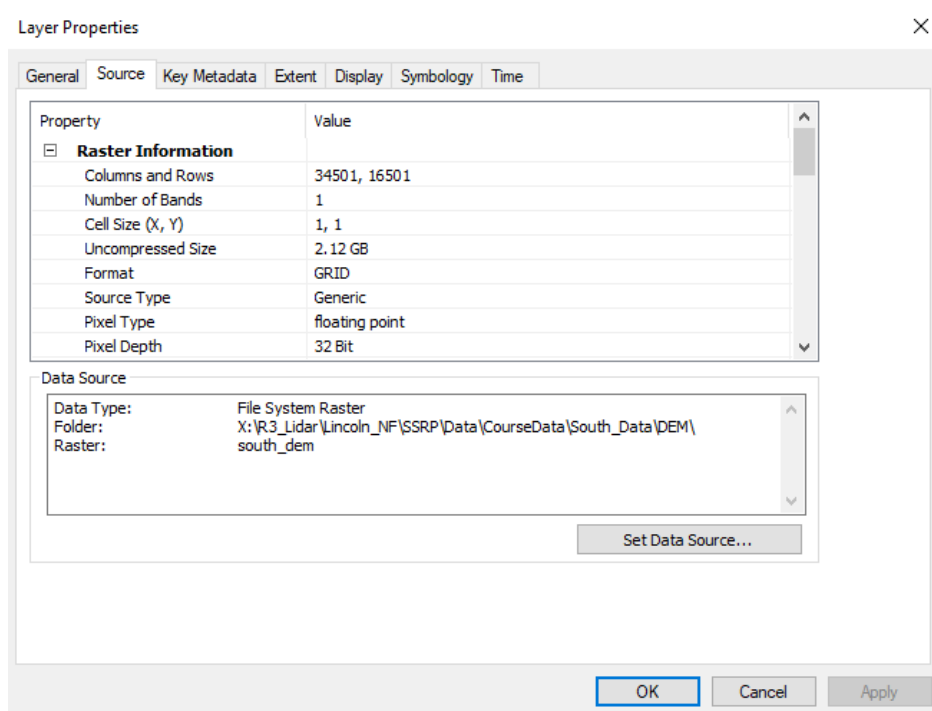


# EXERCISE 1

## Raster Basics



### Objectives

Understanding the characteristics of different types of lidar derived raster data sets is valuable, especially as you begin manipulating them using spatial analysis tools in ArcMap. In this exercise, you will explore rasters in ArcMap to gain a better understanding of them, how the data is stored, and what kinds of things to pay attention to when working with lidar derived rasters. Although this is an introductory exercise to rasters, the information within is used on a daily basis by remote sensing specialists who utilize a variety of disparate datasets. The data provided for this exercise is from the Lincoln National Forest in New Mexico.

### Required Data

**south\_dem** – Digital elevation model in ArcGRID format derived from the last returns of the lidar point cloud

**LincolnNF\_CHM\_1M.img** – Canopy height layer derived from the lidar point cloud

**LincolnNF\_CCM\_10M.asc** Percent canopy cover derived from the lidar point cloud in ascii format



Lincoln\_NF\_NAIP2020\_5M.tif – NAIP imagery resampled to 5 meters for the study area on the Lincoln National Forest

**Prerequisites**

- It is recommended that you are somewhat proficient using ArcMap.

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# Part 1: Add Raster Data and Build Pyramids

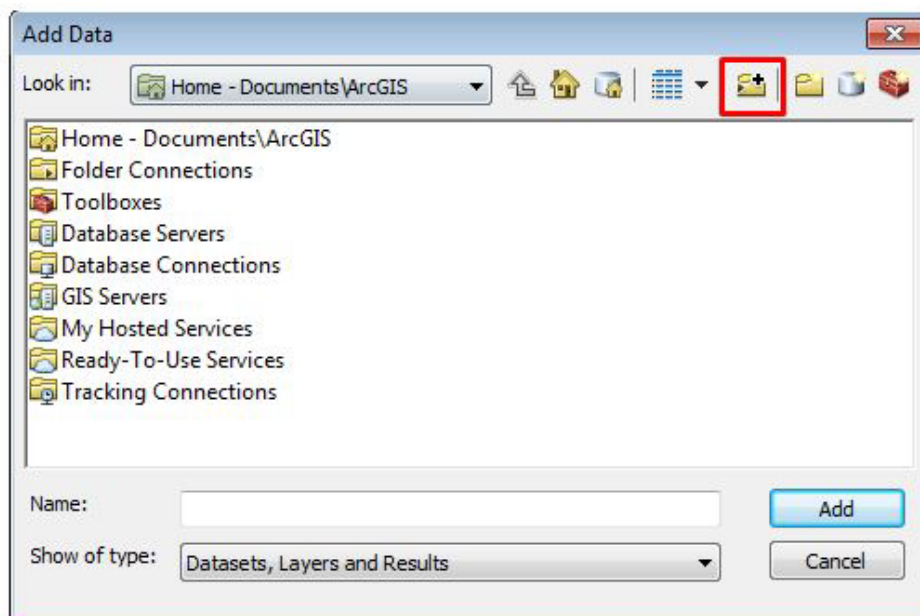
*Note: Before beginning the exercise, make sure you have either copied the course data folder over to your personal T drive folder or you have downloaded and the data to the C:\ drive if you are working with a local installation of ArcMap.*

## A. Start ArcMap

1. Start ArcMap by clicking on the Start button and navigation to All Programs. ArcGIS, then open ArcMap.
2. If prompted with a dialog box asking whether you would like to open an existing map, choose a blank map and click ok.

## B. Add a DEM image

1. Click the Add Data button (first graphic). If you don't see the drive letter where your course data is saved in the Add Data dialog, click the Connect to Folder button (second graphic).



2. Navigate to the location where you copied the course data contents, select the data folder (...\South\_Data\) and click OK.
3. Then in the DEM folder locate the file called **lincolnrf\_dem\_south** and add it. The DEM should look similar to the one on the next page after you have built Pyramids.

**Note:** This DEM is in Arc Grid format, which is a native raster format for ArcMap that is not preferable. If you do not specify an extension for your raster outputs in ArcMap, the output will be created as an Arc Grid file by default. An Arc Grid file has a few caveats: it does not display an extension (e.g., .tif or .img); you are not able to easily drag it into your ArcMap from a windows explorer window, instead you need to

navigate to it through the Add Data button or Arc Catalog; and lastly, Arc Grid files have a character limit of 13 for file names, which is something that you will not encounter with TIFF (.tif) or IMAGE (.img) files.

### C. Build Pyramids

1. A Create Pyramids dialog **may** open asking if you would like to create pyramids for your raster. This is sometimes a good idea if you are going to spend a lot of time working with the given raster in ArcMap because it will speed up the rendering of your raster in the ArcMap Data View. However, it takes a bit of time for ArcMap to build the pyramids, making it less efficient if you are not going to be spending much time working with that raster. Click **No**.

**Note:** Pyramids are versions of a raster data set, varying from coarse to fine resolution, that are used to improve drawing speed of raster layers as you zoom in or out. You have to build pyramids only once for a raster. They are stored with the data as a file with extension \*.rrd.

2. Add the canopy height raster (...\\South\_Data\Lidar\LincolnNF\_South\_CHM\_1m.img).
3. Arrange and view your rasters.
4. Pan and zoom.
  - i. Using the Pan and Zoom tools, explore the two raster datasets.



5. Turn layers on and off in the table of contents to see how they work.
6. To prepare for the next section of the exercise uncheck the canopy height layer so that the only layer visible is the lidar bare earth DEM.

## Part 2: Explore the DEM Raster

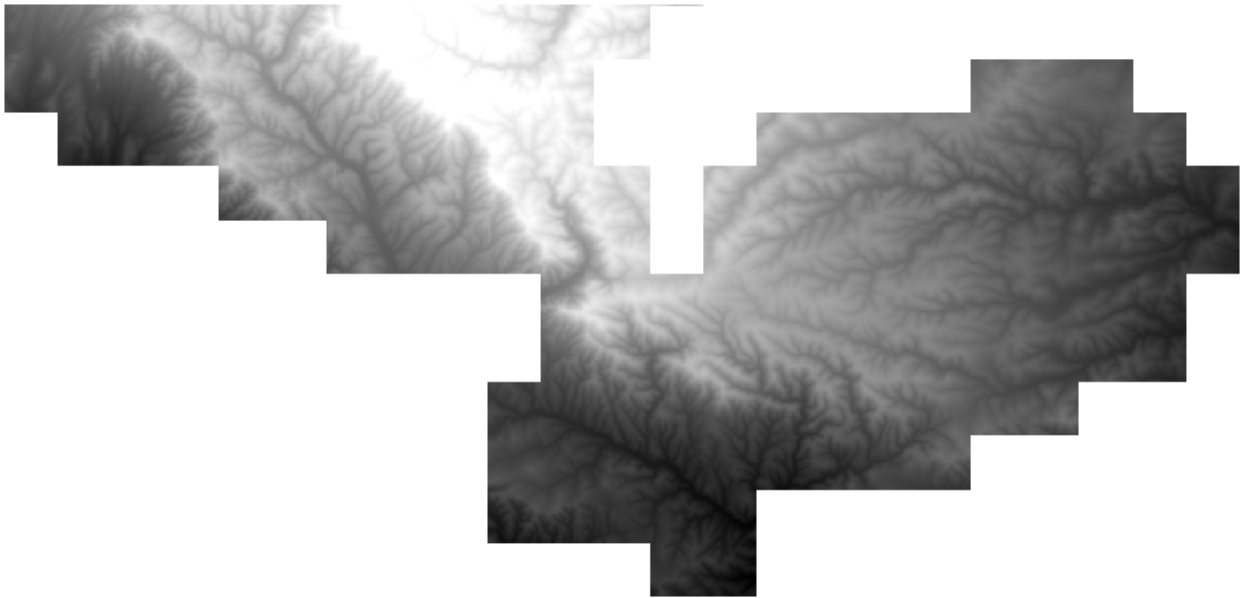
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### A. Open the Layer Properties

1. Zoom to the DEM by right-clicking on it in the Table of Contents and selecting **Zoom to Layer**.
2. Double-click on the DEM layer in the Table of Contents to open the Layer Properties.

### B. Change the appearance

1. Click the Symbology tab and make sure the **Stretched** option is selected in the “Show” pane (in the left window of the Symbology tab).
2. Click the drop-down arrow for the **Stretch type:** and choose **Standard Deviations**.
3. A message window may appear asking to compute statistics for this raster, click **Yes**.
4. Click **Apply**. The DEM should now display with apparent elevation gradient (similar to graphic below).



**Note:** *The Stretched symbology method makes subtle transitions along the selected color ramp but doesn't give you precise information about which data values are associated with which shades of color. In a method like Classified, color transitions are less subtle, and you can see exactly which value ranges correspond to which shades.*

### C. Explore the Source information

1. Click the Source tab in the properties window (double click on the layer to get there) to display the Property information for the DEM. It is good practice to take note of:
  - i. Number of bands = \_\_\_\_\_
  - ii. Cellsize = \_\_\_\_ x \_\_\_\_
  - iii. Uncompressed Size = \_\_\_\_\_ MB
  - iv. Format = \_\_\_\_\_
  - v. Source Type = \_\_\_\_\_
  - vi. Pixel Type = \_\_\_\_\_
  - vii. Pixel Depth = \_\_\_\_\_ bit
2. Click Cancel to close the Layer Properties dialog for this DEM.

*In Summary: You have learned thus far how to load, display and explore DEM data. You should be able to answer the following questions and find out the following information about your DEM*

1. *What type of raster do I have? Discrete or Continuous.*
2. *What is the pixel type of my raster? Floating point or Integer.*
3. *What is the resolution of my raster? Cell size.*
4. *How many bands/layers is my raster? 1 or many.*
5. *What is the Spatial Reference of my raster? UTM, Geographic, etc.*

6. How do I change the Symbology of my raster?

*These questions and their answers are very important when understanding your raster and what to expect from it in manipulation and analysis. It is a good habit to always check the properties of your raster and ensure you are well educated about it before performing any analysis on it.*

### D. Explore Symbology options for DEM

1. With the DEM Layer Properties open, from the Symbology tab change the display from Stretched to Classified (along the left-hand side) underneath the “Show:” pane.
  - i. In this option, you can specify “ranges” of values to be grouped into classes. This is an important step when converting a raster to a vector. You must group and reduce the number of “unique values” that a raster can have in order to output it to a vector.
2. Now locate the **Classify...** button. Click it to open the Classification dialog. Within this dialog you can:
  - i. Choose the Classification Method and Number of Classes.
    - (a) Change the Break Values (located on the right side of the Classification dialog if you have specific values that you wish your classes to break at. Also note the ability to choose % for your Break Values.
    - (b) Set data values to be excluded from the classification (Data Exclusion).
    - (c) Locate the Classification Statistics (upper right-hand corner of the dialog) about your raster. This is a good place to check to make sure your raster values intuitively make sense.
    - (d) Show the Std. Dev. and Mean values for your Histogram.
3. Play around with the options in the Classification dialog and click OK when you have some settings you would like to observe.
4. Then click Apply in the Layer Properties dialog to see the changes you have made.
5. Before you close the Layer Properties, return the DEM to Stretched instead of Classified and click **OK**.

## Part 3: Raster Geometry and Cell Values

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### A. Display NoData

1. For the DEM, go to **Layer Properties, Symbology, Display NoData as** and choose a bright color from the dropdown selection, such as **yellow**.
2. Click **OK**.

**Note:** *NoData values are not zero values but rather pixels that are considered null. Any analysis using these pixels will essentially ignore them; consider them a type of dead area in your raster. They are often the boundaries of images especially satellite images.*

### B. Identify cell values

1. Zoom in and, using the Identify tool (see below), click in the yellow area around the DEM.



2. The Pixel Value is returned as NoData.
3. Now use the Identify tool and click somewhere inside the DEM. The Pixel value represents the Elevation value for that particular pixel (What units are your data in? Sometimes only the horizontal units are displayed in the source tab of the layer properties. You may need to ask the supplier of the data or just use deduction to tell if the vertical units are meters or feet).

## Part 4: Reclassify and Convert DEM Raster to Vector

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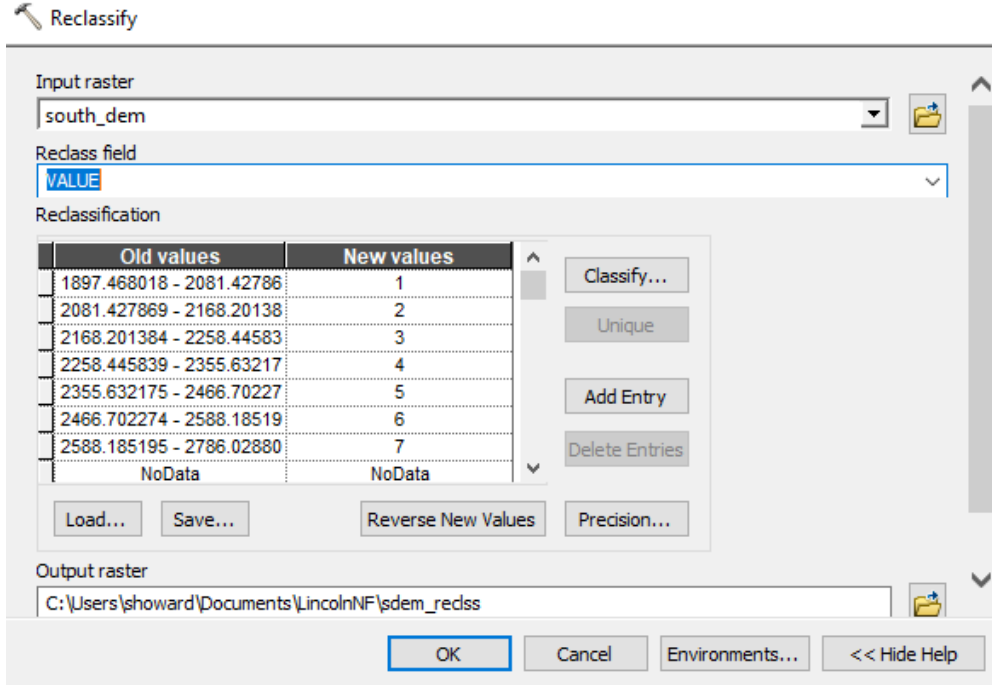
There are certain types of analysis that can only be done using vector data, so it may be necessary sometimes to convert our raster data to vector data. We also may want to reduce the dimensionality of our data so that it is grouped in ways that are easier for us to analyze.

### A. Reclassify a DEM

1. Make sure the ArcToolbox is open (see button below).

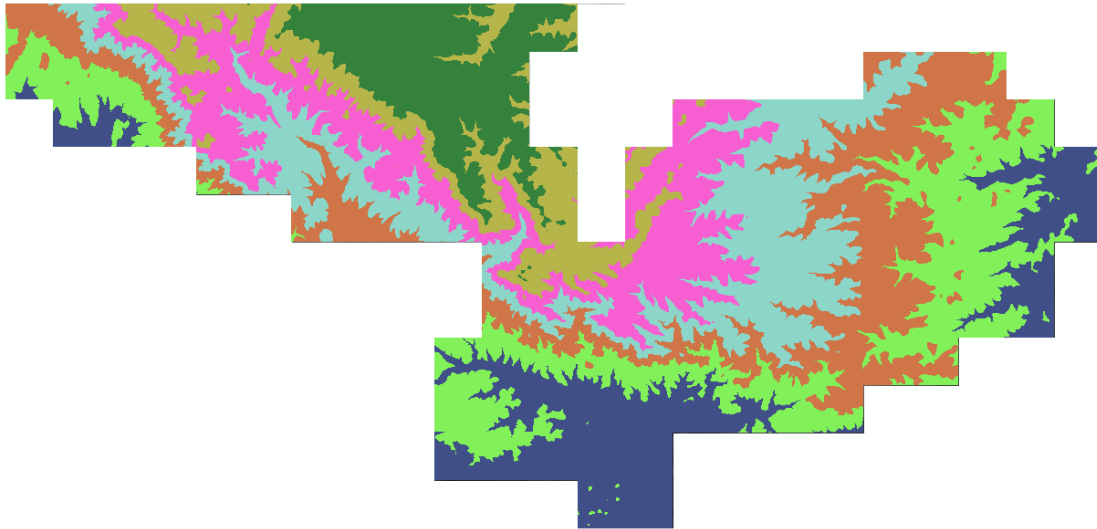


2. From ArcToolbox, navigate to the Spatial Analyst toolbox, then to Reclass and open the **Reclassify** tool.
  - i. You may need to enable your Spatial Analyst license by going to locating the **Customize** toggle on the top of the ArcMap window then select **Extensions...** and then click box next to **Spatial Analyst**.
3. The Input raster should be the **DEM** raster.
4. The Reclass field should read **VALUE**.
5. You can set the Old values and New values ranges under Reclassification.
6. Let's change the classification parameters by clicking on the **Classify...** button. Here you can change the **Break Values** or change the **Method** used to classify.
7. Let's change the **Method** to **Natural Breaks**.
8. Change the number of Classes to **7**.
9. Click **Ok** in the Classification dialog window.
10. Notice the other options you have in Reclassify window.



- i. You can Load a Remap table if you had one using the “Load” option.
  - ii. You can Save the current reclassification table/values as a remap table if you would like using the “Save...” button.
  - iii. You can set the Values to Unique, which makes each unique value in the raster available for a new value (not recommended).
11. Leave the New Values as they are and give the output raster a name and save it to an intuitive location of your choice.
- i. If you attempt to save this reclassified raster as a .tif or .img, you may encounter issues with running the Raster to Polygon tool in later steps. In order to avoid any issues, save this layer as an Esri GRID file by not giving the output raster file a file extension.
  - ii. **Note:** you are limited to **13** characters for your raster name when saving as an Esri GRID.
12. Click **OK** to reclassify the south\_dem.
- i. Your Reclass output raster should look similar to the graphic below.



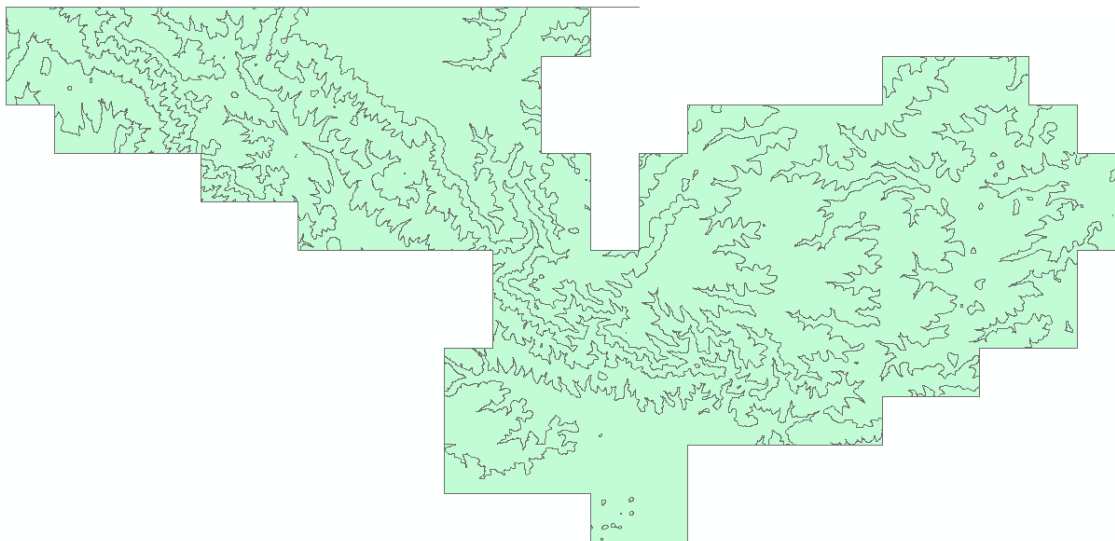


## B. Convert Raster to Polygon

1. From the Conversion Tools toolbox located within the ArcToolbox, navigate to **From Raster**, then open the **Raster to Polygon** tool.
2. The Input raster should be your Reclass output.
3. The Field should read **Value**.
4. Choose an intuitive output location for your shapefile and name it **sdem\_reclass.shp**.
5. Leave **Simplify polygons** box checked.

**Note:** if you would like to preserve the exact extents of the raster classes, then you would want to uncheck this simplify polygons option. Simplifying polygons will redraw some of the boundaries to be more natural and less pixelated.

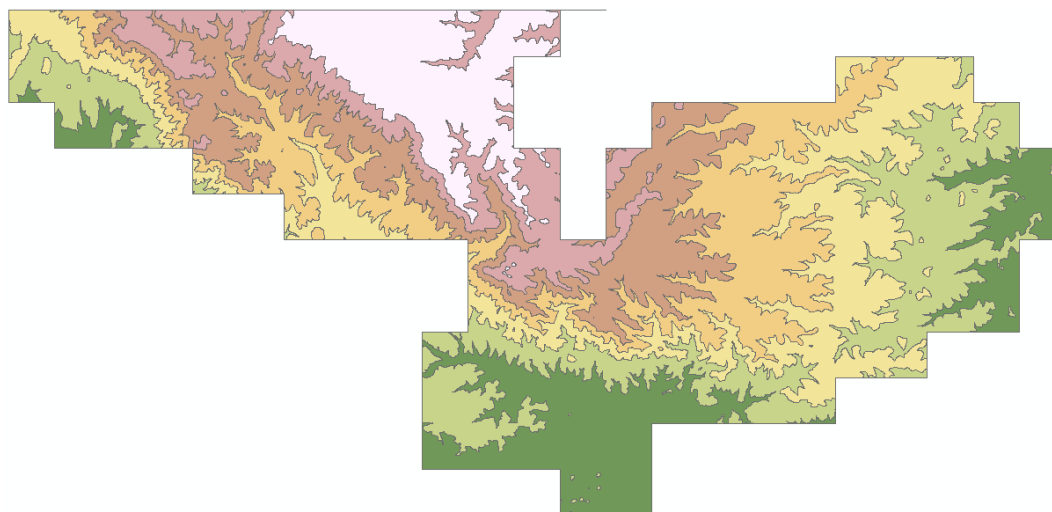
6. Click **OK** to run the conversion.
7. Your output will be automatically added to your ArcMap instance and should look similar to the following graphic (color may vary).



*Note: This reclassification can be done for any of the lidar layers that you received including Height and Canopy Cover. In a later exercise, you will learn how to classify using a variety of rasters and set conditions using the raster calculator tool. If you only need to reclassify one raster the reclassify tool is the easiest tool to use.*

### C. Change appearance of shapefile

1. Open the Layer Properties of `sdem_reclass.shp` and select the **Symbology** tab.
2. Select **Categories** from the “Show:” pane on the left.
3. From the **Value Field** drop down, select **GRIDCODE**.
4. Then Click on the **Add All Values** button near the bottom.
5. Change the Color Ramp if you would like.
6. Click **OK** to display your shapefile with the grid codes (classes) created from the raster DEM.



## Part 5: Convert ASCII to raster

Sometimes lidar outputs from FUSION and other programs are delivered in a format (such as ASCII) that may not work as well in ArcMap. In these situations, we want to convert ASCII to a different raster format. Note that there are many different conversion tools available. Even if this specific conversion process is something that you may not encounter often, it is important to know that there are a variety of different conversion tools that you will likely need to use in your remote sensing analysis.

### A. Locate ASCII to Raster tool

1. From ArcToolbox, select **Conversion Tools, ToRaster**, then open ASCII to Raster.
2. Double click to open the ASCII to Raster dialog.

### B. Set parameters, convert ASCII (float)

1. Click the yellow folder to choose the Input ASCII raster file.
2. Navigate to ...\**South\_Data\Lidar**.
3. Highlight **LincolnNF\_south\_CCM\_10M.asc** and click **Open**.
4. Change the Output raster name to **Lincoln\_south\_canopycover.img** and save it in the **South\_Data\Lidar** folder.
  - i. Don't forget to type the ".img" part.

**Note:** Regular Arcgrid format only allows for raster names to be 13 characters long. If you want to name your raster something longer you need to include a different extension. .img is the ERDAS Imagine format and will work in Imagine as well as ArcMap. .tif is also a common format to use for rasters.

5. Change the **Output Data Type** to **Float**.
6. Click OK to run the conversion.
  - i. The new raster will automatically be added to ArcMap.

*Remember: There are two types of rasters—discrete or continuous. This information is listed under the Source Type. A discrete raster (or thematic raster) can only be in integer format (e.g. Unsigned integer or Signed integer), such as our classified raster we created earlier. A continuous raster can be either in integer or floating point (allows for decimals) format, but floating point is more appropriate since the values are likely to have subtle (decimal) changes. An example of this is the original DEM that we worked with. This is important to remember.*

## Part 6: Explore Lidar Derivatives and NAIP imagery

### A. Add Data and Explore

1. If this layer hasn't already been added to your ArcMap- click the **AddData** button and navigate to ...\**South\_Data\Lidar**. Load the **lincolnrf\_south\_CHM\_1M.img** layer.
2. Make sure the DEM layer is also loaded.
3. Add the NAIP imagery (Lincoln\_NF\_NAIP2020\_5M.tif) located at ...\**South\_Data\NAIP**).

**Note:** If you would like to learn how to access this NAIP imagery directly from the Forest Service image server, visit this tutorial ([Image Services and the Raster Data Warehouse](#)) that provides detailed information on how to add the image server to your ArcMap window.

4. Once you have loaded all of the data, play around with each layer and observe the differences between them. What type of raster is each? What units are they in? What is their pixel size?
5. Now use the **swipe** tool on the **Effects toolbar** to swipe across the raster to explore the differences between the canopy height layer and the imagery.
  - i. Turn off the DEM and make sure the CanopyHeight layer is above the NAIP imagery in the Table of Contents.
  - ii. Turn on the Effects Toolbar by going to **Customize** (on the menu bar on the top of the screen), **Toolbars**, and then **Effects**.
  - iii. Set **lincolnNF\_south\_CHM\_1M.img** as the selectable layer in the effects toolbar.
  - iv. Click the **swipe** tool (see below) and then click somewhere on the Canopy Height layer and swipe across the image to reveal the NAIP imagery



6. What do you notice between the NAIP imagery and the Canopy Height layer with respect to vegetation? Do tall canopy heights correspond to what appears to be mature forest?

**Congratulations!** You now know some of the fundamentals of using raster data in ArcMap.

In summary, basic manipulation and exploration of rasters is a simple process that can provide you with very useful information about your resource of interest at a spatial scale not available to you without raster data. There are endless scenarios where you might need to manipulate and re-organize your raster data to make it more informative, and the more skilled and comfortable you are working with rasters the more useful information you will be able to extract from them. For example: Convert your raster to vector—once you have performed analysis on your raster you may desire to work with it further, but in vector format. Converting your Lidar ASCII to a raster format might be necessary for further analysis.

In the end, make sure you understand what type of raster you are working with and what your manipulation will do to the information contained within it. For example, if you are going to convert from a raster to a vector, you are going to have to make sure your raster is in integer format and that it doesn't have hundreds to thousands of unique values (this would be a rendering nightmare once in vector format). Any manipulation of the original data will change the information, sometimes for the better, but not always. Be aware of what changes you're making and use caution when you do.