GIS Tutorial for Atmospheric Sciences

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Exercise 2

Exploring Spatial Data

Use Case: 2012 Drought in Texas

Now that you've been introduced to the basic features and tools within ArcMap and ArcCatalog, let's take a closer look at the type of information these tools allow you to explore.

The main benefit of GIS is that it allows you to view, manage, store, edit, and analyze both spatial and non-spatial data. Spatial data are data that contain information about location. It can be stored in many different formats, such as shapefiles, geodatabases, and gridded datasets. In this next exercise you will investigate different types of spatial data in ArcCatalog and then visualize that data in ArcMap.

Sub-Sections in Exercise 2:

1. *Exploring Data Types in ArcGIS*
2. *Working with Vector Data in ArcMap*
3. *Adding Web Services to ArcMap*
4. *Exploring Raster Datasets*

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Exploring Data Types in ArcGIS

Spatial data represent objects on the Earth, such as roads, lakes, and cities. Spatial data can also represent atmospheric phenomena such as temperature, humidity, and snowfall amounts. The powerful feature of spatial data and GIS is that this data type can be overlapped to answer complex questions. For example, in Exercise 1, you mapped tornados recorded over the past 60 years. By using the Definition Query you were able to see which States experienced the most tornadoes for certain years.

Spatial data are represented by two types of data models — vector and raster. Vector data represent discrete features such as points, lines, and polygons. GIS terminology refers to vector data as "feature classes." A feature class is composed of a collection of features represented by the same geometry type and containing similar attribute fields.

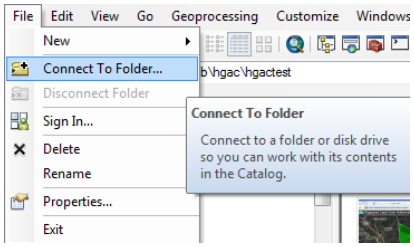
Raster data consists of cells organized in rows and columns. Raster or gridded data are commonly used for continuous fields such as elevation or temperature. Unlike vector data, raster data are not used for discrete data such as points, lines, and polygons. Some common raster data examples are aerial photographs, satellite imagery, Digital Elevation Model (DEM), and background images. Raster data are also commonly used for thematic data, such as land use. However, this can also be used for continuous data such as elevation, temperature, and radar.

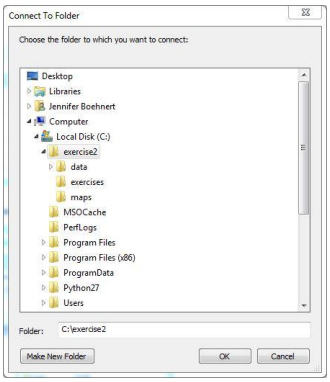
In the next few steps you will explore feature classes and raster dataset.

Step 1 Explore vector files in ArcCatalog

In this first step you will explore different types of vector datasets in ArcCatalog. Vector data represents real world objects as discrete points, lines, or polygons (areas).

- Click **Start > All Programs > ArcGIS > ArcCatalog.**
- Click **File** > Connect To Folder ….

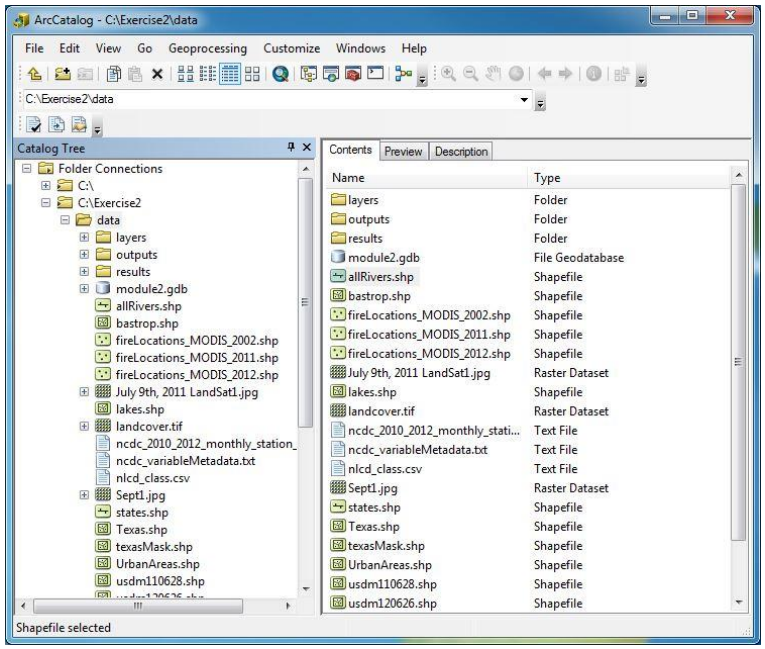




- In the **Connect to** Folder window, navigate to the ***C:\Exercise2\,*** and click **OK**.

You will see this new folder connection appear in your Catalog Tree.

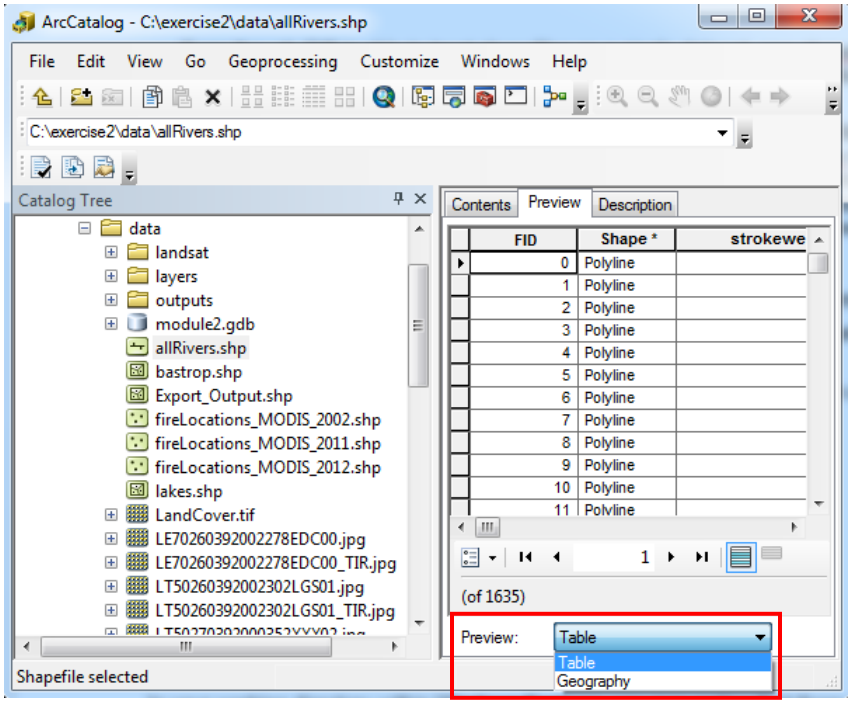
- In the Catalog Tree, expand the folder connection to ***C:\Exercise2***\, by clicking on the **+** sign beside the folder.
- Double click on the ***data*** folder so that its contents appear in the contents window.



You should now see all the datasets you will be working with for exercise 2.

In the contents list, the datasets with green icons are called shapefiles. A shapefile is a vector type of data format that stores information about a single feature class. The geometry type of the shapefile can be seen in the shapefile icon – points , lines , and polygons .

- Select ***allRivers.shp*** in the left-hand window (Catalog Tree).
- Click the **Preview** tab in the Catalog Window.
- Change the Preview type from **Geography** to **Table** using the dropdown at the bottom of the Catalog Window.



This table is called an attribute table. All vector data have an associated attribute table providing non-spatial information about the features. In this particular dataset, you can see there are many attribute fields associated with each feature.

- Scroll right to the end of the table.

What is the name of the last field in the table?

Now that you've seen the non-spatial information for allRivers.shp, you will explore some of its properties.

- Either right-click or double-click on allRivers.shp in the Catalog Tree to open the shapefile Properties window.

Notice that the Shapefile Properties window in ArcCatalog has fewer tabs than the Layer Properties window you saw in ArcMap in the previous exercise. Since you cannot manipulate data in ArcCatalog, you do not need many of the extra tabs.

- Click the **XY Coordinate System** tab.

What coordinate system is this dataset stored in?

- Click the **Fields** tab.

This tab shows the field names and data types in the attribute table. If you wanted to add additional information about each feature, it is possible to add a field to the shapefile using this window.

- Click **Cancel** to close the Shapefile Properties window.

Every shapefile that you see listed here in ArcCatalog is actually composed of a series of files that each performs a specific function in making the spatial layer work properly. Remember in the previous exercise, you learned that ArcCatalog should always be used instead of Windows Explorer when managing data files. This is because ArcCatalog is capable of displaying each shapefile as ONE single file whereas Windows Explorer can only show all the individual files. If just one of these individual files is deleted, there is a chance of corrupting the shapefile. You will now take a look at a shapefile in Windows Explorer.

- Click **Start > Computer**.
- When the Windows Explorer opens, navigate to ***C:\exercise2\data***.

How many files start with allRivers? Write each of the file extensions you see associated with allRivers.

The allRivers shapefile is made up of six files. A shapefile must have **at least three** of these files to be read correctly — **.shp, .dbf**, and .**shx**. While only three are necessary, many shapefiles, like allRivers, are made up of more than three files. The additional files store information such as indexes, metadata, and projection information. The files are as follows:

- SHP - This file holds the feature geometry information.
- DBF - This Dbase file holds the attributes associated with the features.
- SBX, SBN, and SHX- These files are index files for faster searching and querying of the data.
- PRJ - This is the file that holds the projection information about the shapefile.
- XML - This is the metadata file.

Even though the allRivers shapefile is made up of only six files, you were able to count seven. The seventh file is called a lock file. This file protects the shapefile when it is open in a program. Because you are currently viewing the allRivers file in ArcCatalog, this extra file will prevent the shapefile from becoming corrupt if someone else tries to view/edit it while you have it open.

Step 2 Explore feature classes in a file geodatabase

In the exercise2 directory within Windows Explorer, you may notice that there is a directory called module2.gdb. This is a file geodatabase. Geodatabases are an Esri vector data format that does not have the same file-size limitations as shapefiles and provides the user with some additional functions. Despite their flexibility, this file type is an Esri proprietary format and is not open source or published. You will need to consider who will be using your data in the future before selecting this format.

- Double click on the folder module2.gdb to look inside this directory.

Similar to a shapefile, a file geodatabase is composed of many files that hold the attribute information, spatial information, and indexes about the spatial data.

- Close the Windows Explorer.
- In ArcCatalog, expand the file geodatabase called ***module2.gdb*** in the Catalog Tree.

Inside this file geodatabase there are several vector datasets. These datasets are called "Geodatabase Feature Classes." Like feature classes stored in a shapefile, geodatabase feature classes can be points, lines, or polygons.

- Double click on ***cities*** in the ***module2.gdb*** to open the Feature Class Properties window.

As you may have noticed, a geodatabase feature class has more properties than the shapefile. This allows you to access some of the additional functions that are available when using geodatabases.

- Click through the tabs in the Feature Class Properties. When you are finished, close the Properties window by clicking **Cancel**.

Step 3 Explore raster data

In the Catalog Tree you can see symbols that look like grids. This is the symbol for a raster layer.

- Double click the raster layer ***landcover.tif*** to open the Raster Dataset Properties window.

This file is the **National Land Cover Dataset from 2006** published by the USGS.

Notice that the properties are different than those you saw in the shapefile and geodatabase feature classes. Under the first tab, **General**, you can find information about the number of columns and rows, the cell size, and the projection information.

- Click **Cancel** to close the window.
- Click the **Preview** tab if necessary.
- If needed, change the Preview type from Geography to Table.

Some raster datasets can have attribute tables; however, raster tables are structured differently than vector tables. As you already learned, raster datasets are composed of rows and columns of individual cells. Each of these cells is assigned a value. In this dataset there are 17 unique Value classifications, each representing a type of land cover. The Count column specifies how many cells in this dataset are assigned the corresponding value in the Value column.

Take some time to explore the data further within ArcCatalog. When you are finished, close ArcCatalog.

You have just explored some of the most common vector and raster data formats used in GIS - shapefiles, geodatabase feature classes and rasters. In the next section you will display and analyze these datasets in ArcMap.

- Close ArcCatalog.

Working with Vector Data in ArcMap

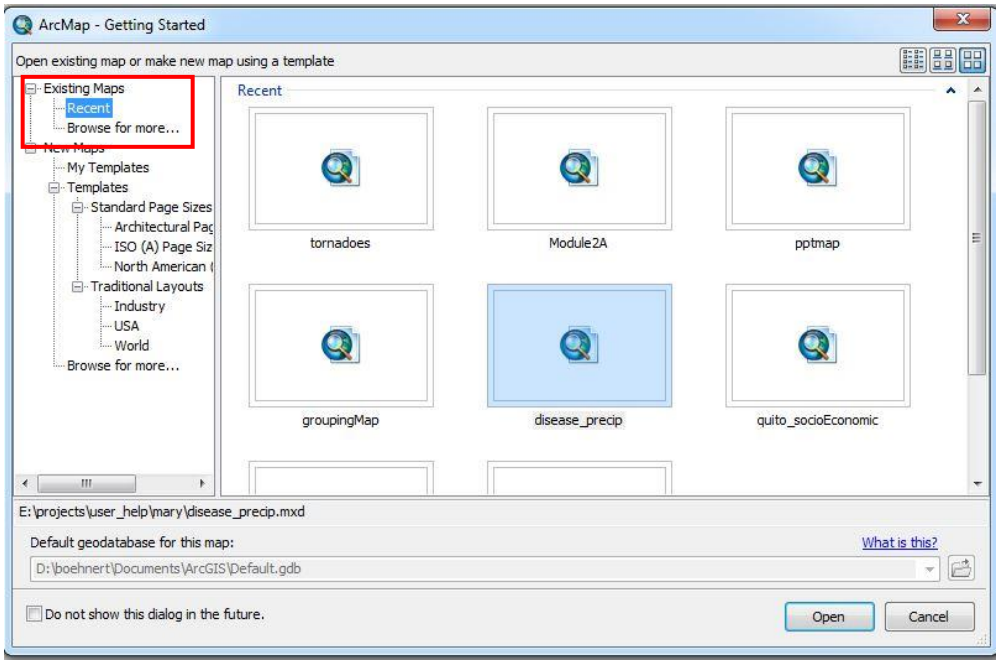
From 2011 through 2012, Texas experienced a severe drought. This drought caused many wildfires and loss of crops. For the rest of this exercise you will work with weather and climate data for the state Texas to better understand the drought and its impacts upon the state of Texas.

Step 4 Working with vector data in ArcMap

In this step you will open an existing ArcMap document and begin to explore information related to the Texas drought.

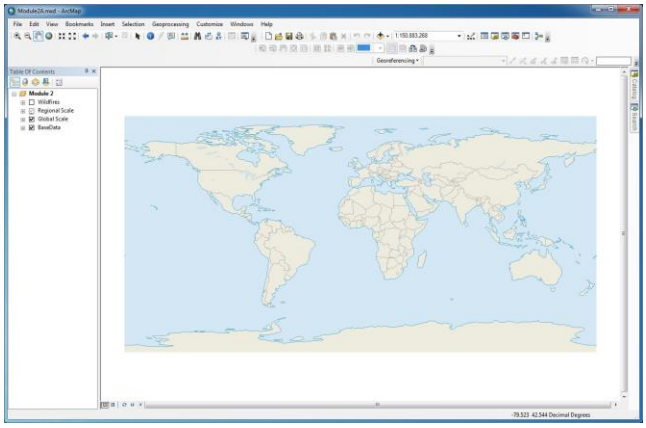
- Start ArcMap by clicking **Start > All Programs > ArcGIS > ArcMap**.

When the dialog appears you will choose to start ArcMap using an existing map.



- Double-click **Browse for more…** under "Existing Maps" in the tree on the left. Navigate to ***C:\exercise2\maps*** and double-click ***Module2.mxd*** to open the map document.

If in Exercise 1 you left the Catalog window docked, you can click the Auto Hide button to hide the window.



In the center of the screen, you should see a map of the world. On the left, you will see the Table of Contents (TOC) describing the layers (datasets) included in the map. These layers are contained in the Data Frame named “Module 2.”

A Data Frame can be thought of as a map containing a number of data layers and properties such as projection, display extent, and annotation. The Data Frame in our map contains four Group Layers – Wildfires, Regional Scale, Global Scale, and BaseData.

A group layer is a way to organize layers in the map — it is a group storing many other layers. In this map example, our layers are grouped together based on scale. The layers in the Global Scale group layer are set up to be viewed when zoomed all the way out. The layers in the Regional Scale group layer are set up to be viewed after you zoom in. First, you are going to explore our global scale data.

- Click the **+** sign to the left of the group layer ***Global Scale*** to open the group layer in the Table of Contents.

This group layer contains two individual layers (Lakes, Administrative Lines). The symbols used to display these features in the map are shown below the layer names in the Table of Contents. For example, the Administration Lines layer is drawn on the map with a thin grey line.

- Turn off the layer ***Administration Lines*** in the Table of Contents by clicking the box to the left of the layer name.

Now all the country boundaries have disappeared.

- Turn the ***Administration Lines*** layer back on.
- Right-click on ***Administration Lines*** in the Table of Contents and select Open Attribute Table.

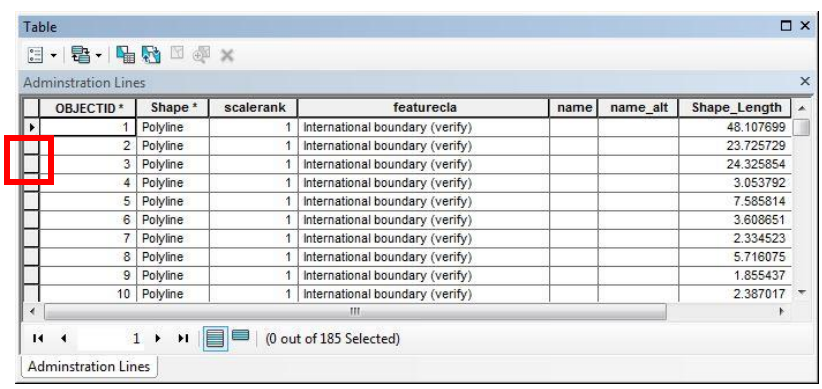
In the table, each row is an individual feature within the Administration Lines feature class. Each column, called a Field, has a field name and describes a particular aspect of the individual feature. The first field is named "OBJECTID*." This field defines a unique identifier for every feature in the dataset. The asterisk shows that there is an index created for this field.

You'll notice that the field "Shape*" also has an asterisk. In this field, the software has automatically added information describing the geometry of the object (Polygon, Point, Polyline, etc.). Every feature within a dataset will always have the same shape. Because this is a polyline shapefile, "Polyline" is the shape listed in the "Shape" field for every feature.

Towards the bottom of the window you see *(0 out of 185 Selected).* This tells you how many features are in the dataset.

This table works much like any database table. You can sort and hide fields, as well as select rows.

- Select a feature (row) by left-clicking in the grey box to the left of the "OBJECTID" field.



OBJECTID *	Shape *	scalerank	featurecla	name	name_alt	Shape_Length
1	Polyline	1	International boundary (verify)			48.107699
2	Polyline	1	International boundary (verify)			23.725729
3	Polyline	1	International boundary (verify)			24.325854
4	Polyline	1	International boundary (verify)			3.053792
5	Polyline	1	International boundary (verify)			7.585814
6	Polyline	1	International boundary (verify)			3.608651
7	Polyline	1	International boundary (verify)			2.334523
8	Polyline	1	International boundary (verify)			5.716075
9	Polyline	1	International boundary (verify)			1.855437
10	Polyline	1	International boundary (verify)			2.387017

You will see the entire row highlighted. By selecting a feature in the table, you also select this same feature on the map. Notice that the polyline you selected is highlighted on the map.

The number of selected features is noted along the bottom of the attribute table where it says "(1 out of 185 Selected)." You can select multiple features either by holding down the

SHIFT key and clicking another row, or by using the CTRL button to add and remove features from your selection one at a time.

Selection is a powerful tool in GIS. Because the attribute table is linked to spatial features on the map, queries can be used to select features based on either non-spatial or spatial information.

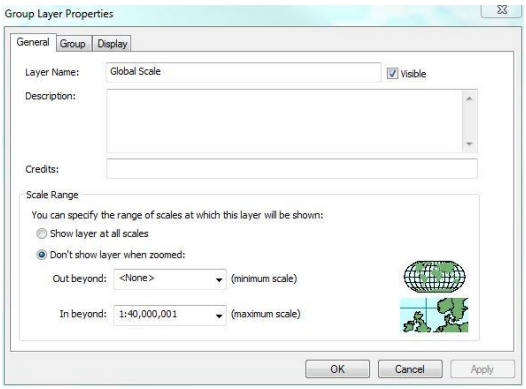
- Click the **Clear Selection** button in the Attribute Table to de-select all features.
- Close the Attribute table by clicking the X in the top right corner of the window.

Step 5 Explore layer properties

Once a dataset is added to ArcMap it is referred to as a layer. A layer is the visual representation of spatial data and contains information about the data source (e.g. shapefile or geodatabase feature class), and how the data are displayed. You will now explore some of the layer properties in your map document.

- Double click on the group layer ***Global Scale*** in the Table of Contents to open the Group Layer Properties Window.
- Click the **General** tab.

In the **Scale Range** box, there is a scale range set for the data inside the group layer. A scale range is the scale at which data are visible. In this situation the data in the Global Scale group layer will turn off when zoomed in beyond 1:40,000,001. Because this property is set at the group-layer level, it is not necessary to set the same property at the feature-layer level; any data you add to this group layer will take on this property.



- Close the **Group Layer Property** window by clicking **Cancel**.
- Double click on the layer ***Lakes*** in the Table of Contents to open the Layer Properties window.
- Click the **General** tab.

In the Description section it is possible to add information about the layer, such as how to use the layer and any credits necessary.

TIP: This should not hold information about the underlying data type itself, just about the layer. All metadata about the underlying data should be stored in the .xml file that is part of the shapefile.

- Select the **Source** tab.

The Source tab contains information about the data extent, data type, data location on disk, geometry type, and projection.

What Data Type is this file?

What Geometry type is this file?

It is important to remember that layers hold information about how to draw the dataset, not the dataset itself. As you can see in the source tab, Lakes is actually stored in a shapefile called lakes.shp.

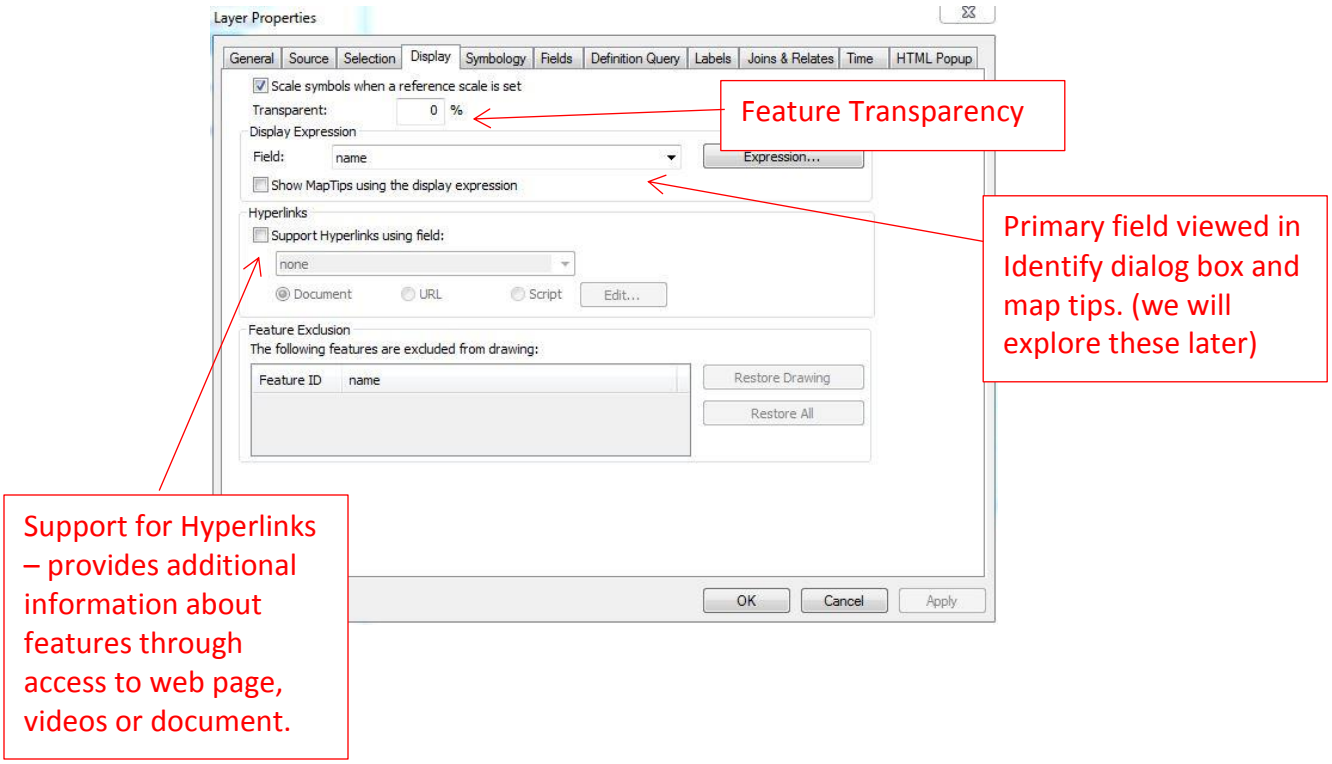
What is the path to this dataset?

- Click the **Selection** tab.

By default when a feature is selected in ArcMap it is highlighted in a turquoise color. You can set up your own selection preferences and use different selection symbols and colors for different layers. We will leave the default for now.

- Click the **Display** tab.

There are many properties that can be set in this tab.



- Check the box to **Show MapTips** using the display expression.
- Click **OK** to close the Layer Properties window.
- Without zooming in, hover your mouse over one of the Great Lakes.

You should see the name of the lake pop up. This is a map tip.

TIP: Because the field to display was set to **Name**, this is the value we see.

- Click the **Identify** button and click the same lake you just hovered over.

Now you will see the Identify window appear. In the top section you see the name of the layer and the primary display field, which you set in the Layer Properties window. In the bottom section you see all the attributes and their values for this feature.

- Close the **Identify** window.
- Double click on ***Lakes*** in the Table of Contents again to open the Layer Properties window.

- Next click the **Symbology** tab.

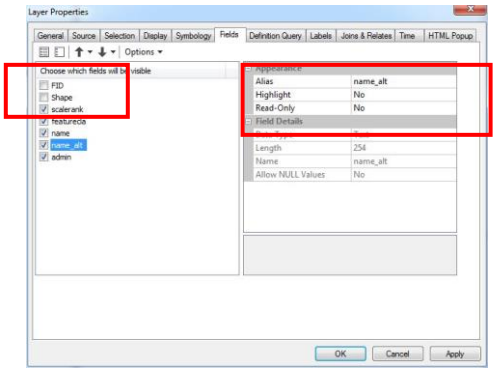
This tab allows you to set up how you display your data. Notice that this shapefile is displayed using a solid light-blue color. You will spend more time in Exercise 3 learning about the Symbology section.

- Click the **Fields** tab.

In this tab, you can turn fields on and off. By turning a field off, you can hide the field in the attribute table so it is no longer visible. This is a nice way to clean up tables and tailor them to the particular map without deleting any information.

It is also possible to change the alias of fields within this tab. A field alias is the name users will see when viewing the attribute table and when requesting information about the data.

- In the left-hand panel uncheck the box next the field **FID** and **Shape**.
- Now click on the field name name_alt. In the right hand panel, change the alias of the field to *Alternative Name*.
- Click **OK** to close the Layer Properties window.



In the next step you will take a look at the attribute table and see the changes you just made.

- Right-click on the layer ***Lakes*** in the Table of Contents and select Open Attribute Table.

Notice that the table only shows 5 fields. The FID and Shape fields are hidden, but they have not been deleted. Also notice that one of the fields is now named Alternative Name.

- Close the Attribute table.

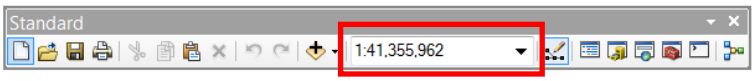
Step 6 Working with scale

Map scale is the relationship between the distance on a map compared to the distance on the ground. A map scale of 1:40,000,000 means that 1 unit on the map represents 40,000,000 units on the ground. It does not matter what the units are they can be feet, meters, or miles, however, they must be same between the map and the ground. In this example you can think of 1:40,000,000 to be 1cm on the map represents 400km (40,000,000cm) on the ground.

- Click the **Zoom In** tool on the Tools toolbar. Draw a box around the continental United States to zoom in.

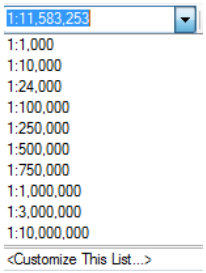
Remember, the Regional Scale group layer is set to only be seen when the maps scale is less than 1:40,000,001, so make sure you have **zoomed in** past 1:40,000,001.

TIP: You can see the current scale of your map in the Standard Toolbar.



Now that you are zoomed in past 40,000,001 the Regional Scale group layer turns on and the Global Scale group layer turns off. Also notice that in the Table of Contents the box beside Global Scale is greyed out with a scale bar underneath.

- Click on the drop-down arrow beside the map scale to see all the pre-defined standard map scales.



- Select 1:10,000,000.
- Expand the group layer ***Regional Scale*** by clicking the **+** sign beside the name in the Table of Contents.

Within this group, you'll notice that the **Cities** layer is greyed out. This is because this layer has its own scale range set.

- With the **Zoom In** tool still selected, draw a box around the state of Texas.

As long as you are zoomed in past 1:8,000,000 (less than 8,000,000), you will see the Cities name become active in the Table of Contents and more detail pop up on your map.

Step 7 Exploring and downloading data for Texas

In the next few sections you are going to take a closer look at the state of Texas to examine the impacts of drought over the past few years. To do this, you will need to add some more information to your map. The first layer you will add displays drought information. This GIS data can be downloaded from the U.S. Drought Monitor website **http://droughtmonitor.unl.edu/.**

- In ArcMap, right-click on ***Module 2*** (Data Frame) in the Table of Contents and select **New Group Layer**.

This created an empty group layer.

- Double click on ***New Group Layer*** in the Table of Contents to open the Group Layer Properties window.
- In the **General** tab, change the Layer Name to *Drought Monitor* and click **OK**.
- Click and drag the group layer ***Regional Scale*** above the ***Drought Monitor*** group layer in the Table of Contents.

In this next step you will add data to the group layer.

- Right-click on ***Drought Monitor*** group layer and select **Add Data…**
- Navigate to ***C:\Exercise2\data*** and select ***usdm110628.shp***.
- Next hold down the SHIFT key and click on the ***usdm120626 and usdm130625*** *layers*.

All three usdm files should now be selected.

- Click **Add**.
- If a warning appears about the data being in a different coordinate system than the Data Frame click **Close**.

Spatial data can be stored in many different coordinate systems. Each system is just another method of defining where features are located on earth. Using a consistent coordinate system ensures that different datasets overlay properly. The warning you just saw is telling you that the data from the Drought Monitor are defined in the North American

1983 coordinate system (NAD83), while our dataset in ArcMap is stored in the WGS 1984 coordinate system. You will learn more about coordinate systems in Exercise 5, but for now, it is sufficient to simply recognize that our new dataset is in a different coordinate system than our map. This will not prevent you from working with the data at this time.

The dataset appears in ArcMap as three separate layers. Because the layers have not been appropriately symbolized yet, it is difficult to understand what the lines and colors are indicating.

You will open the layer property window to set up the symbology for the layer.

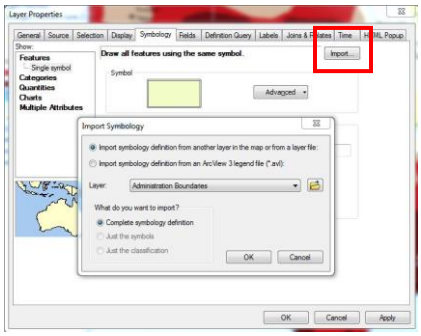
- All three layers are now highlighted in your Table of Contents. Click on any white space in the Table of Contents to unselect the layers.
- Double click on the layer ***usdm110628*** to open the Layer Properties window.
- Click the **Symbology** tab.

You can symbolize the data in a number of ways. One way is to choose the colors and symbolization method ourselves. In Exercise 3 you will spend more time learning about how to do this. Another convenient method is to use a symbology scheme that has already been set up and saved in a layer file.

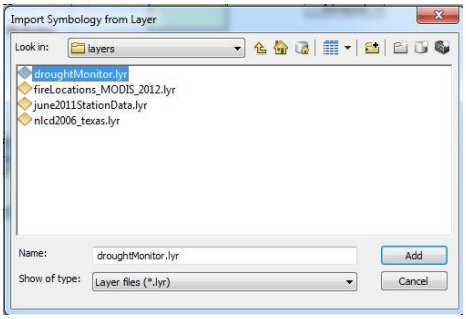
A layer file is a file that stores properties about spatial data. The properties you viewed in the Layer Properties window can be saved to a file with the extension .lyr and applied to any number of other datasets in ArcMap. They are very helpful when you need to symbolize different data in a similar manner. For example, to easily see how the drought has changed over the years, all our drought monitor shapefiles will need to be symbolized similarly. To do so, you will import the symbology from a layer file already saved in C:\exercise2\data\layers called ***droughtmonitor.lyr***.

- In the Symbology tab, click the **Import**... button located on the top right corner of the window.

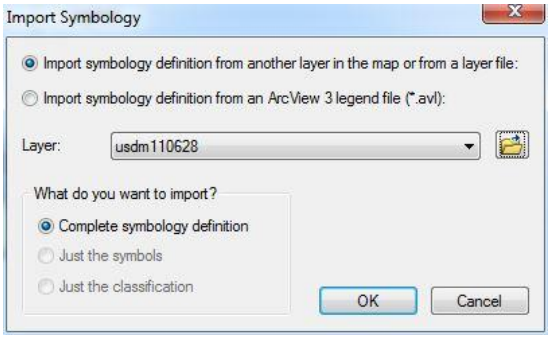
- Click the **Browse** button.
-

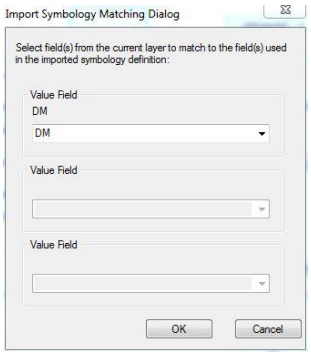


- Navigate to ***C:\exercise2 \data\layers*** and click ***droughtMonitor.lyr***.
- Click **Add**.



- Click **OK** in the **Import Symbology** window.
- Make sure the Value Field used to symbolize the dataset is set to **DM** and click **OK**.





- Back in the Layer Properties window click the **General** tab.
- Change the Layer Name to *Drought Monitor June 28, 2011*. Click **OK** to apply the settings.

Now the June 28th, 2011 drought monitor is symbolized by the drought monitor intensity. The darker red shows higher drought monitor intensity and therefore, represents more intense drought.

- Repeat the actions above to set the layer symbology for the other two layers (***usdm120626*** and ***usdm130625***) to match ***droughtMonitor.lyr***. Make sure the remaining layers are named according to the table below.

Layer	Name
usdm120626	Drought Monitor June 26, 2012
usdm130625	Drought Monitor June 25, 2013

- Turn off the layers ***Drought Monitor June 28, 2011*** and ***Drought Monitor June 26, 2012.***
- Be sure the ***Drought Monitor June 25th, 2013*** is turned on.

You are now looking at the Drought Monitor for the end of June 2013. Now let's take a look at the Drought Monitor for June 2012.

- Turn off the layer ***Drought Monitor June 25, 2013*** and turn on the layer ***Drought Monitor June 26, 2012.***

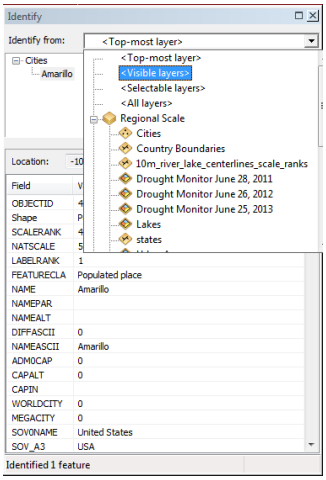
Now you are viewing the Drought Monitor for the end of June 2012.

- Turn off the layer ***Drought Monitor June 26, 2012*** and turn on the layer ***Drought Monitor June 28, 2011.***

Now you are viewing the Drought Monitor for the end of June 2011.

Visualizing the drought monitors is one way to compare the severity of drought over the years. Another way is to look at a specific location and identify the drought monitor intensity at that location for each of the three years we downloaded.

- Turn on all Drought Monitor layers in the Table of Contents.
- Click the **Identify** tool and click on the star representing the city Amarillo (located in the northern part of the state).
- In the Identify window, use the dropdown menu to change the **Identify From**: to <Visible layers>.



- Click the city of Amarillo again.
- Using the **Identify** tool, what are the Drought Monitor values for 2011, 2012 and 2013 (enter your answers in the table below).

CITY	June 28, 2011	June 26, 2012	June 25, 2013
Amarillo			
Houston			
San Antonio			
Dallas			

- Close the Identify window.
- Turn off the ***Drought Monitor*** group layer in the Table of Contents.

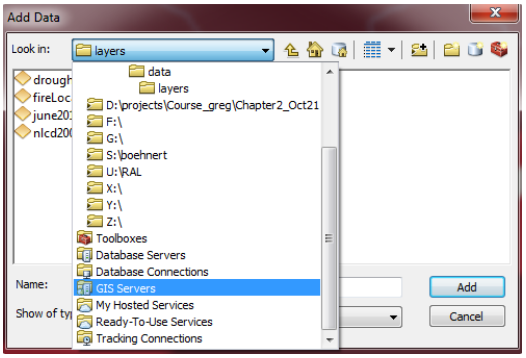
Adding Web Services to ArcMap

Step 8 Add a Web Map Service

In recent years, GIS technology has been moving towards online mapping and data. The Open Geospatial Consortium (OGC) has played a major role in making this possible by developing a standards-based approach using open protocols to share data via the web.

A Web Map Service (WMS) is one of the standard protocols. Many organizations distribute data and maps through WMS. You will access a WMS distributed by NOAA to look at radar compositions.

- To add a Web Map Service to ArcMap click the **Add Data** button.
- In the Add Data window click the drop down arrow in the **Look in:** drop-down box and select ***GIS Servers.***



- In GIS Servers, double click **Add WMS Server**.
- In the URL text box type in `http://nowcoast.noaa.gov/arcgis/services/nowcoast/radar_meteo_imagery_nexrad_time/MapServer/WmsServer?`
- Click the **Get Layers** button. Notice all the different layers this Web Map Service provides.
- Click **OK**.
- In the Add Data window, double click on ***WMS on nowcoast.noaa.gov.***
- Click ***WMS*** and click **Add**.

A new layer is added to the bottom of the layer list in your Table of Contents. This layer is a mosaic Radar layer.

- Drag the ***BaseData*** layer in the Table of Contents below the ***NOAA NWS NEXRAD MRMS Weather Radar Imagery*** layer.
- Zoom into an area that has some weather activity.

TIP: You may need to zoom out to see where there is some rain. This is a real-time radar web mapping service.

The radar is a raster layer. In this dataset, every cell in the raster has a value that represents the reflectivity in dBZ (decibels). The higher reflectivity means more intense precipitation.

- When you are finished exploring the radar data, turn in off in the Table of Contents.

Step 9 Working with non-spatial data

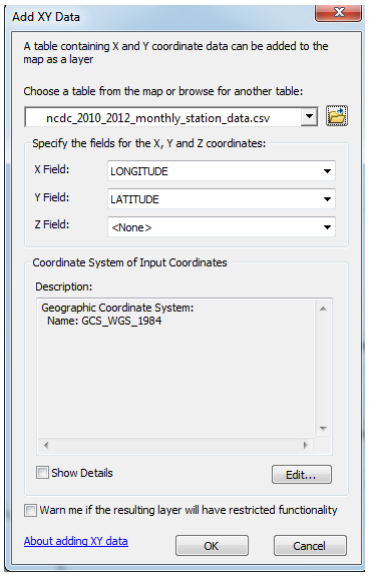
In this next step you are going to use a .csv file to add non-spatial weather station data for Texas. This dataset was downloaded from the National Climatic Data Center (NCDC).

- In Windows Explorer, navigate to ***C:\Exercise2\data*** and open ***ncdc_2010_2012_monthly_station_data.csv*** with Excel.

The first few columns contain information about the station's name, elevation, and location in latitude and longitude. We will use the latitude and longitude columns for displaying the station data on our map in ArcMap. The variable definitions are listed below:

HTDD	Heating Degree Days
CLDD	Cooling Degree Days
DPNP	Departure from Normal Monthly Precipitation
MMNT	Monthly Mean Minimum Temperature
TPCP	Total Precipitation
EMXP	Extreme Maximum Daily Precipitation
MNTM	Monthly Mean Temperature
MMXT	Monthly Mean Maximum Temperature
DPNT	Departure from Normal Monthly Temperature

- When you are finished looking at the data in the excel file, close without saving.
- Make sure you are still zoomed to Texas.
- Back in ArcMap, click the **File > Add Data > Add XY Data**.
- In the Add XY Data window, click the Browse button, and select ***C:\Exercise2\data\ncdc_2010_2012_monthly_station_data.csv.***
- Click **Add**.
- Make sure the X Field is set to ***LONGITUDE*** and the Y field is set to ***LATITUDE***.
- The Coordinate System of Input Coordinates should be automatically set to GCS_WGS_1984.



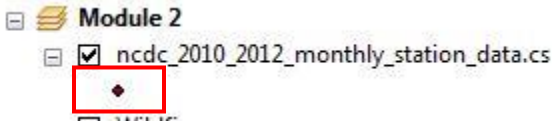
- Click **OK** to add the data as points on the map.
- Click **OK** again when a warning appears about the table not having an Object-ID.

A new layer is added to the top of the layer list in the Table of Contents and 5 points have been added to the map. These points are the station locations. Each point will have monthly summaries for the years 2010 through 2012 for the variables listed in the table above.

TIP: Non-spatial datasets added to ArcMap through the Display X,Y tool are called an **Event Layer**.

It is hard to see the points on the map. You will change the symbology so that this layer is more visible.

- Click on the symbol for the layer ***ncdc_2010_2012_monthly_station_data.csv*** in the Table of Content.

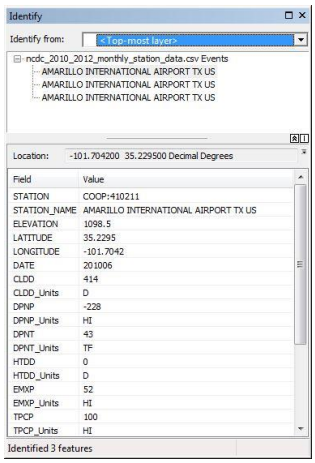


- In the Symbol Selector that appears set the symbol to *Circle 1* and click **OK**.

- Click the **Identify** tool on the Tools toolbar and click the station that is close to Amarillo.

Notice that three features are identified. One feature represents June 2010, another one represents June 2011, and the third is June 2012. You can tell the date by looking at the DATE field

What is the Total Precipitation TPCP for June for each year? (units is HI - hundredths of an inch) - The DATE field will identify the year.



The unit HI means that the value of 100 means 1 inch.

201006 (June 2010)

201106 (June 2011)

201206 (June 2012)

What is the Monthly Mean Temperature MNTN? (units TF - tenths of a degree in F)

The units tenths of a degree in F means that a value 700 is 70.0 F

201006 (June 2010)

201106 (June 2011)

201206 (June 2012)

- Close the Identification window.

So far, you have used the data from the US Drought Monitor to see the areas of drought across Texas since 2010. You have also looked at monthly station data to get more detailed temporal weather information for specific cities.

In the next steps, you will look at some of the impacts of the Texas drought. Using products derived from MODIS satellite imagery, you will examine the number of wildfires that burned in Texas in 2011 and 2012 as compared to 2002.

Exploring Raster Datasets

Step 10 Working with Fire location data

In this section, you will look at the location of wildfires in 2011 derived from MODIS satellite imagery. You will then compare these data to the data from a wetter year, 2002.

One of the costliest wildfires in Texas history was the Bastrop County Complex Wildfire which broke out on Labor Day 2011. This fire burned more than 1600 homes and claimed 2 lives. The Bastrop County Wildfire was one of tens of thousands of wildfires in Texas that summer.

- Turn off the ***ncdc_2010_2012_monthly_station_data.csv Events*** layer.
- Turn on and expand the group layer ***Wildfires*** in the Table of Contents.

This group layer contains two fire locations datasets (one for 2002 and one for 2011), a layer outlining Bastrop County, a gridded land-cover dataset, and two gridded layers from satellite imagery (LandSat). You are going to first explore the fire locations.

- Right-click on the layer ***fireLocations_MODIS_2002*** and select Open Attribute Table.

TIP: If you are interested in learning more about the fire locations MODIS data or downloading this yourself, visit the following website. http://activefiremaps.fs.fed.us/gisdata.php

The table contains information about each fire detected in 2002 via MODIS. In this quick analysis we will investigate the number of fires in 2002 versus 2011and where these fires occurred.

In the table below write the number of fires detected in 2002 from the MODIS satellite. Then open the table for the layer fireLocations_MODIS_2011 and write down the number of fires detected in 2011. HINT: the number of fires detected is the total number of features in each dataset. Refer to Step 4 if you can't remember how to find this information.

Year	Number of Fires Detected
2002	
2011	

Notice that there were many more wildfires detected in the year 2011 than there were in the year 2002.

- Close the Attribute Table window.
- Turn on the layer ***Bastrop County*** in the Table of Contents.
- Right-click on the layer ***Bastrop County*** and select Zoom to Layer.
- Now that you are zoomed into Bastrop County, turn off ***fireLocations_MODIS_2002***

The red points are the fire locations detected in the MODIS imagery. The Bastrop County Complex wildfire burned mostly forested areas (green area in Land Cover dataset).

Many of these datasets can be found at EarthExplorer http://earthexplorer.usgs.gov/.

- Turn on the layer ***July9th, 2011 LandSat***.

This is an image that is derived from a multispectral satellite dataset. That means that the data were captured at specific frequencies across the electromagnetic spectrum. This image of the area around the burn site is a helpful way to visualize what is happening on the ground.

- Turn off the ***fireLocations_MODIS_2011*** layer.

In our image, the greens are forested regions, the pinks are crops, and the white/grey is urban. Notice that the region that experienced the Bastrop Complex fire is very green.

- Turn off the ***July 9th, 2011 LandSat*** layer and turn on the ***Sept. 11th, 2011 LandSat*** layer.

This image was taken on Sept 11th, 2011, about 6 days after the fire burned. Notice the burn area from the Bastrop County Complex fire is clearly visible.

Do you see any other burn-scar areas visible in the satellite imagery that match a fire detection point from the MODIS file?

- Turn on the ***fireLocations_MODIS_2011***.
- Spend some time and explore the fire areas.
- Once you are finished exploring the data, click **File > Save As** and name your new map ***BastropFire.mxd*** save the map in ***C:\Exercise2\maps***.
- Close ArcMap.