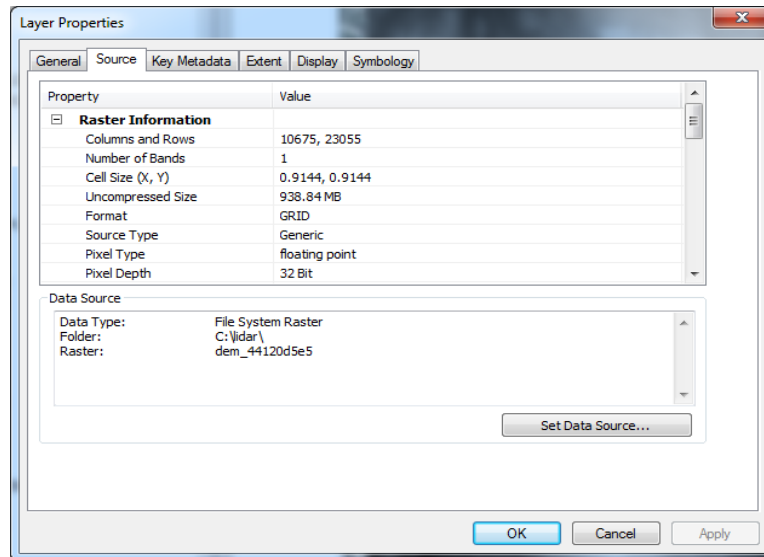


# EXERCISE 1

## 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 Gila National Forest in New Mexico.

### Required Data

**GilaDEM.tif** – Digital elevation model derived from the last returns of the lidar point cloud. Z units are in meters.

**GilaCHM.tif** – Canopy height model derived from the first returns of the lidar point cloud. Z units are in meters.

**GilaCC\_10m.tif** – Percent canopy cover derived from the lidar point cloud

### Prerequisites

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



## Table of Contents

Part 1: Add Raster Data and Build Pyramids.....	3
Part 2: Explore the DEM Raster .....	4
Part 3: Raster Geometry and Cell Values .....	6
Part 4: Reclassify and Convert DEM Raster to Vector .....	7
Part 5: Explore Lidar Derivatives and NAIP imagery .....	10



## Part 1: Add Raster Data and Build Pyramids

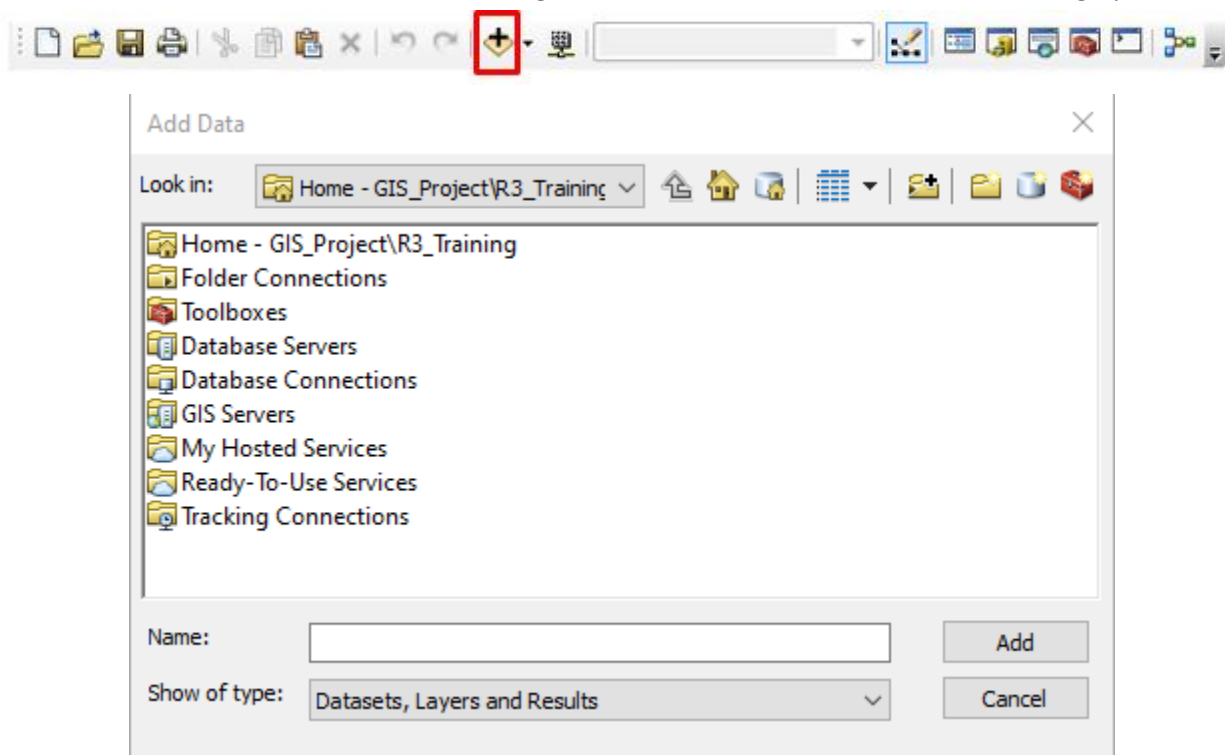
**Note:** Before beginning the exercise, make sure that you have moved the data to the C:\ drive if you are working locally or to your designated folder on the T:\ drive if you are working in Citrix.

### 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 (...\\ProjectData) and click OK.
3. Then in the Lidar folder locate the file called **GilaDEM** 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 TIFF format, which is a commonly used raster format. Another raster format is the 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 (...\\ProjectData\\Lidar\\GilaCHM.tif).
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.

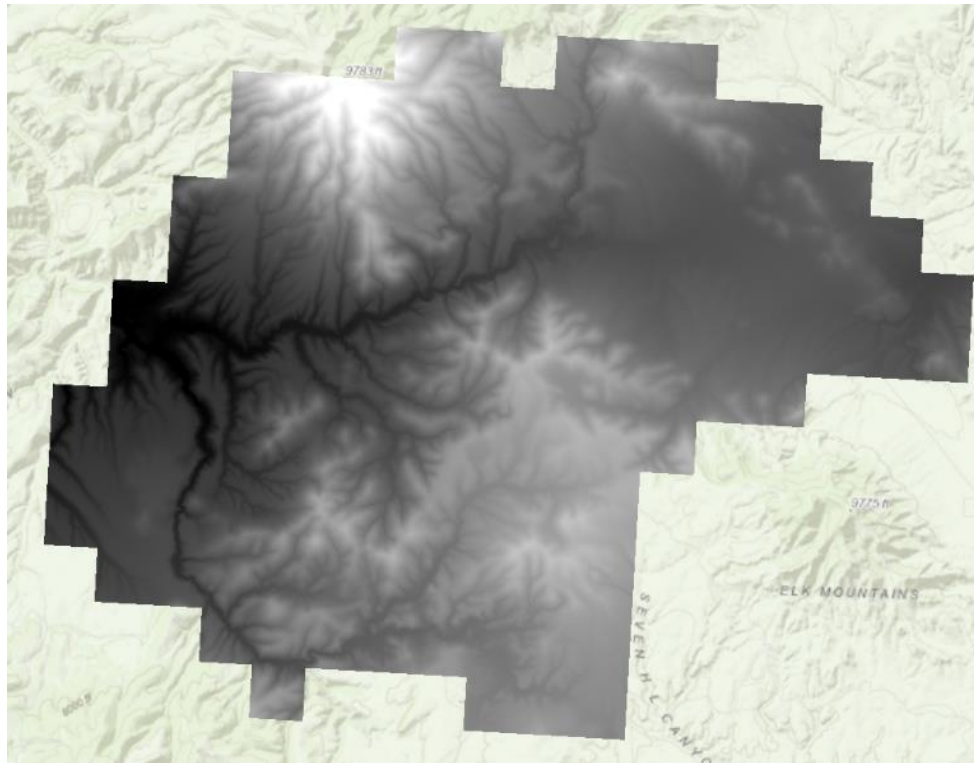
## Part 2: Explore the DEM Raster

### 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.

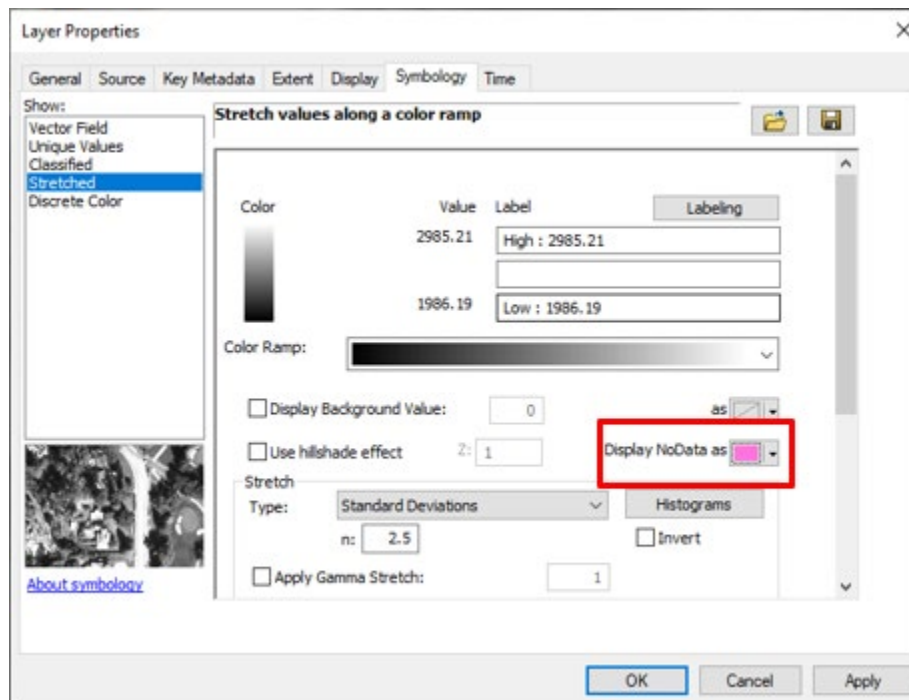
## D. Explore Symbology options for DEM

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

## 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 **pink**.
2. Click **OK**.



**Note:** NoData values are not zero (0) 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 pink 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

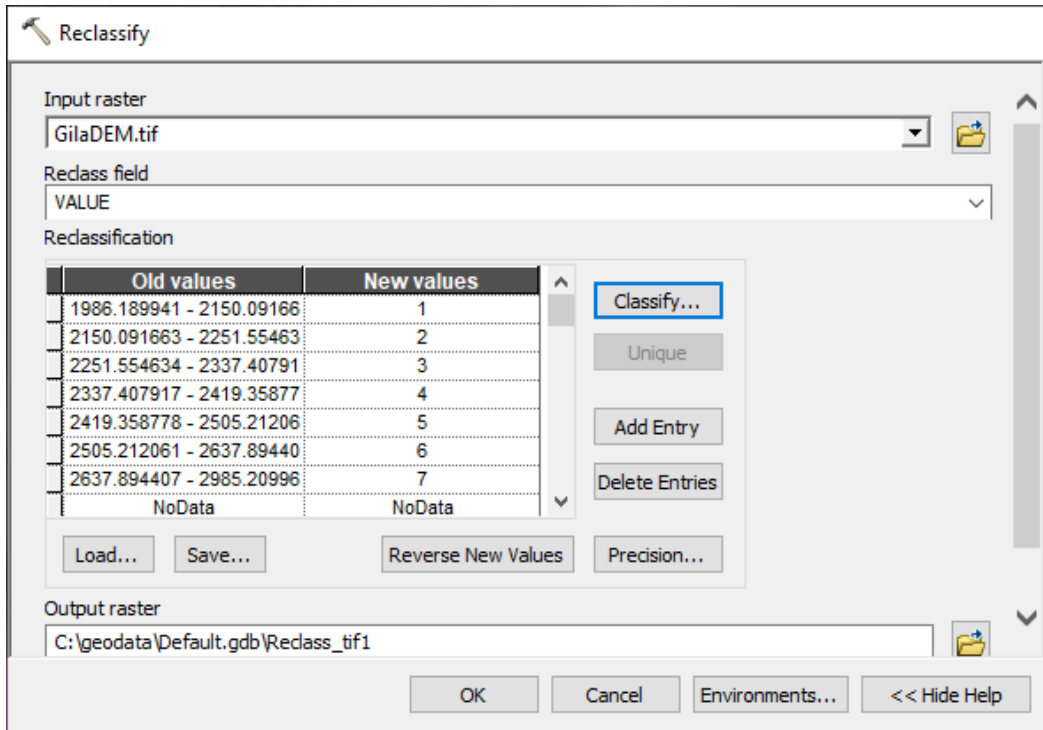
There are certain types of analysis that can only be done using vector data, so it may be necessary sometimes to convert our raster data to vector data. We also may want to reduce the dimensionality of our data so that it is grouped in ways that are easier for us to analyze.

## 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 the **Customize** menu 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.
  - i. Let's change the **Method** to **Natural Breaks**.
  - ii. Change the number of Classes to **7**.
  - iii. Click **Ok** in the Classification dialog window.



**Reclassify**

Input raster: GilaDEM.tif

Reclass field: VALUE

Reclassification:

Old values	New values
1986.189941 - 2150.09166	1
2150.091663 - 2251.55463	2
2251.554634 - 2337.40791	3
2337.407917 - 2419.35877	4
2419.358778 - 2505.21206	5
2505.212061 - 2637.89440	6
2637.894407 - 2985.20996	7
NoData	NoData

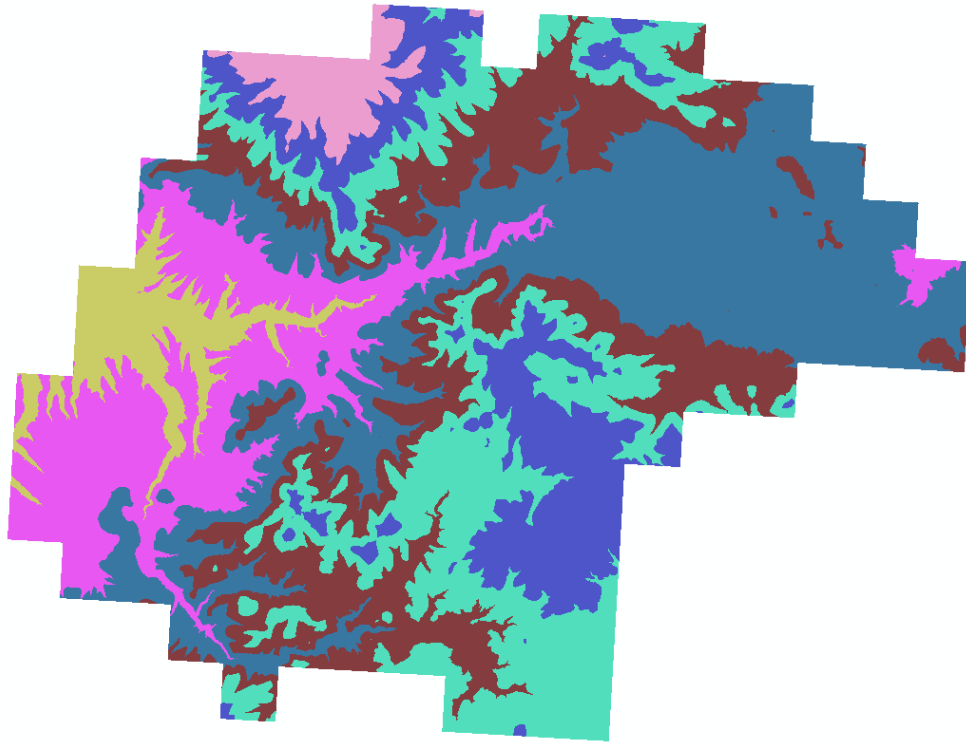
Buttons: Load... Save... Reverse New Values Precision... Classify... Unique Add Entry Delete Entries

Output raster: C:\geodata\Default.gdb\Reclass.tif1

Buttons: OK Cancel Environments... << Hide Help

7. Leave the New Values as they are and name the output raster **GilaDEM\_Reclass.tif** and save it to an intuitive location of your choice.
8. Click **OK** to reclassify the GilaDEM.
  - i. Your Reclass output raster should look similar to the graphic below.



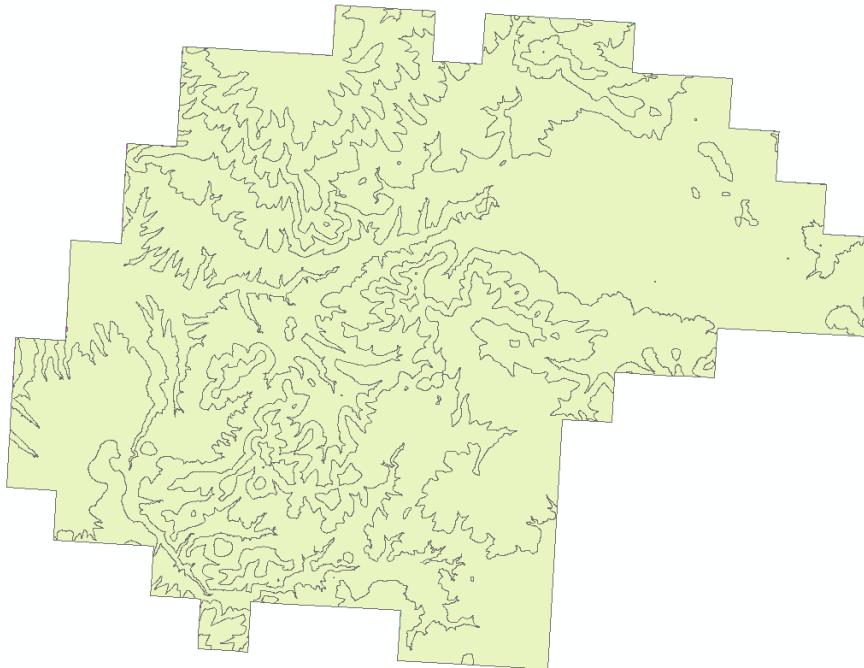


## B. Convert Raster to Polygon

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 **GilaDEM\_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 GilaDEM\_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.

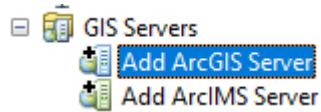
## Part 5: Explore Lidar Derivatives and NAIP imagery

### A. Connect to Image Services and Explore Data

1. If this layer hasn’t already been added to your ArcMap- click the **Add Data** button and navigate to ...\\ProjectData\\Lidar\\. Load the **GilaCC\_10m.tif** layer.
2. Make sure the DEM layer is also loaded.
3. To connect to the Image Services server, open the catalog pane in ArcMap.



4. Under GIS Servers double click on **Add ArcGIS Server**.

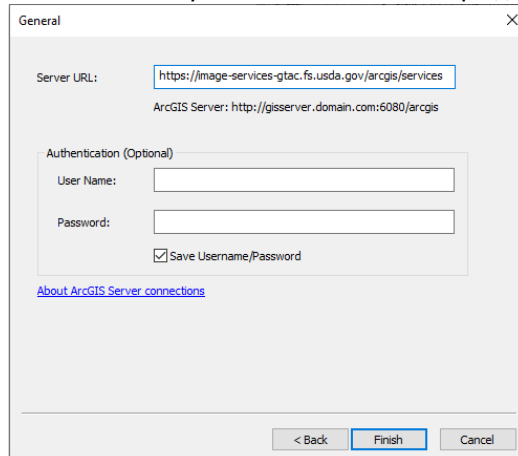


5. Select “Use GIS services” then push “Next”

6. In the box next to Server URL: copy and paste the following address:

- i. <https://image-services-gtac.fs.usda.gov/arcgis/services>

- (a) Make sure that you don’t have two https:// in the url box or this will not work.



- ii. Leave the User Name and Password blank and select **Finish**.

7. Now press the “+” on your newly added image services connection within your catalog pane and select **NAIP**. Drag over the **NAIP2018\_CONUS** to your Table of Contents.

8. 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?

9. 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 **GilaCC\_10m.tif** 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



10. 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.

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.

