

Introduction to ArcGIS

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Goals of the Exercise

This exercise introduces you to ArcGIS Pro. You use these applications to create a map of pan evaporation stations in Texas, and to draw a graph of monthly pan evaporation data measured at these stations. The relationship between ArcGIS and MS Word and Excel is demonstrated so that you can create graphs in Excel, maps in ArcGIS and place the result in a Word file as a report for this homework. In this way, you link the spatial location of the observation sites, with the time variation of the water observations data at those sites. You will also upload your results as a web map of evaporation data so that it can be publicly viewed.

Computer and Data Requirements

To carry out this exercise, you need to have a computer which runs ArcGIS Pro version 2.0. You will also need an ArcGIS Organizational Account to enable you to login to ArcGIS Online.

In the first part of this exercise using ArcGIS Pro, you will be working with the following spatial datasets:

1. A polygon shapefile of the counties of Texas, called **Counties**
2. A point shapefile of pan evaporation stations, called **Evap**
3. A polygon shapefile of the state of Texas, called **Texas**

These shapefiles consist of several files (e.g. **evap.dbf**, **evap.shp**, **evap.shx**). You can get them from this zip file: <http://hydrology.usu.edu/dtarb/giswr/2017/Ex1Data.zip>

You need to establish a working folder to do the exercise on. This can be in any convenient location on the computer you are working on (e.g. C:\Users\dt\Desktop\giswr2017\Ex1).

After you have downloaded the zip file **Ex1Data.zip** double click on the file and you should see Winzip or other zip utility to open the file on your computer (if it doesn't open you'll have to unzip this file on a computer that has a zip utility installed). Extract all files from the zip file to the working folder that you've set up to do this exercise. You should end up with a file list that looks something like this. You may see these data within a sequence of folder names, and if so, click on each folder down through the sequence until you locate the required files.

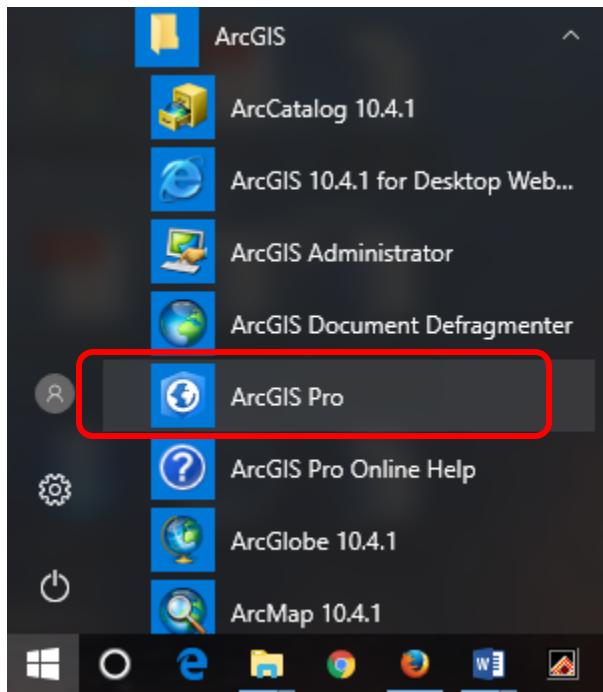
| Name | Date modified | Type | Size |
|--------------|-------------------|--------------|----------|
| Counties.dbf | 9/5/2012 11:41 AM | DBF File | 47 KB |
| Counties | 9/5/2012 11:41 AM | PRJ File | 1 KB |
| Counties.sbn | 9/5/2012 11:41 AM | SBN File | 3 KB |
| Counties.sbx | 9/5/2012 11:41 AM | SBX File | 1 KB |
| Counties.shp | 9/5/2012 11:41 AM | SHP File | 8,450 KB |
| Counties.shp | 9/5/2012 11:41 AM | XML Document | 22 KB |
| Counties.shx | 9/5/2012 11:41 AM | SHX File | 3 KB |
| Evap.dbf | 9/5/2012 11:33 AM | DBF File | 30 KB |
| Evap | 9/5/2012 11:33 AM | PRJ File | 1 KB |
| Evap.sbn | 9/5/2012 11:33 AM | SBN File | 1 KB |
| Evap.sbx | 9/5/2012 11:33 AM | SBX File | 1 KB |
| Evap.shp | 9/5/2012 11:33 AM | SHP File | 2 KB |
| Evap.shx | 9/5/2012 11:33 AM | SHX File | 1 KB |
| Texas.dbf | 9/5/2012 11:44 AM | DBF File | 1 KB |
| Texas | 9/5/2012 11:44 AM | PRJ File | 1 KB |
| Texas.sbn | 9/5/2012 11:44 AM | SBN File | 1 KB |
| Texas.sbx | 9/5/2012 11:44 AM | SBX File | 1 KB |
| Texas.shp | 9/5/2012 11:44 AM | SHP File | 1,058 KB |
| Texas.shp | 9/5/2012 11:44 AM | XML Document | 20 KB |
| Texas.shx | 9/5/2012 11:44 AM | SHX File | 1 KB |

Procedure

Please note that the following procedure is a detailed outline, which can be followed to complete this lesson. However, you are encouraged to experiment with the program and to be creative.

1. Viewing Shapefiles in ArcGIS Pro


Open **ArcGIS Pro**



The first time you open ArcGIS Pro, you will need to sign in using your ArcGIS Online account. For convenience, you may want to leave the “Sign me in automatically” checkbox selected. Once in ArcGIS Pro, you can check whether you are logged in or not in the upper right-hand corner.

ArcGIS Sign In

ArcGIS Pro wants to access your ArcGIS Online account information

Sign In 

Username
pjruess

Password
●●●●●●●●


SIGN IN **CANCEL**

[Forgot password?](#) [Forgot username?](#)

OR

Sign in with **ENTERPRISE ACCOUNT**

ArcGIS Pro developed by:



Esri

Esri publishes a set of ready-to-use maps and apps that are available as part of ArcGIS. ArcGIS is a mapping platform that enables you to create interactive maps and apps to share within your organization or publicly.

Sign me in automatically [Configure your licensing options](#)


ArcGIS Pro

Create a new project
Select a template to use to create a new project

Blank Global Scene... Local Scene... Map.aprx

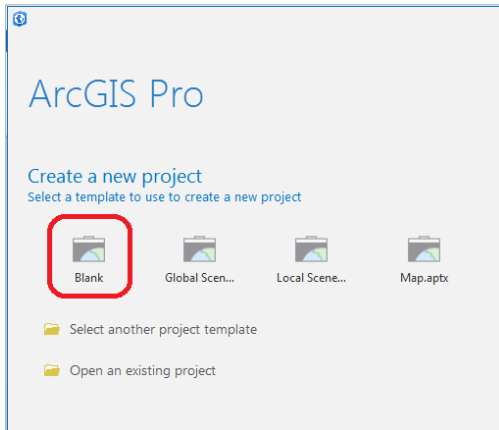
Select another project template

Open an existing project

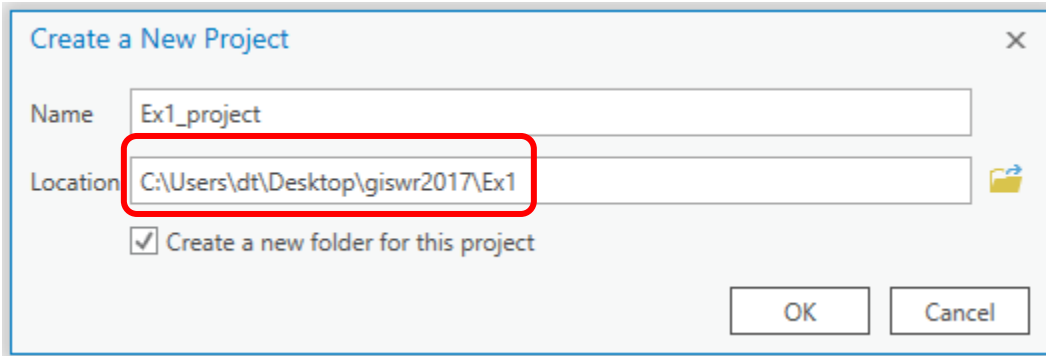
 **pjruess**
<https://www.arcgis.com/>
Sign out

About ArcGIS Pro

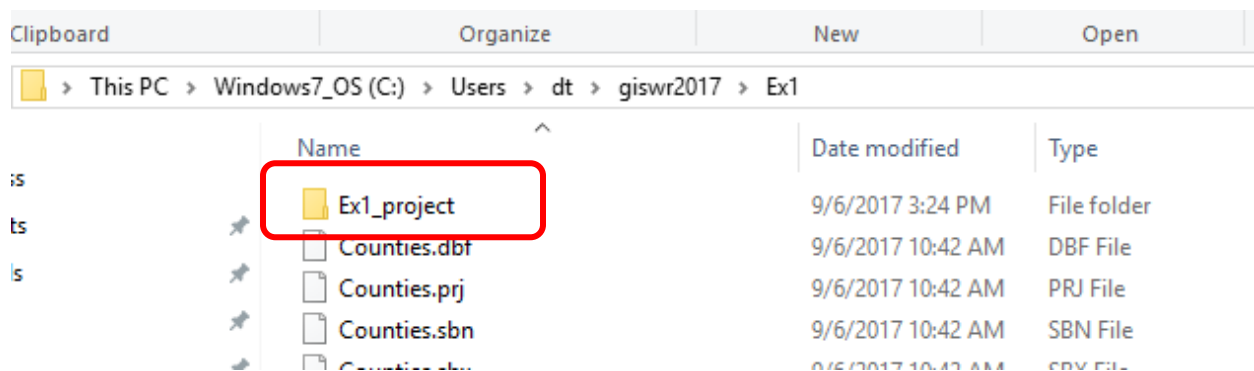
Once you are in ArcGIS Pro, you will want to start with a **Blank** template.



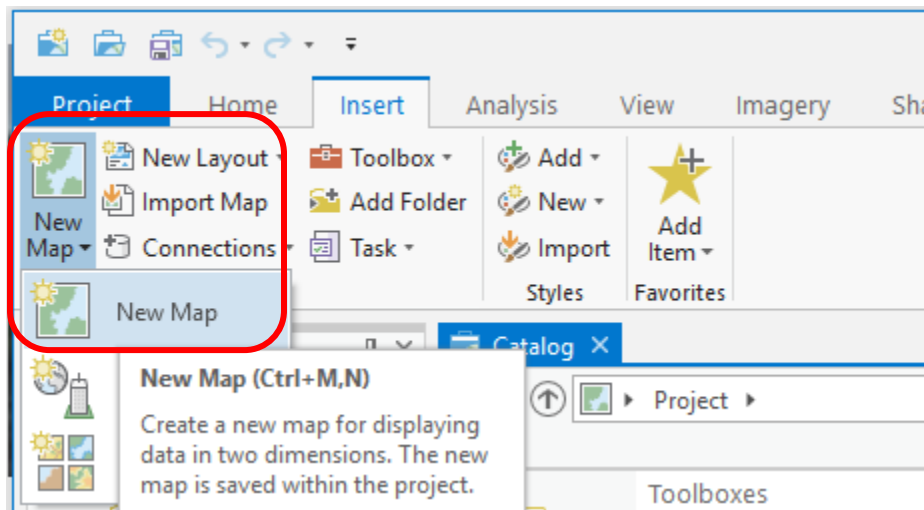
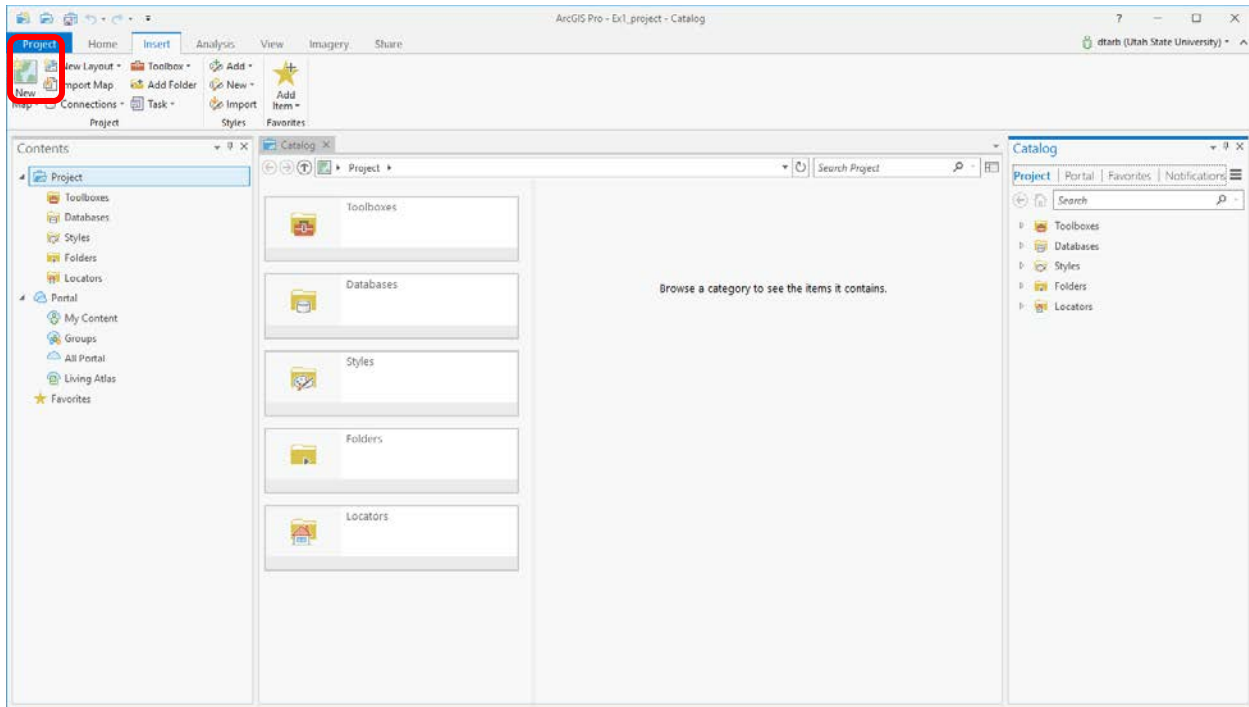
Set the location to the folder where you want the data associated with this project to be saved



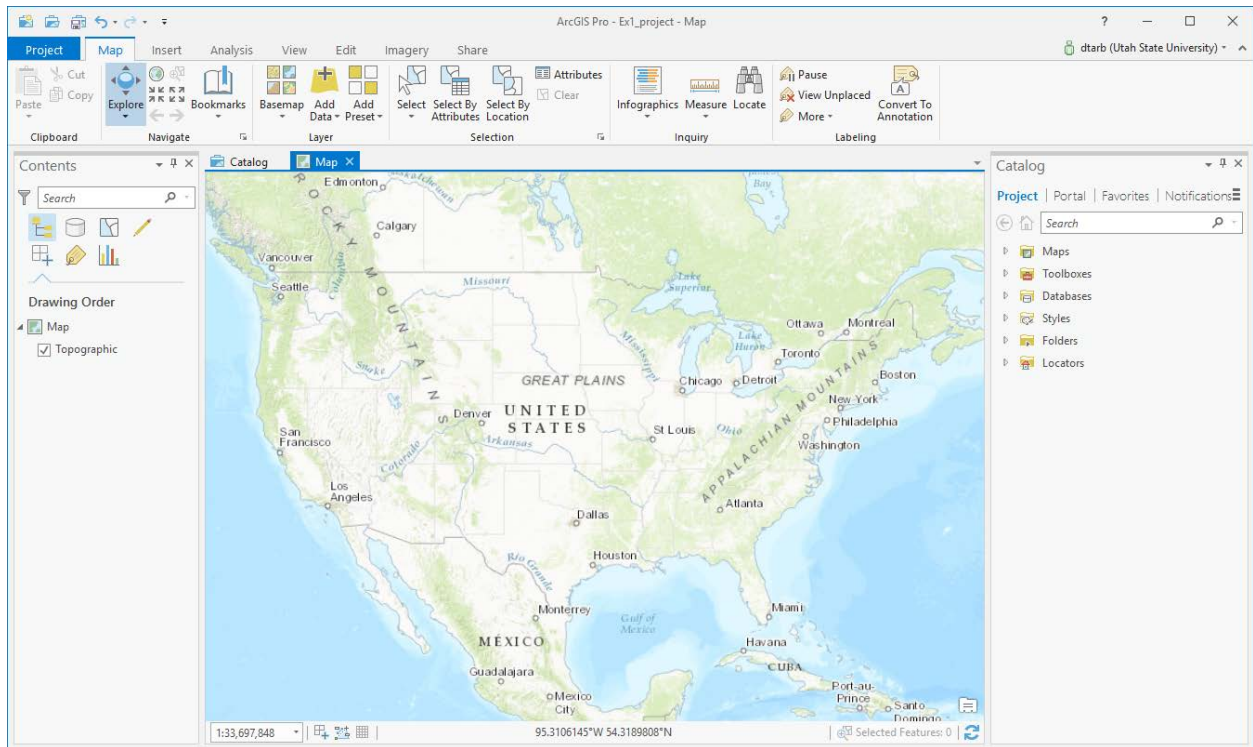
You will see that a folder Ex1_project is created in your folder



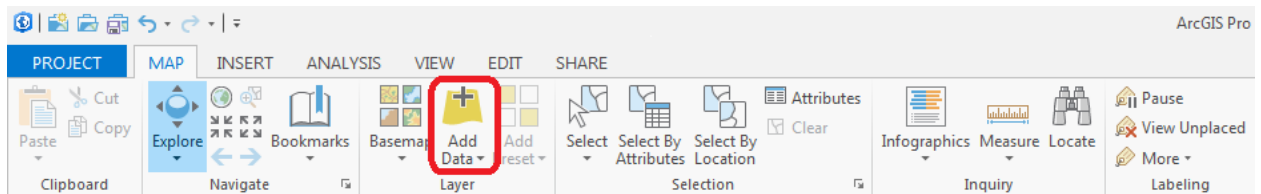
You will also see a blank project catalog template with places to put a lot of stuff. We will learn about some of these later. For now click the **New Map** button in the *Insert* tab to create a map.



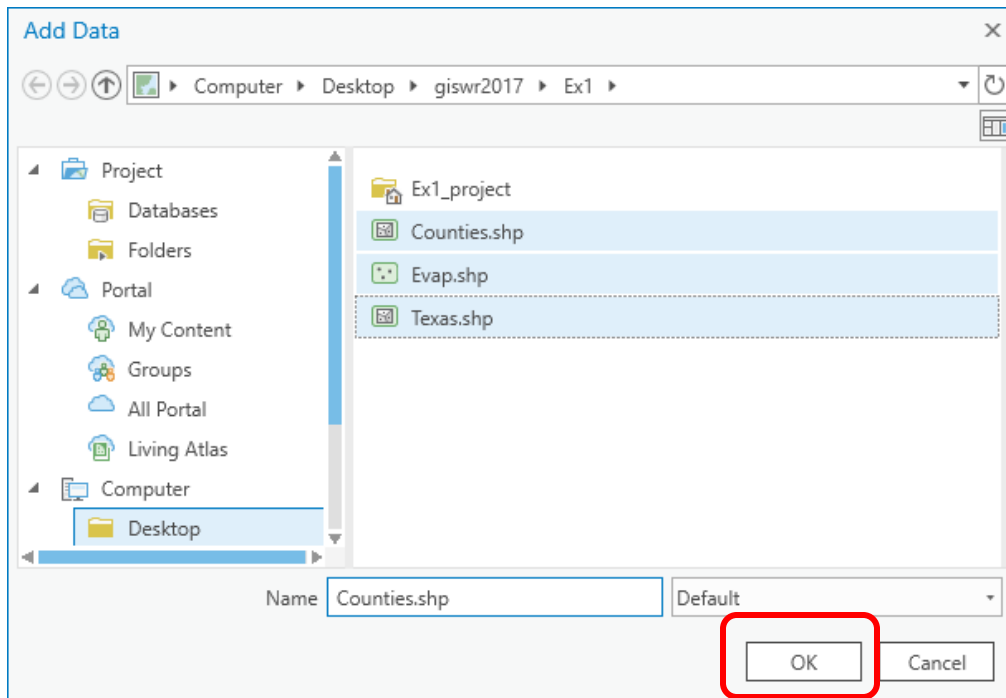
And you'll see a map display open with a nice map of the United States. Pretty cool!



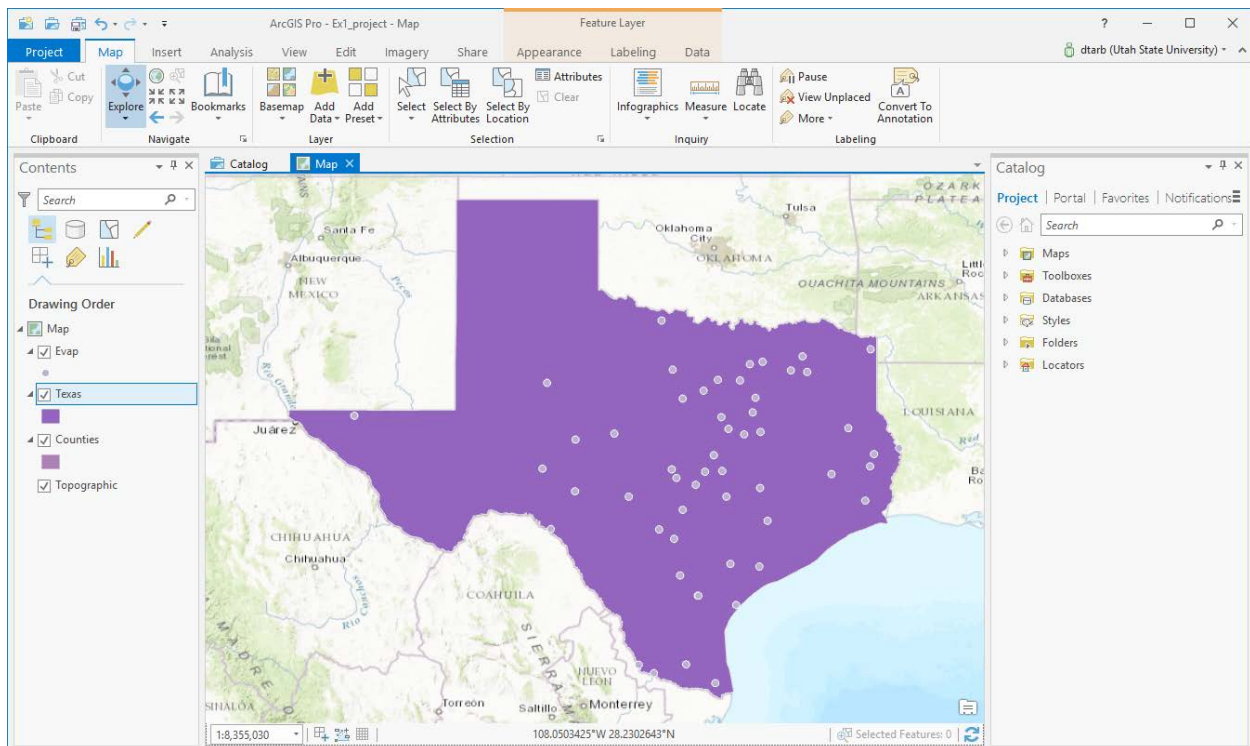
Use the **Add Data** button in the *Map* tab to add the data for this exercise to the map display.



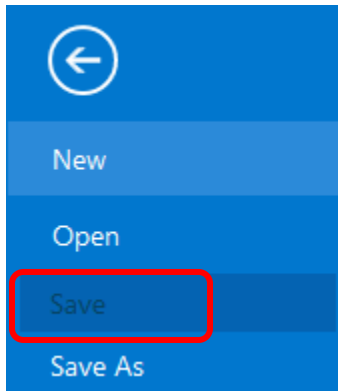
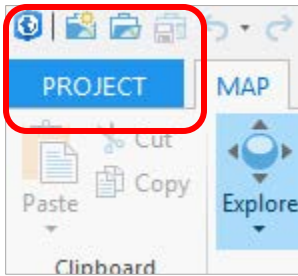
Navigate to the folder containing the exercise data and select all three files at once by using the shift key. Click the OK button to add the data to your ArcMap display.



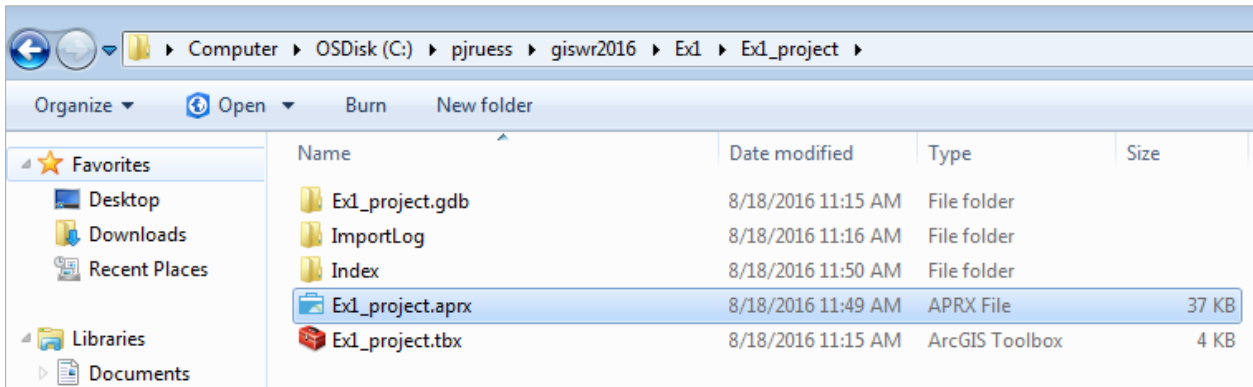
The display should look something like the following.



Let's make sure that we can retrieve the results of these actions if we inadvertently make a mistake and close the application. Use **Project/Save** to save the contents of the current project.

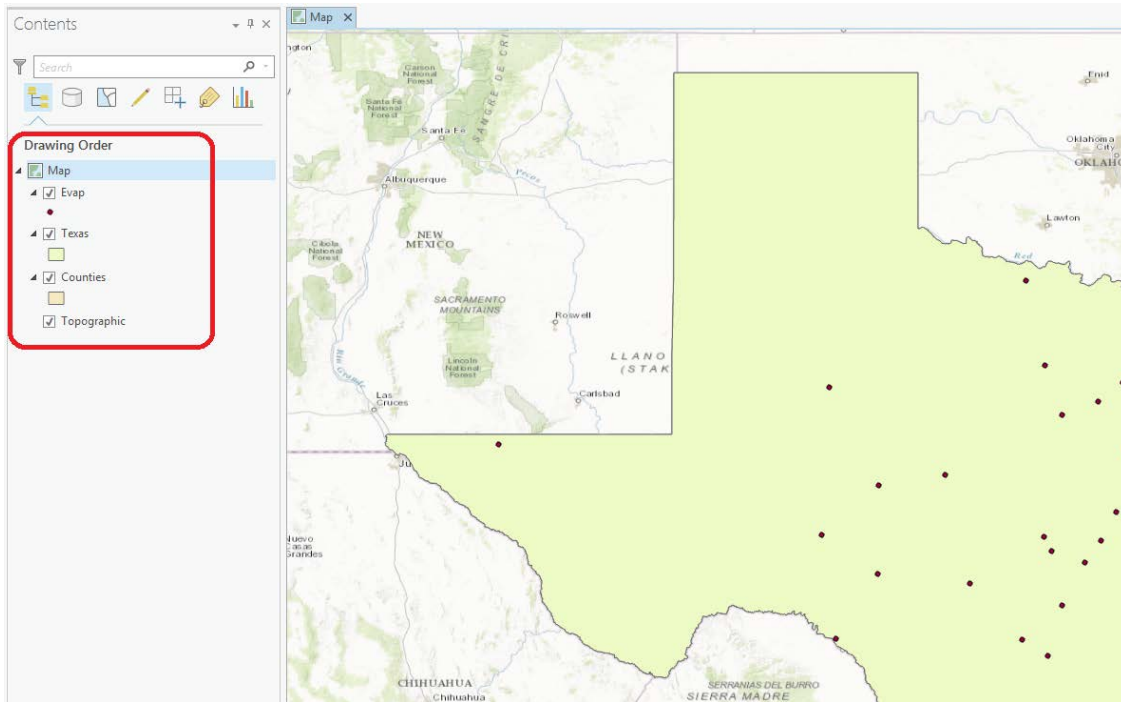


The project will save in the initial destination provided when you created the project (**Ex1_project** for this example). There is an **Ex1_project.aprx** file within the project folder that contains the table of contents and symbology information for your map. You can shut down ArcGIS Pro and reload the same map display by clicking on **Ex1_project.aprx**.

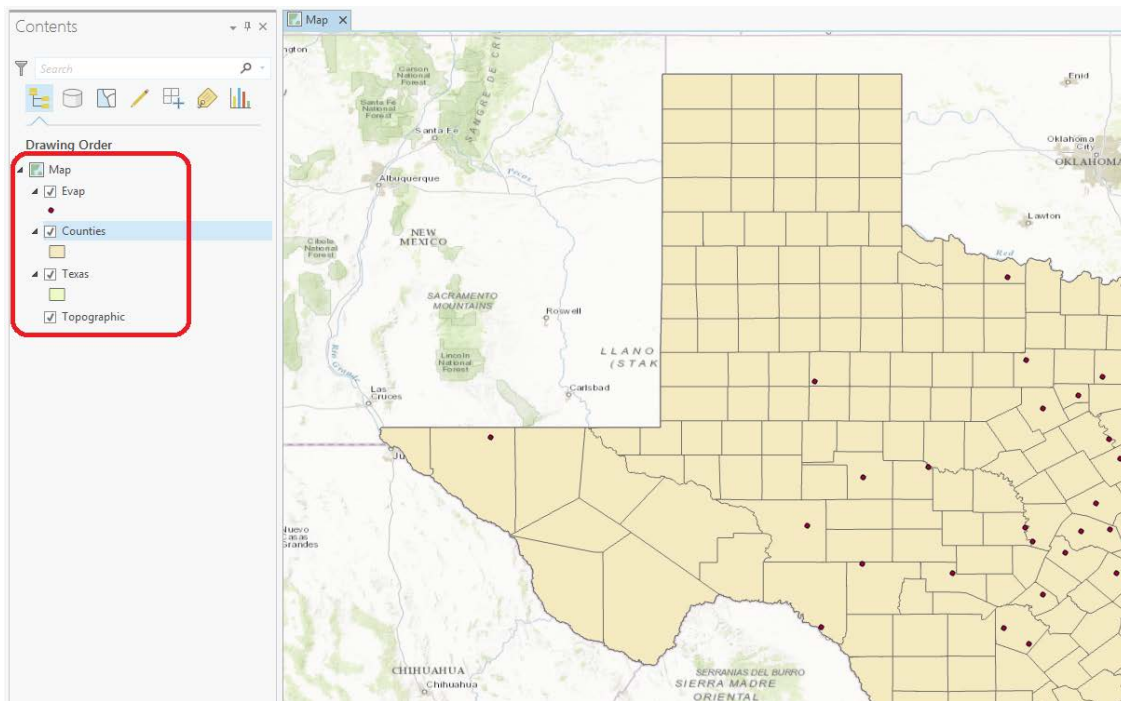


Note that the .aprx file that is saved does not contain the map data, rather it contains references to the data. This means that if you move the data files and then try and load the map document, ArcGIS Pro may not be able to find the data. We'll deal with how to fix this later.

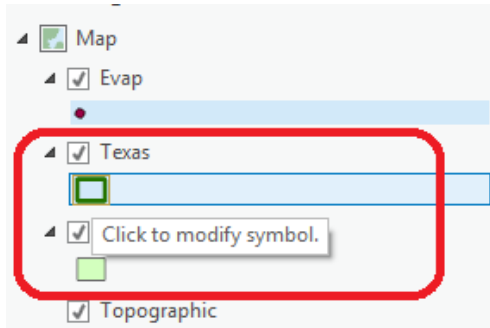
Depending on the order in which themes were added the **Texas** theme may lie above the **Counties** theme so you cannot see the **Counties** theme.



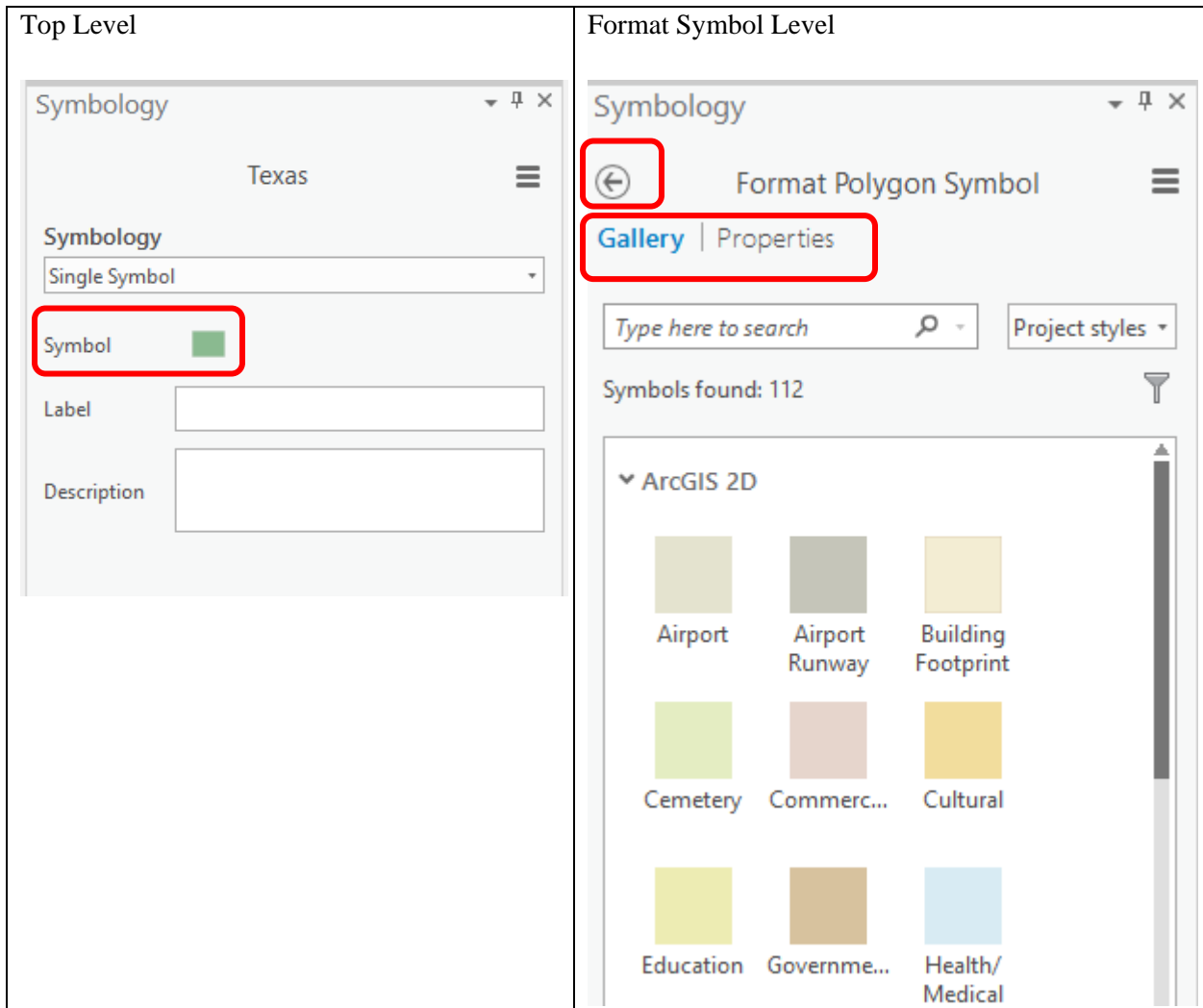
Click on the **Counties** theme and drag it up so that it is located above the **Texas** theme. You'll then get a display showing the counties.



To change the appearance of a map display, you can access the **Symbology** menu by selecting the Symbol displayed in the ArcGIS Pro table of contents and the **Symbology** information will open on the right side of the screen. Alternately, you may right-click on the layer name (ie. "Texas") and select **Symbology**.

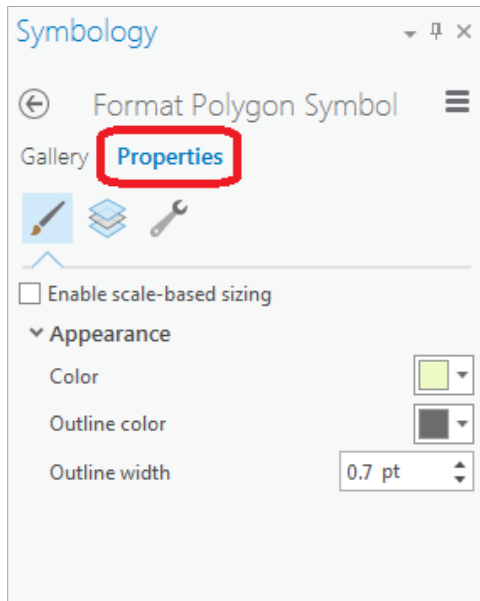


Note that depending on whether you open Symbology through the layer or through the symbol you get into symbology at the top level or at the Format Symbol Level

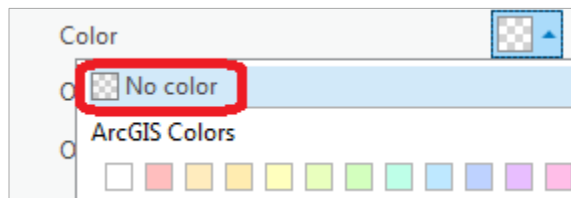


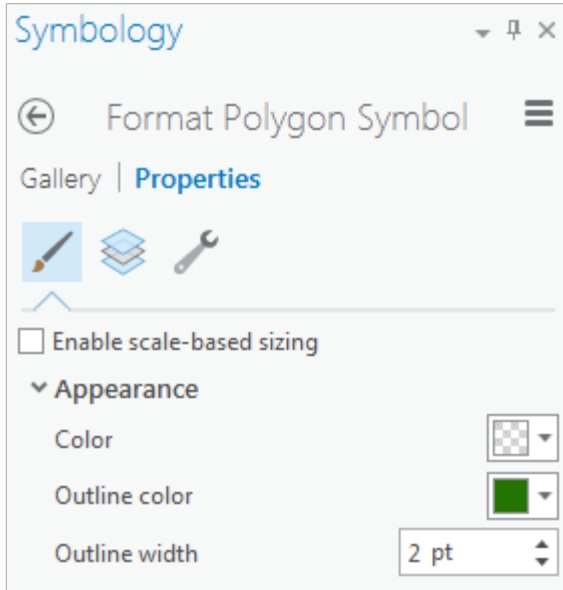
Clicking on the left arrow and Symbol toggles back and forth between these. You can also Toggle between Gallery and Properties to control the ways symbology can be adjusted. Experiment a bit with the options to get a feel for how you can change colors and outlines, or use preset symbology definitions.

Select **Properties**.

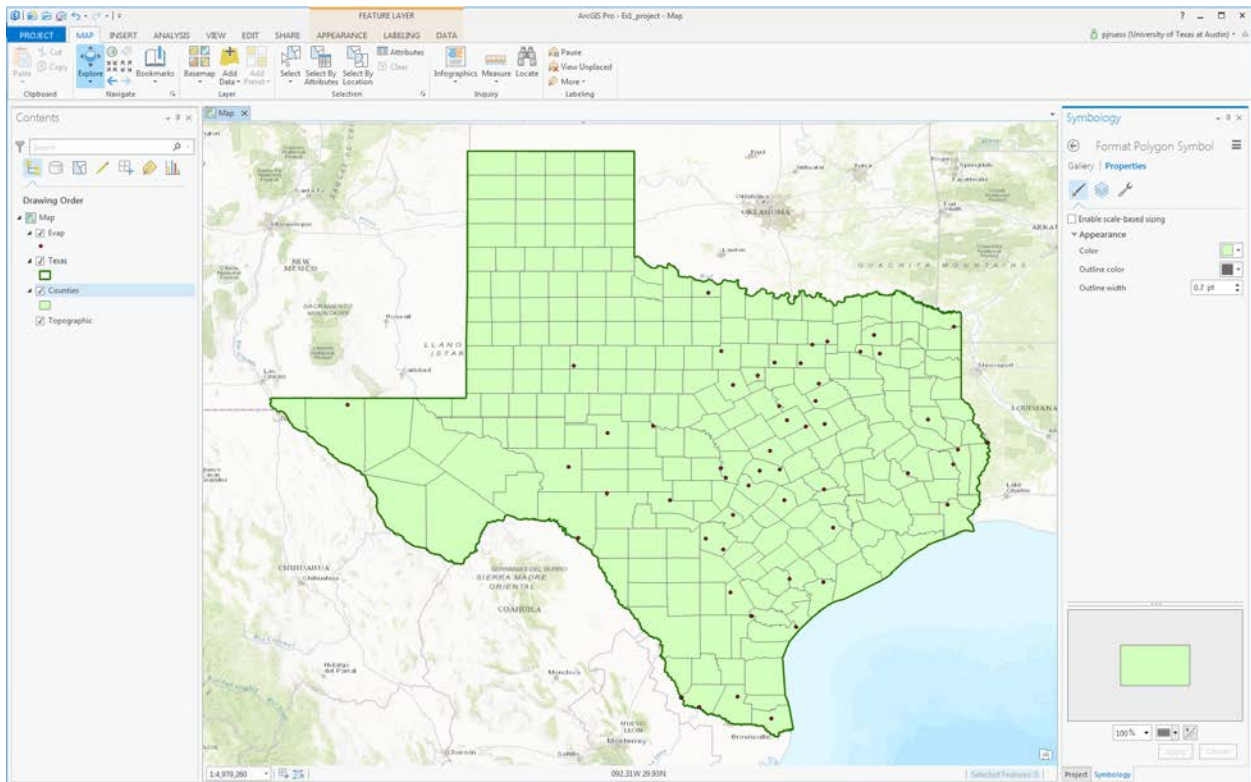


Now make your selections for the **Color**, **Outline Color**, and **Outline Width**, and click **Apply** at the bottom of the screen when finished. You can show the outline of the State of Texas more distinctly by using the **No Color** symbology for the Fill Color and then changing the Outline Color to Green and the **Outline Width** to 2.

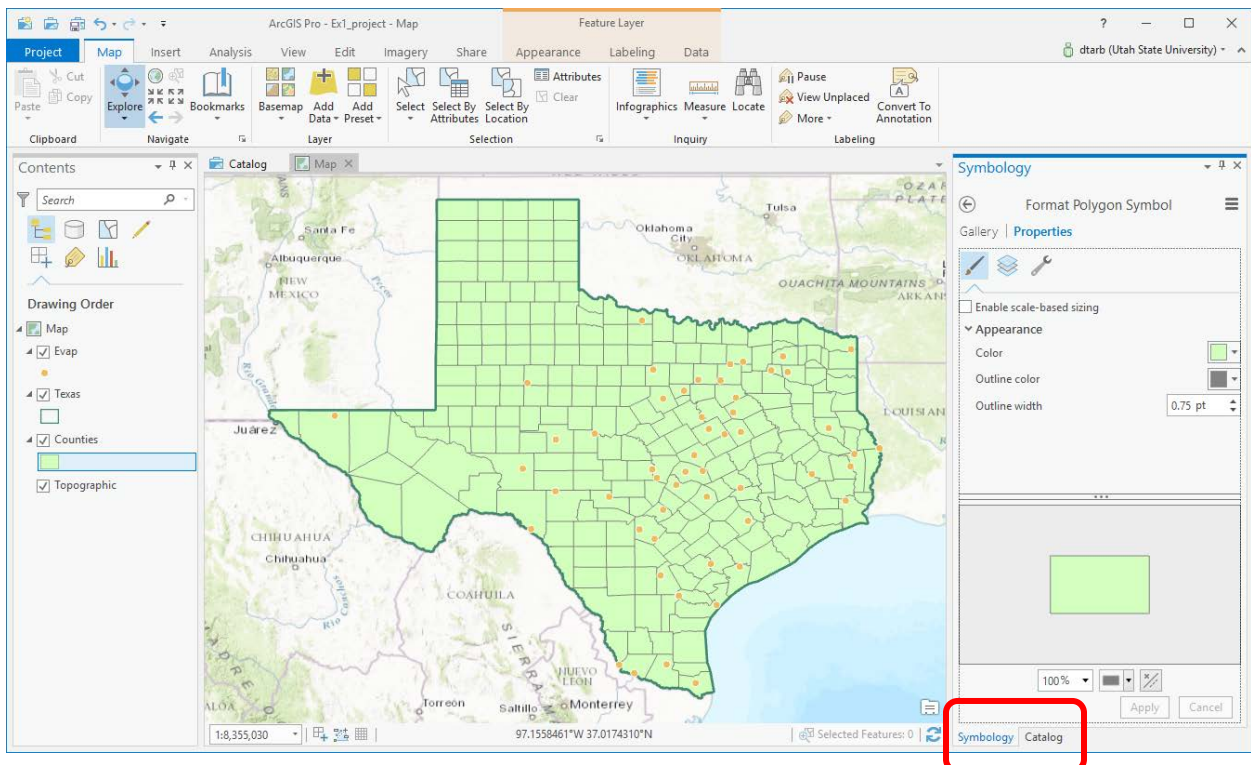
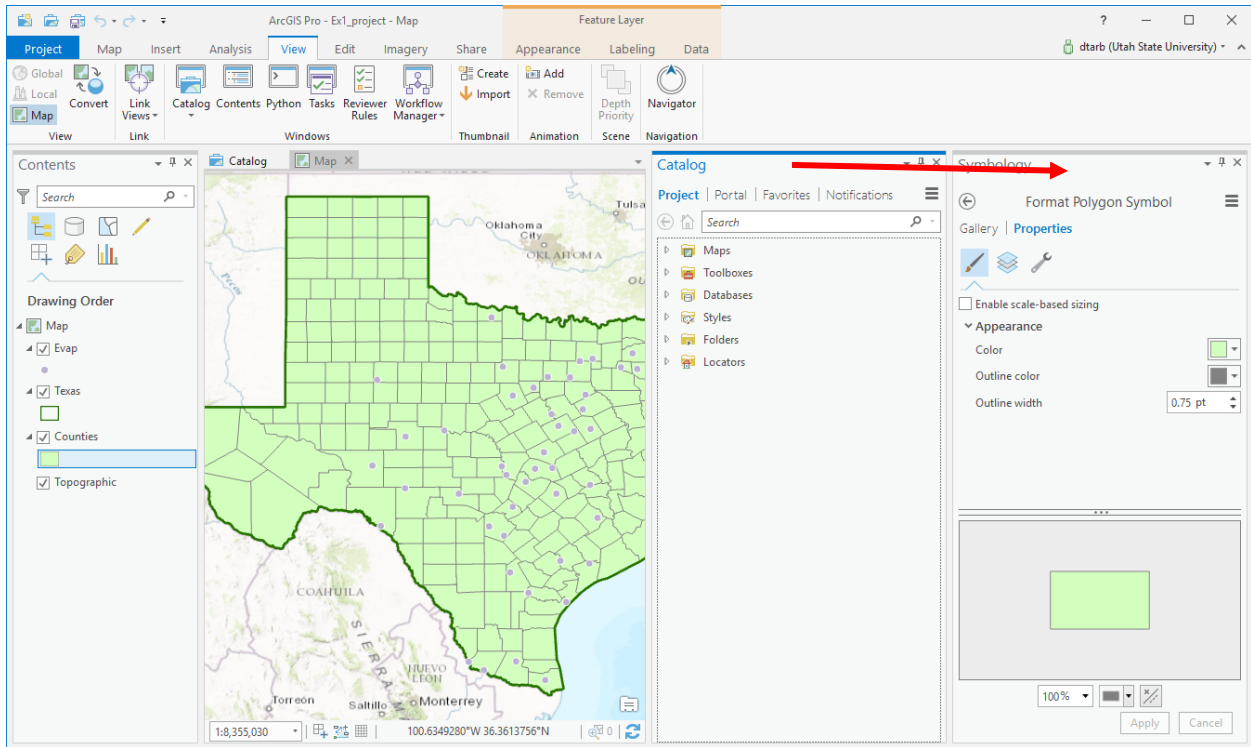




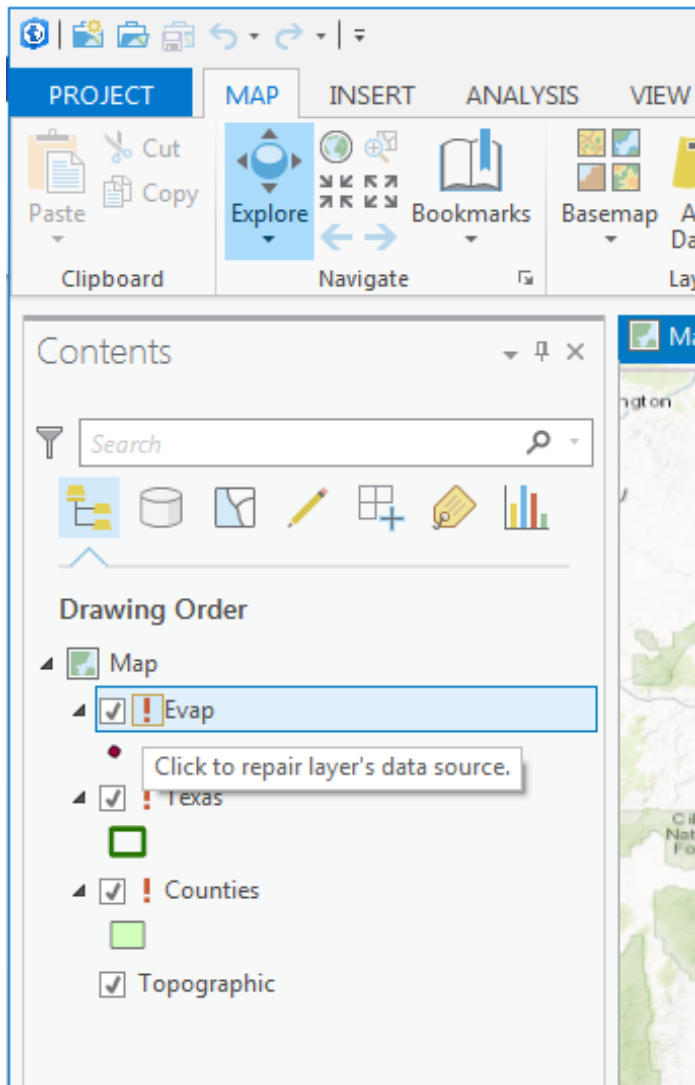
Drag the **Texas** layer above the **Counties** layer, and you'll see that the Counties are not obscured as they were before, and the State of Texas is highlighted with a nice Green outline! We are green in Texas! If you have another color for your Counties, then click on the Counties symbol in the Legend and in the **Symbol Selector** window that appears select a nice green color and hit Ok to recolor your counties.



Note that your display may contain multiple tabs and panes. You can move these around and dock them to suite your preferences and what you are doing. Here I docked the catalog pane and symbology pane together to simplify what I am working with.



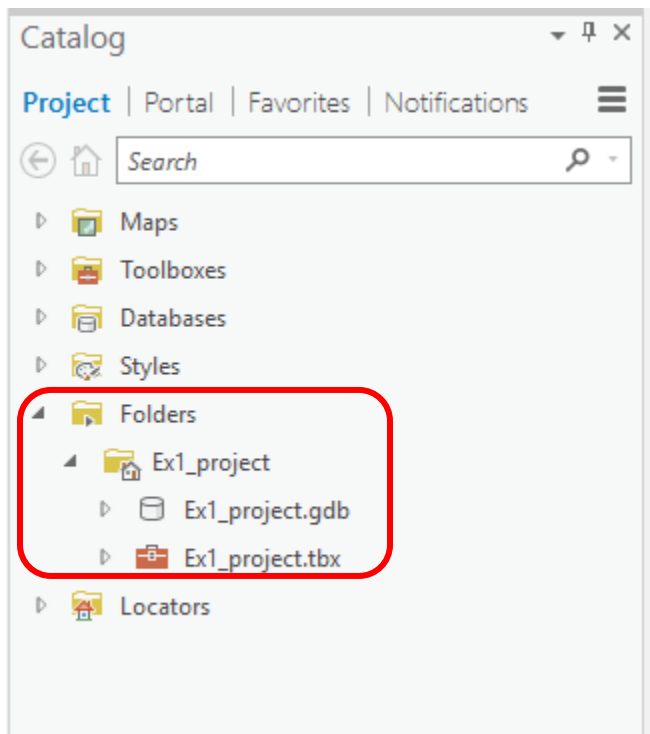
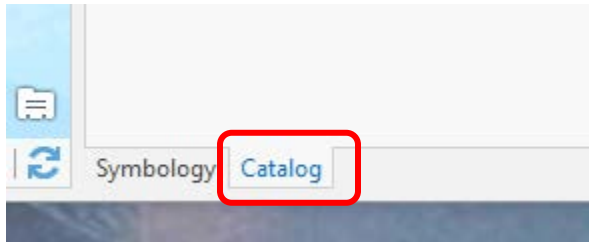
Helpful Tips: *If you move your project folder and open your ArcGIS Pro Ex1_project.aprx file later from another location in your file system, you may see a red exclamation points beside your feature classes. If this happens, click on the red exclamation point and relocate the file where the corresponding data are now stored, and your map will display correctly again.*



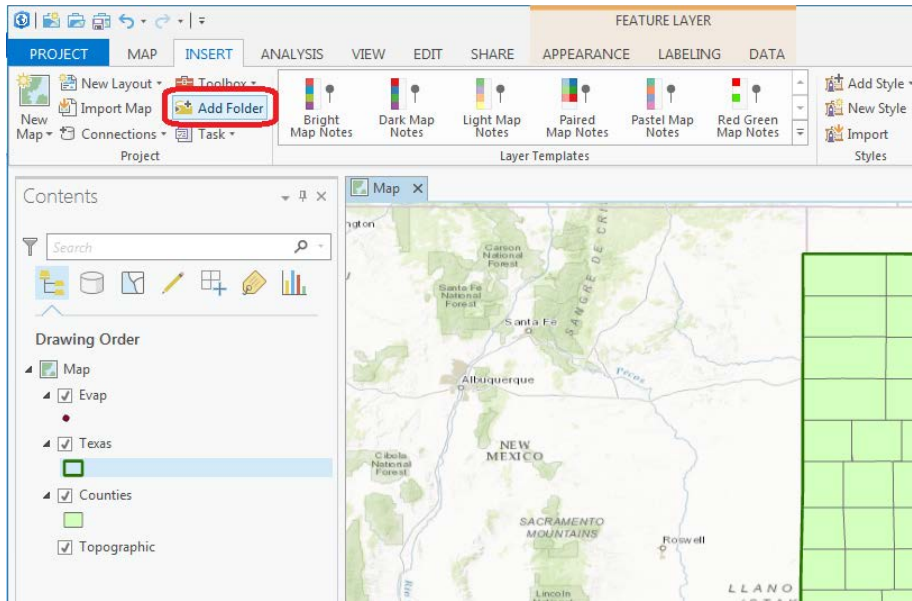
Note that these repairs will need to be made manually for all shapefiles within the .aprx file.

2. Viewing data and metadata using ArcGIS Pro Catalog

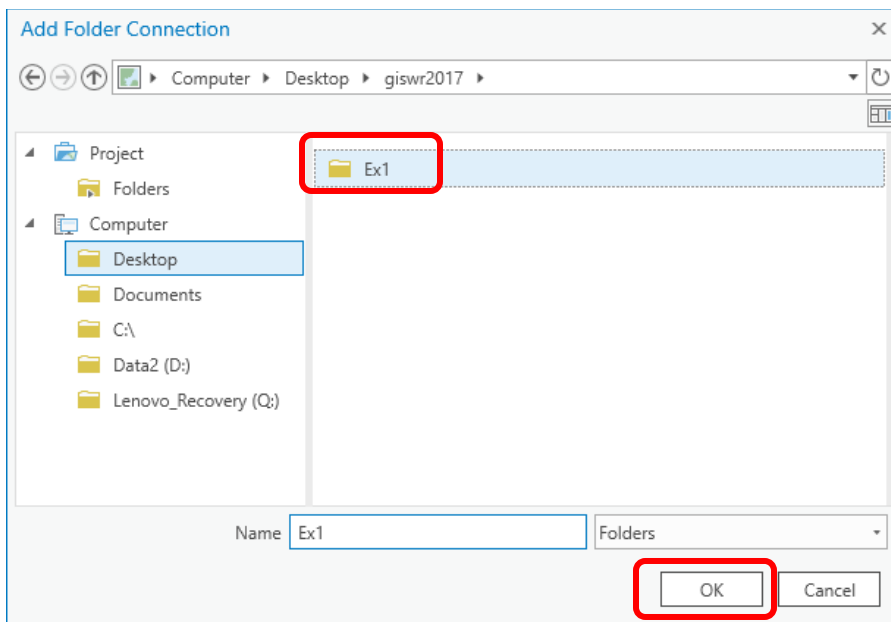
Click on Catalog and expand the folders section.



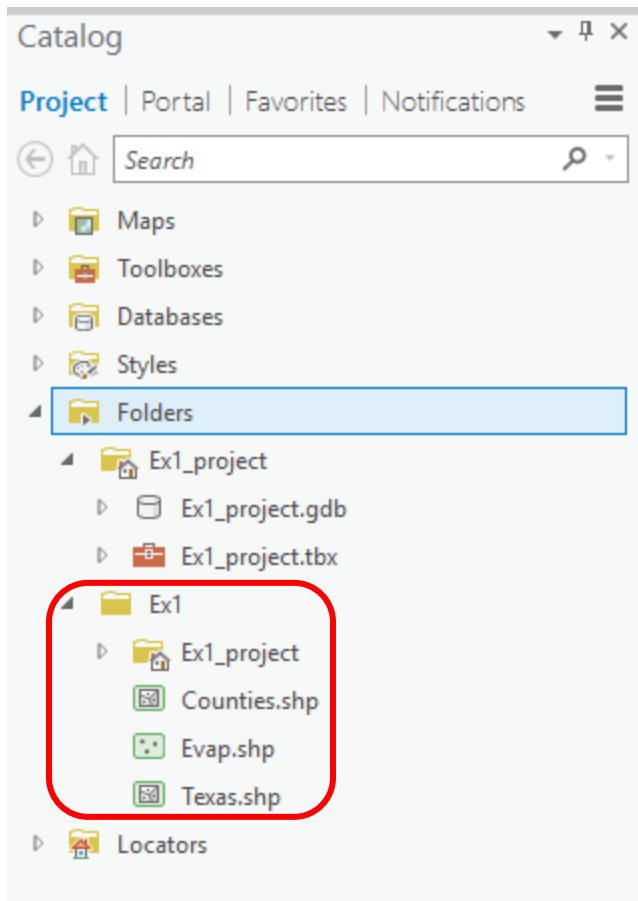
You will initially see only the Ex1_project folder. The shapefiles we added to this project are not in this folder so the catalog is so far unable to operate on them. To attach them so that their metadata can be examined using Catalog click on the **Insert** tab at the top and **Add Folder**



Navigate to the Ex1 folder and click OK to add the folder.

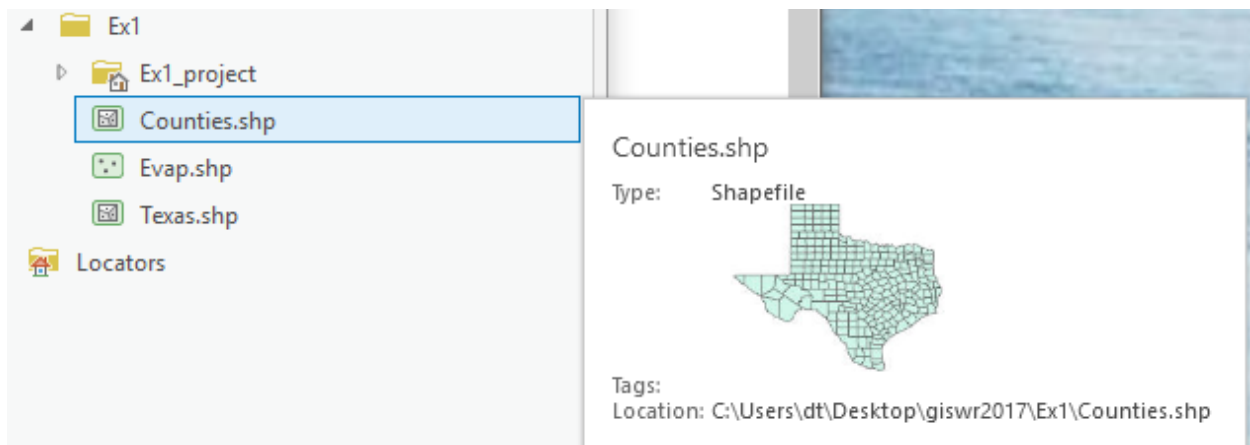


Now in the Folders section of the Project in Catalog you expand the Ex1 folder to see its files showing where your data is stored.

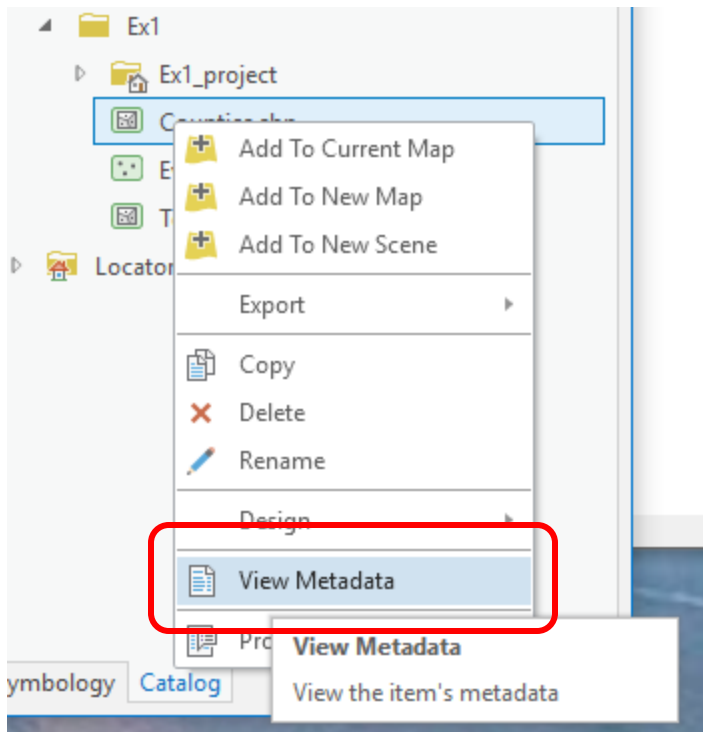


This concept of adding folders to an ArcGIS project can be confusing, so be patient, and remember these are references to data. The data is still on disk where you would normally find it using the Windows browser.

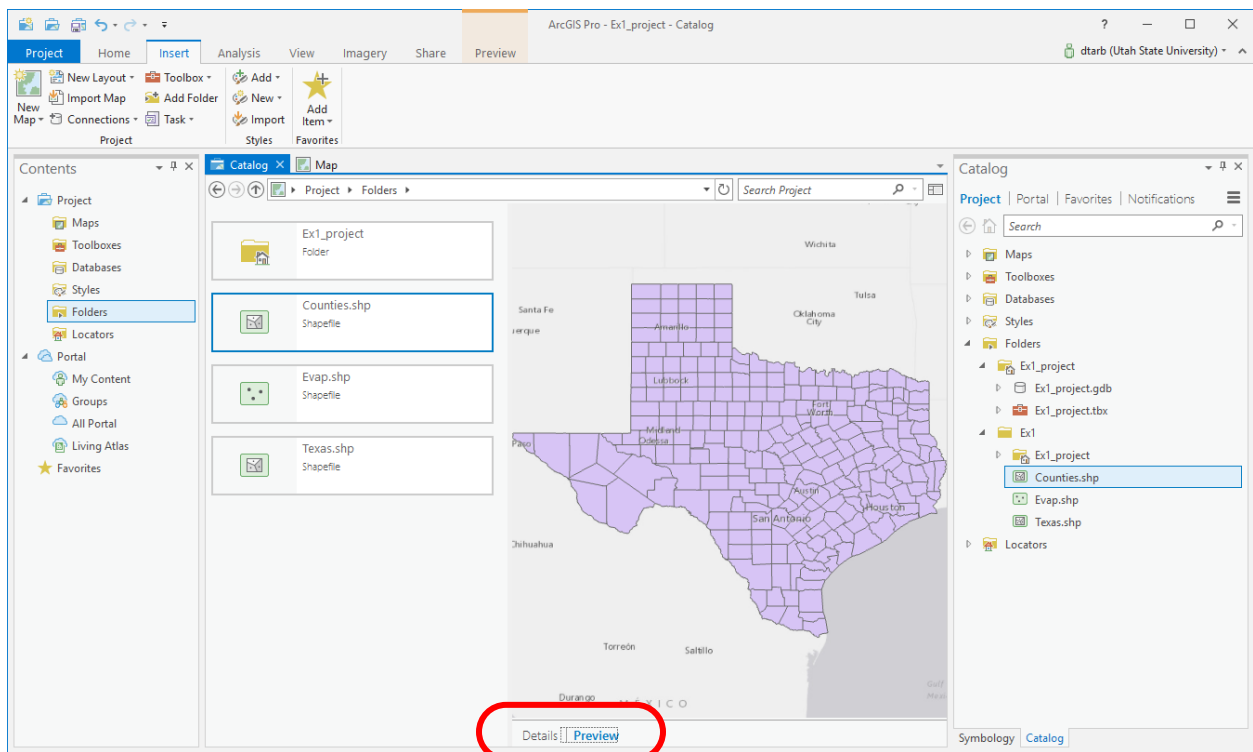
If you click on a data layer in catalog you can see a miniature image of the data.



You can right click to **View Metadata** for an item.

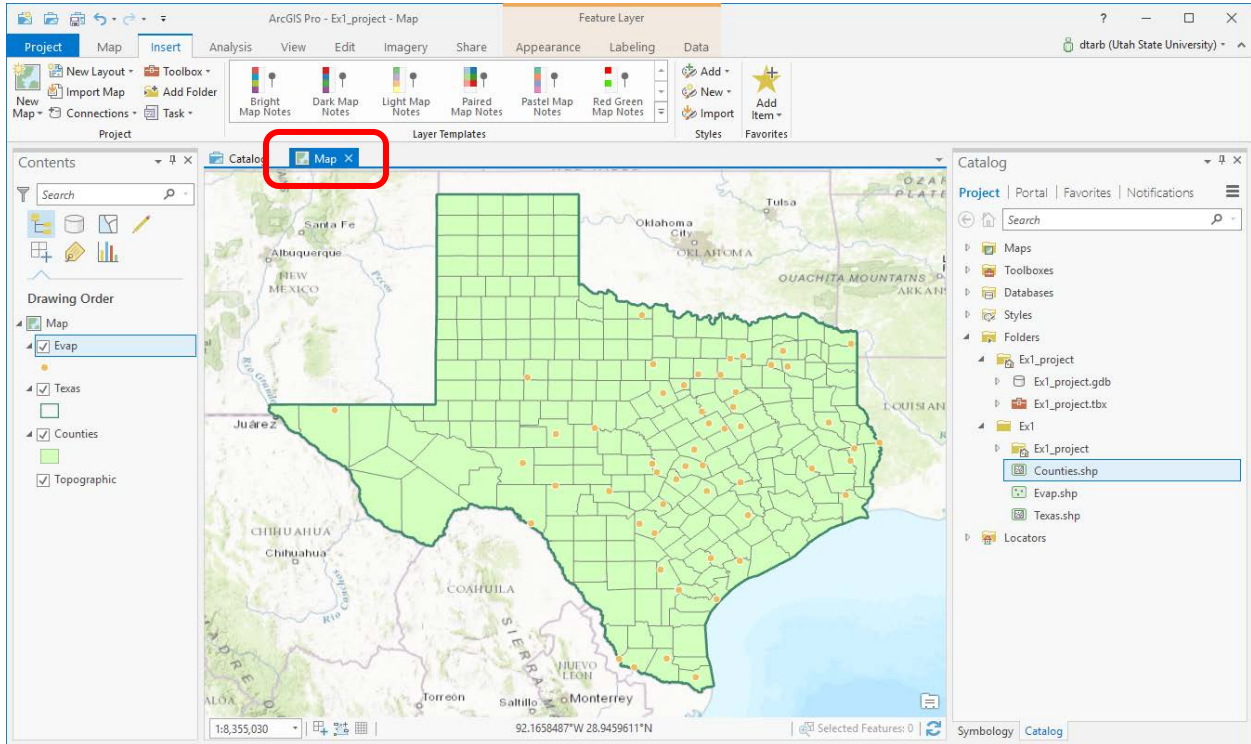


Toggle from Details to Preview

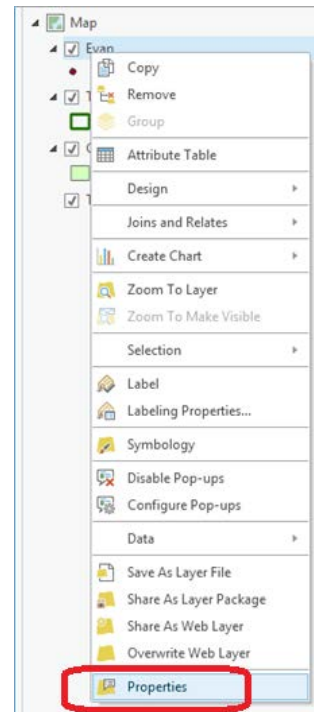


A geographic preview of the data layer is shown for each dataset. This is one of the ways ArcGIS shows the metadata for each dataset. Note that the project has switched to the Catalog tab.

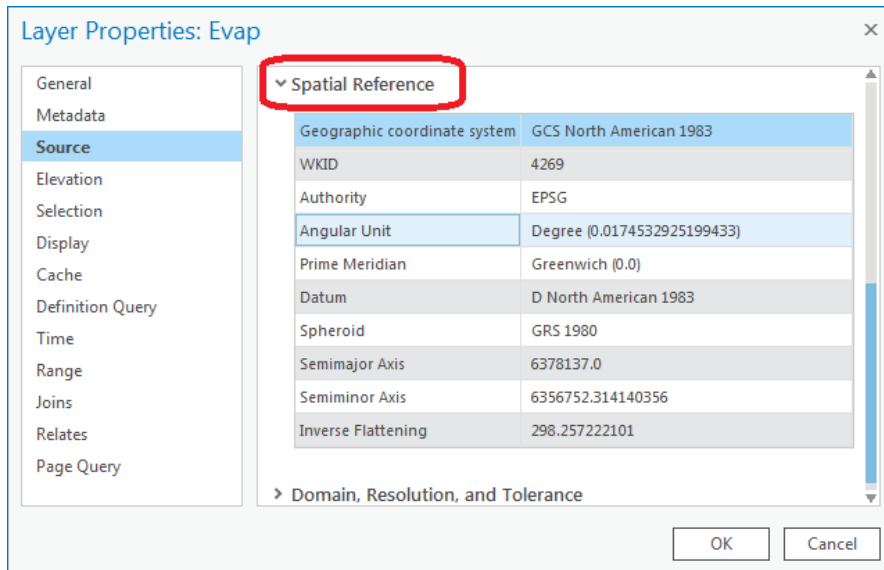
Select the **Map** tab instead of the **Catalog** tab and you'll get your map back again.



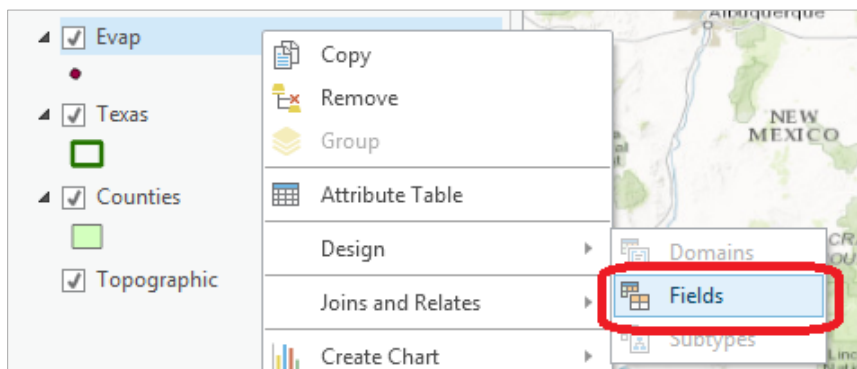
Now, if you right click on a feature class and select **Properties**.



Then navigate to **Source** and **Spatial Reference** to view the parameters of the coordinate system of the data selected. This provides information on projection and datum parameters that we'll learn more about later.



Close **Properties**, right click on a feature class, and select **Design/Fields** to open the Fields tab.



Here you'll see a formal definition of each attribute field with its **Field Name** and **Data Type**. In this case, **ObjectID** means a special data type that indexes each feature as an object in the GIS, **Geometry** means that the Shape field has geographical coordinates stored in it, and **Float** and **Double** mean decimal numbers in single or double precision, respectively. There are some other data types such as Short and Long integers, Text and Date types that we'll encounter later in the course. The attributes **Jan** through **Dec** refer to the pan evaporation in inches during that month, and **Annual** is the total annual evaporation for the year in inches. These values are averages compiled over a number of years (**NumYear**) of data between **FirstYear** and **FinalYear**. The data were compiled by the Texas Water Development Board.

Map **Fields: Evap** X

Current Layer: Evap

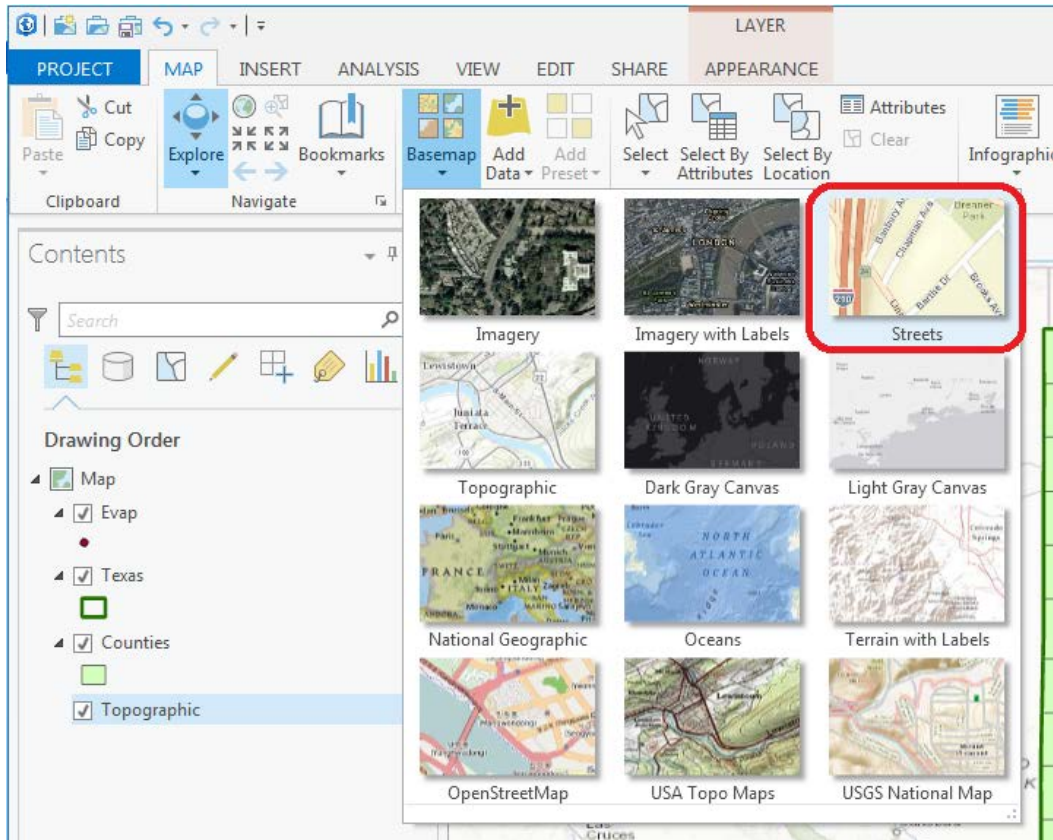
| <input checked="" type="checkbox"/> Visible | <input type="checkbox"/> Read Only | Field Name | Alias | Data Type | <input checked="" type="checkbox"/> Allow NULL | <input type="checkbox"/> Highlight | Number Format | Default | Precision | Scale | Length | |
|---|-------------------------------------|------------|-----------|-----------|--|------------------------------------|---------------|---------|-----------|-------|--------|-----|
| <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | FID | FID | Object ID | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 0 | 0 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Shape | Shape | Geometry | <input type="checkbox"/> | <input type="checkbox"/> | | | | 0 | 0 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Station | Station | Text | <input type="checkbox"/> | <input type="checkbox"/> | | | | 0 | 0 | 254 |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Latitude | Latitude | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Longitude | Longitude | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | NumYear | NumYear | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | FirstYear | FirstYear | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | FinalYear | FinalYear | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Jan | Jan | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Feb | Feb | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Mar | Mar | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Apr | Apr | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | May | May | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Jun | Jun | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Jul | Jul | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Aug | Aug | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Sep | Sep | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Oct | Oct | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Nov | Nov | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Dec | Dec | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Annual | Annual | Double | <input type="checkbox"/> | <input type="checkbox"/> | Numeric | | | 15 | 6 | |

Click here to add a new field.

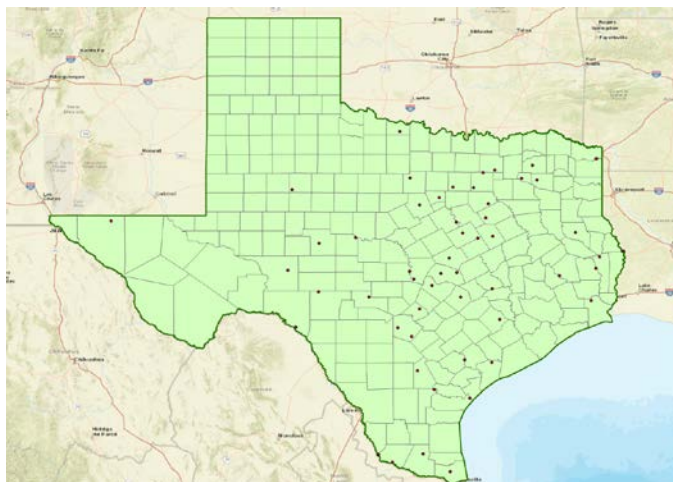
Click on the other two data layers, **Counties** and **Texas**, to preview them also.

3. Using Base Maps from ArcGIS Online

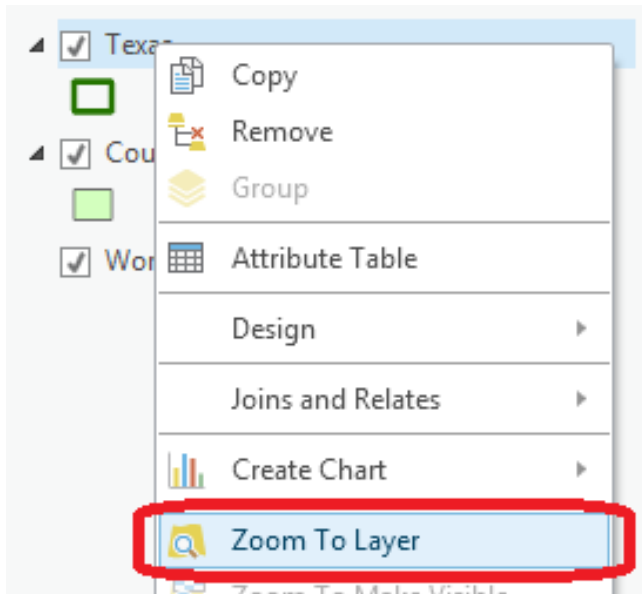
You may have noticed the topographic map that automatically loaded on start-up. This topographic map is an example of an ArcGIS Online basemap, which supplements the local GIS data we have been adding up to this point.



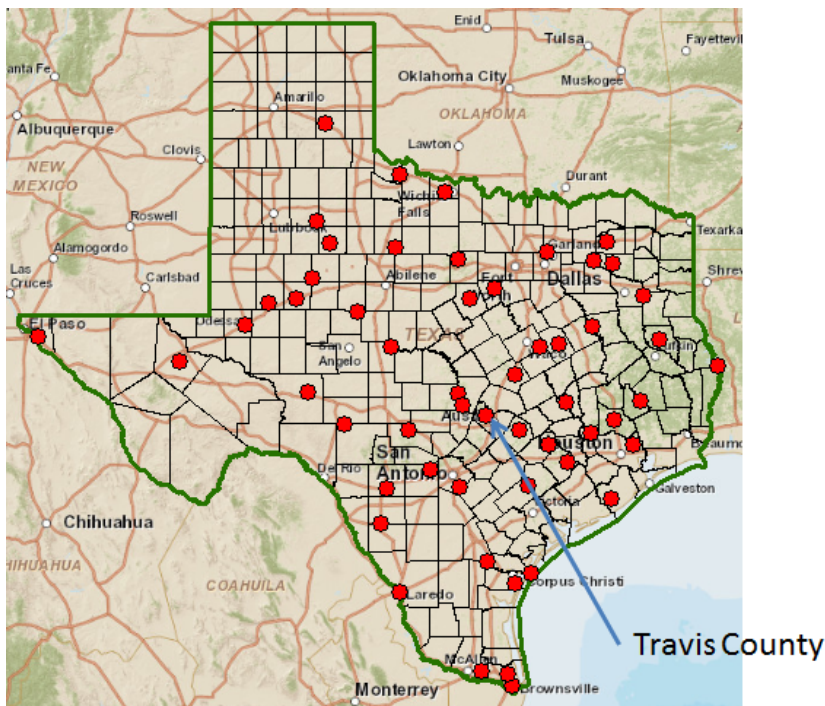
Click on **Basemap** then **Streets** to switch to the **Streets** basemap, and you should see a background map change from the default topography basemap to a display like that shown below. Pretty cool!



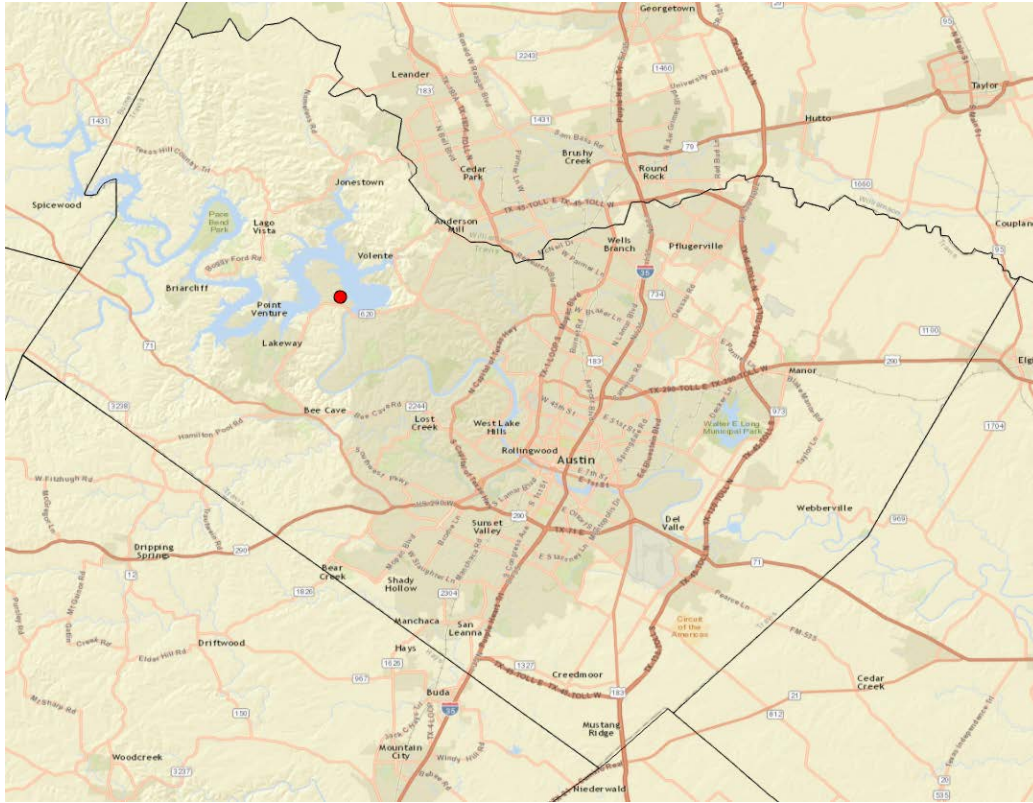
To quickly get the map to center on Texas, right click on the Texas layer and select **Zoom to Layer**



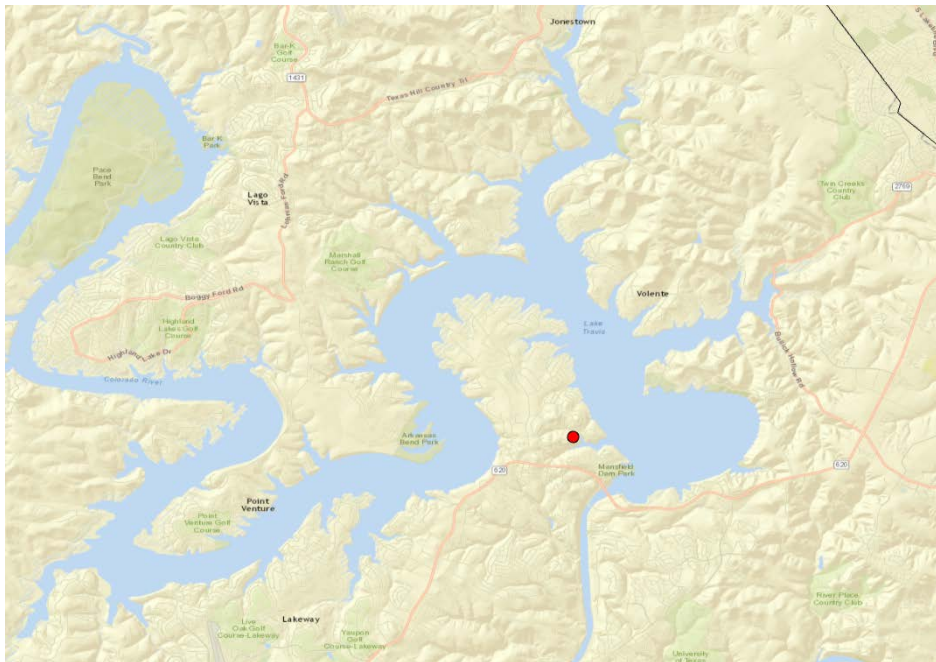
Click on the **Counties** theme and use the Symbol Selector to change the Fill Color to “No Color” so we can see through it to the background map, change the border color to black, and change the border thickness to 1. Click on the symbol for the Evap points and use the Symbol Selector to change the size of the points to 10 and the color to Red. Let’s examine Travis County.



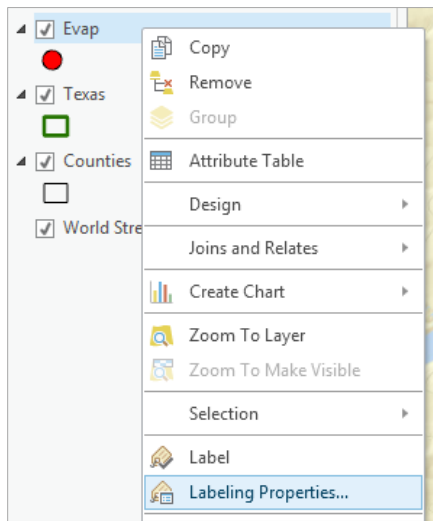
Zoom in to Travis County using the *scroll wheel* or *right-click and pan* (up zooms in, down zooms out).



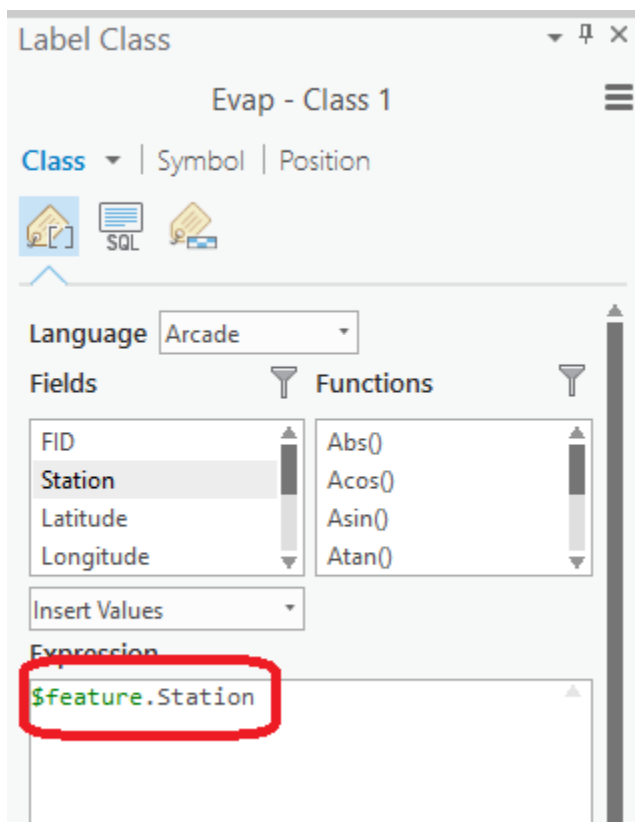
Zoom in to Travis County by Austin in the center of Texas, and let's examine the evaporation site by Lake Travis to the Northwest of the city. Notice how more detailed information appears as you zoom in.



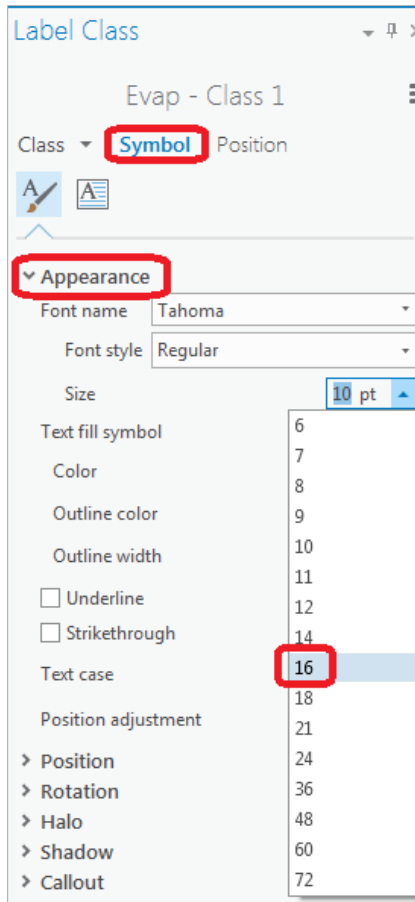
Let's label the sites with their names. To create a label, right click on Evap and select **Labeling Properties** from the menu to open the **Label Class** options on the right side of the screen.



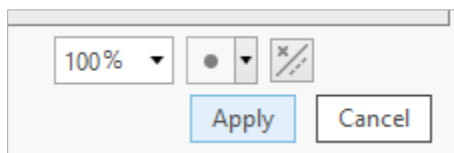
Verify that **Station** is selected (`$feature.Station` in the Expression box).



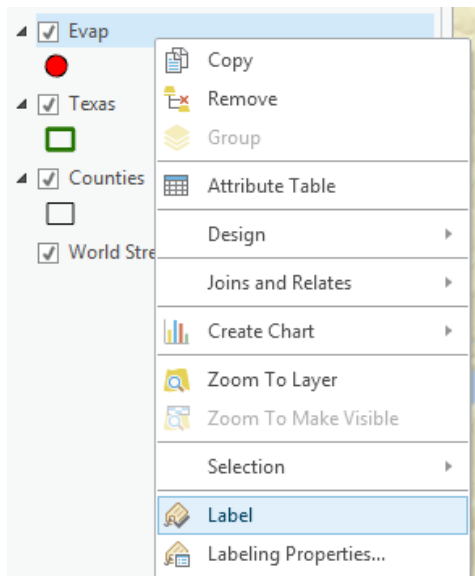
At the top of the **Label Class**, select **Symbol** and **Appearance**, then select **16** point as the type size. Hit **Apply** at the bottom of the screen to accept changes.



Hit **Apply** to confirm these selections



Now, to display the label, right click on the **Evap** theme and select **Label** from the menu.



Now we've got a nice map that shows the location of our observation site labeled with its name.



If you zoom in a bit closer, you can see just where the site is located near Lake Travis. You can even see the access roads you'd use to go to this site.



Now, let's look at some imagery for this location. Proceeding as you did before to get the Street map, use the **BaseMap** button to add data for **Imagery**.



Imagery

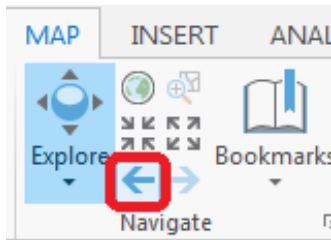
And now you'll see the same information displayed against a background map of orthoimagery, and let's zoom in a bit to see more detail. For the **Evap** theme, I have used the **Properties/Label** to change the color of my site labels from black to blue to make them easier to see against the image background. This is really cool stuff! You can really get a sense of context about where this observation site is located.



Use **File/Save** to save this map display as **Ex1_project.aprx** so that you can get it back later.

4. Accessing and Querying Attribute Data

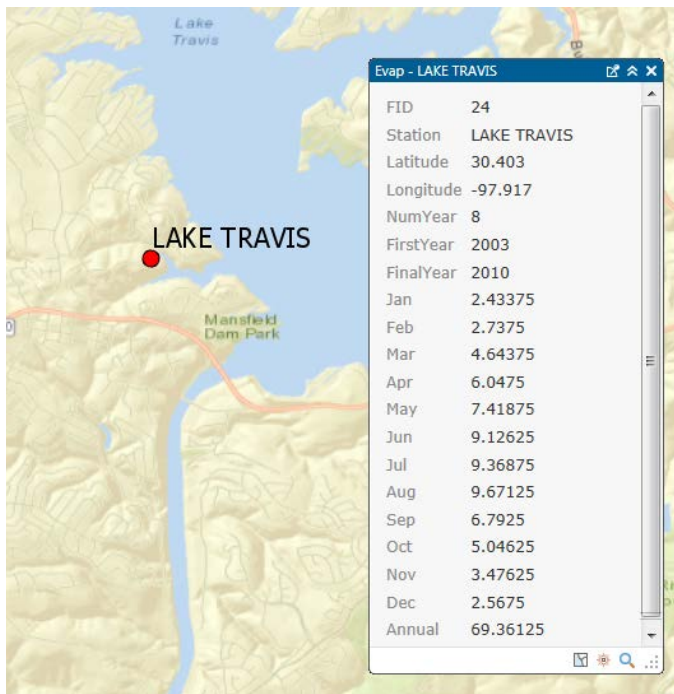
Let's go back to the view we had earlier of Travis County. Use the Go Back to Previous Extent arrow



to step back through the views we have just been working on, and switch back to the **Streets** basemap again. Change the Label color for the **Evap** sites back to Black.

Numerical and text information stored in the fields of the shapefile tables are called **attributes**. To access attribute data of the feature at a specific location, simply click on the feature in the map you are interested in. In this case, click on the Lake Travis evaporation site symbology (the red point).

In the window that pops up you'll see the attributes of that particular feature. In this instance, what you see is that the data for Lake Travis cover the range from 2003 to 2010, the latitude and longitude are 30.403 and -97.917, and the values from Jan through Dec are the mean monthly evaporation recorded at this location whose annual total is 69.36 inches.



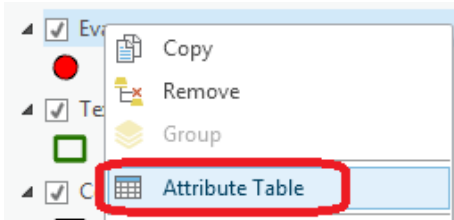
These are pan evaporation data recorded using an instrument like that shown below. The evaporation data were obtained from the Texas Water Development Board. Only data from 2001 onwards is used since the TWDB has quality control checked that information. Monthly evaporation is found by averaging the daily

values of evaporation read from the pan, and multiplying by the number of days in the month. If a month has fewer than 20 daily values recorded, it is excluded from the dataset. Only years with valid monthly data for all 12 months are used in computing the mean monthly and mean annual pan evaporation data shown in the attribute table.

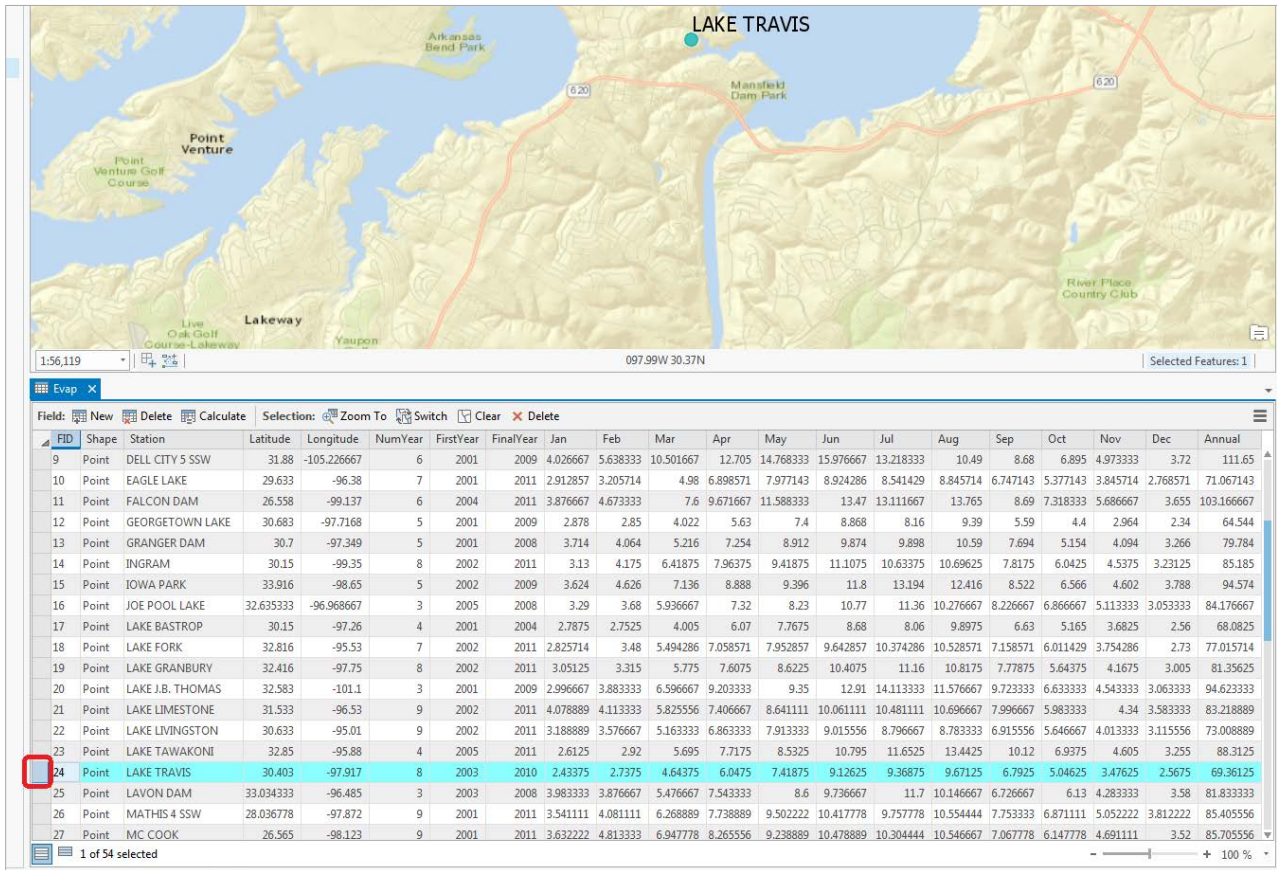


Viewing an Attribute Table

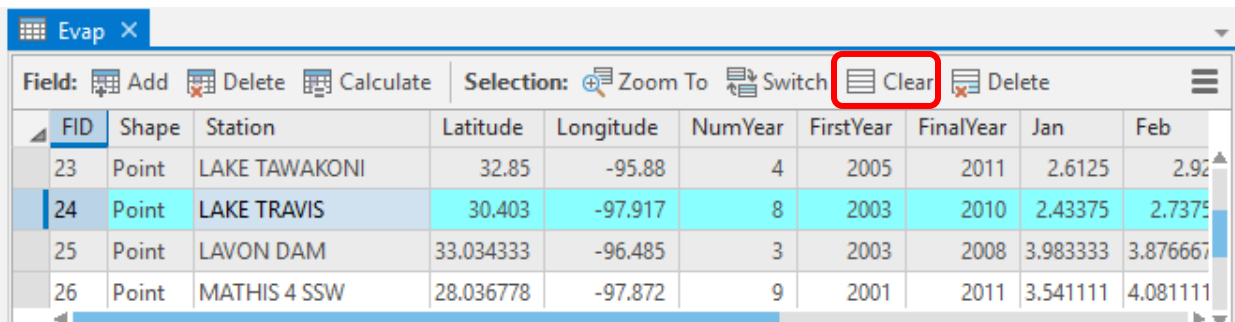
To access attribute data of an entire layer in ArcGIS Pro: right click on the **Evap** layer name in the table of contents, and select **Attribute Table**:



If you scroll down the resulting **Table** and click on the box to the left of **FID 24**, you'll see the record that contains the attributes of the Lake Travis station that you identified earlier. You may have noticed that once you selected the row, the corresponding point was selected in the map – this is a key idea of GIS – map features are described by records in attribute tables.



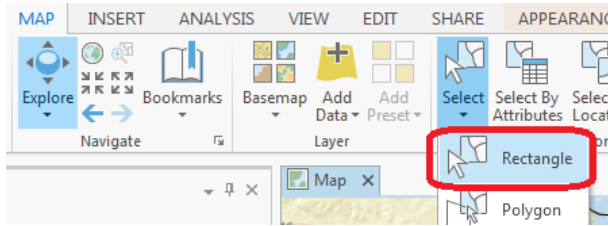
To Clear a Selected feature and select a new one, click on **Clear** at the top of the **Attribute Table**.



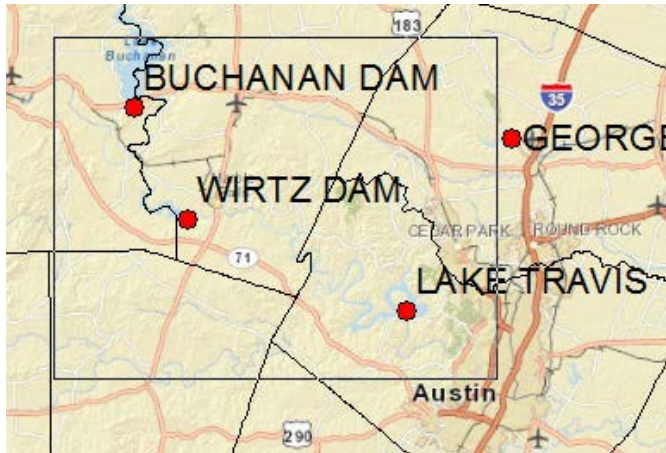
5. Selecting features from a feature class

Selecting features from a feature class involves choosing a subset of all the features in the class for a specific purpose. Feature selection can be made from a map by identifying the geometric shape or from an

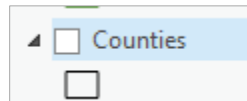
attribute table by identifying the record. Regardless of how you select an object, both the shape in the map and the record in the attribute table will be selected. Click on the **Select/Select Features by Rectangle** tool in the *Map* tab.



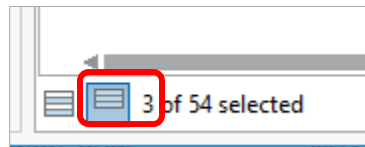
Zoom back a bit and drag a box over the three evaporation sites in the Highland Lakes reservoir system.



you'll see both records highlighted on the map and in the attribute table. I've turned off the Counties layer (click off the check box in the map Legend)



and used **Show selected records** at the bottom of the Attribute Table to just show the three highlighted stations.



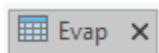
| FID | Shape | Station | Latitude | Longitude | NumYear | FirstYear | FinalYear | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|-----|-------|--------------|----------|-----------|---------|-----------|-----------|---------|--------|---------|--------|---------|---------|---------|---------|--------|---------|---------|--------|----------|
| 5 | Point | BUCHANAN DAM | 30.733 | -98.43 | 5 | 2007 | 2011 | 2.682 | 3.51 | 5.774 | 7.234 | 7.976 | 10.372 | 9.668 | 10.216 | 7.434 | 5.884 | 3.82 | 2.658 | 77.24 |
| 24 | Point | LAKE TRAVIS | 30.403 | -97.917 | 8 | 2003 | 2010 | 2.43375 | 2.7375 | 4.64375 | 6.0475 | 7.41875 | 9.12625 | 9.36875 | 9.67125 | 6.7925 | 5.04625 | 3.47625 | 2.5675 | 69.36125 |
| 52 | Point | WIRTZ DAM | 30.55 | -98.33 | 4 | 2002 | 2006 | 3.4875 | 3.7 | 5.1425 | 8.295 | 10.1375 | 10.805 | 10.615 | 10.8975 | 7.4175 | 5.5425 | 4.4225 | 3.59 | 84.08 |

To clear your selection, choose **Clear**.

Clicking on Show all records, then displays all the records in the attribute table again.

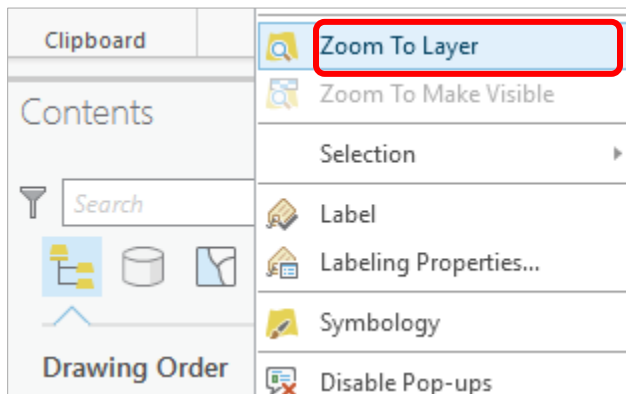
| FID | Shape | Station | Latitude | Longitude | NumYear | FirstYear | FinalYear | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|-----|-------|----------------------|-----------|-------------|---------|-----------|-----------|----------|----------|-----------|----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|-----------|
| 0 | Point | AMISTAD DAM | 29.46 | -101.02 | 8 | 2001 | 2010 | 4.305 | 4.98875 | 7.73875 | 9.7475 | 11.7075 | 14.37375 | 13.5475 | 13.73625 | 9.43 | 7.4575 | 5.77375 | 4.705 | 107.5662 |
| 1 | Point | BARDWELL DAM | 32.263 | -96.637 | 5 | 2001 | 2008 | 4.076 | 3.47 | 5.64 | 7.034 | 8.266 | 9.904 | 10.472 | 10.422 | 7.876 | 7.178 | 4.704 | 3.75 | 82.84 |
| 2 | Point | BEAUMONT RESEAR... | 30.0668 | -94.2866 | 5 | 2001 | 2011 | 2.8 | 2.938 | 4.848 | 6.398 | 8.058 | 7.656 | 7.172 | 7.766 | 5.978 | 5.172 | 3.53 | 2.76 | 65.13 |
| 3 | Point | BENBROOK DAM | 32.647 | -97.443 | 6 | 2002 | 2008 | 3.783333 | 3.743333 | 5.96 | 6.953333 | 7.78 | 8.95 | 9.971667 | 9.688333 | 7.633333 | 5.573333 | 4.658333 | 3.725 | 78.4 |
| 4 | Point | BRAUNIG LAKE | 29.25 | -98.38 | 7 | 2001 | 2010 | 2.83 | 2.962857 | 4.674286 | 6.254286 | 8.442857 | 9.384286 | 9.308571 | 9.47 | 7.424286 | 5.417143 | 4.051429 | 2.834286 | 73.09285 |
| 5 | Point | BUCHANAN DAM | 30.733 | -98.43 | 5 | 2007 | 2011 | 2.682 | 3.51 | 5.774 | 7.234 | 7.976 | 10.372 | 9.668 | 10.216 | 7.434 | 5.884 | 3.82 | 2.658 | 77.2 |
| 6 | Point | CANYON DAM | 29.87 | -98.196 | 9 | 2001 | 2011 | 3.192222 | 3.353333 | 5.173333 | 6.75 | 8.347778 | 10.312222 | 9.074444 | 10.16 | 7.285556 | 5.811111 | 3.977778 | 2.952222 | 76.44777 |
| 7 | Point | CHOKE CANYON DA... | 28.467 | -98.252 | 10 | 2001 | 2011 | 3.269 | 3.989 | 6.158 | 7.735 | 9.724 | 11.043 | 10.586 | 11.272 | 7.793 | 6.685 | 4.503 | 3.137 | 85.95 |
| 8 | Point | COLETO CREEK RESE... | 28.715 | -97.174 | 8 | 2004 | 2011 | 2.4475 | 2.49875 | 3.83625 | 4.50375 | 5.26875 | 5.84875 | 5.39125 | 5.79 | 4.6075 | 4.12625 | 3.0775 | 2.29125 | 49.7 |
| 9 | Point | DELL CITY 5 SSW | 31.88 | -105.226667 | 6 | 2001 | 2009 | 4.026667 | 5.638333 | 10.501667 | 12.705 | 14.768333 | 15.976667 | 13.218333 | 10.49 | 8.68 | 6.895 | 4.973333 | 3.72 | 111.6 |
| 10 | Point | EAGLE LAKE | 29.633 | -96.38 | 7 | 2001 | 2011 | 2.912857 | 3.205714 | 4.98 | 6.898571 | 7.977143 | 8.924286 | 8.541429 | 8.845714 | 6.747143 | 5.377143 | 3.845714 | 2.768571 | 71.06714 |
| 11 | Point | FALCON DAM | 26.558 | -99.137 | 6 | 2004 | 2011 | 3.876667 | 4.673333 | 7.6 | 9.671667 | 11.588333 | 13.47 | 13.111667 | 13.765 | 8.69 | 7.318333 | 5.686667 | 3.655 | 103.16666 |
| 12 | Point | GEORGETOWN LAKE | 30.683 | -97.7168 | 5 | 2001 | 2009 | 2.878 | 2.85 | 4.022 | 5.63 | 7.4 | 8.868 | 8.16 | 9.39 | 5.59 | 4.4 | 2.964 | 2.34 | 64.54 |
| 13 | Point | GRANGER DAM | 30.7 | -97.349 | 5 | 2001 | 2008 | 3.714 | 4.064 | 5.216 | 7.254 | 8.912 | 9.874 | 9.898 | 10.59 | 7.694 | 5.154 | 4.094 | 3.266 | 79.78 |
| 14 | Point | INGRAM | 30.15 | -99.35 | 8 | 2002 | 2011 | 3.13 | 4.175 | 6.41875 | 7.96375 | 9.41875 | 11.1075 | 10.63375 | 10.69625 | 7.8175 | 6.0425 | 4.5375 | 3.23125 | 85.18 |
| 15 | Point | IOWA PARK | 33.916 | -98.65 | 5 | 2002 | 2009 | 3.624 | 4.626 | 7.136 | 8.888 | 9.396 | 11.8 | 13.194 | 12.416 | 8.522 | 6.566 | 4.602 | 3.788 | 94.57 |
| 16 | Point | JOE POOL LAKE | 32.635333 | -96.968667 | 3 | 2005 | 2008 | 3.29 | 3.68 | 5.936667 | 7.32 | 8.23 | 10.77 | 11.36 | 10.276667 | 8.226667 | 6.866667 | 5.113333 | 3.053333 | 84.17666 |
| 17 | Point | LAKE BASTROP | 30.15 | -97.26 | 4 | 2001 | 2004 | 2.7875 | 2.7525 | 4.005 | 6.07 | 7.7675 | 8.68 | 8.06 | 9.8975 | 6.63 | 5.165 | 3.6825 | 2.56 | 68.082 |

Close the Attribute Table by clicking on the X next to the Evap tab:

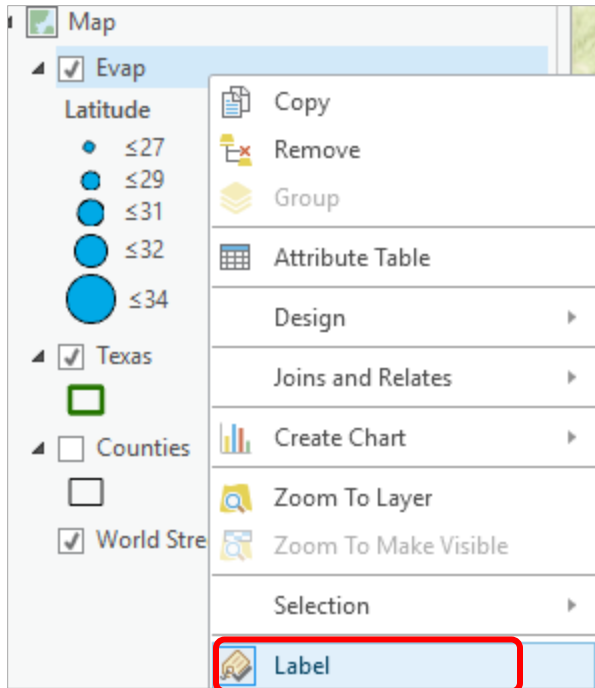


6. Mapping Annual Evaporation

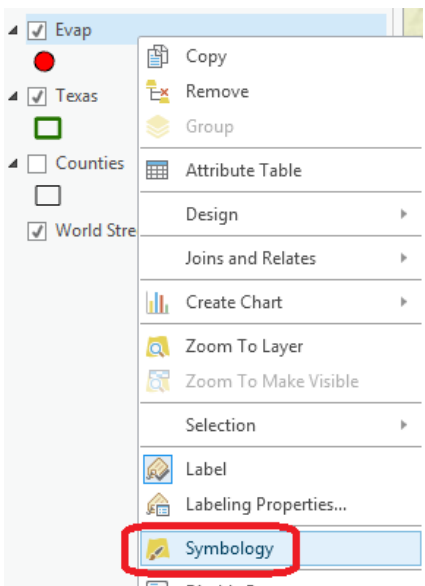
Let's suppose we want to map the values of annual evaporation recorded at the stations, rather than just symbolizing them by their location. Let's zoom out to the state of Texas again. Right click on the **Texas** feature class and select **Zoom to Layer**



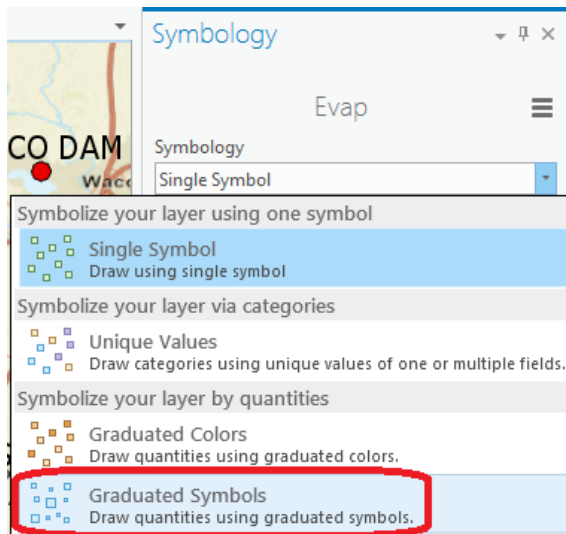
You'll see that there are a lot of labels showing up large in your new map. Get rid of these by right clicking on the Evap layer and toggling the Label entry so that the Labels are turned off.



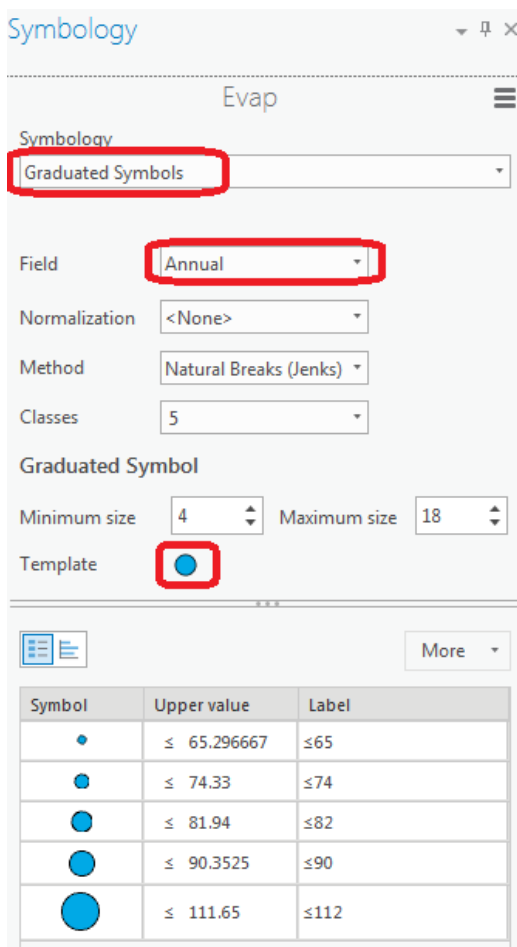
Right click on the **Evap** layer and select **Symbology**.



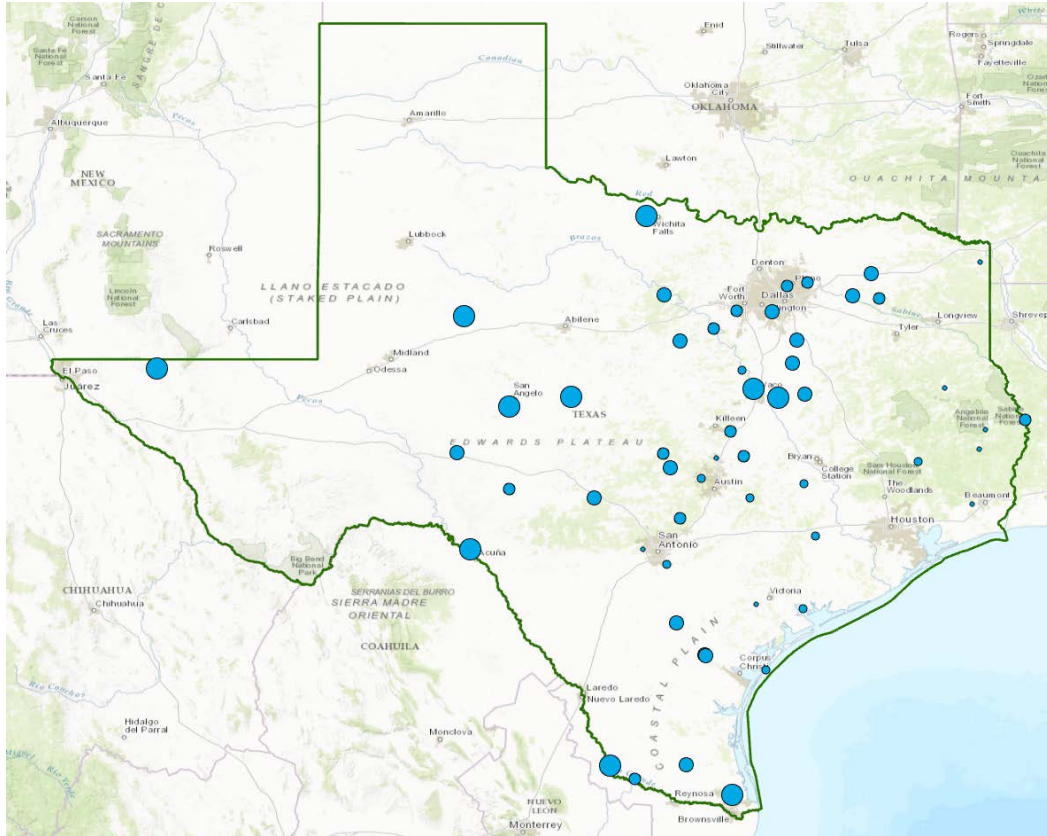
In the Symbology section on the right-hand side, click on “Single Symbol” and change to “Graduated Symbols”.



Change **Field** to “Annual” and make the **Template** color blue.

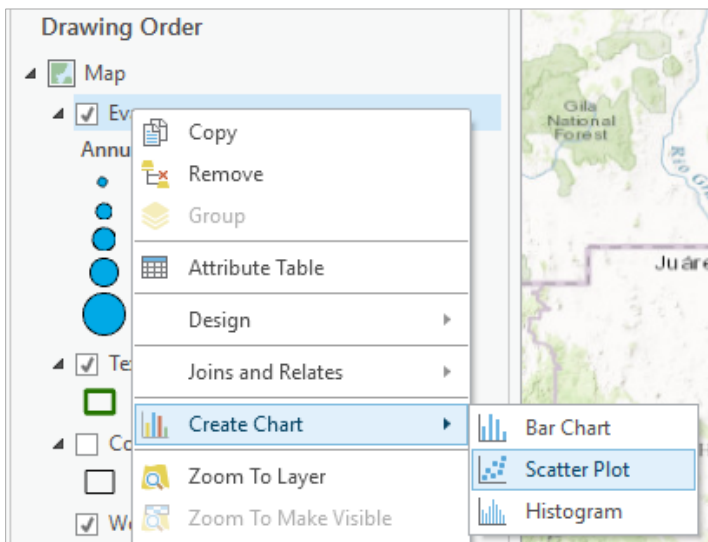


I have turned off all the other layers and added the **Topographic** base map to get the image below. Very cool!

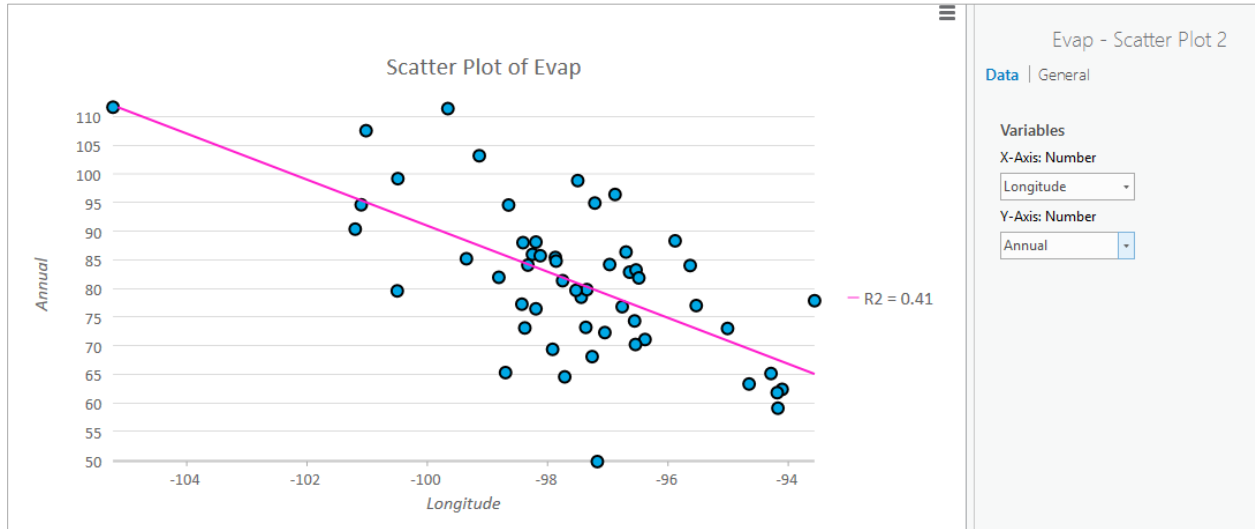


7. Making a Chart

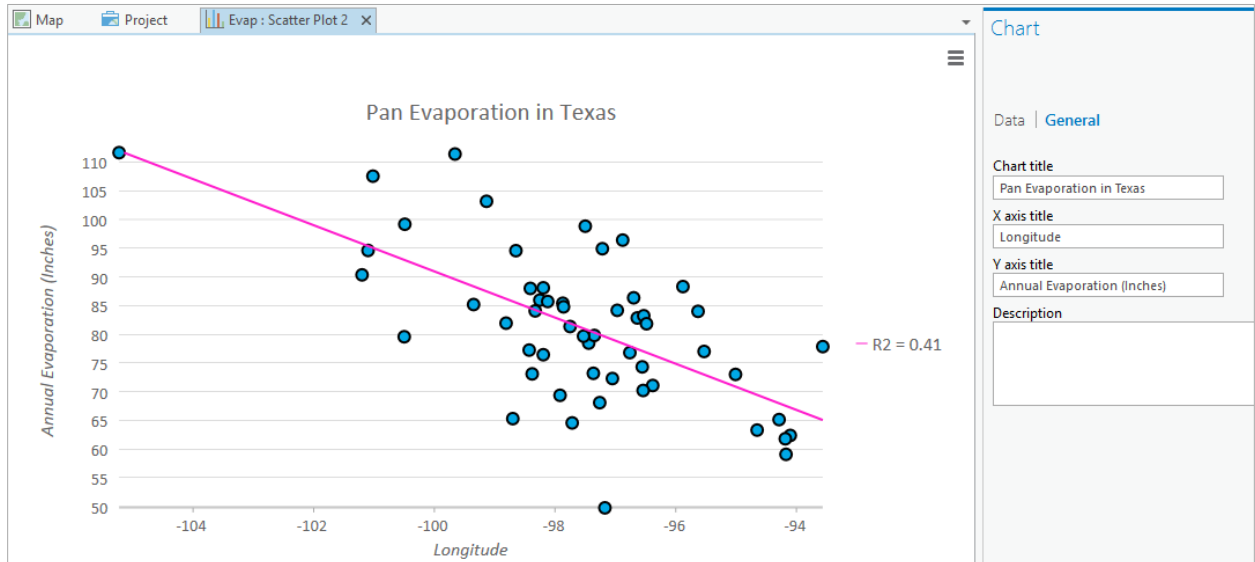
You can see from the map that there is some tendency for lower evaporation values near the coast and to the East and higher values to the West. Charts are useful because they allow you to visualize trends in data. Right-click on **Evap**, hover over **Create Chart**, and select **Scatter Plot**.



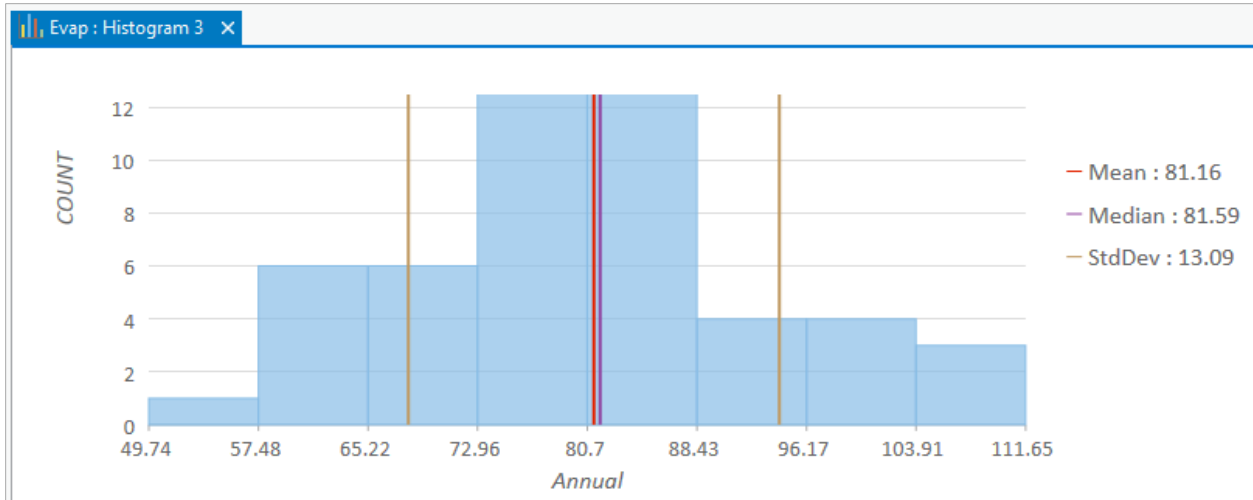
In the panel on the right select X-Axis Number as **Longitude** and Y-Axis Number as **Annual**. The results is a graph of the Annual Evaporation (**Annual**) of all the stations plotted against the **Longitude** of the station. You can see that there is a general trend of the evaporation increasing as you go from East to West in Texas. The color of the chart points is blue, the same as the map points.



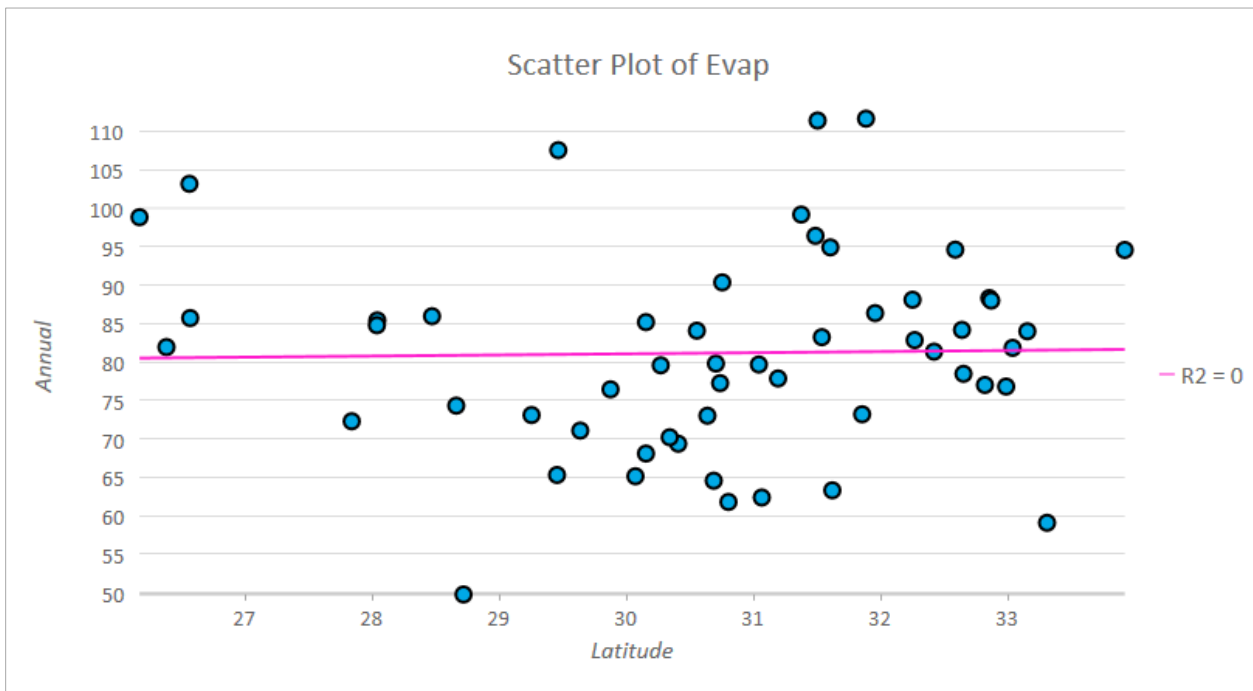
Hit the **General** tab in the pane on the right and edit the graph properties to make them more descriptive. Add a title **Pan Evaporation in Texas** and relabel the vertical axis **Annual Evaporation (Inches)**.



Try some different kinds of charts, such as Bar Charts and Histograms. Note that ArcGIS Pro automatically sorts bar charts from highest to lowest from left to right. See <http://pro.arcgis.com/en/pro-app/help/analysis/geoprocessing/charts/bar-chart.htm> for more details. Here is a pretty cool histogram of the pan evaporation data, with statistical properties of the data as well.



If you create the same kind of graph for Evaporation and Latitude, you can see that there isn't a tendency for evaporation to vary with latitude in Texas, as there is for variation of evaporation with longitude.

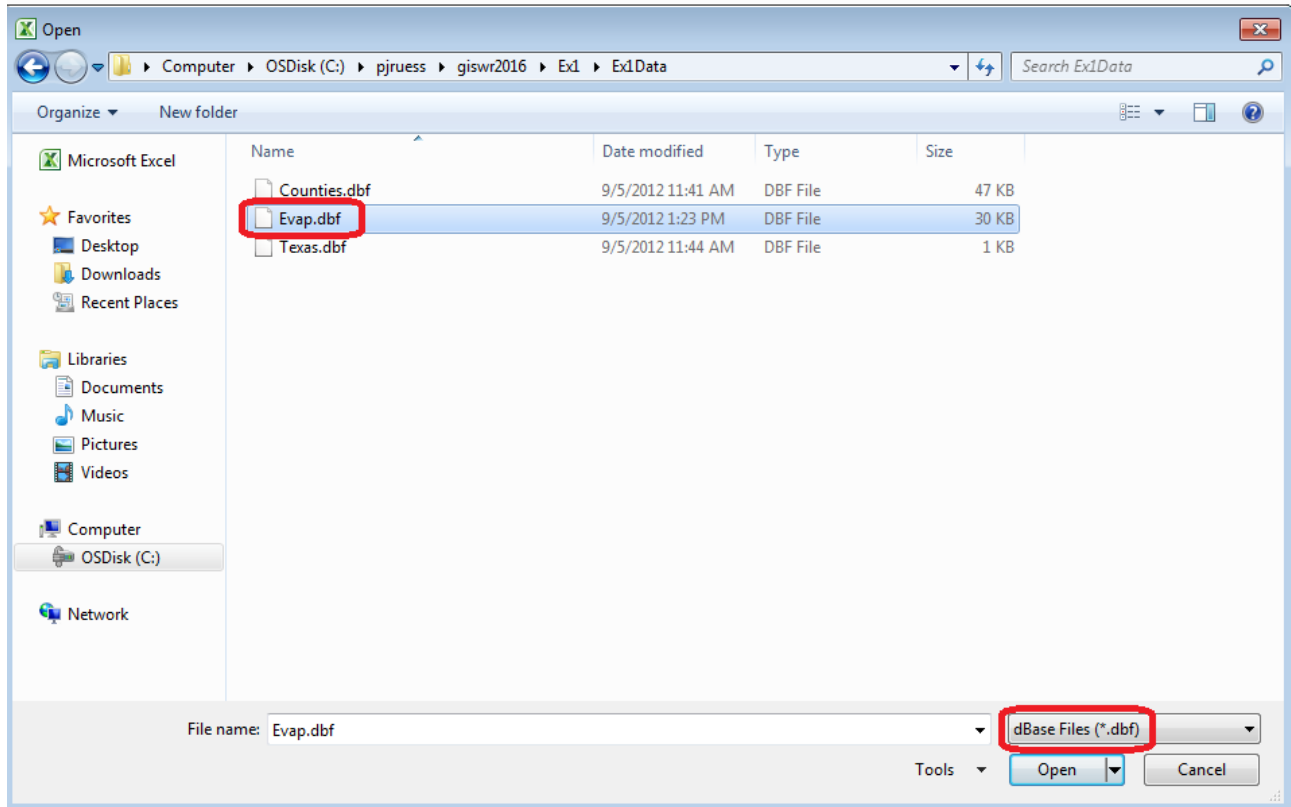


Notice how with some very simple charting steps, we've been able to get some interesting insight into the character of pan evaporation in Texas.

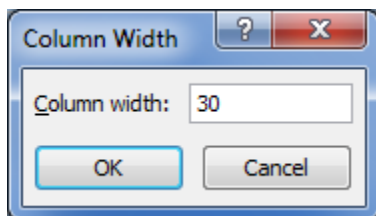
Save your ArcGIS Pro document **Ex1_project.aprx** so that you can retain this display.

Graphing in Excel

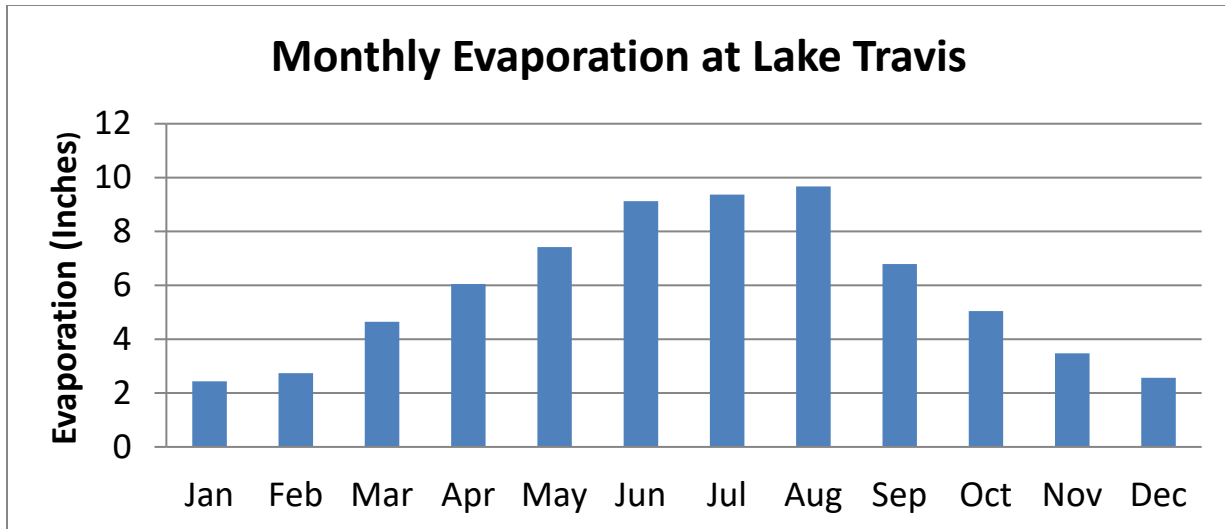
Another graphing option is to make a chart in Excel using the dBase tables given by the evaporation shapefile. Open the evaporation attributes table **Evap.dbf** as a table in **Excel**. Use **Files of Type: dBase files** in Excel to focus only on .dbf tables when you open the table.



When you open the file, you'll see that the Station name is very wide (254 characters). Right click on this column in Excel and select Column width of 30 characters to correct this.



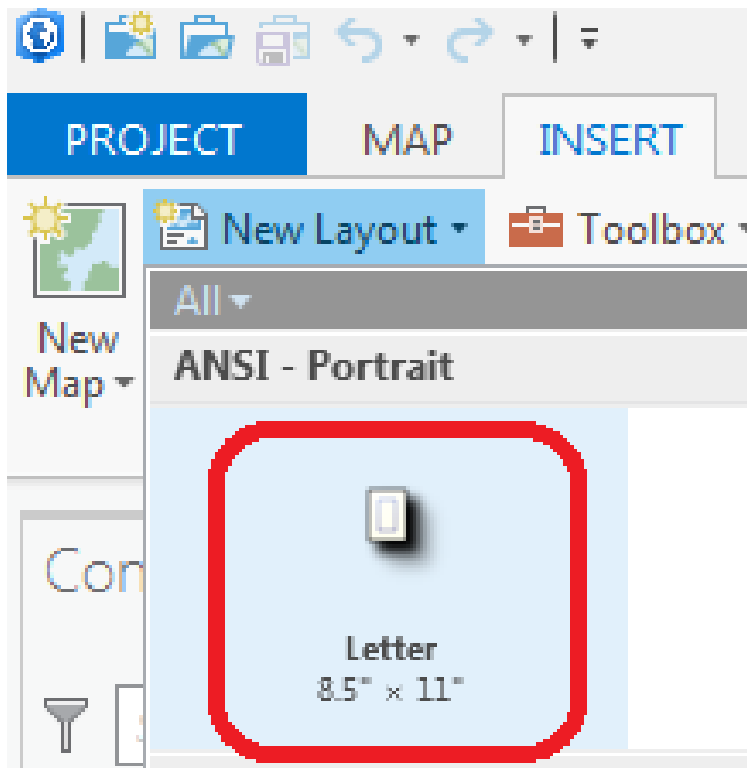
Select the stations you want to plot, copy their records to a new worksheet, delete the columns you don't need there, and then create a chart. Here is an example chart created this way.



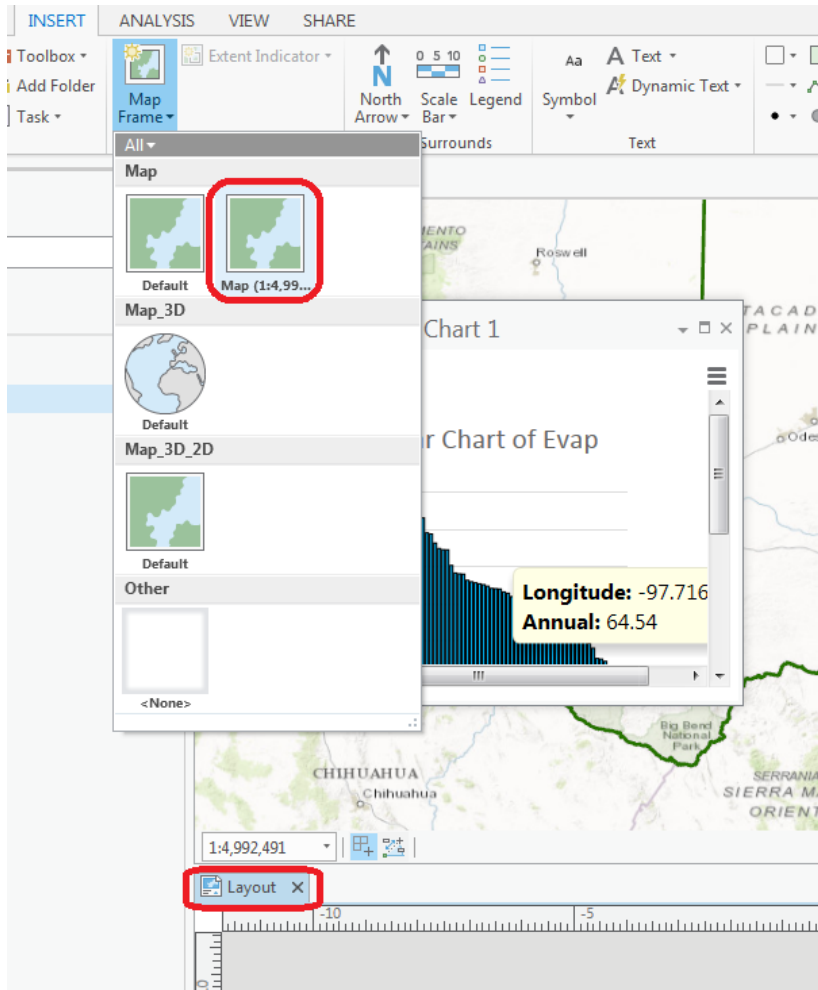
8. Making a Map Layout

Now we are going to create a formal map of evaporation in Texas that includes the charts that we've created.

Under the *Insert* tab, select **New Layout** and pick the "Letter" layout.

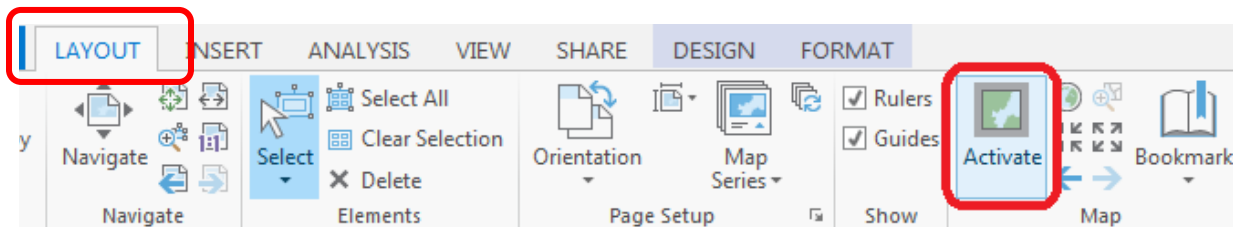


You should now see the layout frame on the bottom portion of the screen. Add a Map Frame to your layout by making sure the Layout is selected and then going to *Insert*, Map Frame/Map (the name of your current map).

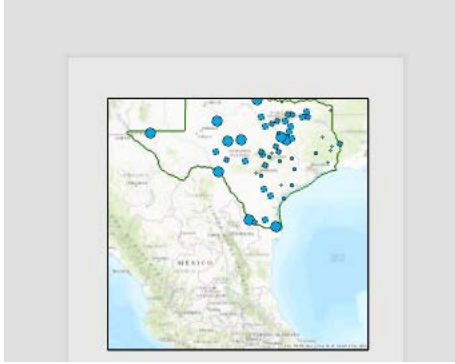


Reduce the size of the data frame in the layout (i.e., rectangle where the spatial data is contained) -- to make room for the graph -- by clicking on the map and moving its handlers.

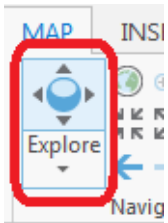
Now, in order to center your map within the map data reference, first select **Layout**, then click **Activate**.



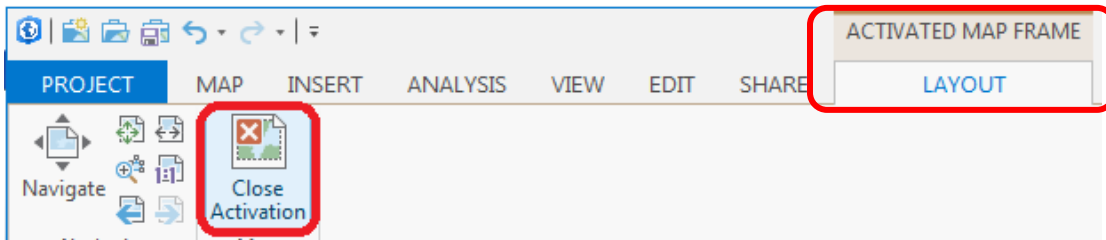
Once **Activate** has been clicked, the **Layout** display region should have a faded paper background as shown in the following image.



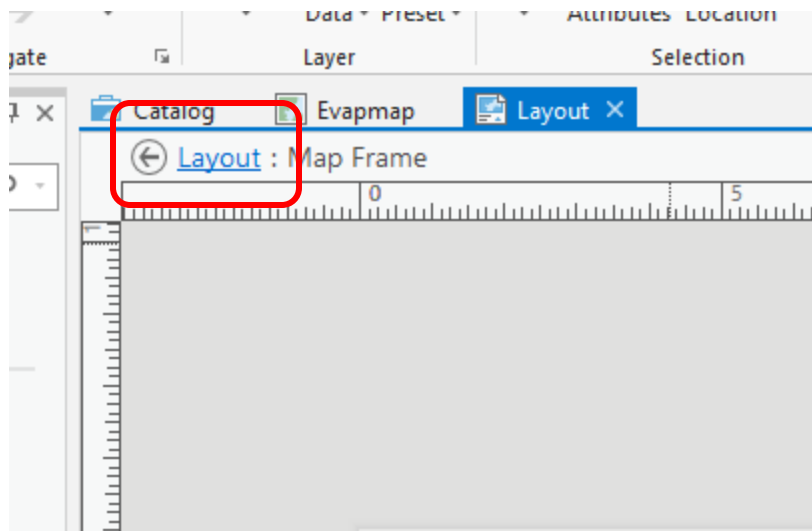
Next, select the **Explore** key and pan/zoom over the map until it is centered over Texas at the scale you want.



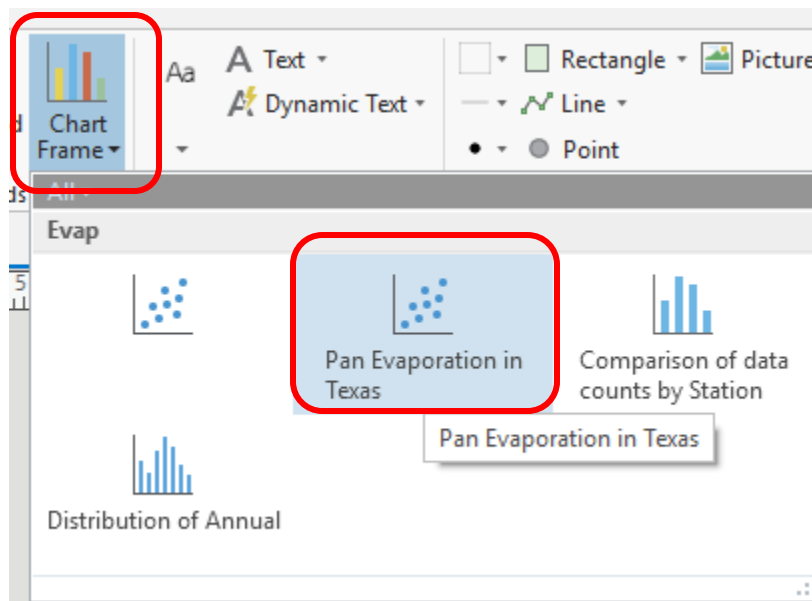
When you are finished adjusting the map, go to *Layout* and select **Close Activation**.



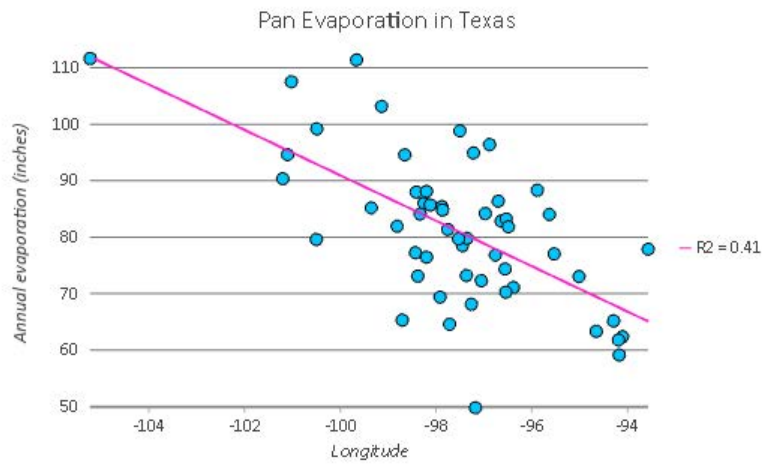
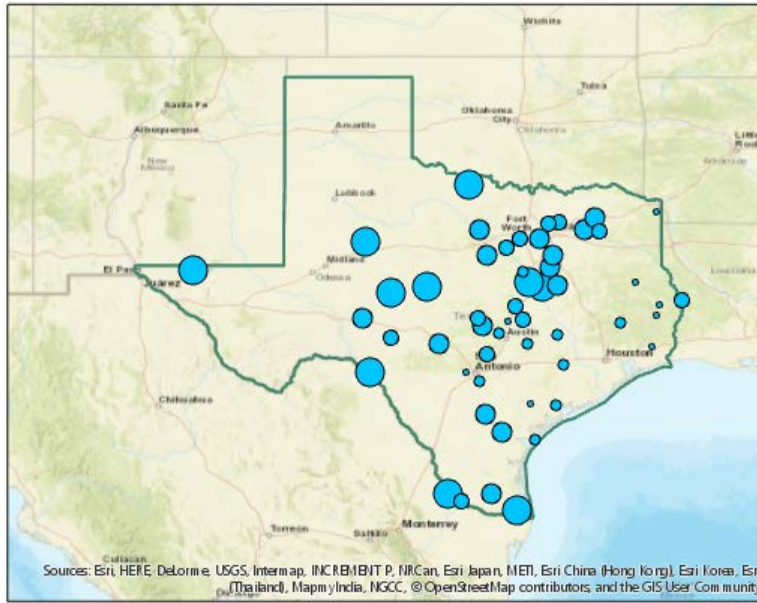
You can also, while the map is activated, click on the back to Layout link to close activation



Now we would like to add a chart to the layout, in the empty space below the map. Click on Chart Frame and select the Pan Evaporation in Texas Chart

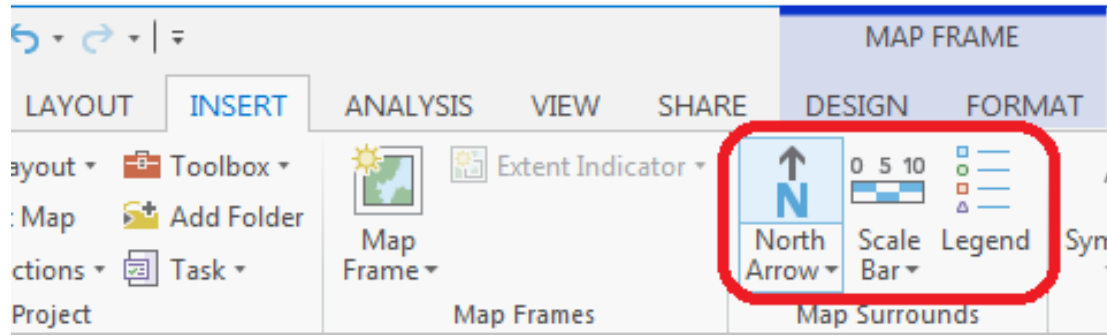


The chart should appear in your layout. Drag it to below the map and size it how you like. The map is shown below in ArcGIS Pro with the chart below it. It may seem as if some of your lines have disappeared in the chart image but that is just because of the scale of the display.



Keep saving your ArcGIS Pro document as you proceed through the map making steps so that if you mess up something you can get back the work you've already done.

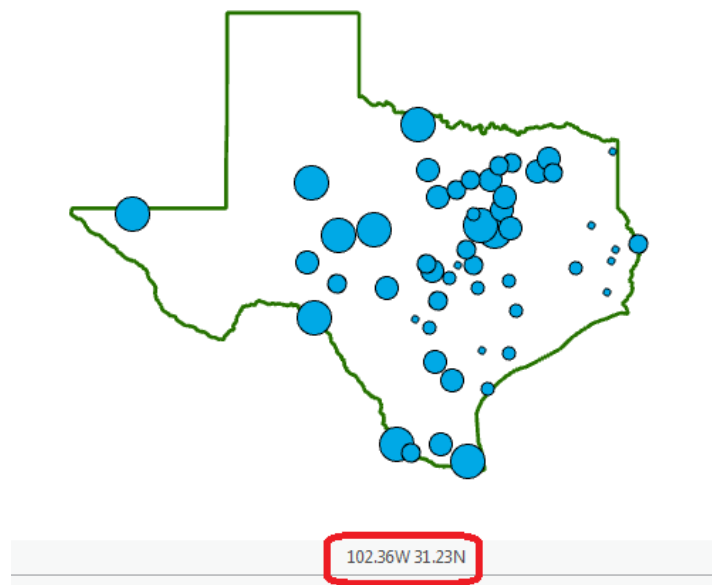
You can also insert a **North Arrow** and a **Scale Bar** under the *Insert* tab.



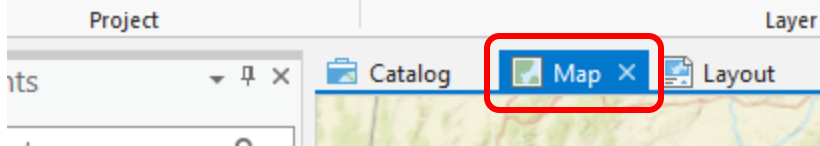
When you put up the scale bar you can select the distance units to be displayed. I have used miles.



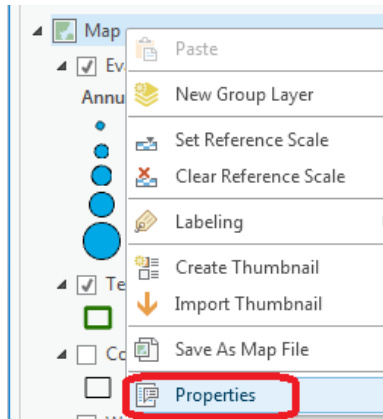
Note that if you look at the bottom right of ArcMap in Data View you see coordinates in Longitude and Latitude. This is an indication that the map is being displayed using geographic coordinates. It is not strictly correct to use a length scale when data is displayed in geographic coordinates as lengths are different in the North-South and East-West directions. You will learn more about this in future classes.



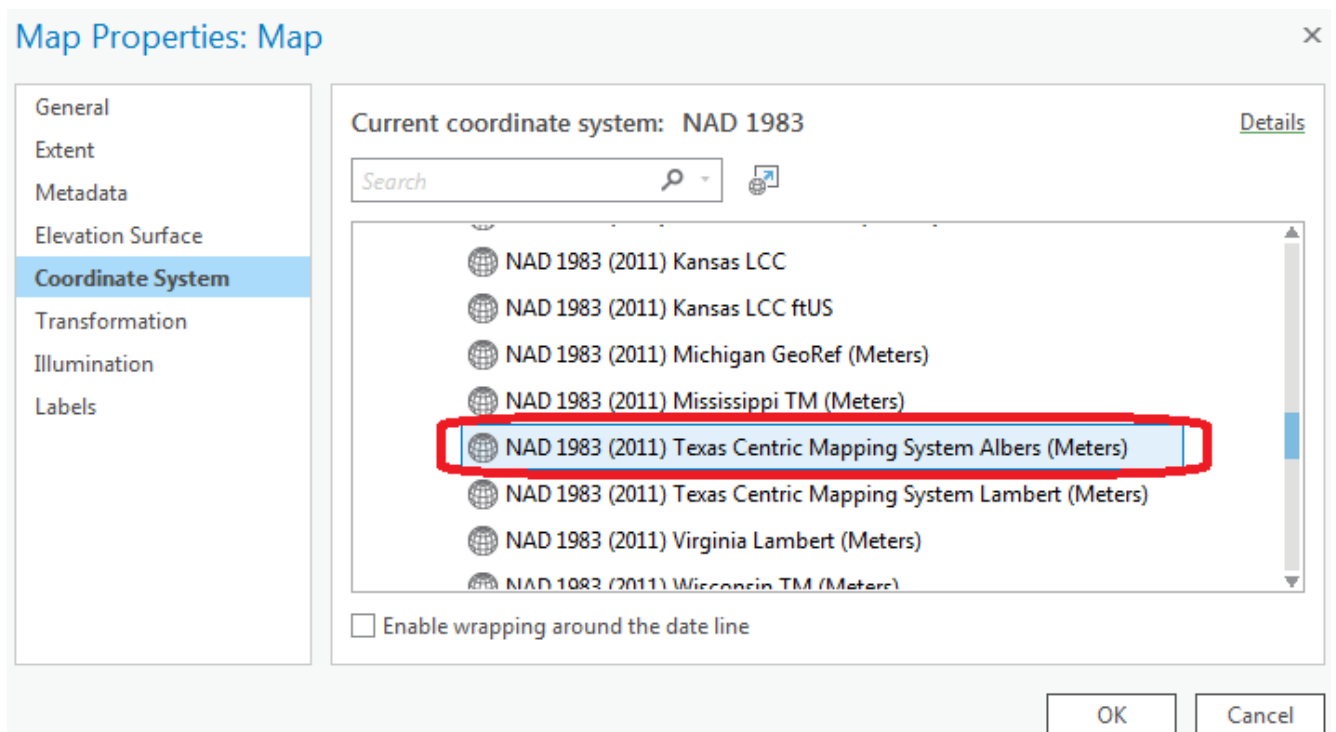
To change the coordinate system, switch to the Project Map tab,



Right-click on the **Map** entry in the table of contents and select properties.

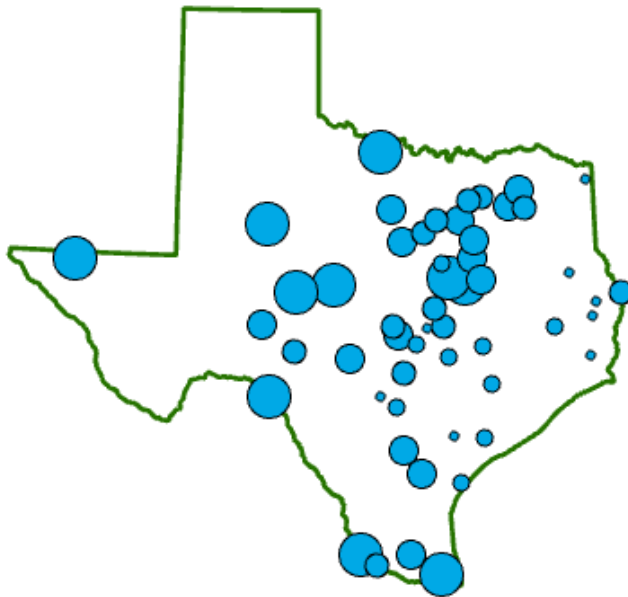
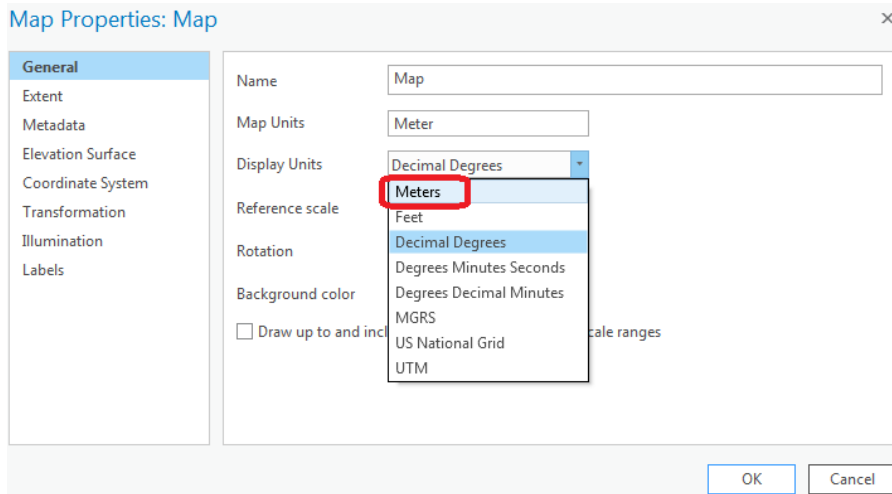


Map is the name of the **Data Frame** used to display information in ArcGIS Pro. In **Map Properties** click on **Coordinate System** and navigate to **Projected Coordinate Systems -> State Systems -> NAD 1983 Texas Centric Mapping System Albers (Meters)**. Click OK.



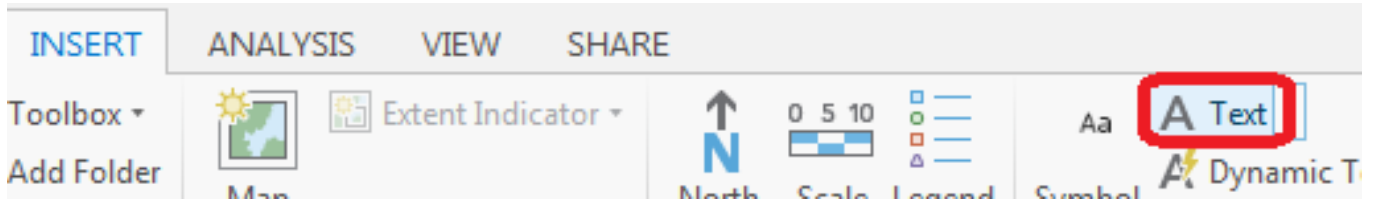
Note that for this exercise it does not really matter which coordinate system we select, but we need a projected coordinate system so that the scale bar is correct. Note that the display of Texas is adjusted according to the new projection.

To change the display units, select the **General** tab in the **Map Properties** and change “Display Units” from Decimal Degrees to Meters.

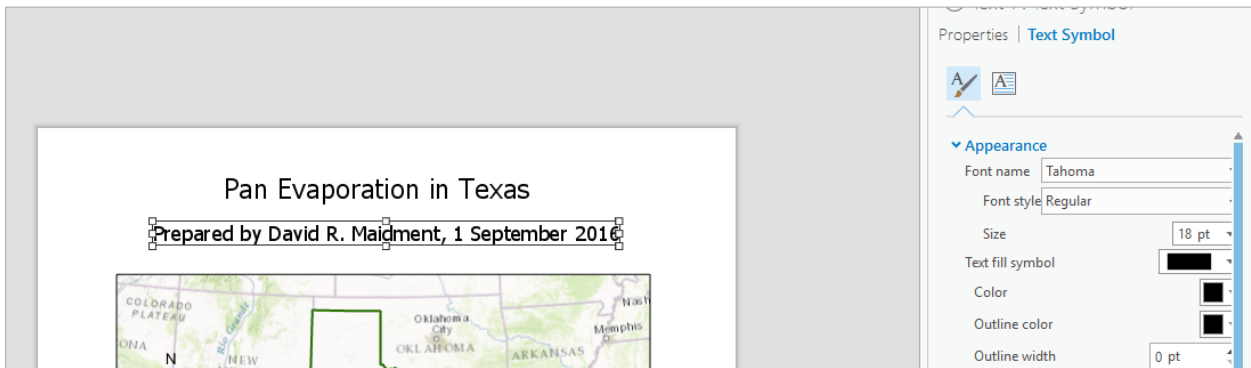


The above map shows corrected display units as well as a Texas map corrected to a more appropriate coordinate system (note the slight tilt).

Switch back to Layout and select **Text** from the *Insert* tab to insert a Title.



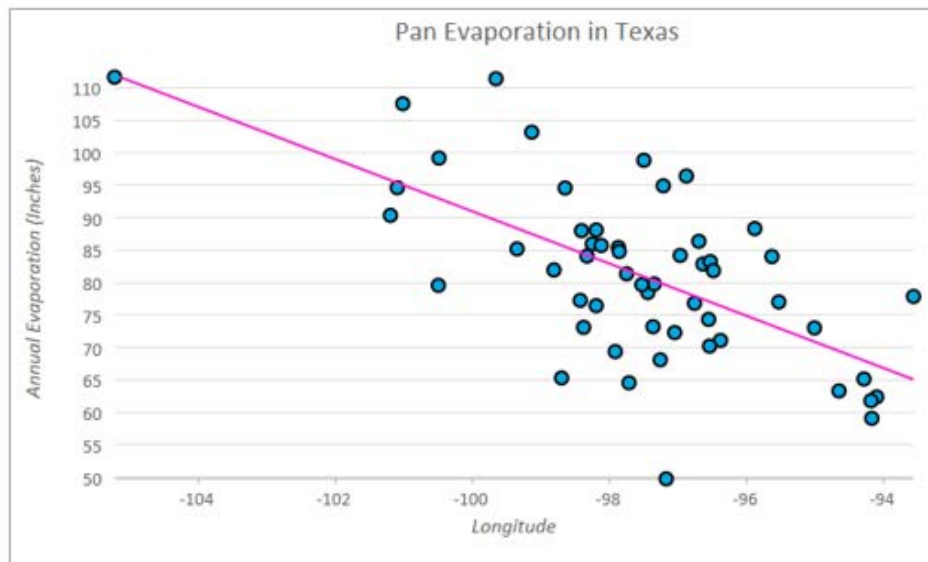
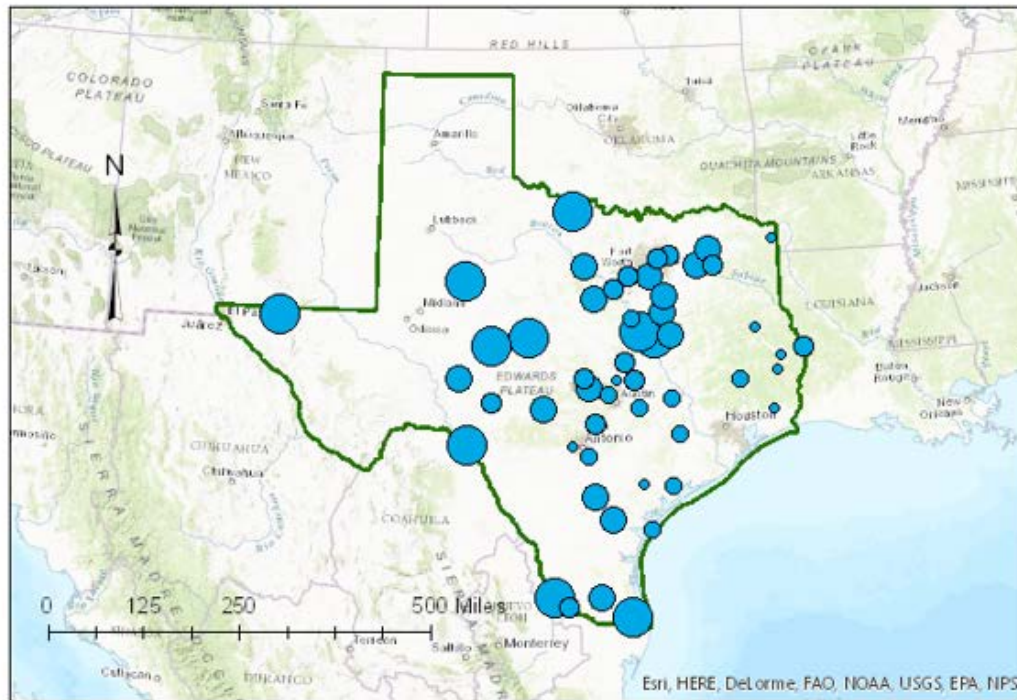
Type the text you would like for your title, and resize the window to automatically resize the font size. Add a second title including your name and the date.



Here is the resulting completed map and chart combination

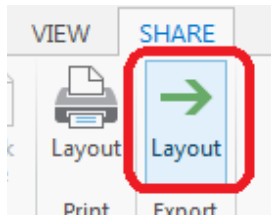
Pan Evaporation in Texas

Prepared by David R. Maidment, 1 September 2016



You can export your map from ArcGIS Pro using by clicking **Layout** in the “Export” section under the *Share* tab. You have the choice of many export formats (PDF, TIFF, JPG etc.). You can also control the

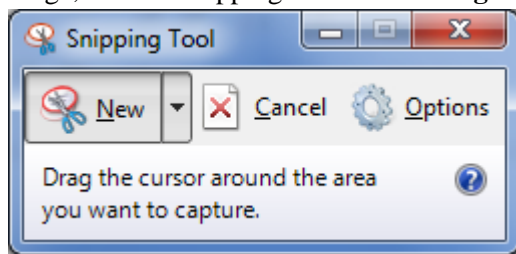
resolution. Here use the TIFF option so that you have a detailed graphic image. You can store this file as **Ex1.tif** in your data file.



Then you can add it to a Word document using **Insert/Picture** and loading this **.tif** file. This preserves the crisp resolution of the ArcMap display in a word document.

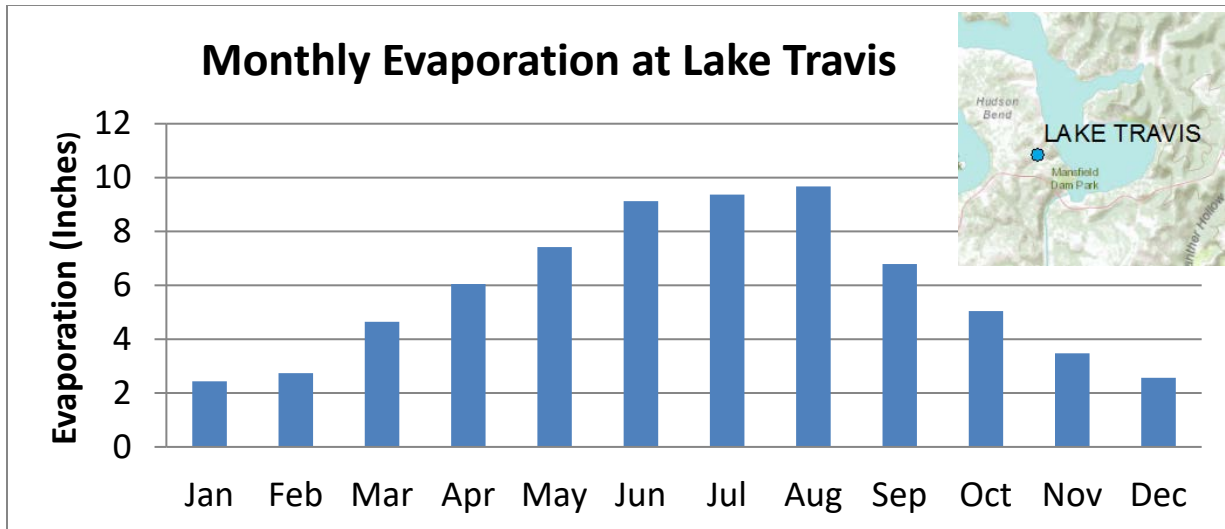
Helpful Tip:

A simpler procedure is to simply copy the screen to the clipboard and crop out the part that you want, saving it to a file for later use. That is how all the images in this exercise were prepared. To copy any image, use the Snipping Tool in **All Programs/Accessories** on your Windows Desktop interface



Drag the cursor around the area that you want to capture and you'll see it copied into a new display, then use **Paste** to insert this snippet into a specific location in your document. If you only want to capture the active frame, press **Alt + Print Screen** and then Paste it to the new document. With this approach you do not have as much control over the resolution of the image, but this approach is a lot easier if you do not require publication quality graphics.

This approach can also be used to add a map to a chart in Excel:

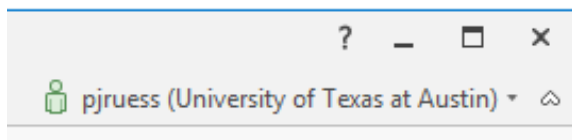


The manipulations just described transfer objects from one application to another.

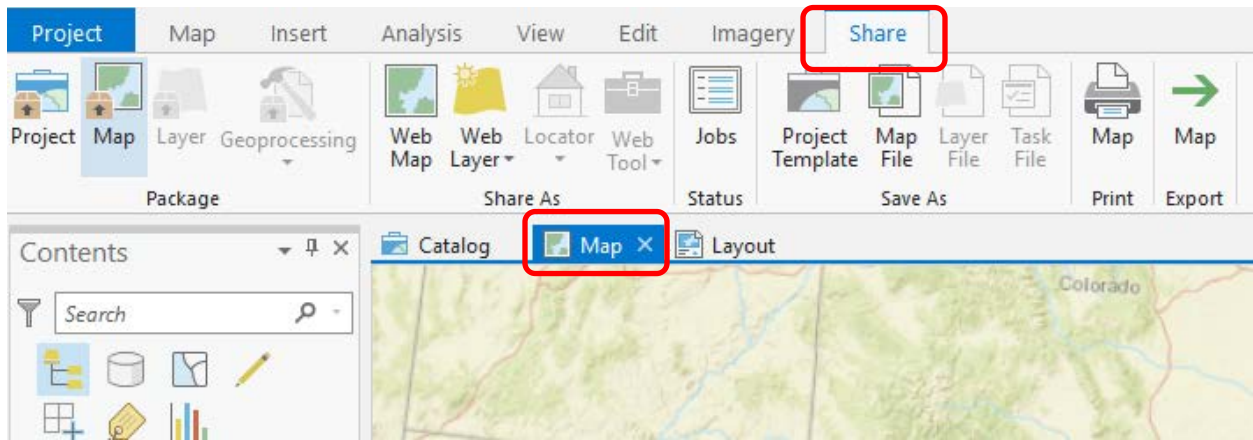
To be turned in: An ArcMap map layout in it showing a map of Texas with gages, coupled with a graph showing monthly evaporation data plotted from the gages. In the presentation of information on maps and charts it is important to include sufficient labeling detail so that the information can be clearly and unambiguously interpreted. You should include a scale bar to indicate distance, a north arrow to indicate direction and labels or legends with units wherever they are needed to interpret map or quantitative values.

9. Sharing a Map Online

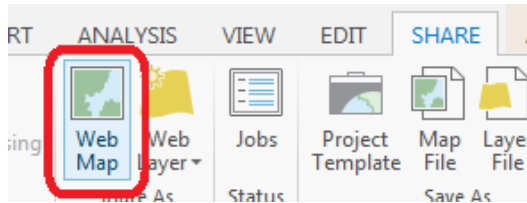
Now, let's suppose that you would like to share your map with your colleagues. This can be done with ArcGIS Online by using the ArcGIS Pro interface. Before creating an online map, you'll want to make sure you're still logged in to ArcGIS Online in your ArcGIS Pro instance (check the upper right-hand corner of the screen).



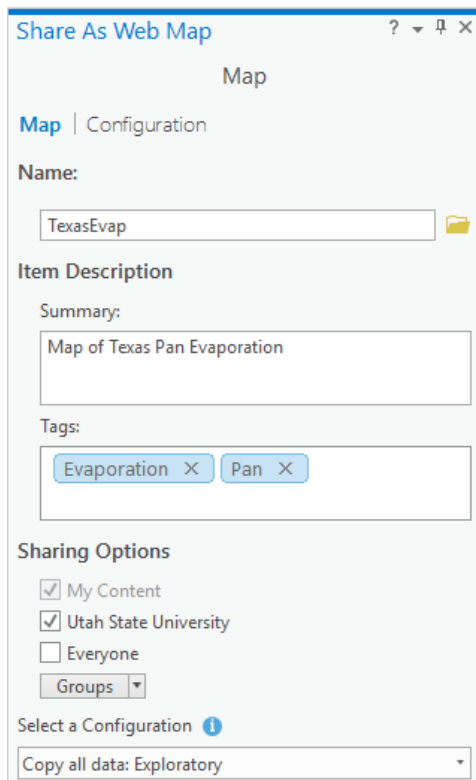
After you're sure you're logged in, go to your Map and the *Share* tab.



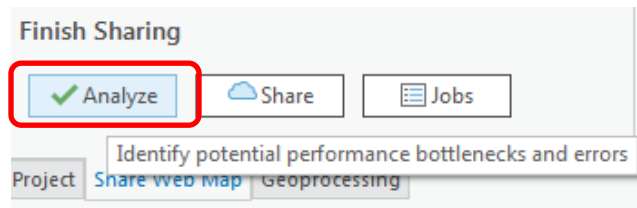
Select **Web Map**.



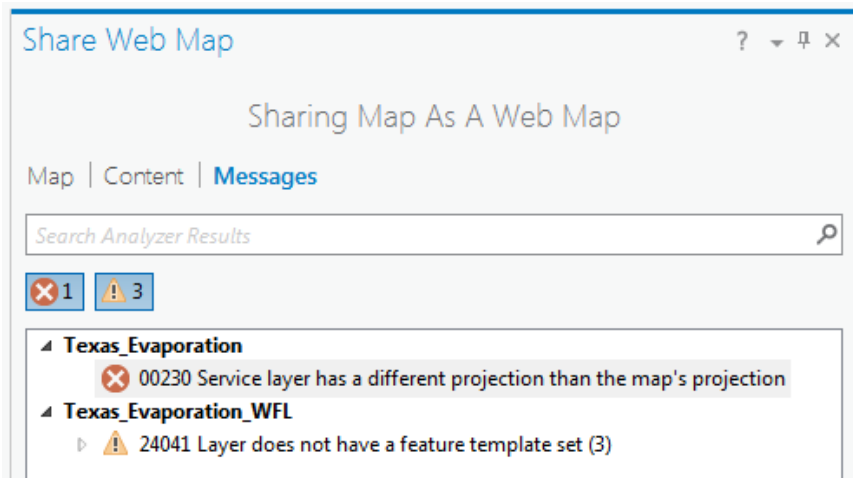
A sidebar will appear on the right where you will be able to give your map a **Name, Item Description, and Tags**. Note that the name cannot hold spaces. Fill out these sections, and select your University under *Sharing Options*. This will enable all other group users to have access to your shared Web Map!



Before sharing your map, click **Analyze** to check that your map has all criterion required for publishing.

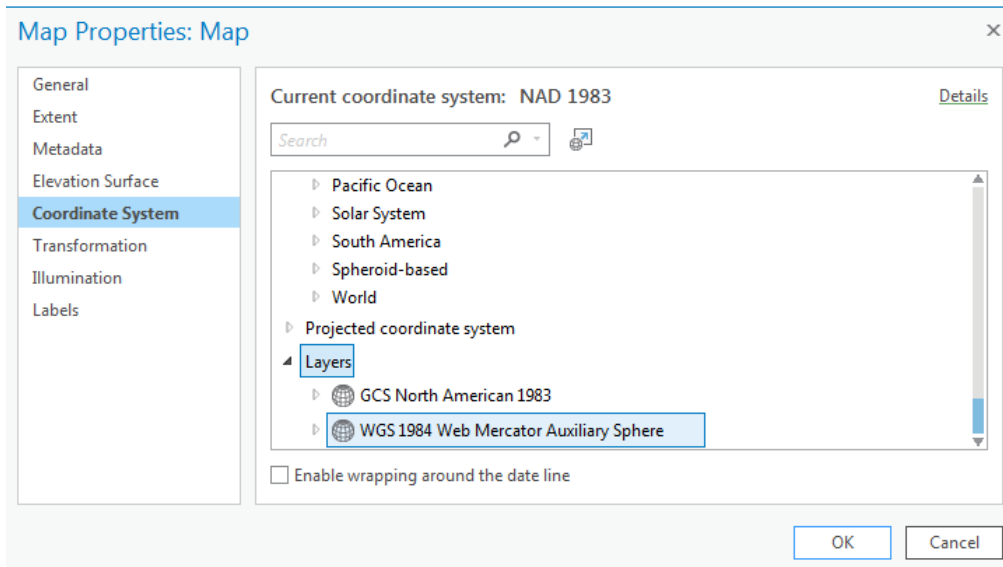


You should receive an error that looks like this:



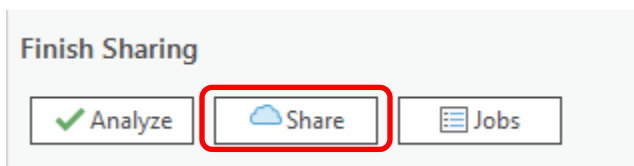
Remember when you previously changed the map's coordinate system to **NAD 1983 (2011) Texas Centric Mapping System Albers (Meters)**? Regrettably, this new coordinate system is different than the coordinate system for the basemap you are currently using (all basemaps use the **WGS 1984** global coordinate system). Hence the service layer (the basemap using **WGS 1984**) has a different projection than the map's projection (which you changed to **NAD 1983**).

A basemap is required for sharing a webmap, and the ArcGIS Pro basemaps cannot be changed from **WGS 1984**; therefore, all maps must be changed to this global projection before publishing online. To change the map projection, go to map properties, scroll to the bottom and expand "layers" (this shows all projections that currently exist in any of the map's layers), and select **WGS 1984 Web Mercator Auxiliary Sphere**. Now **Analyze** your map again for webmap sharing.

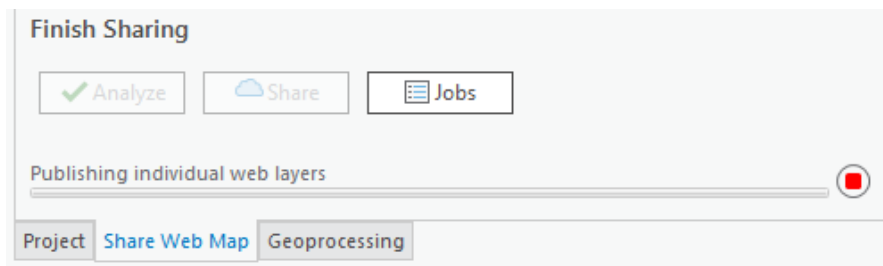


I ignored warnings about Layers not having a feature template set after reading Help on this (found using Google) that one solution is to Do nothing and have a default feature template created.
<http://pro.arcgis.com/en/pro-app/help/sharing/analyzer-warning-messages/24041-layer-does-not-have-a-feature-template-set.htm>

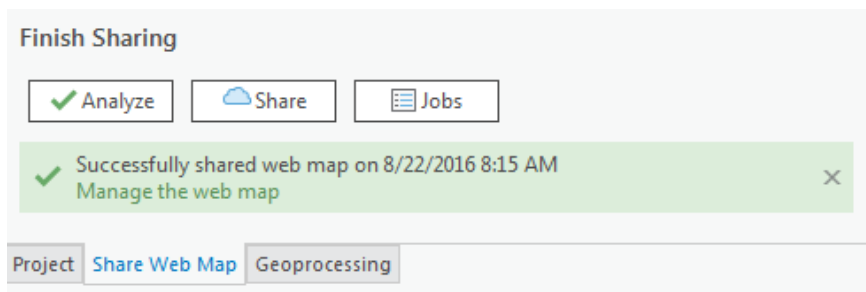
Now that your error is gone, click **Share** to create a web map from your ArcGIS Pro map.



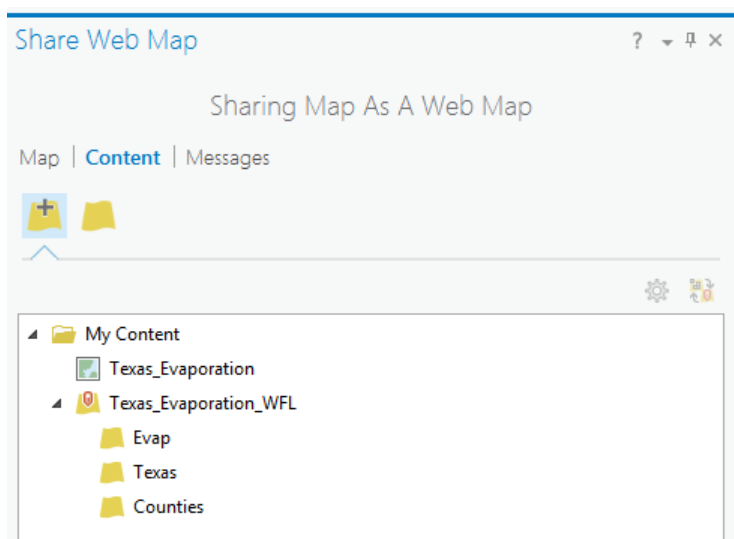
. Once you have selected **Share**, a loading screen should appear that looks like this:



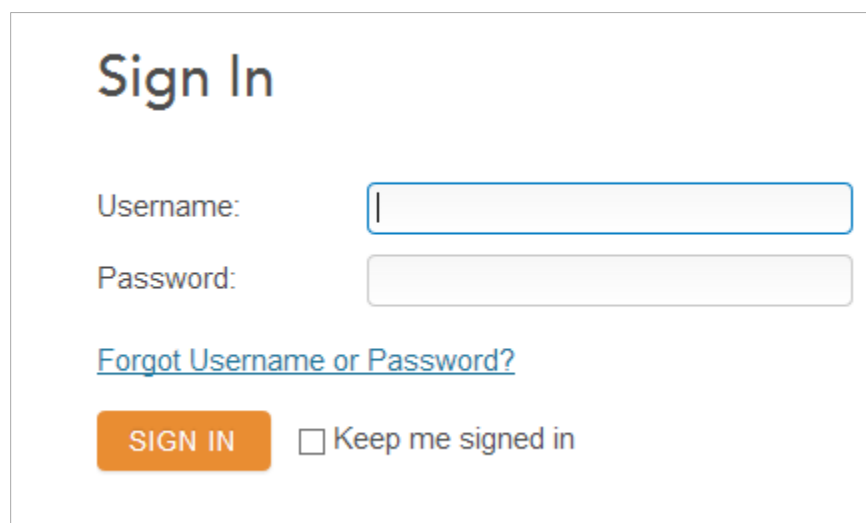
Once your web map has been successfully published you will receive a confirmation message.



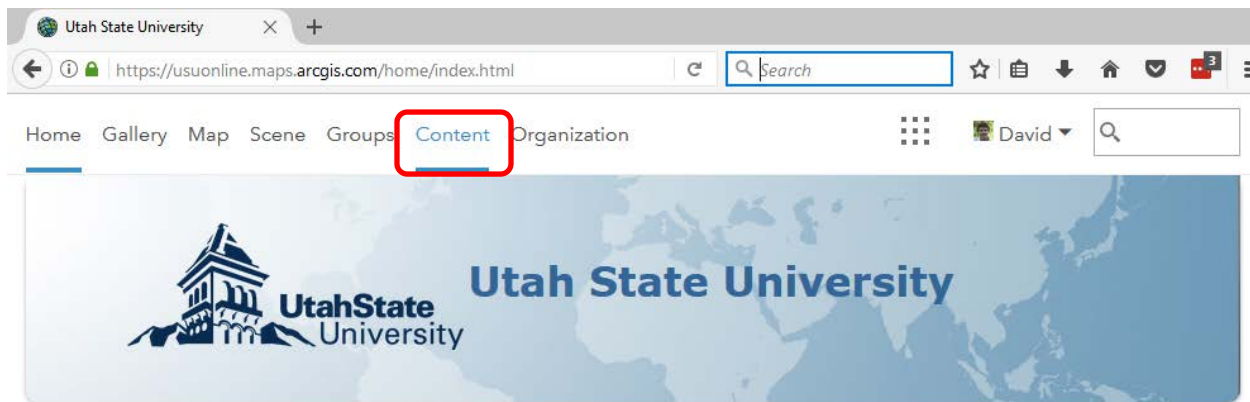
You can also view your webmap in the *Content* tab within the **Sharing Web Map** pane.



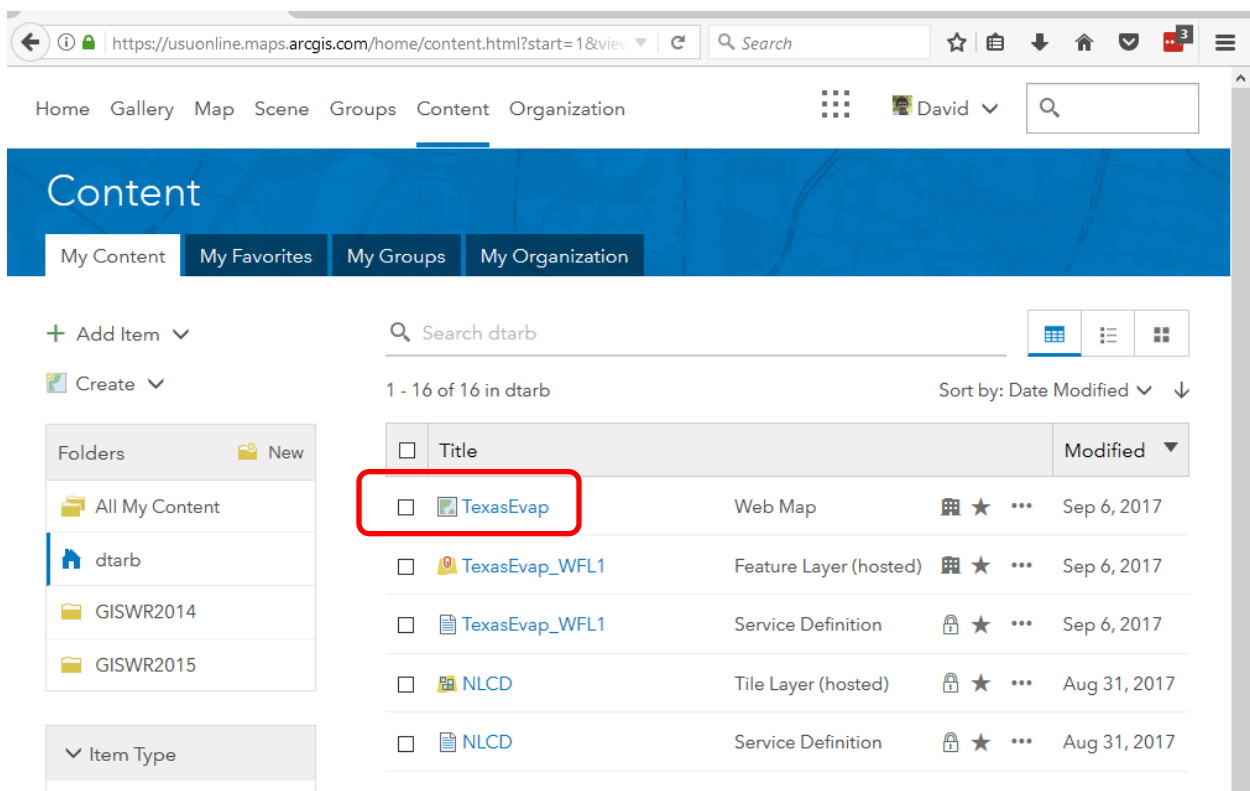
Following publishing, proceed to ArcGIS Online to view your webmap online. Go to <http://www.arcgis.com> and sign in with your ArcGIS Online Username and Password



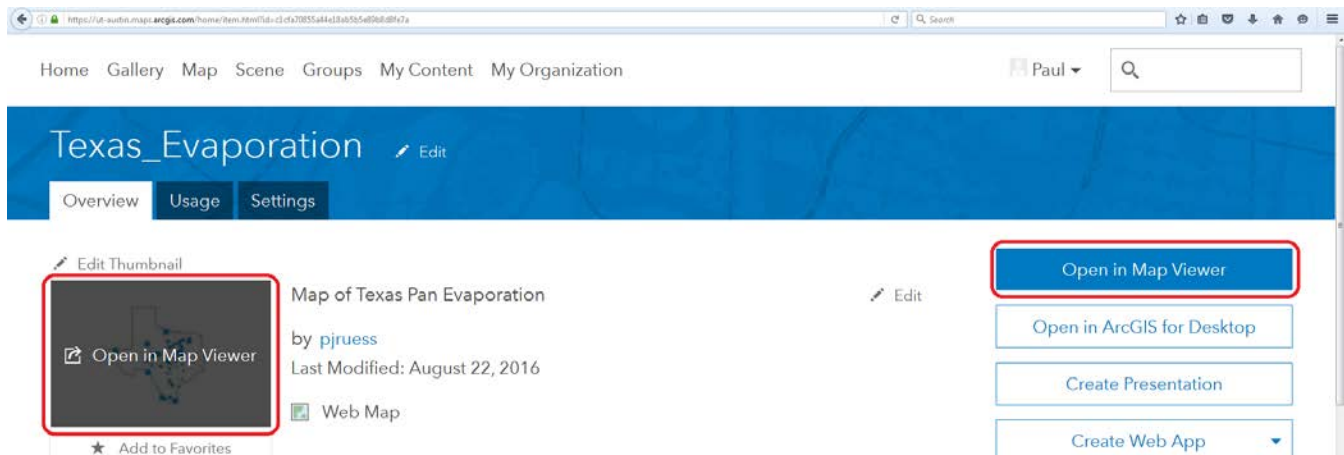
The landing page should look similar to the screen below. Click on "Content"



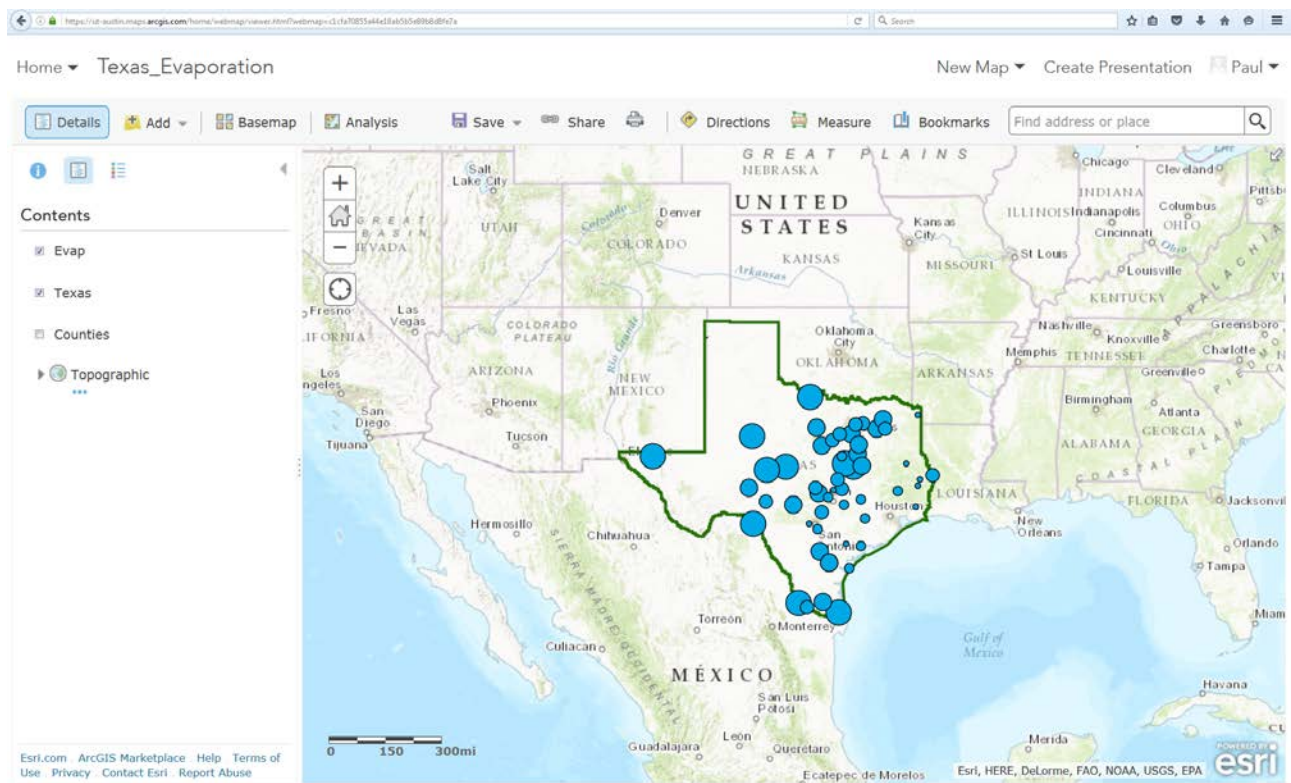
This opens a section where you can manage the content you have added to ArcGIS.com. Click on the Title link for the **Web Map** you just created.



Now select **Open in Map Viewer** from the screen that loaded. Note that this can be done one of two ways: by hovering over the map thumbnail on the left side of the screen, or by selecting the blue **Open in Map Viewer** button from the right side of the screen.



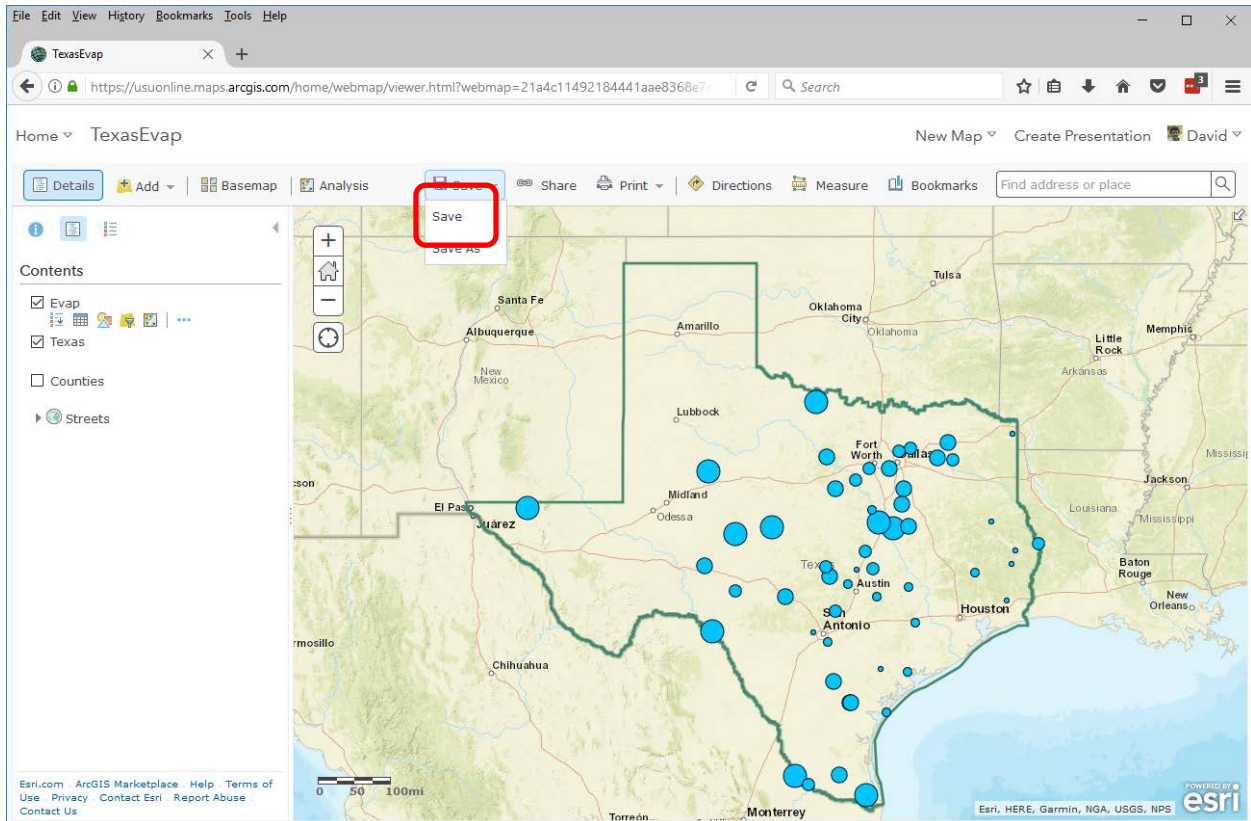
You should now see your ArcGIS Pro map displayed online on the World Wide Web for the people you have shared it with to have access to. Very cool!



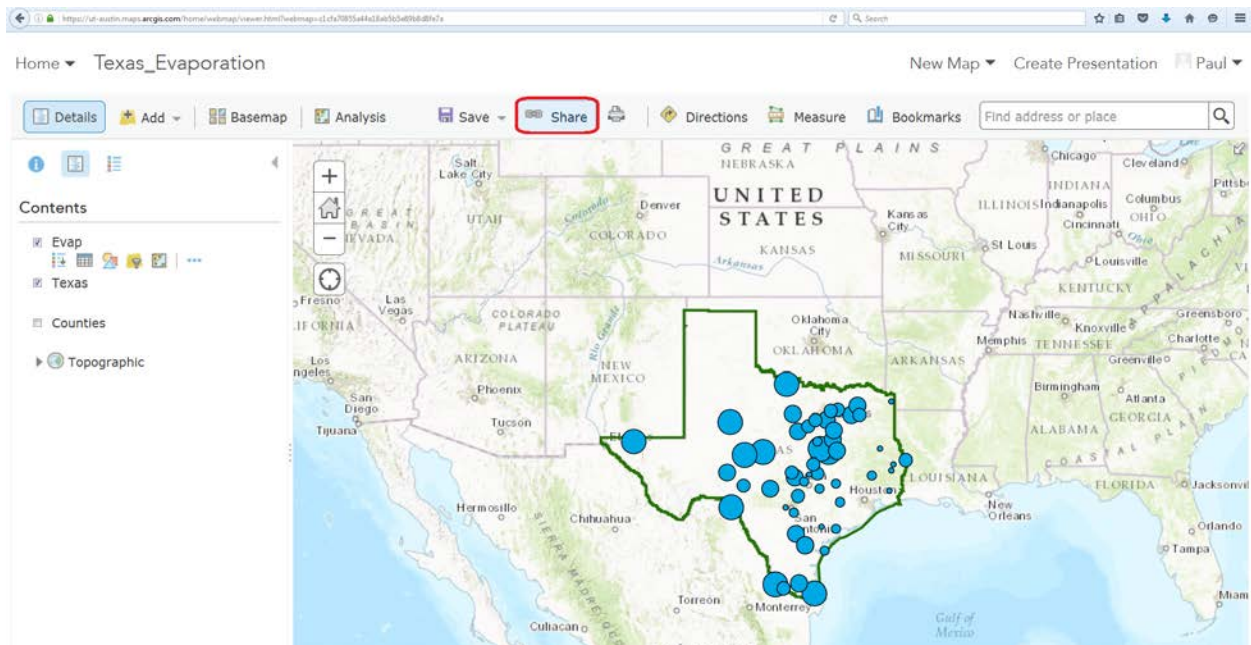
The online web mapping environment provides considerable GIS functionality, and is part of a general trend towards cloud based software (like Google Docs). It is conceivable in the future that a Desktop GIS may not be needed and you do everything in the Browser. At the current stage of development ArcGIS Pro and ArcGIS Online are closely aligned and interoperable.

To illustrate some of this functionality, let's change the Basemap. Click **Basemap** and select **Streets** to set the Street basemap layer.

Once you are sure your basemap is as you want, click **Save** to save your webmap (otherwise you'll have to make these adjustments every time you open up your map).



Once you are finished, click on **Share** at the top of the screen.



In the pop-up screen that appears, copy the hyperlink and turn it in so that I can view it online.

Share

Choose who can view this map.

Your map is currently shared with these people.

Everyone (public)

Utah State University

Members of these groups:



GIS in Water Resources 2011

GISWR 2013

Hydro Online GIS, Web Maps, & Demos

Link to this map

<https://arcg.is/18fmir>

 Facebook  Twitter

Share current map extent

Embed this map

EMBED IN WEBSITE

CREATE A WEB APP

Note: To embed your map, you must share it with Everyone.

DONE

To be turned in: The web link for your map so that I can view it online. Your URL should be similar to the following:

<https://arcg.is/18fmir>

Summary of Items to be Turned In:

(1) An ArcMap map layout in it showing a map of Texas with evaporation gages, coupled with a graph showing evaporation data plotted from the gages. In the presentation of information on maps and charts it is important to include sufficient labeling detail so that the information can be clearly and unambiguously interpreted. You should include a scale bar to indicate distance, a north arrow to indicate direction and labels or legends with units wherever they are needed to interpret map or quantitative values. Let's see some nice cartography!!

(2) The web link for your map so that I can view it online. Please include this as part of the document that you prepare for (1) and submit the result as a single complete document.

The assignment is due in a week from the date it was assigned in class.

UT Austin: Please submit your solution through Canvas to assignment "Exercise 1".

USU: Please submit your assignment as a single Microsoft word or PDF document in Canvas.