

Learning Unit Student Guide

Name of Creator: Jeff Sun
Institution: Casper College
Email: jsun@caspercollege.edu
Phone: Office (307) 268-3560
Cell (307) 277-9766

Title: Estimating Areas of Suitable Grazing Land Using GPS, GIS, and Remote Sensing

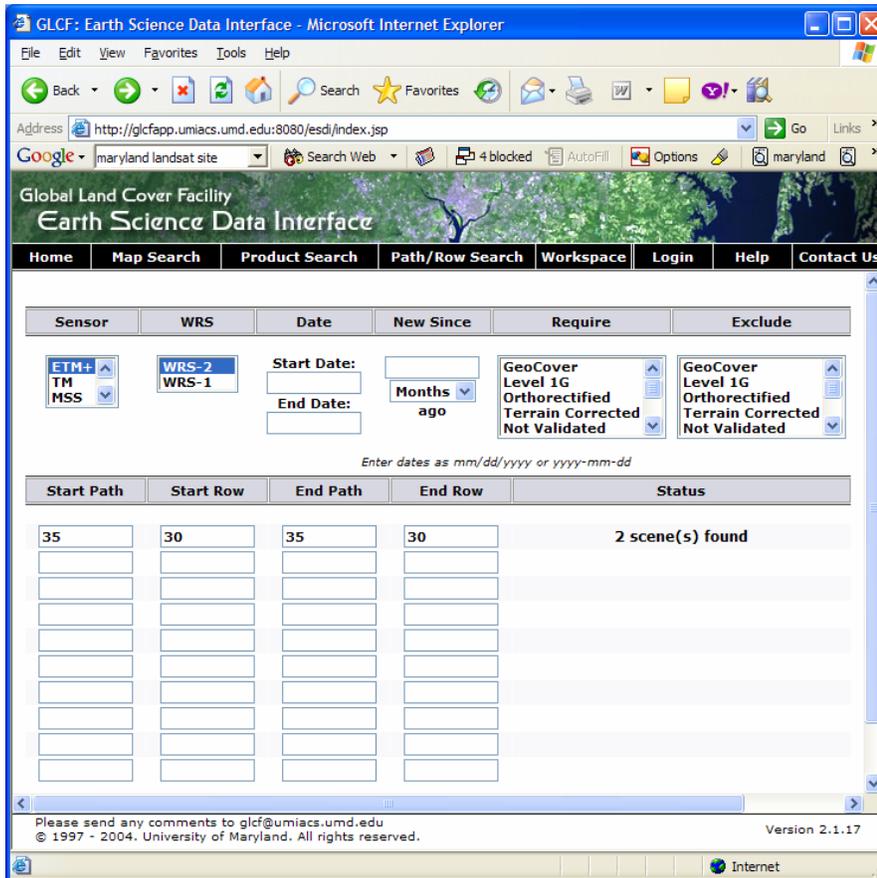
Problem Statement: How GIS, GPS, and Remote Sensing (RS), can estimate suitable areas for grazing.

Short Description: This LU uses Landsat Satellite data, GIS, and GPS to classify suitable rangeland on ranch land located west of Casper, Wyoming. The Normalized Difference Vegetation Index (NDVI) from RS data will be used to ascertain the overall health of the rangeland vegetation while the Natural Resource Conservation Service (NRCS) soil polygons will be used to ascertain the pounds of forage on the range. The NDVI image will be compared to the NRCS soil forage polygons to see if the health of the vegetation in the NDVI image compares to the low or high forage polygons in the NRCS data. Maps will be made per watershed of the study area showing areas of suitable and non-suitable grazing areas based on these two data sets and DEM-derived slope data—as cattle tend to not graze above a certain slope.

GPS units will be used to take field sample points in the study area. The sample points will allow students to compare what they see on their maps and what they see on the ground. Finally, if time permits, GPS collars on cattle may be used to monitor where the cattle actually graze in comparison to the highly suitable grazing areas that the students find within a watershed.

Step 1. Download the necessary remotely sensed Landsat data for the study area from the University of Maryland's Global Land Cover Facility (GLCF) site (<http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

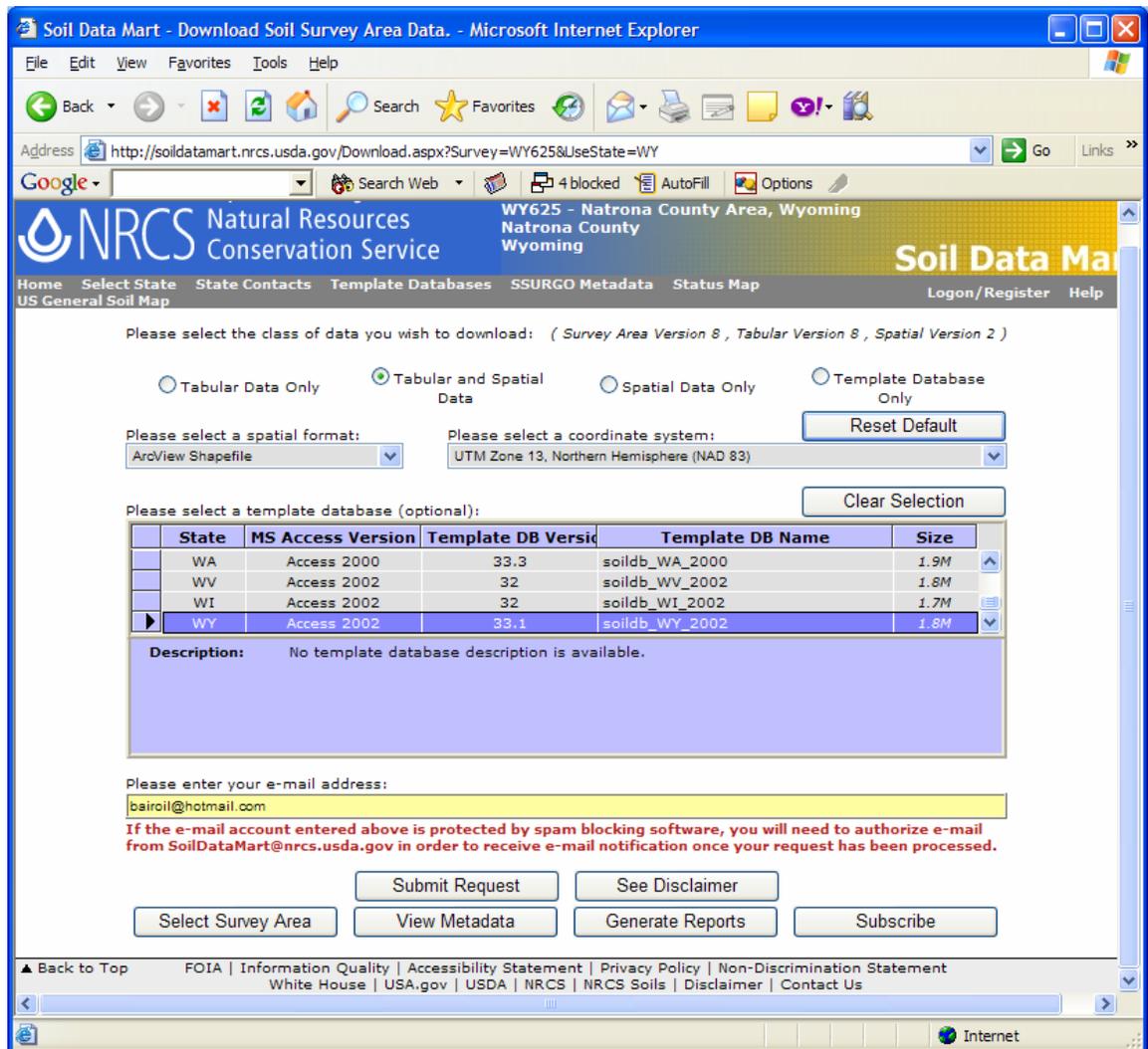
- a. Once at the above site, click on the box that says "Path/ROW Search"
- b. Skip everything at the top and simply enter in the path and row for our study area. The particular path and row we are looking at is Path: 35 and Row: 30



c. Click on the button that says preview and download and there should be a list of 2 scenes that are available for us to download. One scene is in April 2001 and the other is for July 2001. Since this assignment deals with the greenness of the vegetation we want to download the April scene (this allows us to see areas of early spring green-up as opposed to the cacophony of mid-summer greenness). However, since these downloads can take a long time with everyone in class doing it at once. The scene above has already been downloaded for you and is available in the data folder of the lab on the S drive.

Step 2. We will be comparing the Landsat medium-resolution remotely sensed data we have just downloaded to the NRCS soil polygon data. Lets download that next. Go to the NRCS soil data mart site (<http://soildatamart.nrcs.usda.gov/>) and download the NRCS soil polygons for Natrona County, Wyoming

a. This site is pretty self explanatory and is like the other sites we have visited in class previously in the first couple of weeks of school. Remember we want the soil and tabular data for Wyoming in Natrona County.



b. Once you input your email you will get a notification stating what position you are in the queue; an email will be sent to you when the order is ready. Sometimes this can take a few minutes or it can take up to a day to get the email. Since we are in a classroom setting the soils data have already been downloaded for you and put in the data folder on the S drive.

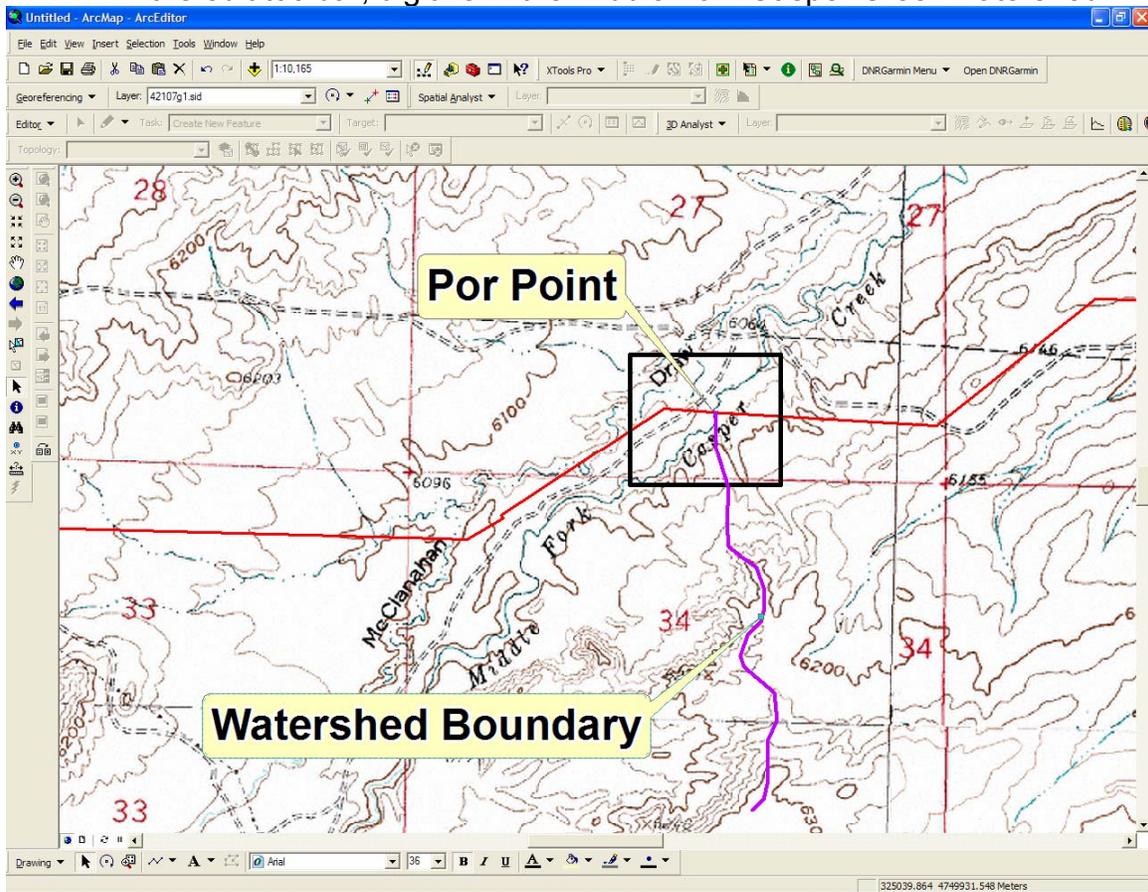
Step 3. This lesson focuses on areas that are suitable for grazing on a ranch. Since we need some way of cataloging those areas we are going to find the suitable areas of grazing in each major watershed of the ranch. Watersheds are useful in that they serve as natural areas or barriers of different ecosystems on the ranch. In this step we will learn how to create a watershed both in a manual way and using tools. Both ways use ArcGIS

Steps to digitizing watersheds manually

- a. Open up ArcMap and load in the ranch boundary shapefile from the data folder on the S drive. Also go to the State of Wyoming GIS clearinghouse site at (<http://wgjac2.state.wy.us/html/index.asp>). This is

the site we have visited the 2nd week in class where you can download aerial and topographic maps for Wyoming. Download the 4 USGE DRG-e Topo maps of Broadmesa, Gaylord Reservoir, Stinkingwater Creek, and 8 mile Reservoir. Load these 4 topo maps along with the ranch boundary into ArcMap. You should see that the ranch boundary should cover the 4 topo maps

- b. Create a blank Polygon shapefile in ArcCatalog and name it “watersheds” with a project of UTM NAD 27 Zone 13. Load it into your ArcMap session and begin editing on this shapefile.
- c. Locate where the Middle Fork of Casper Creek leaves the ranch boundary in the North Western part of the ranch. This is called the POR point (point of reference). This is where the first watershed will begin. Using your blank watershed shapefile and the digitizing tool on the edit toolbar, digitize in the Middle Fork Casper Creek watershed.



A more detailed demonstration of this will be performed for you on the overhead projector. The trick is to pretend you are a drop of water and which watershed you would run off into if you were that drop of water. Digitize in the boundary staying on the ridges and high grounds.

- d. Repeat step C for the other watersheds on the ranch of Coyote Creek, and for The South Fork of Casper Creek.

Steps to Creating Watersheds using the Watershed Tools in ArcGIS

You can perform the same steps above in ArcGIS using the watershed tools in ArcToolbox. Below are the steps to do this. As the student it is up to you on which method you use to create the three watersheds. If you choose to use the automated approach below make sure you create the 3 watersheds as above in the manual steps

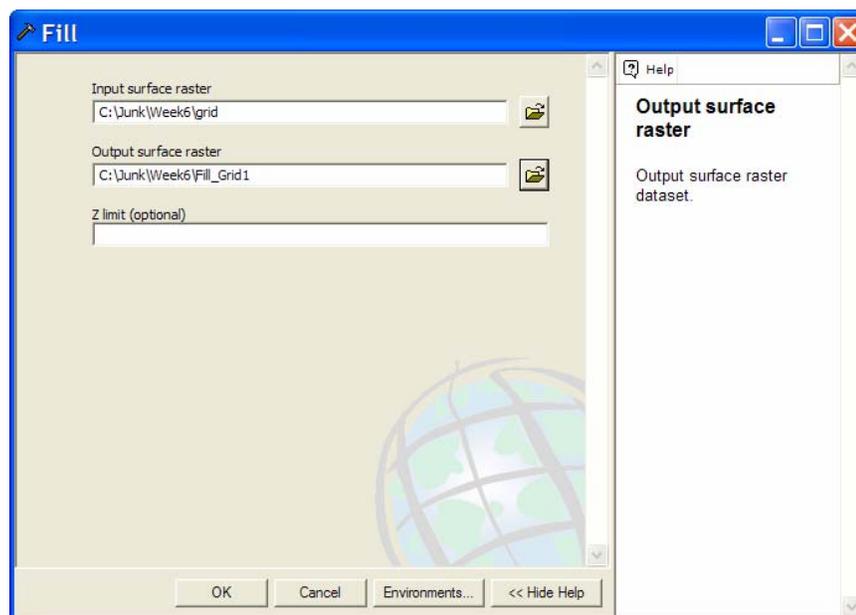
Creating Watershed Automatically using Digital Elevation Models:

Go to the WyGIS data catalog Web site below

<http://www.wygisc.uwyo.edu/24k/dem.html>

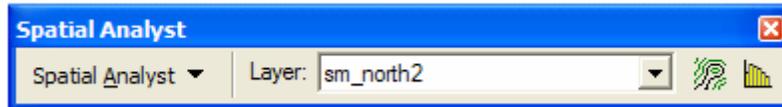
This takes you to the download page that you were two weeks ago for lab4. Explore the elevation data available for both the 100,000 scale and the 24000 scale DEMs. Pick the same DEM for the same area where you manually digitized your watershed. If the area you picked was in the western part of the state or in the powder river basin you may be able to use a 10m DEM if not then you will have to use a 30m DEM. **Make sure you download the GRID option.** You will need to unzip the downloaded file. You will then notice that the DEM is an e00 extension. Do you remember how to convert e00 files so you can open them in ArcGIS? If not look back to lab 1!!

Because DEMs often contain imperfections called “sinks”, we must perform a “fill” operation. Before this can be done, make sure that the Spatial Analyst extension is enabled. Open ArcCatalog and Select “Tools → Extensions” and make sure that the Spatial Analyst box is checked. With ArcCatalog still open, find the “Fill (spatial analyst)” tool from ArcToolbox. Use the DEM that you just downloaded as the input raster and call the output raster “Fill_Grid1”. The Tool may take a few minutes.



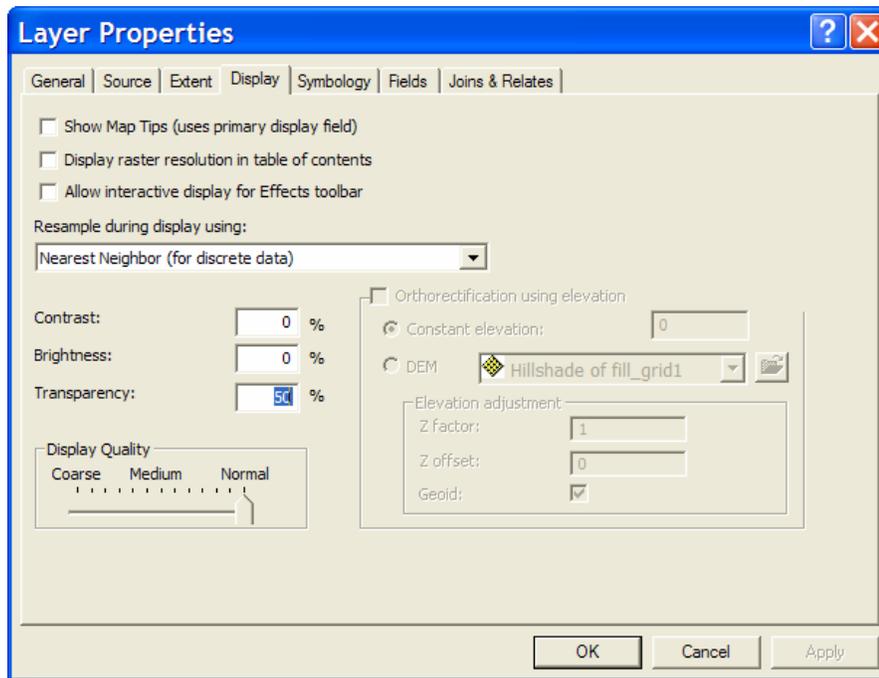
Go ahead and launch ArcMap and add the “Fill Grid1” DEM file. In ArcMap, make sure that Spatial Analyst is activated using the same procedure that you used in ArcCatalog. Change the symbology of the DEM so that it is displayed in color.

In ArcMap, make sure that the Spatial Analyst toolbar is displayed.



In Spatial Analyst, choose the “Surface Analysis → Hillshade” option. Use the “Fill_Grid1” grid as the input and call the output “Hillshade”. Once your “Hillshade” has drawn to the map, move it below the DEM in the table of contents. If you wish you may save your hillshade to your folder or leave as temporary as in the example above.

Now change the transparency of the hillshade to 50 % as in the example below

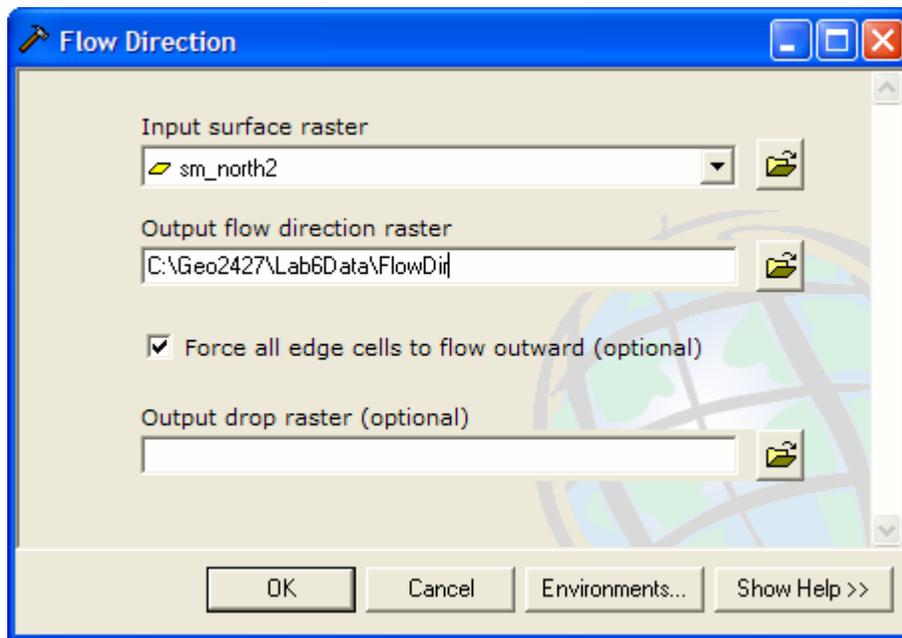


(Right click, Fill_Grid1 Properties → Display tab. Transparency: 50%)

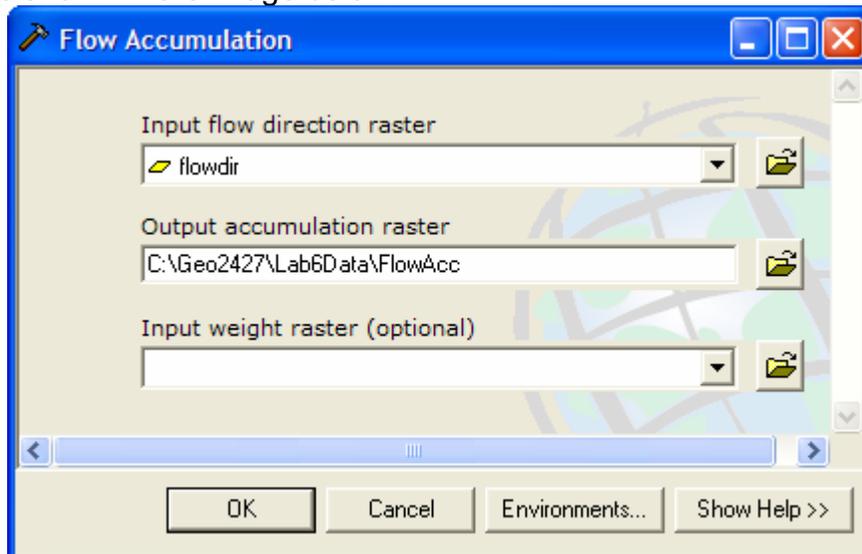
You should now be seeing partially “through” your DEM to your hillshade relief map. (see question 1). This is a good display exercise to show you how to use elevation and display in sort of a 3D format on a 2 dimensional screen. Later we will use this data to display in 3D format, but for now keep this technique in mind for your maps and projects that you do to show elevation change across an area.

More DEM Tools:

One of the features you can extract from a DEM is flow direction. The flow direction function will examine a cell within a DEM and all of its surrounding cells to determine which way a raindrop will flow. From ArcToolbox, select “Flow Direction (spatial analysis)”. The input grid is “Fill_Grid1” and the output grid should be called “FlowDir”.



The flow direction grid is necessary to make a flow accumulation grid; which is what we're really after. (see question 2). To make the flow accumulation grid, launch the "Flow Accumulation (sa)" program from ArcToolbox and use the options as shown in the image below.

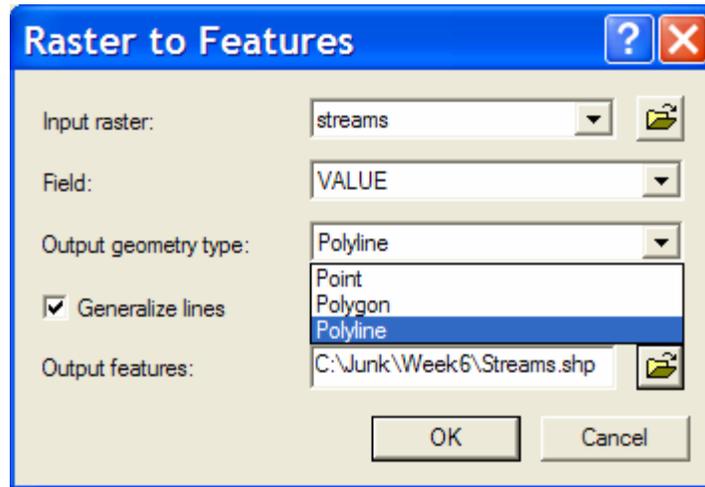


The flow accumulation Grid you just made shows values for each of the cell based on where the water flows in the DEM. You can see that eventually in the lowest elevations are white lines. This is where the flow is the heaviest and ends in the raster. The reason it ends is because this is where the streams are in the grid

Now, reclassify the "FlowAcc" grid you just made into a nominal dichotomous grid. Assign "1" to flow accumulations greater than 100 and "No Data" to every other value. Call the new grid, "Streams". Use the same reclassification

procedure that we used earlier in the lab. What you just did was assign a 1 to all cells that have 100 or more cells that flow into it and all the other cells as being 0.

Once the “Streams” raster grid has been made (it should only have values for the stream channels) we can convert it into a vector dataset. From the “Spatial Analyst” menu, choose “Convert → Raster to Features”. Use the option shown below. Call the new shapefile “Streams.shp”. (see question 3) Save your project.

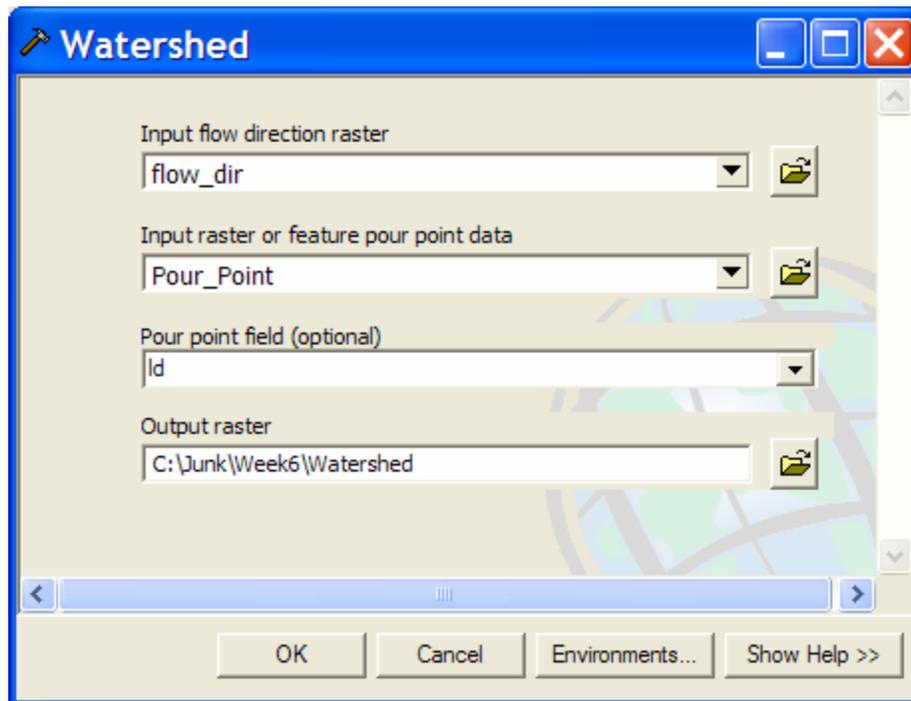


Creating a Watershed:

A watershed is a region where all rainfall eventually passes a common point along a stream. For example, any rainfall that falls on the Casper College campus that doesn't evaporate or infiltrate the ground will eventually pass through a point along the North Platte River where say Wyoming BLVD crosses the N. Platte in Evansville. In ArcGIS, to delineate a watershed, you need a flow accumulation grid (which we made earlier) and a pour point. This pour point is a point within a stream channel that sees water flow past it from a defined region (watershed). In ArcCatalog, make a new shapefile called “PourPoint.shp” and define the coordinate system to be “NAD 1927 UTM Zone 13N”.

Load this shapefile into ArcMap and add a point anywhere on a stream in your map. Open the attribute table and enter a value of “1” in the “ID” field of the record for the newly created point. Make sure that you “Stop Editing” and “Save Your Edits”. If you omit the “1” value in the “ID” field, the watershed creation step (next) will not work properly.

Open ArcToolbox and choose the “Watershed (spatial analysis)” program. Your input flow direction raster is the “FlowDir” grid that you made earlier in the lab. Use the “PourPoint.shp” shapefile that you just made as the feature pour point data. Call the output grid “Watershed”.



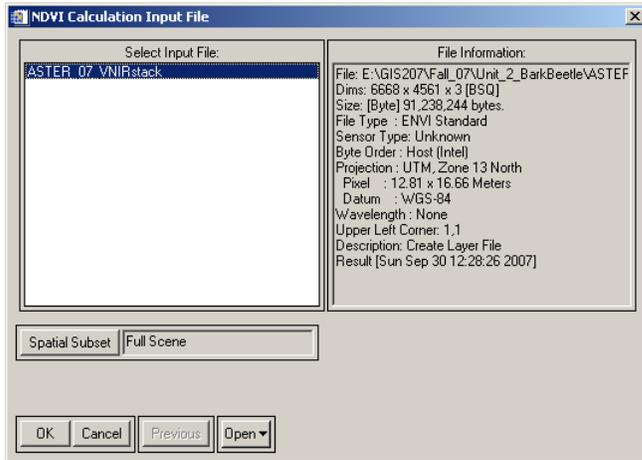
What you have just done is create a watershed from the Pour Point up. This watershed shows the area (in the original DEM that you downloaded) where all the water comes from that passes through your Pour Point. Remember to repeat this for the 3 watersheds in the study area.

Step 4. Now that the students have some knowledge of the area and what it looks like they will take a field trip out to the study area. Students will visually inspect areas that they think would be areas of Suitable/Non-Suitable grazing areas and take GPS sample points of each. They will also catalog these areas in a journal. This will be used to see if the GIS/RS data you are analyzing in class matches up with what you saw and cataloged out in the field.

Step 5. ENVI will be used to create an NDVI image from the RS data that was downloaded in step 1. We will go through a lecture on what NDVI is and how it is used to see where healthy green vegetation is on the ranch for the time period in which our remotely sensed image was acquired. Remember NDVI is the ratio of the Red band to the Near Infrared band.

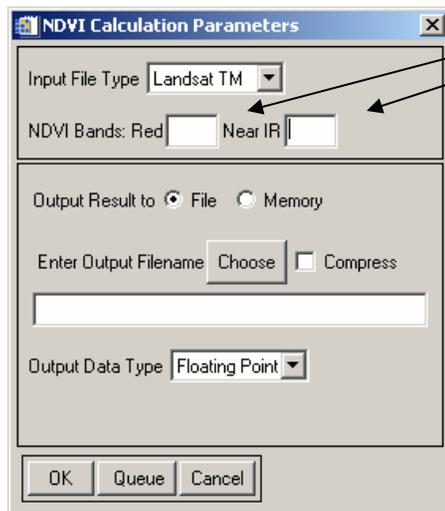
- a. Start ENVI and add your clipped remote sensed image bands by using File→Open image file. The data has been stacked and the bands ordered already for you. Also the data has been subset to the ranch boundary so that all you will be working with is the RS data that is inside the ranch boundary.

- b. On the Main Menu, select Transform→NDVI
- c. At the next screen, select your image stack as the input file to the NDVI calculation as shown below:



- d. Next, you must specify the bands that will be input to the NDVI.

The dialog should default to Landsat TM and specify the proper bands since this is Landsat Data.



Specify a place to save the output and name the output NDVI_ENVI by selecting the “Choose” button and accept the default output data type as Floating Point—this will allow decimals. Since NDVI ranges only from -1 to 1, we must have decimals.

Click OK to run the process. After it completes, you will have a grayscale NDVI image added to your available bands list. View this image in an ENVI display window.

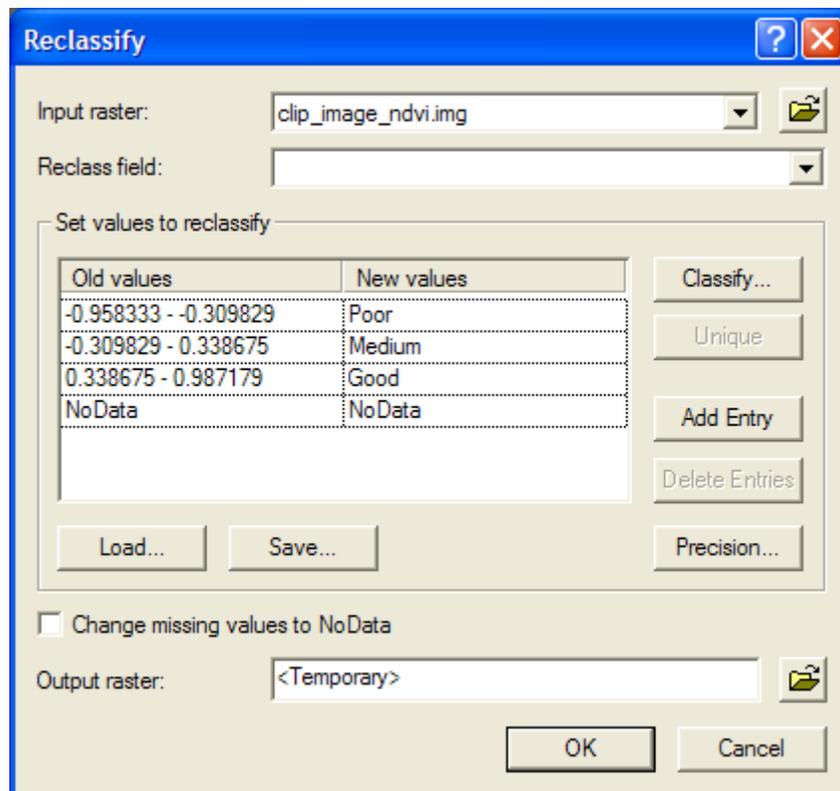
- e. Examine your NDVI Image

In the image you have created (NDVI_ENVI) you will see a range of gray tones. Darker gray pixels have lower DN values, and lighter gray pixels have higher DN values. Lower NDVI values imply that the vegetation at that location is expelling less water, or is less healthy or more stressed than areas with high NDVI values, so light colored areas in the image have “greener” vegetation.

Finally export this NDVI as an image file so that we can use it in ArcMap. To do this click on File→Save File As and then click on ESRI GRID. Save it your thumb drive and make sure and name it appropriately.

Step 6. Now load the NDVI RS image into ArcMap. Remember that NDVI has values between -1 and 1 with 1 being the most green. We will now split the numbers up into 3 parts: areas of good vegetation, medium vegetation, and poor vegetation. This will turn the data from a quantitative data set into a qualitative one.

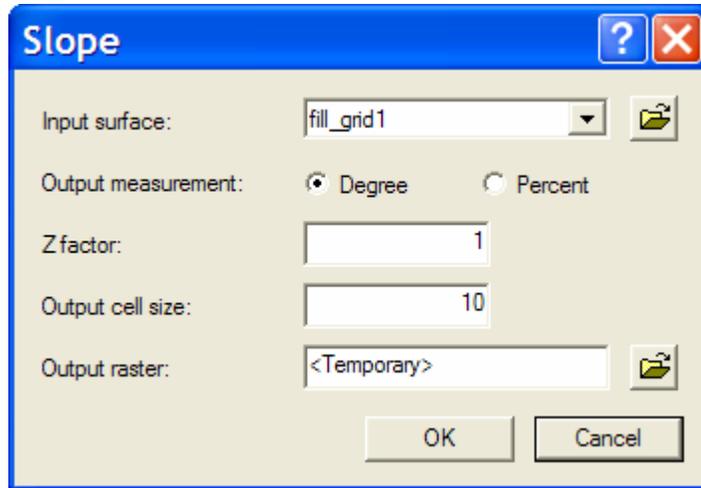
- a. In ArcMap use the reclassify option under the spatial analyst button and classify the NDVI image into 3 classes. Make sure you save the image on your thumb drive and name it appropriately.



Step 7. Next we will take the DEM that we used in creating the watersheds and create a slope map from it. Livestock, especially cattle, tend to not graze on high slopes or hills. Therefore after we create the slope map, repeat step 6a above

and classify the slope data into areas of good, medium, and poor slopes. With the high slopes being poor and so on.

a. As you might imagine, the slope of a landform is simply the local difference between elevations. More specifically, a single grid cell is compared against all of its surrounding grid cells to find the local relief. As you may remember from high school math, the slope of a function is defined as rise/run ($\Delta y/\Delta x$). From the Spatial Analyst toolbar, select “Surface Analysis → Slope”. Use the DEM as the input raster and call the output raster “Slope” (leave all other settings to their defaults).



b. Repeat step 6a to reclassify the slope data into 3 classes of slope

Step 8. Load in the reclassified slope data into an ArcMap session along with the reclassified NDVI image. Next we need to classify the soil data into areas of good, medium, and poor soils based on a column the NRCS has in the soil data called Pounds of Forage. Each soil polygon as a number which corresponds to the pounds of forage per polygon. Load the soil layer into ArcMap and open the attribute table look at this data.

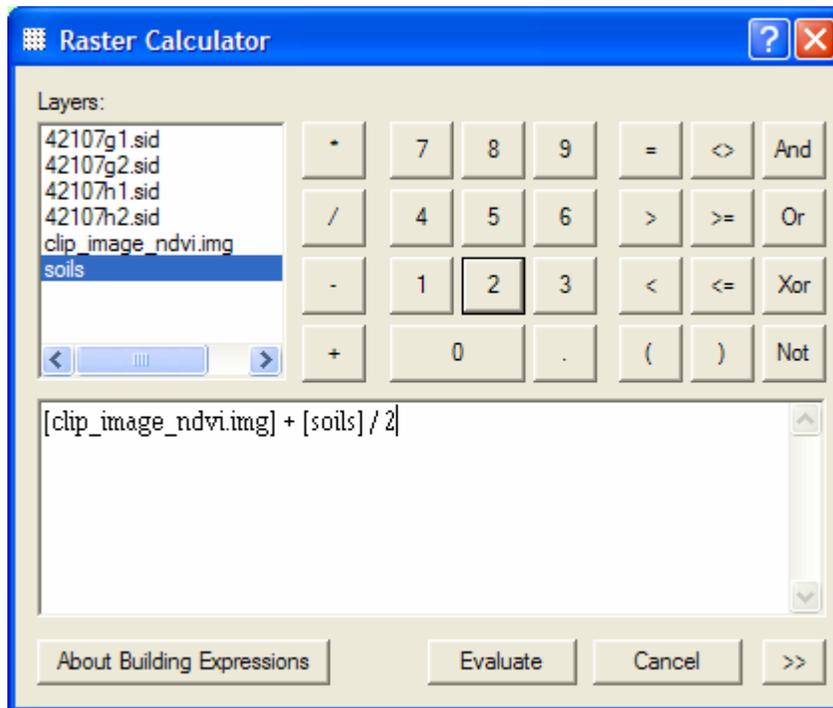
a. Note the highlighted column.

STSSAID_1	SEQNUM_I	RSID_C	RSNAME_C	lbs_unit	PRODI
WY625	1	034XY338W	SALINE LOWLAND (10-14SE)	307198.6962	2500
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	123.449339	700
WY625	1	034XY322W	LOAMY (10-14SE)	995100.592743	1400
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	495293.269917	700
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	412811.50162	700
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	34084.660912	700
WY625	1	034XY322W	LOAMY (10-14SE)	275433.589007	1400
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	21136.774495	700
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	13502.374251	700
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	367679.174458	700
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	103713.951241	700
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	60146.047327	700
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	13014.297447	700
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	6691.670119	700
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	8265.29102	700
WY625	1	034XY322W	LOAMY (10-14SE)	37117.253071	1400
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	28155.374062	700
WY625	1	034XY322W	LOAMY (10-14SE)	735911.273098	1400
WY625	1	034XY322W	LOAMY (10-14SE)	45856.896936	1400
WY625	1	034XY322W	LOAMY (10-14SE)	640197.324472	1400
			Loamy	1466.797611	1400
WY625	1	034XY322W	LOAMY (10-14SE)	46409.530416	1400
WY625	1	034XY318W	IMPERVIOUS CLAY (10-14SE)	20556.503762	700
WY625	1	034XY322W	LOAMY (10-14SE)	236961.65111	1400
WY625	1	034XY322W	LOAMY (10-14SE)	29940.513041	1400

b. Use the convert option in the spatial analyst tool button to convert the soils from vector data to raster data as the DEM and the RS data are in raster form and we will be using raster calculator to perform the next step of the lab.

Step 9. Finally we will use Raster Calculator under the spatial analyst button to combine the soil data with the slope data, and then the NDVI image with the soil data. We will have two final data sets that we can then compare to one another.

a. Open up raster calculator and under the spatial analyst button. What you will do is add the the Remote Sensed NDVI image to the Slope data then divide by 2 so that we get numbers of 1, 2, 3. 1 being areas of suitable grazing, 2 being areas of medium grazing, and 3 being areas of poor grazing.



- b. Repeat the step above except add the slope data to the soil data and divide by 2.

Step 10. Now you have two data sets. One data set of good, medium, and poor areas of grazing with the NDVI image. The other is the same data except with the soil data instead of the NDVI image.

Do the two data sets show the same areas of good grazing or are there different areas?

Overlay the shapefile of your GPS points that we created out in the field. How does your field data compare with what the GIS and Remote Sensing data tells you.

Deliverables (work in your groups of 2-3 students)

1. **Create maps showing the areas of grazing with the soil data and the Remote Sensed Data. In both maps make sure your GPS data is overlaid and labeled with what kind grazing you had it as in your field notes. Make sure all the necessary map elements are on the maps.**
2. **Discuss the questions above in Step 10. Based on the discussions we have had in class answer the questions with at least 1 page each.**
3. **You will be tested on this learning unit in the next exam as well.**