Workshop 3: Introduction to Spatial Analyst

This exercise introduces the Spatial Analyst extension for ArcGIS 9.1. Within the ArcGIS suite of programs, Spatial Analyst serves as the primary modeling and analytical tool for raster or grid-based data. Spatial Analyst encompasses a wide range of analytical and geoprocessing tools, including tools for surface analysis, interpolation, reclassification, grid mathematics, zonal and focal functions, and distance and density computations. While most of Spatial Analyst's tools perform some sort of cell-based analysis, many of tools carry out data conversions or pre-processing. For instance, before executing a statistical routine, users often wish to reclassify values, convert from vector to raster format, or modify the cell size. All of these tasks can be accomplished with Spatial Analyst.

Overview

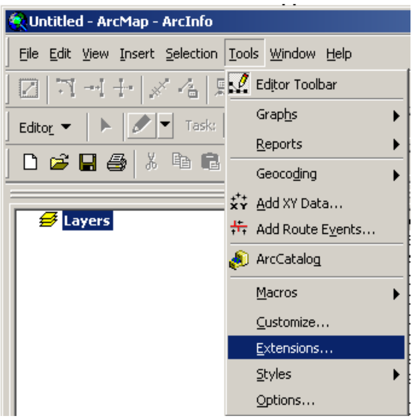
In this workshop, we will learn about the capabilities of Spatial Analyst in the context of a typical GIS project. Suppose we want to identify suitable areas for a re-vegetation project near Hilo. These areas must meet specific criteria for slope, aspect, rainfall, solar radiation, and land use. Starting with a variety of data (including an elevation grid, rainfall samples points, a solar radiation grid, and land use polygons), we will create a new grid for each of the five criteria. Then we will combine these grids into one raster that shows the areas that meet all five criteria.

Step 1: Enable Spatial Analyst and Toolbar

Before starting, create a new folder for your work on the **(Z:)** drive entitled **"gis_workshop3"**. The full path should be:

Z:\gis_workshop3

Now start ArcMap 9.1 with a new empty map. Before going any further, you will need to enable the **[Spatial Analyst]** extension. To do so, click on the **[Tools]** menu and select **[Extensions]**. Tick the box next to **[Spatial Analyst]** and close the window.



Next you will need to display the **[Spatial Analyst]** toolbar by going to the **[View]** menu, choosing **[Toolbars]**, and then selecting **[Spatial Analyst]**. The **[Spatial Analyst]** toolbar, which can be docked anywhere, should appear as below:

Layer: dem_10

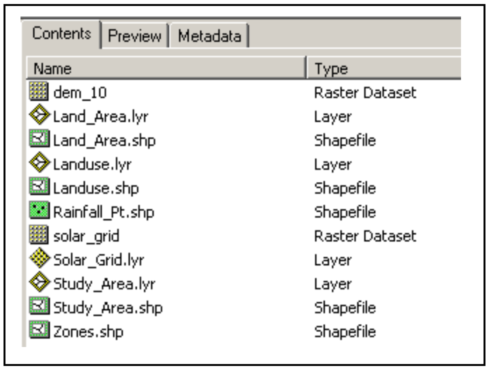
Step 2: Copy Input Data

From the standard toolbar, click on the ArcCatalog icon to launch ArcCatalog, or alternatively, open ArcCatalog from the **[Start]** button.

The data for this workshop lies in the folder:

I:\ITER_GIS_Workshops_Fall2005\Workshop3\Data

First, let us copy all the files from the above (I:) drive location to our new folder on the (Z:) drive. Remember to copy the files using ArcCatalog to ensure that all the necessary files are transferred. Please refer to Workshop 1 if you have forgotten how to copy files in ArcCatalog. After copying the files, our new (Z:) drive folder should contain the following:



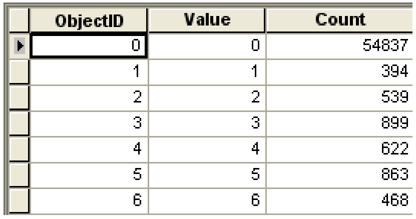
Name	Type
dem_10	Raster Dataset
Land_Area.lyr	Layer
Land_Area.shp	Shapefile
Landuse.lyr	Layer
Landuse.shp	Shapefile
Rainfall_Pt.shp	Shapefile
solar_grid	Raster Dataset
Solar_Grid.lyr	Layer
Study_Area.lyr	Layer
Study_Area.shp	Shapefile
Zones.shp	Shapefile

We can now work exclusively from our (Z:) drive folder. With the **[Preview]** tab selected, click on each of the input files one at a time to get an brief overview of the data.

Step 3: Add DEM_10

Switch to your ArcMap window, click on the **[Add Data]** button , and add the raster data set **DEM_10** (a digital elevation model with cell size = 10) to your ArcMap document. Right-click on the layer name, and open the **[Layer Properties]** menu. Under the **[Source]** tab, you will see a variety of information. Some of the most useful entries include the number of rows and columns, cell size, extent, projected coordinate system, datum, and map units.

DEM_10 Attribute Table.

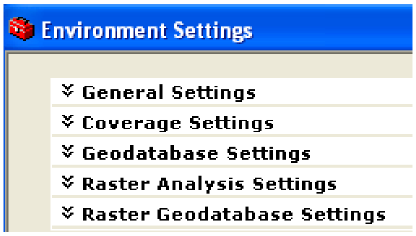


ObjectID	Value	Count
0	0	54837
1	1	394
2	2	539
3	3	899
4	4	622
5	5	863
6	6	468

Next right-click on the layer **DEM_10** in the Table of Contents and select **[Open Attribute Table].** Note that attribute tables for rasters contain 3 fields: object id, value, and count. Essentially raster tables function as histograms, with the value column displaying a list cell values and the count column displaying the frequency of each value. For floating point rasters with greater than 512 unique values, ArcGIS will not build an attribute table, nor will you be able to view it. In this case, the **[Open Attribute Table]** option will appear in dim letters.

Step 4: Setting the Environment

Click on the Toolbox icon to open the Toolbox. Right-click on the empty space anywhere in the Toolbox window and select **[Environments].** In the **[Environmental Settings]** dialog box, we can set various options that apply to any tool we execute. For instance, under the **[General Settings]** tab, which we can expand by clicking the adjacent arrows, we can set the following parameters:



Current workspace (input folder): Z:\gis_workshop3
Scratch workspace (output folder): Z:\gis_workshop3
Output coordinate system: Same as layer DEM_10

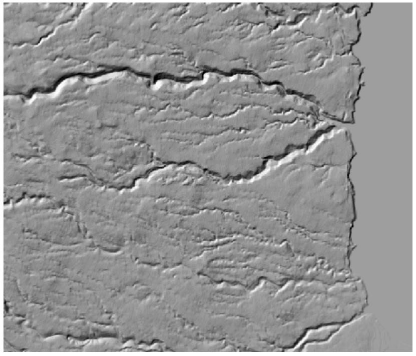
Under the heading **[Raster Analysis Settings]**, set the cell size to “Same as layer DEM_10”, or 10 meters on a side. Note that these settings apply to all tools run from the Toolbox, but not to those run from the toolbar. Click **[OK]** to save these settings. For tools run from the **[Spatial Analyst]** toolbar, you must define the analysis environment from the toolbar’s pull-down menu by choosing **[Options]** at the bottom of the list**.** Most of the toolbar settings are comparable to those in the Toolbox. Later in this exercise, we will modify the analysis environment for the toolbar.

For both ArcToolbox and the toolbar, setting the environment helps to minimize the required inputs when running specific tools. For example, once your default cell size and coordinate system are defined, you will not need to define these parameters each time you run a tool, unless you want to override the default settings.

Step 5: Surface Analysis

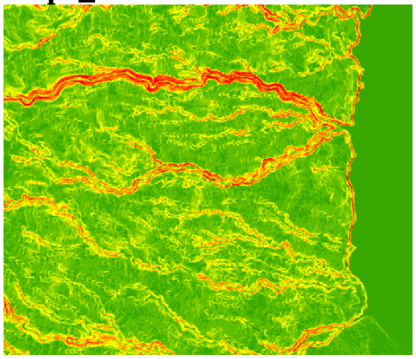
In this step, we will create raster data sets for slope and aspect, as well as hillshade, which we will use for display. In the Toolbox, expand **Spatial Analysis Tools** > **Surface Tools**. Let us create the hillshade grid first. Double-click on the **[Hillshade]** tool. For the required parameters (i.e., the ones with green dots next to them), choose **DEM_10** as the input and type in **Z:\gis_workshop3\HS_10** as the output raster. Leave the remaining parameters at their default settings, and click **[OK].** When ArcGIS completes this task, close the run window. ArcGIS automatically adds the new hillshade to your map. Using the default parameters for sun azimuth and altitude, ArcGIS assigns an integer from 0 to 255 to each cell, based on the amount of sunlight hitting each cell. The more light exposure, the higher the hillshade value. Note that the relatively flat areas on the map receive much more light than the steep stream channels. Hillshade maps have a 3D look to them, although they are actually

HS_10 raster.



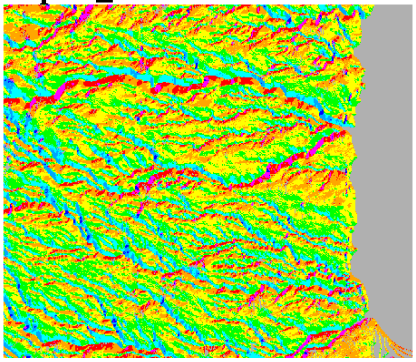
two-dimensional. They make excellent background layers on which to overlay partially transparent layers.

Slope_10 raster.



Next double-click on the **[Slope]** tool, choosing **DEM_10** as the input and **Z:\gis_workshop3\Slope_10** as the output raster. Leave the output measurement in degrees, and click **[OK].** After closing the run window, ArcGIS displays the new slope raster. When calculating slope, ArcGIS computes the maximum change in elevation from each cell to its neighbors. Like the hillshade raster, the slope grid illustrates a sharp contrast between the steep stream channels (shown in red) and the gently sloping areas in between (shown in green). The coastline also exhibits a steep bluff, while the ocean area is flat. Later in this exercise, we will learn how to exclude the ocean from our area of analysis.

Aspect_10 raster.



Lastly, double-click on the **[Aspect]** tool in the Toolbox, selecting **DEM_10** as the input and **Z:\gis_workshop3\Aspect_10** as the output raster. Click **[OK],** and close the run window when completed. The **[Aspect]** Tool computes the steepest downslope direction for each cell, based on the elevations of neighboring cells. The output cells contain direction measured in degrees, starting at 0 degrees for north-facing cells and moving clockwise back to 360 degrees. Flat cells are given a designation of –1.

In general, the **Aspect_10** raster exhibits an easterly aspect, with stream channels areas showing both northern and southern aspects depending on where the cell lies relative to the stream. The offshore cells appear flat as we would expect.

If you have not done so already, be sure to save your map document!

Step 6: Interpolation

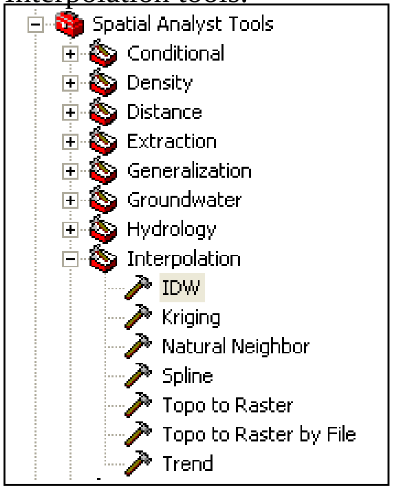
One of the most common ways to create a raster surface is to interpolate from point data. Based on the assumption that geographic values are spatially autocorrelated (i.e., that near points are more alike than distant ones), the process of interpolation applies various mathematical techniques to estimate unknown values. In this step, we will generate a rainfall grid using point data as our starting point.

A few different methods of interpolation are available in Spatial Analyst, including Inverse Distance Weighting (IDW), Kriging, Natural Neighbor, and Spline techniques. The first three methods are weighted average techniques, while the last one relies on curve-fitting techniques. Each method has advantages and disadvantages, depending upon the particular data distributions and trends.

A detailed comparison of the interpolation methods is beyond the scope of this exercise, but I will offer a couple observations about how ArcGIS treats these methods. IDW is the only method that allows users to define barriers, effectively by dividing the area of interpolation into independent regions. Kriging, which uses spatial autocorrelations and sophisticated math to generate weights, works best on normally distributed data. If you want to apply kriging in more advanced ways, the ArcGIS extension Geostatistical Analyst offers additional features. Spline techniques, which rely on curve-fitting techniques, capture high and low points, instead of averaging out the extremes. While spline techniques can estimate values outside the range of input values, they perform poorly on densely distributed points with extreme gradients.

In your map document, add the three data sets: **Rainfall_Pt.shp**, **Study_Area.lyr**, and **Land_Area.lyr**. Make sure the rainfall points are at the top of the Table of Contents. Click of the full extent icon 🌍 to view all of the rainfall sample points. You may want to change the color of the rainfall points to make them more visible.

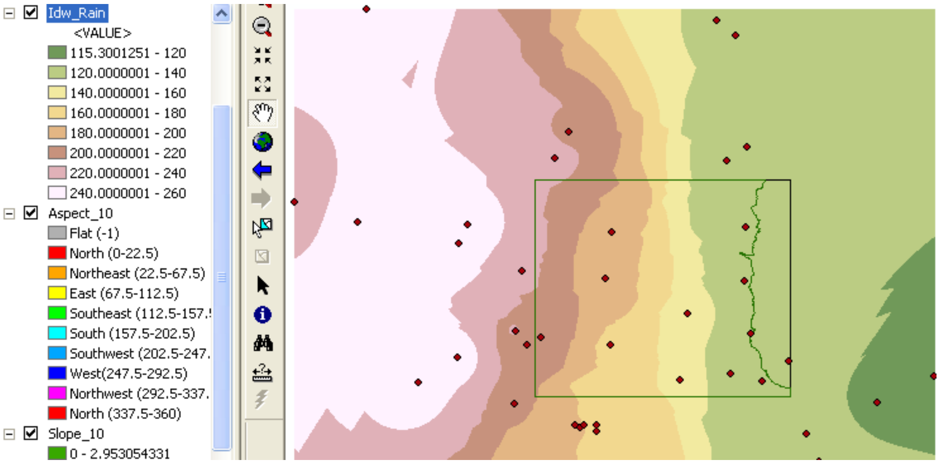
Interpolation tools.



Now we are ready to interpolate a surface from these points. Open the attribute table for **Rainfall_Pt.shp**, and observe that the last column entitled “Rain_inch” contains annual rainfall values in inches. In the **ArcToolbox > Spatial Analyst Tools > Interpolation** folder, open the **[IDW]** tool. Enter the following parameters, and press **[OK].**

Input Point Features:	Rainfall_Pt
Z value field:	Rain_inch
Output raster:	Z:\gis_workshop3\IDW_Rain
Search Radius:	Variable
Number of Points:	6

After the tool runs, close the run window and look at the new layer. Let us symbolize this layer differently. Open the **[Layer Properties]** menu for **IDW_Rain**, and select the **[Symbology]** tab. In the window in the upper right, make sure the “Classified” option is highlighted. Select “8” for the number of classes and press the “Classify” button. In the Classify dialog box, select “Manual” as the method and enter the following break values: 120, 140, 160, 180, 200, 220, 240, and 260. Press **[OK]** twice. Your interpolation surface **IDW_rain** should appear as follows:



To save our symbols, right-click on the layer **IDW_Rain**, choose **[Save as layer file],** navigate to your folder, and name your layer **IDW_Rain.lyr**. Once you save these symbols in a layer file, you may import them and use them to represent other layers. We will try this in a moment.

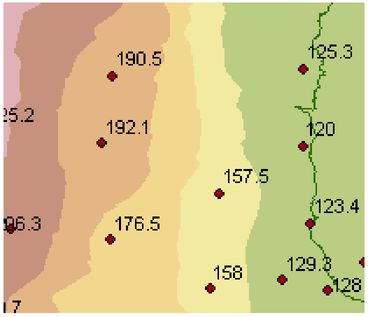
Let us interpolate another rainfall surface, this time using the method of kriging. From the Interpolation set of tools, open the **[Kriging]** tool and choose the following parameters:

Input Point Features:	Rainfall_Pt
Z value field:	Rain_inch
Output raster:	Z:\gis_workshop3\Kriging_Rain
Search Radius:	Variable
Number of Points:	6

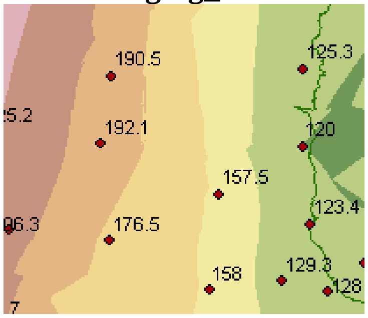
After this interpolation finishes, open the **[Layer Properties]** window for **Kriging_Rain**, and click on the **[Symbology]** tab. Instead of manually setting the symbols, we can import the symbols from the layer **IDW_Rain.lyr** by pressing the **[Import]** button and browsing to the layer we just saved **IDW_Rain.lyr**. Now our two interpolation surfaces have the same categories and color symbols, making them visually comparable.

To visually evaluate surfaces, it is often useful to display and label the input points over the surfaces. Open the **[Labels]** tab under the **[Layer Properties]** menu for **Rainfall_Pt.shp**. Tick the box next to "Label features in this layer", and choose "Rain_inch" as the label field. Now we can see the labeled input points on top of the output surfaces. If you want to view the kriging and IDW surfaces simultaneously side-by-side, you can put them in different data frames and view them in layout mode. Otherwise, you can tick and untick the box next to the kriging surface to view them separately. The two surfaces exhibit similar patterns, although they are distinctly different. Evaluating which surface fits our data better is a complicated and lengthy process that is beyond the scope of this exercise. It is important to note that fitting surfaces typically requires multiple iterations and a systematic analysis of parameters and techniques.

IDW_Rain.



Kriging_Rain.



Let us arbitrarily choose to use the kringing surface for the rest of our analysis. At this point, we can remove the layer **IDW_rain** from our map document to simplify the Table of Contents.

Step 7: Extraction

As you probably noticed, our kriging interpolation surface extends well beyond our study area. In this step, we will look at a couple different ways to extract subsets of data. In a previous workshop, we used the Clip tool (**ArcToolbox** > **Analysis Tools** > **Extract** > **Clip**) to extract part of a data set; however, this tool only operates on vector data, not grids. To clip raster data, you may use a raster clip tool from the following location:

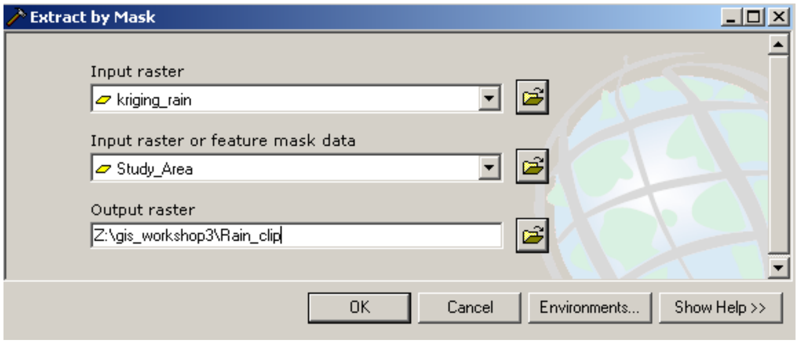
ArcToolbox > Data Management Tools > Raster > Clip

Another way to clip raster data is to use the Extraction tools found under the Spatial Analyst tool set:

ArcToolbox > Spatial Analyst Tools > Extraction

Within Spatial Analyst's tool set, probably the easiest way to limit the extent of our kriging surface is to use the [Extract by Mask] tool. This tool applies the concept of masks, which can be either feature or raster layers in ArcGIS. A mask layer serves as a layer that delimits which cells to include (and exclude) in a particular analysis. If a cell in the mask layer has valid data, then ArcGIS will process that cell; otherwise if the cell has “NoData” in it, then ArcGIS will not process that cell.

Double-click on the [Extract by Mask] tool, enter **Kriging_Rain** as the input raster, **Study_Area** as the input mask, and **Z:\gis_workshop3\Rain_Clip** as the output.



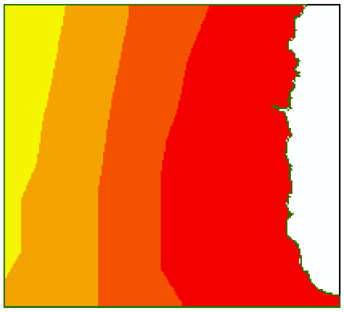
Input raster: kriging_rain

Input raster or feature mask data: Study_Area

Output raster: Z:\gis_workshop3\Rain_clip

After this tool runs, open the **[Layer Properties]** window for **Rain_Clip**, press the **[Symbology]** tab, highlight “Classified”, and import the layer file **IDW_Rain.lyr** to assign the same categories and symbols as the other interpolation surfaces. We now can remove the layer **Kriging_Rain** from our map document, and untick the box next to **Rainfall_pt.shp**.

Solar_clip raster.



Let us practice what we just learned on another grid. Add the layer file **Solar_Grid.lyr** to your map document. Using the [Extract by Mask] tool again, extract the cells from **Solar_Grid.lyr** that fall within the **Land_Area.lyr** and give the output raster the name **Solar_Clip**. Now symbolize the clipped data set by importing the symbols from the file **Solar_Grid.lyr**. You can remove **Solar_Grid** from your map now. Once completed, your clipped raster should resemble the one on the left. Your map may look slightly different, depending on what layers are visible behind the **Solar_Clip** raster.

Step7: Vector to Raster

Our last piece of input data is a shapefile containing land use polygons. Add the layer file **Landuse.lyr** to your map document. Before using this data set, we must convert it to raster format. We can do this from the Spatial Analyst toolbar menu.

Pull down the toolbar menu and select **[Options]**. Under the **[General]** tab, set the working directory to **Z:\gis_workshop3** and coordinate system to be the same as the active data frame. Under the **[Cell Size]** tab, set the analysis cell size to “Same as the layer DEM_10”, or 10 meters. Click **[OK]**.

Next, pull down the Spatial Analyst toolbar again, and select **[Convert] > [Features to Raster].** Choose **Landuse** as the input feature, "LANDCOVER" as the field, 10 as the cell size, and **Z:\gis_workshop3\Landuse_Grid** as the output raster. Click **[OK].**

Input features: Landuse
Field: LANDCOVER
Output cell size: 10
Output raster: orkshop3\Test\Landuse_grid

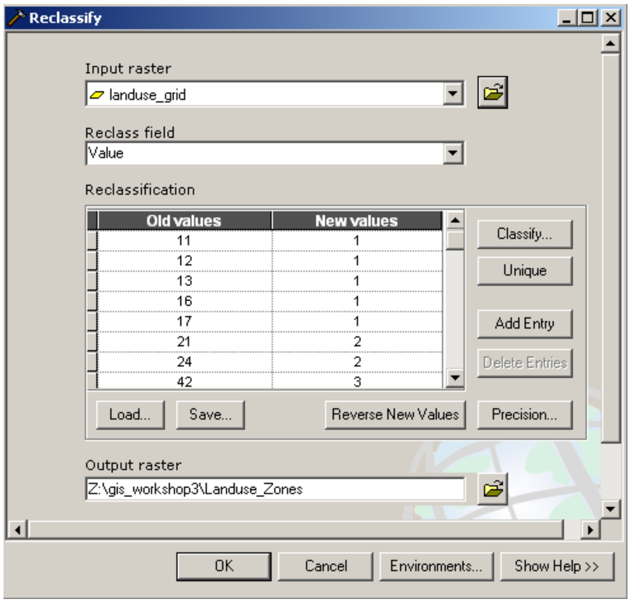
Move the output raster **Landuse_Grid** above **Landuse.lyr** in the Table of Contents. (Beware of quirk: If ArcGIS misnames the grid "**Landuse_Grid-Landuse_Grid**", then click on the name in the Table of Contents and type in "**Landuse_Grid"**). Open the **[Layer Properties]** menu for **Landuse_Grid** and press the **[Symbology]** tab. Notice that this raster is symbolized with 8 unique values.

Step 8: Reclassification

Old Values	New Values	New Label
11-17	1	Urban
21-24	2	Agriculture
42	3	Forest

Instead of our 8 unique land use codes, suppose we want to reclassify our data values into three categories: (1) urban, (2) agriculture, and (3) forest. To convert from the original grid to a new grid, use the mapping table on the left.

Under **Spatial Analyst Tools > Reclass**, open the [Reclassify] tool. Set the input raster to **Landuse_Grid**, the reclass field to "Value", the output raster to **Landuse_Zones**, and type in the mapping table below. To make the table appear as below, you may need to press the button entitled **[Unique].** Press **[OK].**



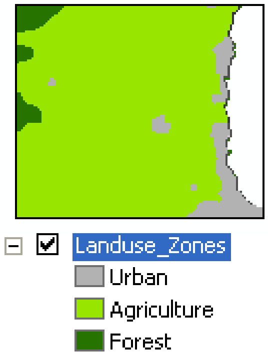
Input raster: landuse_grid
Reclass field: Value

Reclassification

Old values	New values
11	1
12	1
13	1
16	1
17	1
21	2
24	2
42	3

Output raster: Z:\gis_workshop3\Landuse_Zones

Landuse_Zones raster.



Once ArcGIS adds the new grid, you can symbolize and label the three new categories appropriately. Your grid should resemble the one to the left, depending on your symbol selections. You can remove **Landuse_Grid** from your map now.

Remember to save your map document if you have done so recently.

Step9: Raster Math

In the previous steps, we generated, interpolated, extracted, converted and reclassified raster surfaces. Now we are ready to use some of Spatial Analyst's mathematical operations on these grids. Using five of the raster surfaces (**Slope_10, Aspect_10, Rain_Clip, Solar_Clip, and Landuse_Zones**) from our map document, we will use Spatial Analyst to find cells that meet the following criteria:

(1) Mean slope < 25 degrees.
(2) Aspect between 135 and 225 degrees (south-facing).
(3) Rainfall < 180 inches per year.
(4) Solar radiation >= 350 Calories/cm^2 per day.
(5) Land use not equal to 1 (urban).

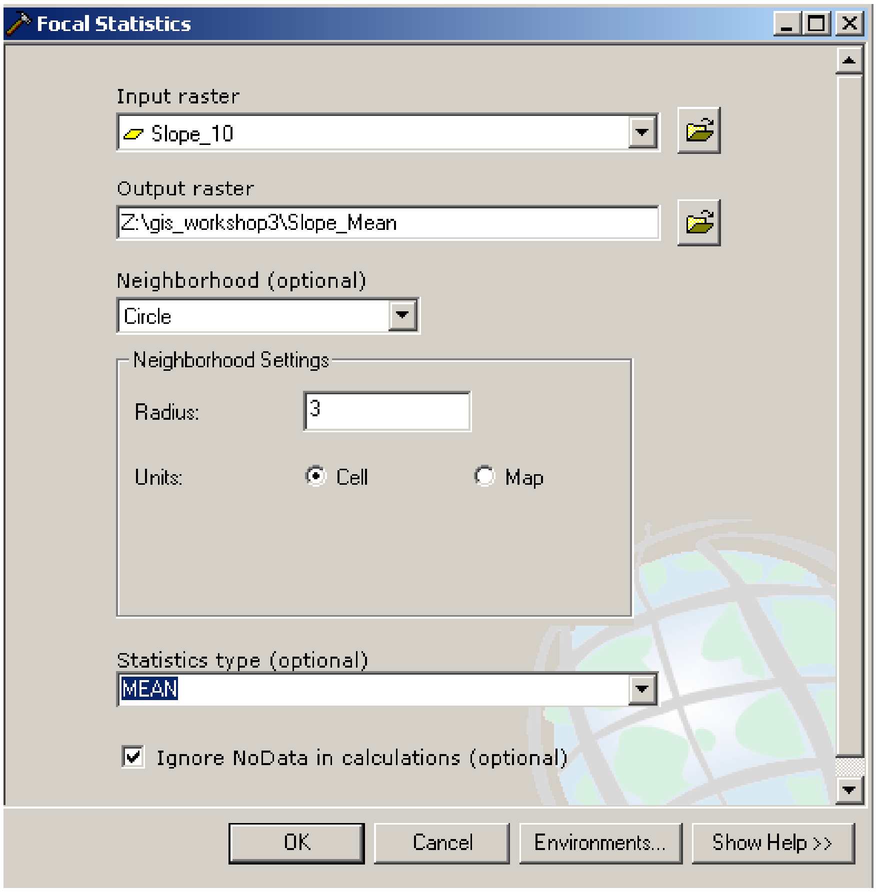
Those cells that meet all the above criteria will be considered suitable for our re-vegetation project. As a first step, we will treat each of these criteria individually, creating a binary (0/1) raster for each one. Binary rasters store values of either 0 or 1 in each cell. In our case, we will store a value of 1 in cells that meet the specified criteria, and a value of 0 in cells that do not. After creating these rasters, we can combine them into a one grid that stores overall suitability.

9A. Mean Slope

Before we make any further calculations, let us define the data set **Land_Area** as our mask to restrict our analysis to cells on land. We can do this from the **[Environmental Settings]** menu. Under the section **[Raster Analysis Settings]**, select **Land_Area** as the mask, and click **[OK].** Now all Toolbox computations will be limited to the land area polygon.

Using the grid **Slope_10**, let us compute a new grid **Slope_Mean** that contains slope values averaged over a 30-meter radius. The average slope grid will smooth out localized irregularities in the topography. This step gives us an opportunity to familiarize ourselves with neighborhood functions and statistics.

To compute mean slope, open **Spatial Analyst Tools > Neighborhood > Focal Statistics**. Complete the dialog box as follows, selecting a circular neighborhood with a radius of 3 cells:



Input raster: Slope_10

Output raster: Z:\gis_workshop3\Slope_Mean

Neighborhood (optional): Circle

Neighborhood Settings

Radius: 3

Units: ● Cell ○ Map

Statistics type (optional): MEAN

☑ Ignore NoData in calculations (optional)

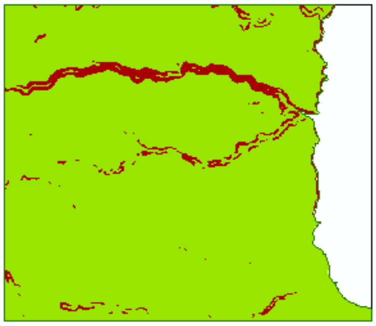
Note that you can work in either cell units (number of cells) or map units (meters). You also can choose the shape of the neighborhood and the type of statistic you wish to calculate. Click **[OK]** and close the run window when complete. ArcGIS adds **Slope_Mean** to your map. Do not worry about the symbols in this layer since it is an intermediate step.

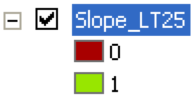
To create a binary grid that delineates slopes less than 25 degrees, open the tool:

Spatial Analyst Tools > **Math** > **Logical** > **Less Than**

In the dialog box, choose **Slope_Mean** as the input raster, “25” as constant value 2, and name the output raster **Slope_LT25**.

Slope_LT25 raster.

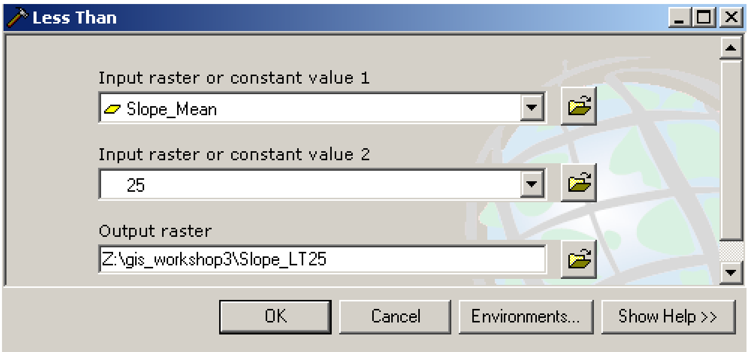




☑ Slope_LT25

🟥 0

🟩 1



Input raster or constant value 1: Slope_Mean

Input raster or constant value 2: 25

Output raster: Z:\gis_workshop3\Slope_LT25

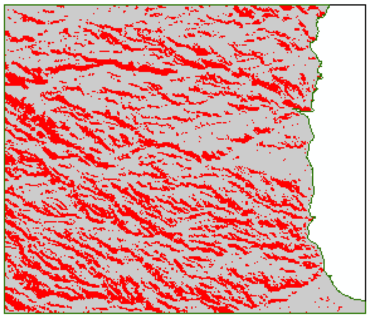
The **[Less Than]** tool creates a binary raster, where cells with a slope less than 25 degrees have a value of 1. Looking at the resulting raster, you can see that most cells, except for the stream ravines and coastal bluffs, have a slope less than 25 degrees. For now, leave the symbols at their randomly selected values.

9B. Aspect

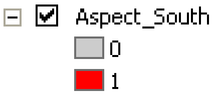
To create a binary grid for southern aspects, we can use the **[Con]** tool from the following location:

Spatial Analyst Tools > **Conditional** > **Con**.

Aspect_South raster.



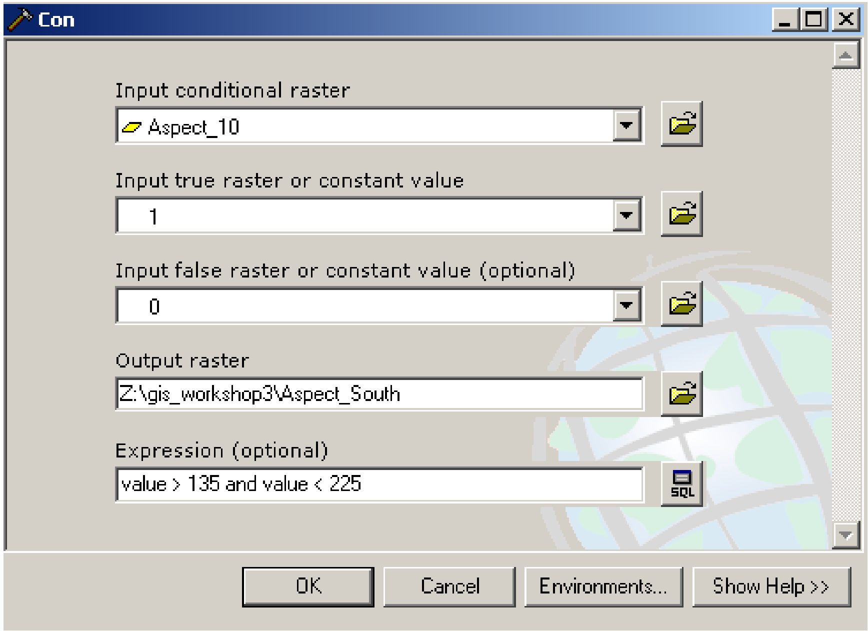
This tool operates as a traditional if-then-else statement. You will need to enter the input raster **Aspect_10**, the output value (1) for cells that meet the condition, the output value (0) for cells that do not meet the condition, the output raster name **Aspect_South**, and the conditional expression. In our case, the condition is for cell values to fall within the range 135 to 225 degrees (see below).



☑ Aspect_South

⬜ 0

🟥 1



Input conditional raster: Aspect_10

Input true raster or constant value: 1

Input false raster or constant value (optional): 0

Output raster: Z:\gis_workshop3\Aspect_South

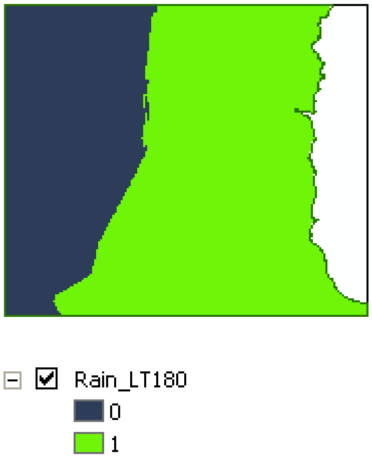
Expression (optional): value > 135 and value < 225

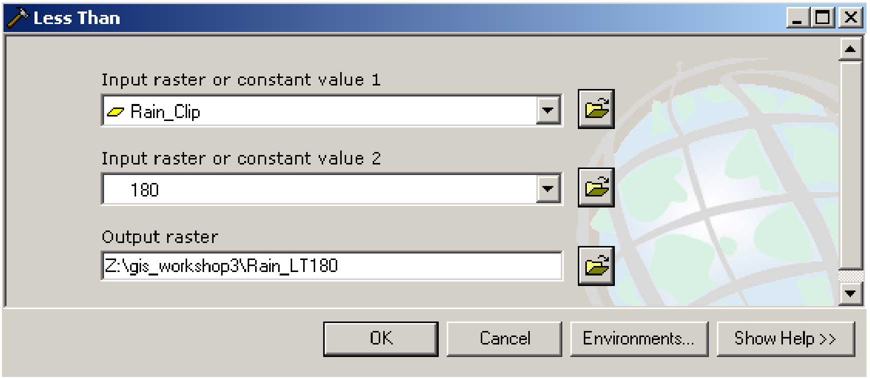
From the resulting raster, you can see that many of the cells meeting this condition lie on the north side of stream gulches.

9C. Rainfall

To create a binary grid for rainfall, we can use the **[Less Than]** tool as we did in Step 9A, except this time choose **Rain_Clip** as the input raster, “180” as constant value 2, and **Rain_LT180** as the output. The resulting grid delimits the lower elevations with less than 180 inches of annual rain.

Rain_LT180 raster.





Input raster or constant value 1: Rain_Clip

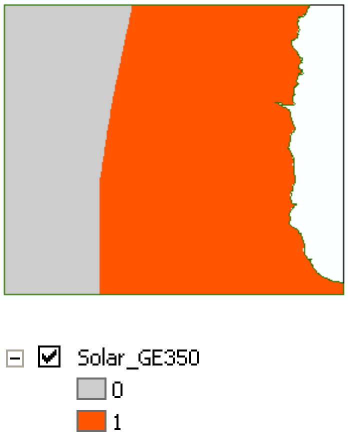
Input raster or constant value 2: 180

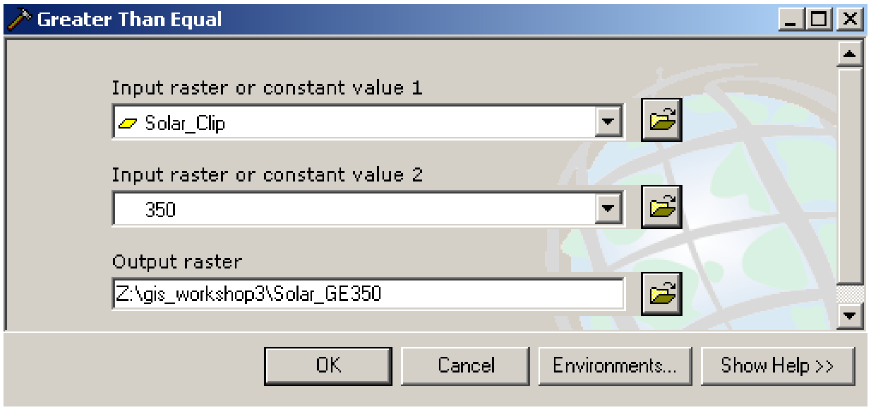
Output raster: Z:\gis_workshop3\Rain_LT180

9D. Solar Radiation

This step is similar to the last, except this time we will use the **[Greater Than Equal]** tool from the same tool set. Enter the parameters below, naming the output **Solar_GE350**, and click **[OK].**

Solar_GE350 raster.





Input raster or constant value 1: Solar_Clip

Input raster or constant value 2: 350

Output raster: Z:\gis_workshop3\Solar_GE350

Like the rainfall pattern, the lower elevation cells meet the condition while the higher and cloudier areas do not.

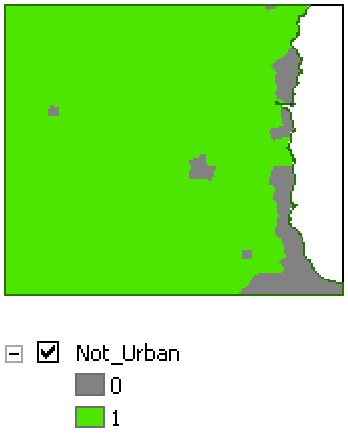
9E. Land Use.

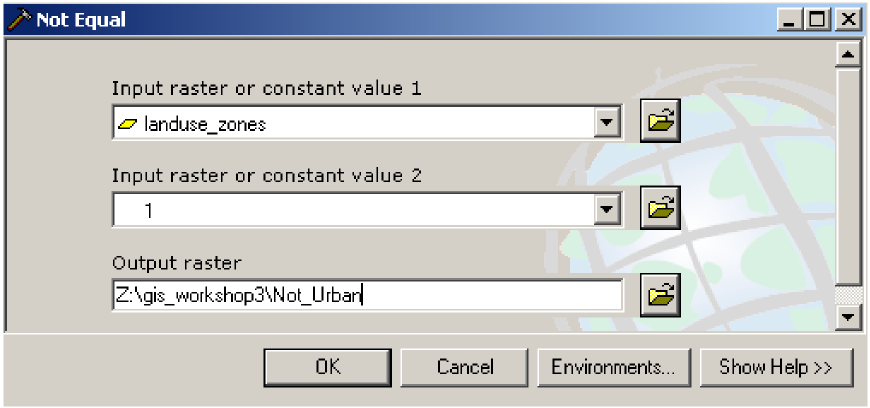
Finally, to compute the binary raster for land use, we can use the tool:

Spatial Analyst Tools > **Math** > **Logical** > **Not Equal**.

Enter the parameters below and click **[OK].**

Not_Urban raster.





Input raster or constant value 1: landuse_zones

Input raster or constant value 2: 1

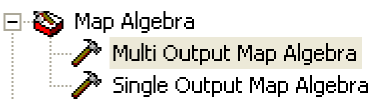
Output raster: Z:\gis_workshop3\Not_Urban

The output raster **Not_Urban** separates cells into urban (1) and non-urban (0) areas.

Step 10: Map Algebra

One of the most powerful aspects of Spatial Analyst is its map algebra language. This language allows you to manipulate and process grids, much the same way that regular algebra allows you to manipulate variables and numbers. Map algebra processing includes: basic operations such as addition, subtraction, and multiplication; arithmetic functions such as absolute value and truncation of decimal places; trigonometric functions such as sine and inverse tangent; logarithms, square roots, and powers; conditional expressions; neighborhood functions and statistics; and geographic functions such as slope and hillshade.

ArcToolbox.

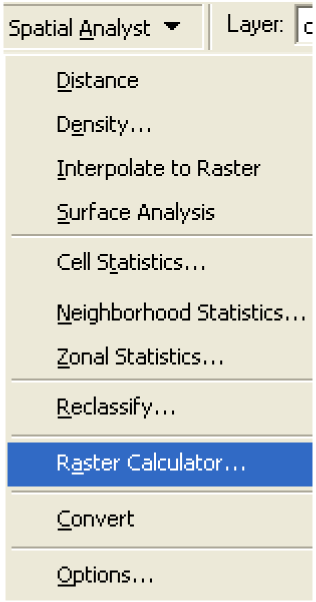


Throughout this exercise, we have used various tools from ArcToolbox and the toolbar to process our grids. Instead of using these tools, we could have performed virtually all of these tasks using Spatial Analyst's map algebra language.

How can we access this language? ArcGIS provides four ways to access map algebra: two ways from the Toolbox, one from the Spatial Analyst toolbar, and another from the ArcInfo command prompt. We will ignore the last method because it is mostly useful for programmers who want to automate lengthy routines.

In ArcToolbox, under **Spatial Analyst Tools > Map Algebra**, you will find two map algebra tools. As the names imply, one allows for multiple statements and outputs, while the other allows for single expressions and outputs. Until you become comfortable with the syntax of map algebra, it makes sense to use the **[Single Output Map Algebra]** tool, executing one statement at a time. This makes it easier to find and correct syntax errors.

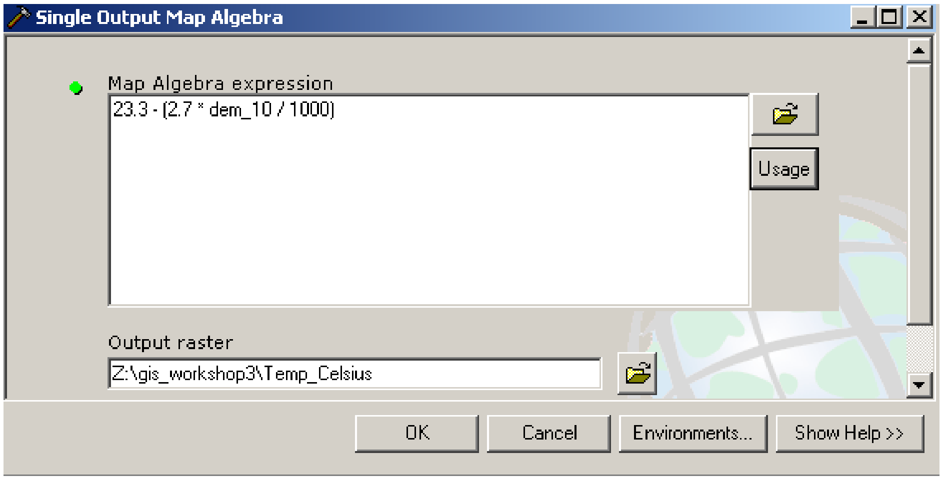
Spatial Analyst Toolbar.



Open the **[Single Output Map Algebra]** tool, and then press the **[Usage]** button to view the list of operations and functions. Notice that the list includes hillshade, slope, aspect, kriging, greater than, reclass, etc. Just for fun, let us look at how map algebra syntax works.

Suppose we want to use the mean sea-level temperature (23.3°C) and elevation (**DEM_10**) to make a rough estimate of the average temperature in each cell, based on environmental lapse rates. In the **[Single Output Map Algebra]** tool, we can set the output raster to **Temp_Celsius** and type in the right side of the following equation in the expression window:

Temp_Celsius = 23.3 - (2.7 * **DEM_10** / 1000)



Map Algebra expression
23.3 - (2.7 * dem_10 / 1000)

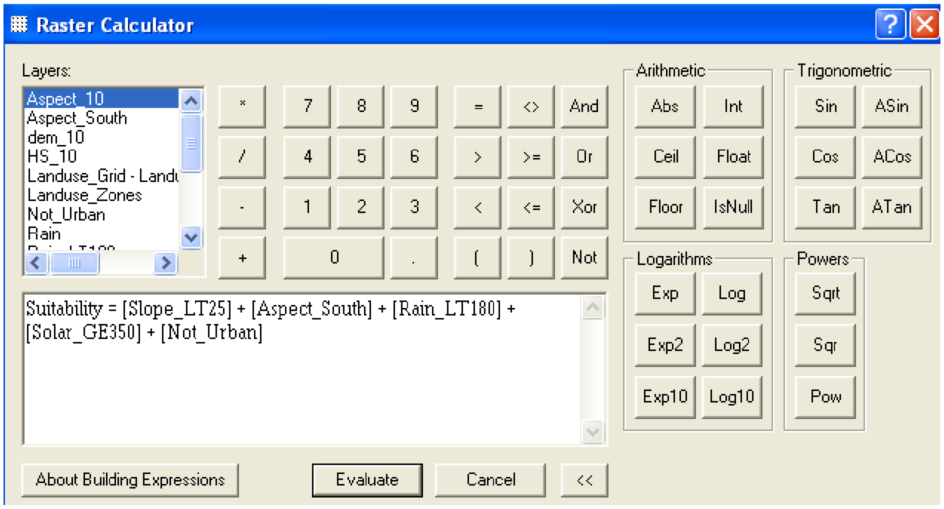
Output raster
Z:\gis_workshop3\Temp_Celsius

This tool executes the above algebraic equation on a cell-by-cell basis, assigning temperatures to each cell, and producing a new grid that shows how temperature declines with elevation. Untick the box next to the grid **Temp_Celsius** to make it invisible.

Now let us use the toolbar's **[Raster Calculator]** to finish our project. We will use our five binary grids (**Slope_LT25, Aspect_South, Rain_LT180, Solar_GE350, and Not_Urban**) to identify cells that meet all five criteria. Since our binary grids delimit suitable areas with a value of 1 and unsuitable areas with a zero, we can sum these grids on a cell-by-cell basis to get an overall measure of suitability. In the summed grid, those cells that sum to five meet all five criteria.

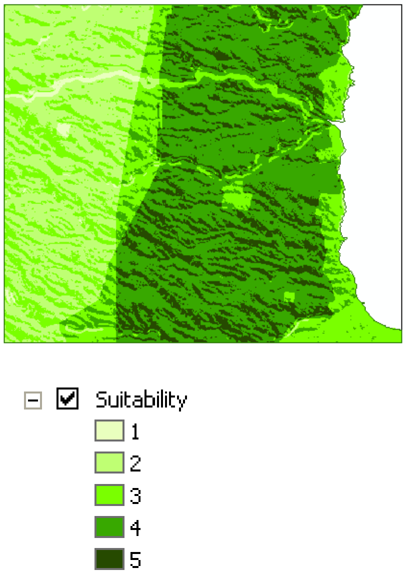
From the Spatial Analyst toolbar, open the **[Raster Calculator],** and press the expand button >> to view additional functions. In the expression window, enter the equation below (either manually or using buttons) and press **[Evaluate]**:

Suitability = [Slope_LT25] + [Aspect_South] + [Rain_LT180] + [Solar_GE350] + [Not_Urban]



```
Suitability = [Slope_LT25] + [Aspect_South] + [Rain_LT180] +
[Solar_GE350] + [Not_Urban]
```

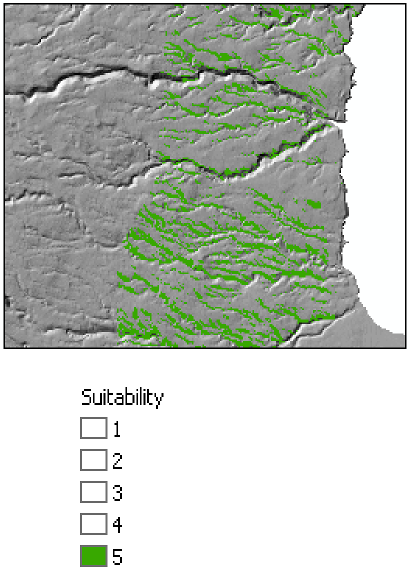
Suitability raster.



This expression creates a new raster called **Suitability,** with values ranging from 1 to 5. You can view the exact distribution of these values in the attribute table. The map on the upper left shows this raster, symbolized from light to dark, with the darkest areas representing the most suitable cells.

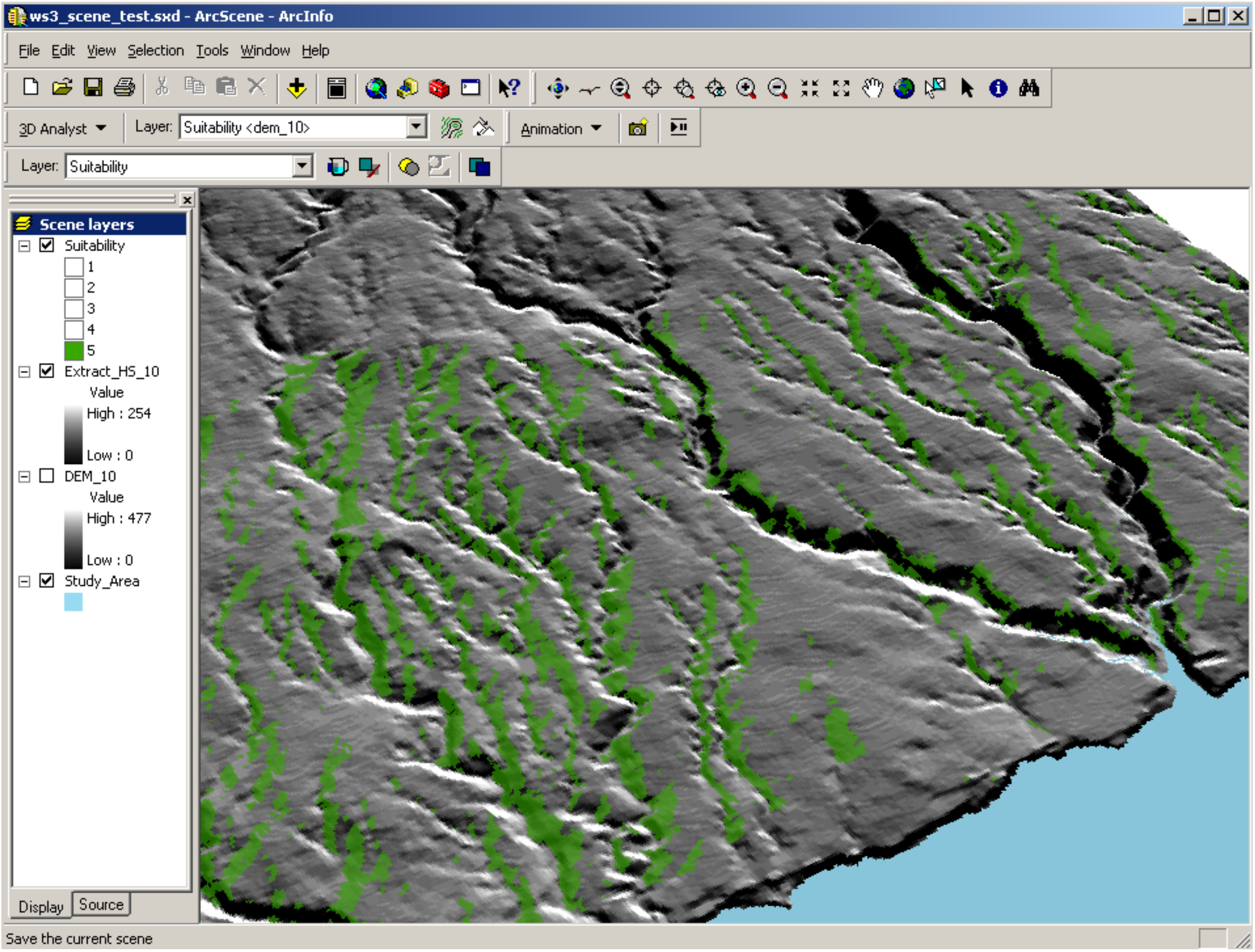
Another way to view this result is to overlay **Suitability** on top of the hillshade raster **HS_10**. Untick the boxes next to every layer except **Suitability** and **HS_10**. If you want, you can use the **[Extract by Mask]** tool, along with the **Land_Area** layer, to create a subset of the hillshade layer that excludes the ocean.

Suitability raster.



Since we are interested primarily in cells with a value of 5, we can make the other categories invisible. For **Suitability**, open the **[Layer Properties]** menu, and symbolize values of 5 in “leaf green” and other values as “hollow” or “no color”. Under the **[Display]** tab for **Suitability**, set the transparency to 40% to allow the hillshade layer to show through partially. The map should appear similar to the adjacent map.

We also can use ArcScene to view our results in 3D. Enable the 3D Analyst extension and open ArcScene. Add **Suitability**, **HS_10** (or your extracted hillshade layer if you created one), and **DEM_10** to a new ArcScene document. In the **[Layer Properties]** menus for **Suitability** and **HS_10**, set the source of base heights to **DEM_10**. In the Table of Contents, untick the box next to **DEM_10** to make it invisible. Now symbolize the grids appropriately, as we did in ArcMap. For the hillshade layer, under the **[Rendering]** tab, set the draw priority to 2 to ensure that the hillshade layer appears behind **Suitability**. You may want to add the **Study_Area** shapefile to your document, and symbolize it in blue to represent the ocean. The map below shows a close-up perspective of these layers in ArcScene.



Layer: Suitability <dem_10>

Layer: Suitability

Save the current scene

Congratulations! You are now ready to apply Spatial Analyst to your own research.

Acknowledgements
Lars Brabyn and Paul Beere, University of Waikato
DBEDT (http://www.state.hi.us/dbedt/gis/download.htm)
ESRI Virtual Campus
NOAA (http://biogeo.nos.noaa.gov/products/mapping/dems/)