GST 102: Spatial Analysis Lab Series

Lab 7: Raster Data Analysis – Working with Topographic Data

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Introduction

This lab is part of a series of lab exercises designed through a grant initiative by the National Information, Security & Geospatial Technologies Consortium (NISGTC), funded by the United States Department of Labor in partnership with the Department of Education under the Trade Adjustment Assistance Community College and Career Training Grant Program (TAACCCT).

In this lab, students will learn about topographic data and how to use it for analysis. We will introduce creating Triangular Irregular Networks (TINs) and using the raster data model. We will be looking at terrain analysis methods such as slopes and hillshades using ArcGIS. There are several applications for the TIN models with regard to terrain analysis.

Your instructor may require that you provide screen captures and/or exported files. Please check with your instructor for the requirements specific to your class.

This lab includes the following tasks:

1. Creating a Triangulated Irregular Network
2. Using the Raster to look at Environmental Issues
3. Reclassifying Rasters
4. Using the Raster Calculator
5. Using Weighted Sums

Objective: Learn Basics of Terrain Analysis

The objective of this lab is to learn the basic terrain analysis operations of ArcGIS. Using the terrain analysis tools, we can find the slope of a surface. Using the derived datasets, we will be able to learn how to approach environmental issues.

Lab Settings

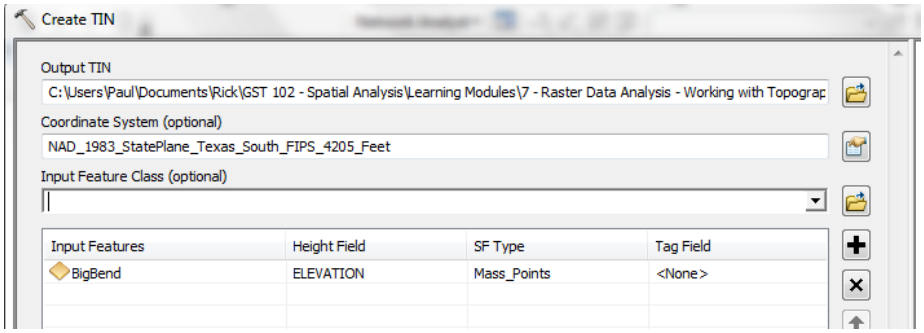
Required Virtual Machines and Applications

Windows Machine User Account	Train
Windows Machine User Password	Train1ng$

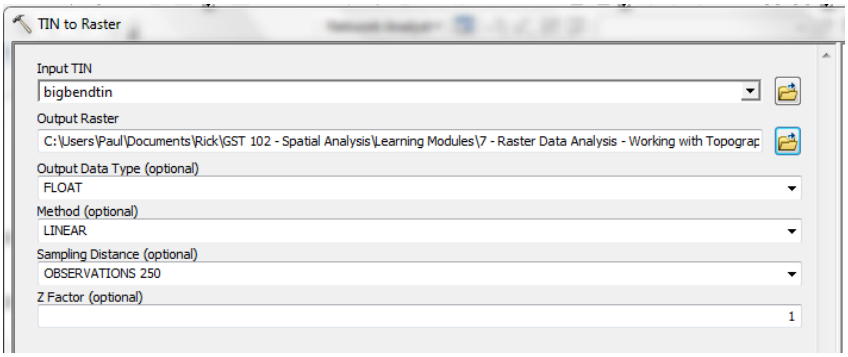
1 Triangulated Irregular Networks

Triangulated Irregular Networks (TINs) use a point type file in order to create the surface. The surface is created by triangulating all the points in the file.

1. Log into the computer, using the information provided in the Lab Settings section.
2. The data for this lab is located on the lab machine on the shared drive in the folder *GST 102\Lab 7*
3. Click **Start->All Programs->ArcGIS->ArcMap 10.1**. ArcMap will open.
4. Browse to your *Lab 7* folder and add the file called **BigBend.shp** to a blank map ArcMap. This shapefile contains point features, which are located in West Texas. Open the layer's attribute table and note that each point has an elevation value.
5. Open ArcToolbox and click **3D Analyst Tools -> Data Management ->TIN->Create TIN, the** Create TIN tool. Unlike the other tools, it will ask to set the output first. Set the output to your *GST 102\Lab 7* Folder. Set the projection to **NAD_1983_StatePlane_Texas_South_FIPS_4205_Feet**. Finally, set the input to the BigBend.shp file that you added to ArcMap. The rest of the data fields are set automatically.



6. Click **OK** and your TIN will be created (it may take a minute so be patient).
7. Now before the TIN is useable we should turn it into a raster so we can perform raster analysis on it. In ArcToolbox click on **3D Analyst -> Conversion -> From TIN -> Tin to Raster**. For this, we will only need to enter the input and the output file. The output file name cannot be longer than 13 characters. Name the file **`Tin_Raster`**, set the output to your *GST 102\Lab 7\Data* Folder. Click **OK.**

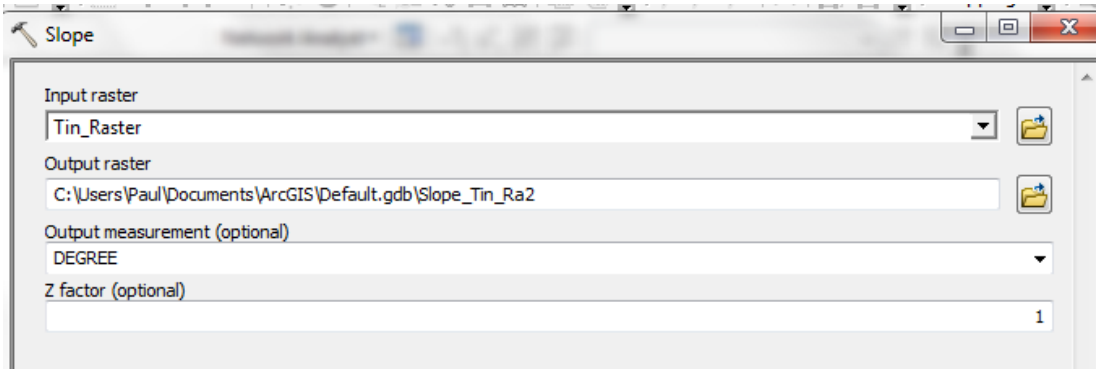


8. We will be using this TIN for the tasks that follow in this lab.

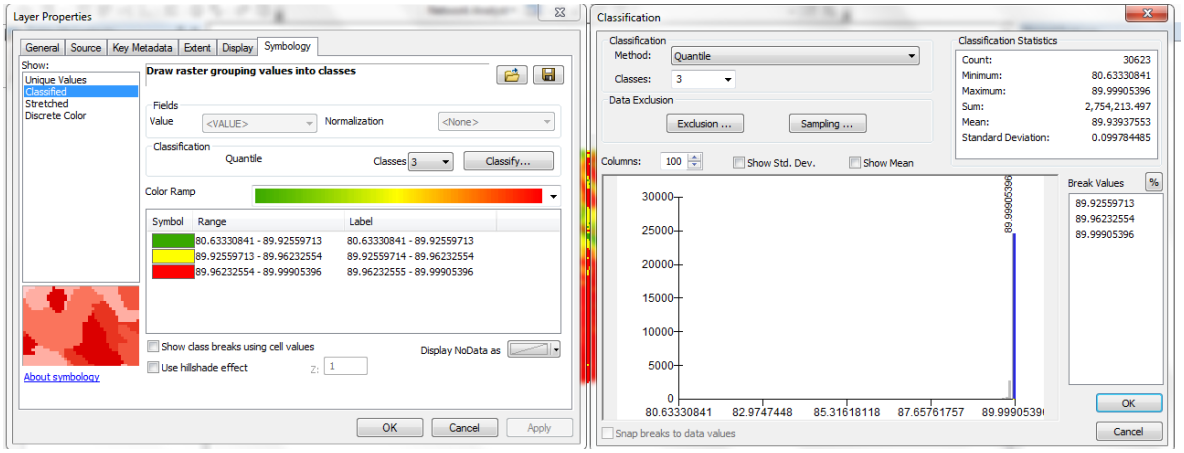
2 Using the Raster to Look at Environmental Issues

In this task, we will be looking at environmental issues that can be solved using the raster TIN we just created. As it is derived from elevation data, we may use it to calculate the slope or the steepness between two points, the aspect in which direction the area is facing, and the hillshade or shaded relief model showing the shaded areas. ArcGIS has all the tools to do these analyses.

1. Use the Tin_Raster file that we just created.
2. Use the **Search** function to find the Slope tool(Spatial Analyst) or open the tool window by clicking on **ArcToolbox->Spatial Analyst Tools->Surface->Slope**
3. In the Slope tool window, set the input as Tin_Raster. Keep the **Output measurement** as *DEGREE*; this represents the degree of steepness of the slope that is calculated. The other option is the percentage rise of the slope; we will be using the degree. The Z factor will be left as *1*. **Click OK.**



4. The output layer, however, must be changed to have a more meaningful appearance. Right-click on the Slope layer you just created and select **Properties**. Go to the **Symbology** tab and **click** the **Classify** button. **Select** the **Quantile** option in the classification method dropdown. Click **OK** and your slope should be more distinguishable.

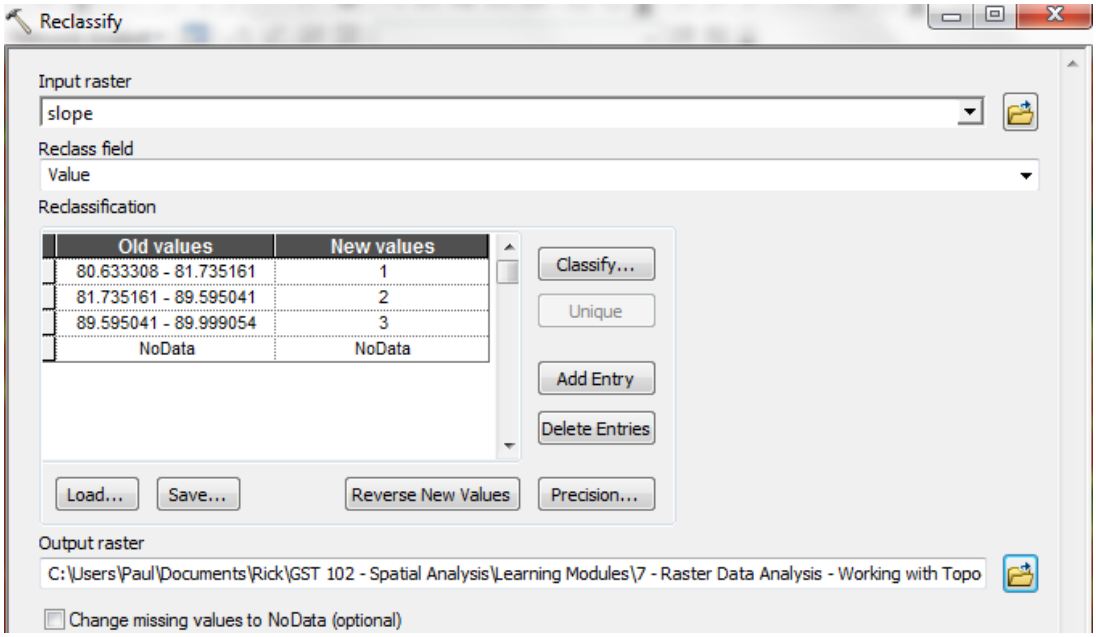


5. Now, we will be looking at the aspect of the area. Once again, click on your **Spatial Analyst Tools->Surface->Aspect.Open** the tool. This tool is simple, it requires an input and an output. Set the input to the *Tin_Raster* and the output to your *GST Folder* and call it **`Aspect`**. Click **OK.**
6. The resulting raster will have the direction the area is facing.
7. The next thing to create is the Hillshade. This tool is also found in the **Spatial Analyst Tools** toolbox and the **Surface** toolset. We will use the *Tin_Raster* again for the input and save the output to your *GST 102 folder*. In the tool window, we can set the azimuth, which is the angle of the light source and the altitude that is how high the light source is above the horizon. For our intents and purposes, we will use the defaults.
8. We will now look at Viewshed Analysis. This will give us all the areas that are in the line of sight from a certain point. Add the shapefile called **Viewpoint.shp** found in your Lab 7 folder to your map. Next, find the **Viewshed** tool in the **Spatial Analyst Tools** toolbox. You will be required to insert an **Input raster**, which will be your *Tin_Raster,* and an **Input point feature,** which will be the *Viewpoint* layer. Set the output to your *GST 102 folder*. Click **OK.**
9. Make screenshots of your Slope, Aspect, Hillshade and Viewshed layers for submission, if required by your instructor.

3 Raster Reclassification

Raster reclassification is a method we use to make our choices simpler when selecting a site for a specific purpose.

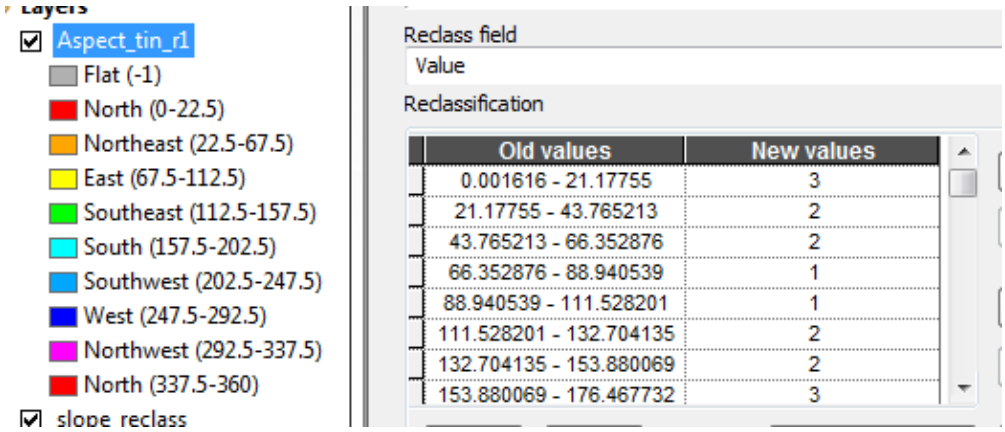
1. We will be looking at an area of suitability for a particular plant species. Using the raster classification will make it easier when we do the map algebra.
2. Find the **Reclassify** tool, in the **Reclass** toolset under **Spatial Analyst Tools**. **Click** on the tool. The window will open. Set the input as your **Slope** layer and store the output in your data folder as `Slope_Reclass`. The Reclass field will be the Value field.



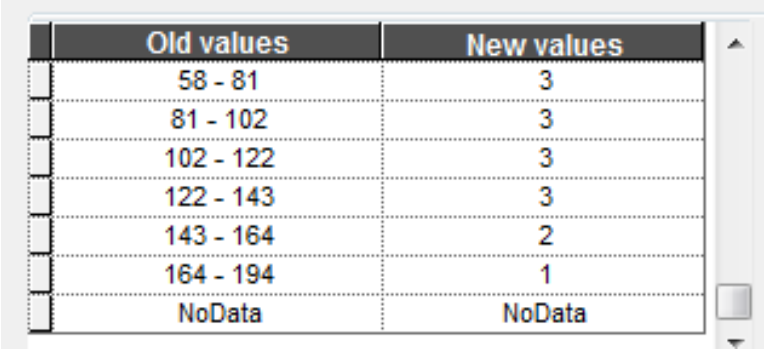
3. We want to look for features on practically vertical slopes, but vertical slopes are not quite ideal. Thus, we want to set the Reclassification values from highest to lowest based on their slope by looking at the table below. **Click OK** and look at the reclassification.

Old values	New values
80.633308 - 81.735161	3
81.735161 - 89.595041	1
89.595041 - 89.999054	2
NoData	NoData

4. Now we will use the **Reclassify** tool again and look at the aspect. In the Reclassify tool window click **Classify** and set the number of classes to *16*. This will give us a better break down that allows us to specify East, Northeast and Southeast more accurately. We will now try to fit the classification to the aspect values. We want all the areas on the east facing slopes. Hence, the values that indicate east facing slopes will be set to 1. The northeast and southeast slopes are the next best locations so set them to 2. The remaining slopes can be set to 3. Your classification values should end up looking like the figure below. Save it in your data folder as **`Aspect_rec`**.



5. The next reclassification will be of the hillshade. The areas that get the most sun are the favored spots. Look at the brightness gradient in the values for the Hillshade layer in the Table of Contents. You will notice that higher numbers indicate more sun and lower numbers, less. **Reclassify** the values in the table like the image below. Set the output to your data folder as **`Hillshade_rec`**.



Old values	New values
58 - 81	3
81 - 102	3
102 - 122	3
122 - 143	3
143 - 164	2
164 - 194	1
NoData	NoData

6. Make a screenshot of each of the three resulting rasters, if required by your instructor.

4 Using the Raster Calculator

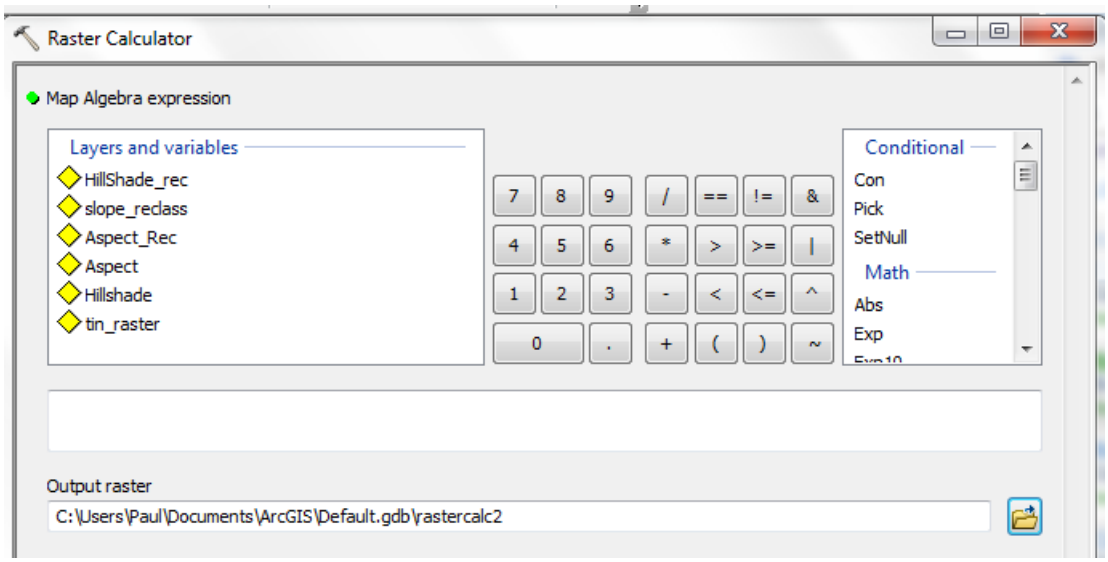
1. We will be using the raster calculator to do map algebra on the three raster layers we have just created in the previous task.

Old values	New values
80.633308 - 81.735161	3
81.735161 - 89.595041	1
89.595041 - 89.999054	2
NoData	NoData

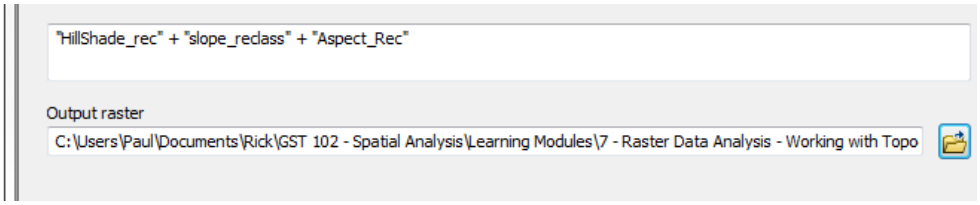
Old values	New values
0.001616 - 21.17755	3
21.17755 - 43.765213	2
43.765213 - 66.352876	2
66.352876 - 88.940539	1
88.940539 - 111.528201	1
111.528201 - 132.704135	2
132.704135 - 153.880069	2
153.880069 - 176.467732	3

Old values	New values
58 - 81	3
81 - 102	3
102 - 122	3
122 - 143	3
143 - 164	2
164 - 194	1
NoData	NoData

2. In the last task, we reclassified the layers so we could calculate an area suitable for a certain species of plant. To calculate the overall area suitability from our slope, sunlight (Hillshade) and Aspect, we will use the raster calculator. As the areas are all the same size, extent, projection and cell size, the addition will be easy. Our reclassification will help make this easier as well. We classified the best-fit data to the lowest values (1s and 2s) with the more unsuitable areas having higher values (3s).
3. The Raster Calculator (**Spatial Analyst Tools->Map Algebra**) allows us to add the values of each grid, however, if they are not in the same format with the same number of classes, the result is not useable or applicable. This is why we reclassified everything.



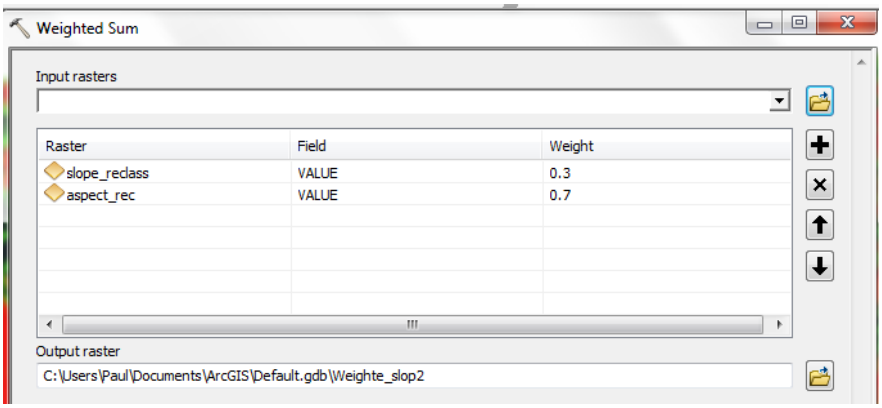
4. To find the best suited area for our plant, we will begin by adding the Hillshade_Rec to the Slope_reclass to the Aspect_rec together using the expression builder, and saving the output raster as **`Suited_Sites`**. Double-click on the layer name to add them to the calculator window. Your expression should look like the one in screenshot below.



5. The resulting raster will show the suitable locations for the plant. The lower the number, the better suited the site.

5 Weighted Sums

1. The weighted sum of the layers is useful if one of the layers is considered more important than another. For this, we will take the aspect to be of weight 0.7 and the slope to be less important at 0.3.
2. Search for the **Weighted Sum** tool in ArcMap (**Spatial Analyst Tools->Overlay)**. We will be adding the **Aspect_rec** and the **Slope_reclass** layers.



3. Save the output as **Wtd_SumSites**. Once again, the lowest values are the ones that are most suited. However, there will be a difference in your results from the Raster Calculator and the Weighted Sum due to the change in variables. Compare the two rasters.

Conclusion

In this lab, we can see the use of the Network Analysis extension in ArcGIS. There are many applications for these analyses. They allow for a great amount of data to be considered when calculating the best sites, routes, and service areas.

Discussion Questions

1. What is the importance of a TIN?

2. How can we apply the viewshed to real life problems?

3. Compare the Raster Calculator and the Weighted Sum tools. Discuss the advantages or each tool.