

## Cookbook 16 October 2013

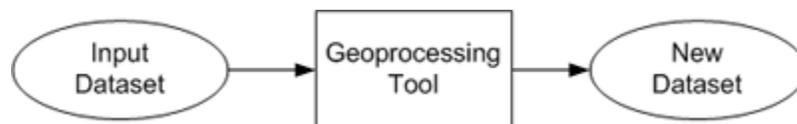
### *Raster Data and Spatial Analyst (Part 2)*

#### Overview

1. Raster Symbology
2. Raster Conversion: Raster to Vector, Vector to Raster
3. Raster/DEM Conversion: Contour
4. DEM Derivatives: Slope and Aspect
5. DEM Derivatives: Reclassify
6. DEM Derivatives: Raster Calculator
7. Many More Tools – Explore!

#### **What is Geoprocessing?**

A typical geoprocessing tool performs an operation on an ArcGIS dataset (such as a feature class, raster, or table) and produces a new dataset as the result of the tool = data transformation. Each geoprocessing tool performs a small yet essential operation on geographic data, such as projecting a dataset from one map projection to another, adding a field to a table, or creating a buffer zone around features. When use together you have spatial analysis!



#### **More Information**

- What is geoprocessing?  
[http://resources.arcgis.com/en/help/main/10.1/index.html#/What\\_is\\_geoprocessing/002s00000001000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/What_is_geoprocessing/002s00000001000000/)

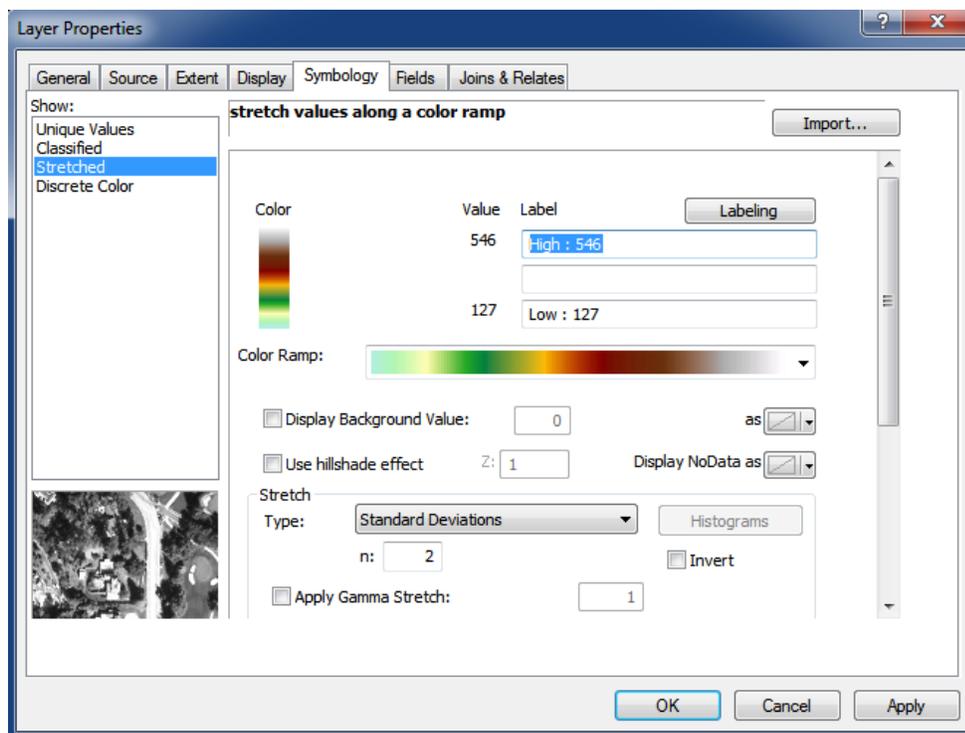
## 1) Raster Symbology

You can display a raster in four different ways...depending on what is the most meaningful.

1. Unique Values. Here, a color is assigned to each unique grid value. For example you have an elevation range between 127 and 546 m, so you have 420 unique elevation values in 1 m increments. This is useful for certain types of classified grids, but not for 420 unique values!
2. Classified. Here, the data between 127 and 546 m are classified using different classification methods, number of classes, and color bars. This may be useful for showing the data, for example, in 50 m intervals.
3. Stretched = the default for grids. Here the data range is stretched along a color ramp. This often gives you the best looking grids.
4. Discrete Color. That's similar to the Unique Values, but you specify how many colors you want to use. This may be useful for certain types of grids, but probably not for a DEM.

***The same "Lying with Maps" Rule apply for Grids!***

1. Use meaningful colors.
2. Use the most appropriate method for your particular application.
3. For DEMs: Classified into equal elevation zones and Stretched are usually the most appropriate.
4. For other grids: You make a deliberate choice!

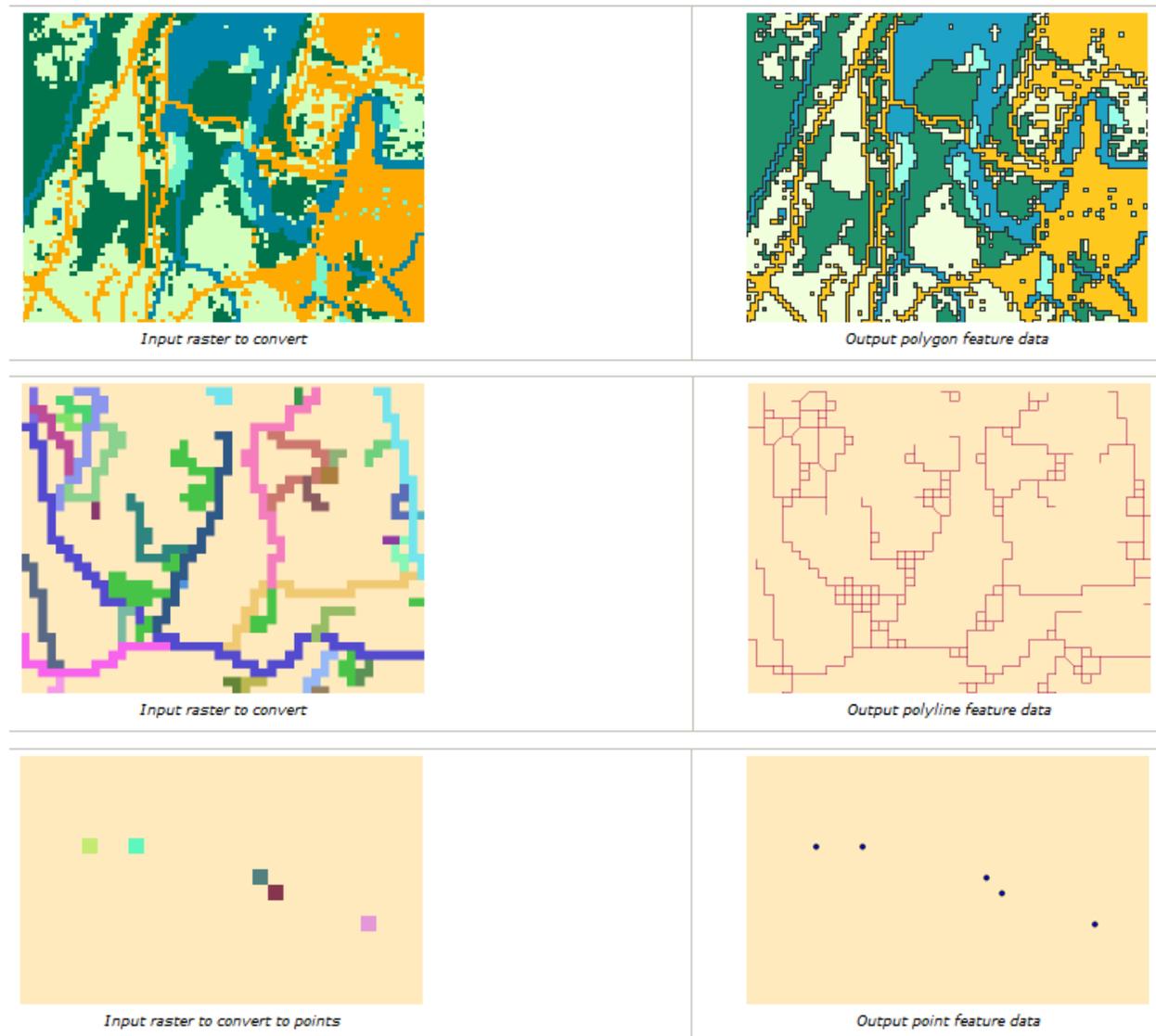


## 2) DEM Conversion: Raster to Vector, Vector to Raster

### 2.1) You want to convert a raster to vector

- You work with a wind speed grid and select all grid cells with a wind speed 30 m above the ground of 5 m/s or more. Now you may want to export these grid cells as polygons for additions analysis such as buffering, union, intersect, etc.
- You have selected all elevations above (or below) a certain elevation. Now you may want to export these grid cells as polygons for additions analysis such as buffering, union, intersect, etc.

You can convert raster data to polygon, line, or point features. Select the appropriate feature type based on what the raster data represents.



When you convert a raster dataset containing area features, each group of contiguous cells with the same values converts to a polygon. Arcs are created from cell borders in the raster. NoData cells in the input raster do not become polygons in the output.

When you convert a raster dataset containing linear features, a polyline is created from each cell in the input raster dataset. The polyline is positioned so that it passes through the center of each cell. NoData cells in the input raster dataset do not become features in the output.

When you convert a raster dataset containing point features, each cell in the input raster dataset converts to a point in the output. Each new point is positioned at the center of the cell it represents. NoData cells do not convert to points.

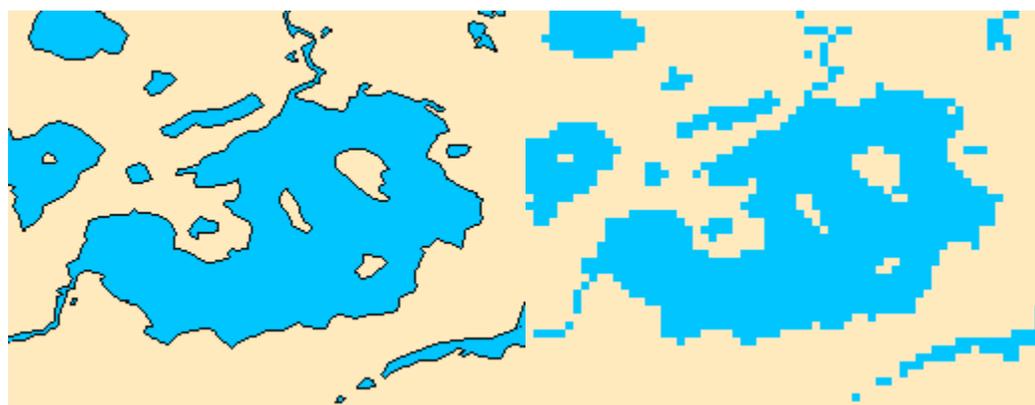
### More Information

- About converting from raster data  
[http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/About\\_converting\\_from\\_raster\\_data/001200000000n000000/](http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/About_converting_from_raster_data/001200000000n000000/)
- An overview of the From Raster toolset  
[http://resources.arcgis.com/en/help/main/10.1/index.html#/An\\_overview\\_of\\_the\\_From\\_Raster\\_toolset/0012000000004000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/An_overview_of_the_From_Raster_toolset/0012000000004000000/)

## 2.2) You want to convert a vector to raster

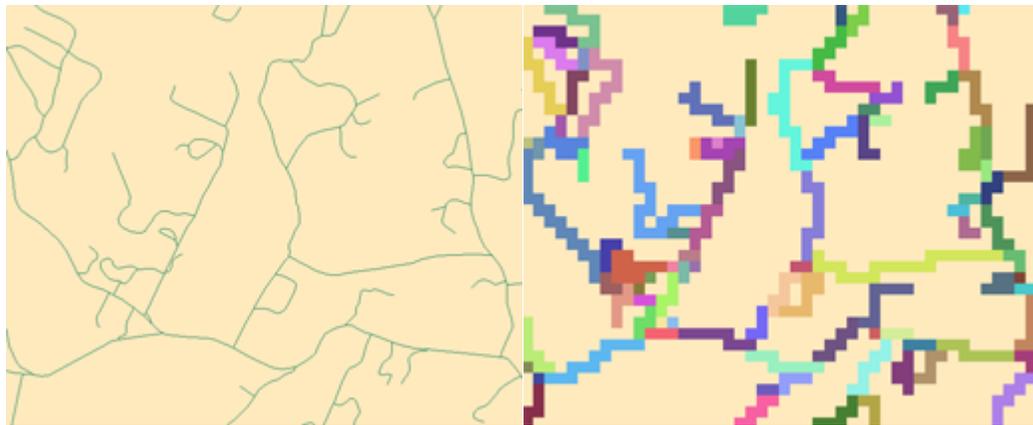
You can convert any feature class (polygon, polyline, or point) to a raster with the Feature To Raster tool.

- When you convert polygons, cells are usually given the value of the polygon found at the center of each cell.
- When you convert polylines, cells are usually given the value of the line that intersects each cell. Cells that are not intersected by a line are given the value of NoData.
- When you convert points, cells are usually given the value of the points found within each cell. Cells that do not contain a point are given the value of NoData.



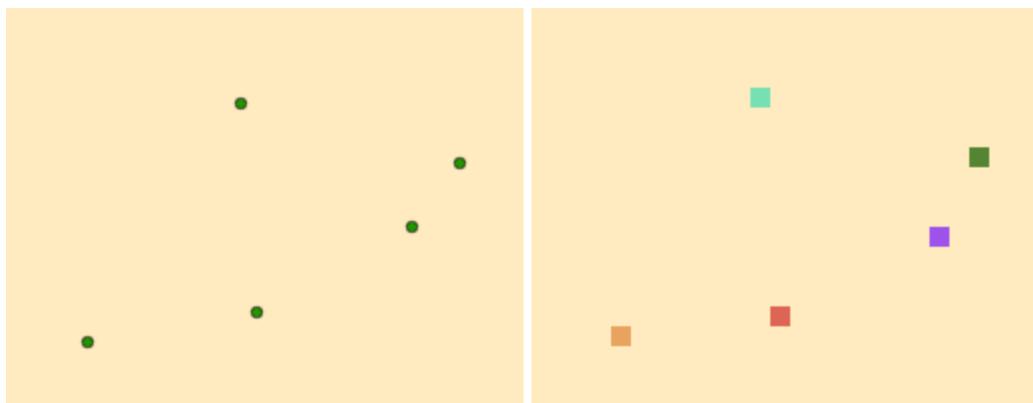
Input Polygons

Output Raster



Input Polylines

Output Raster



Input Points

Output Raster

### More Information

- Converting features to raster data  
[http://resources.arcgis.com/en/help/main/10.1/index.html#/Converting\\_features\\_to\\_raster\\_data/001200000033000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/Converting_features_to_raster_data/001200000033000000/)
- An overview of the To Raster toolset  
[http://resources.arcgis.com/en/help/main/10.1/index.html#/An\\_overview\\_of\\_the\\_To\\_Raster\\_toolset/00120000002r000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/An_overview_of_the_To_Raster_toolset/00120000002r000000/)

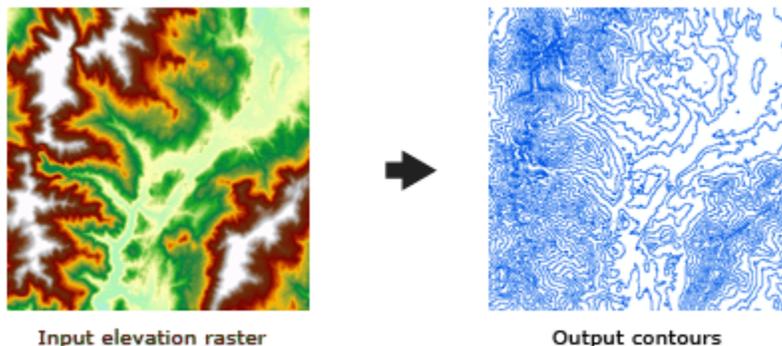
### **3) Raster/DEM Conversion: Contour**

Contours are lines that connect locations of equal value in a raster dataset that represents continuous phenomena such as elevation, temperature, precipitation, pollution, or atmospheric pressure. The line features connect cells of a constant value in the input. Contour lines are generally referred to as isolines but can also have specific terms depending on what is being measured. Some examples are isobars for pressure, isotherms for temperature, and isohyets for precipitation.

The distribution of the contour lines shows how values change across a surface. Where there is little change in a value, the lines are spaced farther apart. Where the values rise or fall rapidly, the lines are closer together.

**Contour creation tools:** Contour, Contour List, Contour with Barriers

These tools create a polyline feature dataset from an input raster.



#### **Why create contours?**

By following the polyline of a particular contour, you can identify which locations have the same value. Contours are also a useful surface representation, because they allow you to simultaneously visualize flat and steep areas (distance between contours) and ridges and valleys (converging and diverging polylines).

The example above shows an input elevation dataset and the output contour dataset. The areas where the contours are closer together indicate the steeper locations. They correspond with the areas of higher elevation (in white on the input elevation dataset).

#### **More Information**

- How Contouring works  
[http://resources.arcgis.com/en/help/main/10.1/index.html#/How\\_Contouring\\_works/009z000000vq000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/How_Contouring_works/009z000000vq000000/)
- An overview of the Surface toolset  
[http://resources.arcgis.com/en/help/main/10.1/index.html#/An\\_overview\\_of\\_the\\_Surface\\_tools/009z000000tq000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/An_overview_of_the_Surface_tools/009z000000tq000000/)

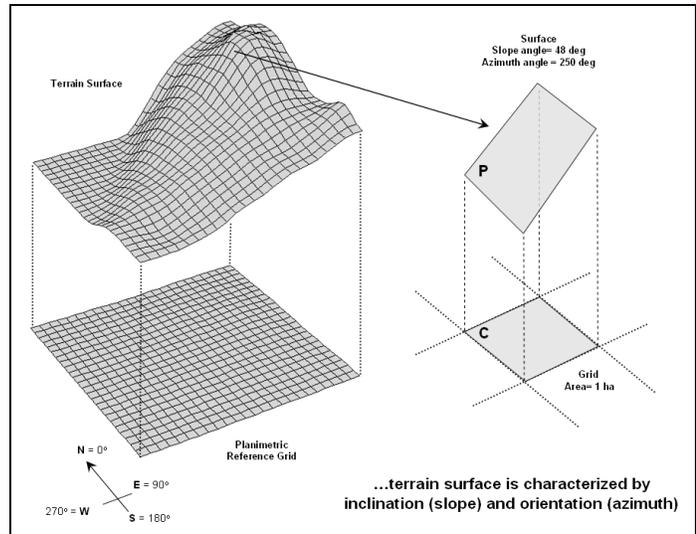
## 4) DEM Derivatives: Slope and Aspect

Here we are deriving new raster data based on our input raster, in this case a DEM.

Slope = the steepness or pitch of each DEM cell between 0° (horizontal) and 90° (vertical).

Aspect = the direction that each grid cell is facing between 0° and 360° (azimuth or compass direction).

Horizontal areas are coded -1 for aspect.

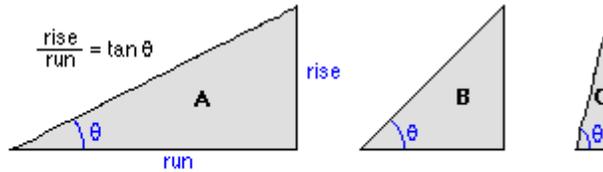


### 4.1) Slope

The Slope tool is most frequently run on an elevation dataset, as the following diagrams show. Steeper slopes are shaded red on the output slope raster.

Degree of slope =  $\theta$

Percent of slope =  $\frac{\text{rise}}{\text{run}} * 100$



Degree of slope =

Percent of slope =

30

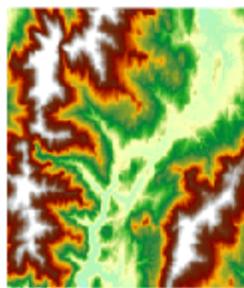
58

45

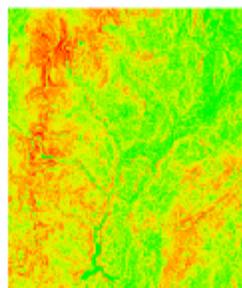
100

76

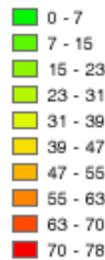
373



Input elevation raster



Output slope raster  
(in degrees)

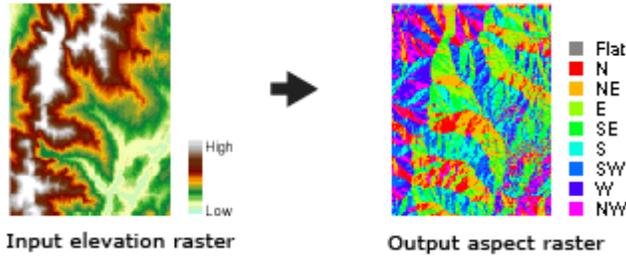
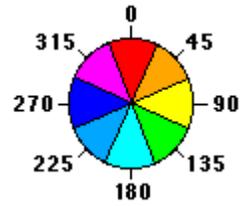


See

[http://resources.arcgis.com/en/help/main/10.1/index.html#/How\\_Slope\\_works/009z000000vz000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/How_Slope_works/009z000000vz000000/) for more information about the Slope tool

## 4.2) Aspect

The values of each cell in the output raster indicate the compass direction that the surface faces at that location. It is measured clockwise in degrees from 0 (due north) to 360 (again due north), coming full circle. Flat areas having no downslope direction are given a value of -1.



See

[http://resources.arcgis.com/en/help/main/10.1/index.html#/How\\_Aspect\\_works/009z000000vp000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/How_Aspect_works/009z000000vp000000/) for more information about the Aspect tool.

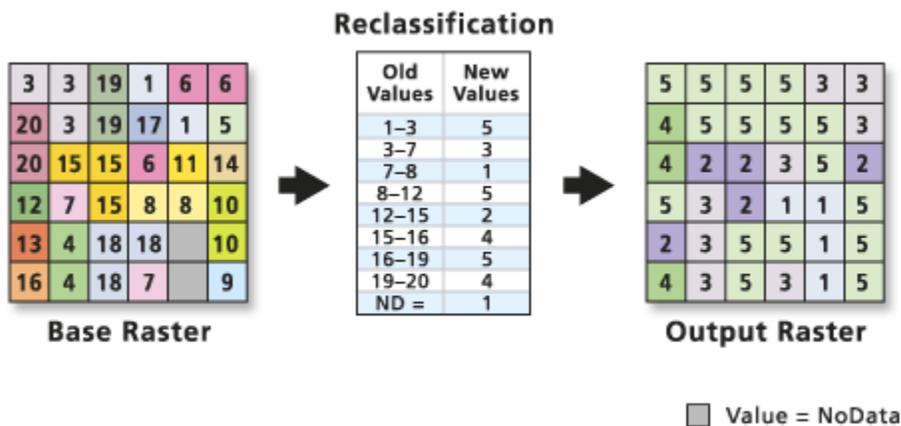
## 4.3) Your Turn: Adams Slope and Aspect

1. Open your copy of the Adams DEM.
2. Run the Slope and Aspect tools on the Adams DEM and make sure you save the resulting grids to a logical location!
3. Explore the resulting grids and adjust the Symbology.

Each grid cells in the resulting grids now contains either the slope angle or the aspect of the grid cell.

## 5) DEM Derivatives: Reclassify

Sometimes it is beneficial to *reclassify* a grid into a new grid to *simplify* the information.



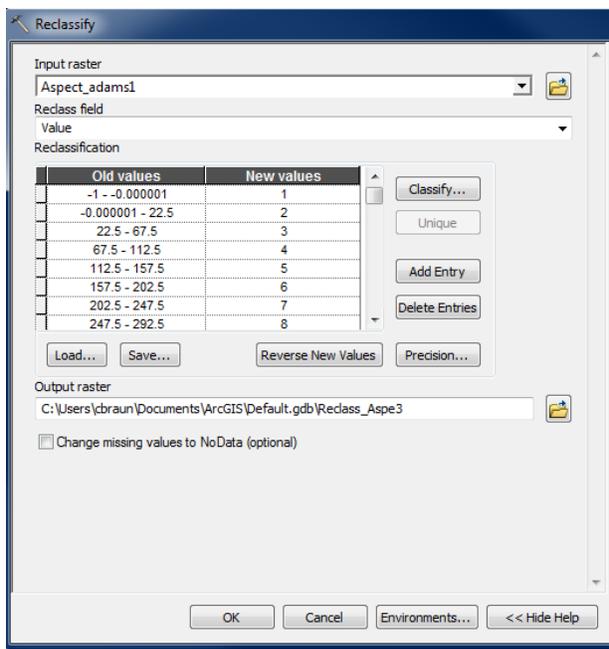
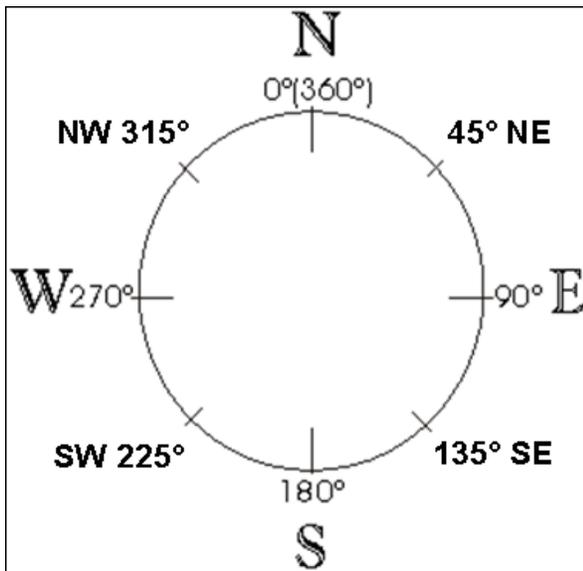
**Example: Aspect Grid**

- When you create an aspect grid from a DEM...the aspect grid will contain the aspect for each grid cell as an angle between 0 and 360°.
- Flat cells (slope = zero) have no aspect and are assigned a -1 value.

That's too detailed for most applications!

We are more often interested in the 4 or 8 main aspects of each individual grid cell.

Here, you reclassify the *original* aspect grid into a new *simplified* grid that represents meaningful aspect classes, such as northerly, easterly, etc. Each new aspect class receives a unique code that is used to control the displayed color – choose meaningful colors for your aspect classes.



Aspect (raw)	Reclass Classes	Reclass Code	Color
-1	No aspect (= flat, slope = 0°)	1	Blue
0 to 45°	Northerly	2	Grey
45 to 135°	Easterly	3	Red
135 to 225°	Southerly	4	Yellow
225 to 315°	Westerly	5	Green
315 to 360°	Northerly (again)	2	Grey

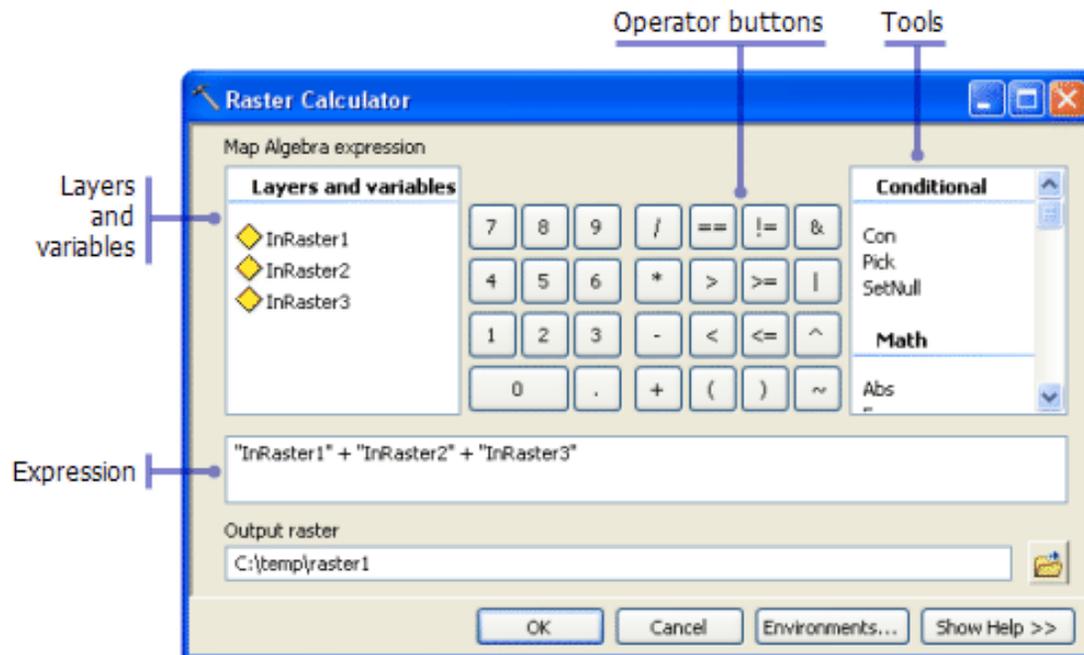
***Make sure you save the resulting grid to a logical location!***

## More Information

- Understanding reclassification  
<http://resources.arcgis.com/en/help/main/10.1/index.html#//009z000000st000000>
- An overview of the Reclass tools  
[http://resources.arcgis.com/en/help/main/10.1/index.html#//An\\_overview\\_of\\_the\\_Reclas\\_tools/009z000000sm000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#//An_overview_of_the_Reclas_tools/009z000000sm000000/)
- Reclass by ranges of values  
<http://resources.arcgis.com/en/help/main/10.1/index.html#//009z000000sw000000>

## 6) DEM Derivatives: Raster Calculator

Raster Calculator is a very powerful tool to make calculations on a single grid or on multiple grids. These input grids can be the original grids, the derived grids, logical grids, or output grids from previous Raster Calculator map algebra.



### Important!

- When multiple operators are used in an expression, they are not necessarily executed in left-to-right order. The operator with the highest precedence value will be executed first. For more information on operator precedence, see operator precedence table in the Tool Help. You can use parentheses to control the execution order.

- Boolean (~, &, ^, |) operators have a higher precedence level than Relational (<, <=, >, >=, ==, !=) operators. Therefore, when Boolean operators are used in the same expression as Relational operators, the Boolean operators will be executed first. To change the order of execution, use parentheses

When building expressions in the Raster Calculator tool, clicking and double-clicking on the various layers, variables, buttons, and tool names available in the dialog box will help you to avoid syntax errors that may otherwise be made while typing!

The Map Algebra used in Raster Calculator has a syntax, or a set of rules, that must be followed to create a valid expression. If these rules are not adhered to, the expression may be invalid and will not execute, or you may get results you did not expect.

The resulting grid of Boolean expressions is a new grid with two values: 1 if the condition was met, 0 is the condition was not met.

### More Information

- How Raster Calculator works  
[http://resources.arcgis.com/en/help/main/10.1/index.html#/How\\_Raster\\_Calculator\\_works/009z000000z8000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/How_Raster_Calculator_works/009z000000z8000000/)
- Building expressions in Raster Calculator  
[http://resources.arcgis.com/en/help/main/10.1/index.html#/Building\\_expressions\\_in\\_Raster\\_Calculator/009z000000zn000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/Building_expressions_in_Raster_Calculator/009z000000zn000000/)
- Raster Calculator (Spatial Analyst)  
[http://resources.arcgis.com/en/help/main/10.1/index.html#/Raster\\_Calculator/009z000000z7000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/Raster_Calculator/009z000000z7000000/)

### Your Turn (Part 1)

Using Raster Calculator – find all areas in Adams that match the criteria:

- All elevations in Adams above 1,000 m.
- All flat aspects in Adams.
- All slopes in Adams steeper than 20° and above 500 m.

### Your Turn (Part 2)

Find all areas of Adams (MA) above 500 m in elevation, face east, and are pitched less than 20°.

**Original Grid: DEM of Adams.** Now you create 3 derivative grids using Raster Calculator:

Grid 1	Condition 1	elevation >500 m	1 = true, 0 = false
Grid 2	Condition 2	slope angle < 20°	1 = true, 0 = false
Grid 3	Condition 3	easterly aspect (45° to 135°)	1 = true, 0 = false

Final step you add all three logical grids together – the final grid contains as grid values 0, 1, 2, 3.

- 3 All 3 conditions are met!
- 2 Only 2 conditions are met, but we do not know which two!
- 1 Only 1 condition is met, but we do not know which one!
- 0 None of the 3 conditions is met!

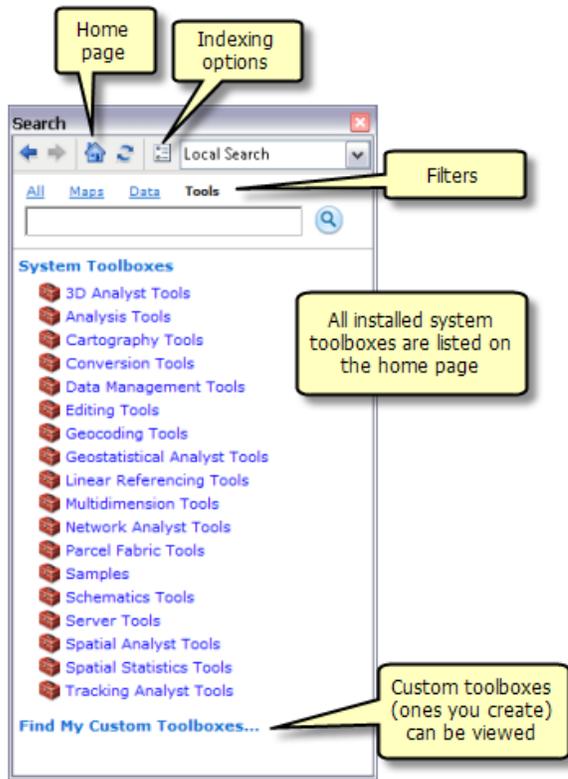
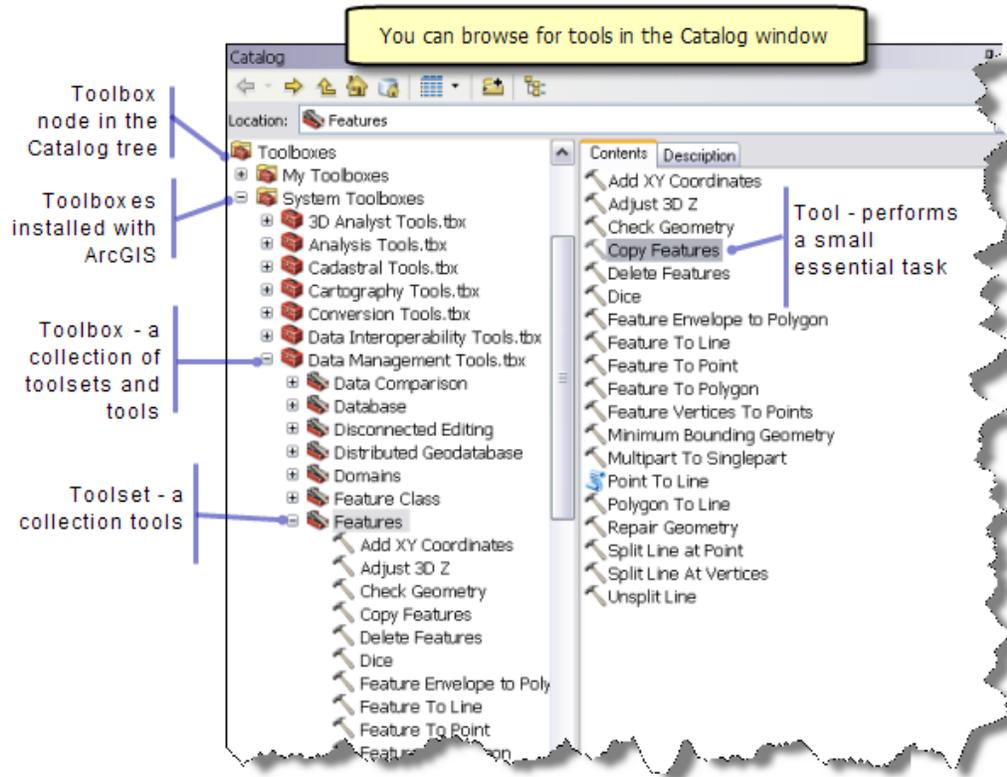
➔ *Always explore the results to see if they make sense!*

## 7) Many more Tools – Explore!

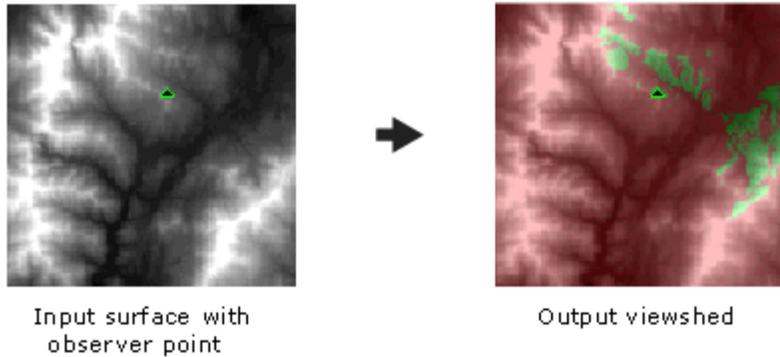
Search for Tools in the ArcGIS Resource Center or ArcGIS Help!



## Browse for Tools in ArcMap or ArcCatalog!



For example, you may want to determine the viewshed = the cells in an input raster that can be seen from one or more observation locations.

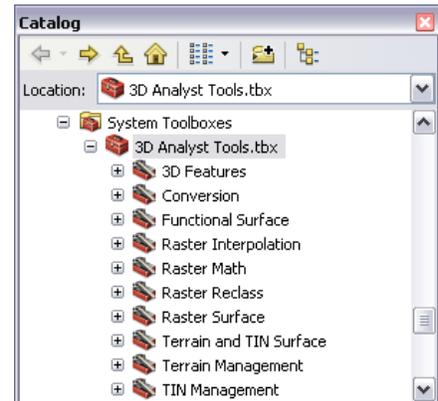


Simply search for Viewshed in the ArcGIS Resource Center or the ArcGIS Help and you find all the information you need to understand and use the Viewshed tool:

- How Viewshed works.
- How to use the Viewshed tool and how to set the tool parameters.

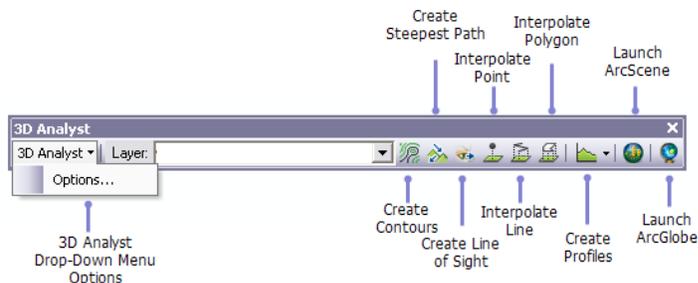
### 7.1) 3D Analyst Tools

You can use 3D Analyst to understand and sculpt terrain to allow for events such as water runoff and flooding. Mining companies, geologists, and researchers can use 3D Analyst capabilities to learn more about subsurface geological bodies, such as the 3D intersections of deviated boreholes and subsurface strata. Local governments, city planners, and military organizations can leverage 3D Analyst to ask complex 3D questions about man-made structures, especially in regard to both current and proposed lines of sight within an urban area.



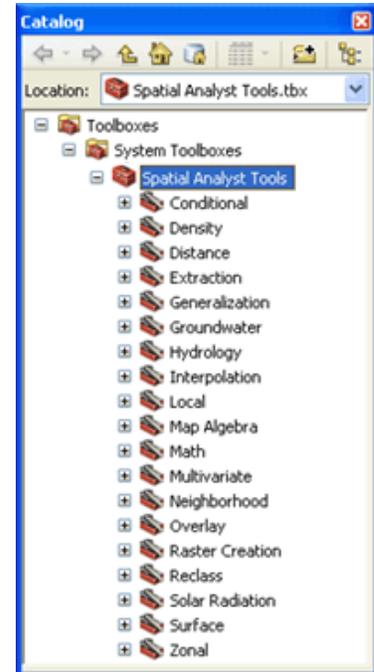
An overview of the 3D Analyst toolbox

[http://resources.arcgis.com/en/help/main/10.1/index.html#/An\\_overview\\_of\\_the\\_3D\\_Analyst\\_toolbox/00q900000070000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/An_overview_of_the_3D_Analyst_toolbox/00q900000070000000/)



## 7.2) Spatial Analyst Tools

ArcGIS Spatial Analyst provides a broad range of powerful spatial modeling and analysis capabilities. You can create, query, map, and analyze cell-based raster data; perform integrated raster/vector analysis; derive new information from existing data; query information across multiple data layers; and fully integrate cell-based raster data with traditional vector data sources.



An overview of the Spatial Analyst Toolbox

<http://resources.arcgis.com/en/help/main/10.1/index.html#//009z0000003000000>