Lab 10: Raster Analyses

What You'll Learn**:** Spatial analysis and modeling with raster data. You will estimate the access costs for all points on a landscape, based on slope and distance to roads. You'll then apply a threshold to this access cost.

You should read chapter 10 in the GIS Fundamentals textbook before performing this lab.

Data are located in the Lab10\ subdirectory, including *mar_rd83.shp,* a vector road layer, in NAD83 UTM zone 15 coordinates, meters, and *mardem*, a raster elevation grid, NAD83 UTM zone 15 coordinates, 30m cell size, Z units in meters

What You'll Produce: A map of a cost surface with an applied threshold.

Background

Raster analysis is commonly applied when working with continuous data, e.g. elevation, slope, or distance from features of interest. In this exercise we will calculate an access cost surface based on raster and vector data layers. This is a highly simplified example, but introduces basic tools are useful in a range of problems.

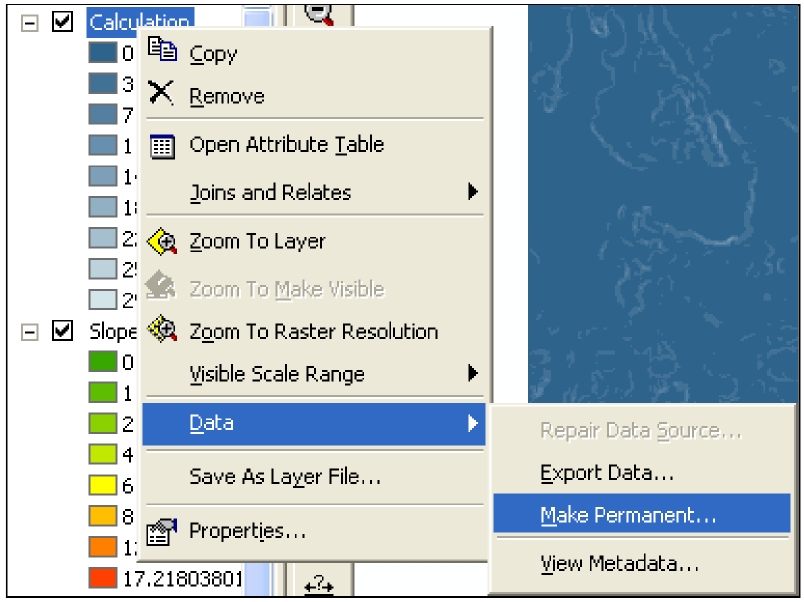
Our cost surface will depend on slope and distance to existing roads. In our problem, we will assign a road construction cost of $25 per meter of road required. We have a vector data layer of roads, digitized from USGS maps, and we will use grid functions to convert this to a cost data layer.

Slope also affects access costs, because roads on steeper terrain are more expensive. The cost is nonlinear, increasing slowly at first for low slopes, then more rapidly at steeper slopes. We will derive slope from a DEM data layer. We will modify the tables associated with both the derived slope and distance layers to include a cost column. To reflect the nonlinearity in slope costs, we will apply the trigonometric sine function to model this increase in cost. We will then add these two cost layers. Finally, we wish to apply an upper threshold of $5,000 to consider only those areas that are within our budget.

You should note that most layers that are output from ArcMap raster functions are temporary. If you wish to save them, you must explicitly make them permanent. Temporary files are available as long as the session is running. However, if you have not saved them, and you close an ArcMap project, you will likely lose your temporary files.

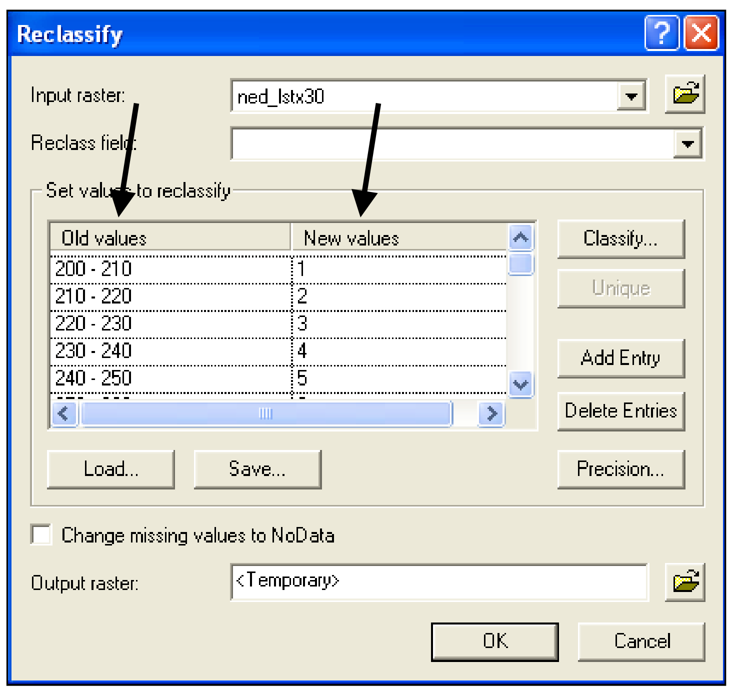
Much of the work in this lesson has been covered in previous lessons.

Make temporary raster layers permanent by right clicking on the name in the Table of Contents (TOC), then left clicking on the **Data -> Make Permanent** choice in the dropdown menu.



Before we start, we need to describe a difference between a permanent reclassification you'll be doing today, and a display reclass you've done before and you'll also do today.

Remember, a reclassification is a conversion from one set of numbers to another. We do this in a raster GIS through a reclass table. This table has a column for input values (Old values in the figure at right) and a column for output values (New values in the figure at right). Each cell value is examined, and input value matched to an entry in the table, and the corresponding output value reassigned according to the table. For example, the table at right specifies that all Old values between 210 and 220 are assigned a new value of 2.



In a permanent reclassification, each output value is saved to a new raster. In a display reclassification, the value is used only to assign symbols for display. No data are changed in the source file, nor are new files saved. In previous lessons we have only performed reclassifications for display. Today we will perform a permanent reclassification. It is easy to get confused, because the classify menus for applying these classifications are similar.

Start ArcGIS - ArcMAP

- Create a new map project, add the raster ***mardem*** to the view, and inspect it.

Use the  cursor and the layer **Properties –Source** tab. What are the units of the elevation? What are the highest and lowest elevation values? Does it make sense?

- Derive the slope for *mardem. S*elect **Spatial Analyst – Surface Analysis – Slope**. Specify degrees units for slope. Name the output file *mar_slope*.

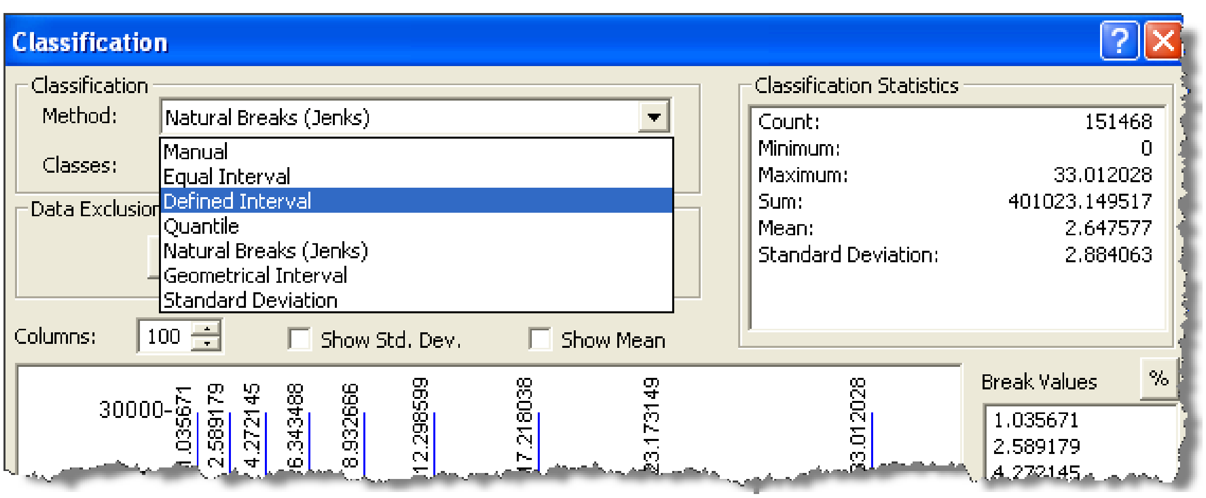
- To keep the view uncluttered, remove the *mardem* grid from the map.

- Examine the slope layer. The should be values from 0 to about 33 degrees.

- Select Spatial Analyst – **Reclassify**. You'll get a popup menu, with a reclassification table, similar to the table in the figure on the previous page (***Video: L10_1_Reclass.mov***).

- At this popup menu click on the **Classify** button. This will open a classification window that is exactly equal to the window you see when changing the symbology for a layer. However, in this case you are using to change the assignment or classification table.

- Here, select a **Defined Interval** classification with an interval width of 1.



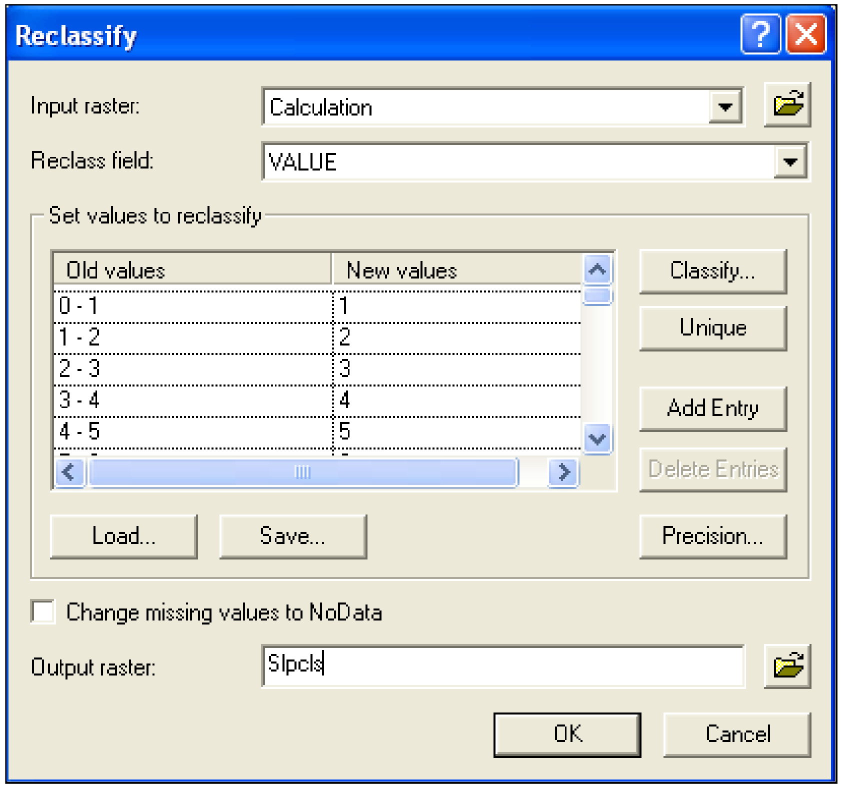
- Left click on OK

Note this returns you back to the Reclassify menu, but that the reclassification table has been changed. Now the Old values to New values list should reflect the reclassification you specified, as illustrated in the figure below.

Also note that you can save this reclassification table, for example, if you wish to use it again in the future, and you can load saved tables.

Also note you can specify how missing data are assigned, and you must specify the name and optionally the directory of your output file

Name the output grid something like *Slpcls*.

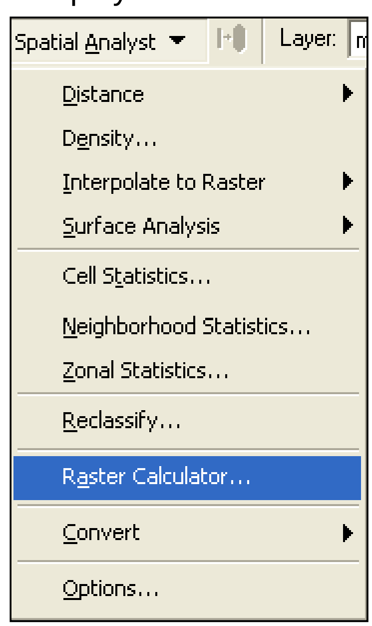


During the subsequent steps we walk you through you may wonder, why work on all these derived layers, why don't we just work on the slope layer? You could easily skip several of these steps but the first time it is best that you see the details of each step.

- Now remove the original slope layer, it just clutters your display.

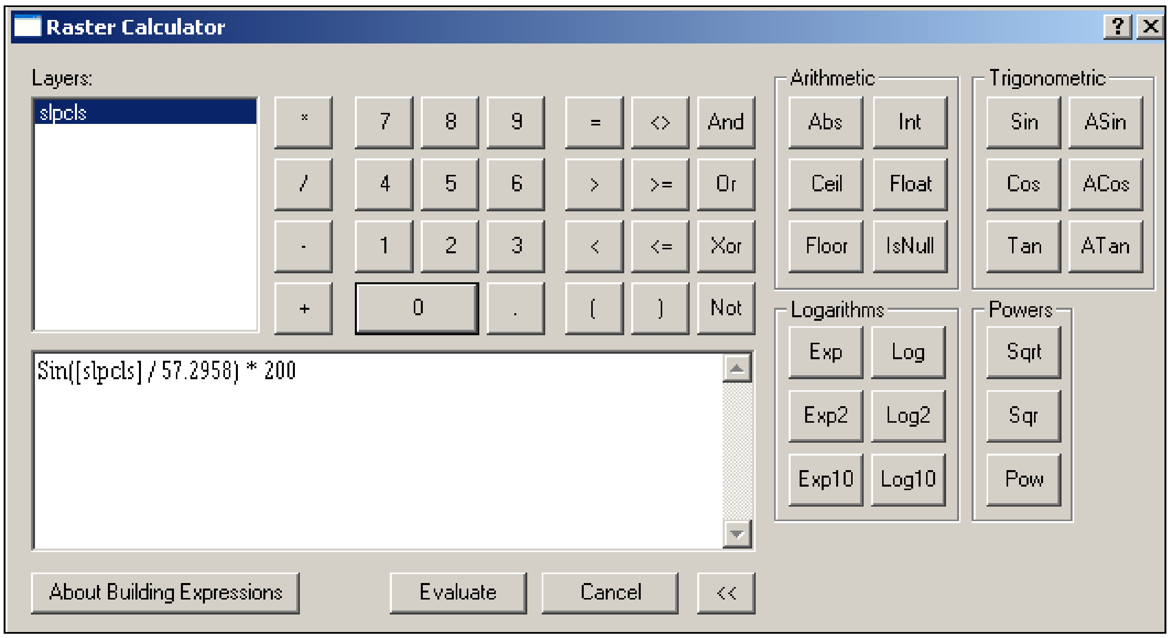
Next we will apply a formula that determines the cost of building on slopes.

- Left click on **Spatial Analyst – Raster Calculator (*Video: L10_2_Raster_Calculator.mov*)**



If the Raster Calculator window is missing functions shown in the figure below on the right, use the >> button to display the Trigonometric functions.

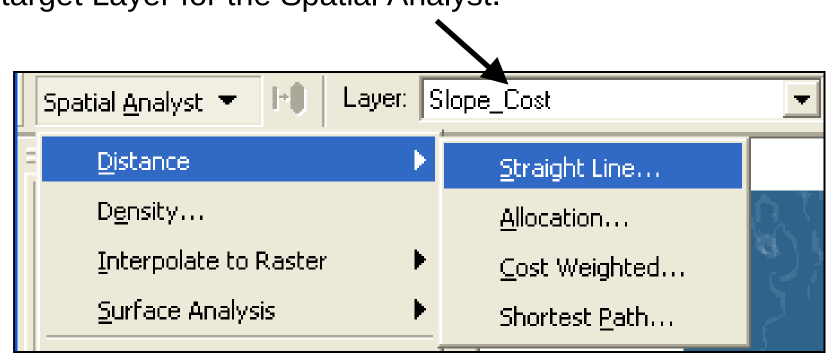
- Type the following function into the center window: Sin(slpcls/57.2958) * 200.
- Enter as shown below, and left click on **Evaluate**. Note that it is better to use the calculator buttons than to type the equation using the keyboard – generally, you'll see fewer syntax errors.



- Make the layer permanent: Right click the layer you just calculated, then left click **Data → Make Permanent**, and name the output *Slope_Cost*.
- Remove Calculation, and add Slope_Cost to your data view. Verify the cost layer makes sense, and that they are highest where slopes are steep.

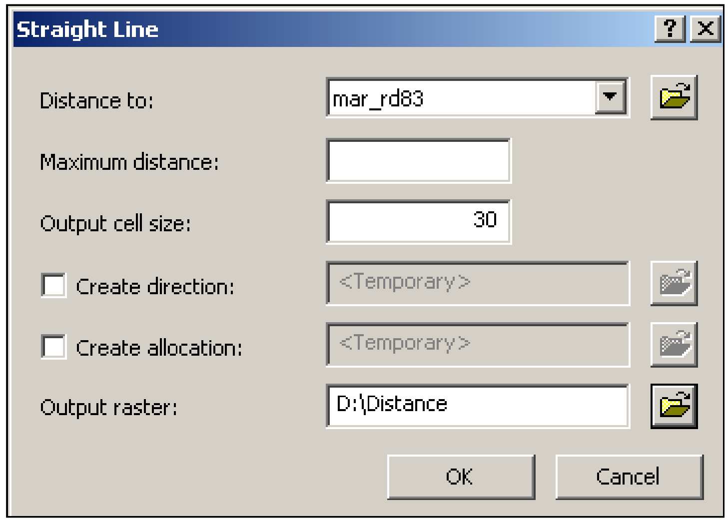
Next, we need to display and generate our distance costs from the roads layer.

- Add the *Mar_rd83.shp* file.
- Make sure *Slope_Cost* is the target Layer for the Spatial Analyst.
- Then left click **Spatial Analyst – Distance – Straight Line**.

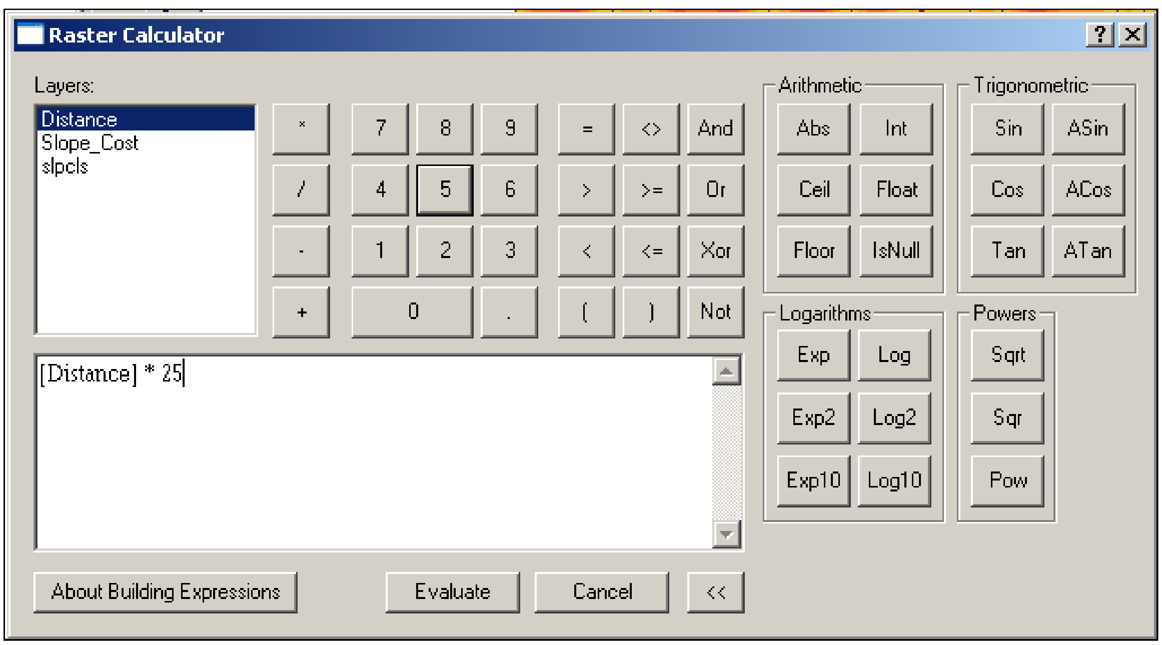


- Set the cell size to 30 and store output with a name *Distance*.
- Examine the result layer, and make sure it is reasonable.

Now, multiply the distance layer you just produced by the cost per unit distance to estimate distance cost.

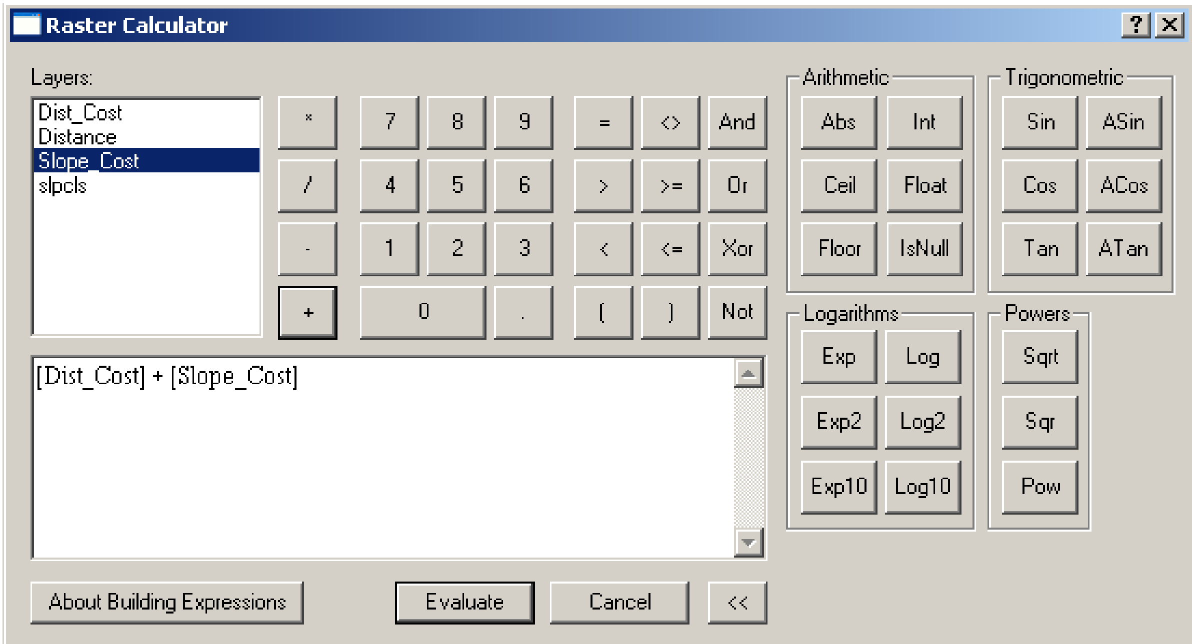


- Left click **Spatial Analyst – Raster Calculator** and enter the equation as shown below, then left click **Evaluate**. If all goes well you will get an additional layer named *Calculation*.



- **Make Permanent** this new *Calculation*, and name it *Dist_Cost*.
- Remove *Calculation* from the data view, and add *Dist_Cost*.

Our next step is to combine the two sets of costs. Open the Raster map calculator again (**Spatial Analyst-Raster Calculator**), and add the two cost layers, as below:



This should result in our new layer, again titled *Calculation*.

Make this new *Calculation* permanent, name it *Total_Cost,* add it to the view, and remove *Calculation* as before.

Examine the *Total_Cost* layer and make sure it makes sense.

Think a minute about what you've just done. You first calculated a slope, and then a cost associated with building a road per unit distance across the slope. Then you calculated a distance, and then a cost associated with building a road to that distance from an existing road. Both of these were calculated for every grid cell in your study area. You then added these two together for an estimated total cost to build a road to any portion of the mapped area. A real problem would include many other factors, like soils, surface vegetation, slope constraints over minimum segments, etc., but this would only lengthen the analysis, and not change the basic way you are applying the tools.

Our job now is to select those areas below the $5,000 threshold. We will do this by creating a mask grid. This grid will have 1 at all locations where the costs are below $5000, and 0 where the costs are above $5,000. We will then multiply this with our total cost grid, to zero out those areas we don't wish to consider.

Reclassify Total_Cost by **Spatial Analyst –Reclassify—Classify**.

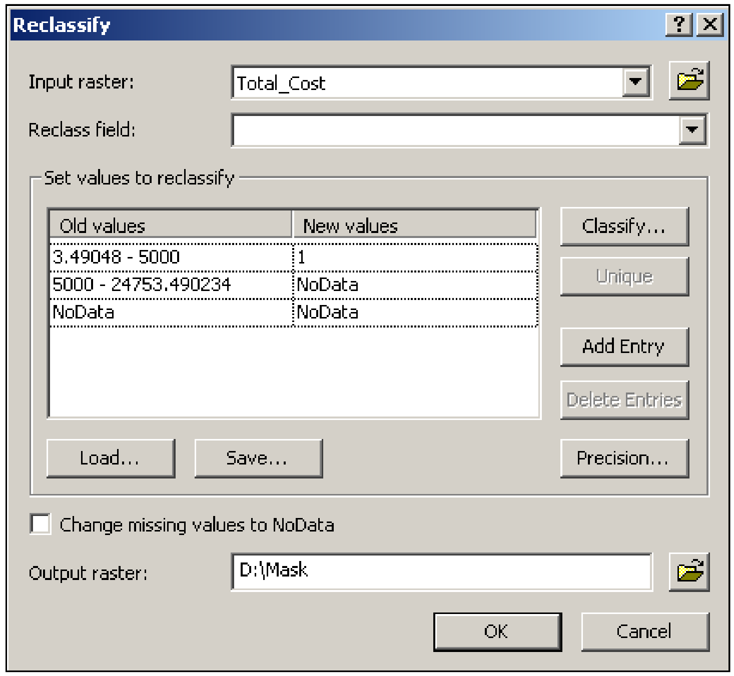
In the reclassification window (not shown), set the

– **Method** to Equal Interval,
– **Classes** to 2,
– Type in 5000 in place of the first **Break Value**,
– Leave the 2nd **Break Value** at the current (maximum) level.
– Left click **OK**

This should result in a reclassification table as shown at right.

Make sure you have NoData for the New value of the 5000 to 24753.49024 category.

Make sure you specify the output raster name, here shown as *Mask*.



Multiply the Total Cost raster by the Mask raster. Left click on **Spatial Analyst – Raster Calculator** and multiply *Total Cost* by *Mask*. Then make Calculation permanent, giving it a name like *Final_Cost*.

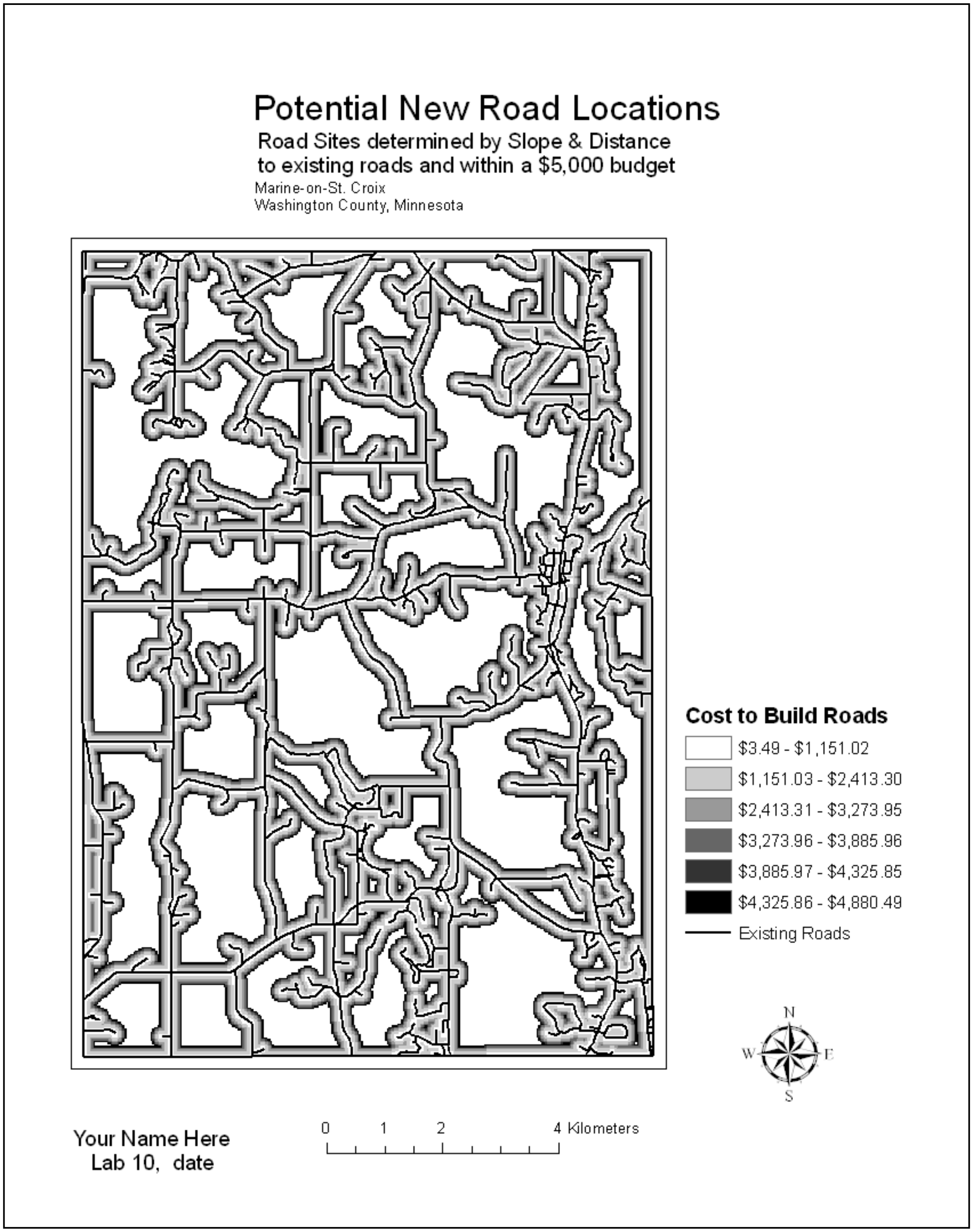
Display the *Final Cost* layer in your data view.

Add the roads layer, *mar_83.shp,* and create a layout with appropriate legend, titles, name, north arrow, etc. Create a pdf of the map.

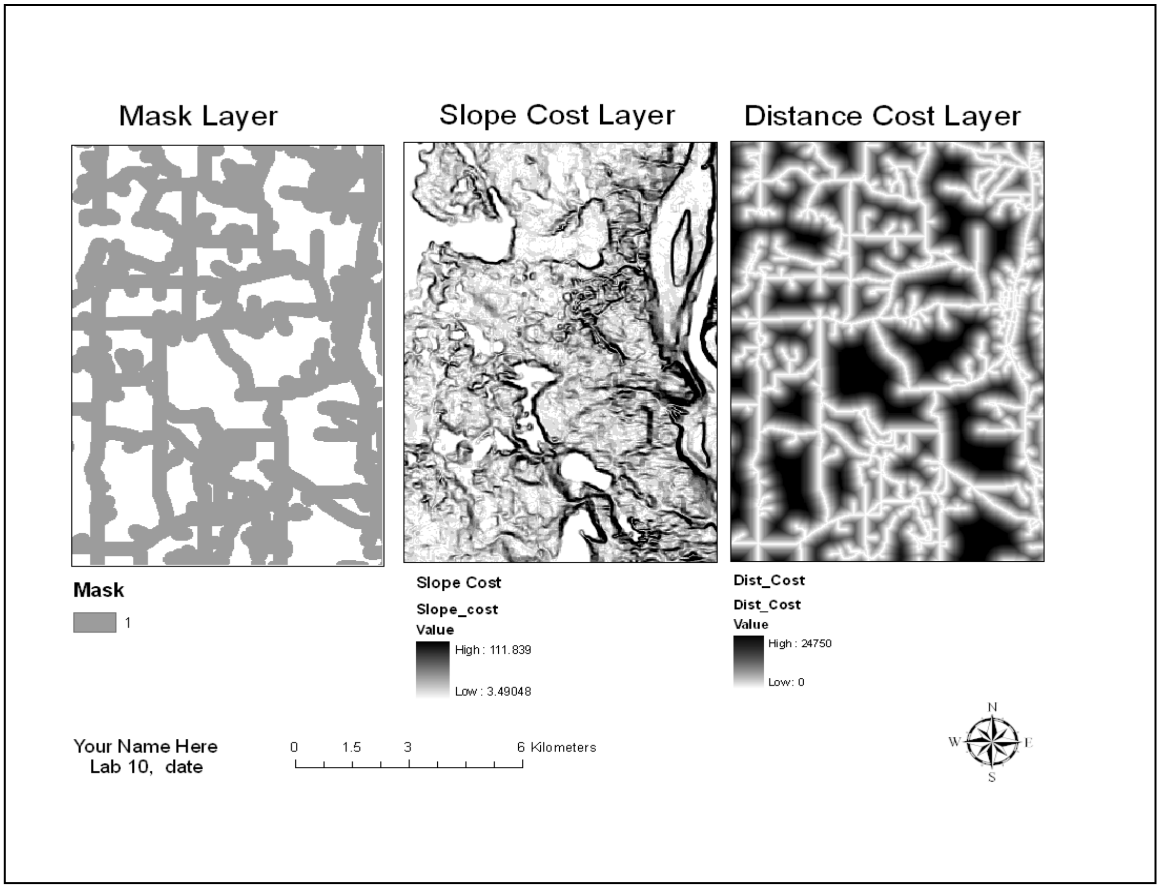
Also create a composite layout with three separate data frames on the same layout, with 1) a data frame with the *mask* layer, 2) another data frame with the *slope_costs* layer, and 3) a data frame with the dist_cost layer.

.

Color the mask as gray and white, and color the distance and slopes costs as graduated colors, with a gray monochromatic color set. Include the appropriate legend for each map.


Potential New Road Locations
Road Sites determined by Slope & Distance
to existing roads and within a $5,000 budget
Marine-on-St. Croix
Washington County, Minnesota
Cost to Build Roads
$3.49 - $1,151.02
$1,151.03 - $2,413.30
$2,413.31 - $3,273.95
$3,273.96 - $3,885.96
$3,885.97 - $4,325.85
$4,325.86 - $4,880.49
Existing Roads
N
W
E
S
0
1
2
4 Kilometers
Your Name Here
Lab 10, date

An example of you composite map of source data.



MAPS TO TURN IN:
(via WebVista as .pdf's)

- **Potential New Road Location**
- **Three working maps shown above (on one page)**