegetation, and deciduous from coniferous vegetation
Band 2 - Green	0.52 - 0.60	Emphasizes peak vegetation, which is useful for assessing plant vigor
Band 3 - Red	0.63 - 0.69	Discriminates vegetation slopes
Band 4 - Near Infrared	0.77 - 0.90	Emphasizes biomass content and shorelines
Band 5 - Short-wave Infrared	1.55 - 1.75	Discriminates moisture content of soil and vegetation; penetrates thin clouds
Band 6 - Thermal Infrared	10.40 - 12.50	Thermal mapping and estimated soil moisture
Band 7 - Short-wave Infrared	2.09 - 2.35	Hydrothermally altered rocks associated with mineral deposits
Band 8 - Panchromatic	0.52 - 0.90	15 meter resolution, sharper image definition

Landsat 7 Spectral Band Combinations

Usage	Bands (R,G,B)
Natural Color	3,2,1
False Color (urban)	7,5,3
Color Infrared (vegetation)	4,3,2
Agriculture	5,4,1
Atmospheric Penetration	7,5,4
Healthy Vegetation	4,5,1
Land/Water	4,5,3
Natural With Atmospheric Removal	7,4,2
Shortwave Infrared	7,4,3
Vegetation Analysis	5,4,3

Part 3: Unsupervised Image Classification

1) You can stay "zoomed in" to the same region as in Part 2 for this part. We are going to perform an "unsupervised" image classification, in which GRASS will create "classes" of pixels that share similar "spectral signatures." That is, if a set of objects share similar reflectance characteristics across all the different wavelengths of light, then GRASS will say that they are the same "class" of objects (or pixels, really).

2) To start, we must create an imagery "group" and "subgroup" to tell GRASS which bands of light to look at. Use *i.group* to do this. You must first create the group, and then you can create the subgroup (watch the video for specifics). Choose bands 1, 2, 3, 4, 5, 61, and 7 for your group and subgroup. We are going to ignore the panchromatic band for our classification.

3) Now we are going to perform the actual classification. This is an iterative process, and you will have to use your judgment. You will tell GRASS how many classes you think there are, and then it will categorize the image into that many classes for you. However, you shouldn't just choose any random number of classes; there are some "natural" levels of clustering that will be apparent as you step through different class numbers. You should watch the video for more hints about this, but the following procedures in Step 4, 4a, and 4b should be repeated with different numbers of classes until one result seems best to you.

4) Open up two tools from the I*magery > Classify image* sub-menu: *i.cluster*, and *i.maxlik. i.cluster* examines your map to find the groups of "spectral signatures" that are similar at the clustering level you've told it, and *i.maxlik* then finds all the pixels that seem to most closely match that set of "spectral signatures," and performs the actual classification and output map. You need to run *i.cluster* first, and then provide the output files to *i.maxlik* second. As you experiment with values in *i.cluster*, you must then update i.maxlik to get a new classified output map.

4a) Do the “clustering” routine. You must give *i.cluster* the input imagery group and subgroup names (from step 2), and the desired number of clusters (e.g., 10). You then tell it to output a “signature” file, and a report text file. The “signature” file will stay “inside” GRASS, but the report file will be written to your hard-disk (usually in your home folder). It is important to remember the name of the signature file, as you will need to pass this name to *i.maxlik* in the next step. There is one “magic” value you can use to influence the output of the clustering routine: the “separation” value (look on the “settings” tab). This value will be unique to each image and each number of clusters. Start at 0, and gradually increase it until you see the clusters separate better. If you go too low, you will get only one cluster. If you go too high, you may never reach a good clustering configuration.

4b) Do the “classification” routine. You now must pass the “signature” file to *i.maxlik* as well as the imagery group and subgroup. Give an output map name for your output classified map. This is your final product. You will need to interpret what the classes “are” by looking at the “report” file generated during the clustering routine in step 4a. Each time you re-run the clustering and classification routines, you should check the new report file. It will tell you the percentages of each band of light that compose each resulting cluster. This information is invaluable to deciphering what each cluster “means” (i.e., what set of reflectances are being grouped together by GRASS).

5) Once you have come up with a satisfactory classification result, and you are pretty sure you know what the classes “mean,” save an output image. You should include a legend with this map.

Part 4: Writeup

Prepare a brief report (1-2 pages) about your analyses. This should be roughly divided into four sections.

1) In the first part, describe your <u>qualitative image analyses.</u> First, detail the two workflows you came up with. What were your goals with each workflow (i.e., what were you trying to enhance?). Embed your two output images as figures, and refer to them in this description. Compare the two images. Describe the patterning that is apparent in each image. Is one “better” than the other? What did you learn doing this procedure?

2) In the second part, discuss the band manipulation of the Landsat image in GRASS. Embed your images (Panchromatic, Natural Color, False Color, and NDVI), and refer to them in the text. Compare the tonal patterns in each image. What kinds features are highlighted in each? What are the strengths and weaknesses of each type of image? What did you learn by comparing all four images?

3) In the third part, report your findings from the unsupervised image classification of the Landsat image. How many classes did you end up with in your area? What kind of objects or surfaces do these classes relate to? How did you determine this (i.e., what, exactly, about each spectral signature did you look at to make your determination)? What were the difficulties of the analysis?

4) In the final part, briefly reflect on the technical procedures you conducted above. This is certainly the most demanding workflow we have done in the class (as it should be for the final project). How have you “scaffolded” your GIS skills from the previous projects? Can you envision how all the different skills we have practiced cab be fit together into a single “workflow” for archaeological GIS?

You will turn the writeup in in digital format through TurnItIn on Blackboard. You should include your output graphics as a figures embedded in the writeup.