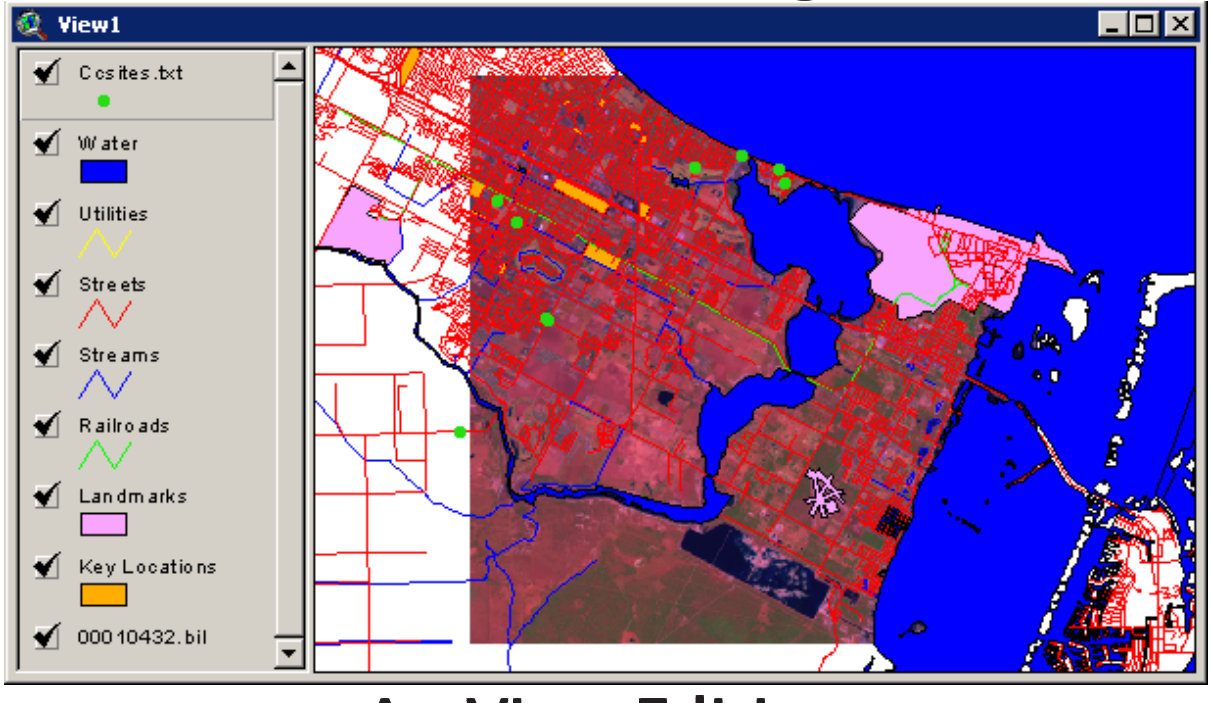
Geographic Information Systems and the GLOBE Program



ArcView Edition

Table of Contents

Chapter 1: What is GIS?

Manual GIS: Students in a school in Jordan are assigned the task of preparing a detailed map of their community. They gather resources such as topographic maps, road maps, their GLOBE Landsat image, the locations of students' homes, some aerial photos, and some charts provided by their local government showing locations of businesses, parks, etc.

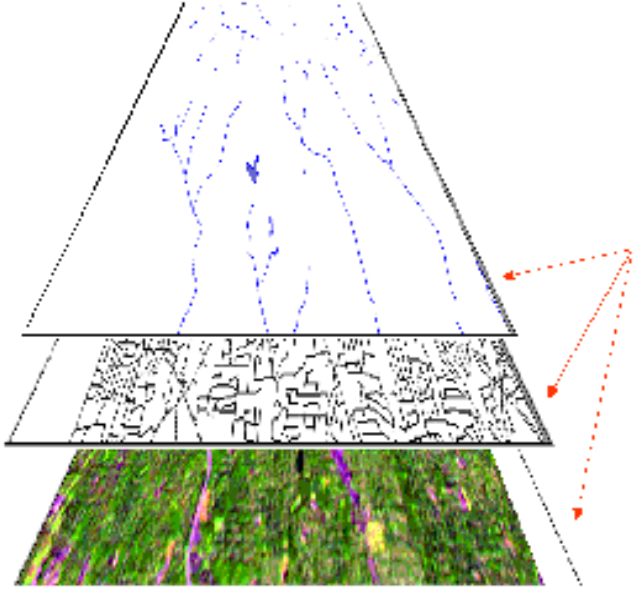
Instead of making one map, the students decide that each team will map only one kind of feature. One team maps roads, while another maps water bodies. One maps the locations of student homes, and another maps agricultural areas. Each of these features is called a "theme." The students decide that they will map each theme on a separate sheet of transparent plastic, so that themes can be placed one on top of another, or on top of other maps.

After much hard work (maps drawn at different scales must be enlarged or reduced so that all layers are drawn to the same scale) the job is done, and the students begin to experiment with what these layers can show them.

They discover that by selectively placing one layer on top of another, they see the relationships between different kinds of surface features. They ask questions about the location of large parking areas with respect to bodies of water (runoff from these areas can be a significant source of pollution in water bodies). They look for patterns of business locations with respect to transportation routes.

The layering of features made it easier to see how one particular feature is related to others and to ask questions about these relationships. This is an example of a simple Geographic Information System (GIS).

The illustration below shows their layers for water and roads stacked over their satellite image.



Layers, or "Themes"

From these layers, they could investigate how the pattern of roads and water bodies is related to local topography.

What is Electronic GIS?

GIS software such as ArcView and ArcVoyager accomplish the same tasks as the students in the previous example. With GIS software, the computer takes numbers and words that describe places on the Earth, stored in databases and spreadsheets, and displays them as map layers on your computer monitor. In addition to allowing great flexibility in how data are displayed, GIS software also allows us to ask questions based on the data. The students' question about the locations of parking lots and bodies of water is called a **Query**.

The key to relating different pieces of data that describe places on the earth is that these data are "geospatial." That is, for every point we want to map there is a unique set of numbers, latitude and longitude, that describe where that place is.

GIS, then, is a system for entering, storing, displaying, manipulating and analyzing "geospatial" data.

Who Uses GIS?

Geographic Information Systems are used by anyone who needs to work with information that is related to places on the Earth. In a few recent GIS publications, the following topics were covered:

- Natural Resources: forestry management, habitat identification and evaluation.
- Community services: fire, ambulance, police, crime investigations, utility management.
- Health: mapping the spread of infectious agents .
- Energy: mapping oil, coal and natural gas deposits, exploring for energy resources.
- Mapping natural phenomena: earthquakes, tsunamis, volcanoes, hurricanes, floods.
- Business: courier services, real estate analysis, demographics, sales analysis.
- Water resources: mapping aquifers, planning water needs based on community growth.
- Sea floor exploration: mapping the sea floor, searching for wrecks.
- Education: bus routes, population demographics, student mapping of local environments.

Why Should I Use GIS in My Classroom?

Real learning occurs when students work with problems that have significance to them as "explorers of learning" and members of communities that range in scope from local to world wide.

Whether their interest lies in looking for patterns to the world's earthquakes, tracking whales in their migration, looking at patterns of westward settlement, mapping old cemeteries in their village, or investigating the watershed of a local water body, GIS provides a "hands-on" method of gathering, displaying, interacting with, and investigating geographic data from the real world.

The data students use may be obtained from online services, local, state or regional agencies, or it may be information that students have gathered in the field using an inexpensive GPS (Global Positioning System) receiver to accurately locate data points.

Geography plays an important part in much of what we do, yet our students often have a poor knowledge of geographic data. GIS provides a tool that can bring Geography to life in and out of the classroom. For examples of the use of GIS in the classroom, see *GIS in Schools*.[1]

You can also visit ESRI's (Earth Systems Research Institute) "Schools and Libraries" program at:

http://www.esri.com/industries/k-12/hrynggis.html

for information, tutorials, files and examples of GIS projects in education.

What Is the Purpose of this Tutorial?

This series of tutorials will provide a brief introduction to two of the common software packages available to schools: ArcView® and ArcVoyager®.

ArcView and ArcVoyager are produced by ESRI (Environmental Systems Research Institute) of Redlands, CA. ArcView is one of the industry standard GIS programs and is relatively costly. ArcVoyager is a "school version" of ArcView and is available free to schools from ESRI. It contains most of the functioning of ArcView. A separate tutorial will be devoted to each.

What this Tutorial is NOT:

There are many excellent books available that will give you a thorough introduction to GIS[2]. Many are quite lengthy. This tutorial is not intended to replace any of them. It is designed to give you a "quick start" in using GIS software as part of your GLOBE teaching and learning experience.

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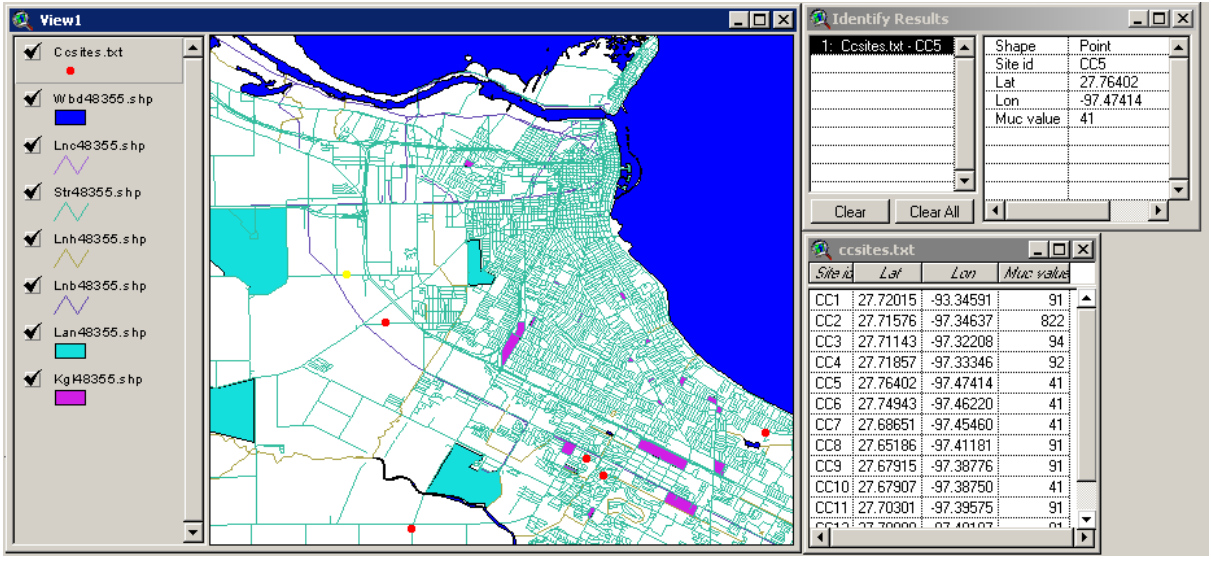
1. Audet and Ludwig, GIS in Schools, ESRI Press, 2000

2. Getting to Know ArcView GIS, ESRI Press, 1996 - 1998

A GIS Example

The map below is a GIS project for Corpus Christi, Texas. The layers of data that represent water, roads, etc. were downloaded free from Internet sites. The colored dots represent data gathered by participants at a GLOBE workshop for the validation of their GLOBE land cover map.

The participants created a table of their data in a word processor. They added this data table to the GIS display as a series of dots. Each dot represents a site visited for accuracy assessment. The inset tables show both the data table they prepared from their field observations, and the results of "querying" the system about the yellow point. This group was able to see how the sites they visited are related to local features.



What Kinds of Data Does a GIS System Work With?

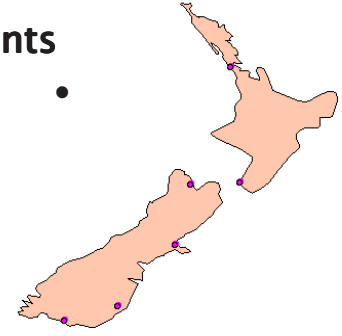
A GIS system displays two basic types of data; **raster** and **vector**.

Raster Data: Raster data are items, usually images, that are composed of "pixels." These may be satellite images, such as the one shown to the right, scanned maps, aerial photos, or any object that shows pixels when enlarged. Raster data are saved as independent files, just as you would save a picture file.

Vector Data: Vector data, such as the sample from Corpus Christi, TX, shown at the right, are drawings that represent features such as streets, rivers, railroads, lakes, city blocks, or almost any feature you can imagine being drawn on a map.

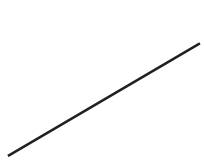
What are the different kinds of Vector data?

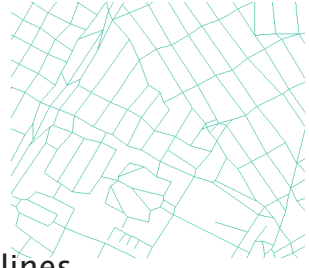
Points



Points are used to display individual locations, or data sampled at specific points, such as temperature, pH, and conductivity. This figure shows major cities in New Zealand.

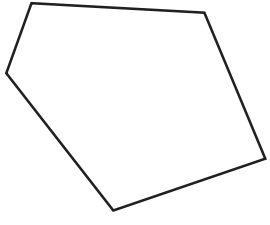
Lines

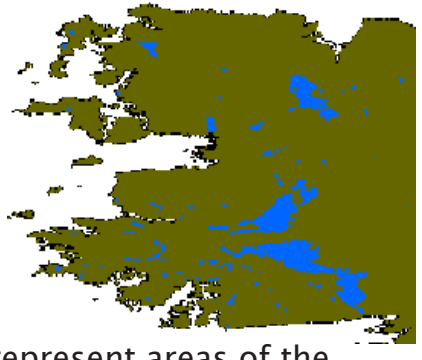




Lines represent linear features, such as roads, trails, streams, and contour lines.

Polygons



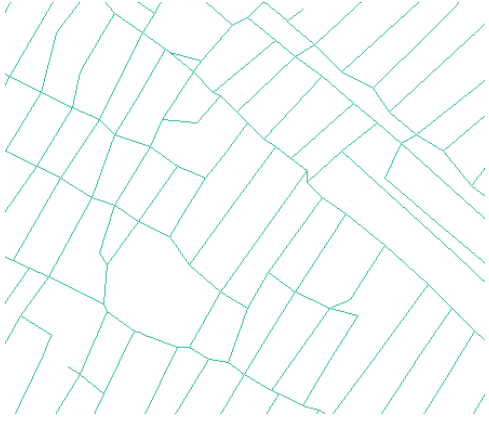


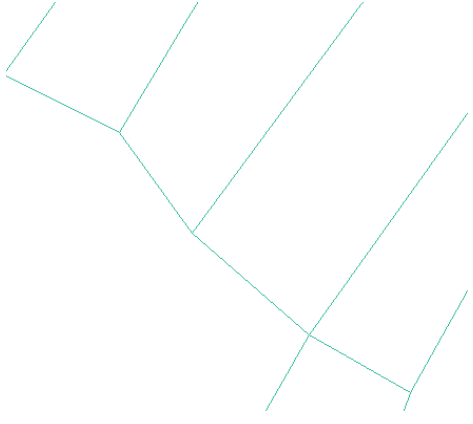
Polygons are closed figures and represent areas of the Earth's surface. These may be lakes, cities, shopping malls, national parks, or any feature that can be described by area. The figure above shows lakes (blue) and part of the land area (green) of Ireland as polygon data.

Vector data are not stored as “images” the way raster data are. They are drawn on the monitor from information contained in database or spreadsheet files. They are redrawn at best screen resolution every time you zoom in or out. Thus, they never show “pixels,” as raster data do.

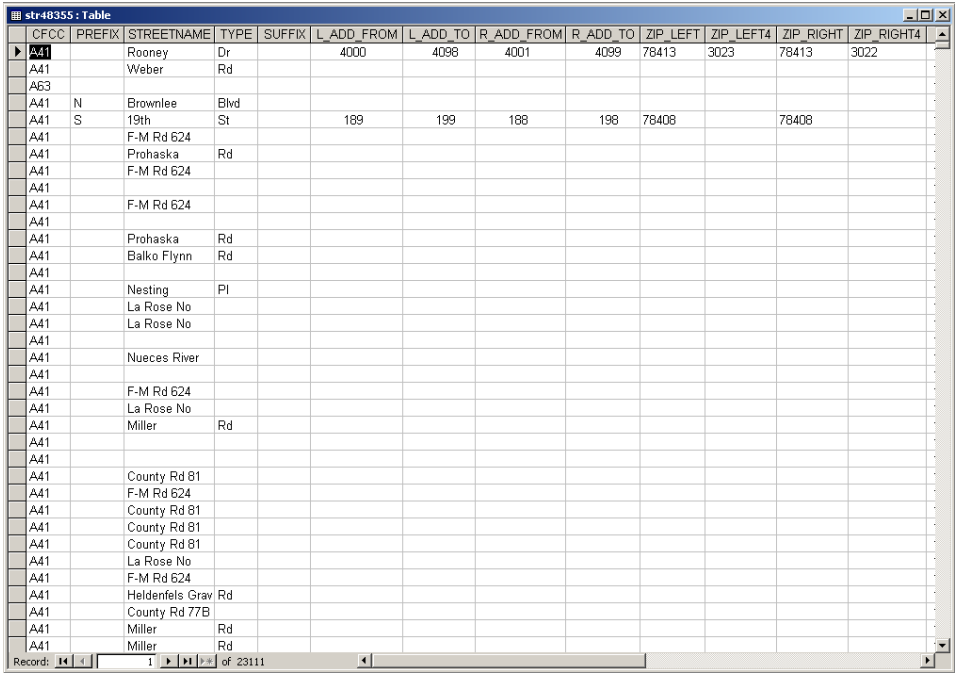
The figure below shows GIS vector data for some of the streets in Corpus Christi, TX.

The three figures below show successive “zooms” on a part of this street data. Notice that even with an increase of magnification, there are no pixels seen in the data. The streets are redrawn in each zoom at highest resolution using data about them stored in a database file.





The figure below shows part of the database file used by the GIS software to draw the streets. These are the only data that are stored to produce this street layer, or **theme**. The columns marked "*L_add_from*" to *"R_add_to*" contain the coordinates used to draw the individual streets.



str48355 : Table

CFCC	PREFIX	STREETNAME	TYPE	SUFFIX	L_ADD_FROM	L_ADD_TO	R_ADD_FROM	R_ADD_TO	ZIP_LEFT	ZIP_LEFT4	ZIP_RIGHT	ZIP_RIGHT4
A41		Rooney	Dr		4000	4098	4001	4099	78413	3023	78413	3022
A41		Weber	Rd									
A63												
A41	N	Brownlee	Blvd									
A41	S	19th	St		189	199	188	198	78408		78408	
A41		F-M Rd 624										
A41		Prohaska	Rd									
A41		F-M Rd 624										
A41												
A41		F-M Rd 624										
A41												
A41		Prohaska	Rd									
A41		Balko Flynn	Rd									
A41												
A41		Nesting	Pl									
A41		La Rose No										
A41		La Rose No										
A41												
A41		Nueces River										
A41												
A41		F-M Rd 624										
A41		La Rose No										
A41		Miller	Rd									
A41												
A41												
A41		County Rd 81										
A41		F-M Rd 624										
A41		County Rd 81										
A41		County Rd 81										
A41		County Rd 81										
A41		La Rose No										
A41		F-M Rd 624										
A41		Heldenfels Grav	Rd									
A41		County Rd 77B										
A41		Miller	Rd									
A41		Miller	Rd									

Record: 1 of 23111

In addition to the location data, you will also note such information as "*Streetname*," "*Type*," and "*Zip_left*." These data, along with others not shown, are called the **Attributes** of the theme. They provide extra information about each feature in the theme, and can be displayed, analyzed or investigated by using the GIS software.

Each separate layer, or **theme**, in a GIS view has a separate **Attributes** table.

Chapter 2: What is ArcView?

ArcView: ESRI, the producer of ArcView, has been an industry leader in the production of GIS software and in the support of GIS education. ArcView is available for both PC (V3.3) and Macintosh (V3.0). The Macintosh version is not supported and cannot use many of the extensions that are available. ESRI has recently released a major update to it's GIS offerings in the form of ARC GIS (V9.x) for high-end PC machines, but continues to support ArcView.

How Can I Get ArcView? ArcView can be purchased from ESRI. However, schools can earn a free copy of ArcView by completing a project for the **ESRI Community Atlas Project.** See Appendix IV for more details.

Installing ArcView

ArcView (PC): ArcView is simple to install. Like most PC software, the installation CD automatically loads an installation wizard. Unless you wish to install on a drive other than "C," select the "default" values at each step and ArcView will install two folders: *AV_GIS30*, which is the program folder, and *ESRIdat*a, which contains data supplied by ESRI.

ArcView (Mac): Insert the ArcView CD into your CD drive. The disk contains an installer which will install two folders when you double click the icon. *AV_GIS30a*, the program folder, and *ESRIdata*, a folder of data provided by ESRI.

Once installation is complete, you should create a new folder in your *ESRIdata* folder. Label this *GIS Projects*. Storing all your projects here will simplify data access.

Chapter 3: Finding the Data in ArcView

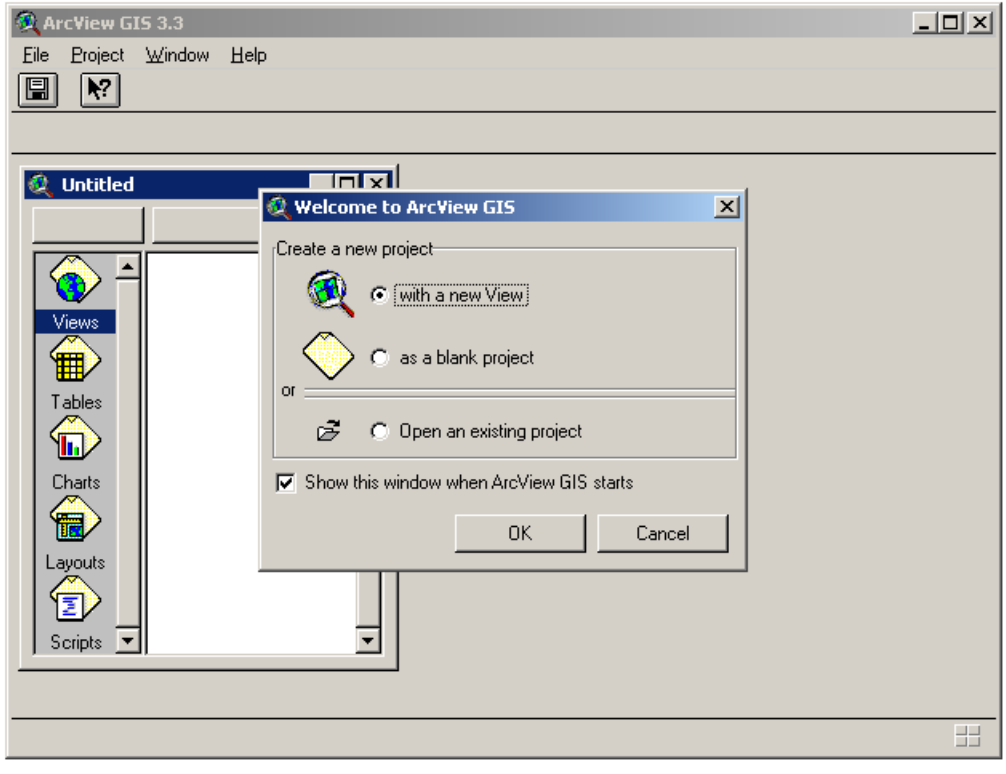
This section will guide you through opening ArcView and navigating to the built-in data files.

Objective

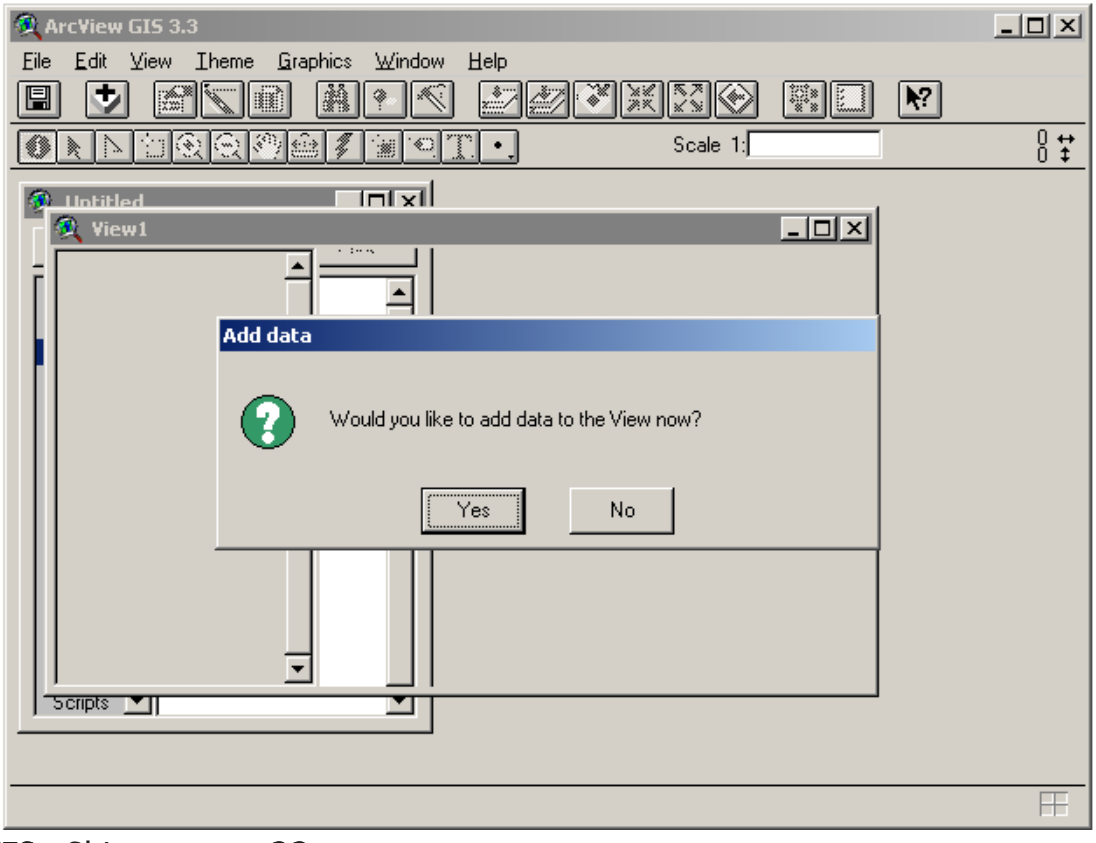
- Locate the data files supplied with ArcView.

Finding Data in ArcView

- Launch ArcView.
- ArcView may open with the **Welcome Window**, shown to the right. The **Project Window** allows you to create a new project or open an existing project. If you do not see this screen, skip to **page 19**.
- Choose create a new project with a new view and click **OK**.

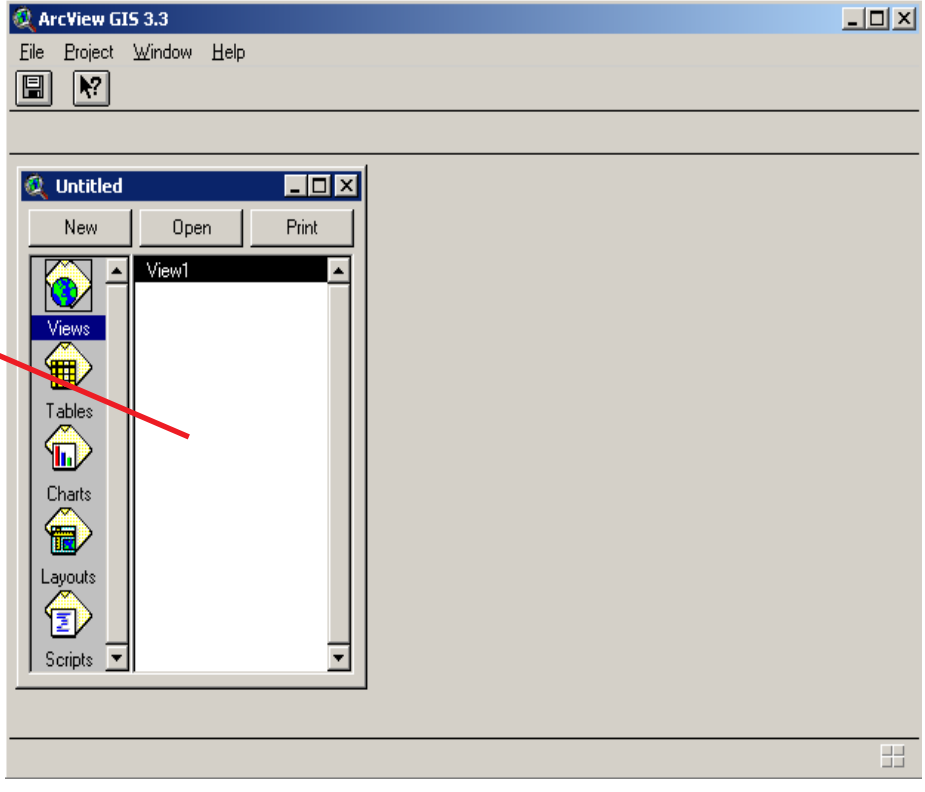


- ArcView now asks if you want to add data.

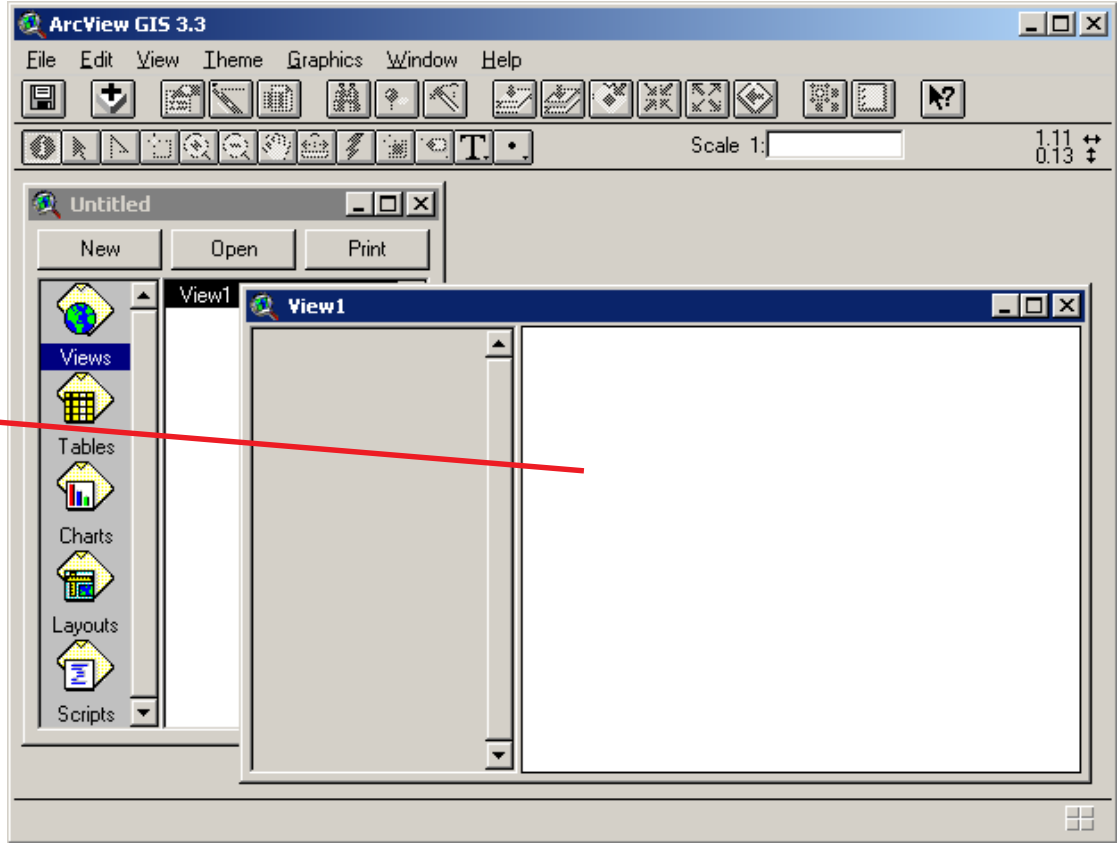


- Click **YES**. Skip to **page 22**.

- If ArcView does not open with the **Welcome Window**, ArcView opens with the **Project Window**, shown below. The **Project Window** shows the contents of your project. It is from this window that you bring certain types of data into your "view."

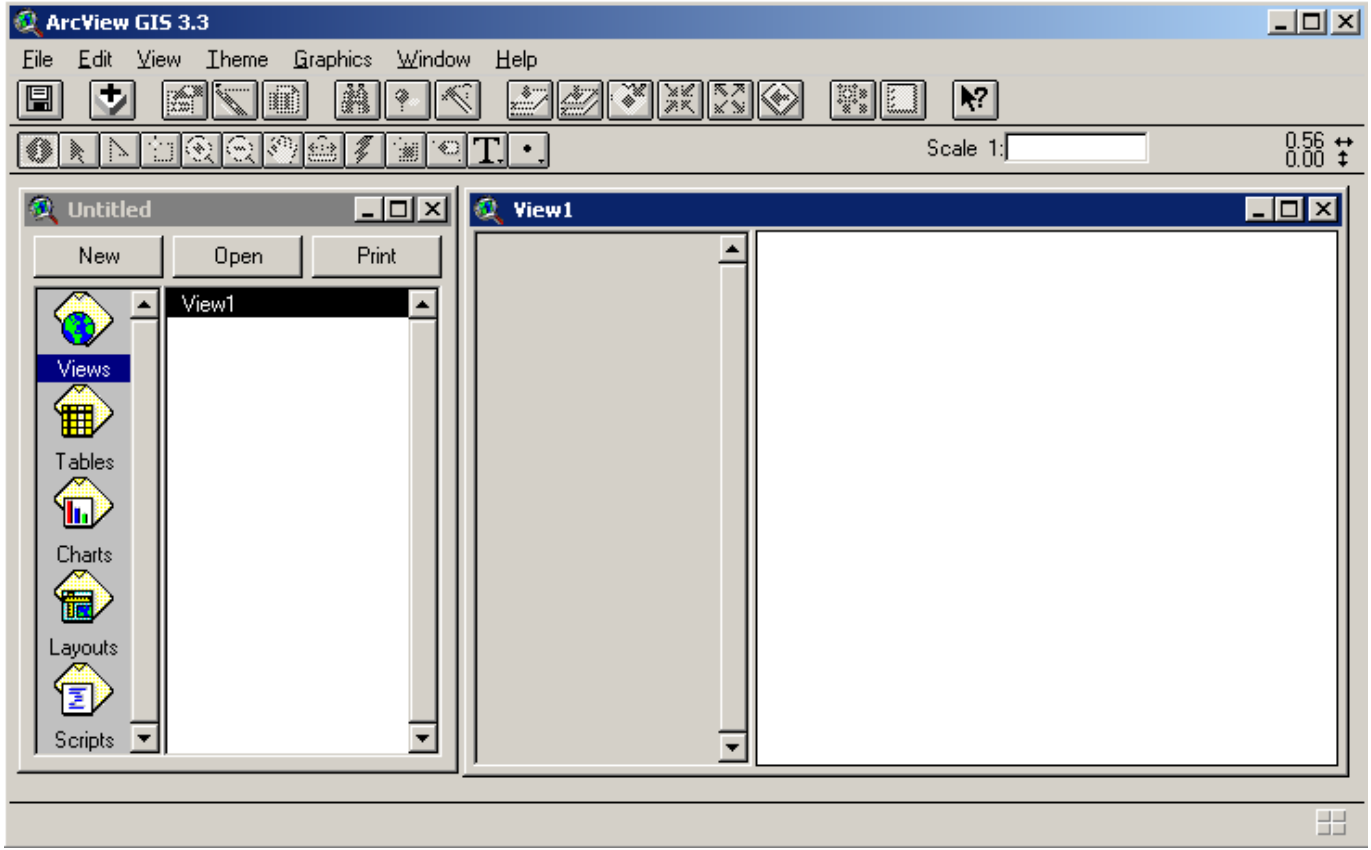


- Click the **New** button in the menu for the **Project Window**. Arcview opens the **View Window**, shown below.



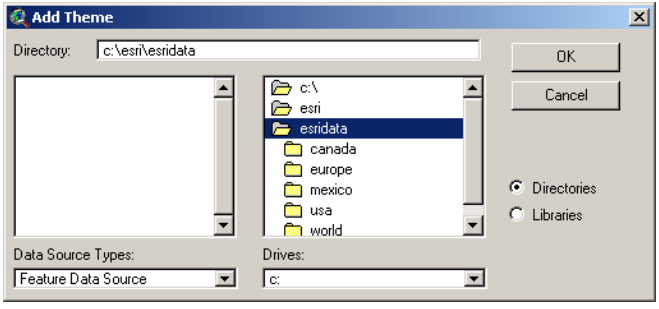
View Window

- This new **View Window** may cover the **Project Window**. Drag it by its title bar to the right, and drag its lower-right corner to fill the background window.



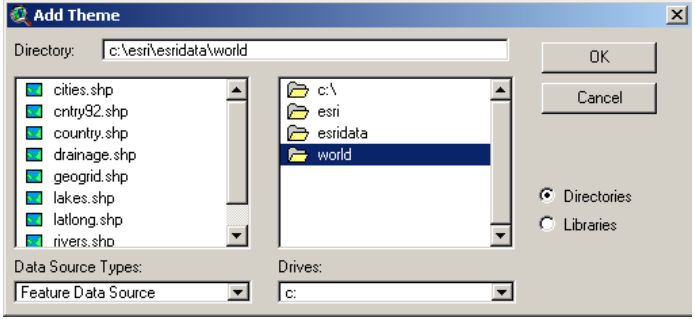
- Click the **Add Theme** button, shown to the right. It is at the left end of the button bar.

- Navigate to your *ESRIdata* folder, shown below and open this folder.



- From the *ESRIdata* folder, select the *world* folder and open it.

- The contents of this folder are listed. These files all have the extension ".shp." These are ArcView **shape files**, and represent different forms of vector data (Point, Line and Polygon).



Chapter summary: In this chapter, you learned how to add data to a new view. In the next chapter, you will use this skill to begin a new project and explore the power of ArcView.

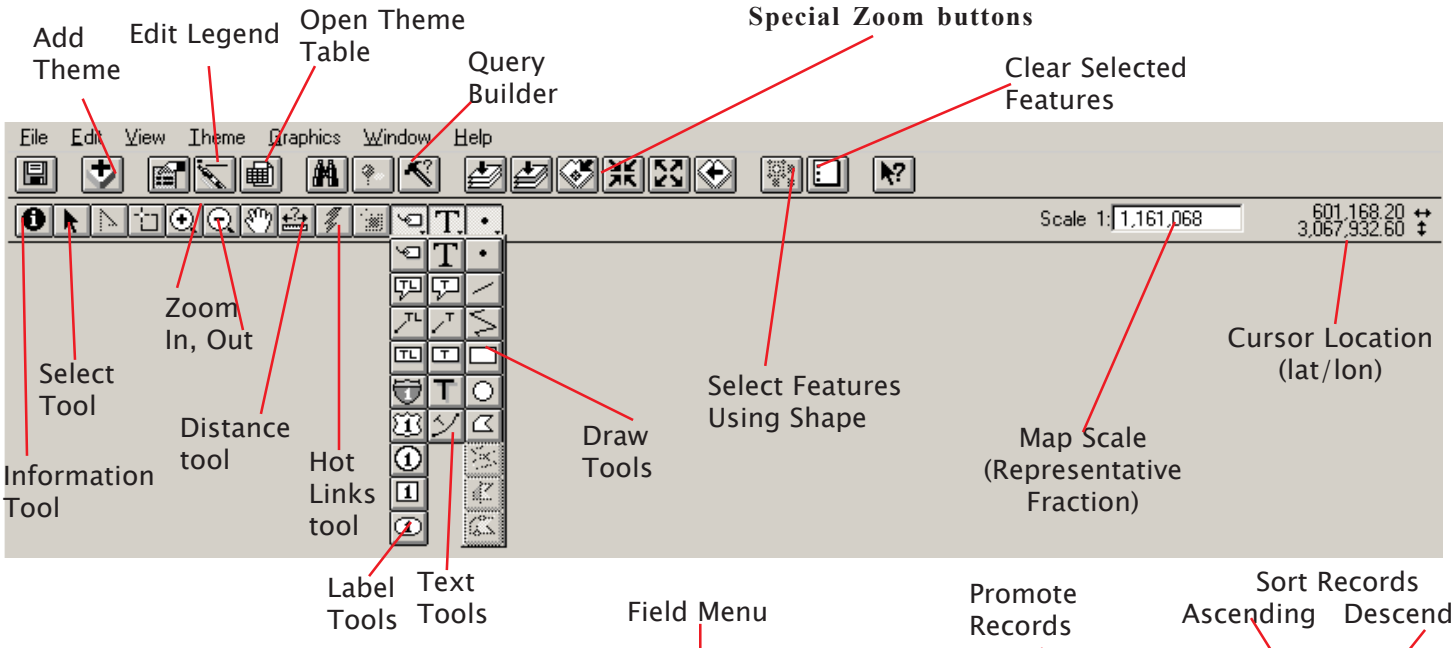
Chapter 4: A Beginning Map Using ESRI Data

In this chapter you will use and explore some of ArcView's menus and windows.

Objectives

- Create a new project.
- Add themes from ArcView's data base.
- Change the appearance of themes.
- Examine the map scale for your view.
- Use the Legend Editor, Fill Palette, and Color Palette.
- Zoom to selected areas of your map.
- Obtain information about features in the project's themes.
- Examine the information (attributes) in a theme's data table.
- Sort the data table and use the Query Tool to select specific entries.
- Use ArcView's maps and attribute tables to investigate topographic and geographic problems.
- Change the properties of a View.
- Look at an unusual map projection.

ArcView Toolbars



Tables Menu and Toolbar

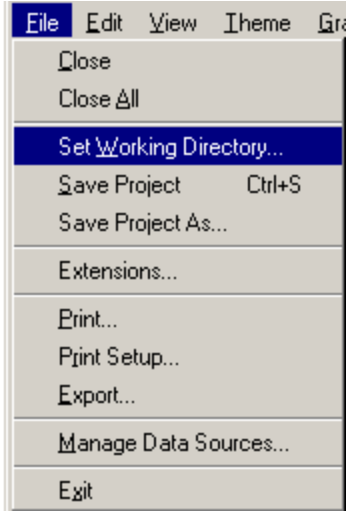
Starting with ArcView

- Launch ArcView.
- Create a new project.

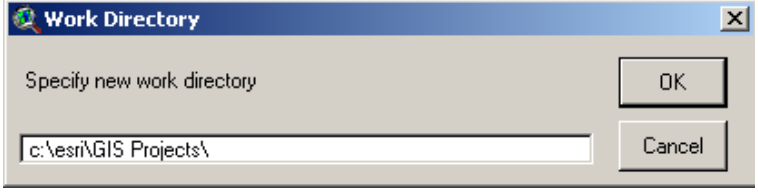
Setting the Working Directory

Unless you tell ArcView where you want your project saved and where your project files are located, the program will select a default location, usually one you do not want. The **working directory** should be the *GIS Projects* folder you set up when you loaded ArcView. Set this after you have created a new view.

- From the **File** menu, select **Set Working Directory**.



- Specify the **path** to your GIS Projects folder. ArcView 3.xx does not have a browse capability for this, so you must manually specify the path. The format for the PC platform is shown below and is in the standard format.



Example: Suppose your *GIS Projects* folder is located in a directory called "esri" on your "C" drive, your path would be:

C:\esri\GIS Projects

For Macintosh Users

For Macintosh users the idea of a path name may be something new. The path consists of each location you must double click to reach your folder.

- The author's folder is stored on the hard drive *My Drive*, in a folder called *ESRI* and is called *GIS Projects*. Note that each step is separated by a colon (:) and there are no spaces, except where they occur in location names.

A Macintosh Example: Suppose your *GIS Projects* folder is located in a folder called "ESRI" on your main fixed drive, which you have named "My Drive." Your path would be:

My Drive:ESRI:GIS Projects

Saving Projects and Opening Saved Projects

Saving a Project: Now that we have the working directory set, it is a good idea to learn to save your project. ArcView does not automatically save your work for you so remember to save your work often.

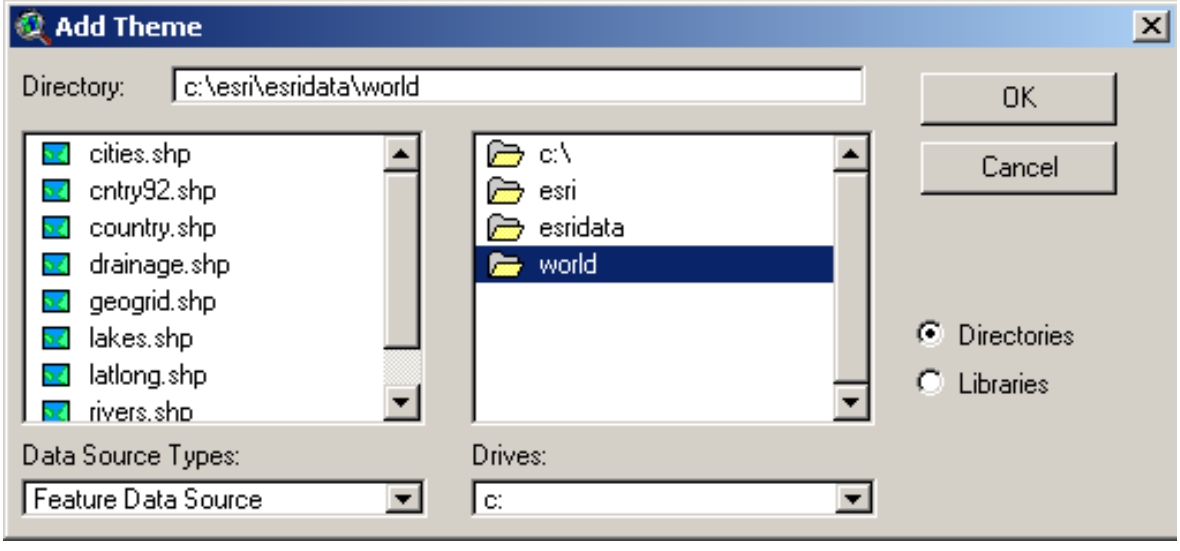
- From the **File** menu, select **Save Project** .
- If you have set the working directory, ArcView will open your *GIS Projects* folder. If not, navigate to that folder.
- Give your project an appropriate name, and be certain to attach the extension .*prj*.

Opening a Project

- Launch ArcView if it is not already open.
- From the **File** menu, select **Open Project**.
- Navigate to your working directory, select your project and click **Open**.

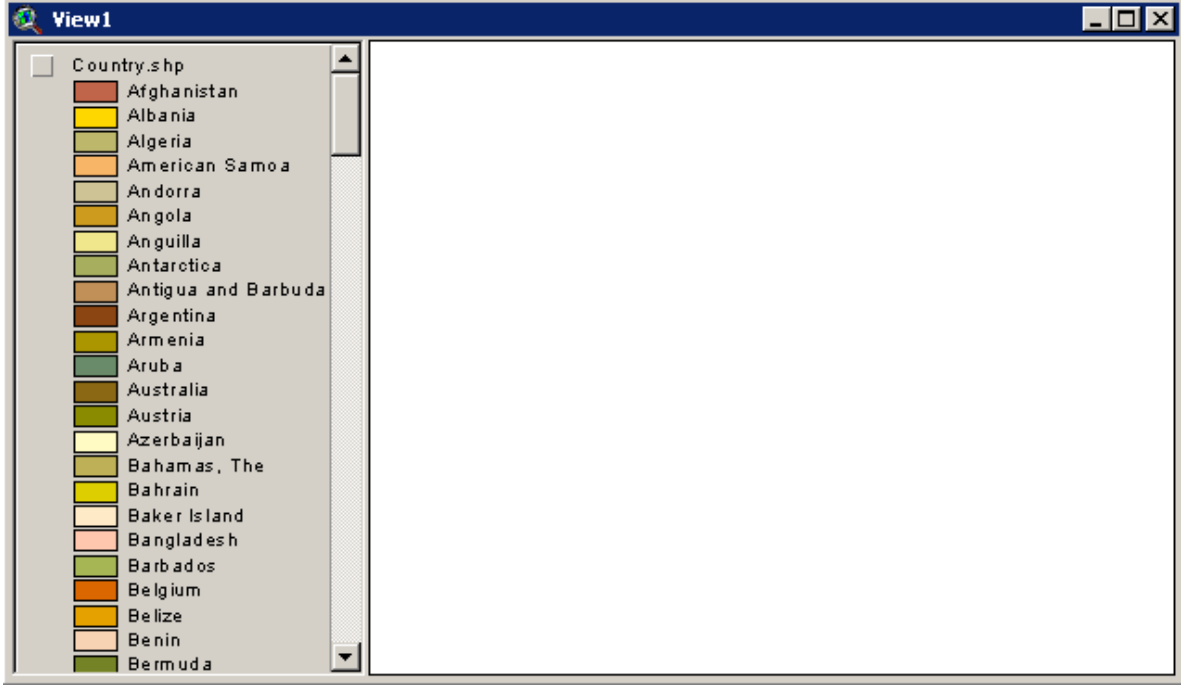
Note: A saved ArcView project contains the path to each of the files used in it. If you move any of these files, ArcView will not find them, and will prompt you for the location of each. This is one reason you should keep your working projects and files in one area.

- Click the **Add Themes** button.
- Navigate to the *world* data folder and select the *country.shp* file in the **Add Theme** window.



- Click OK in the **Add Theme** box.

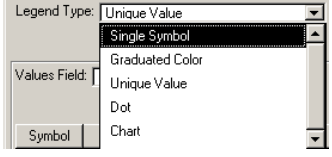
- Your **View** window now shows the *country.shp* theme added to the **View Table of Contents** window. Although there is one *country.shp* file, each separate country has been given a different color. For simplicity, let's make all the countries the same color.



- Double click on the name of any country in the **View Table of Contents** listing. This opens the **Legend Editor**. Here is where we select some of the options for displaying themes.

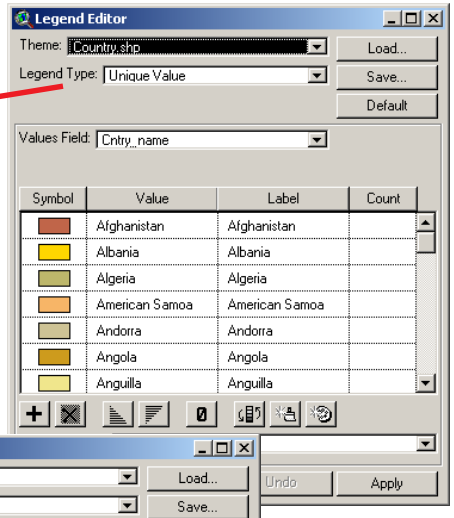
- Notice that the **Legend Type** pull-down menu displays **unique value**. This means that each country is displayed as a separate color based on its name.

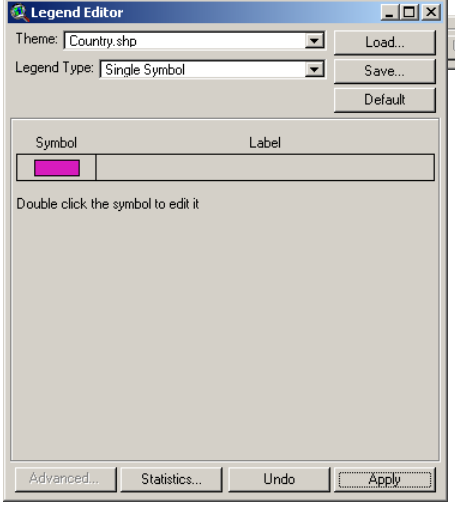
- Click on the **Legend Type** pull-down menu, and select **single symbol** .



- Click the **Apply** button. The **Legend Editor** view changes (the color selected by the system may differ).

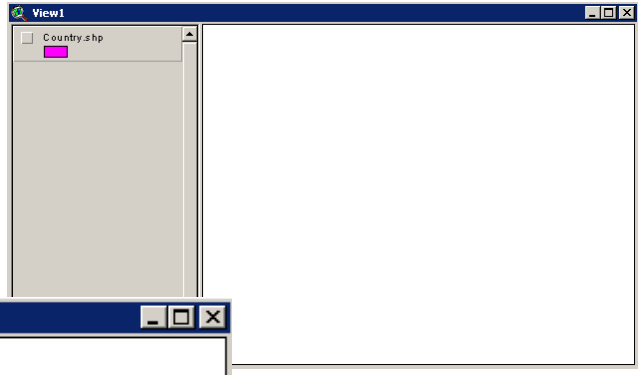
- Close the **Legend Editor**.

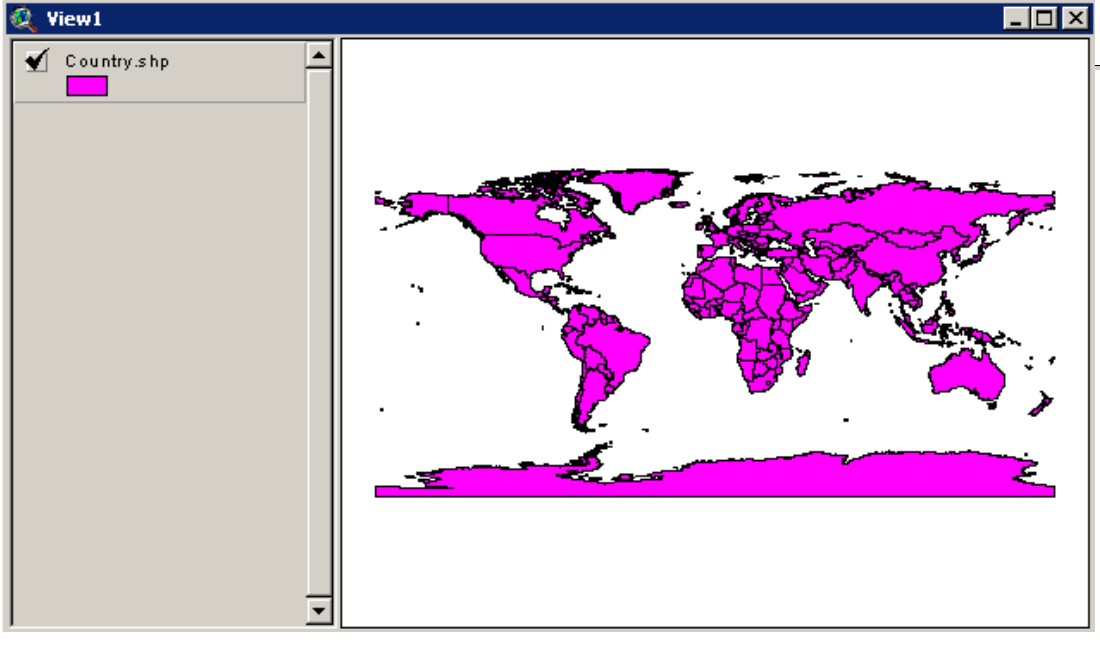




- The **View** window **Table of Contents** will now show the *country.shp* file as all one color. The color you see may be different from what is shown.

- Click once in the small box before the *country.shp* theme to turn on this theme. The world country map appears.

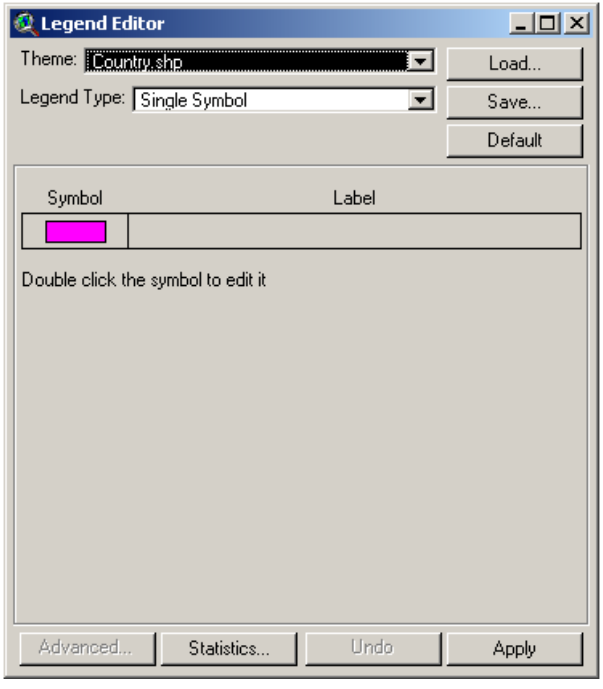




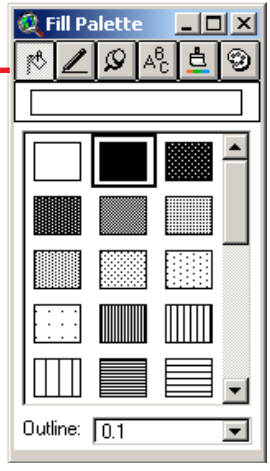
Coloring the Base Map

The map of the world you created is a “base.” You will add other layers or themes on top of it. If the color of this base is too dark, overlying layers will not show well. Your first task is to change the color of the base map.

- Double click the *coutry.shp* theme in the **View Table of Contents** window to open the **Legend Editor**. You may also click the **Edit Legend button** in the tool bar.

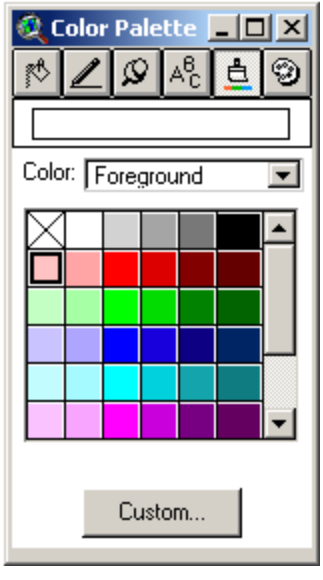


- Double click the color patch beneath the *symbol* heading in the **Legend Editor**.



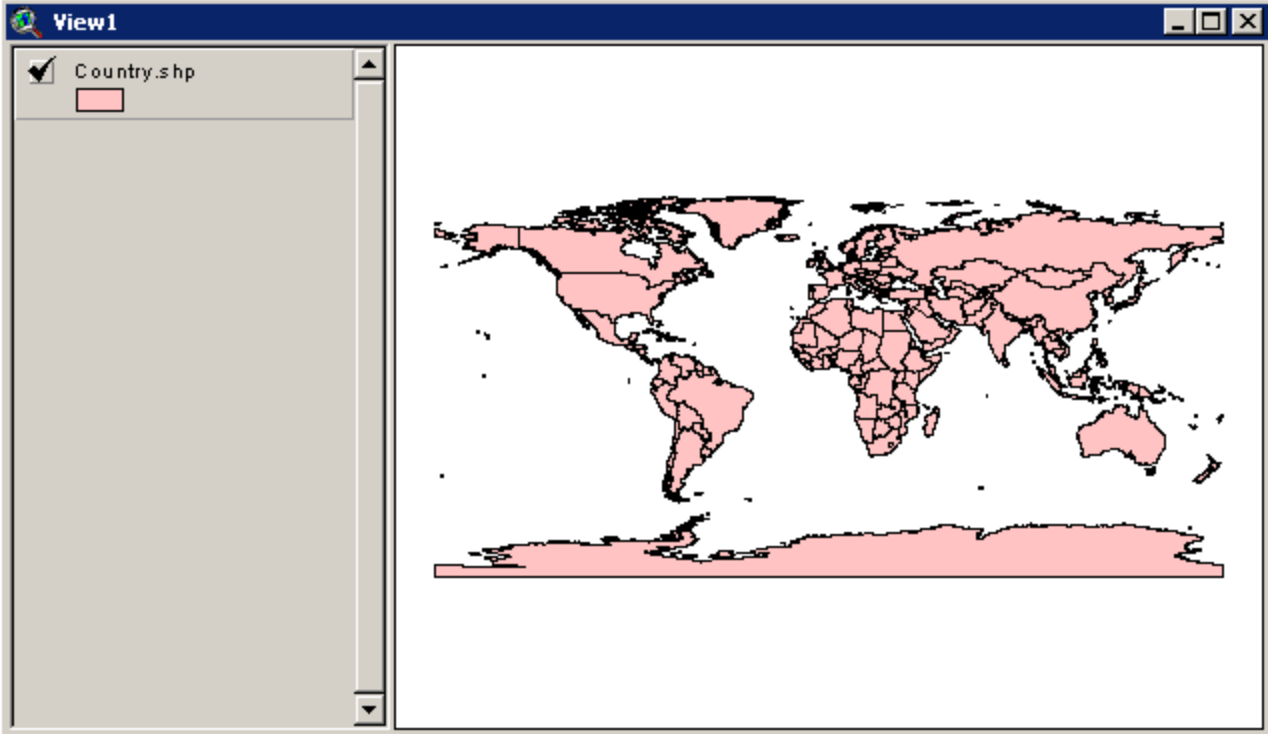
- This will open the **Fill Palette** window. The **Fill Palette** changes the display characteristics of a theme.
- Click once on the **paint brush** in the Fill Palette menu.

- From the **Color Palette** menu, select a light color, such as the pink that is shown to the right.



- Close the **Color Palette**.
- Click **Apply** and Close the **Legend Editor**.

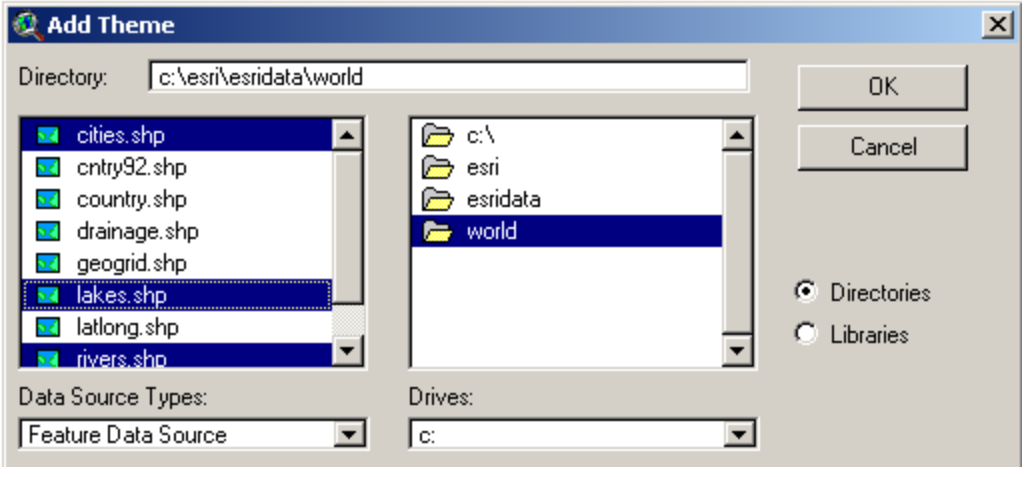
- Your world map should now appear like the one below.



Hint: Now would be a good time to save your project.

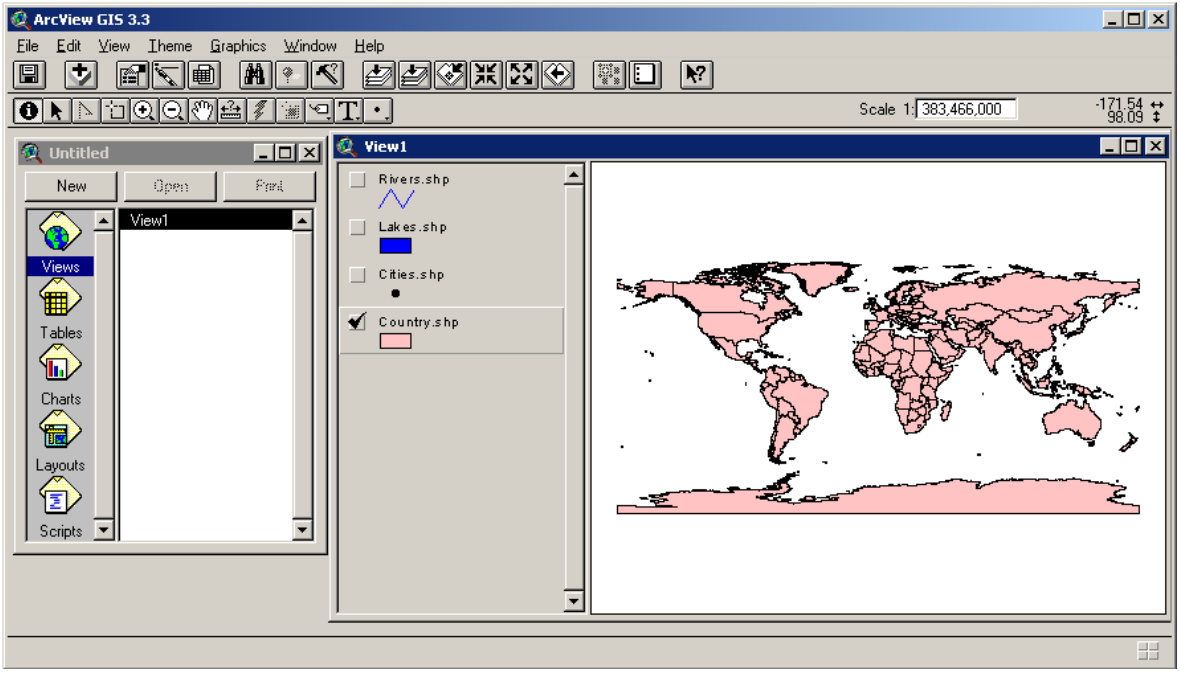
Adding More Themes

- Using the add themes button, navigate to your *world* folder, and select the files for the world's *cities*, *rivers* and *lakes*. To select multiple files, hold down the **Shift** key as you click each one (Shift-click).



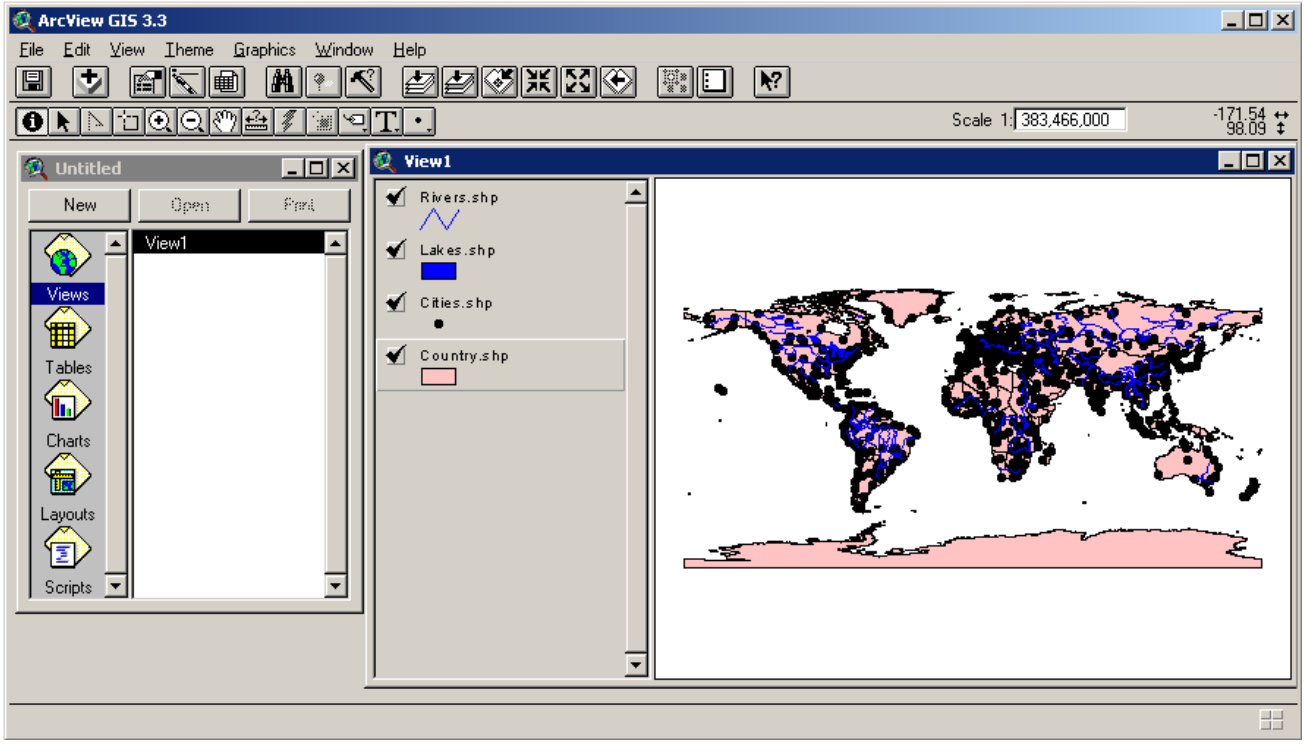
- Click **OK** when you have all of the files selected.

- The new themes are added in reverse order; the last added is first in the **View Table of Contents** window. In the **View**, the lowest layer is drawn first, and the other layers are drawn on top of it. The top theme is the topmost layer.



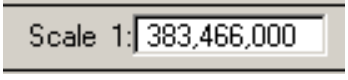
- Notice that the *country.shp* theme appears raised. This is the active theme. Operations are performed on the active theme. To make a different theme active, simply click on its name. To make more than one theme active, hold the shift key down as you click.

- Turn on the *rivers*, *lakes* and *cities* themes by clicking in the boxes before their names.



- Note how jumbled things look. ArcView draws rivers, lakes and cities at one size regardless of magnification.

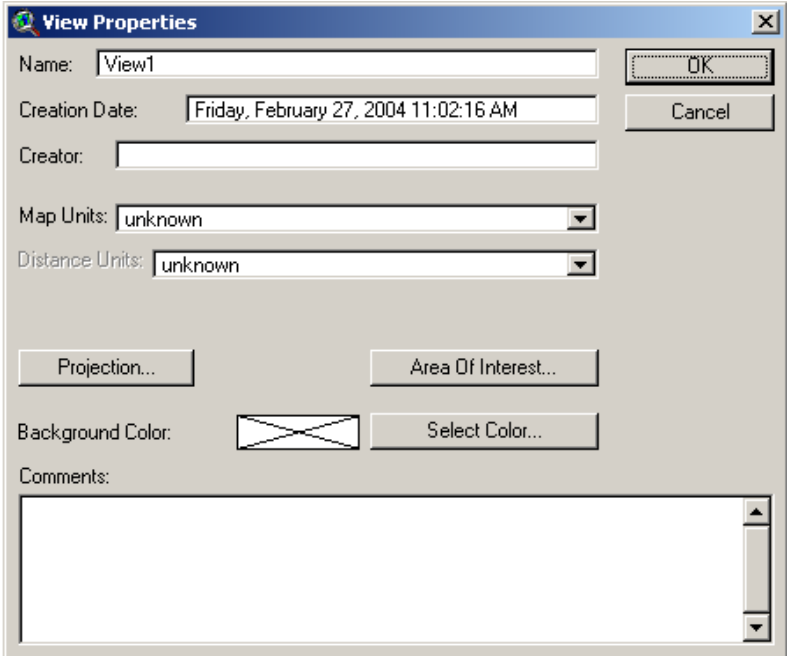
- Notice the value in the **Scale** window. This is the "Representative Fraction" (RF) scale of the map. It means that one of any unit on the map is equal to 383,466,000 of the same unit on the ground. **Example**: Objects that are 5 cm apart on the screen are 1,917,330,000 cm or 19,173 km apart on the ground. Watch this scale as you change magnification in your view window. Your values may vary slightly, depending on the size of your view window and your exact amount of zoom.



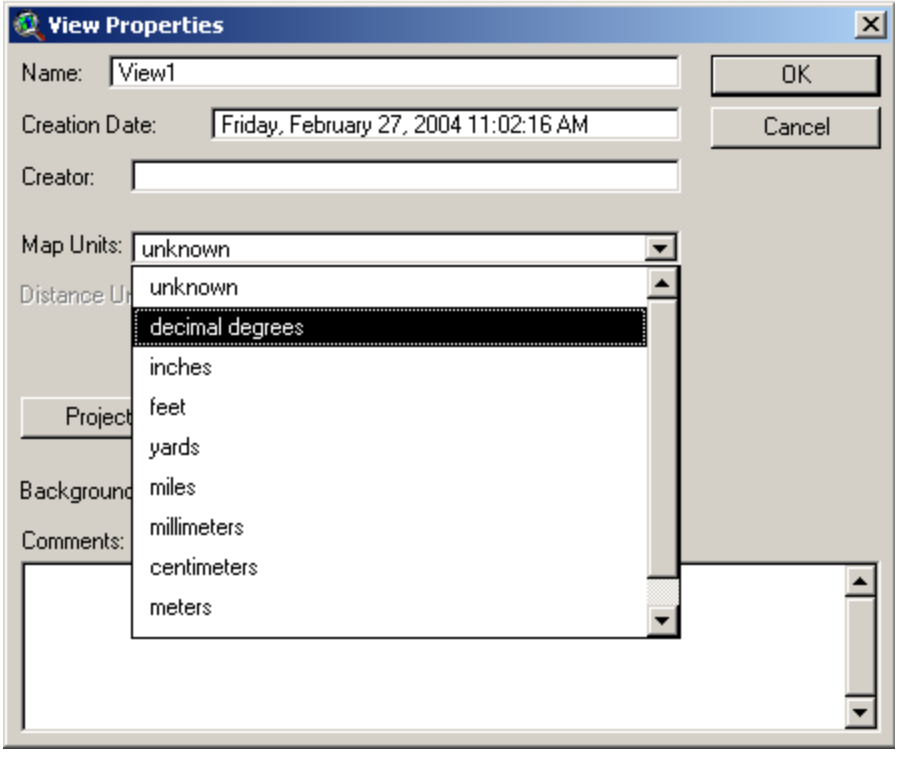
What If My Scale Window Is Blank?

If your **View Scale** window is blank it is because ArcView does not know the units of the map and data.

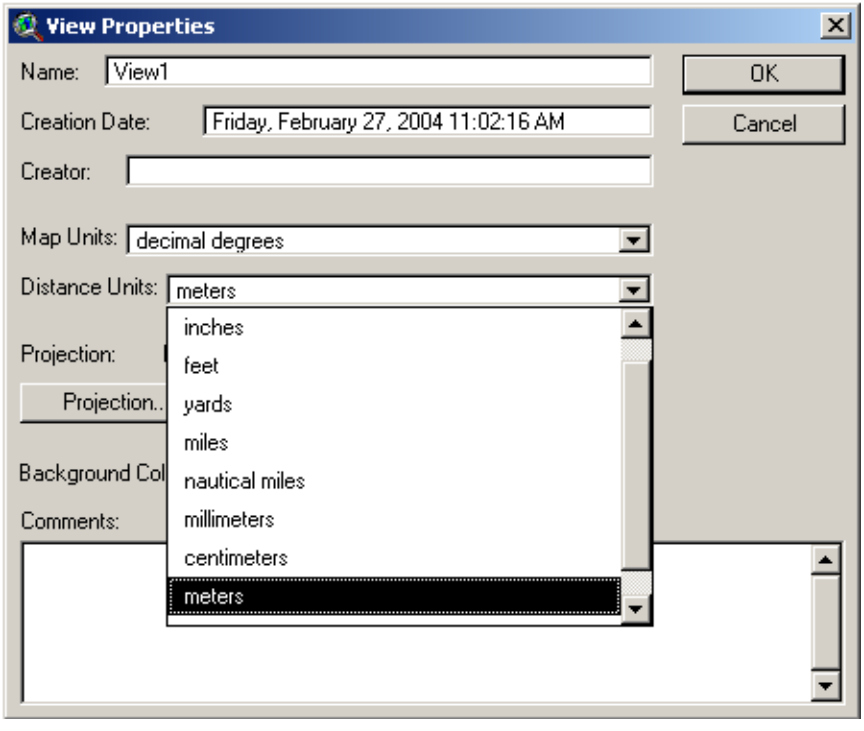
- From the **View** menu, select **Properties**. The **View Properties** box opens. Note that both **Map Units** and **Distance Units** are unknown.



- Unless you know that your data are projected differently, from the **Map Units** pull-down menu, select **decimal degrees**.



- From the **Distance Units** pull-down menu, select **meters** .

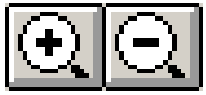


- Click **OK** to close the **View Properties** box. Your View **Scale** window should read properly.

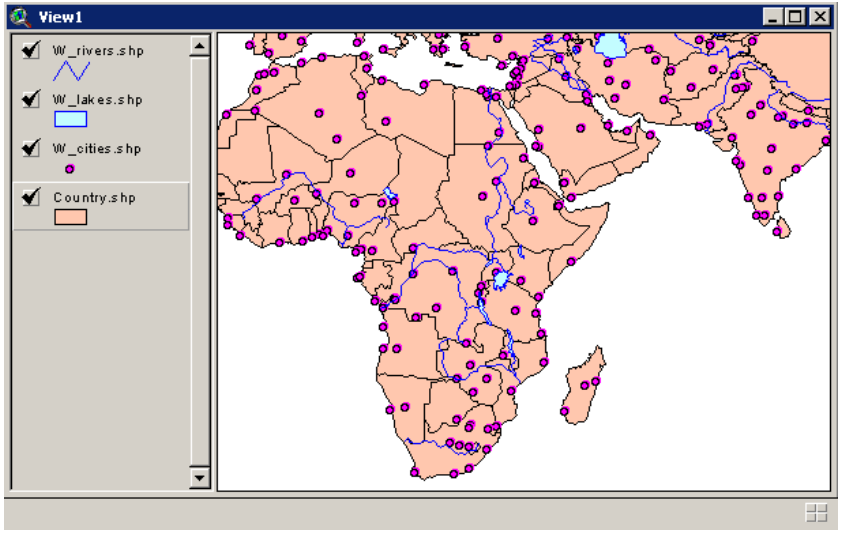
- You may change the scale of your view at any time by using the **View Scale** window. Click once in the **View Scale** window and enter a scale. You may use commas in your entry.

Zooming in on Africa

- Select the **Zoom In** tool from the tool bar.



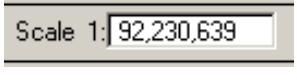
- Click several times on the east coast of Africa, until your view window looks like the one shown below.



Now the overlying themes have a better proportion.

- If you wish to recolor any of the themes use the same procedure you used to change the color of the base country map. The view to the left shows the *lakes* and *rivers* themes colored blue.

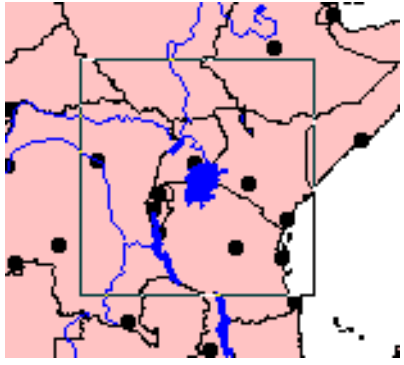
- Note the value in the **Scale** window at this level of magnification. The value of 1:92,230,639 means that 1 unit on the map covers a <u>smaller</u> area on the ground than that shown on page 38. The smaller the number, the more detail it shows.



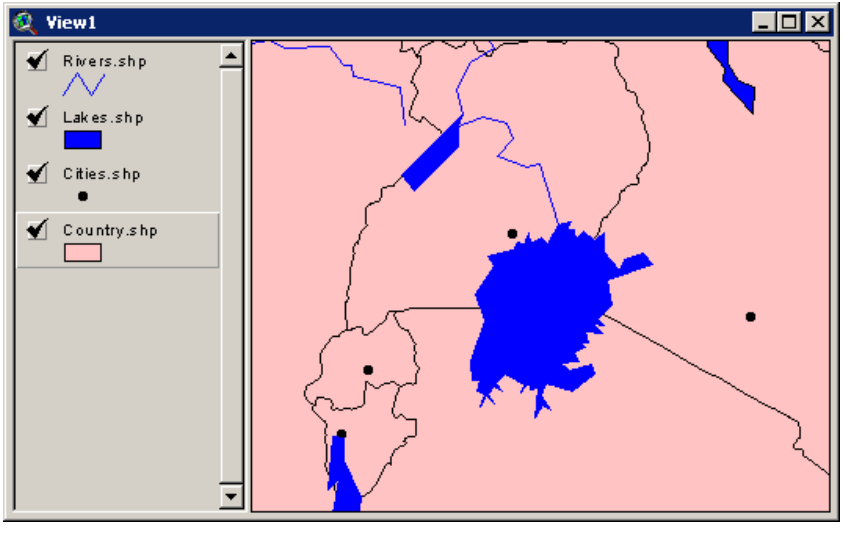
In this example, 5 cm on the screen would equal 4,611 km on the ground.

Zooming in to a Specific Area

Rather than zooming one step at a time,you can quickly zoom to a specific area.



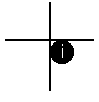
- Select the **Zoom In** tool
- Hold down your mouse button and **draw a box** around the area shown to the right. You will zoom in on the area that you boxed.

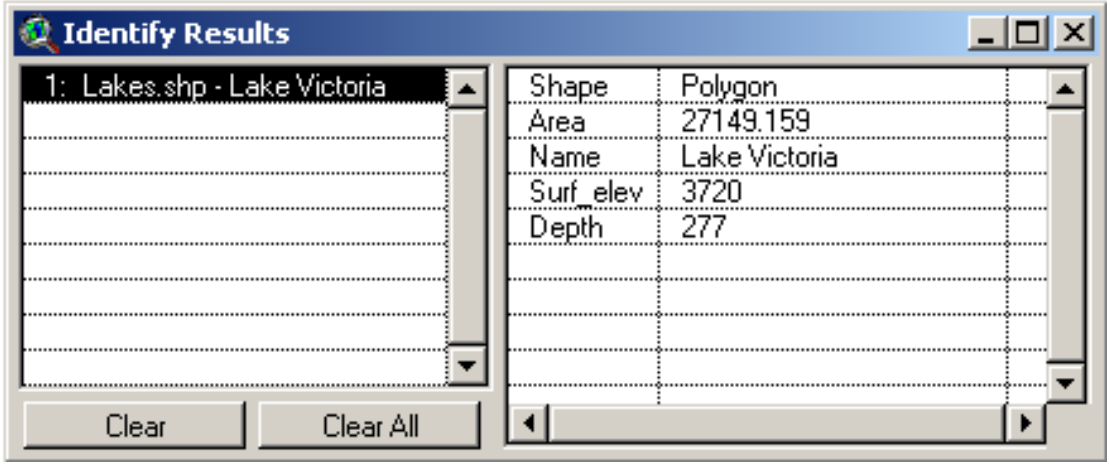


- Note the scale at this magnification. Now 5 cm on the screen is even less.

Theme Attribute Tables

Along with data that describe how and where to draw themes, each theme contains additional information. These data are called the theme's **attributes.** There are two tools to examine these attributes.

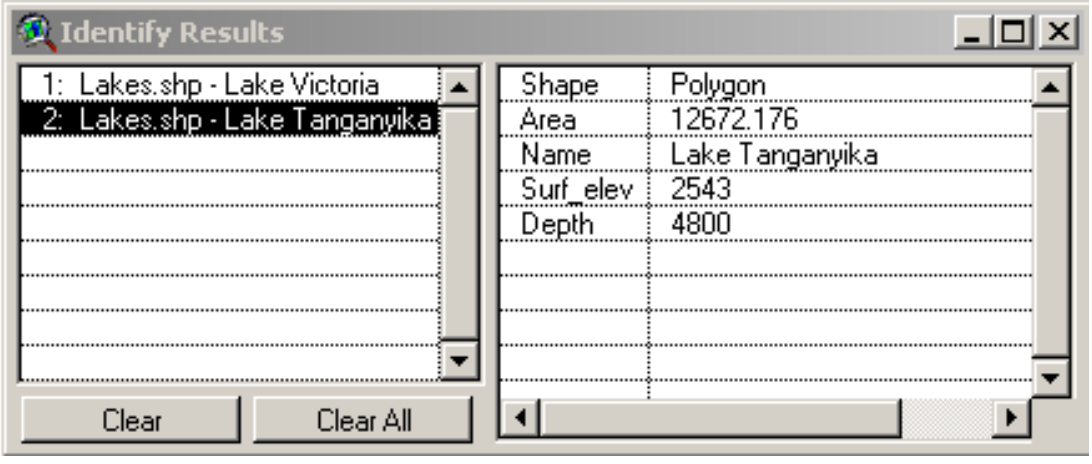
- Click once on the *lakes* (or *w_lakes*) theme to make it active. Its title should appear raised. Tools and measurements are applied to the active theme.
- Select the **Information Tool** from the tool bar. 
- Move your cursor into the **View** window. Notice the cursor appears like this: 
- Move your cursor over the large lake near the center of your screen and click once.
- The **Identify Results** table opens, as shown on the next page.



- This table shows the attributes of the single feature you clicked on, in this case the lake. The **Information Tool** only works for the theme that is active. That is, the "raised" theme in the **View Table of Contents**.

- This is Lake Victoria. Note that the attributes of this lake include the type of vector data (a polygon), its surface elevation and its depth.

- Use the **Information Tool** to click on the long lake to the southwest of Lake Victoria.

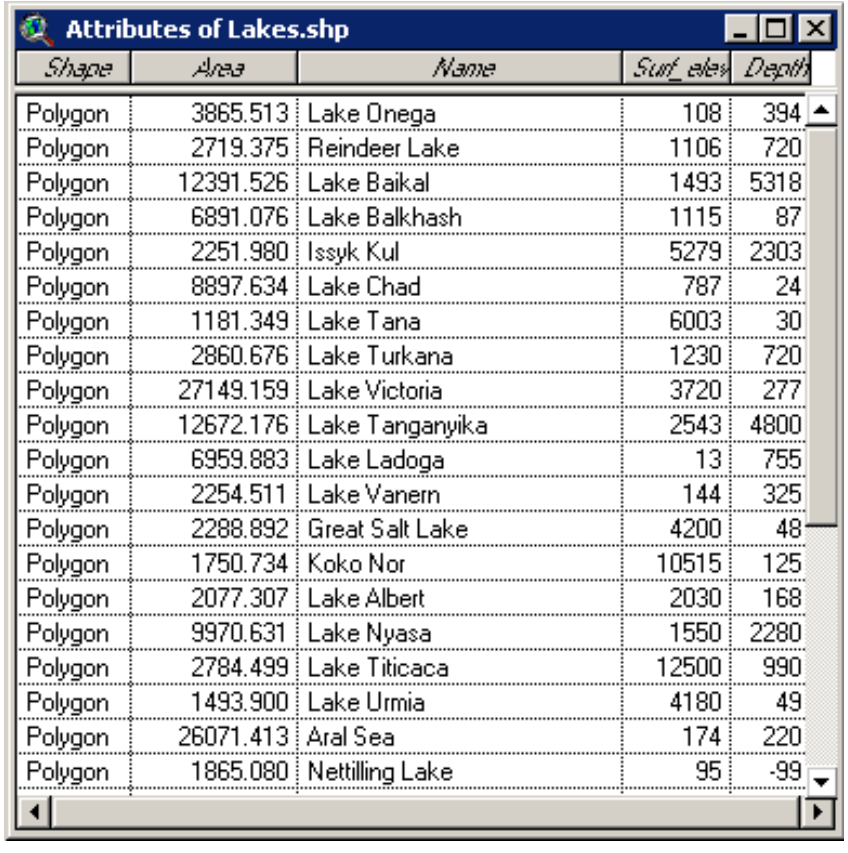


- Lake Tanganyika is added to the table, and its attributes are displayed. You may view the characteristics of any feature in the table by clicking on its name.

- **Close** this table.

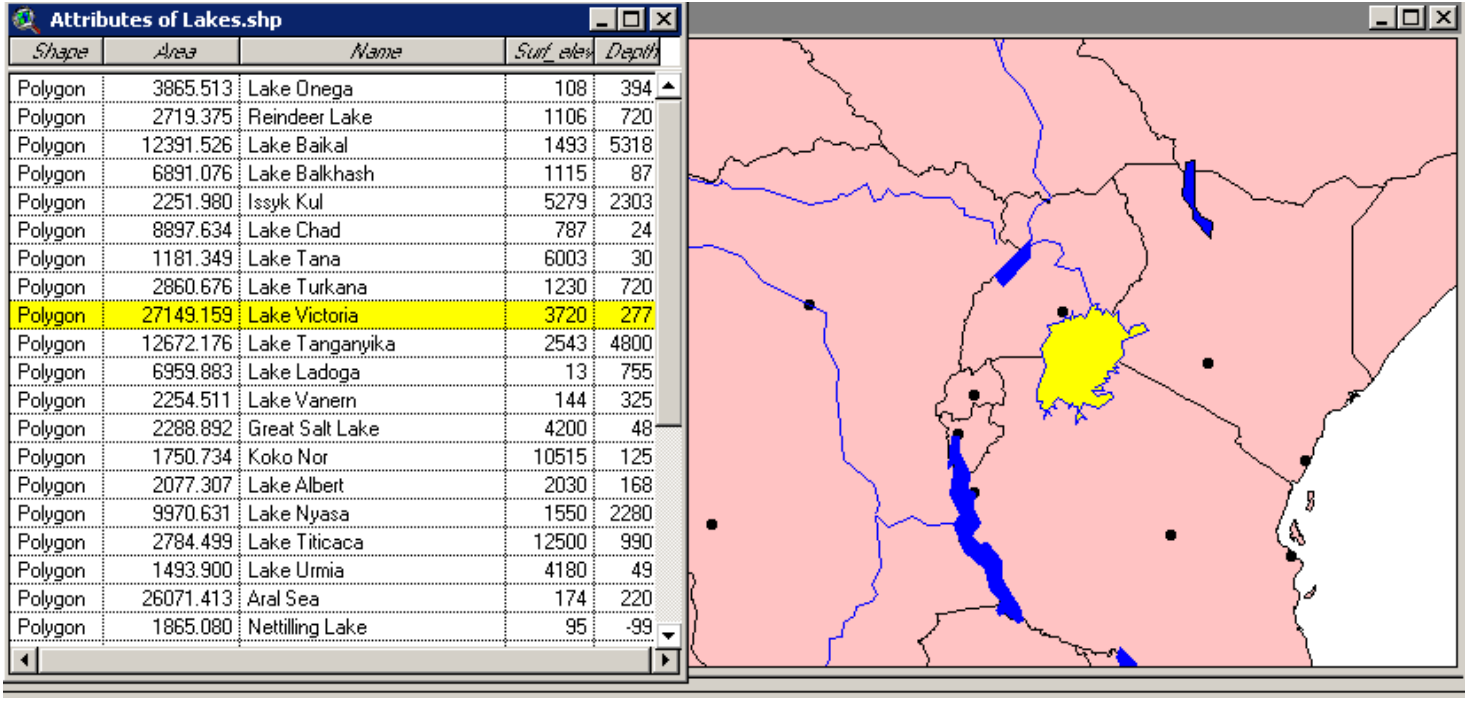
What About the Other Lakes?

- Rather than viewing the lakes of the world one at a time, you can examine the data for the whole collection at once.
- With the lakes theme active, click the **Open Theme Table** button. 
- The attribute table for all the lakes in the *lakes.shp* file opens.
- Notice that there is a new menu and toolbar, the **Tables Menu and Tables Toolbar**.



Shape	Area	Name	Surf_elev	Depth
Polygon	3865.513	Lake Onega	108	394
Polygon	2719.375	Reindeer Lake	1106	720
Polygon	12391.526	Lake Baikal	1493	5318
Polygon	6891.076	Lake Balkhash	1115	87
Polygon	2251.980	Issyk Kul	5279	2303
Polygon	8897.634	Lake Chad	787	24
Polygon	1181.349	Lake Tana	6003	30
Polygon	2860.676	Lake Turkana	1230	720
Polygon	27149.159	Lake Victoria	3720	277
Polygon	12672.176	Lake Tanganyika	2543	4800
Polygon	6959.883	Lake Ladoga	13	755
Polygon	2254.511	Lake Vanern	144	325
Polygon	2288.892	Great Salt Lake	4200	48
Polygon	1750.734	Koko Nor	10515	125
Polygon	2077.307	Lake Albert	2030	168
Polygon	9970.631	Lake Nyasa	1550	2280
Polygon	2784.499	Lake Titicaca	12500	990
Polygon	1493.900	Lake Urmia	4180	49
Polygon	26071.413	Aral Sea	174	220
Polygon	1865.080	Nettilling Lake	95	-99

- Scroll through this table until you find Lake Victoria, and click once on its name. Notice that both the name in the table and the shape in the **View** window are highlighted in yellow.

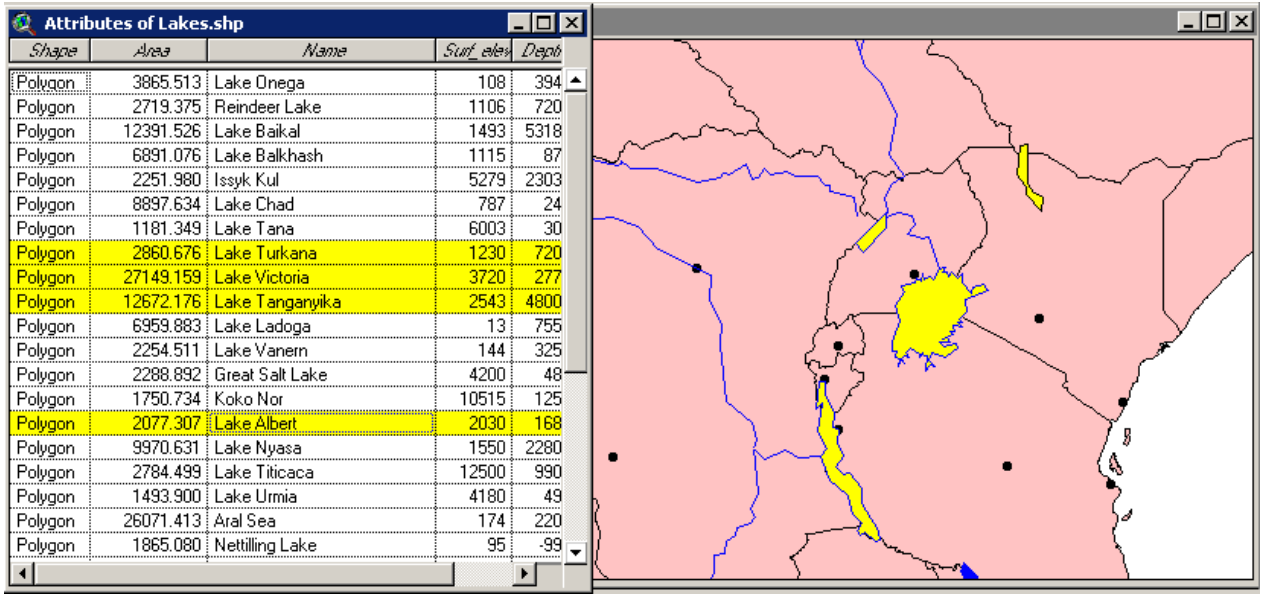


Attributes of Lakes.shp

Shape	Area	Name	Surf_alev	Depth
Polygon	3865.513	Lake Onega	108	394
Polygon	2719.375	Reindeer Lake	1106	720
Polygon	12391.526	Lake Baikal	1493	5318
Polygon	6891.076	Lake Balkhash	1115	87
Polygon	2251.980	Issyk Kul	5279	2303
Polygon	8897.634	Lake Chad	787	24
Polygon	1181.349	Lake Tana	6003	30
Polygon	2860.676	Lake Turkana	1230	720
Polygon	27149.159	Lake Victoria	3720	277
Polygon	12672.176	Lake Tanganyika	2543	4800
Polygon	6959.883	Lake Ladoga	13	755
Polygon	2254.511	Lake Vanern	144	325
Polygon	2288.892	Great Salt Lake	4200	48
Polygon	1750.734	Koko Nor	10515	125
Polygon	2077.307	Lake Albert	2030	168
Polygon	9970.631	Lake Nyasa	1550	2280
Polygon	2784.499	Lake Titicaca	12500	990
Polygon	1493.900	Lake Urmia	4180	49
Polygon	26071.413	Aral Sea	174	220
Polygon	1865.080	Nettilling Lake	95	-99

- The **Tables Menu**, displays how many items you selected and how many are in the database.

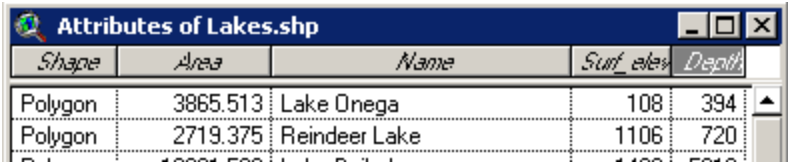
- Select more than one item by using the “shift-click” method. Hold down the shift key as you select Lakes Turkana, Tanganyika, Albert and Victoria. The visual below shows the results of selecting all the lakes in the vicinity of Lake Victoria.



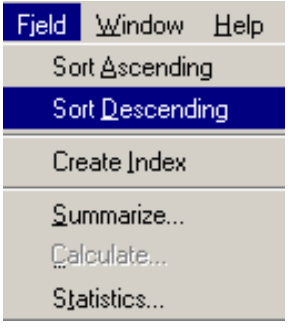
Shape	Area	Name	Surf_ales	Depth
Polygon	3865.513	Lake Onega	108	394
Polygon	2719.375	Reindeer Lake	1106	720
Polygon	12391.526	Lake Baikal	1493	5318
Polygon	6891.076	Lake Balkhash	1115	87
Polygon	2251.980	Issyk Kul	5279	2303
Polygon	8897.634	Lake Chad	787	24
Polygon	1181.349	Lake Tana	6003	30
Polygon	2860.676	Lake Turkana	1230	720
Polygon	27149.159	Lake Victoria	3720	277
Polygon	12672.176	Lake Tanganyika	2543	4800
Polygon	6959.883	Lake Ladoga	13	755
Polygon	2254.511	Lake Vanern	144	325
Polygon	2288.892	Great Salt Lake	4200	48
Polygon	1750.734	Koko Nor	10515	125
Polygon	2077.307	Lake Albert	2030	168
Polygon	9970.631	Lake Nyasa	1550	2280
Polygon	2784.499	Lake Titicaca	12500	990
Polygon	1493.900	Lake Urmia	4180	49
Polygon	26071.413	Aral Sea	174	220
Polygon	1865.080	Nettilling Lake	95	-99

- Turn off your selections by clicking the **Unselect Records** button. 
- Take some time now to experiment with the tools you have just used.
- When you are ready to proceed, click the **Unselect Records** button.

You may have noticed that the lakes in the table are not arranged in any particular order. ArcVoyager has several ways to arrange the data.

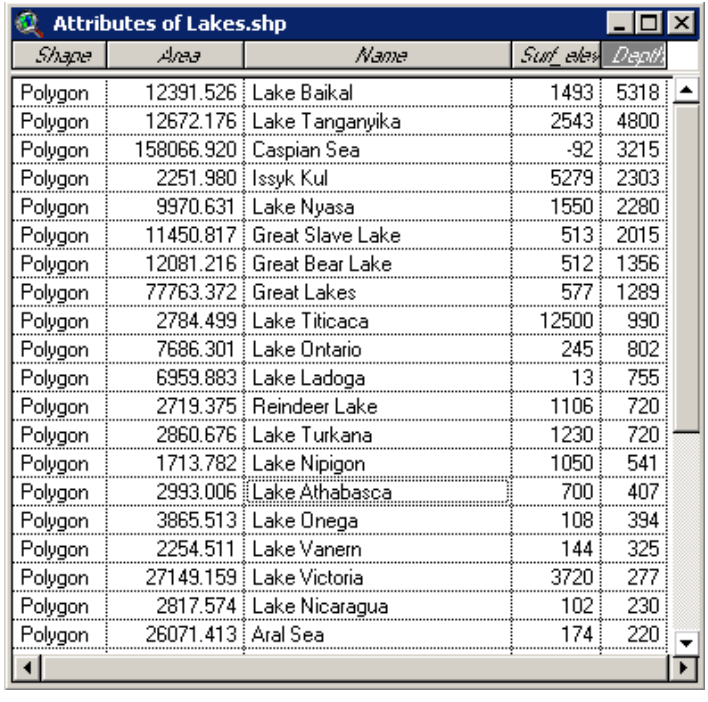


- **Click** once on the heading of the *Depth* column. It turns gray as shown right.



- From the **Field** menu select **Sort Descending**.

- The lakes in the file are sorted by depth, from deepest to most shallow, as shown in the partial table to the right.



Shape	Area	Name	Surf_elev	Depth
Polygon	12391.526	Lake Baikal	1493	5318
Polygon	12672.176	Lake Tanganyika	2543	4800
Polygon	158066.920	Caspian Sea	-92	3215
Polygon	2251.980	Issyk Kul	5279	2303
Polygon	9970.631	Lake Nyasa	1550	2280
Polygon	11450.817	Great Slave Lake	513	2015
Polygon	12081.216	Great Bear Lake	512	1356
Polygon	77763.372	Great Lakes	577	1289
Polygon	2784.499	Lake Titicaca	12500	990
Polygon	7686.301	Lake Ontario	245	802
Polygon	6959.883	Lake Ladoga	13	755
Polygon	2719.375	Reindeer Lake	1106	720
Polygon	2860.676	Lake Turkana	1230	720
Polygon	1713.782	Lake Nipigon	1050	541
Polygon	2993.006	Lake Athabasca	700	407
Polygon	3865.513	Lake Onega	108	394
Polygon	2254.511	Lake Vanern	144	325
Polygon	27149.159	Lake Victoria	3720	277
Polygon	2817.574	Lake Nicaragua	102	230
Polygon	26071.413	Aral Sea	174	220

- **Shift-Click** the names of the four lakes in your view area (Victoria, Tanganyika, Turkana and Albert).

- Click the **Promote Records** button. The selected records are brought to the top of the file.

Attributes of Lakes.shp

Shape	Area	Name	Surf_elev	Depth
Polygon	12391.526	Lake Baikal	1493	5318
Polygon	12672.176	Lake Tanganyika	2543	4800
Polygon	158066.920	Caspian Sea	-92	3215
Polygon	2251.980	Issyk Kul	5279	2303
Polygon	9970.631	Lake Nyasa	1550	2280
Polygon	11450.817	Great Slave Lake	513	2015
Polygon	12081.216	Great Bear Lake	512	1356
Polygon	77763.372	Great Lakes	577	1289
Polygon	2784.499	Lake Titicaca	12500	990
Polygon	7686.301	Lake Ontario	245	802
Polygon	6959.883	Lake Ladoga	13	755
Polygon	2719.375	Reindeer Lake	1106	720
Polygon	2860.676	Lake Turkana	1230	720
Polygon	1713.782	Lake Nipigon	1050	541
Polygon	2993.006	Lake Athabasca	700	407
Polygon	3865.513	Lake Onega	108	394
Polygon	2254.511	Lake Vanern	144	325
Polygon	27149.159	Lake Victoria	3720	277
Polygon	2817.574	Lake Nicaragua	102	230
Polygon	26071.413	Aral Sea	174	220
Polygon	10411.781	Lake Erie	570	210
Polygon	2077.307	Lake Albert	2030	168

Attributes of Lakes.shp

Shape	Area	Name	Surf_elev	Depth
Polygon	12672.176	Lake Tanganyika	2543	4800
Polygon	2860.676	Lake Turkana	1230	720
Polygon	27149.159	Lake Victoria	3720	277
Polygon	2077.307	Lake Albert	2030	168
Polygon	12391.526	Lake Baikal	1493	5318
Polygon	158066.920	Caspian Sea	-92	3215
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Polygon	11450.817	Great Slave Lake	513	2015
Polygon	12081.216	Great Bear Lake	512	1356
Polygon	77763.372	Great Lakes	577	1289
Polygon	2784.499	Lake Titicaca	12500	990
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Polygon	2993.006	Lake Athabasca	700	407
Polygon	3865.513	Lake Onega	108	394
Polygon	2254.511	Lake Vanern	144	325
Polygon	2817.574	Lake Nicaragua	102	230
Polygon	26071.413	Aral Sea	174	220
Polygon	10411.781	Lake Erie	570	210

Now a question

Lake Tanganyika is much deeper than the other three lakes. Lake Turkana is much deeper than Victoria or Albert. Why should this be so? What is there about the Geography of this part of Africa that might cause this to occur? This question links Geography and Geology, and helps students see the connections between surface features (Topography) and the Geophysical forces that produce them.

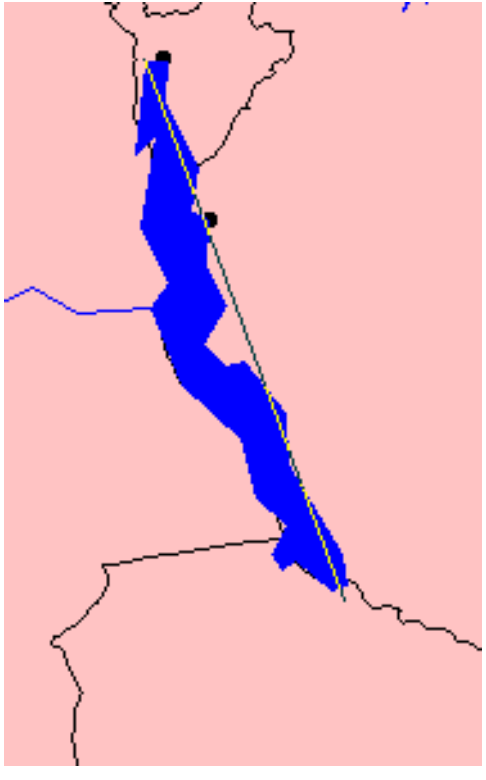
Find Lake Nyasa. What would you predict about its depth? Why? What geophysical forces have acted in this region?

(For the answer to this question see Chapter 7)

How Large is a Feature?

ArcView has a distance measuring tool to determine linear distances.

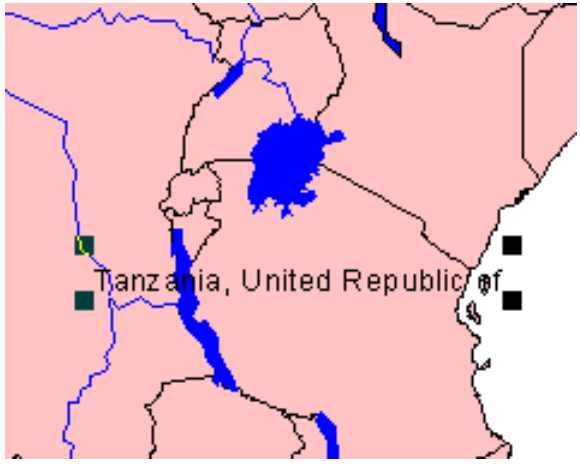
- Click the **Distance tool** to make it active.
- Place the cursor at the north end of Lake Tanganika (you may have to adjust your view)
- Hold the mouse button down, and drag the length of the lake as shown to the right.
- **Double click** at the south end of the lake.
- The length of the lake will be displayed on the screen. The PC display is in the lower-left screen, and for Macintosh computers it is in the upper left. Your result will vary slightly, depending on where you draw your line segment. The distance is the length you measured – not necessarily the actual length of the lake.

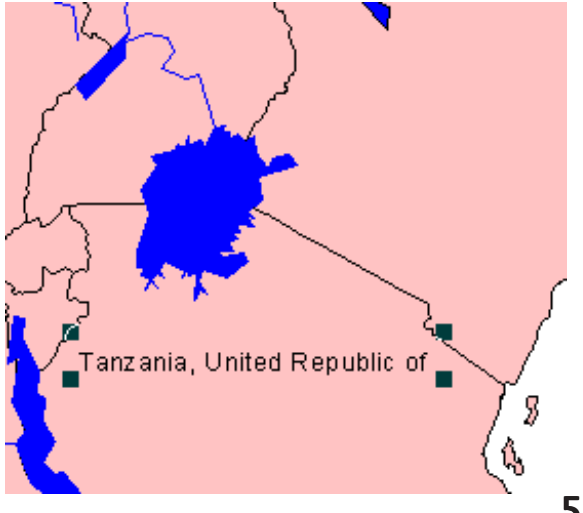


Segment Length: 645,986.17 m Length: 645,986.17 m

Labeling Locations

- Make the *Country.shp* theme active.
- Click the **Label Tool** button. 
- Click once in the country south of Lake Victoria.
- The country is labeled *Tanzania*.
- Click on the **Select Tool.**
- Be sure the *Tanzania* label is active (its corner handles are visible). If they are not, click once on the label.
- You can now **drag and resize** the label.

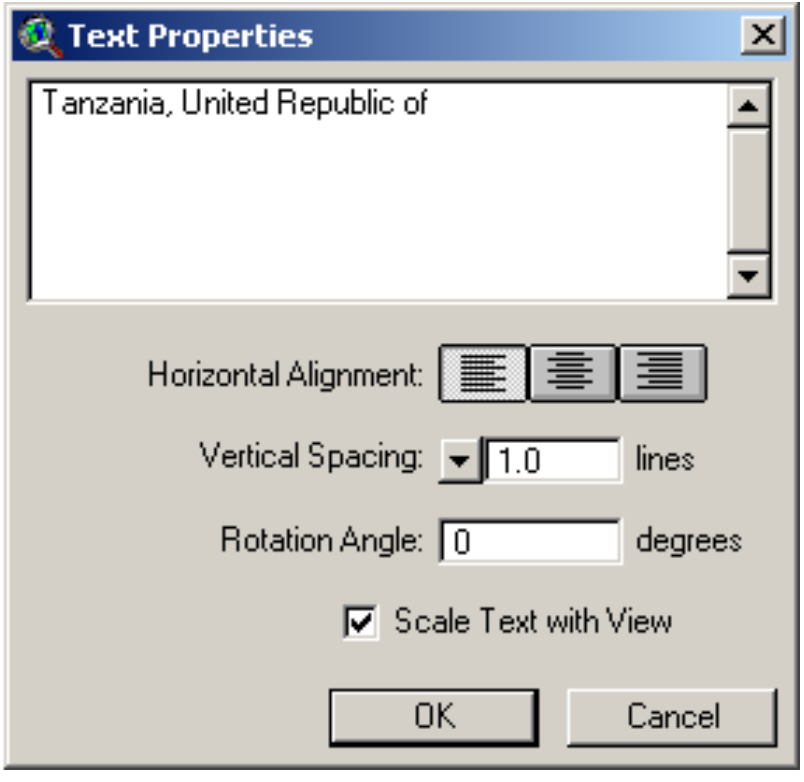




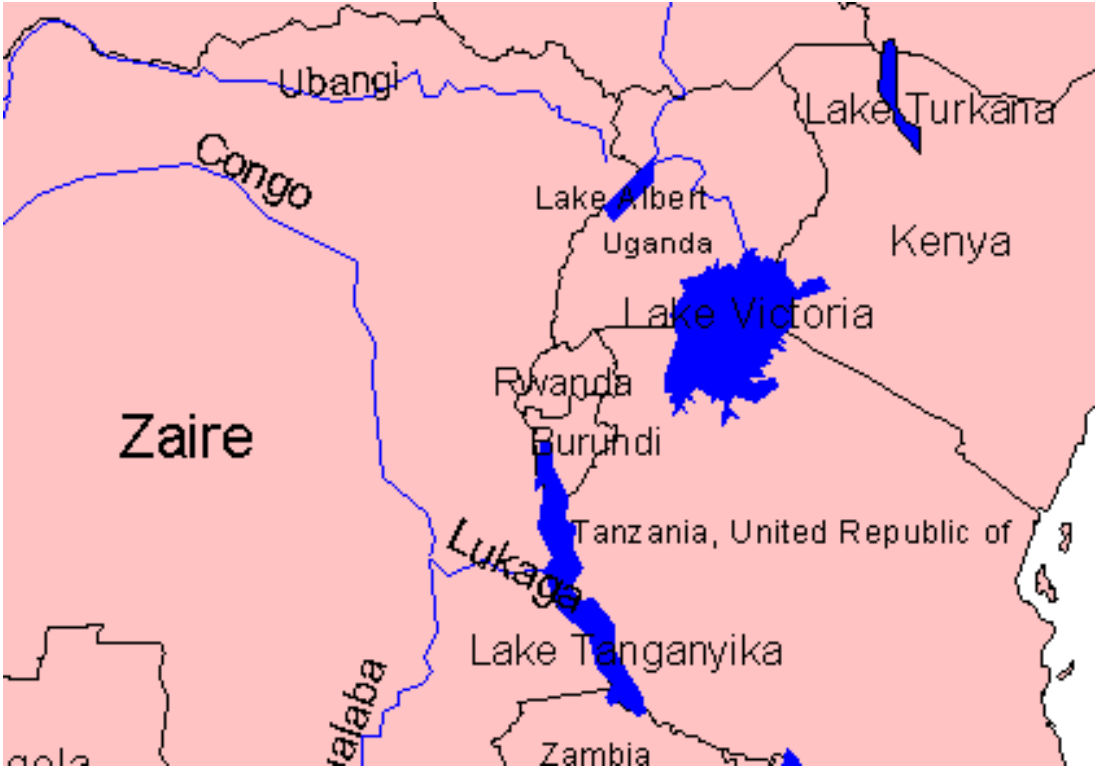
- Double-click the Tanzania label. The **Text Properties** box opens. You can change the appearance of the label.

- To remove a label:
  - Click the **Select Tool.**
  - Click the label to make it active.
  - Hit the **Delete** key.

- Label the other countries in the region around Lake Victoria.

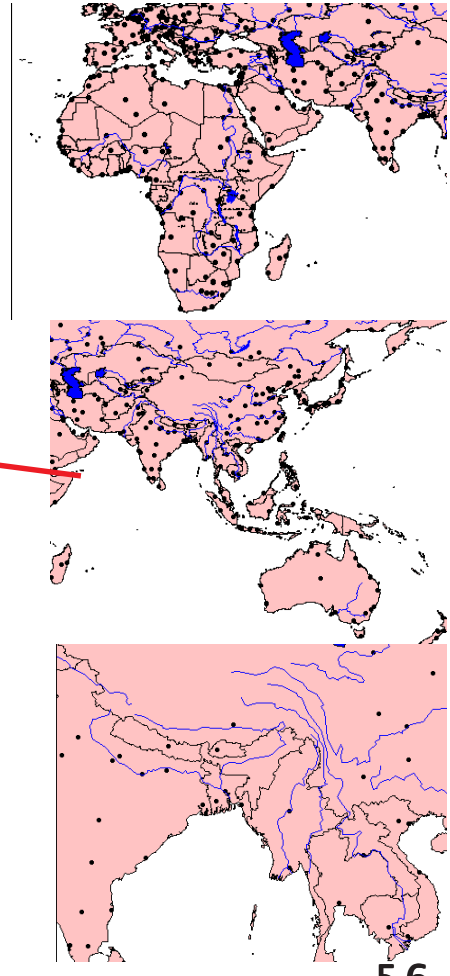


- Make the *Lakes* theme active, and label the lakes in your view area.
- Repeat this process for the *rivers* in your view area.



Another Question:

- **Zoom out** until your view is similar to the one shown to the right.
- Select the **Drag Tool**.
- Position the **Drag Tool** over Africa. Hold the mouse button down, and drag the image to your left until you see the region shown to the right.



Questions: Why does the drainage pattern (the pattern shown by these rivers) appear the way it does? Are there topographical features that influence the pattern that rivers take? Where do these rivers flow? What are their outlets? Can you use Arcview to find different kinds of drainage patterns in other areas? (Try the Central United States, or Northern South America). What topographic features affect the drainage patterns in these areas?

Building a Query

A query is an ArcVoyager tool to make sophisticated inquiries (called queries) about data contained in attribute tables.

- Make the *cities.shp* theme active.
- Open the **Attributes table** of this theme (Use the **Tables** button). 

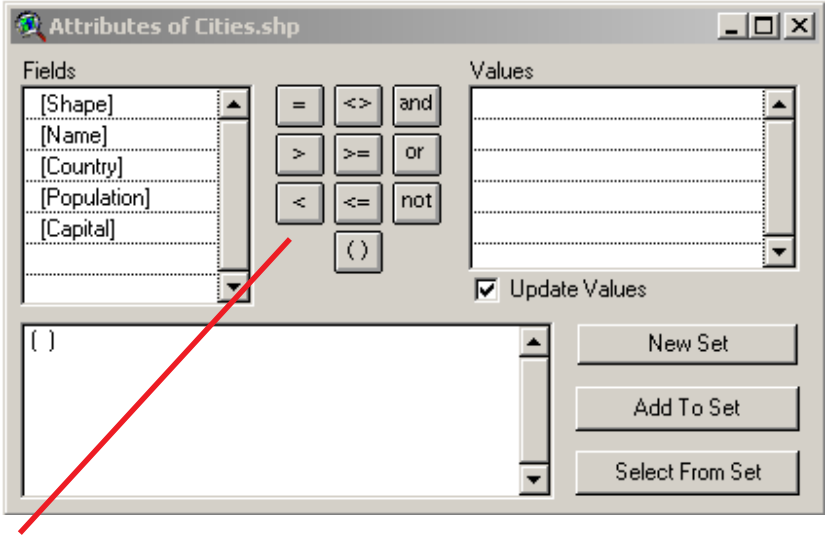
Attributes of Cities.shp

Shape	Name	Country	Population	Ca
Point	Murmansk	Russia	468000	
Point	Arkhangelsk	Russia	416000	
Point	Saint Petersburg	Russia	5825000	
Point	Magadan	Russia	152000	
Point	Perm'	Russia	1160000	
Point	Yekaterinburg	Russia	1620000	
Point	Nizhniy Novgorod	Russia	2025000	
Point	Glasgow	UK	1800000	
Point	Kazan'	Russia	1140000	
Point	Chelyabinsk	Russia	1325000	
Point	Omsk	Russia	1175000	
Point	Novosibirsk	Russia	1600000	
Point	Ufa	Russia	1100000	
Point	Vilnius	Lithuania	582000	
Point	Belfast	UK	685000	
Point	Gdansk	Poland	909000	
Point	Minsk	Byelarus	1650000	
Point	Leeds	UK	1540000	
Point	Hamburg	Germany	2225000	
Point	Manchester	UK	2775000	

- A **Query** is a set of instructions that act on the attribute table using **logical operators**. These are operations such as “equals,” “is greater than,” or comparisons such as “and” or “or”.

> Find the cities of the world which have a population greater than or equal to 6,000,000 people.

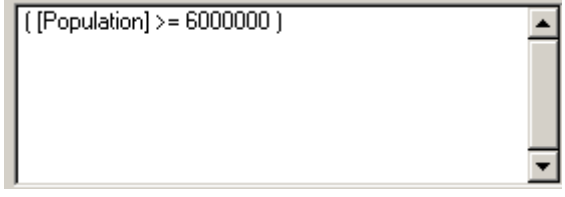
- Select the **Query Tool** button shown to the right. 
- The **Query Box** opens.

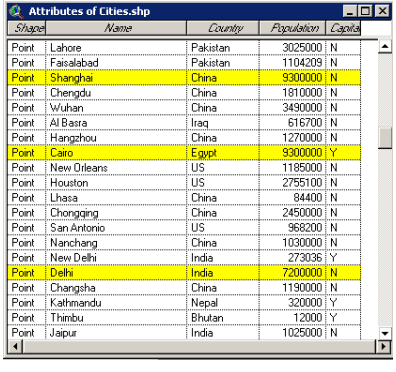


- Note the set of logical operators represented by the keys in the top center of the window.

To create the query:

- Double click the **Population** entry in the **Fields** column. **Population** now appears in the query dialog area.
- Click once on the "greater than or equal to" button in the set of logical operators.
- Enter the value **6000000**. The value must be entered without spaces or commas.
- Click the **New Set** button in the **Query Box**. The data table shows several cities highlighted. Close the Query Box.

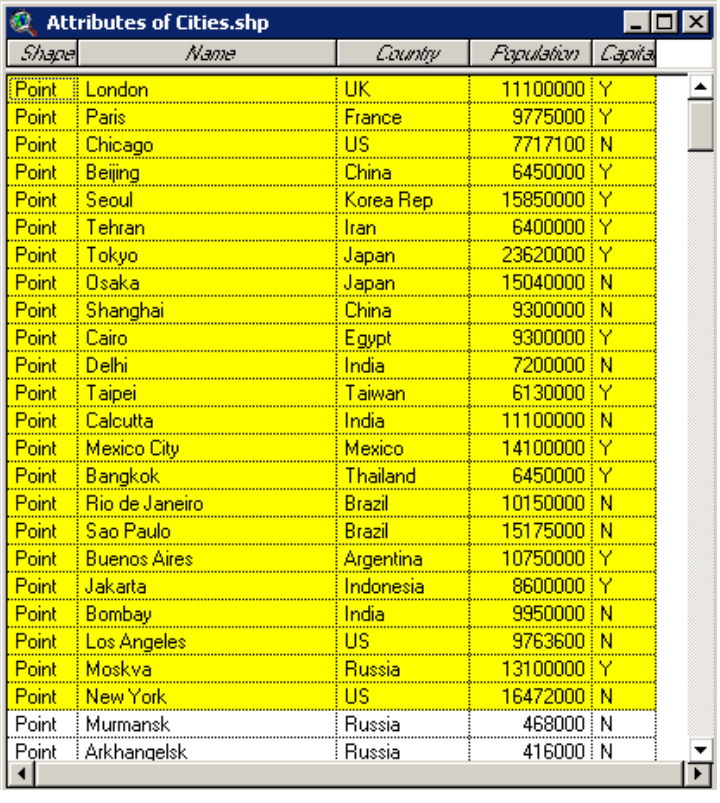




Attributes of Cities.shp

Shape	Name	Country	Population	Capita
Point	Lahore	Pakistan	3025000	N
Point	Faisalabad	Pakistan	1104209	N
Point	Shanghai	China	9300000	N
Point	Chengdu	China	1810000	N
Point	Wuhan	China	3490000	N
Point	Al Basra	Iraq	616700	N
Point	Hangzhou	China	1270000	N
Point	Cairo	Egypt	9300000	Y
Point	New Orleans	US	1185000	N
Point	Houston	US	2755100	N
Point	Lhasa	China	84400	N
Point	Chongqing	China	2450000	N
Point	San Antonio	US	968200	N
Point	Nanchang	China	1030000	N
Point	New Delhi	India	273036	Y
Point	Delhi	India	7200000	N
Point	Changsha	China	1190000	N
Point	Kathmandu	Nepal	320000	Y
Point	Thimbu	Bhutan	12000	Y
Point	Jaipur	India	1025000	N

- The results of the query are distributed throughout the table. **Promote** them using the **Promote tool**. Promoting brings all the entries satisfying your query to the top of the table and displays them in the order they appeared in the attributes table. They have not been sorted.



Attributes of Cities.shp

Shape	Name	Country	Population	Capital
Point	London	UK	11100000	Y
Point	Paris	France	9775000	Y
Point	Chicago	US	7717100	N
Point	Beijing	China	6450000	Y
Point	Seoul	Korea Rep	15850000	Y
Point	Tehran	Iran	6400000	Y
Point	Tokyo	Japan	23620000	Y
Point	Osaka	Japan	15040000	N
Point	Shanghai	China	9300000	N
Point	Cairo	Egypt	9300000	Y
Point	Delhi	India	7200000	N
Point	Taipei	Taiwan	6130000	Y
Point	Calcutta	India	11100000	N
Point	Mexico City	Mexico	14100000	Y
Point	Bangkok	Thailand	6450000	Y
Point	Rio de Janeiro	Brazil	10150000	N
Point	Sao Paulo	Brazil	15175000	N
Point	Buenos Aires	Argentina	10750000	Y
Point	Jakarta	Indonesia	8600000	Y
Point	Bombay	India	9950000	N
Point	Los Angeles	US	9763600	N
Point	Moskva	Russia	13100000	Y
Point	New York	US	16472000	N
Point	Murmansk	Russia	468000	N
Point	Arkhangelsk	Russia	416000	N

Sorting the Results of the Query

- Click on the title of the *Population* column to make it active.
- From the **Field** menu, select **Sort Descending**. The cities of 6,000,000 or more inhabitants are now arranged in order of decreasing population.

Attributes of Cities.shp

Shape	Name	Country	Population	Capital
Point	Tokyo	Japan	23620000	Y
Point	New York	US	16472000	N
Point	Seoul	Korea Rep	15850000	Y
Point	Sao Paulo	Brazil	15175000	N
Point	Osaka	Japan	15040000	N
Point	Mexico City	Mexico	14100000	Y
Point	Moskva	Russia	13100000	Y
Point	Calcutta	India	11100000	N
Point	London	UK	11100000	Y
Point	Buenos Aires	Argentina	10750000	Y
Point	Rio de Janeiro	Brazil	10150000	N
Point	Bombay	India	9950000	N
Point	Paris	France	9775000	Y
Point	Los Angeles	US	9763600	N
Point	Cairo	Egypt	9300000	Y
Point	Shanghai	China	9300000	N
Point	Jakarta	Indonesia	8600000	Y
Point	Chicago	US	7717100	N
Point	Delhi	India	7200000	N
Point	Beijing	China	6450000	Y
Point	Bangkok	Thailand	6450000	Y
Point	Tehran	Iran	6400000	Y
Point	Taipei	Taiwan	6130000	Y
Point	Saint Petersburg	Russia	5825000	N
Point	Istanbul	Turkey	5750000	N

More Questions: Is there a pattern to the locations of the world's most populous cities? Are there exceptions to this pattern? In which country (or countries) are there the most large cities? How many of these are country capitals? Do you need more information to help you answer any parts of this question?

Suggestions: Examine the locations of the largest cities on a regional or continental basis. This involves zooming in and out. ArcView has some tools that will help you do this quickly.

1 2 3 4 5 6

1. **Zoom to the Extent of all Themes**: This zooms you out to the largest area covered by any theme.

2. **Zoom to the Extent of Active Theme**: This zooms you out to the largest area covered by the **active** theme. In the current project, all themes are global, and buttons 1 and 2 do the same thing. If you had a theme that covered only one continent, it would zoom out to the extent of that continent if that was the active theme.

3. **Zoom to the Extent of Selected Features**: This zooms you out to the largest area covered by the features you have selected (they appear yellow on your view.) If you selected all the lakes in Europe, the zoom would cover only Europe.

4. **Zoom In on Center of View:** Zooms in one step on the center of the current view.

5. **Zoom Out from Center of View**: Zooms out one step from the center of the current view.

6. **Return to your previous extent of view**. Takes you back to your previous degree of zoom.

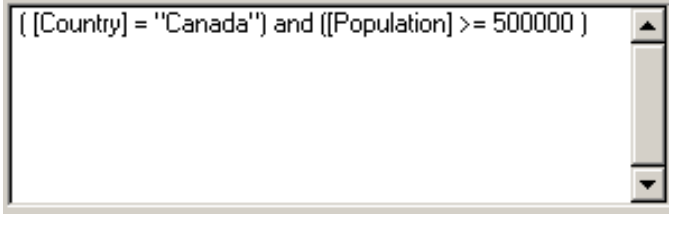
Building A More Sophisticated Query

Multiple logical operators can be combined in a single query. To illustrate this:

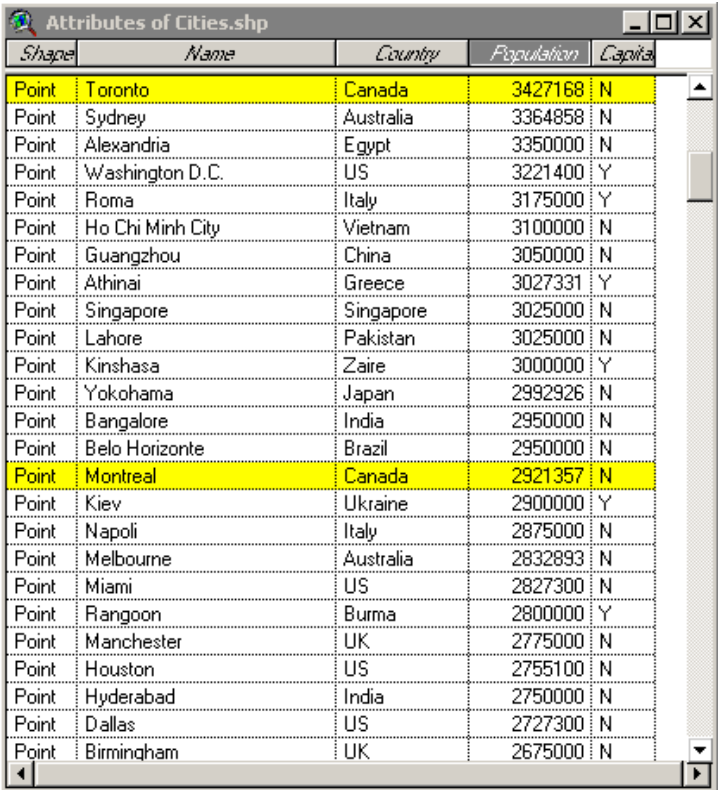
How many cities in Canada have a population of at least 500,000?

- Make the *cities.shp* theme active.
- Open the **Attributes table** of the cities theme.
- Open the **Query Builder**.
- Make the following selections:
  - Double click the *country* field in the **Fields** column.
  - Click the "=" button from the logical operators.
  - Scroll down to and double click *Canada* from the **Values** menu on the right.
  - Click the "and" operator.
  - Double click *population* in the **Fields** menu.
  - Click the ">=" operator.
  - Enter 500000.

- Your **Query Dialog box** should appear like the one to the right.

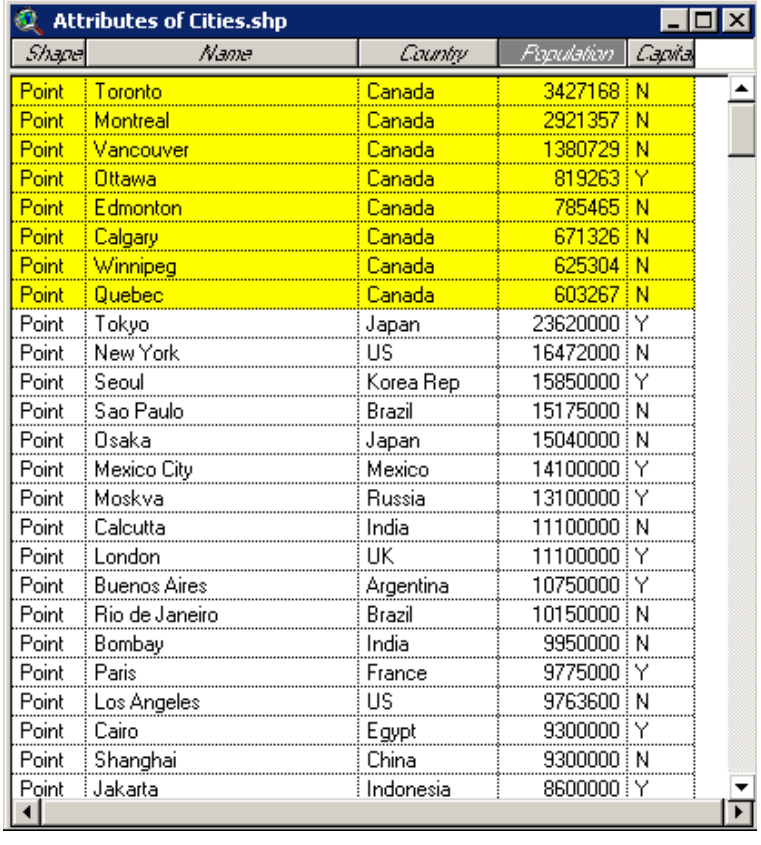


- Click the **New Set** button and then close the Query Dialogue.
- Two cities are highlighted. There are others but they are farther down in the table.



Shape	Name	Country	Population	Capital
Point	Toronto	Canada	3427168	N
Point	Sydney	Australia	3364858	N
Point	Alexandria	Egypt	3350000	N
Point	Washington D.C.	US	3221400	Y
Point	Roma	Italy	3175000	Y
Point	Ho Chi Minh City	Vietnam	3100000	N
Point	Guangzhou	China	3050000	N
Point	Athinai	Greece	3027331	Y
Point	Singapore	Singapore	3025000	N
Point	Lahore	Pakistan	3025000	N
Point	Kinshasa	Zaire	3000000	Y
Point	Yokohama	Japan	2992926	N
Point	Bangalore	India	2950000	N
Point	Belo Horizonte	Brazil	2950000	N
Point	Montreal	Canada	2921357	N
Point	Kiev	Ukraine	2900000	Y
Point	Napoli	Italy	2875000	N
Point	Melbourne	Australia	2832893	N
Point	Miami	US	2827300	N
Point	Rangoon	Burma	2800000	Y
Point	Manchester	UK	2775000	N
Point	Houston	US	2755100	N
Point	Hyderabad	India	2750000	N
Point	Dallas	US	2727300	N
Point	Birmingham	UK	2675000	N

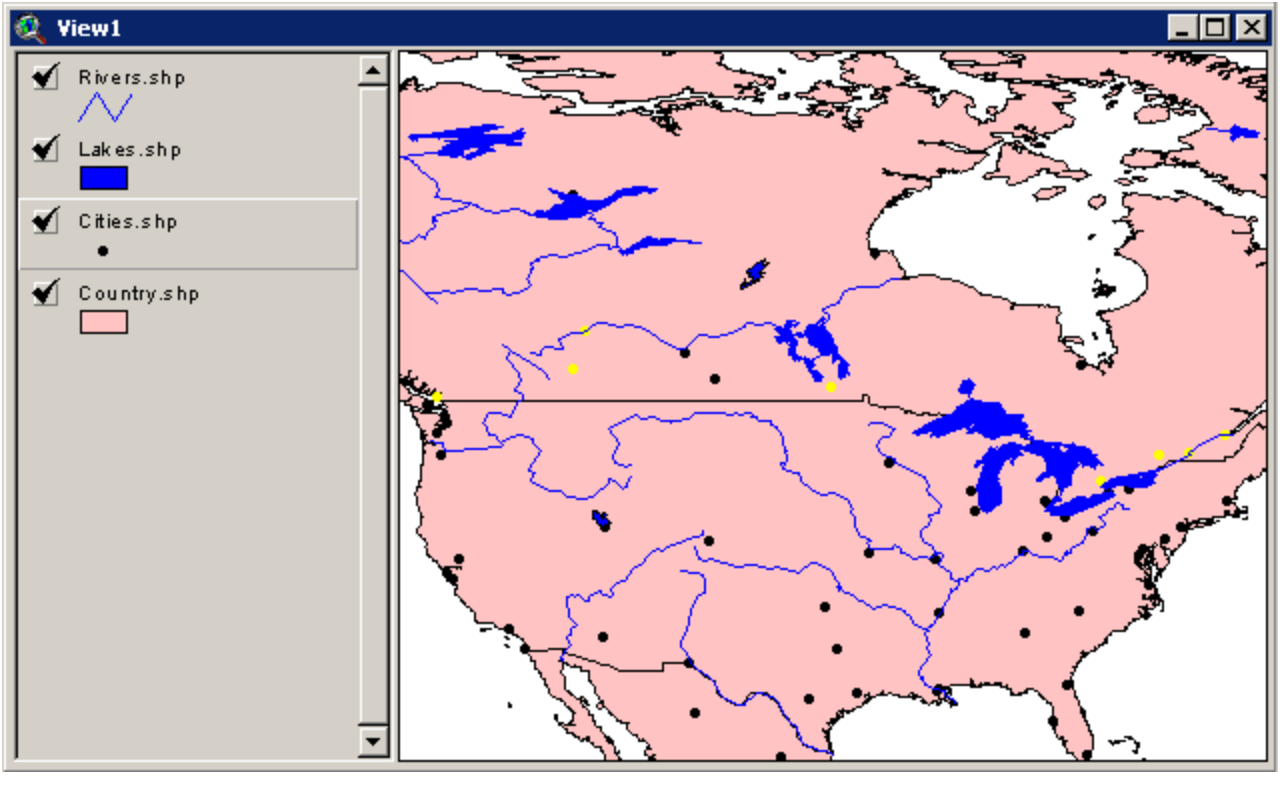
- Click the **Promote** button, and see the full results of the **Query**. You can string together multiple queries to make your information search as precise as necessary.



Attributes of Cities.shp

Shape	Name	Country	Population	Capital
Point	Toronto	Canada	3427168	N
Point	Montreal	Canada	2921357	N
Point	Vancouver	Canada	1380729	N
Point	Ottawa	Canada	819263	Y
Point	Edmonton	Canada	785465	N
Point	Calgary	Canada	671326	N
Point	Winnipeg	Canada	625304	N
Point	Quebec	Canada	603267	N
Point	Tokyo	Japan	23620000	Y
Point	New York	US	16472000	N
Point	Seoul	Korea Rep	15850000	Y
Point	Sao Paulo	Brazil	15175000	N
Point	Osaka	Japan	15040000	N
Point	Mexico City	Mexico	14100000	Y
Point	Moskva	Russia	13100000	Y
Point	Calcutta	India	11100000	N
Point	London	UK	11100000	Y
Point	Buenos Aires	Argentina	10750000	Y
Point	Rio de Janeiro	Brazil	10150000	N
Point	Bombay	India	9950000	N
Point	Paris	France	9775000	Y
Point	Los Angeles	US	9763600	N
Point	Cairo	Egypt	9300000	Y
Point	Shanghai	China	9300000	N
Point	Jakarta	Indonesia	8600000	Y

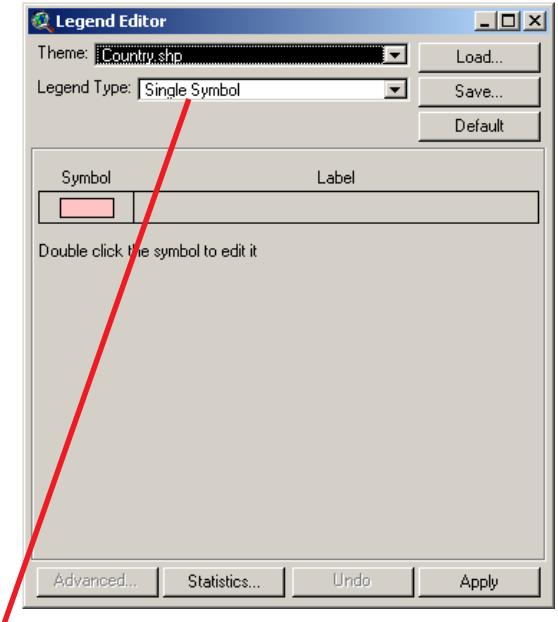
- Click in your View window to make it active. Click the zoom to selected button. The cities selected by your query are highlighted.

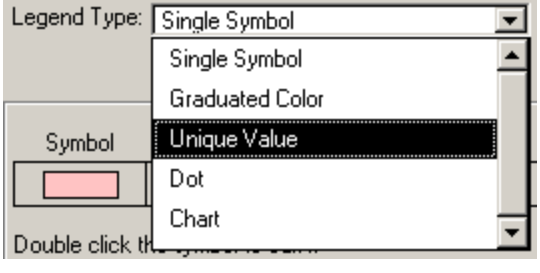


Changing the Way a Theme is Displayed

You have been working with all the nations of the world displayed as one color. This is not typical of political maps. Now you will display each country as a separate color.

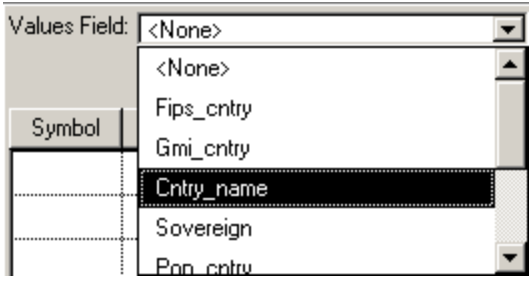
- **Zoom to the Extent of All Themes** so that you see the entire world.
- Turn off the display of the *lakes*, *rivers*, and *cities* themes.
- Double-click on the *country.shp* theme in the **View** window **Table of Contents**. This brings up the theme's **Legend Editor** box.
- Notice that the **Legend Type** pull-down menu displays **Single Symbol**. This means that every feature in the theme is displayed with the same color.
- In this **Legend Type** pull-down menu, select **Unique Value**.

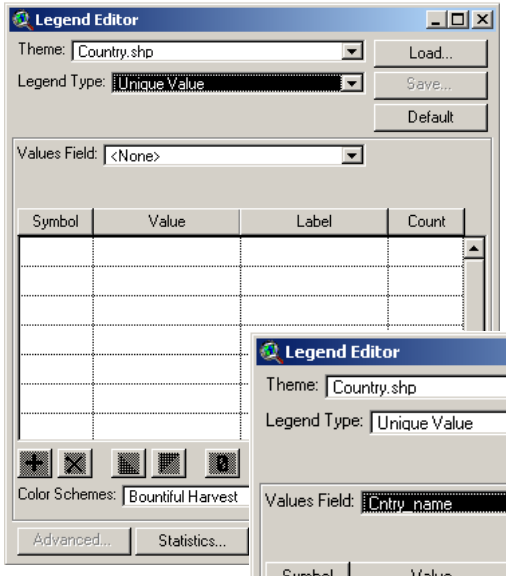


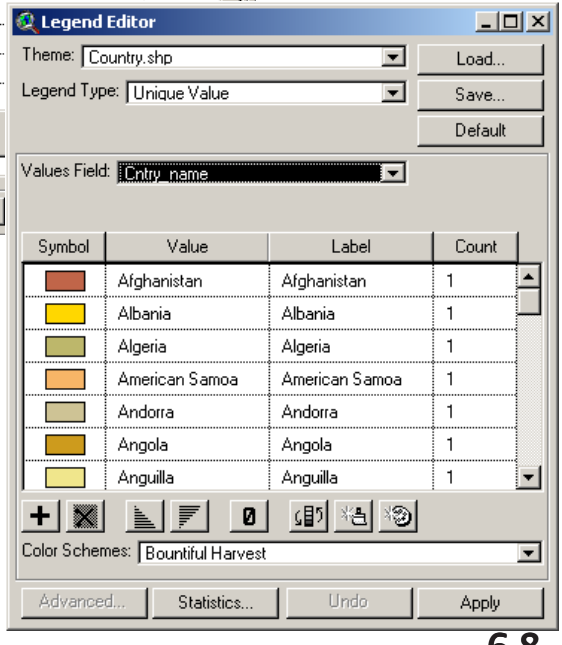


- The **Legend Editor** should appear as shown to the right. You must tell the system what *field*, or column in the theme's data table you wish to have the legend linked to.

- From the **Values Field** pull-down menu, select **Name**, or **Country Name**.



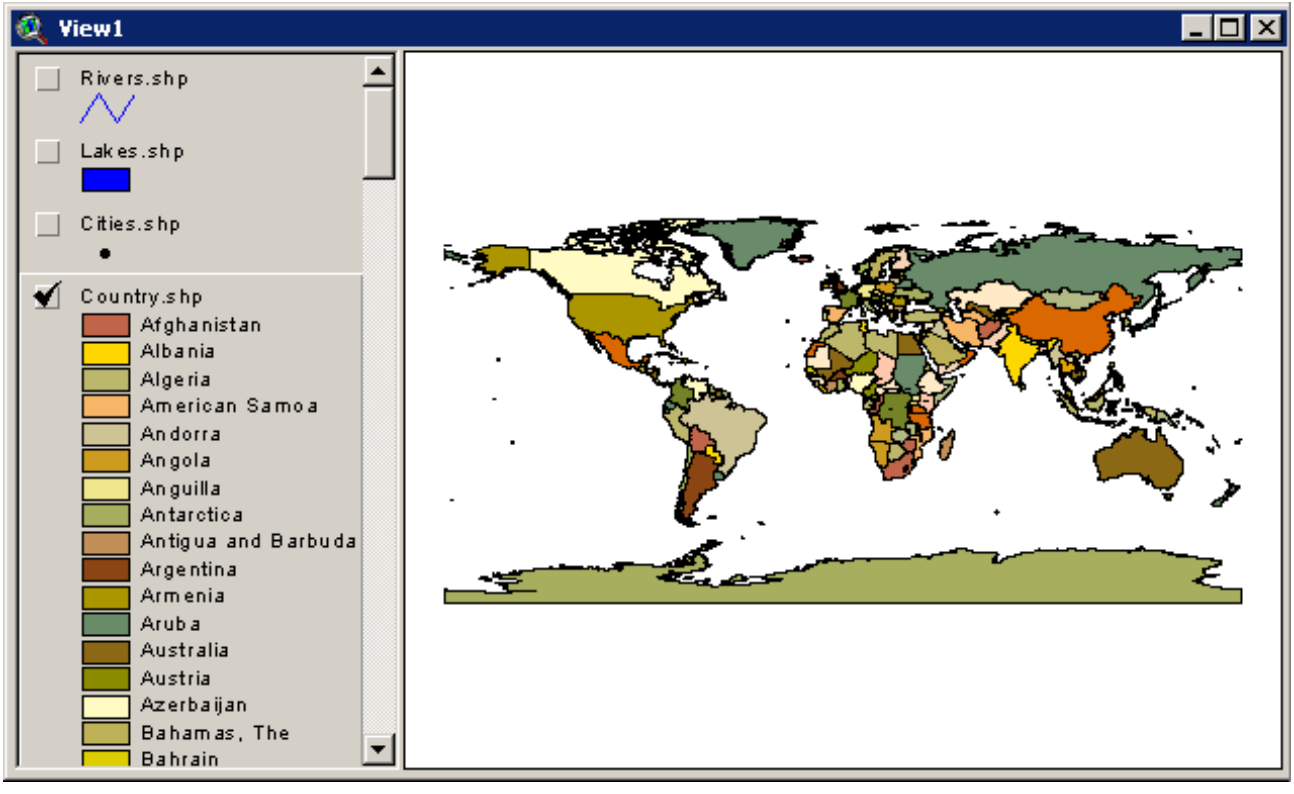




- The **Legend Editor** now shows a unique color for each country, based on its name. The **Color Schemes** pull-down menu near the bottom of the window allows you to choose different sets of colors. Choose one you like.

- Click the **Apply** button and close the **Legend Editor**.

- Each of the countries of the world is now listed in the **View Table of Contents**. The map now resembles traditional political maps.

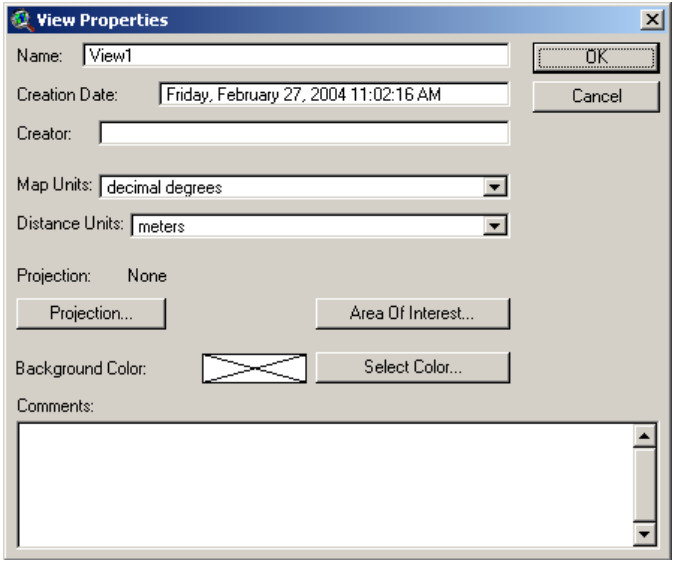


You will work with the **Legend Editor** much more in later projects.

A First Look at Projections and Units

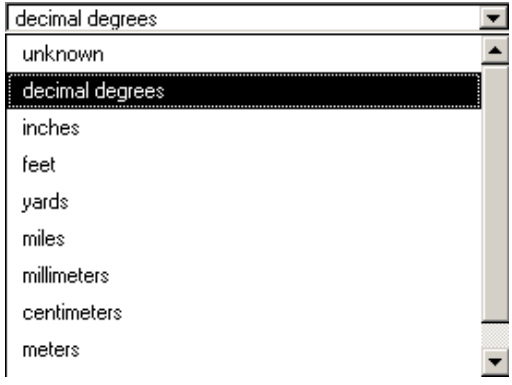
Any map is an attempt to render a round Earth on a flat surface, whether it be on your computer screen or a piece of paper. Imaging trying to flatten an orange; no matter how you cut and push, there is going to be some distortion, somewhere. Numerous schemes, called projections, have been devised to transfer the Earth to flat surfaces and each has certain advantages and disadvantages. ArcView can use and display data in many different projections. You will examine one interesting projection. As you add other sources of data in later projects, you will deal more in depth with projections.

- **Zoom to Extent of All Themes**.
- From the main menu, select **View --> Properties**.
- The **View Properties** box opens.
- You may rename the **View Window** by typing a new name in the **Name** line.

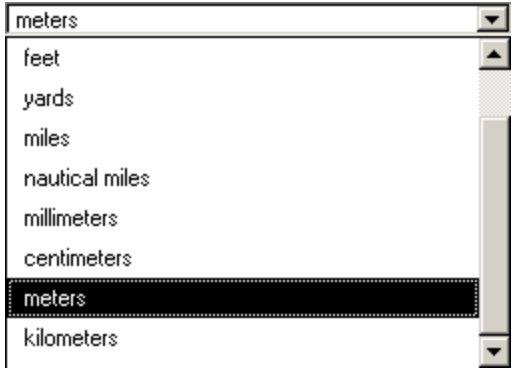


- Be certain that both the **Map Units** and **Distance Units** windows have selections in them. If they do not:

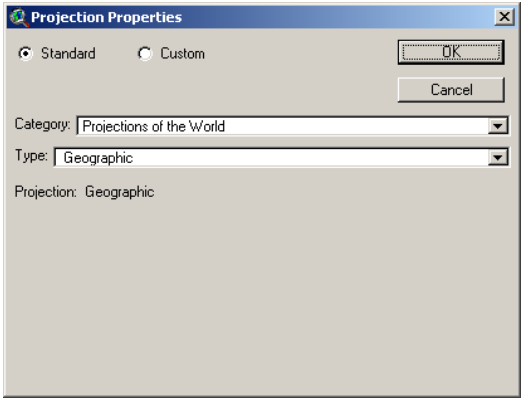
- In the **Map Units** pull-down menu, select an appropriate unit. If you are unsure what unit to use select **Decimal Degrees**.



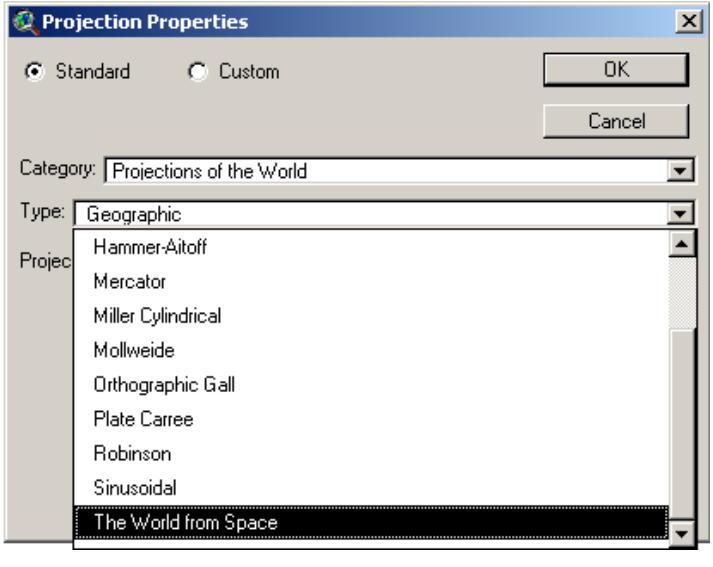
- In the **Distance Units** pull-down menu, select the surface distance unit of your choice. For all projects in this tutorial **meters** are the unit of choice.



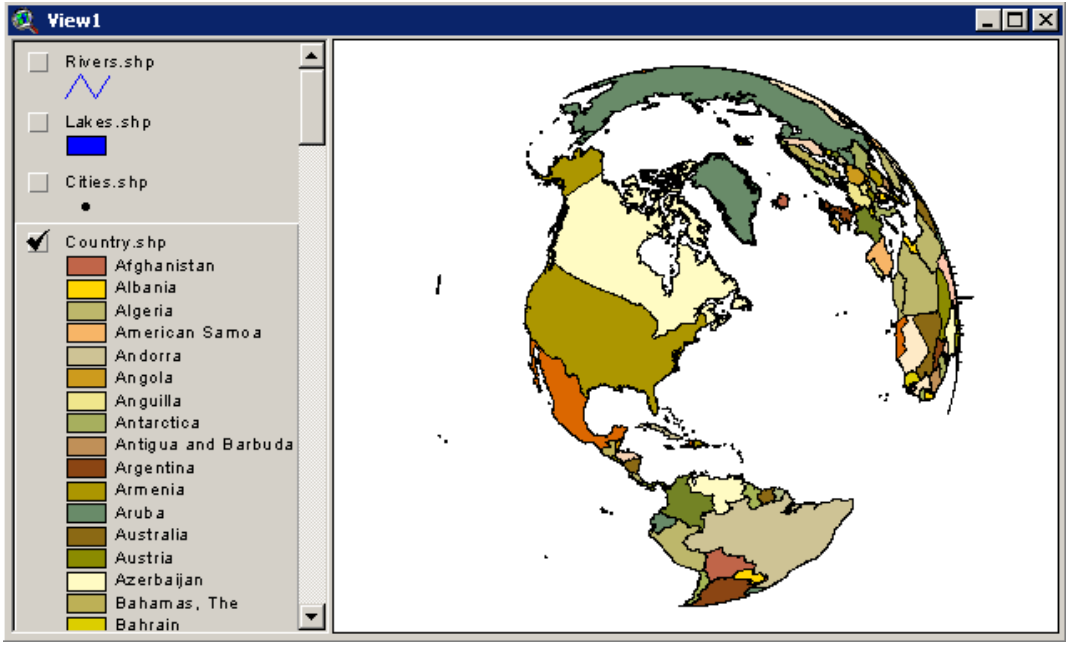
- Click once on the **Projection** button in the **View Properties** box.
  - The **Projection Properties** window opens.



  - From the **Type** pull-down menu, select **The World from Space**.
  - Click **OK** to close the **Projections Properties** box.
  - Click **OK** to close the **View Properties** window.



- The **View** window shows an approximation of the Earth as seen from space. Unfortunately, this view cannot be rotated, and is only useful for Western Hemisphere projects.

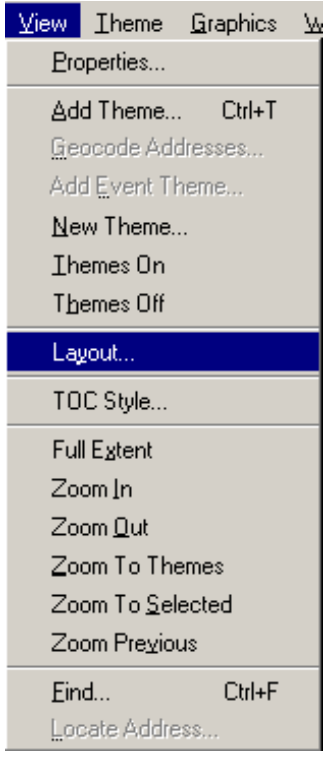


Chapter Summary: In this chapter, you started a new project, added themes from ArcView's internal data base, and manipulated and analyzed some of the properties of these themes.

Later projects in this tutorial will acquaint you with methods of acquiring local more detailed data sets and show you how to incorporate GLOBE student data as themes in your projects.

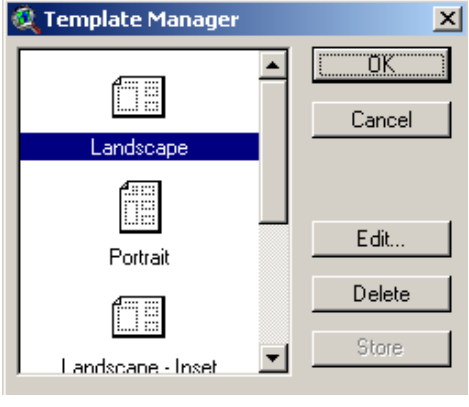
Chapter 5: Creating a Printed Map and Exporting Your Project

ArcView has two methods of producing printed output. One is to print directly from ArcView by creating a Layout. The other is to Export the View or Layout window in a form that can be used in graphics or word processing programs.



Creating a Layout

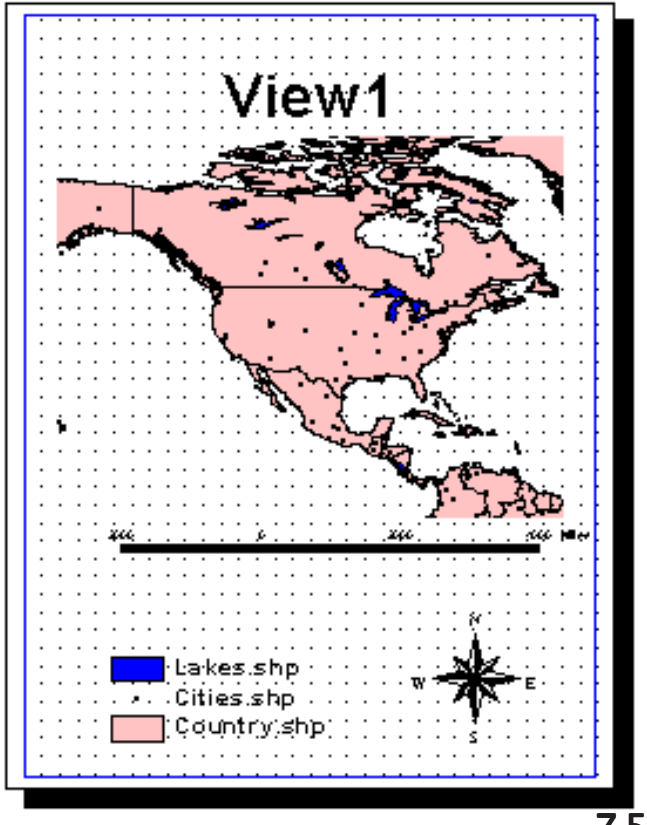
- Open an existing or create a new ArcView project.
- From the **View** menu in the main menu bar, select **Layout**.
- The **Template Manager** opens.



- From the list, select a template for your **Layout** and click **OK**. The author selected **Portrait**.
- A **Layout** is created with the elements from your view.

  It contains:

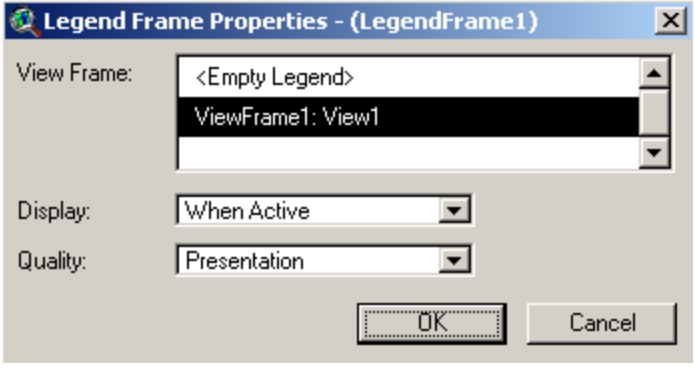
  - The map from your **View** window.
  - The **Theme Legend** from the **View Table of Contents**.
  - A scale.
  - A compass rose.



- At this point, you may select **Print** from the **File** menu and print the **Layout** as it appears. The next pages will show you how to make modifications to this **Layout**.

Changing the Layout

There are some simple modifications you can make to the appearance of your **Layout** that will give it a customized look.



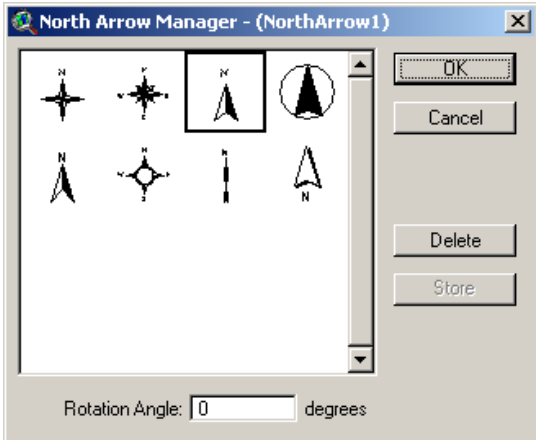
Controlling When Themes are Displayed

- Click on the **Select** tool. 
- Double click on the **Legend** in the **Layout.** The **Legend Frame Properties** box opens.
- The **Display** pull-down menu in this box has two options.

- These options cause a Theme in your View to be displayed in the Layout:
  - at all times.
  - or only when the theme is active in the View window.
- Choose “Always” and click OK.

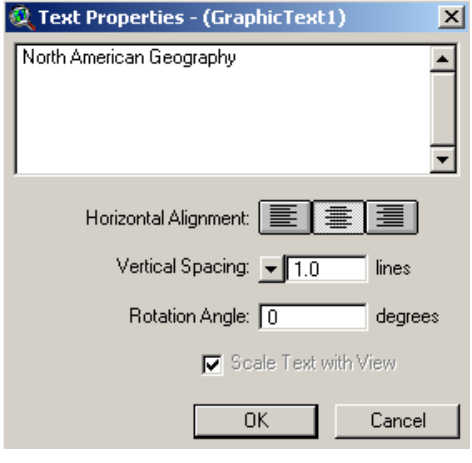
The Compass Rose

- Double click on the **Compass Rose** in the Layout. You can select any of the forms shown.
- Click OK.

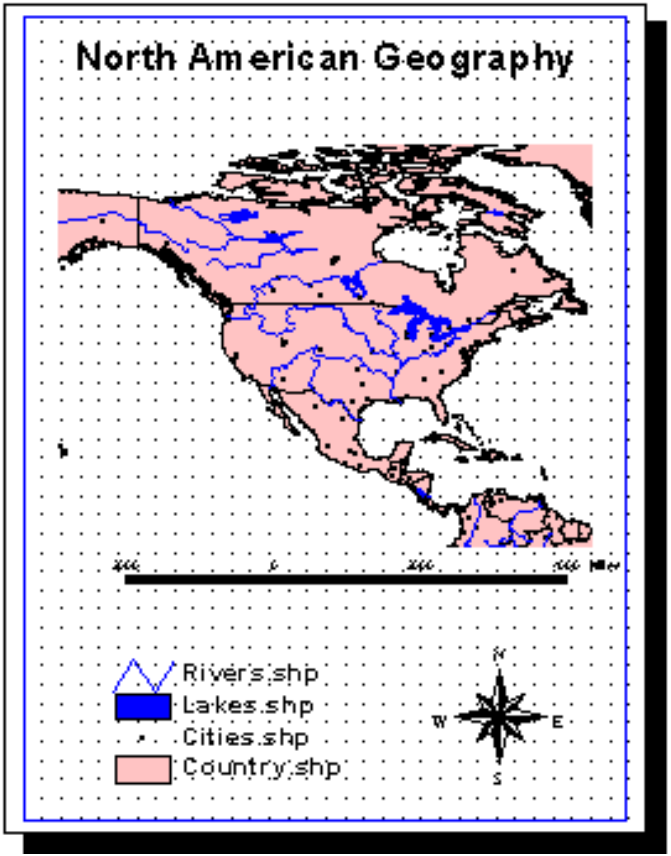


The Layout Title

- Double click on the **Title** in the Layout. The **Text Properties** box opens. Here you can change the Layout title by typing a new one in the dialog area.
- Click OK.



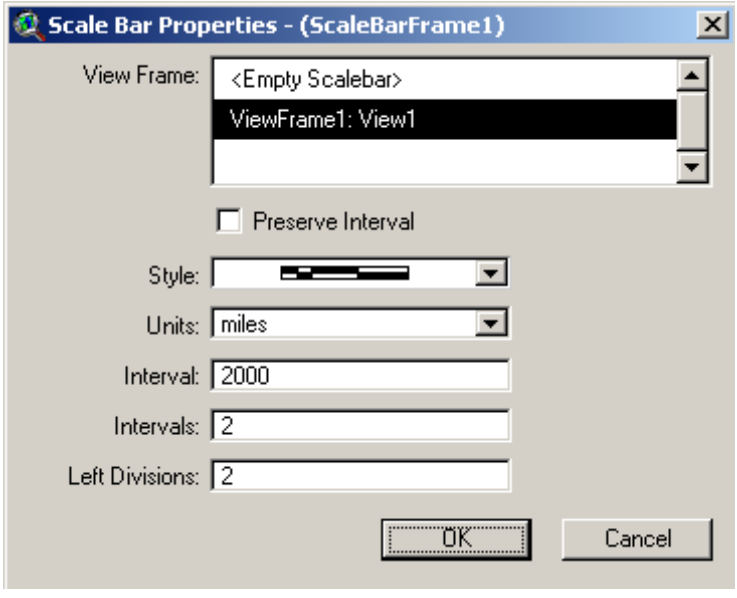
- Once you have selected a title, click once on the **Title** to make it active. You can drag it to a new position, or resize it as shown below.



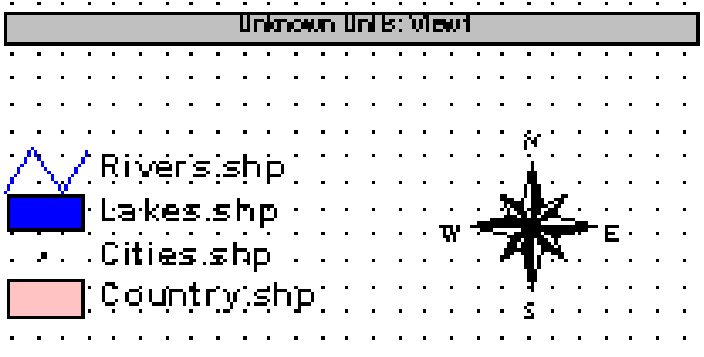
The Map Scale

- Double click on the **Scale Bar** in the Layout. In the **Scale Bar Properties** box, you may change the **Scale Style** and the **Units** of measure for the map. The interval information is determined by the area shown in the **View** window.

- Click OK.



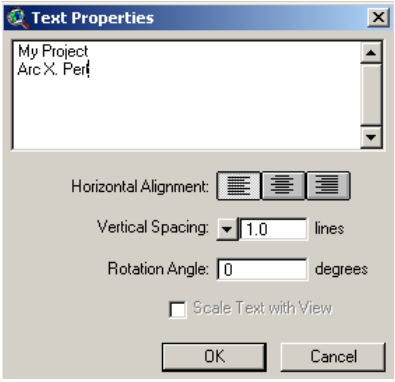
Note: If the Scale Bar in your **Layout** appears "gray" as in the example below, it is because no distance units have been specified in your **View**. See **Chapter 4.**

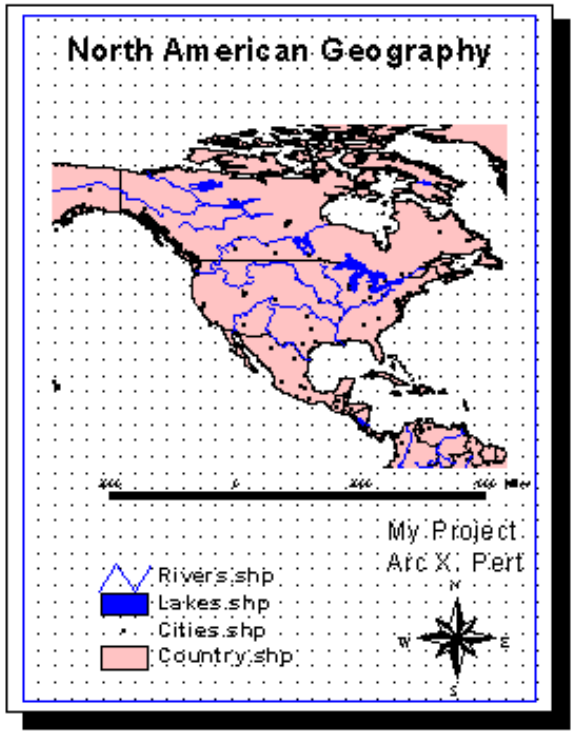


Adding Text to the Layout

You may add text to your Layout: 

- Select the **Text Tool** from the tool bar.
- Click a location in the **Layout** to insert text.
- The **Text Properties** Box opens.
- Enter your text in the **Text Window**. When you click **OK**, that text will be inserted into the **Layout**.



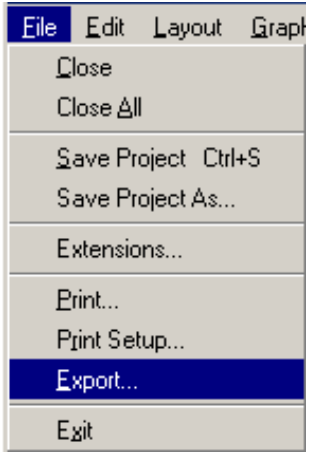


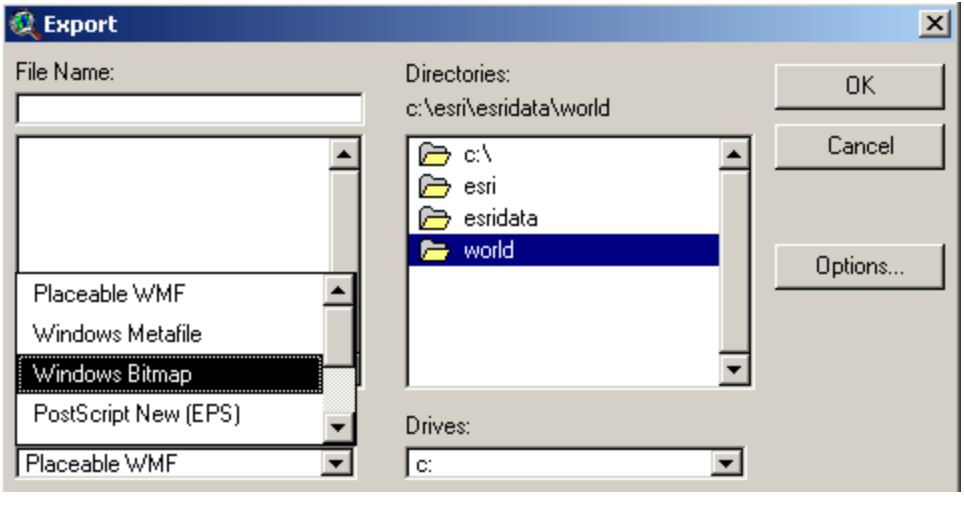
- **To move or resize this text box**:
  - Choose the **Select** tool.
  - Click on the text.
  - Drag and resize the text box.

Exporting the View and Layout Windows

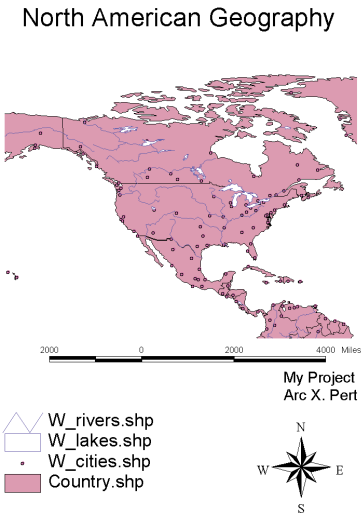
ArcView will allow you to export the contents of the **View** window or the **Layout** in graphics format. These images can be used in graphics or word processing programs.

- To **Export** either the **View** or **Layout** window, select **Export** from the **File** menu. The **Export** window, along with supported file types are shown.

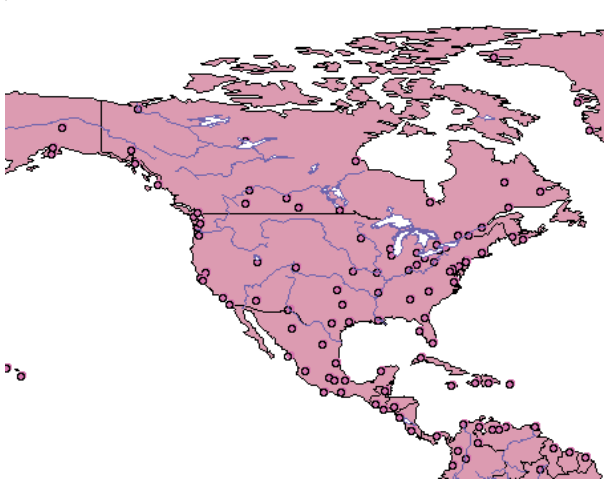




If you export the Layout, the entire contents of the Layout window will appear in the graphic. Exporting the **View** window will only show the active themes in the window. The **View Table of Contents** window is not exported. The results of Exporting are shown below.



Exported Layout window



Exported View window

Chapter Summary: In this chapter, you learned how to create and export a layout. You learned how to manipulate the different map elements. Creating a layout that is clearly organized is important so that information can be shared effectively.

Chapter 6: Downloading and Incorporating GLOBE Student Data

This chapter and Chapter 7 will deal with acquiring and displaying other data sets in ArcView. In order to be useful, such data must be geospatial. That is, they must contain coordinates that relate each data item to a place on the Earth.

Consider the data you send to the GLOBE database. Every item is related to a measurement site that you have defined with latitude and longitude. These are the geospatial components of your data and make them appropriate for use in ArcView.

In this chapter, you will:

- Enter the GLOBE site, select a dataset to view, and create a table of those data.
- Download this data table to your computer.
- Incorporate these data as an Event Theme in ArcView.
- Save this theme as a Shapefile.
- Use the Legend Editor to change the nature of the data display.

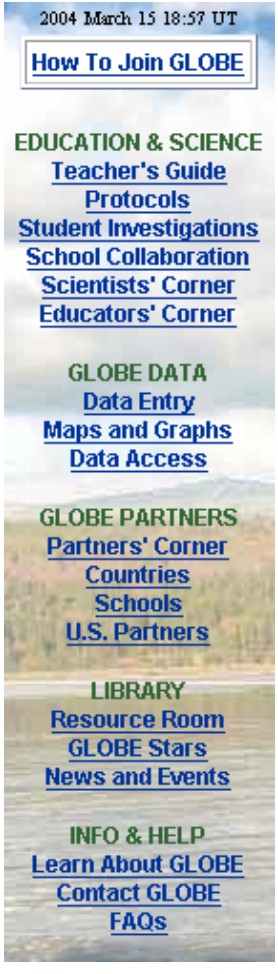
Note:

1. It is assumed that you are familiar with the GLOBE website.
2. The appearance of pages on the GLOBE website changes, so the screens you meet may differ slightly from those in place at the time of this writing.

Part I: Getting the Data from the GLOBE Website

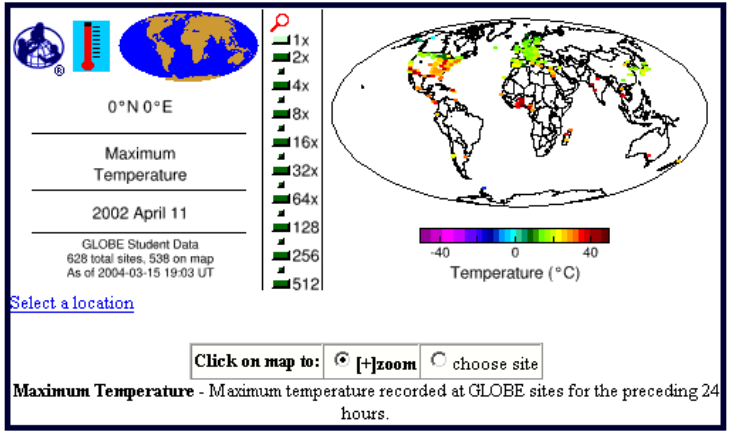
Note: All files used in these tutorials are available from the University of New Hampshire GLOBE site at www.globe.unh.edu. Follow the "GIS" links. You may also order the complete tutorial and the necessary files on CD from the UNH site.

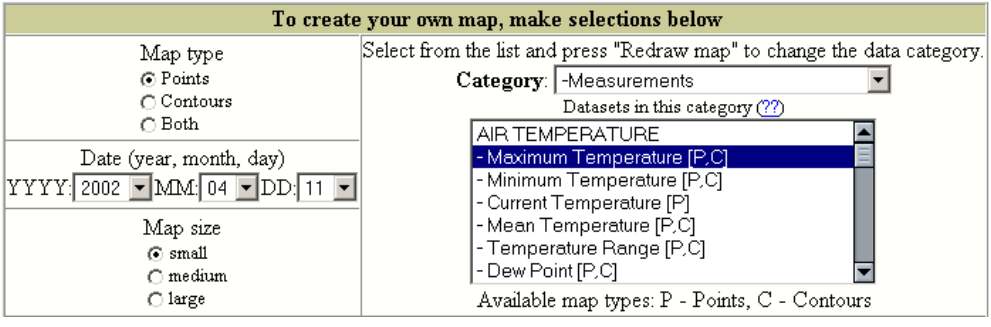
- Go to the GLOBE website, *www.globe.gov,* and select **Enter the GLOBE Site**.
- You do not have to log in with your GLOBE ID and password. You will be using the public parts of the GLOBE webspace.
- From the main menu, under **GLOBE DATA** select **Maps and Graphs.**



- At the **Maps & Graphs** screen, select **GLOBE Maps**.

- At the **Maps** screen, use the default protocol which is Maximum Temperature. As shown in the visual, select the date of April 11, 2002, and click the **Redraw Map** button.



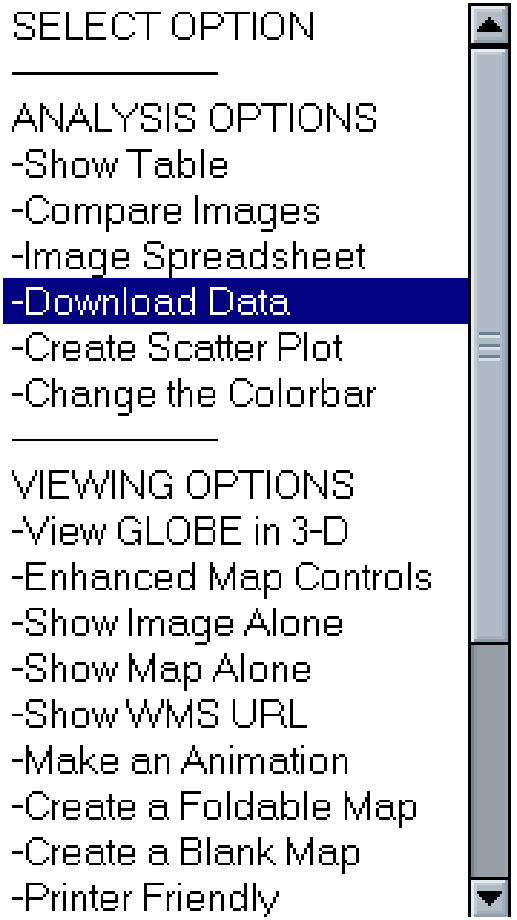


- There are about 500 data points shown for Maximum Temperature for this data set. These are the data you will incorporate as a layer in a GIS project.

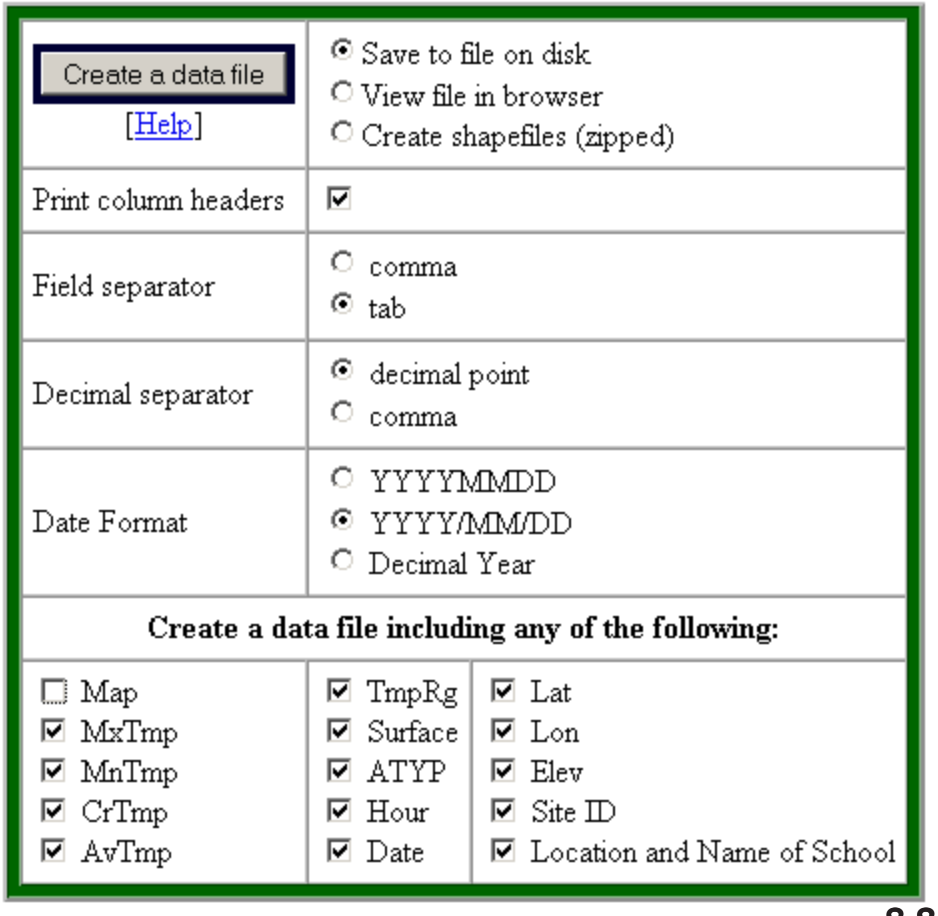
Downloading the Data

- Below the map is the **Other Options** pull-down menu.

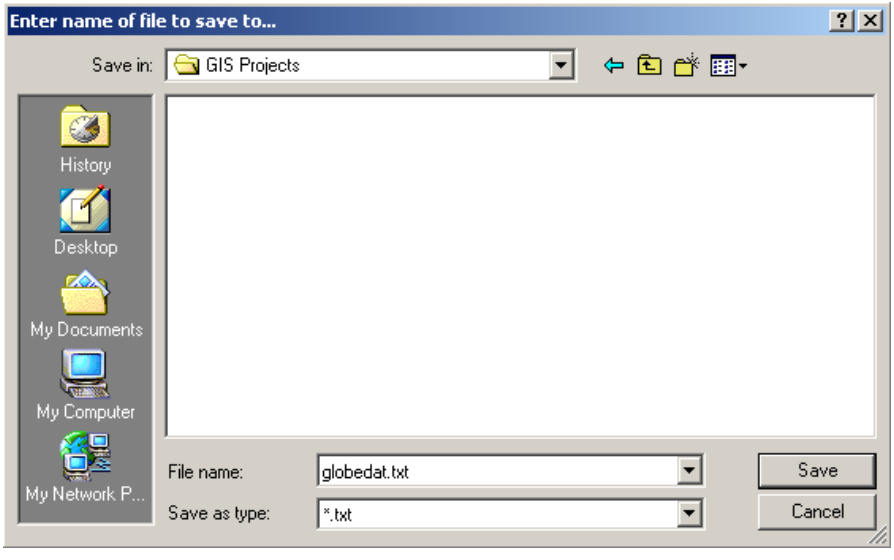
- From this menu select **Download Data** (right).
- Click the **Go** button.



- After your screen "refreshes," scroll to the bottom of the screen where you will see the **Data Specifications** window.
- The only change you should make is to turn off the **Map** item in the list of parameters at the bottom of the box.
- Click the **Create a data file** button.



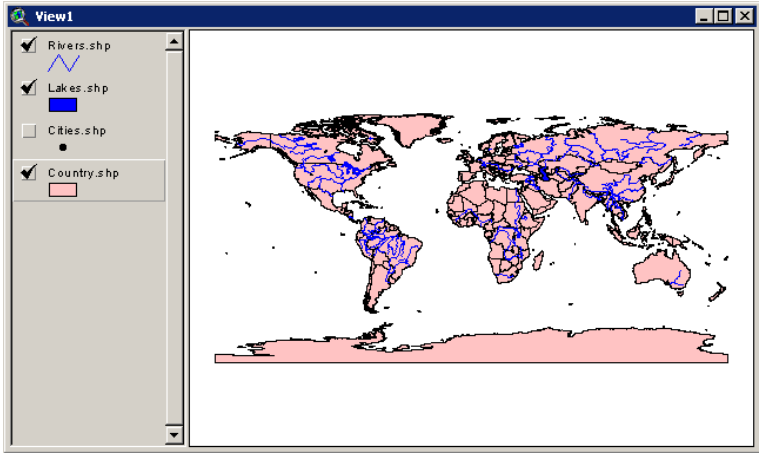
- The system will prompt you to select a location for this file. You should select the *GIS Projects* folder you created when you installed ArcView.

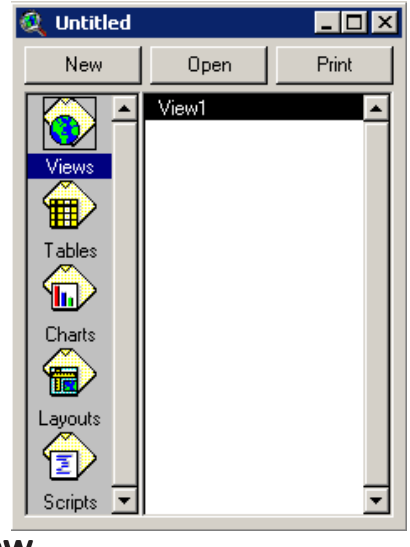


The GLOBE Maximum Temperature data have been saved to your GIS Projects folder. You can now incorporate them into a GIS project.

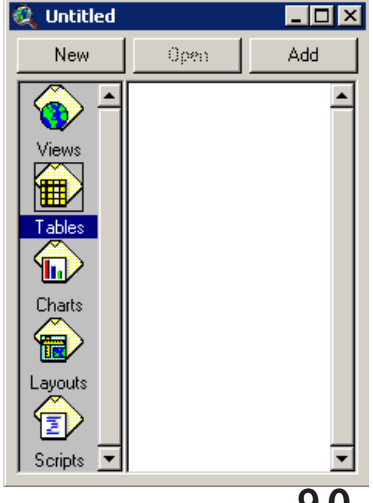
Using the GLOBE data in ArcView

- Start a new project using the same themes from Chapter 4.
- Turn off the *cities.shp* theme.
- Click in the **Project Window** to make it active. You may have to move your **View** window to find it.





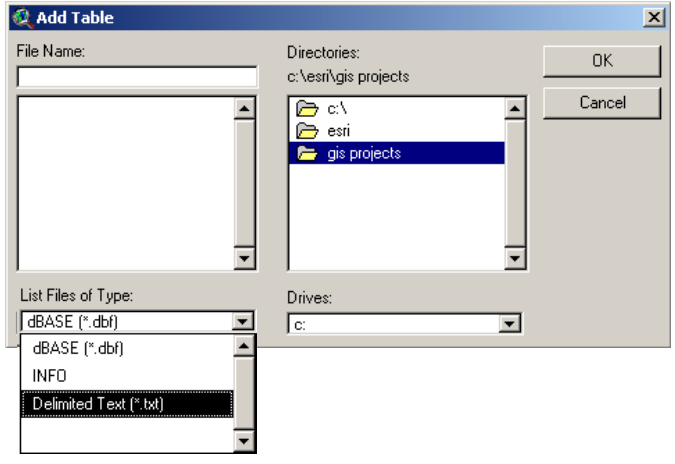
- In the **Project Window**, click once on the **Tables** button as shown to the right. Notice that the upper set of buttons changes.



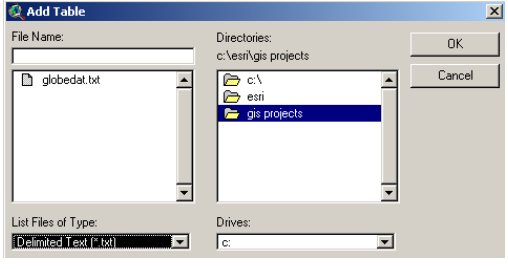
- Click on the **Add** button in the **Project Window**. The **Add Table** dialog box opens. Navigate to the *GIS Projects* folder where you stored the data you downloaded from the GLOBE page.

- Notice that your file *globedat.txt* does not appear in the file window. This is because ArcView expects file types created by **DBase**, a database software. You need to tell the system what type of file format you are using.

- From the **List Files of Type** pull-down menu in the bottom-left of this box select **Delimited Text (.txt)**, as shown to the right.[1]



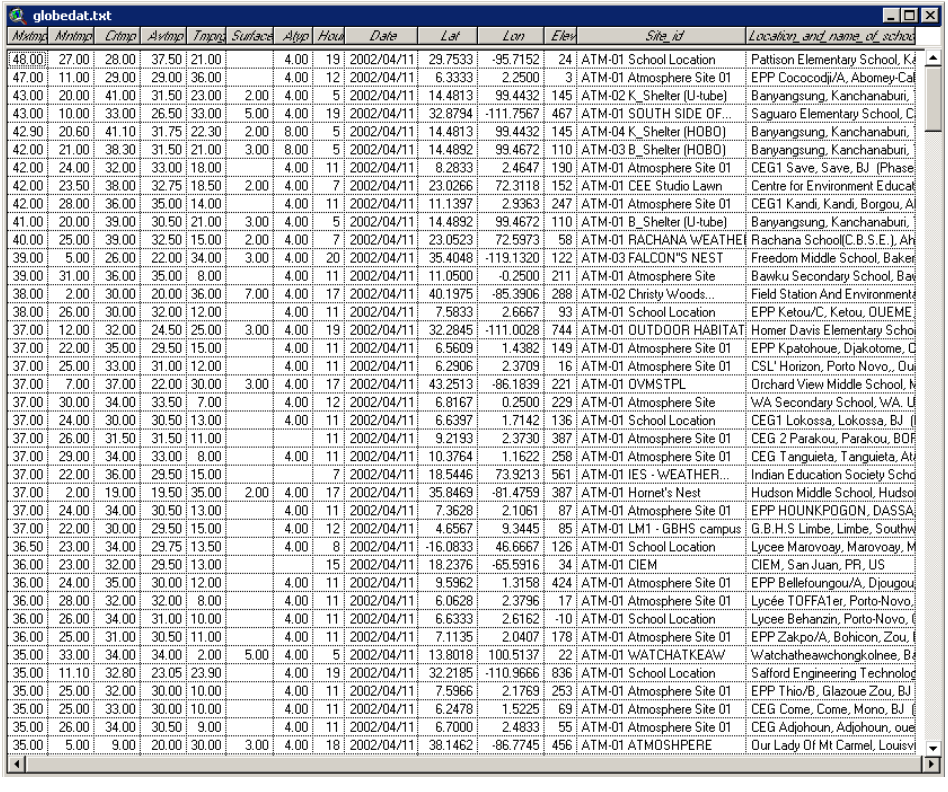
- Your file should appear in the files window.



- Click on the file **globedat.txt** to select it, and click **OK**.

1. The term Delimited text refers to the structure of the file you downloaded. The file is a plain, or "text file, but since it contains columns of data, a character is needed to separate the columns. GLOBE data use a tab key to separate individual columns; they are called "tab-delimited files." Selecting **Delimited text** tells ArcVoyager to look for a character to separate columns in the file.

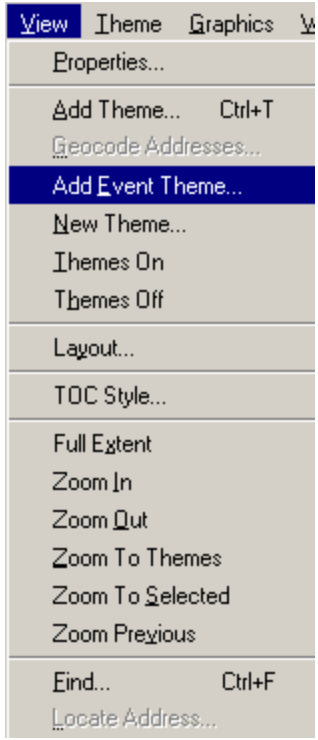
- Your downloaded file opens with items separated into columns. Notice that the column containing the school name appears incomplete. The data are all there, but the default value for the width of the column is not large enough to show it all. You can use all of the **Table Tools** you saw in Chapter 5 with this table.



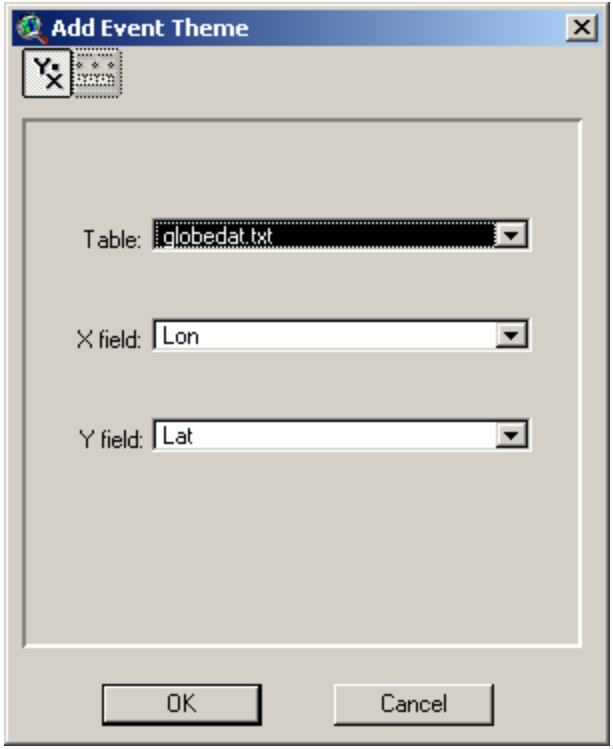
globedat.txt

Mxtmp	Mntmp	Otmp	Avtmp	Tmpq	Surface	Atyp	Hour	Date	Lat	Lon	Elev	Site_id	Location_and_name_of_school
48.00	27.00	28.00	37.50	21.00		4.00	19	2002/04/11	29.7533	-95.7152	24	ATM-01 School Location	Pattison Elementary School, Ka
47.00	11.00	29.00	29.00	36.00		4.00	12	2002/04/11	6.3333	2.2500	3	ATM-01 Atmosphere Site 01	EPP Cococodji/A, Abomey-Cal
43.00	20.00	41.00	31.50	23.00	2.00	4.00	5	2002/04/11	14.4813	99.4432	145	ATM-02 K_Shelter (U-tube)	Banyangsung, Kanchanaburi,
43.00	10.00	33.00	26.50	33.00	5.00	4.00	19	2002/04/11	32.8794	-111.7567	467	ATM-01 SOUTH SIDE OF...	Saguaro Elementary School, C
42.90	20.60	41.10	31.75	22.30	2.00	8.00	5	2002/04/11	14.4813	99.4432	145	ATM-04 K_Shelter (HOBO)	Banyangsung, Kanchanaburi,
42.00	21.00	38.30	31.50	21.00	3.00	8.00	5	2002/04/11	14.4892	99.4672	110	ATM-03 B_Shelter (HOBO)	Banyangsung, Kanchanaburi,
42.00	24.00	32.00	33.00	18.00		4.00	11	2002/04/11	8.2833	2.4647	190	ATM-01 Atmosphere Site 01	CEG1 Save, Save, BJ (Phase
42.00	23.50	38.00	32.75	18.50	2.00	4.00	7	2002/04/11	23.0266	72.3118	152	ATM-01 CEE Studio Lawn	Centre for Environment Educat
42.00	28.00	36.00	35.00	14.00		4.00	11	2002/04/11	11.1397	2.9363	247	ATM-01 Atmosphere Site 01	CEG1 Kandi, Kandi, Borgou, Al
41.00	20.00	39.00	30.50	21.00	3.00	4.00	5	2002/04/11	14.4892	99.4672	110	ATM-01 B_Shelter (U-tube)	Banyangsung, Kanchanaburi,
40.00	25.00	39.00	32.50	15.00	2.00	4.00	7	2002/04/11	23.0523	72.5973	58	ATM-01 RACHANA WEATHEI	Rachana School(C.B.S.E.), Ah
39.00	5.00	26.00	22.00	34.00	3.00	4.00	20	2002/04/11	35.4048	-119.1320	122	ATM-03 FALCON"S NEST	Freedom Middle School, Baker
39.00	31.00	36.00	35.00	8.00		4.00	11	2002/04/11	11.0500	-0.2500	211	ATM-01 Atmosphere Site	Bawku Secondary School, Bav
38.00	2.00	30.00	20.00	36.00	7.00	4.00	17	2002/04/11	40.1975	-85.3906	288	ATM-02 Christy Woods...	Field Station And Environmenta
38.00	26.00	30.00	32.00	12.00		4.00	11	2002/04/11	7.5833	2.6667	93	ATM-01 School Location	EPP Ketou/C, Ketou, OUEME,
37.00	12.00	32.00	24.50	25.00	3.00	4.00	19	2002/04/11	32.2845	-111.0028	744	ATM-01 OUTDOOR HABITAT	Homer Davis Elementary Scho
37.00	22.00	35.00	29.50	15.00		4.00	11	2002/04/11	6.5609	1.4382	149	ATM-01 Atmosphere Site 01	EPP Kpatohoue, Djakotome, C
37.00	25.00	33.00	31.00	12.00		4.00	11	2002/04/11	6.2906	2.3709	16	ATM-01 Atmosphere Site 01	CSL' Horizon, Porto Novo,, Ou
37.00	7.00	37.00	22.00	30.00	3.00	4.00	17	2002/04/11	43.2513	-86.1839	221	ATM-01 OVMSTPL	Orchard View Middle School, N
37.00	30.00	34.00	33.50	7.00		4.00	12	2002/04/11	6.8167	0.2500	229	ATM-01 Atmosphere Site	WA Secondary School, WA. LI
37.00	24.00	30.00	30.50	13.00		4.00	11	2002/04/11	6.6397	1.7142	136	ATM-01 School Location	CEG1 Lokossa, Lokossa, BJ (
37.00	26.00	31.50	31.50	11.00			11	2002/04/11	9.2193	2.3730	387	ATM-01 Atmosphere Site 01	CEG 2 Parakou, Parakou, BOF
37.00	29.00	34.00	33.00	8.00		4.00	11	2002/04/11	10.3764	1.1622	258	ATM-01 Atmosphere Site 01	CEG Tanguieta, Tanguieta, Ata
37.00	22.00	36.00	29.50	15.00			7	2002/04/11	18.5446	73.9213	561	ATM-01 IES - WEATHER...	Indian Education Society Scho
37.00	2.00	19.00	19.50	35.00	2.00	4.00	17	2002/04/11	35.8469	-81.4759	387	ATM-01 Hornet's Nest	Hudson Middle School, Hudso
37.00	24.00	34.00	30.50	13.00		4.00	11	2002/04/11	7.3628	2.1061	87	ATM-01 Atmosphere Site 01	EPP HOUNKPOGON, DASSA,
37.00	22.00	30.00	29.50	15.00		4.00	12	2002/04/11	4.6567	9.3445	85	ATM-01 LM1 - GBHS campus	G.B.H.S Limbe, Limbe, Southw
36.50	23.00	34.00	29.75	13.50		4.00	8	2002/04/11	-16.0833	46.6667	126	ATM-01 School Location	Lycee Marovoay, Marovoay, M
36.00	23.00	32.00	29.50	13.00			15	2002/04/11	18.2376	-65.5916	34	ATM-01 CIEM	CIEM, San Juan, PR, US
36.00	24.00	35.00	30.00	12.00		4.00	11	2002/04/11	9.5962	1.3158	424	ATM-01 Atmosphere Site 01	EPP Bellefoungou/A, Djougou,
36.00	28.00	32.00	32.00	8.00		4.00	11	2002/04/11	6.0628	2.3796	17	ATM-01 Atmosphere Site 01	Lycée TOFFA1er, Porto-Novo,
36.00	26.00	34.00	31.00	10.00		4.00	11	2002/04/11	6.6333	2.6162	-10	ATM-01 School Location	Lycee Behanzin, Porto-Novo, (
36.00	25.00	31.00	30.50	11.00		4.00	11	2002/04/11	7.1135	2.0407	178	ATM-01 Atmosphere Site 01	EPP Zakpo/A, Bohicon, Zou, (
35.00	33.00	34.00	34.00	2.00	5.00	4.00	5	2002/04/11	13.8018	100.5137	22	ATM-01 WATCHATKEAW	Watchatheawchongkolnee, Ba
35.00	11.10	32.80	23.05	23.90		4.00	19	2002/04/11	32.2185	-110.9666	836	ATM-01 School Location	Safford Engineering Technolog
35.00	25.00	32.00	30.00	10.00		4.00	11	2002/04/11	7.5966	2.1769	253	ATM-01 Atmosphere Site 01	EPP Thio/B, Glazoue Zou, BJ
35.00	25.00	33.00	30.00	10.00		4.00	11	2002/04/11	6.2478	1.5225	69	ATM-01 Atmosphere Site 01	CEG Come, Come, Mono, BJ (
35.00	26.00	34.00	30.50	9.00		4.00	11	2002/04/11	6.7000	2.4833	55	ATM-01 Atmosphere Site 01	CEG Adjohoun, Adjohoun, oue
35.00	5.00	9.00	20.00	30.00	3.00	4.00	18	2002/04/11	38.1462	-86.7745	456	ATM-01 ATMOSHPERE	Our Lady Of Mt Carmel, Louisvi

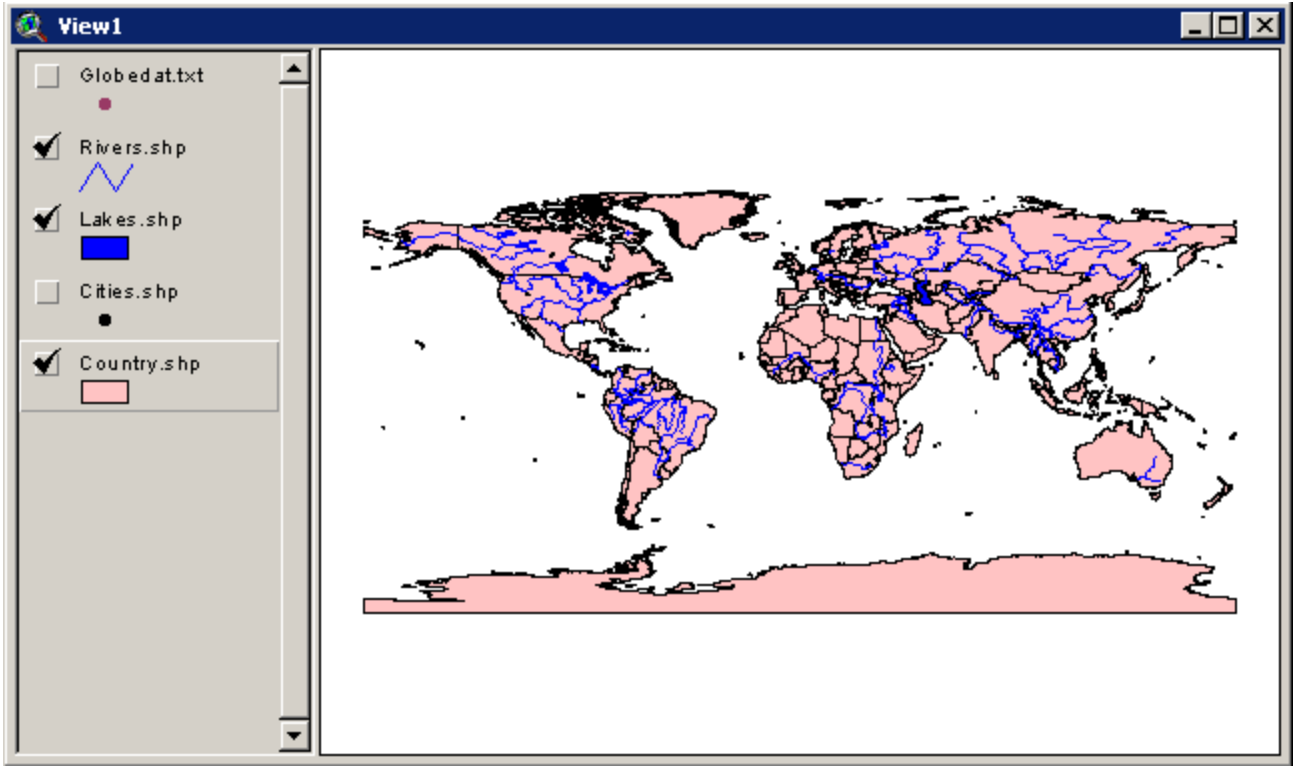
- Select your **View Window** to make it active.
- You will now add these data to your **View** as an **Event Theme**.
- From the **View** menu, select **Add Event Theme**.



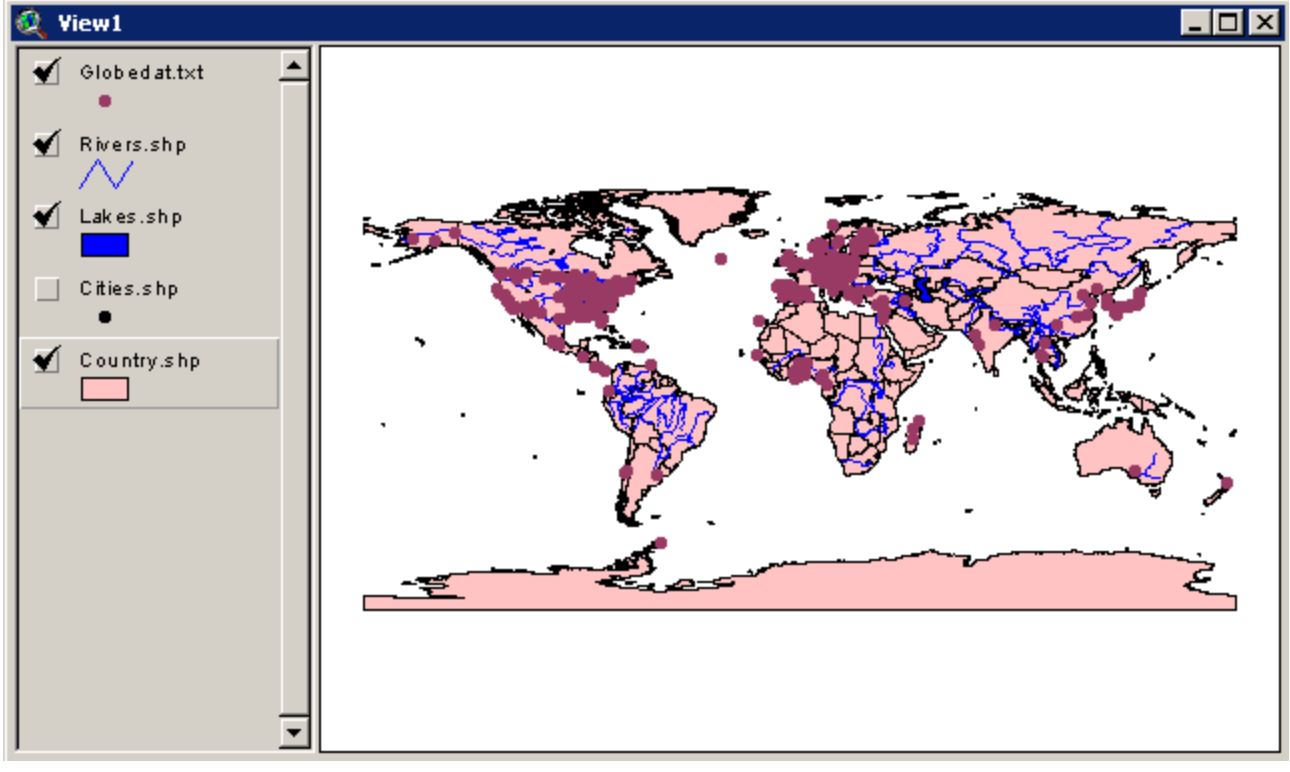
- The **Add Event Theme** specifications box opens. Here you tell the system what columns in your data table contain the important spatial data (latitude and longitude.) GLOBE data tables use column headings of “lat” and “lon” that ArcView recognizes, so these columns are automatically selected.
- Click **OK**.



- The data are added to the **View Window Table of Contents** and named *globedat.txt*.

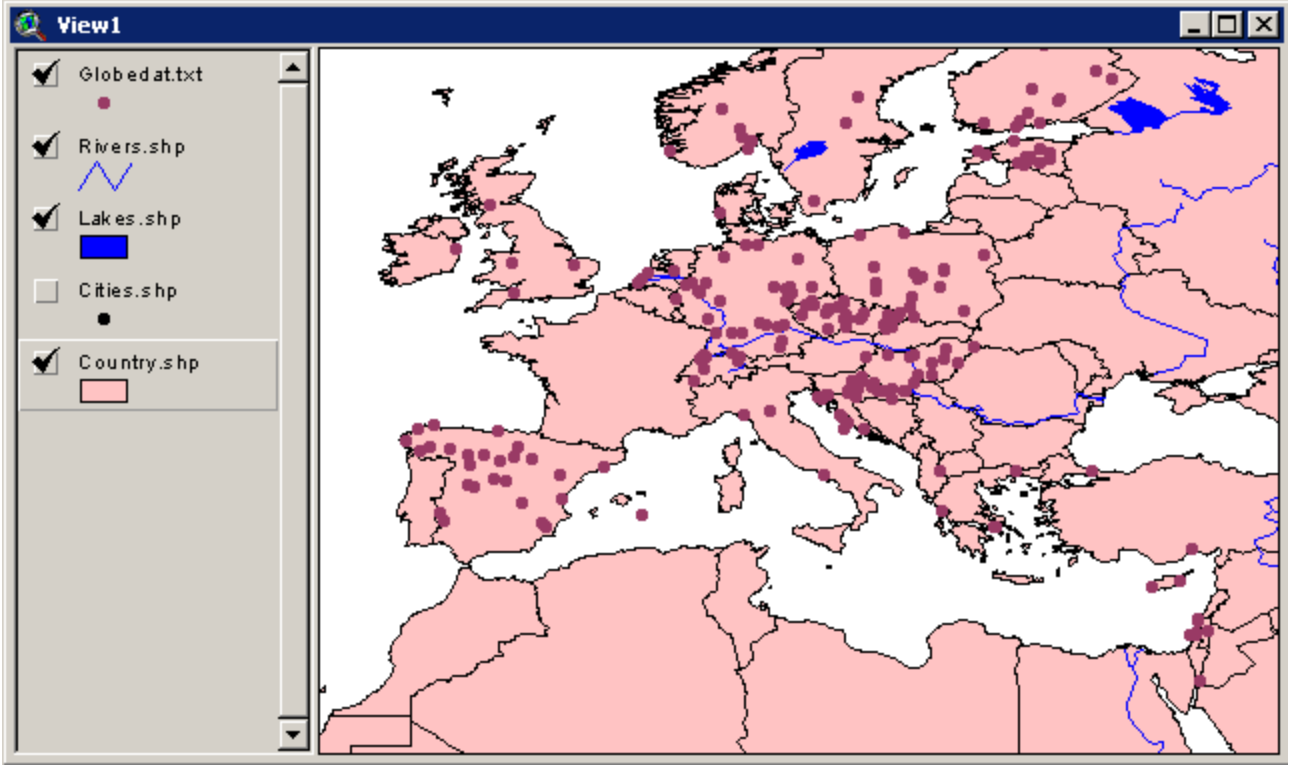


- Turn on the *globedat.txt* theme. The data points are added, but it does not look like the display on the GLOBE website. All the points are displayed in the same color and at this scale the dots representing the data points are very large.

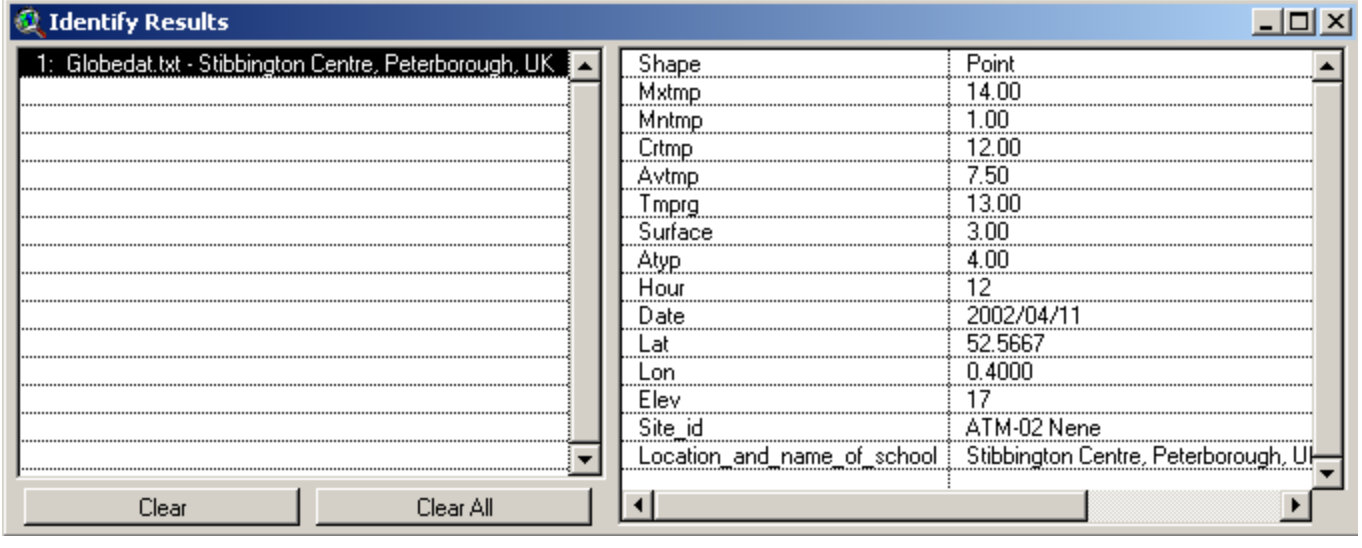


- **Zoom in** on the large cluster of dots in Europe. Your display should resemble the one below.

- You can change any of the display colors to suit your preferences.



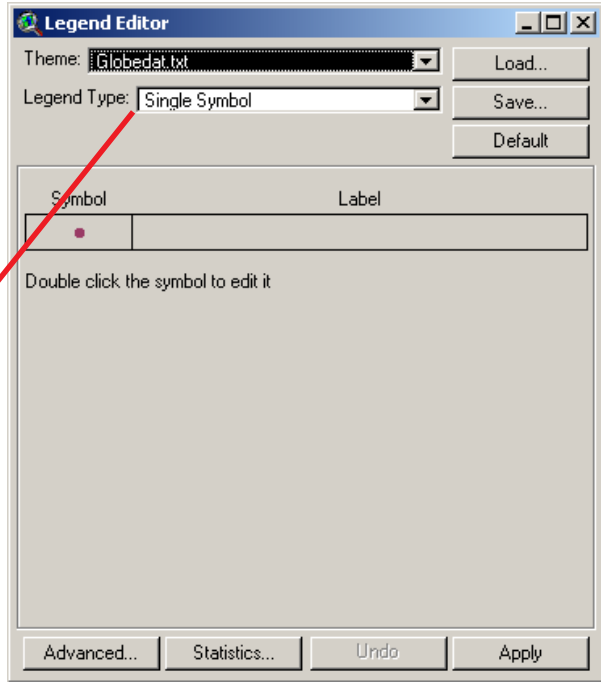
- Make the *globedat.txt* theme active.
- Use the **Information** tool to see data from any one of the points.

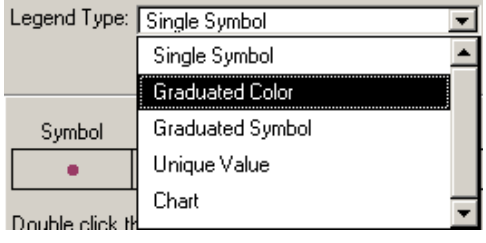


Changing the Display

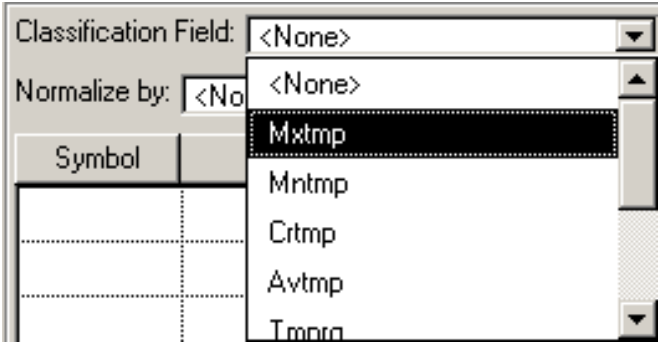
All of the data points in your **View** are displayed with the same color. A better understanding of the data occurs when the points are displayed with a color scheme keyed to temperature.

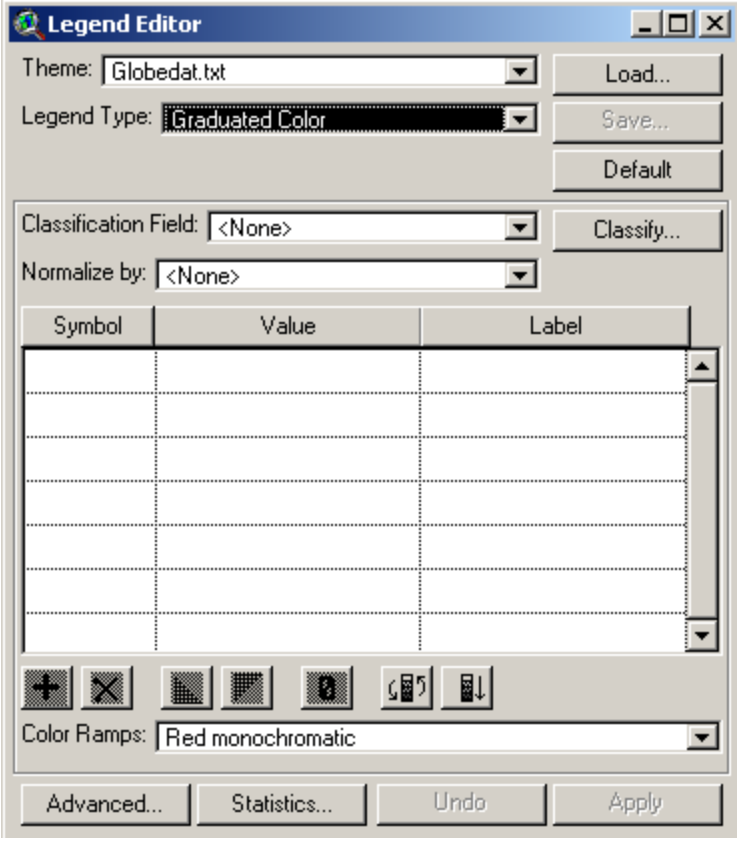
- Double click on the *globedat.txt* theme in the **View Table of Contents**. This opens the **Legend Editor**.
- The **Legend Type** pull-down menu lists **Single Symbol**. This causes all data in the *globedat.txt* file to be displayed with the same color symbol.
- From the **Legend Type** menu select **Graduated Color**.



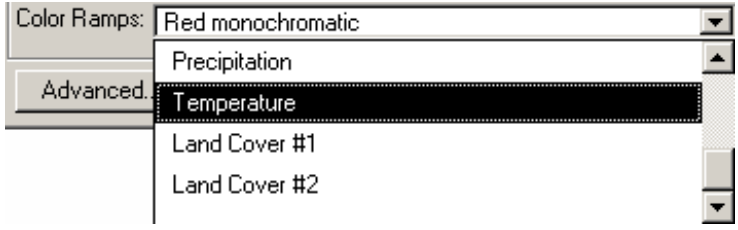


- Notice the **Legend Editor** view now changes. You will now have to tell the system which variable in the data table you wish to use to control the color scheme.
- From the **Classification Field** pull-down menu, select **MxTmp** (maximum temperature) . This will use the reported maximum temperatures to control the color of the data points.

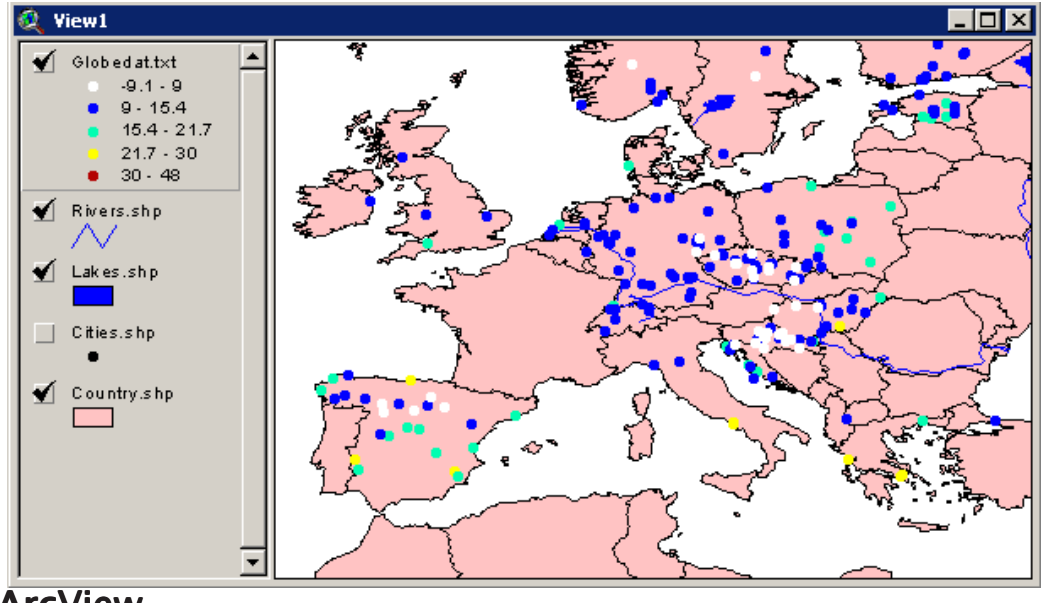




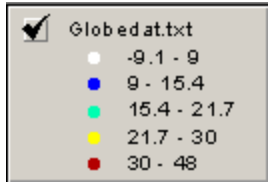
- The **Color Ramp** pull-down menu near the bottom of the **Legend Editor** window lists the color schemes you can use. From this menu, select **Temperature**. Using this **Color Ramp** gives a uniform standard for displaying temperature data.



- Click the **Apply** button and close the **Legend Editor**. Europe's temperature data are displayed with the new classification.

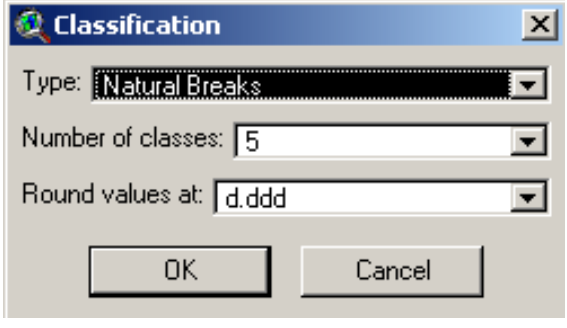


- Examine the *globedat.txt* legend. There are 5 ranges of temperature.



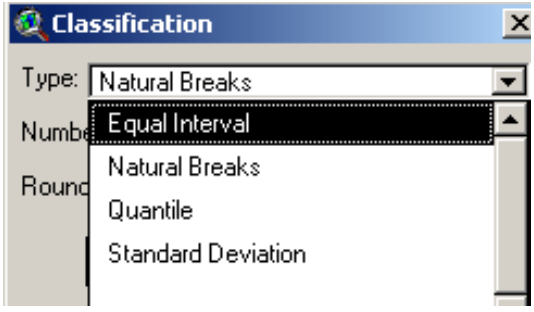
What do you notice about the temperatures in each range? Why do they occur this way?

- The ArcView system defaults to 5 classes and selects natural breaks in the data to separate the groups. This often results in peculiar looking legends.
- Double click on the *globedat.txt* theme to reopen the **Legend Editor**.
- Click on the **Classify...** button to the right of the **MxTmp** and note its settings.
- These settings tell the system to:
  - Find natural breaks in the data to produce the classes.
  - Find only 5 classes.
  - Display the data to 3 decimal points.

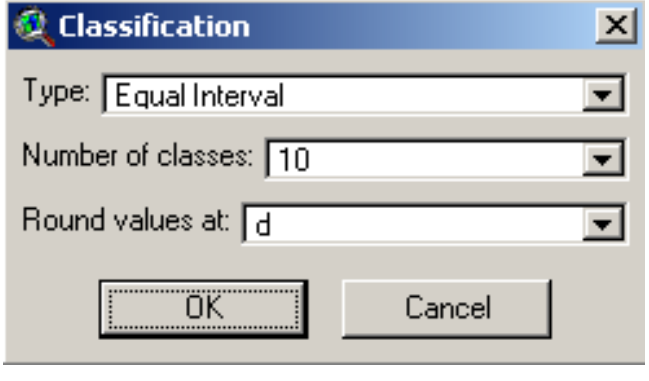


You will now change these settings.

- From each of the pull-down menus in the **Classification** window, make the following changes:
  - Set **Type** to **Equal Intervals.**
  - Set **Number of classes** to **10.**
  - Set **Round value at d.**

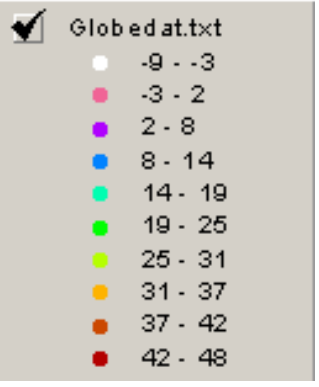


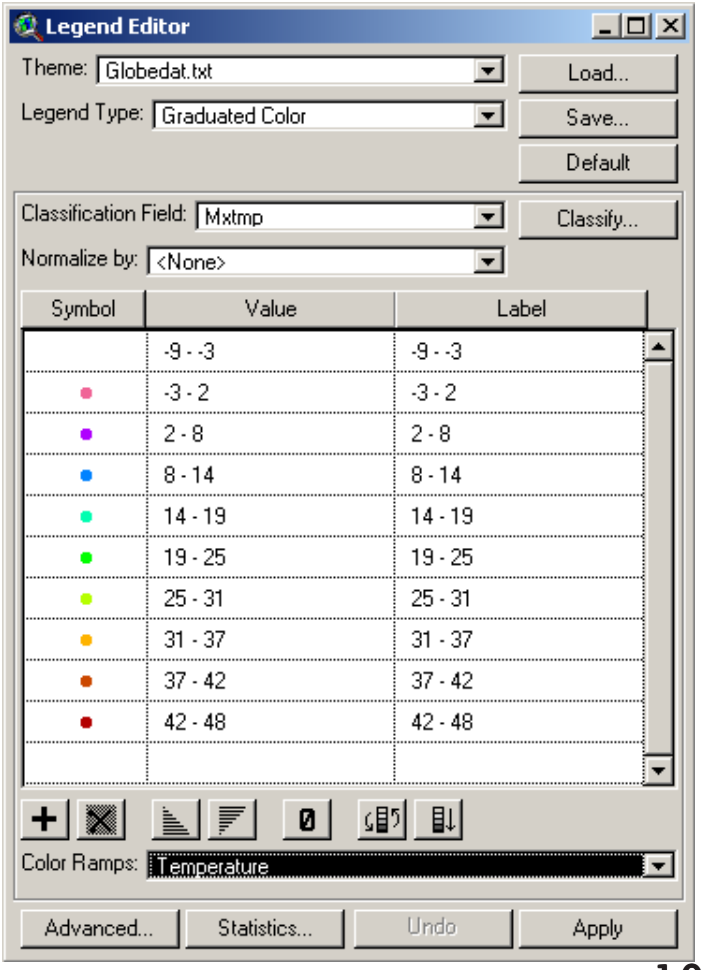
- Your **Classification** window should look like the one below.



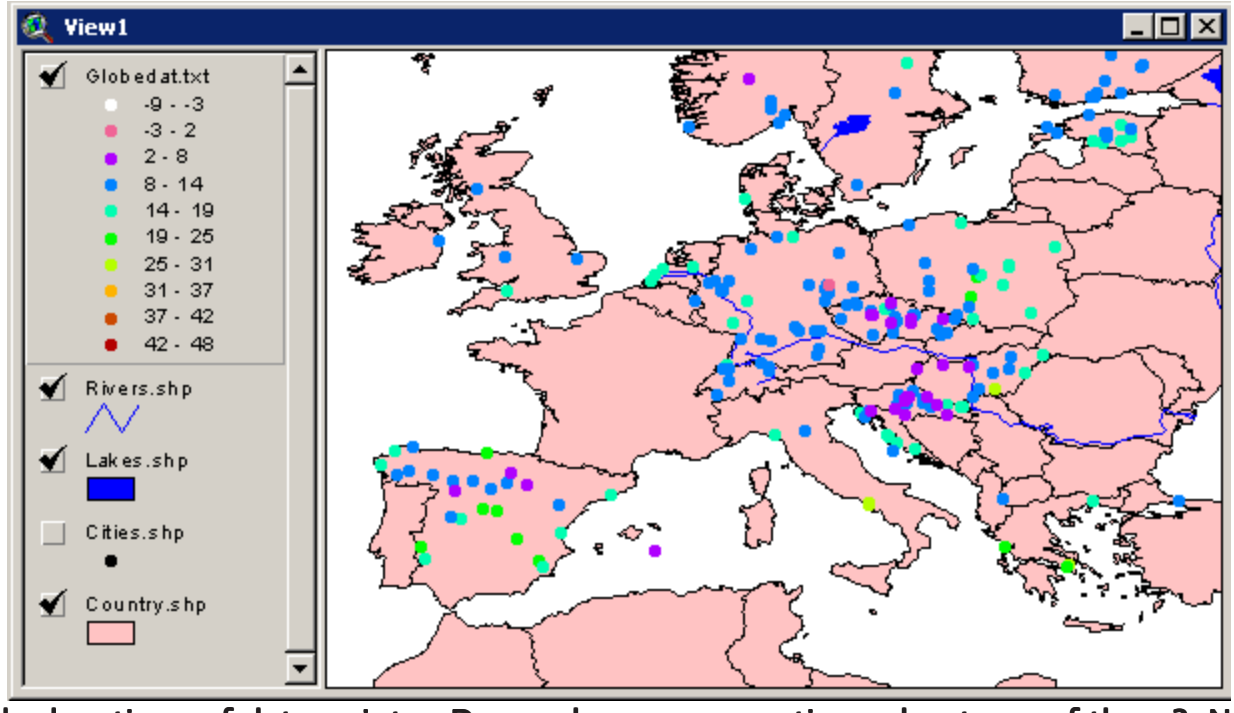
- Click **OK** in the **Classification** window.

- Notice that the **Color Ramp** may have reverted to Monochromatic Red.
- Change the **Color Ramp** back to **Temperature**.
- Click **Apply** in the **Legend Editor** window.
- The **Legend Editor** should now resemble the one to the right.
- Close the **Legend Editor**.
- The legend in the **View Table of Contents** window should now resemble the one shown to the right. Temperatures are rounded to the nearest whole degree, and are in classes of equal range.





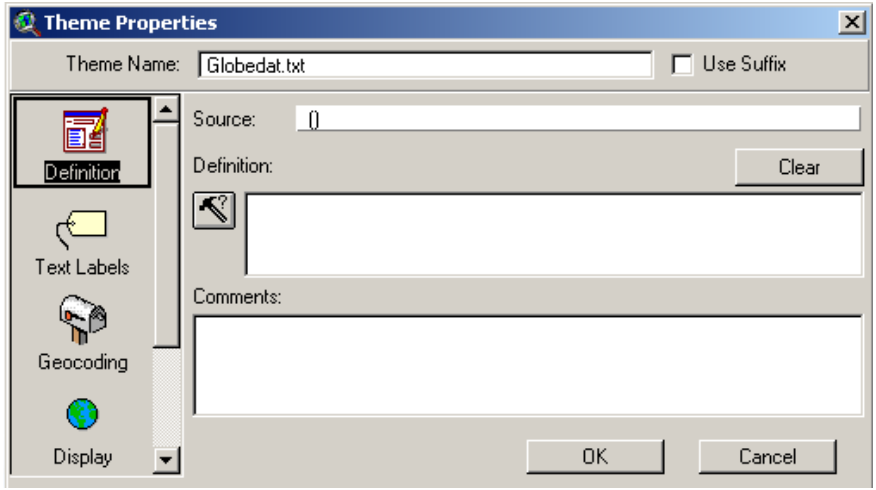
- Your **View** window should resemble the one below.

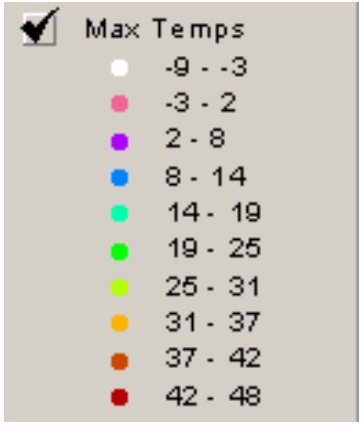


Observe the locations of data points. Do you have any questions about any of these? Notice that some points appear to be plotted out in the ocean. What is the cause of this error? Is it errors in site definition? Are they typographical errors or errors in the GPS measurements? Are they errors in the *country.shp* file provided with ArcView? How could you and your students find out?

Your new theme displays maximum temperature, but is still named *globedat.txt*.

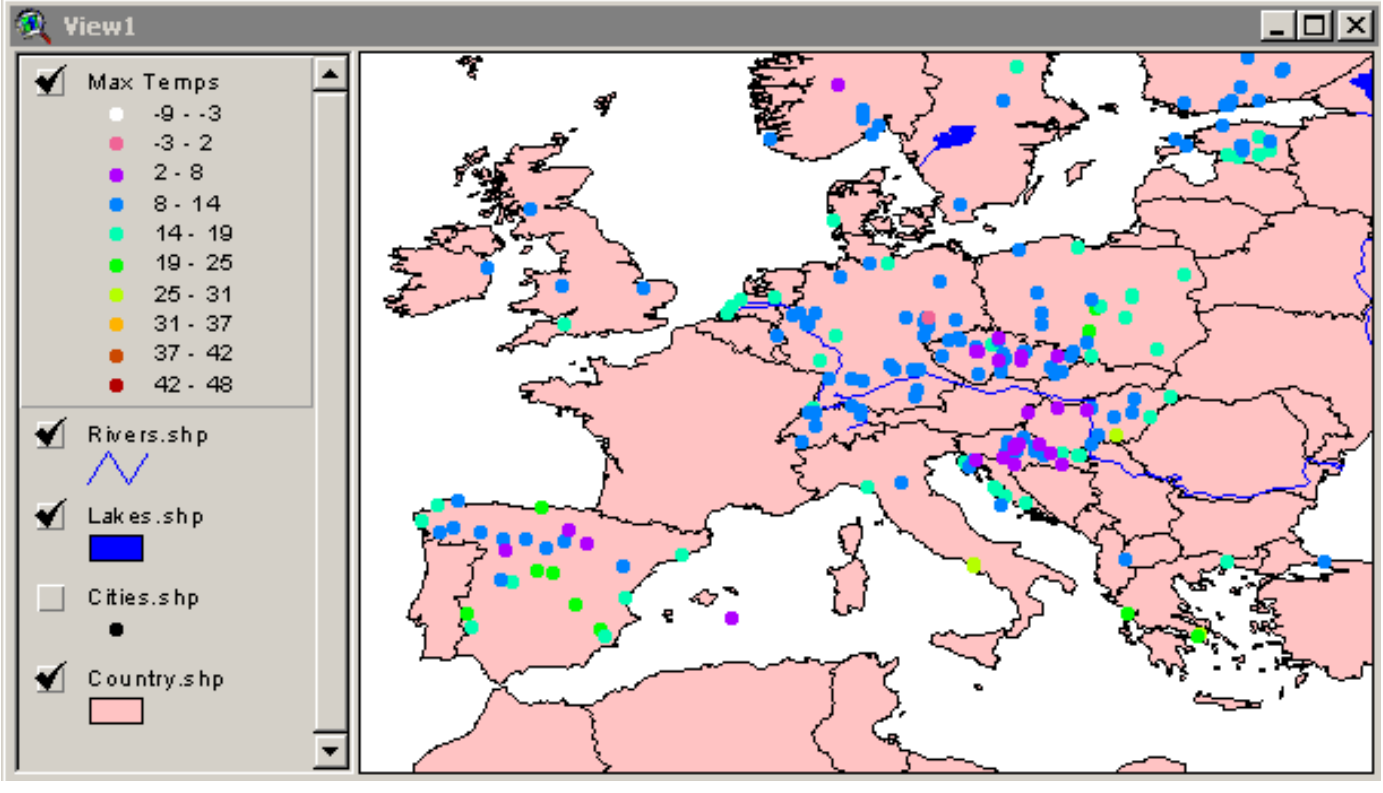
- Make the *globedat.txt* theme active.
- From **Theme** in the main menu, select **Properties**. The **Theme Properties** window opens, shown at the right.





- Change the theme name by entering **Max Temps** in the **Theme Name** box.
- Click **OK.**
- The legend now is labeled to properly describe what is being shown (left).

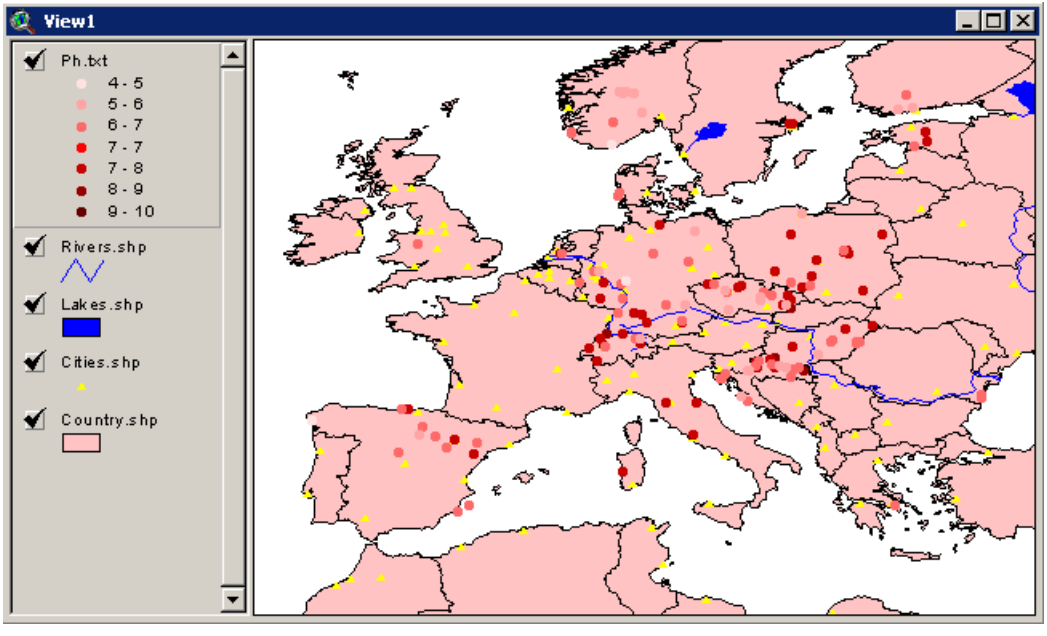
- Your **View** now shows the GLOBE data as a color coded theme, in 10 equal classes.



- Remember to save your project. You can now create a **Layout** and either **Print** or **Export** it.

What Other GLOBE Datasets Can I Use?

All GLOBE data are downloaded in the form of tab-delimited text files and can be brought into ArcVoyager as Event Themes using the process outlined in this chapter. The figure below shows the result of importing pH values for April 11, 2002.



The pH data were classified to 7 classes because the reported range in the table was from pH 4 to 9+. The Monochromatic Red Color Ramp was used. The cities are represented by the yellow triangles.

Is there any pattern to the distribution of pH values for this map? What other information might you need to help you answer this question? Are the pH values related to the proximity of a site to a city? Does topography play a part? How could you find out?

Presenting data in a visual, geographically-related form allows students to develop their own questions for investigations, and helps them to visualize other types of data they may need to answer their questions.

Chapter Summary: In this chapter, you saw how to download GLOBE student data from the GLOBE server and incorporate those data as an event theme in ArcView. You also saw how to use the Legend Editor to change the nature of the data display.

What is Next? Upcoming chapters will cover locating other sources of GIS data, and using satellite images as themes in a View.

Chapter 7: Other Data Sources

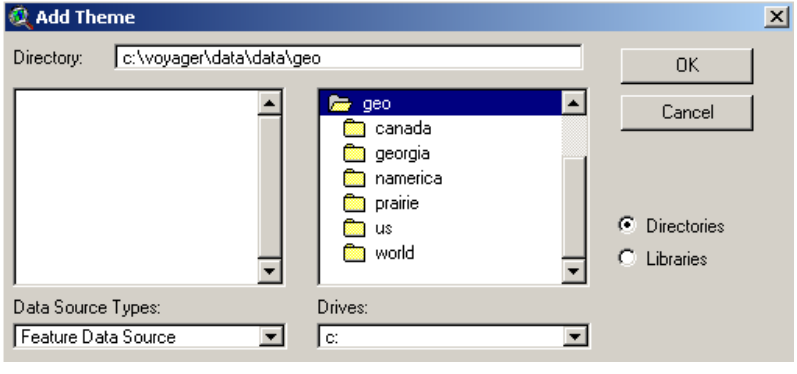
So far the data sets you have worked with have been *small scale*. That is: Objects on the map appear small. Another way to think about this is that one unit on the map covers a large area on the ground (ex: 1:500,000). Such maps cover large areas and are limited in detail. On a large scale map, one map unit covers a small area on the ground (ex: 1:25,000) and shows more detail.

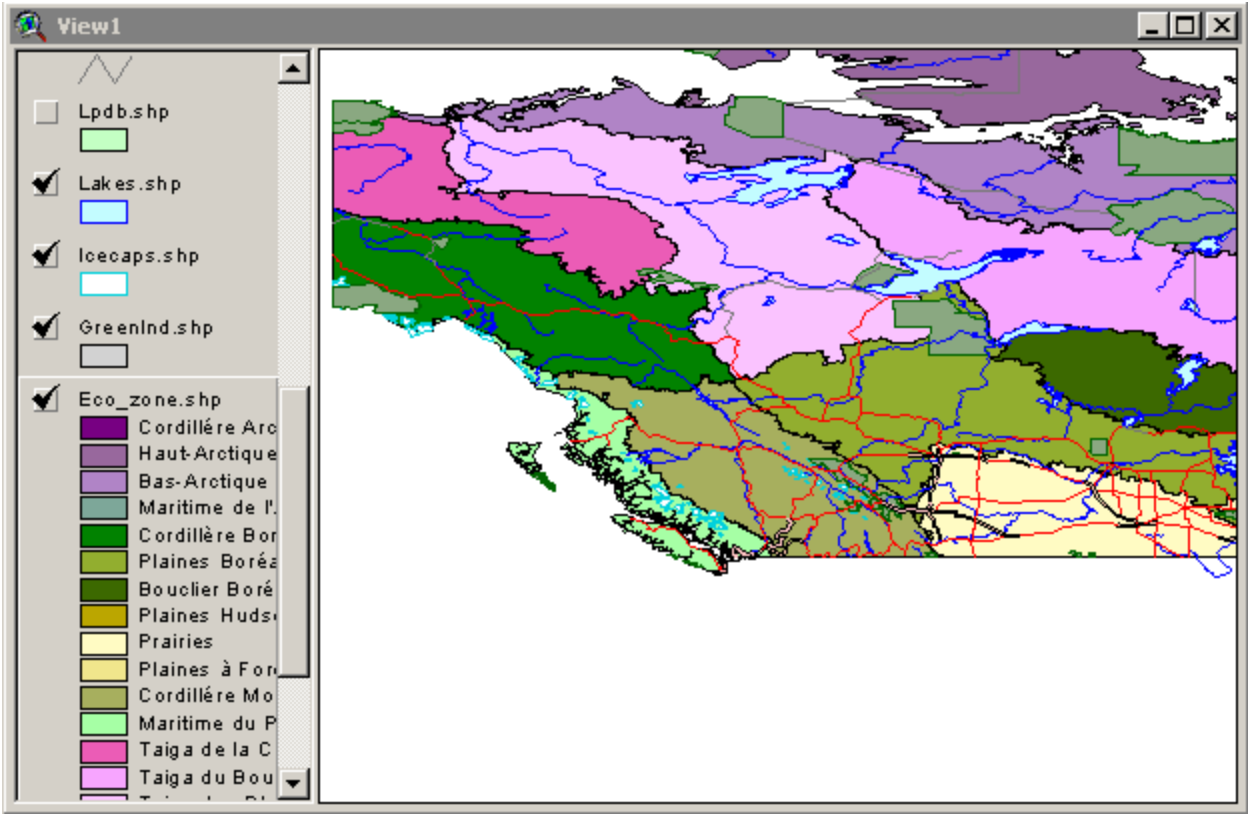
Objectives

- Investigate data sets provided with ArcView
- Investigate other data sets provided with ArcVoyager
- Incorporate ArcView's images into GIS projects
- Become familiar with some types of GIS data available from other sources

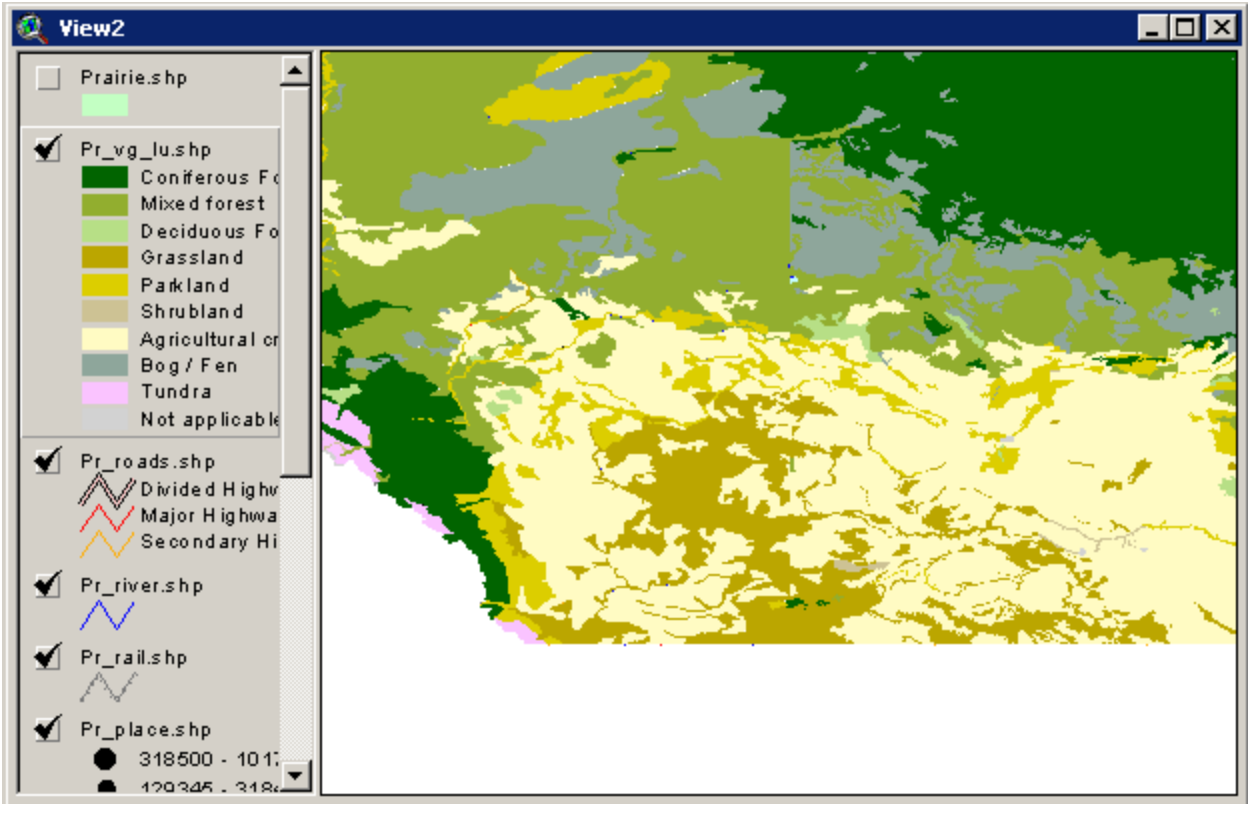
ArcVoyager's Data Sets

ArcView is a professional GIS package. The example data sets included with it are very limited. Because ArcVoyager is designed as an educational tool, many data sets are supplied with it. You may wish to download the ArcVoyager data sets to explore them. Some examples of projects using these files follow.

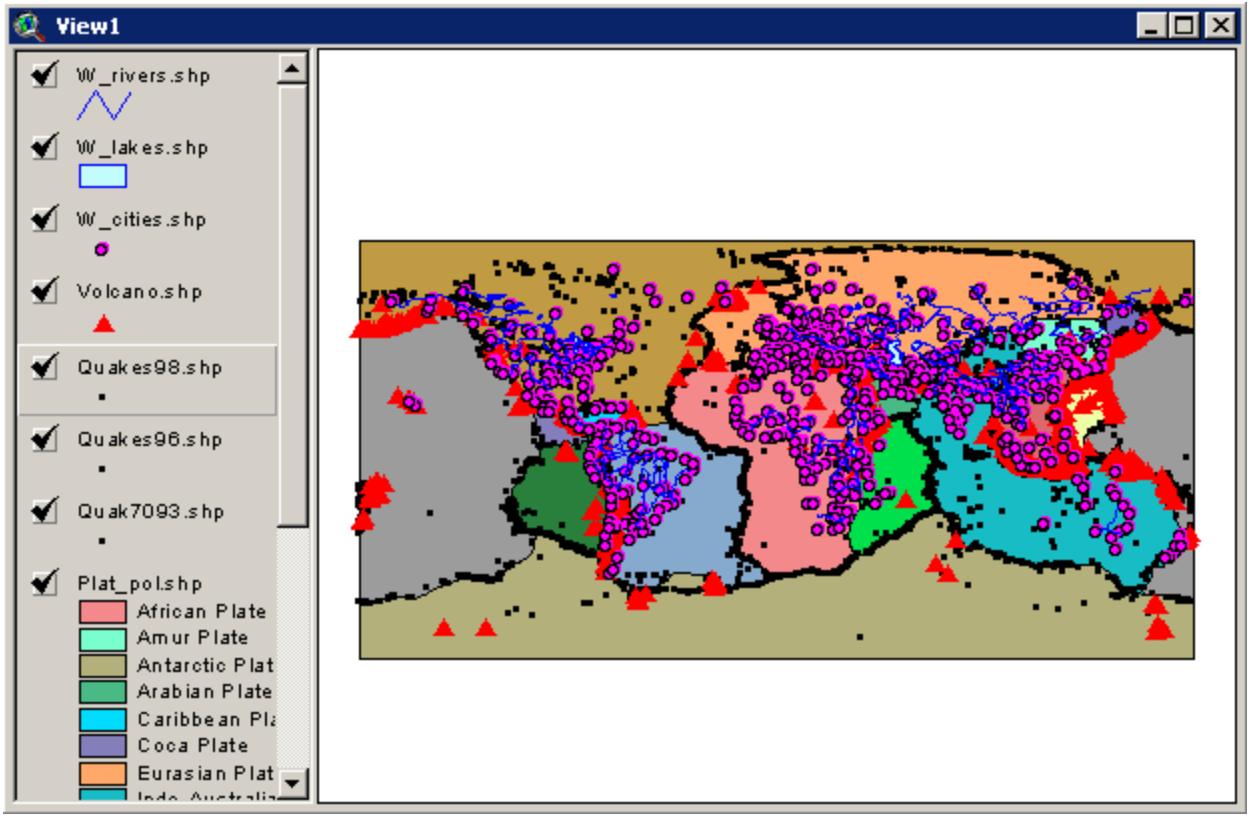




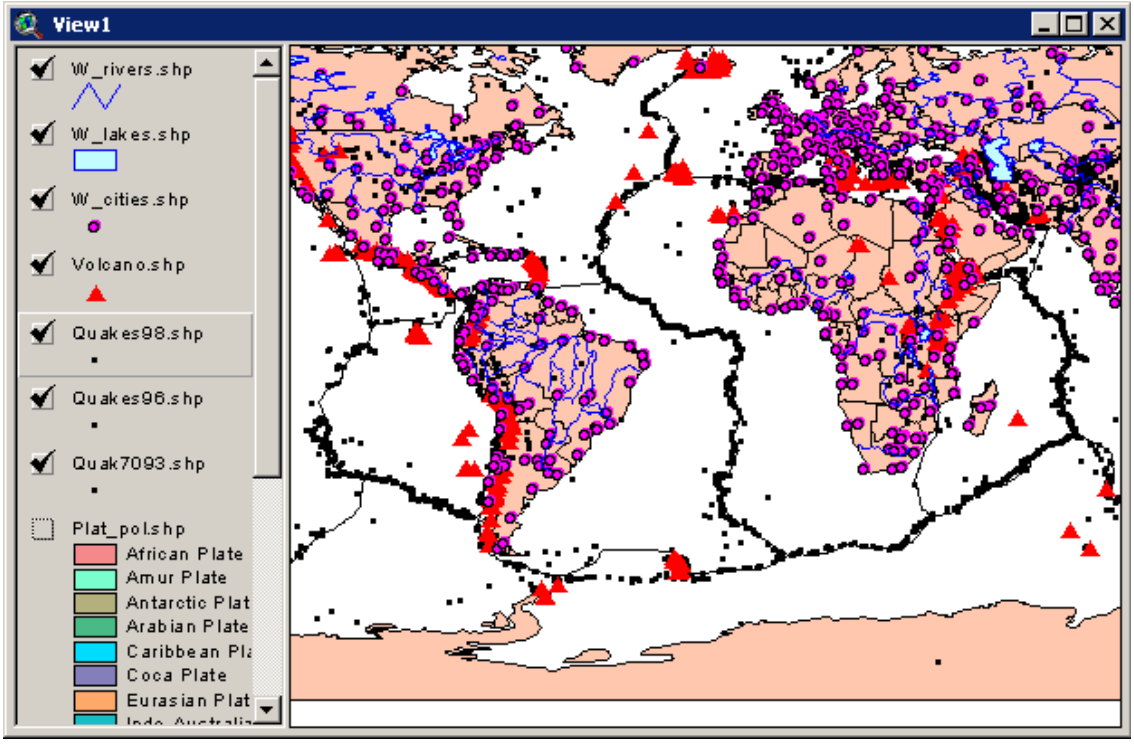
Using data from the *Canada* folder, the ecological zones of Canada can be investigated.



Data from the *Prairie* folder shows the land cover types of the central prairies of the United States.



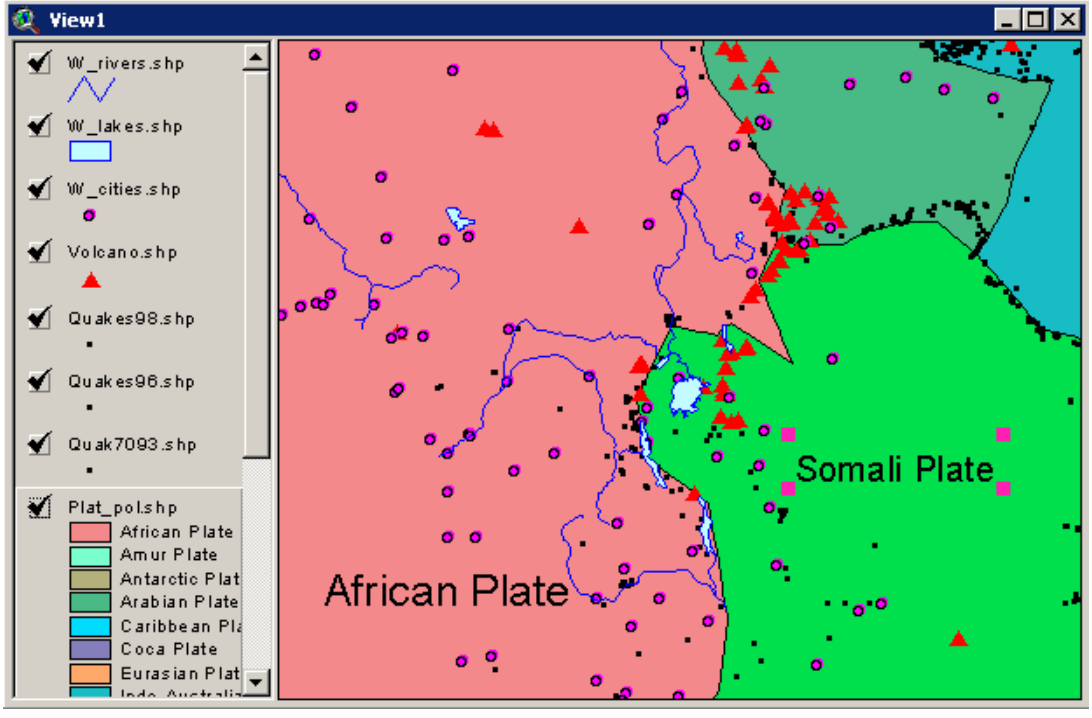
Data from the *World* folder shows the relationship between the Earth's tectonic plates, volcanic eruptions, and earthquakes.



This view of the Mid-Atlantic Ridge, which shows plate boundaries, volcanoes and earthquakes, helps students visualize the actions occurring along our planet's tectonic boundaries.

All of these views can be created using the ArcView tools you have learned so far from the data contained in ArcVoyager's *geo* folder.

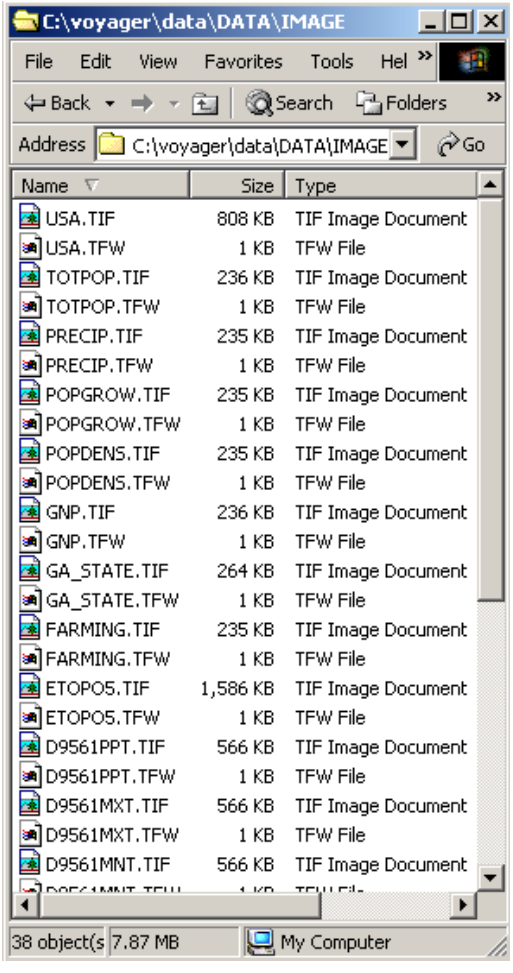
The Answer to a Question:

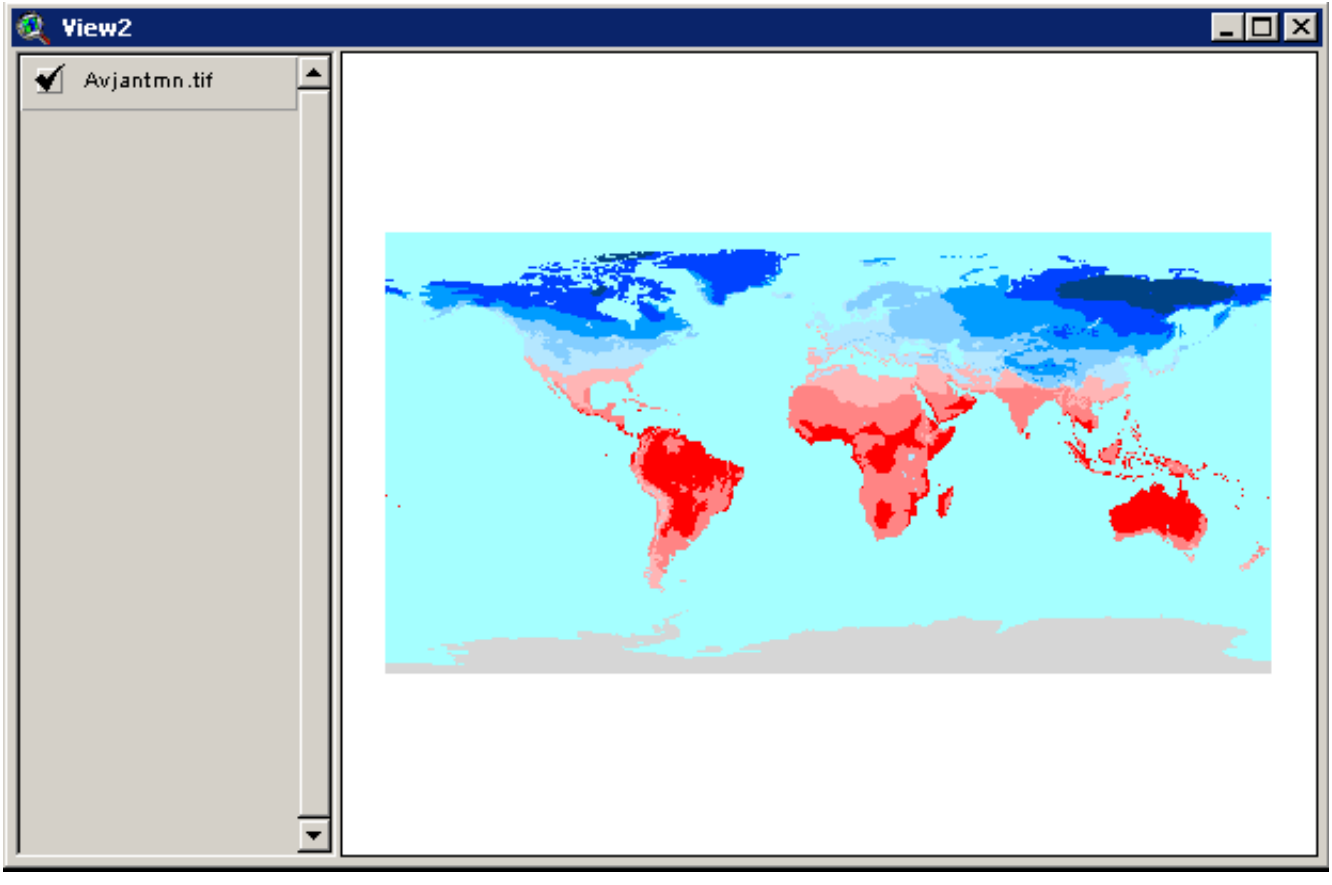


This is the view of Africa you used in Chapters 4 and 5. Lakes Tanganyika and Turkana lie in the great Rift Valley of Africa. This valley is being created as the African and Somali plates move apart. It is similar to the Mid-Atlantic Ridge, except that it is tearing a continent apart instead of an ocean floor. It may be the site of a future ocean.

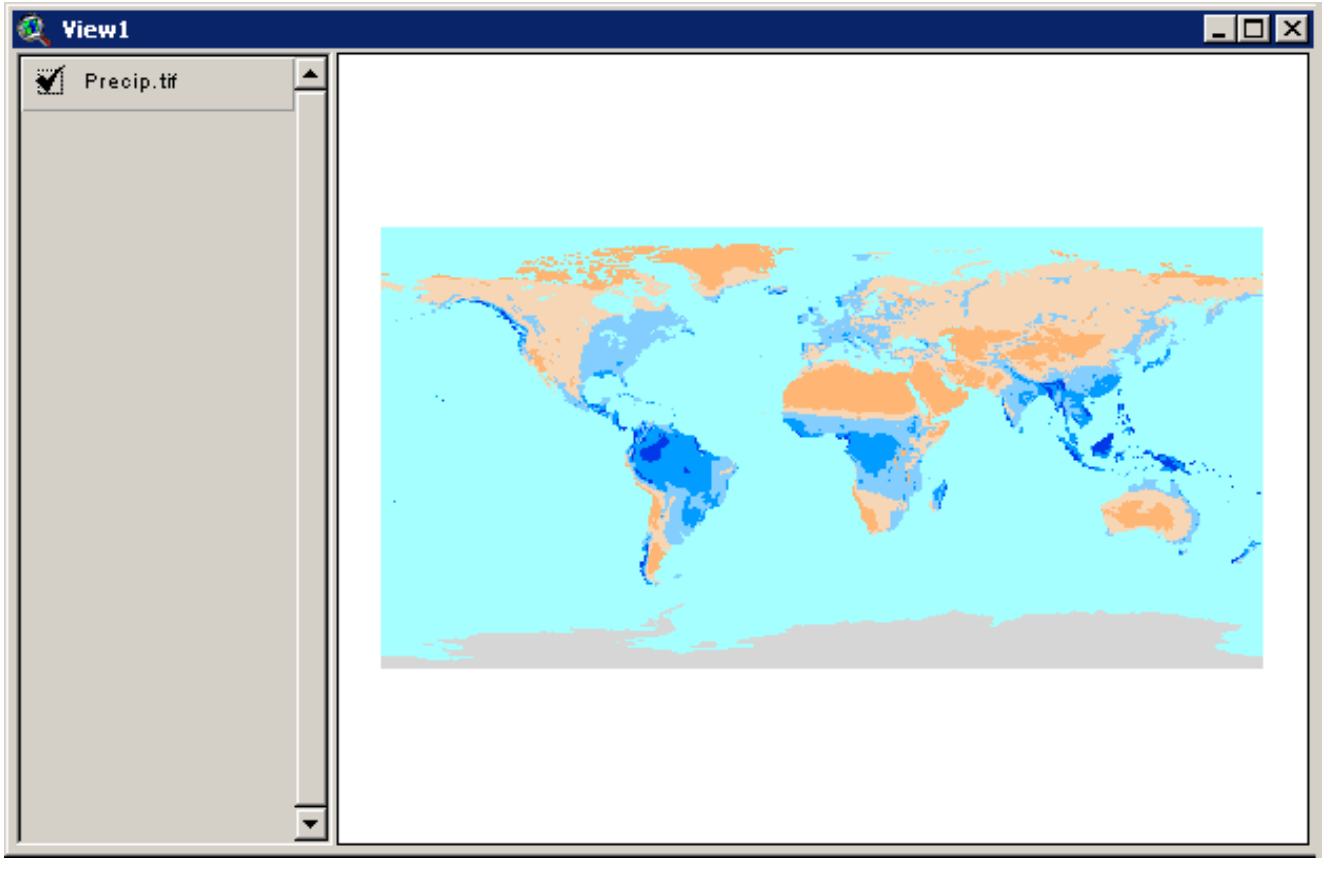
Using ArcVoyager Image Data in ArcView

In addition to the world data files, ArcVoyager's data also contains a folder of *images*. Part of this image listing is shown to the right. Each of these images is provided as a *TIF* file. This is a common graphic format. Note that each is accompanied by a *.TFW* file. This is a *World File*, which contains the georeferencing data needed to place the image in ArcVoyager.



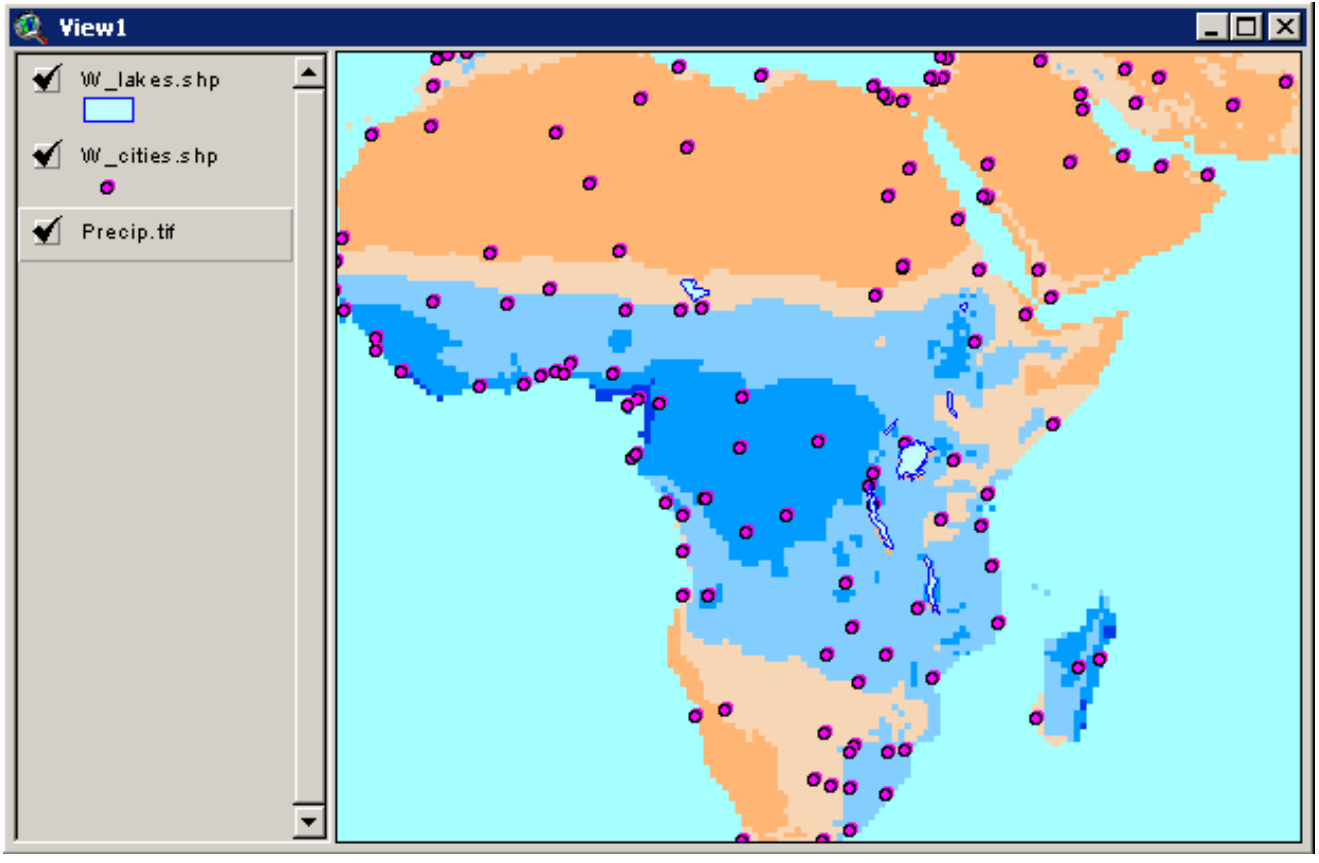


Average World Minimum Temperatures for January

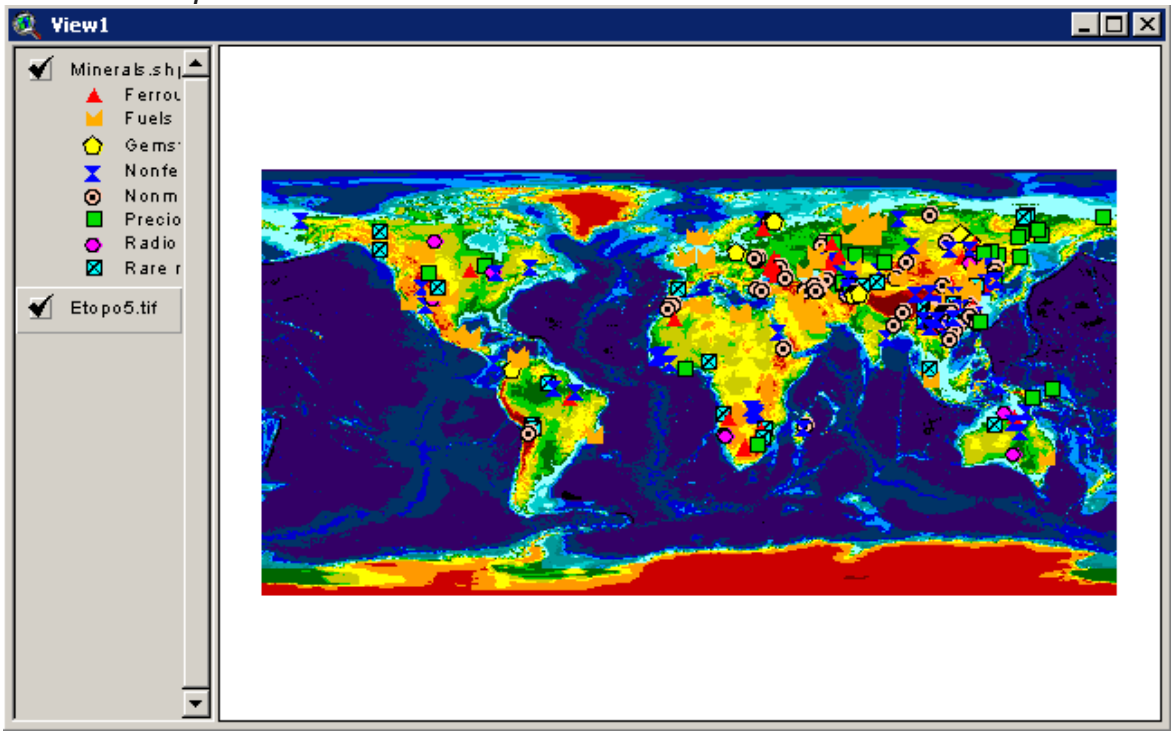


Average World Precipitation

The view below shows the world precipitation image used as a base layer for world lakes and cities zoomed in on Africa.



The visual below was produced from one of the *.TIF* files in the Image folder, and the *minerals shape file* from the world data file.

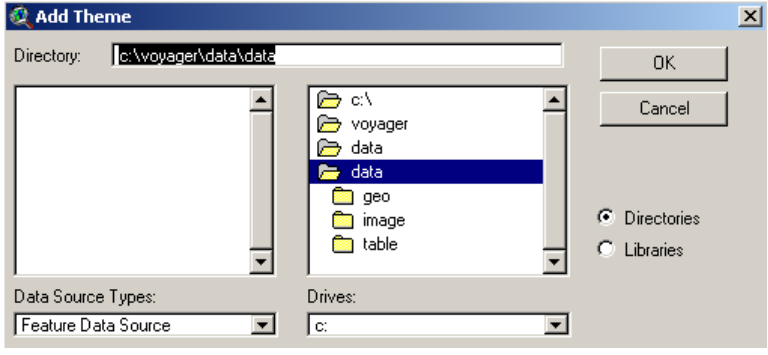


From this image, and other data available, can you relate the location of mineral deposits to any other world features?

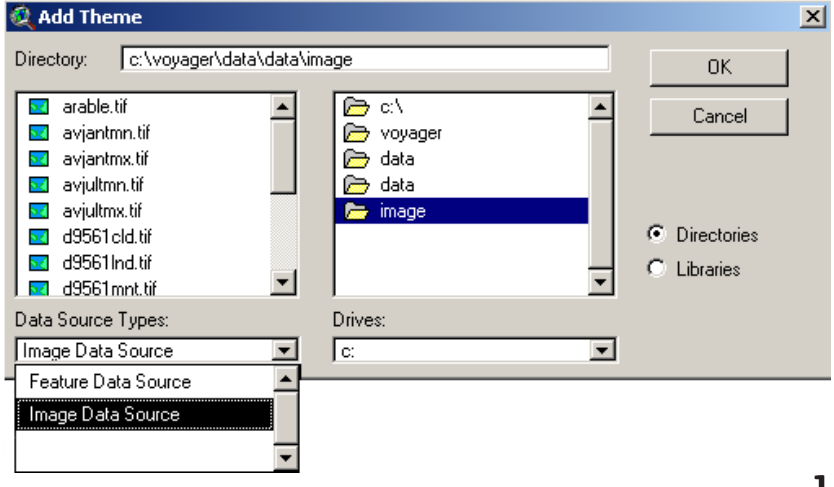
How Do I Use These Images in ArcView?

To incorporate one of these images in a view:

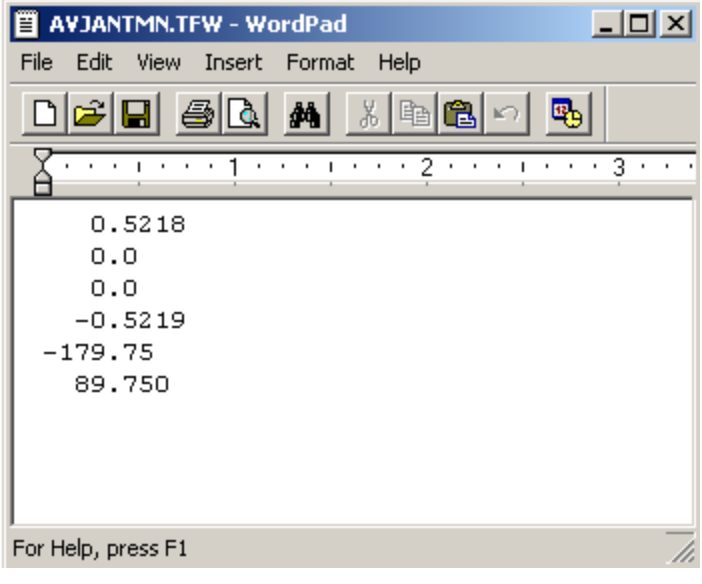
- Be sure your **View window** is active.
- Click the **Add Themes** button, and navigate to your Voyager *images folder*.
- **Open** the folder. It appears empty.



- From the **Data Source Types** pull-down menu, select **Image Data Source**.
- The images available appear in the **Data sources** window.
- You can select these images just as you would a shape file. They will appear like any other theme in your **View Table of Contents** window. Note that the *.TFW* (world) files are not shown in the **Data sources** list. These provide georeferencing information only.



- The visual below shows the contents of the *TFW* file for the *January minimum temperatures* image. It is a simple text file and can be opened in any word processor. This file contains data on latitude, longitude and pixel size and it is read by ArcVoyager to establish locations. With the appropriate data, you can write world files to use many different images in ArcView.



The lines of the world file provide the following data:

- Horizontal size of a pixel
- Rotation term for a row of pixels
- Rotation term for a column of pixels
- Vertical size of a pixel
- Longitude of the center of the upper-left pixel
- Latitude of the center of the upper-left pixel

External Sources of GIS Data

There are many sources of GIS data besides those provided with ArcView and ArcVoyager. Some are World Wide Web based and others may be found locally. A list of some types of local sources of GIS data is given in Appendix I.

The balance of this chapter will be devoted to GIS data that can be downloaded from the Internet.

GIS on the Internet

There is a vast number of World Wide Web sites that provide GIS data in one form or another. Searching for "GIS data" with your favorite search engine will produce many pages of listings. This tutorial will not try to list any significant number of these, but will deal mostly with how to handle some of the various forms of data that they provide. A short list of reliable sources is given in Appendix I.

Drawbacks to GIS Data on the Internet

There are several significant drawbacks to obtaining data on the Internet.

a. Many data files are large, even when compressed, and require long download times on a dial-up connection. If you must use a dial-up connection, you can often request these files on compact discs at a reasonable cost. A university contact may be of help here, too, as universities have faster internet connections.

b. Not all GIS data files are provided in the same geographic **projection**. This will be dealt with as you look at some sample data.

c. Files that you download may not have the same precision in their **registration**. There may be significant differences (up to tens of meters) between a feature's location in a file and its actual location on the ground. This is generally a function of the accuracy and precision of the data that were gathered to prepare the file.

What Kinds of Files are Available?

Some of the common GIS files available for download include:

- *Shape Files* and *Database tables*, similar to those you have already used
- *TIFF* format images, either with external world files, or as *GEOTIF* files, with built-in location data.
- *Digital Line Graphics (DLG)* files: These are usually scanned topographic maps that contain spatial data. They can be used as a base layer for other themes. These are large files which, depending on their scale, cover relatively small areas.
- *Digital Orthographic Quadrangle (DOQ)* files: These are generally scanned aerial photographs, often with 1m resolution. These are large files that cover a small area in great detail.

Downloading *DLG* and *DOQ* files can be a frustrating and time consuming process if you are using a dial-up connection. If you wish to incorporate these types of data, you should try to find a contact who can supply these on compact discs (CD's).

Handling the Data Once You Have Downloaded It:

Generally the data you download are compressed in some fashion. At the simplest level they will be in the zipped format. Your PC should have extraction software built in while *Stuffit Expander* for the Macintosh will unzip such files.[1]

You will sometimes receive files with the extension *.tar*. These are files compressed with a Unix operating system. *Stuffit Expander* for the Macintosh and PC will decompress these files.[1]

Often GIS shapefile data are supplied in a file format that contains the extension *.e00*. This is an *Arc/Info Interchange* file. Arc/Info is the software used to produce these data files. These files must be imported into ArcView using an ESRI utility program called *Import*. If *Import* is not installed on your computer with ArcView, it is available as a free download for both Macintosh and PC computers.[2] If you need to Import *.e00* files, see **Appendix II: Importing Arc Export (E00) Files** for details of the process.

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1. A free version of Stuffit Expander can be downloaded from Aladdin Co. at: http://www.aladdinsys.com/downloads/index.html

2. The Import utility can be downloaded for Macintosh or PC computers from the ESRI site at: http://gis.esri.com/download/index.cfm?fuseaction=download.all

Using A Sample Data Set

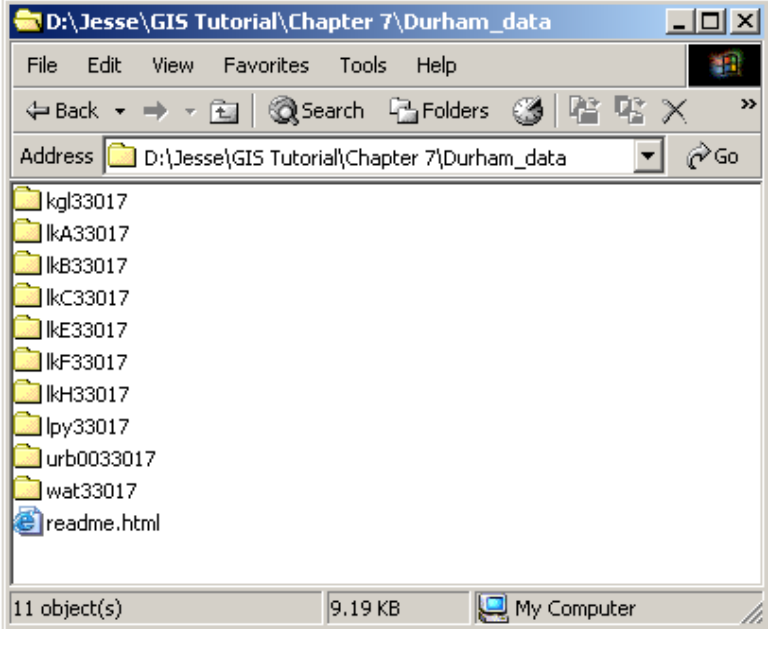
This section of the tutorial will use a sample dataset for Durham, New Hampshire. These data will also be used in Chapters 8, 9 and 10. The full set of data for these chapters may be found on the available CD. The data are contained in the Ch_7Data folder.

These files were downloaded from the U.S. Census Bureau's TIGER/Line® site at:

www.census.gov/geo/www/tiger

The Census TIGER data in shapefile format are used courtesy of ESRI.

Users outside the United States should search for GIS data sites within their own countries, provinces or states. See **Appendix I** for further information.



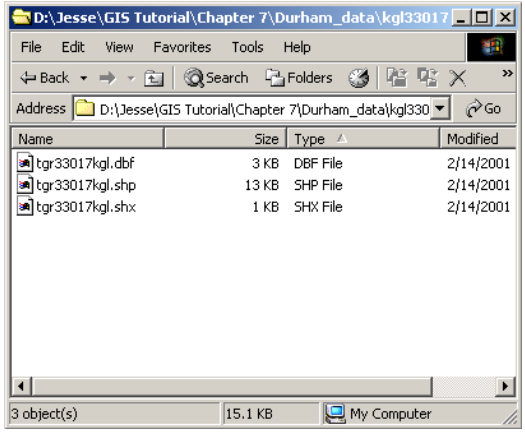
What Do The Files Contain?

The files are in the *Chapter 7* folder labeled *Durham_data*. Its contents are shown to the right.

Each folder contains the files for one theme, in a code used by the Census Bureau. The three letters identify the theme according to the following:

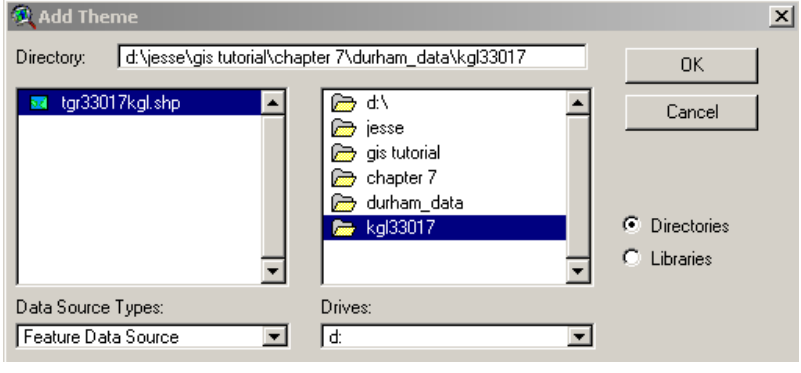
Code	Theme
kgl	Key Geographic Locations
lpy	Landmarks
lkA	Roads
lkB	Rails
lkC	Misc. Transport
lkE	Physical
lkF	Non-Visible
lkH	Hydrography
urb	Urban Areas
wat	Water Polygons

- Opening the *KGL* folder shows the shape files and database table that are provided.

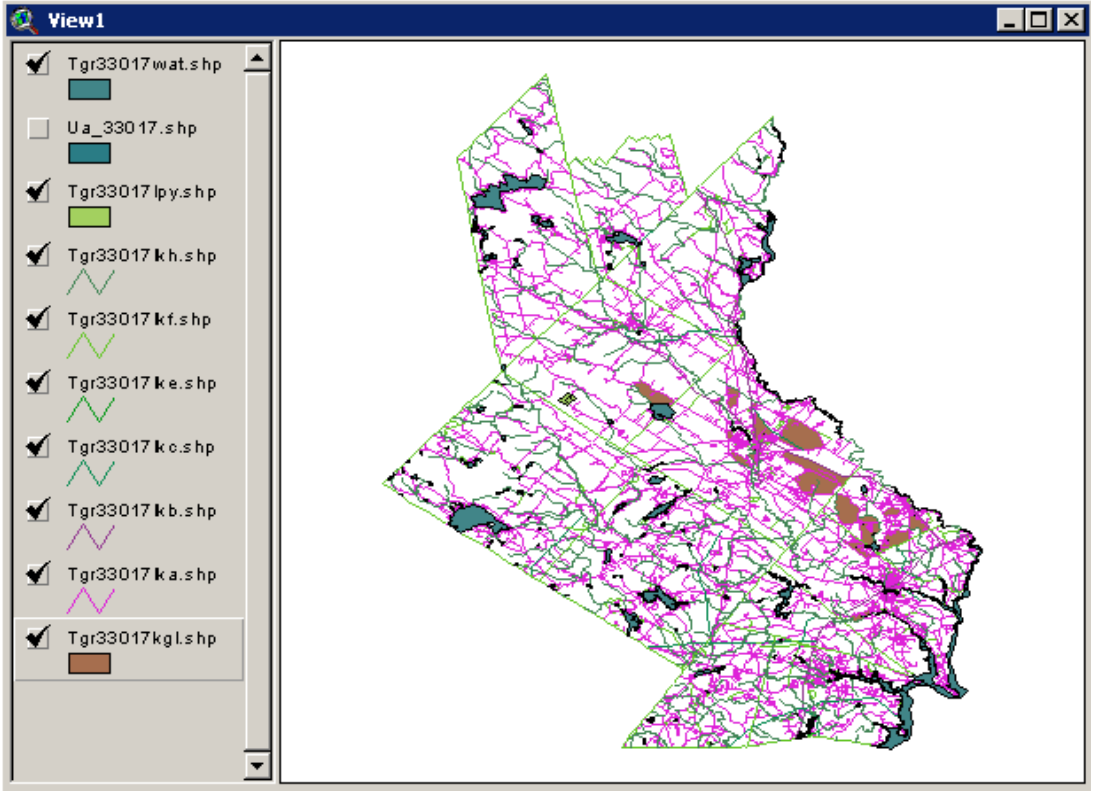


Using These Files

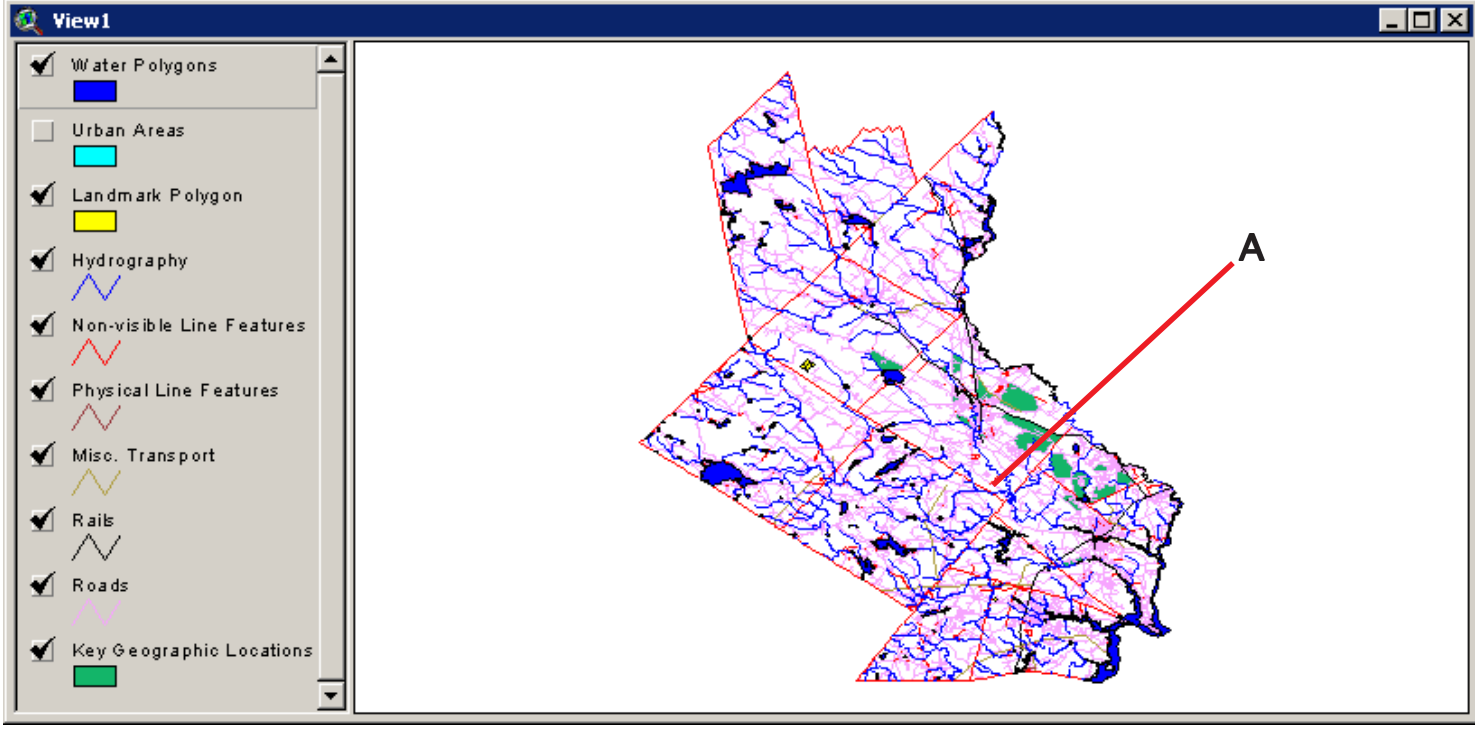
- Launch ArcView and create a new project.
- Don't forget to set your working directory.
- Use the **Add Themes** button to access each of the themes. You will notice as you open each folder that only the *.shp* file (shape file) is shown.



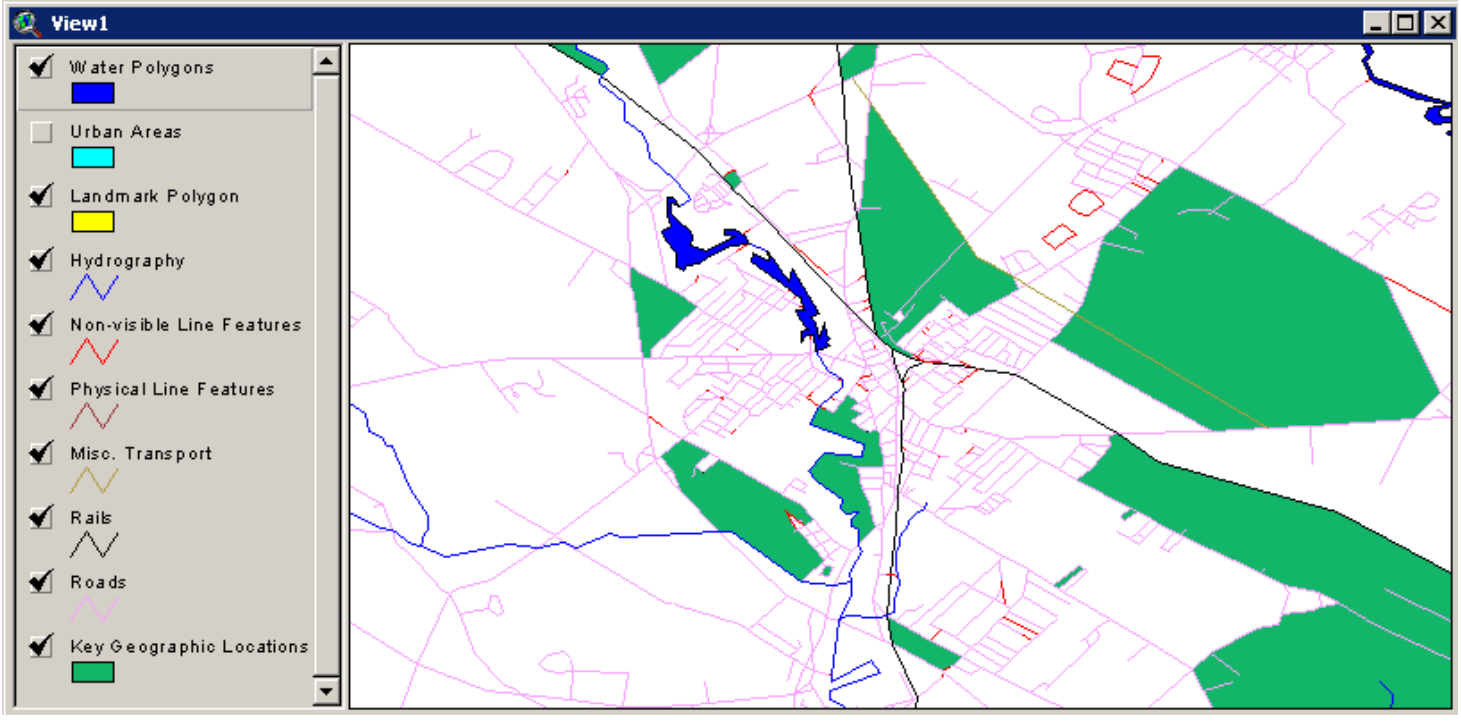
- After you have added all the themes your **View** window should resemble the one shown below. Remember that ArcView colors the themes in its own way. The colors do not reflect what the theme represents.



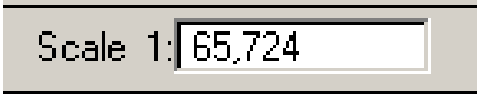
- You may wish to relabel and recolor the themes. The figure shows one possible way of coloring and labeling these themes.



- Zoom in on the area shown by the letter “A” above.



- Note the scale of this view. The small number of this scale indicates that the view covers a small area, but in much greater detail than in the files provided with ArcView or ArcVoyager.



So far, these tutorials have not addressed the subject of data projection. Chapter 4 made a brief reference to projections, and it is now time to examine this idea in more detail. A projection is a mathematical way of transferring points on a sphere (the Earth) to a flat surface (your map or GIS project). There are many different types of projections, each one having certain advantages and disadvantages. No projection can accurately render all aspects of the Earth onto a flat map. Some show size and shape accurately, others show distances and directions. Except for a globe, no map can be accurate in all aspects.

The most commonly known projection is the *Mercator* Projection, used in most familiar world maps. The data you have been working with so far have been projected in geographic form, using standard longitude and latitude in the Mercator system. The GLOBE data you used in Chapter 6 are also Mercator projected and they are compatible with ArcView's data. Data that you gather with your GPS, as long as you are using GLOBE's WGS-84 standard[1], are also completely compatible with ArcView. With other data sources, this will not always be the case. Many states, provinces, countries or regions use specific projections, such as individual state projections in the United States, or Great Britain's National Grids. Before you try to use datasets, you should determine how they are projected.

ArcView can handle many different projections, but all your data need to be in the **same** projection. "Mix and match" does not work. ArcView has the capability to convert the projection of point, line and polygon data. The process is beyond the scope of this tutorial. See the Using ArcView GIS manual.[2]

Chapter Summary: In this chapter, you have seen that there are other sources of GIS data that can be incorporated into ArcView. There are many sources of such data on the Internet, but many data types are represented by very large files and need a fast connection to download. Also, the projection of the data must be considered.

What Comes Next? In Chapter 8 you will create event themes and shape files from GPS data you have gathered locally, and Chapter 9 will deal with incorporating your GLOBE Landsat image as a theme in a GIS project.

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1. See the GPS section of your GLOBE Program Teacher's Guide

2. Using ArcView GIS, ESRI, 1996

Chapter 8: Creating Your Own Data

You have been working with data prepared by someone else. The value of GIS lies in the ability to include your own data as a theme in a project. Such data might include:

- the locations of local sites with endangered plant or animal species.
- local cemeteries.
- historical sites.
- students' homes.
- the location of your GLOBE study sites.
- or any other geographically-referenced feature the could be the subject of student investigations.

Objectives

- Prepare a text formatted data table of "local" point locations.
- Add this table to a View as an Event Theme.
- Convert this Event Theme to a Shape Table.
- Prepare a Text Table with the boundaries of a Polygon Theme.
- Add this Table to a View as an Event Theme.
- Convert this Event Theme to a Shape Table.
- Change the appearance of this Shape Table.

The Data: For this project, you will use data from Durham, New Hampshire. You will prepare a table of locations on the campus of the University of New Hampshire and add this to your view as a shape file. In the second part of the project, you will use some data on property boundaries to add a polygon file to the same Durham data.

Part I - Point Sources of Data

In Chapter 6 you downloaded and incorporated GLOBE Program data. These data were in the form of a tab-delimited text file which you included as a point theme in your **View**. You will now prepare a similar file from scratch.

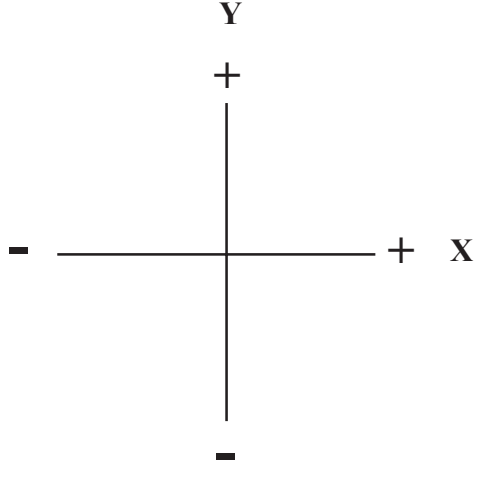
Assume that you have been out wandering the campus of the University of New Hampshire, which is in Durham, New Hampshire. Using your GPS unit, you have determined the locations of four important campus sites. You will combine these locations with the Durham data layers from Chapter 7.

Your notes for your walk are shown below.

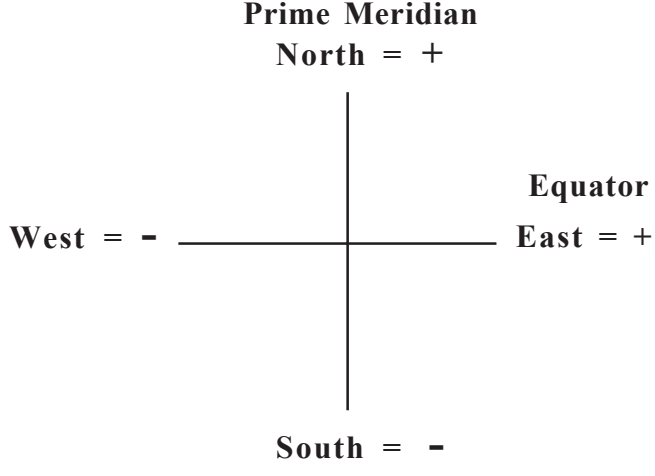
Site number	latitude	longitude	site name
1	43.13448° N	70.93633° W	Morse Hall
2	43.13614° N	70.93247° W	Thompson Hall
3	43.13464° N	70.93018° w	The Student Union
4	43.13602° N	70.93434° W	Vinny's Coffee

ArcView's Conventions:

In recording coordinates we generally include a degree symbol (°), and north, south, east or west notations. Neither is used in ArcView. If we are using a geographic (Mercator) projection, which is ArcView's default, ArcView assumes that the units are degrees. Direction is represented in a Cartesian system. This is the common graph format we are familiar with, (below) where positive and negative directions are given with respect to the intersection of the X and Y axes. In ArcView, the Equator and the Prime Meridian are the axes, and latitude becomes positive in the Northern Hemisphere and negative in the Southern Hemisphere. Similarly, eastern longitudes are positive, and western longitudes are negative.



Cartesian Graphing Conventions



ArcView Direction Conventions

Preparing The Table:

- Open your favorite word processing program. You may use any word processor, including Notepad for the PC and Simpletext for the Macintosh. The only requirement is that it utilizes the **Tab** key and save files as plain text. This includes almost all common word processors. Notepad and Simpletext are ideal for this because *.txt* files are their default format.

- Enter the data from the notes in your word processor. Between entries, press the **Tab** key **once**. This will tell ArcView where the column separators in the table are. **Do not** use spaces or multiple tabs to line up your entries. Press **Enter (Return)** at the end of each line. **Do not** include any special formatting, such as fancy fonts, underlines, boldface, etc. You may use either "latitude" and "longitude" or their abbreviations "lat" and "lon" for column headings. ArcView will recognize both.

Site number	latitude	longitude	site name
1	43.13448° N	70.93633° W	Morse Hall
2	43.13614° N	70.93247° W	Thompson Hall
3	43.13464° N	70.93018° w	The Student Union
4	43.13602° N	70.93434° W	Vinny's Coffee

- When finished, your table should look something like the one below. The actual spacing may vary depending on the word processor you use.

Data point	Lat	Lon	Name
1	43.13448	-70.93633	Morse Hall
2	43.13614	-70.93247	Thompson Hall
3	43.13464	-70.93018	Student Union
4	43.13602	-70.93434	Vinney's Coffee

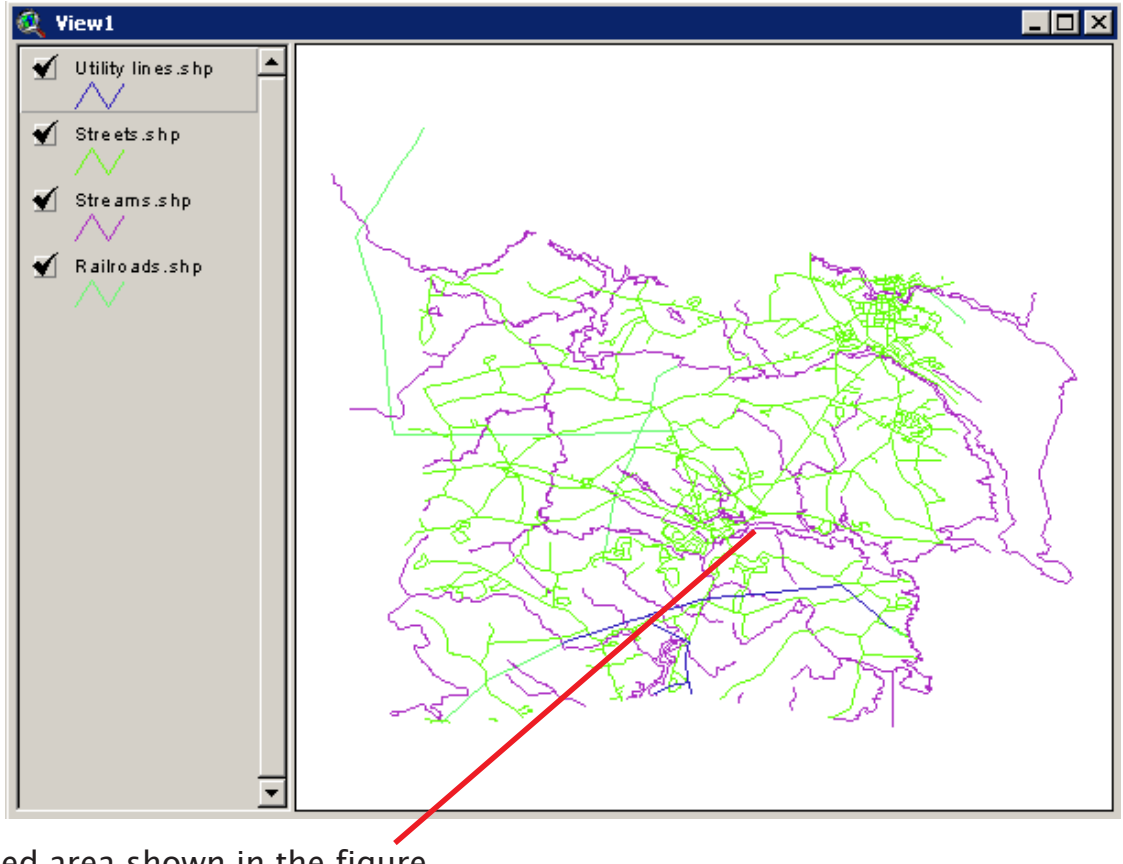
The fact that column headings do not line up with column entries is not important. ArcView will use the tab separators to create the proper alignment in the data table.

Save Your File

- From your program's **File** menu, select **Save As**. Name the file *locations.txt* and select "text" from your program's file format menu. (If you are using Notepad or Simpletext the file will automatically be saved as text.) This saves the file as a simple text file with no special formatting. Be certain that the extension *.txt* is appended to the file name and save your file in the \Chapter 8\Durham_sub folder that contains your Durham data layers.

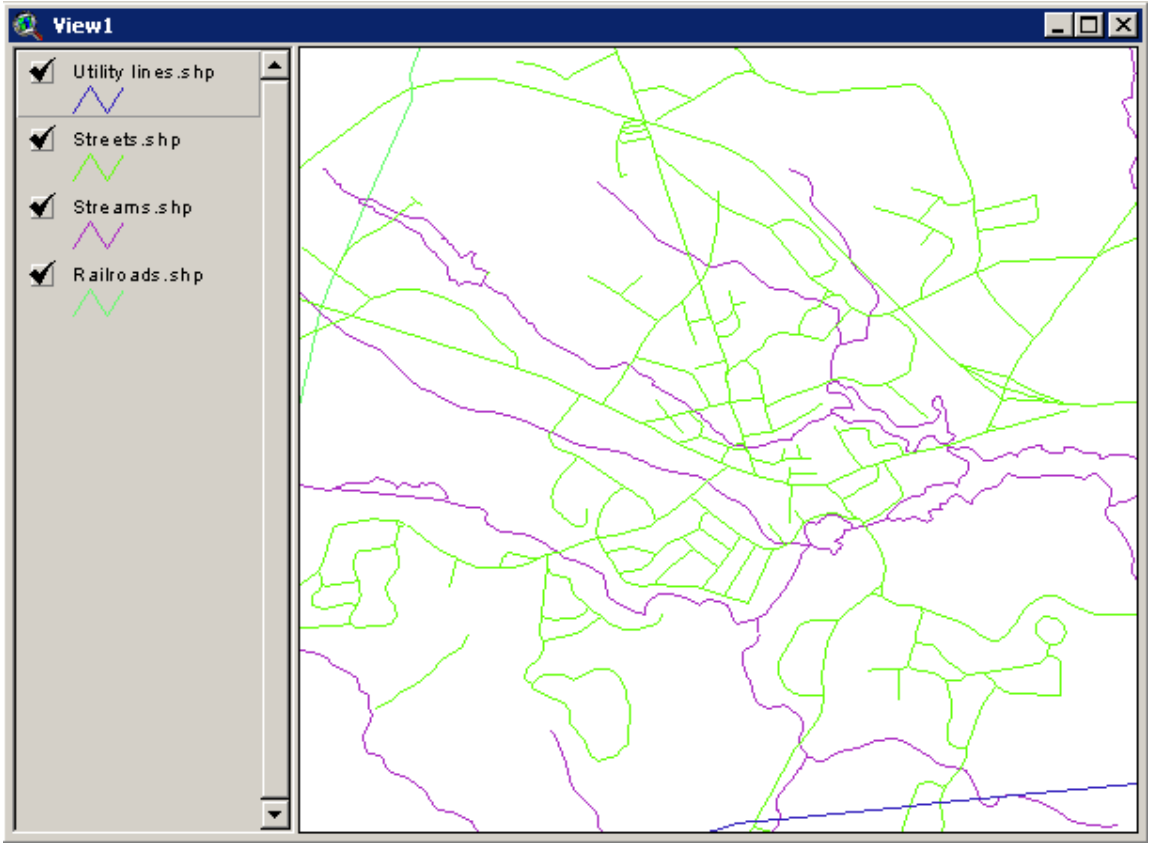
Including the Table in Your View

- **Launch** ArcView.
- Navigate to the *\Chapter 8\Durham_sub* folder, and add the files contained in it. For convenience, this is a subset of the data used in Chapter 7.
- **Zoom to the Full Extent** of the themes.
- Your view should resemble the one shown.

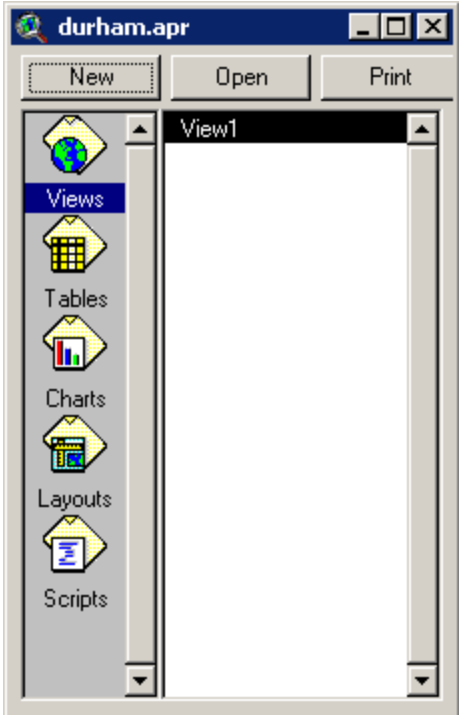


- **Zoom** in on the labeled area shown in the figure.

- Adjust your **View** until see the area shown below.

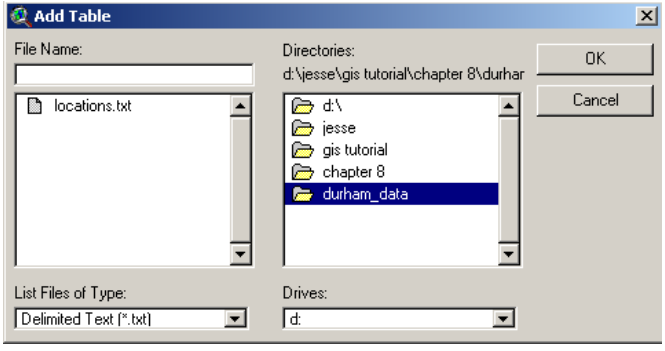


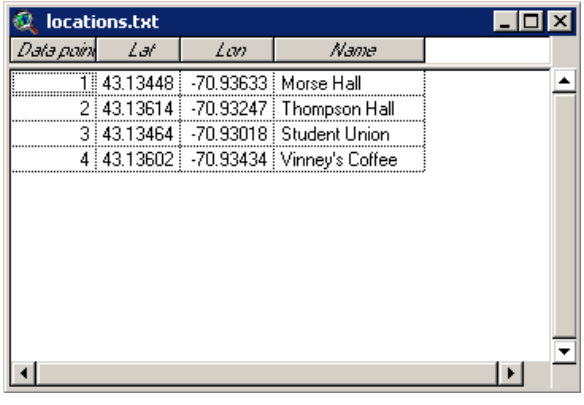
- Click on the **Project** window to make it active.



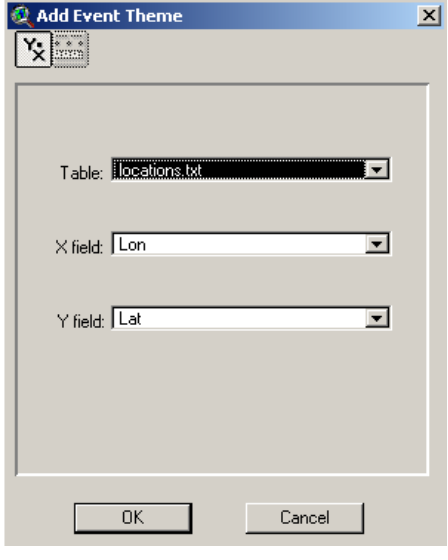
- Click the **Tables** button and then click **Add**.

- From the **List Files of Type** menu, select **Delimited Text**.
- Navigate to your data folder and select the *locations.txt* file you prepared. Click **Open**.
- Your table opens. Note that everything is in its proper column, because of the tab characters between entries.

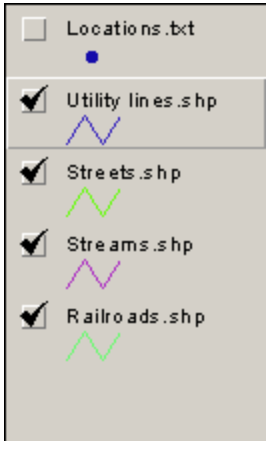




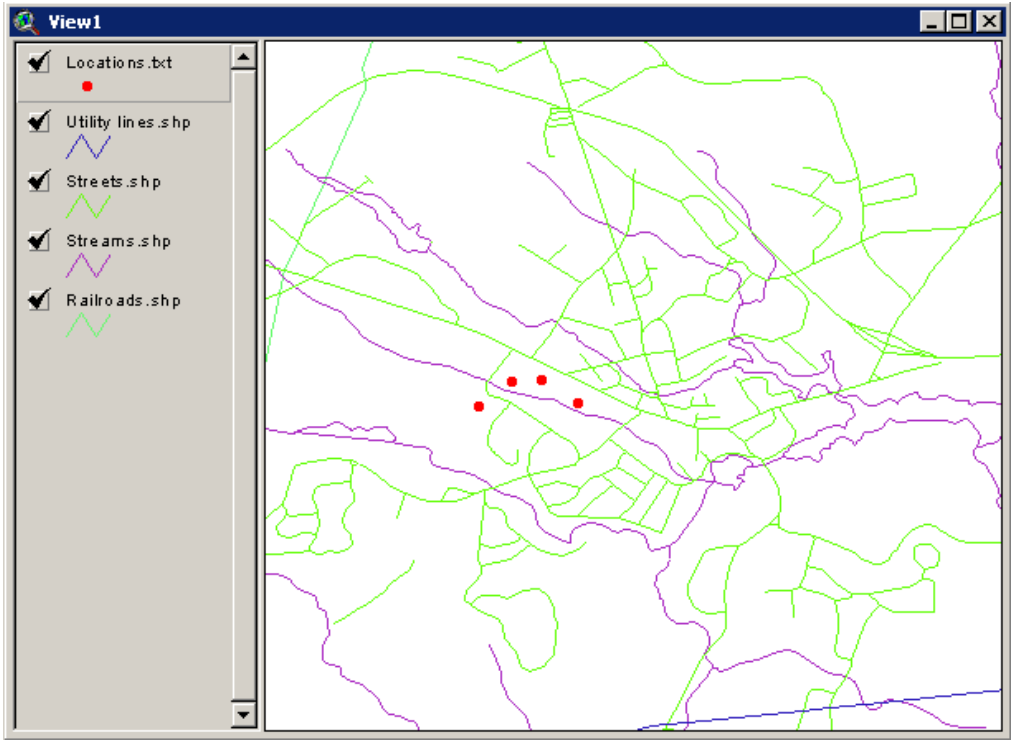
- From the **View** menu, select **Add Event Theme**.
- ArcView should automatically detect the file name, and select "lon" (or longitude) for the X Field and "lat" for the Y Field. If it does not, use the pull-down menus to select these values.
- In the **Add Event Theme** box, click **OK.**



- The **View Table of Contents** now shows your *locations.txt* file added as an event theme.



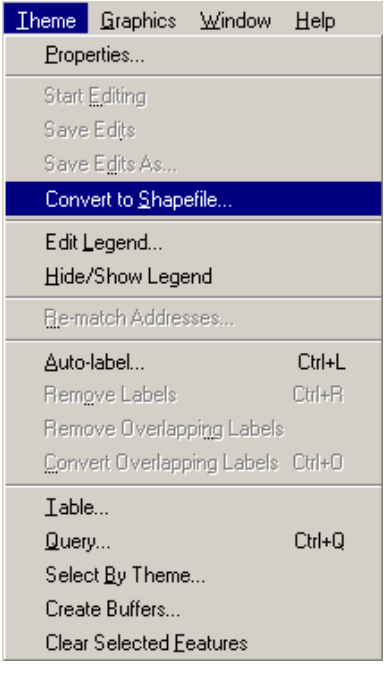
- Activate the theme and the campus locations appear. The author changed their color to red for contrast.

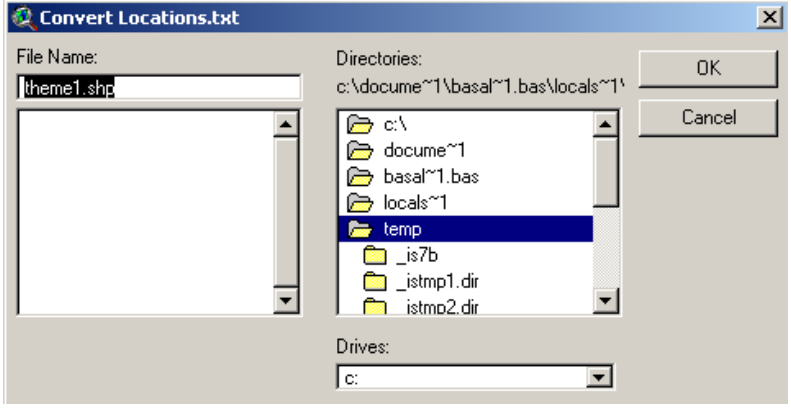


Converting the Locations Theme to a Shape File

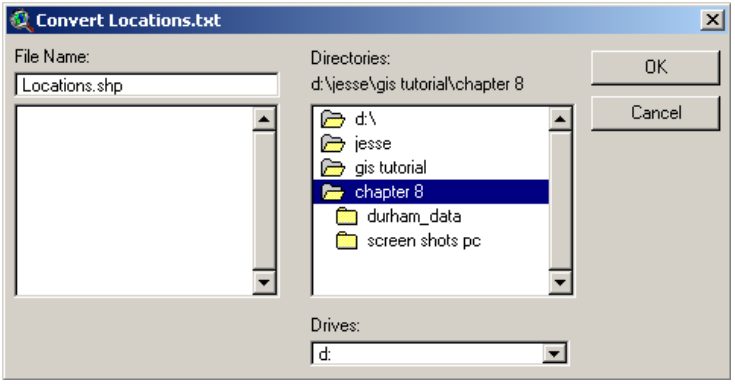
If you have a set of features that you want to work with, it is advantageous to convert them to a shape file. They can be a permanent part of your map and be worked with as any other shape file.

- Be sure the *Locations.txt* event theme is active.
- From the **Theme** menu in the main menu bar, select **Convert to Shapefile**.
- The **Save Shapefile** box opens.



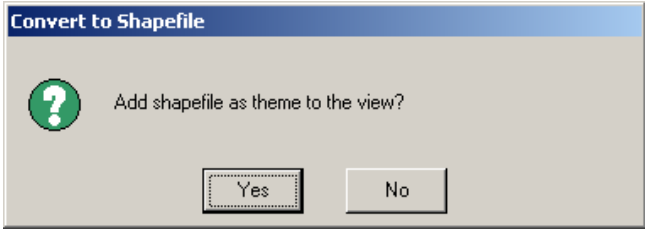


- Rename the shapefile *Locations.shp* and navigate to the folder you wish to save it in.

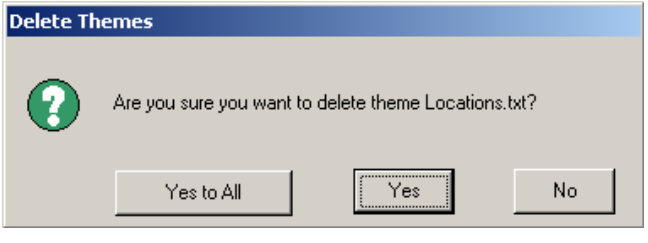


- Click **OK**.

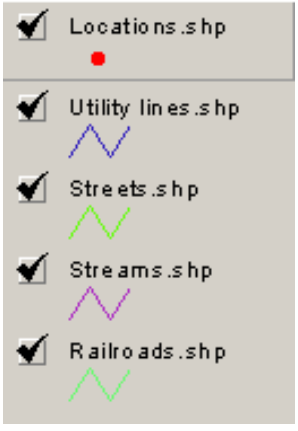
- You will be prompted to add the shapefile as a theme to the view. Click **Yes**.



- With the *Locations.txt* theme active, select **Delete Theme** from the **Edit** menu. In the **Delete Themes** box click **Yes**.



- The **View Table of Contents** window now shows the Locations.shp file.



- If you examine the folder where you saved the *locations shp* file, you will see that there are three files added. They are:

  - *Locations.dbf* is the database table in Dbase format. Dbase is a popular database program.
  - *Locations.shp* and *Locations.shx* are the actual shape file. All three must be available to ArcView.

Using the process outlined here, you can incorporate any locally-collected data into your ArcView projects. The only qualification is that your local data must be in the same projection as the base layers. You will look more closely at projections in **Chapter 10: Using Images in ArcView**.

Part II: Creating a Polygon Shapefile

All of the table data you have imported into Arcview have been in **point** format. However, you might wish to add themes that describe **areas**. These are described by **polygon** themes. In the next section, you will create a polygon theme from data collected for the site of a building development and learn how to change the appearance of the shapefile.

The Project: You are a real estate agent for a property in Durham, New Hampshire. You want to display the location of your property in GIS software for use in a state project that shows the location of land available for development. GIS data for your town contain only basic layers, so you will have to add your property yourself. Using your GPS (Global Positioning System) unit, you locate the corners of the property.

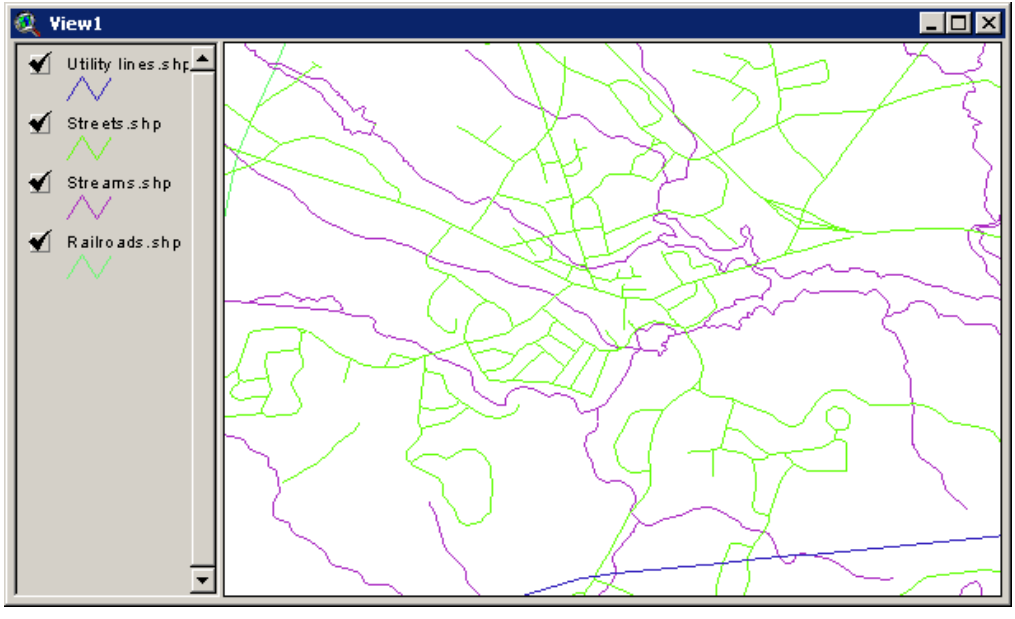
#		
1	43.1692	−709244
2	43.1762	−709264
3	43.1732	−709316
4	43.168	−709321

Preparing the Data

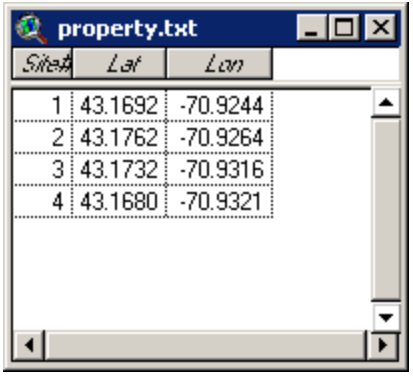
- Before beginning set your working directory to the folder containing the data for this chapter.

- Use your word processor to create a tab-delimited text (*.txt*) file of the corner-point data. Name this file *property.txt*.

- Launch ArcView and from the Chapter 8 files, open and add the GIS data files for Durham. They are located in the *Durham_Sub* folder. Your view should resemble the one shown to the right (color and order of themes is not important.)

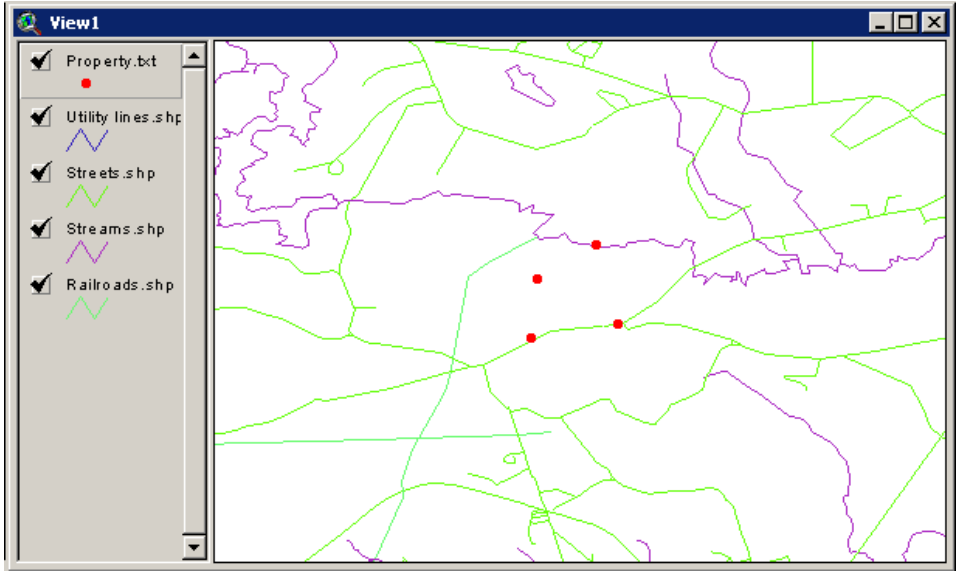


- From the **Project** window, **Add** the *property.txt* table.



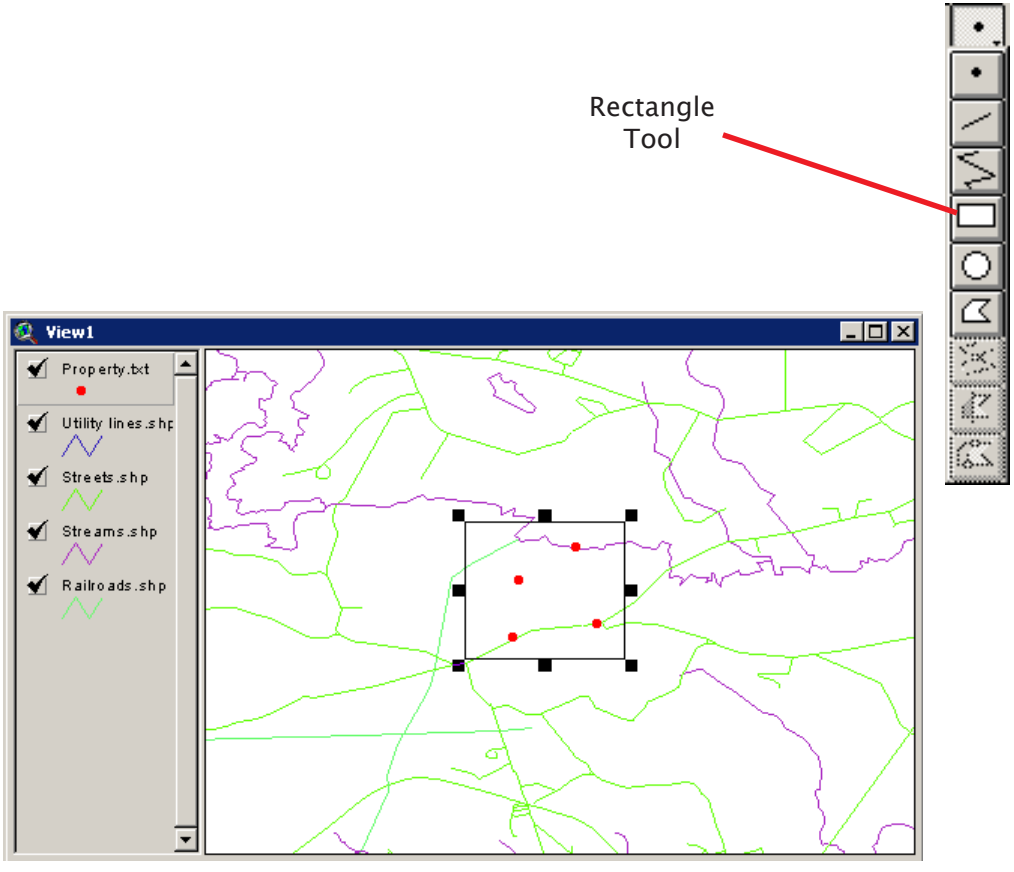
- Create an **Event Theme** from this table.

- Activate the *Property.txt* theme and zoom in on the area of the property boundary markers.



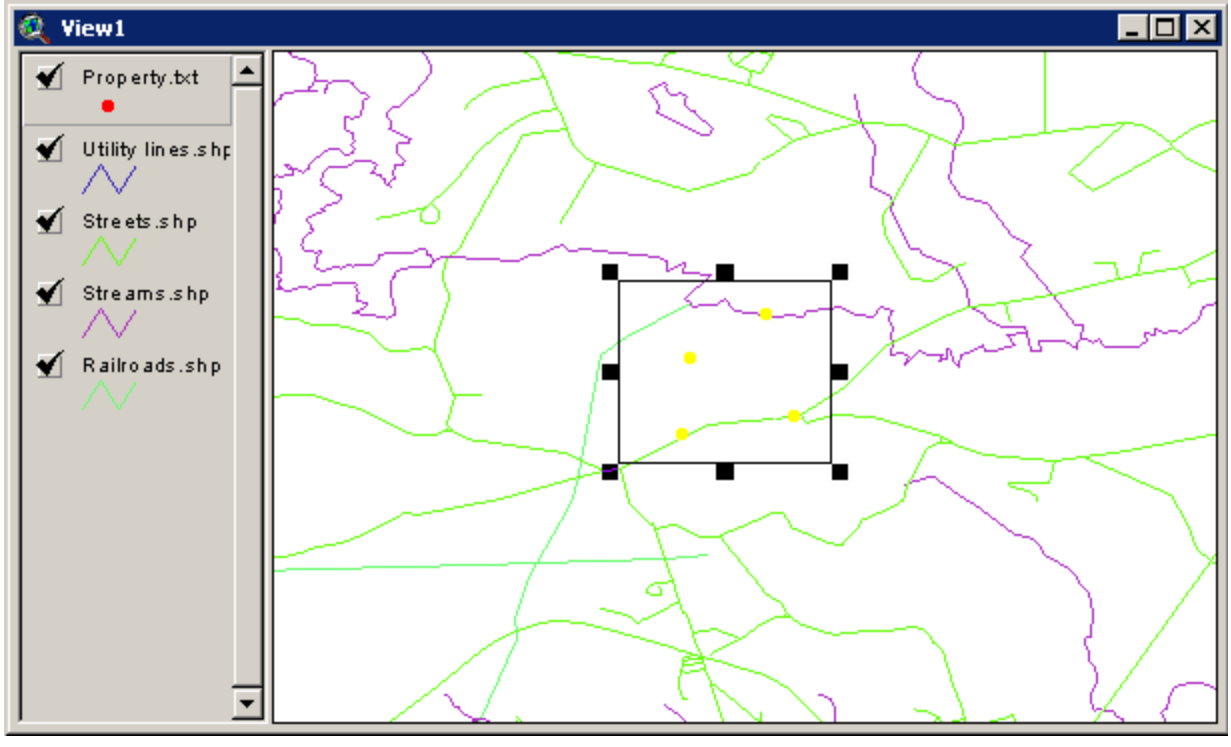
Making the Shapefile

- From the **Drawing Tools** in the **tools bar** select the **rectangle** tool.
- Your cursor becomes a "+" shape when you move it into the **View Window**.
- Move your cursor into the view. Hold down the left mouse button and **draw a rectangle** around the dots as shown in the diagram to the right.
- The size of the rectangle is not critical, but it does need to include all corner points.

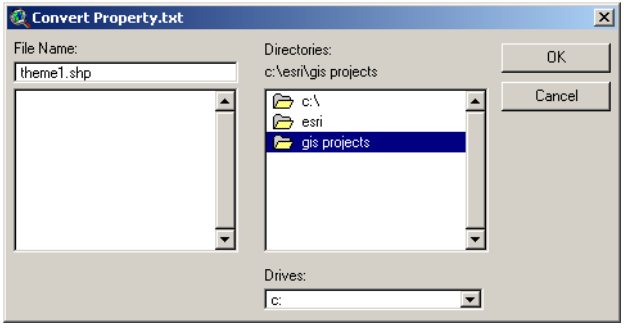


- Make sure the *Property.txt* theme is active.

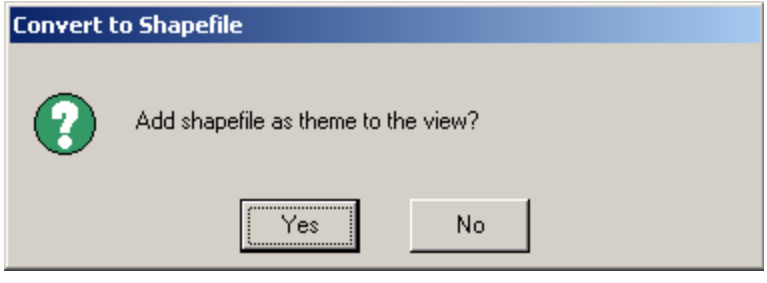
- Click the **Select Features Using Shape** button (right). The dots representing the property boundaries will turn yellow (see below.) This button selects all members of the active theme within the shape you drew.



- From the **Theme** menu, select **Convert to Shapefile**.
- In the dialog box that opens, be certain that your *GIS Data* folder is the destination. Leave the default name as it is and click **Save.** This is only a temporary file and does not need to be renamed.

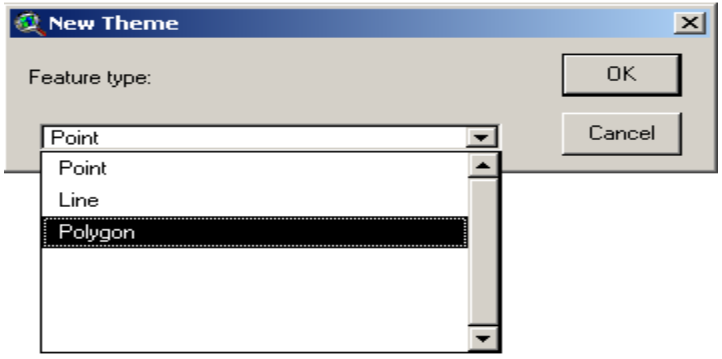


- The next dialog box asks if you want to **Add shapefile as theme to a view**? Click **Yes**.

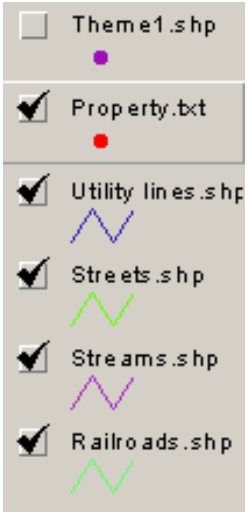


- The new theme now appears in the **View Table of Contents**.
- Make this new theme active.
- From the **View** menu, select **New Theme**. The **New Theme** box opens.

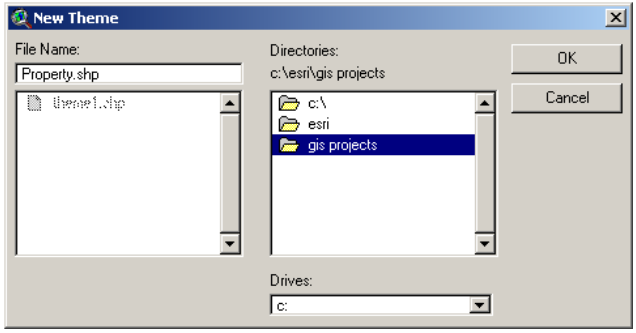
- From the **Feature Type** pull-down menu select **Polygon**.



- Click **OK**.



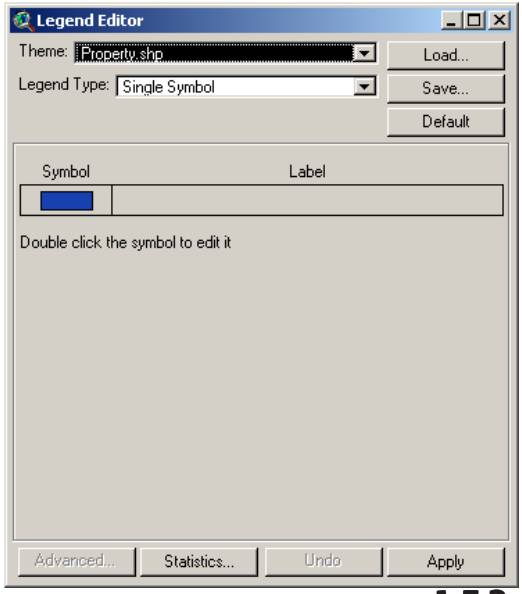
- In the **Save New Theme** dialog box, give the file the name *Property.shp*.



- Click **OK**.

- The *Property.shp* theme appears in the **View Table of Contents** window. Note that its check box is outlined with a dashed line. This means that the shapefile can be edited.

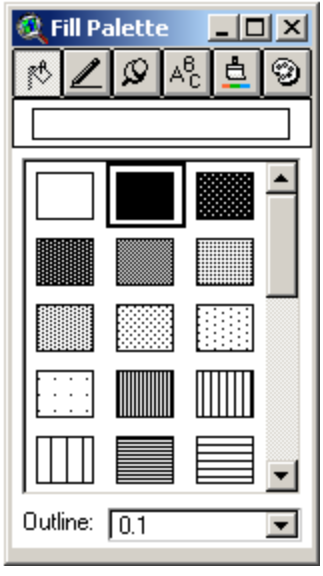
- Double Click on the name *Property.shp* to open the **Legend Editor**.



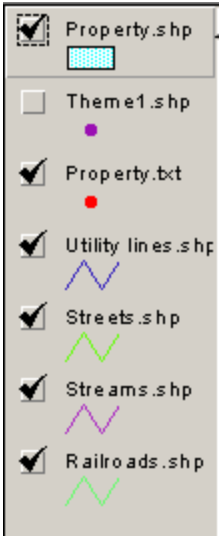
- Double Click on the colored rectangle below **Symbol** to open the **Fill Palette**.

- **Select a fill pattern** from those shown, then select a color for your shapefile.

- After you have done this:
  - close the **Fill Palette**.
  - click **Apply** in the **Legend Editor**.
  - close the **Legend Editor**.

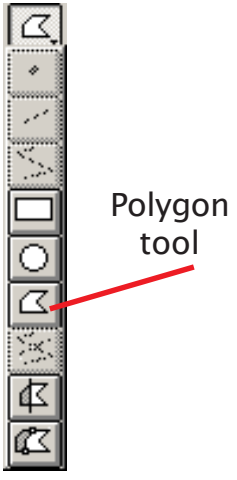


- Your new fill pattern and color are now displayed in the **View Table of Contents**.

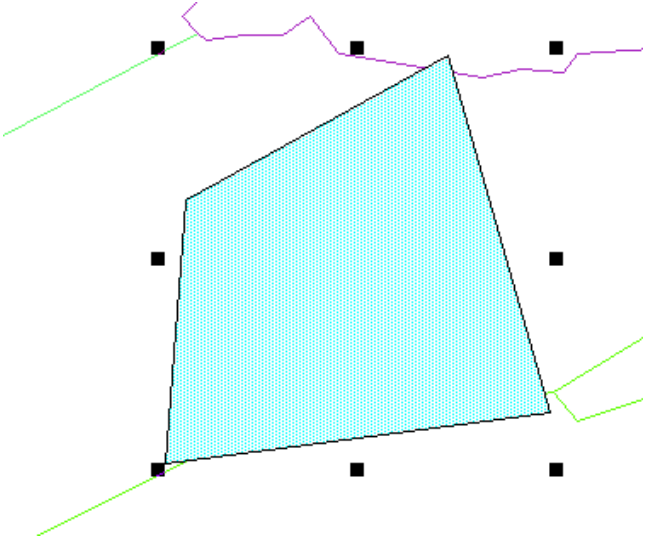


- From the **Draw** menu, select the **Polygon** tool.

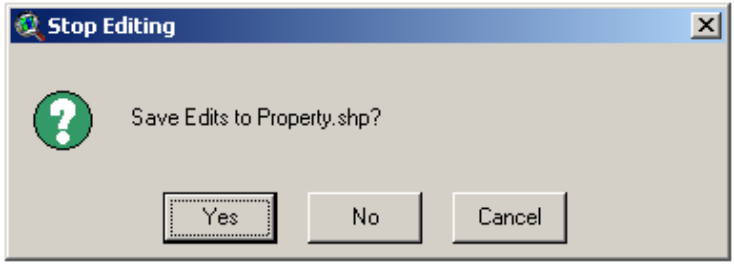
- Use this tool to draw a multisided shape (a polygon) that encloses all of the property boundary points. To do this:
  - Ignore the rectangle you drew earlier.
  - Click close to, but outside one of the corner points.
  - Move the cursor in any direction to start to "corral" the dots.
  - When you need to turn a corner, click the mouse button once. This forms a corner, or vertex.
  - When you have enclosed all four points, double click to end the process.



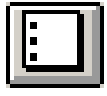
- You should have a shape, outlining the property, colored and filled as you selected.



- From the **Theme** menu, select **Stop Editing**.
- At the **Save Edits** dialog box click **Yes**.

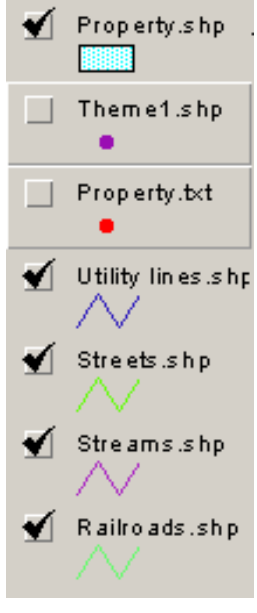


- *Property.shp* now appears as a theme in the **View Table of Contents** .
- **Click** once on the **Clear Selected Features** button.

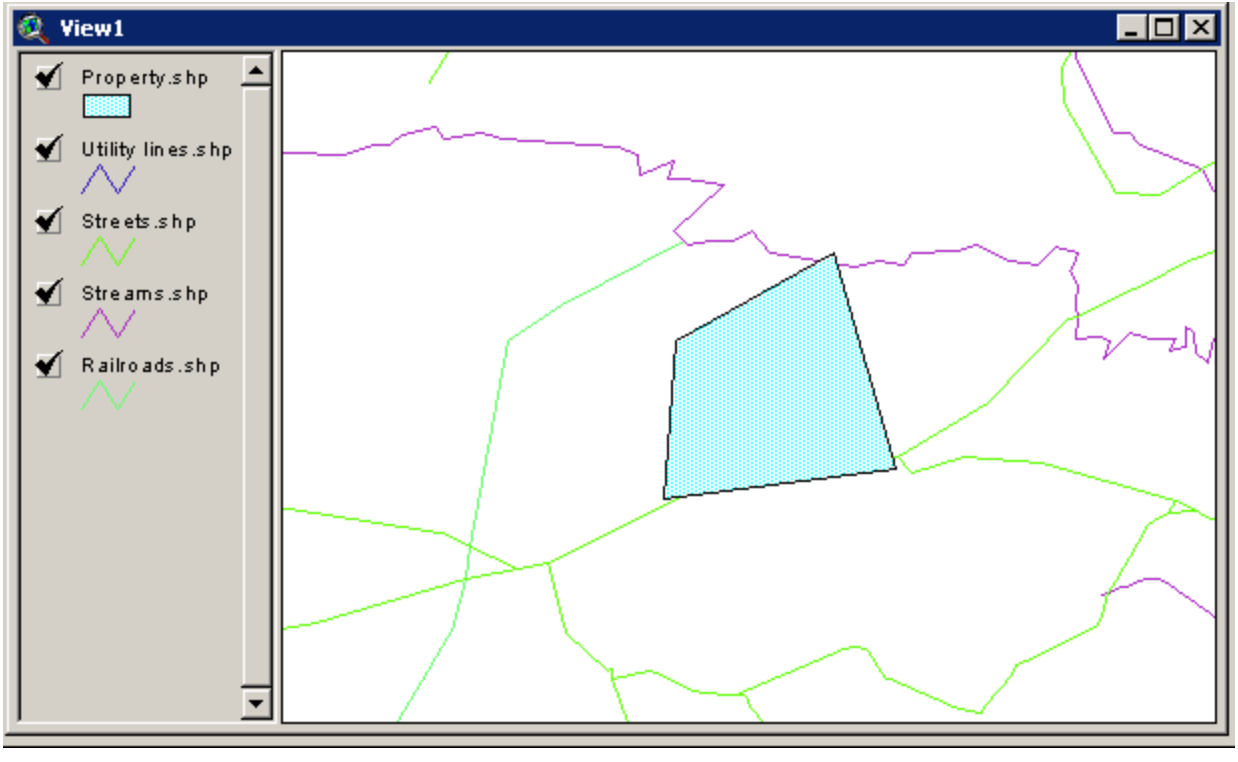


- Choose the **Select** (arrow) tool and click once on the original rectangle that you drew. Its "handles" appear.

- From the **Edit** menu, select **Cut Graphics**. This removes the rectangle.
- If either the *Theme1.shp* or the *Property.txt* theme is on, turn it off.
- Make both these themes (Property.txt and Theme1.shp) active.
  - click on one to make it active
  - Shift-click the other and both will be active
- From the **Edit** menu, select **Delete Themes**. Delete both themes.

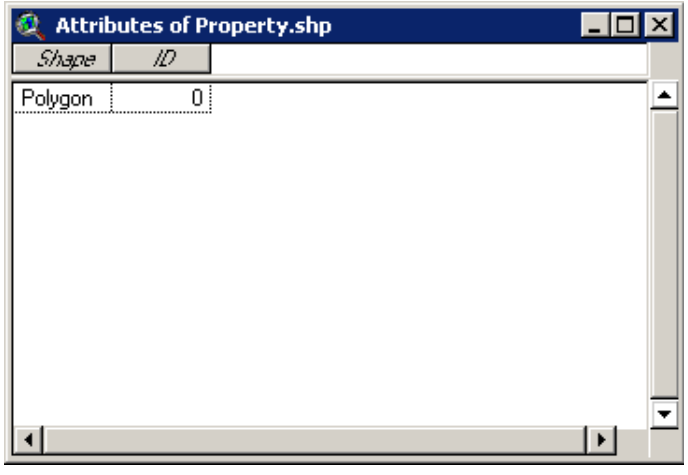


- Your **View Table of Contents** should resemble the one below, with the property as a shapefile.



Editing the Theme Attributes Table

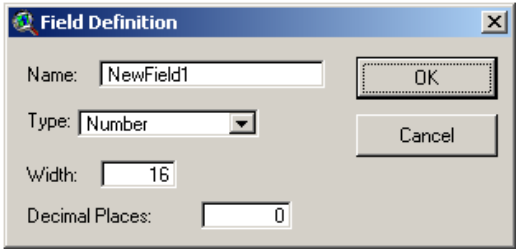
Now that you have created a shapefile, you need to add information to its **Attribute Table**. As with other shapefiles, this table will provide the user with information about the feature represented by the shapefile.



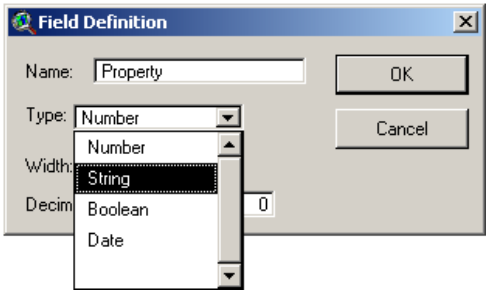
- Be sure that the *Property.shp* file is active.
- From the **Theme** menu, select **Table**, or click the **Open Theme Table** button.

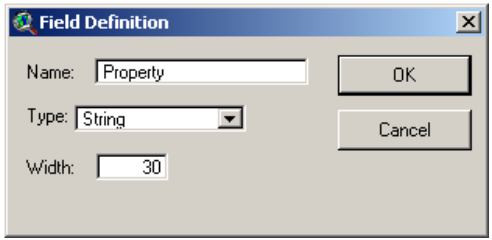
- The **Attributes Table** of your new shapefile opens.
- The table contains no data except for the shape and ID of the theme. You will now add data (attributes) to this table. First, a note about the **Attribute Table** structure. *Columns* in this table are called **fields**, while *rows* are called **records**. You will first add a new field to the table, then add data to that field. Notice that the first field in the table is used by ArcView to identify the type of shapefile (polygon) and the second field is used to record the ID number.

- From the **Table** menu, select **Start Editing**.
- From the **Edit** menu, select **Add Field**. The **Field Definition** box opens,

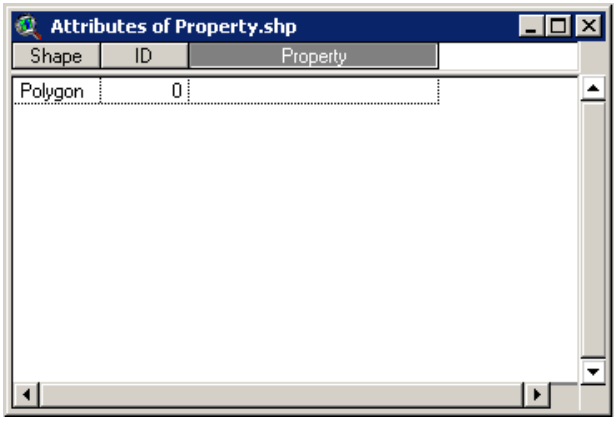


- Enter *Property* in the **Name** field.
- In the **Type** pull-down menu, select **String** (right). This tells the system that the contents of the filed will be a "string" of characters. These may be numbers, letters or symbols.
- In the **Width** field, enter 30. That gives enough space to enter a description.
- Click **OK**.

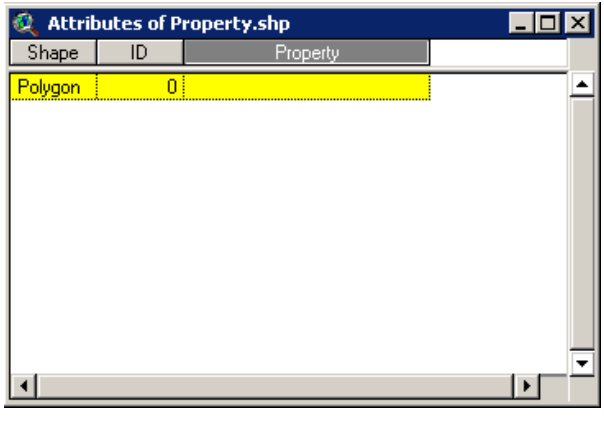




- The **Attributes Table** appears again.

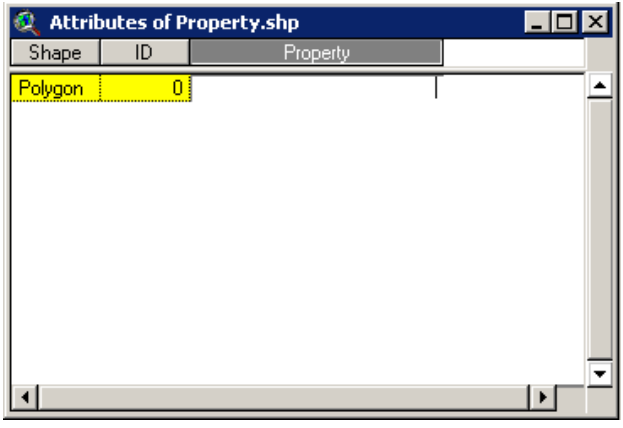


- Click on the first **Record** in the table. The Field line turns yellow, and the table appears as shown below.

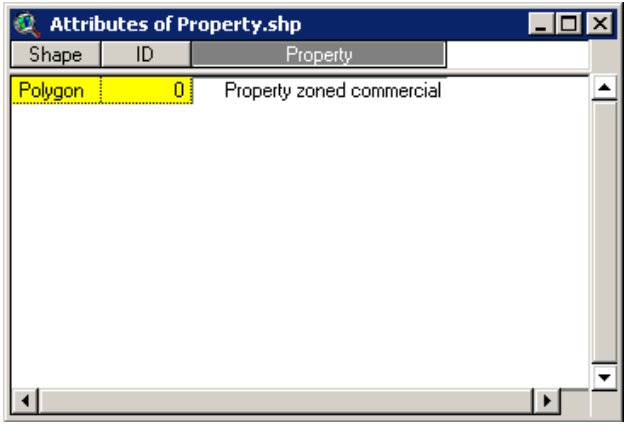


- Click on the **Table Edit** Tool. This allows you to enter new data in the table.

Table Edit Tool



- Click in the space under *Property*, A cursor appears at the right end of the space.

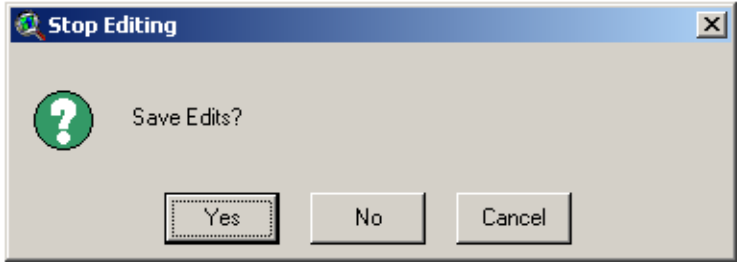


- Enter “Property zoned commercial” in this space. You can add as many fields to this table as needed to describe the property.

- From the **Table** menu, select **Stop Editing**.
- In the **Save Edits** box, click **Yes**.
- Be sure to **Save** your project.
- Close the **Attributes Table**.
- The **Project window** lists the **Attributes of Property.shp** table as part of your project.
- When you close your project, and quit ArcView, you will see that the system has added a number of files to your directory. Several are from the intermediary steps and may be deleted. The only ones you need to keep are the parts of the Property shapefile listed below:

property.dbf
property.shp
property.shx

These are the files necessary to describe the *Property shapefile.*



Shapefiles represent a way of displaying a theme that covers a part of the Earth's surface. In exploring the various theme layers included with ArcView, you have discovered that most of them are shapefiles.

Chapter Summary: In the U.S., detailed GIS data can be downloaded for every county from the TIGER data base, which is accessed through the ESRI site at www.esri.com. Most states maintain Offices of GIS which have state data available for downloading, generally free or at a very low cost. Most nations maintain national or regional GIS databases which can often be obtained by contacting local universities.

These data usually do not include small-scale features that are of interest in local projects ingeography, science or history. The ability to include such student-gathered data gives GIS great value as an educational mapping and visualization tool.

Chapter 9: Hot Links

In Chapter 8 you added "local" data to a view by the following process:

- Gathering field data including GPS values.
- Preparing a text-formatted table of these data.
- Importing these data as an **Event Theme** in ArcView.

Plotting the location of local features or data sources is valuable, but the user who is not familiar with the area of the **View** can only evaluate the data by what is included in the **Attributes Table**. It would be helpful if the user could see a picture or an Mpeg movie of the area, or view other files such as charts, graphs, or documents that are important to understanding the feature.

Making such data about a location available is accomplished using **Hot Links**. A **Hot Link** provides a connection between a feature in the **View** and an external file.

Objectives:

- Create a data table of campus locations that includes references to local images.
- Import this table as an Event Theme.
- Hot Link each separate entry to a campus photograph.
- Activate these Hot Links in ArcView.

The Data

Use the same data as we used in Chapter 8. They are reproduced below:

#		
1	43.13448	-7093633
2	43.13614	-7093247
3	43.13464	-7093018
4	43.13602	-7093434

- Prepare a text table of these data (review the process from Chapter 8) but this time you will add another field specifying the location of the images you wish to link to the campus locations.

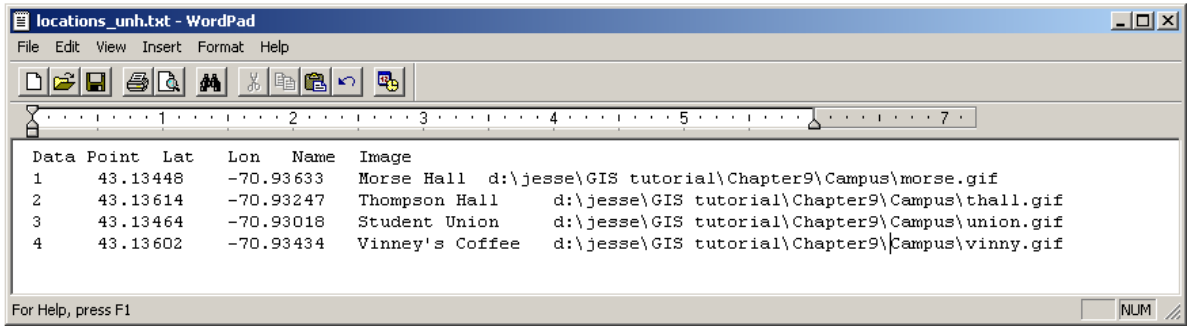
Hot Links in ArcView

Because ArcView is flexible about the location of data, you can place the files for this project in your *GIS Projects* folder.

From the *Chapter 10 Files*, copy the folders *Campus* and *Durham_Sub* into your *GIS Projects* folder.

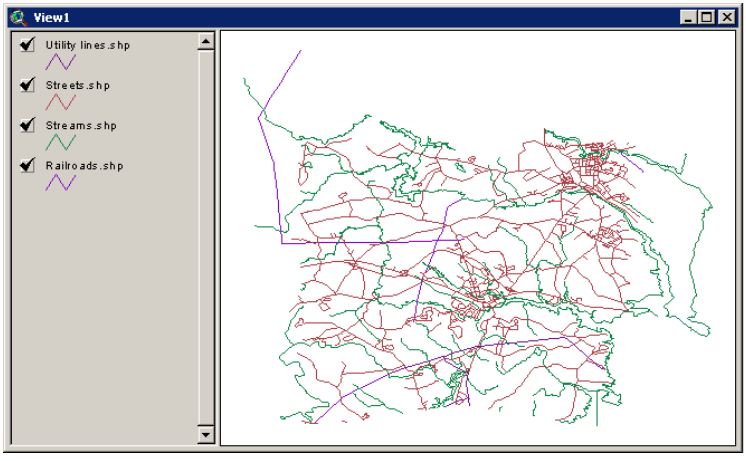
- Examine the contents of the folder *Campus.* Each file is a digital image of a location on the UNH campus. The *Durham_sub* folder contains the same data you used in Chapter 8.

- In NotePad, SimpleText**,** or your favorite word processor, create a tab delimited file of the data. This time, add another column containing the data shown below. Your table must specify the complete path to your data. An examples is given below. Be certain to specify the complete path to your directory.



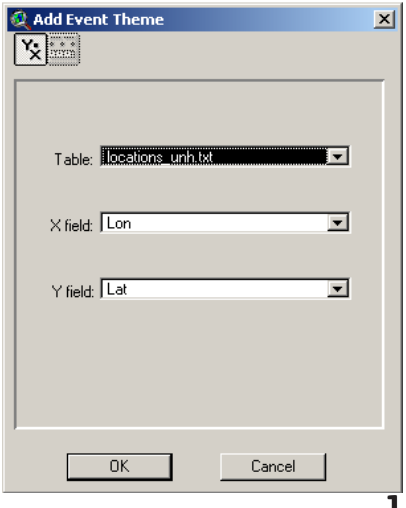
- **Save** your file as a text file, and be certain that the extension *.txt* is appended.

- Launch ArcView.
- **Add Themes** and select the files in the *Durham_sub* folder. You can add all the files at once by using the shift-click method.
- Make all the Themes active.
- From the **Project** window, select **Tables**, then **Add**.
- Navigate to your ArcView *Data* folder and **Add** the table you created.



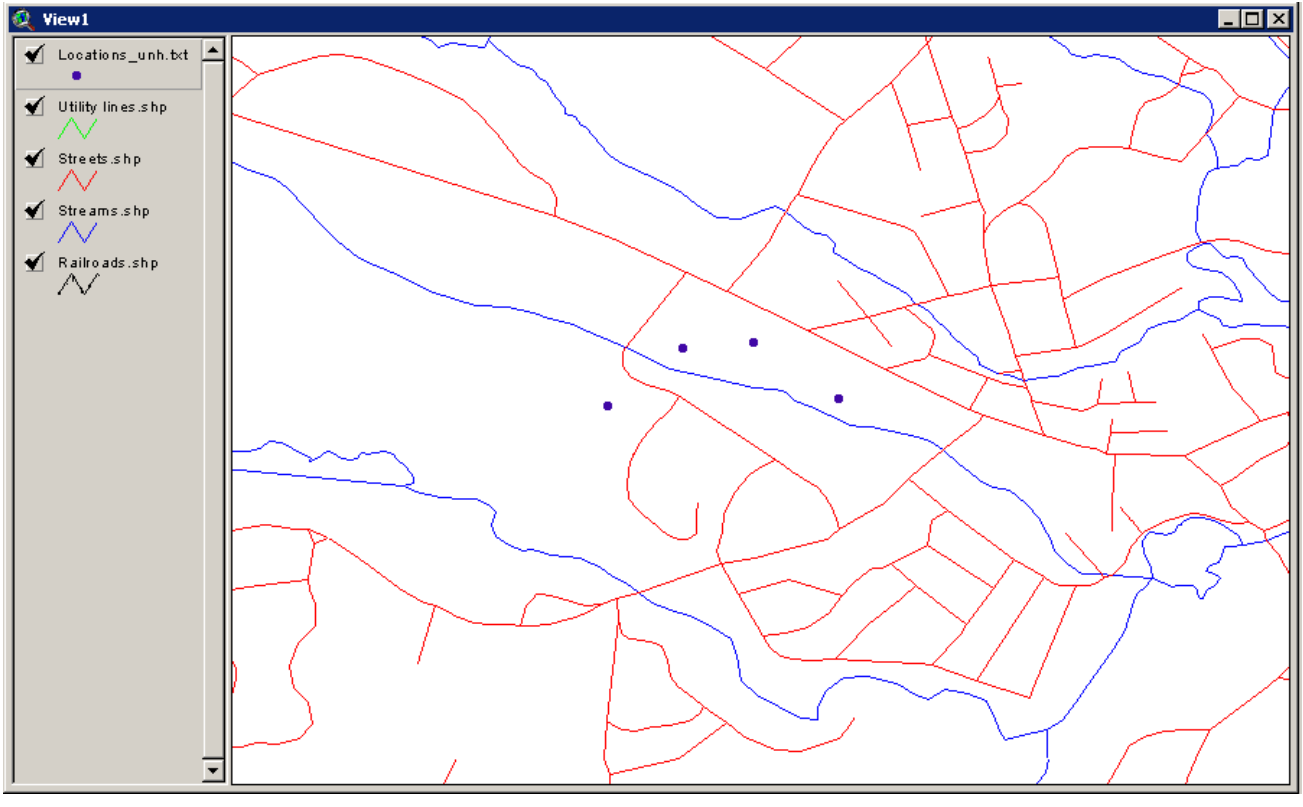
locations_unh.txt

Data point	Lat	Lon	Name	Image
1	43.13448	-70.93633	Morse Hall	d:\jesse\GIS tutorial\Chapter9\Campus\morse.gif
2	43.13614	-70.93247	Thompson Hall	d:\jesse\GIS tutorial\Chapter9\Campus\thall.gif
3	43.13464	-70.93018	Student Union	d:\jesse\GIS tutorial\Chapter9\Campus\union.gif
4	43.13602	-70.93434	Vinney's Coffee	d:\jesse\GIS tutorial\Chapter9\Campus\vinny.gif

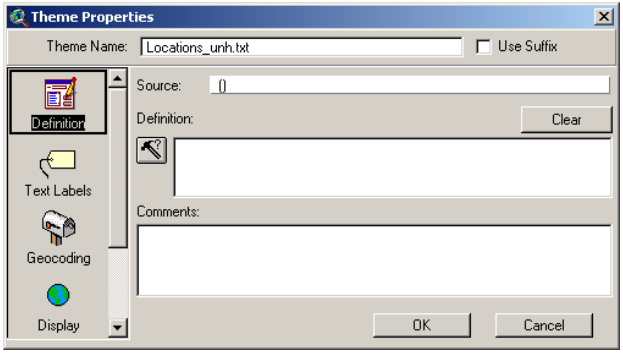


- Make your **View** window active, and from the **View** menu, select **Add Event Theme.** If the entries are correct, click **OK**.
- Click on the Theme in the **View** window to make it active.

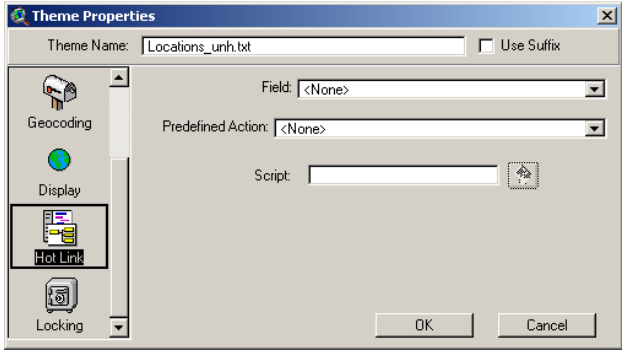
- Zoom in so your **View** window resembles the one below. Again, the dots show the campus locations.



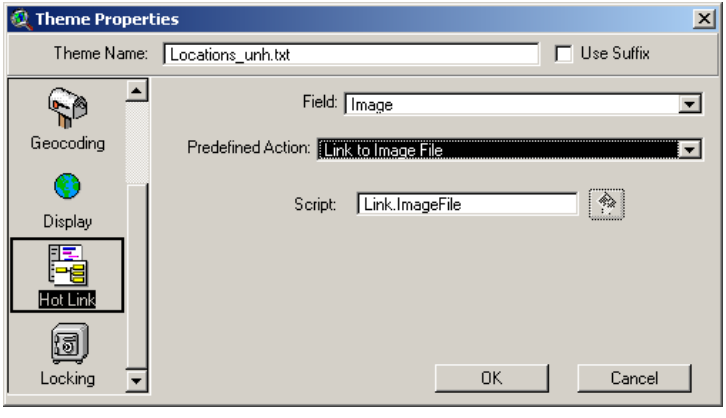
- From the **Theme** menu, select **Properties**.
- The **Theme Properties** window opens.

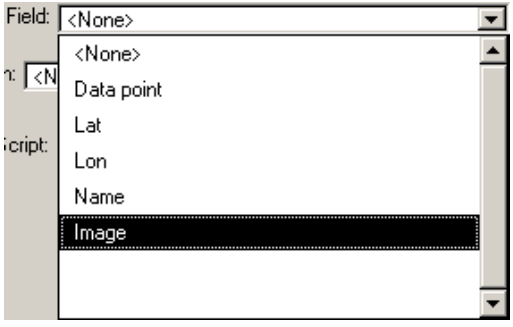


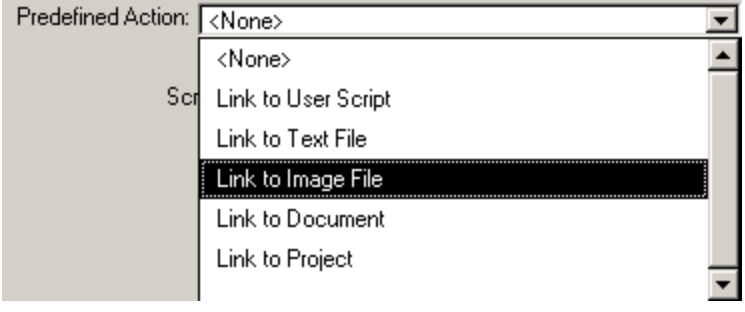
- Scroll down the menu on the left side of this window and select **Hot Links**.



- From the **Field** pull-down menu, select **Image**. This tells the system that you will be linking to whatever file is named in the **Attributes Table** field named **Image**.
- In the **Predefined Action** pull-down menu, select **Link to Image File**. This tells ArcVoyager that the **Hot Linked** file will be in an image format.
- Your **Theme Properties** window should now resemble the one below.

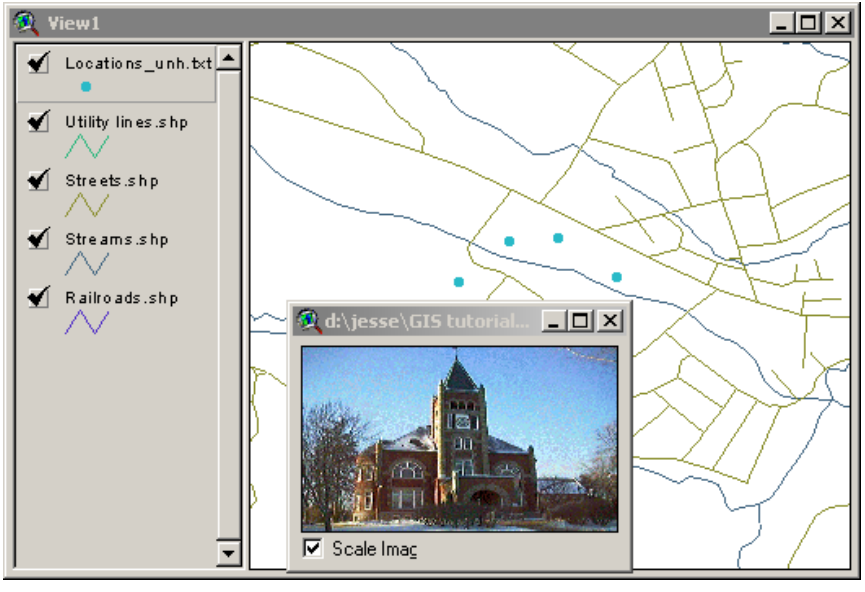






- Click **OK**.

- In the **Tools** bar, click on the **Hot Link** tool to make it active. 
- Move your cursor into the **View** window. Note that it takes the shape of the **Hot Links** button.
- Place the tip of the cursor over one of the campus locations, and click once. The image associated with that location in the **Attributes** table opens.



- Clicking on the other campus location points will open the appropriate image for each.

Chapter Summary: Using Hot Links allows you to link elements of a theme to external files. Images, movies, tables, charts, and graphs can all be used to provide the user with more information about the contents of a theme.

What Can I Do With This?

Many aspects of the study of science, history, geography, mathematics and language are linked to places. A few projects are suggested below.

- Plot the locations of your GLOBE Program measurement sites, and Hot Link to photographs of your sites or graphs of your GLOBE data.
- Have students collect locations and photographs of historic sites in your area and display them, along with historical information.
- Data about environmentally sensitive areas can be Hot Linked to their locations in a View.
- Using data from on-line environmental sites, track the migration of wildlife species and make Hot Links to images of breeding or nesting grounds.
- Collect data about the locations of old cemeteries in your region, and Hot Link these to lists of family names represented there.

Chapter 10: Using GLOBE Landsat Images in ArcView

As part of the GLOBE Program, your school has received a Landsat Thematic Mapper (TM) image of the 15 km x 15 km area around your school.* Since this is the area your students will be taking most of their GLOBE measurements, it would be ideal to include this image as a theme in ArcVoyager.

Beginning in 2001, the GLOBE Program began supplying these images in a format that is compatible with ArcView. For images prior to 2001, it is necessary to to register the images (see **Appendix III**).

Objectives

- Set the projection for your view.
- Select an Image Data Source.
- Add a Landsat Thematic Mapper image to the View window.
- Overlay vector data on this image.

The data you will use for this exercise are from Corpus Christi, Texas. Download the *Chapter 10 data* folder from the University of New Hampshire GLOBE site, or copy the *Chapter 10 data* folder from the CD you received. Place this folder in your *GIS Projects* folder.

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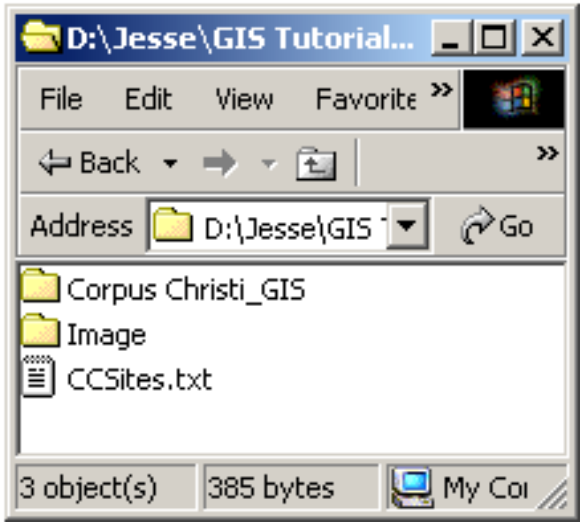
*. Schools that joined GLOBE prior to 2001 automatically received an image. If do not have an image, call the GLOBE Help Desk at 1 - 800 - 858 - 9947. If you have joined GLOBE since 2001, your school must have a GLOBE-trained teacher, and have submitted at least 250 data entries to receive an image. If you have questions, please contact the Help Desk at 1 - 800 - 858 - 9947.

- Open the *Chapter 10 data* folder. Its contents are shown to the right.



- Open the **Image** folder. Its contents are shown below. It contains three files. The numerical part of the file name is a code used by the image supplier to identify each image.

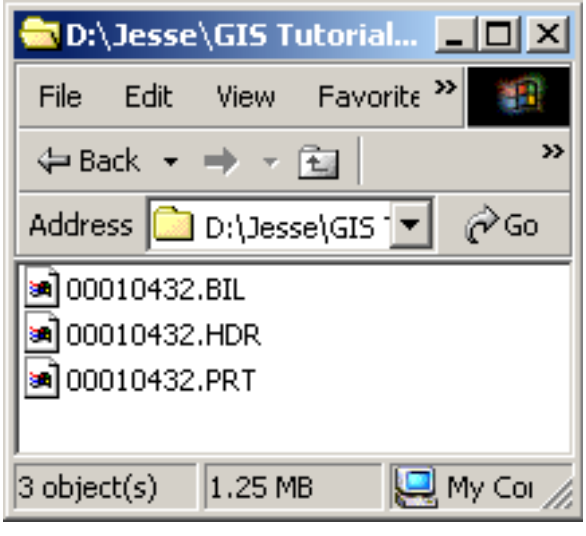


Image File Formats:

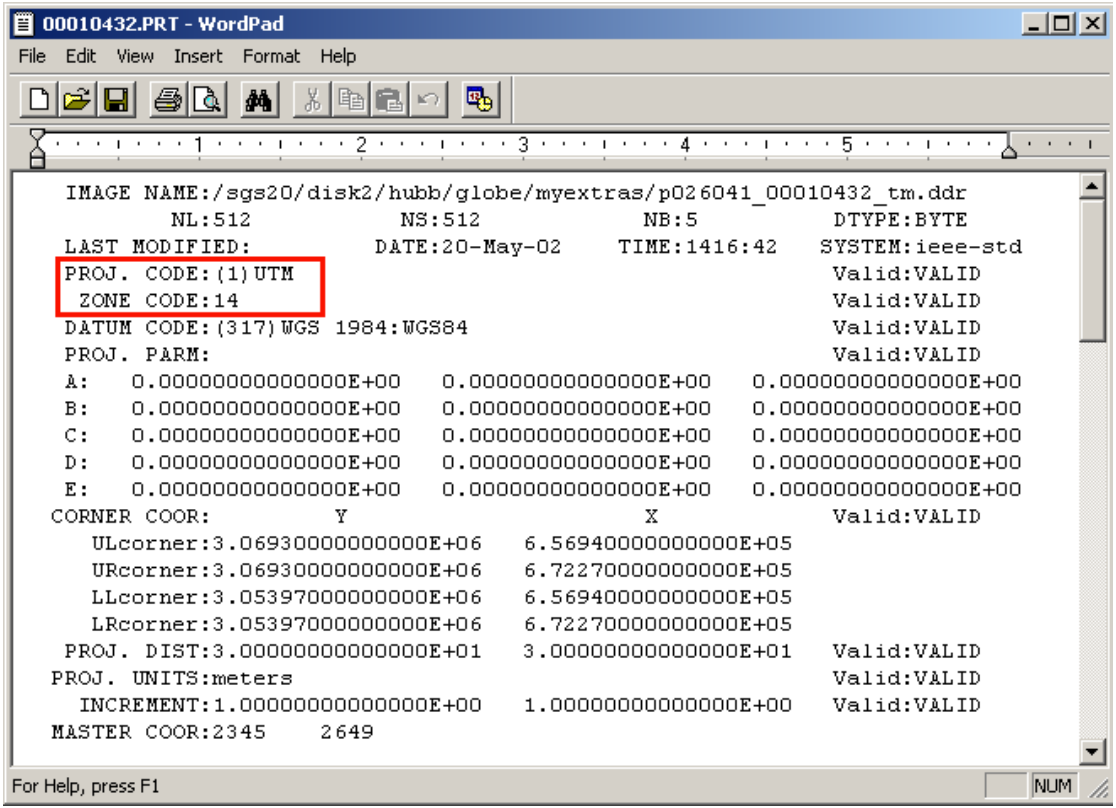
The Image folder contains three files.

00010432.bil	This is the actual Landsat image of Corpus Christi. While it is GIS compatible, it is still completely readable by MultiSpec, the image analysis software used in GLOBE, and all MultiSpec activities can be performed as usual.
00010432.hdr	This header file is used to provide your GIS software with the coordinates necessary to locate this image on the Earth's surface.
00010432.prt	This is a projection file. It is a simple text file that contains information you will need to use this image in ArcView.

Note: Before beginning to work with your own local image, copy all the files from the GLOBE-supplied disk to your computer's hard drive. Put the GLOBE disk in a safe place as your "archive." If you are going to make copies of the image to load on other machines, make copies from your computer's hard drive.

Examining the Projection File

- Use Notepad, Simple Text, or your favorite word processor to open the projection (*.prt)* file for the Corpus Christi image. The figure below shows the first page of that file.



What This File Tells You

The important part of this file, outlined in red, tells you that this image is projected in the system known as **Universal Transverse Mercator (UTM)** and that the image is located in **Zone 14**.

What Is UTM?

As discussed earlier, (Chapter 4 and Chapter 7) there are many different methods of transferring the round Earth to a flat surface. Each of these methods, called a projection, has advantages and disadvantages. Looking at a Mercator map of the Earth (the most common projection for world maps) you can see that a disadvantage of this projection is that it greatly distorts the sizes of land masses far from the equator. Greenland is not really as large as this projection makes it appear.

In the UTM system, the Earth is divided into 60 zones of longitude. Each zone is 6° of longitude wide. Imagine peeling an orange and finding it made of 60 equal-size segments. Each of these segments, running from north to south, is analogous to a zone in the UTM system.

The numbering of these zones begins at the International Date Line, and increases to the east. The United States is covered by 10 zones, beginning with #10 on the west coast and ending with #19 on the east coast. Positions in the UTM system are measured in meters north (called northings) and east (called eastings) of fixed reference lines.

For the Northern Hemisphere, the Equator is assigned a value of 0,000,000. Latitude, or the northing coordinate is measured in meters from the equator.

For the Southern Hemisphere, the South Pole is the origin and locations are measured in meters north of that point. The Equator is assigned a value of 10,000,000.

For each longitudinal zone, the Central Meridian (line of longitude) is assigned a value of 500,000. Longitude measurements, called easting coordinates, increase from west to east in each zone. Values less than 500,000 are to the west of the Central Meridian, and values greater than 500,000 are to the east of this line.

In this system all longitudes are not measured from a common point (the Prime Meridian) but from the central meridian in each zone. This is why you must also know the zone you are in.

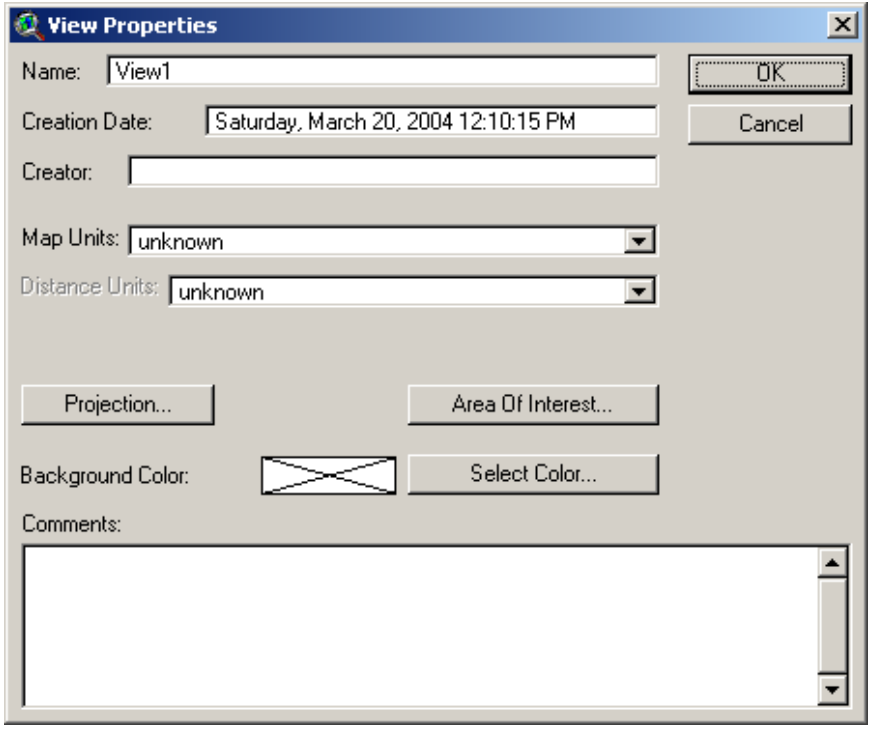
The diagram below shows the **Coordinate Window** for a point in a **View** of Corpus Christi, Texas, using UTM coordinates.

This value is the **Northing Coordinate**. This point is located 3,068,474.74 m from the Equator.

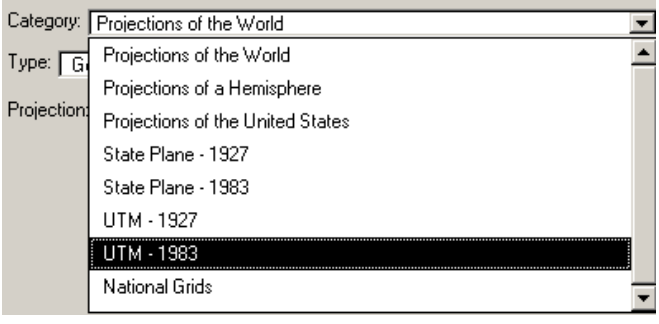
This value is the **Easting Coordinate**. The point lies to the east of the central meridian (the value is greater than 500,000). This point is 112,746.44 m east of the central meridian.

Adding the Corpus Christi Image to ArcView

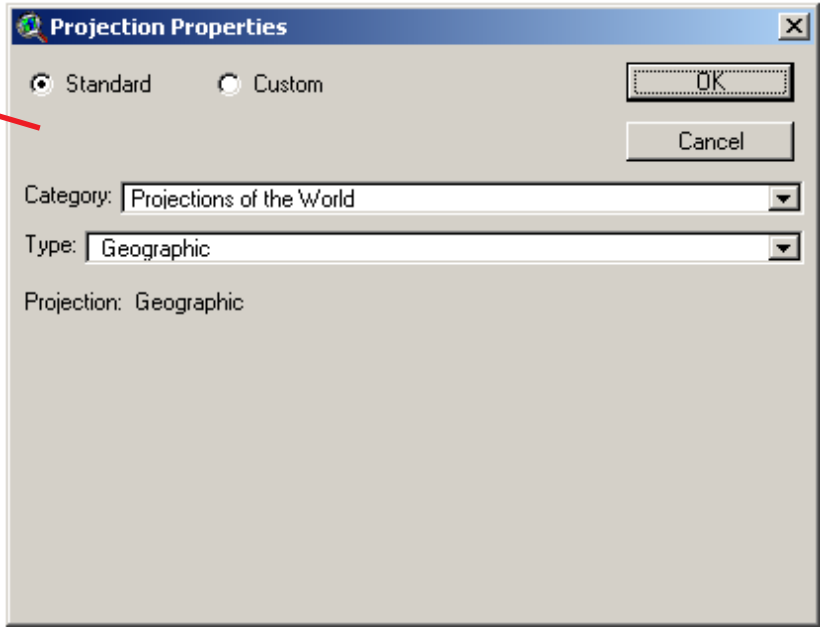
- Launch ArcView and start a **New Project**.
- From the **View** menu, in the main menu bar, select **Properties**.
- The **View Properties** window opens.

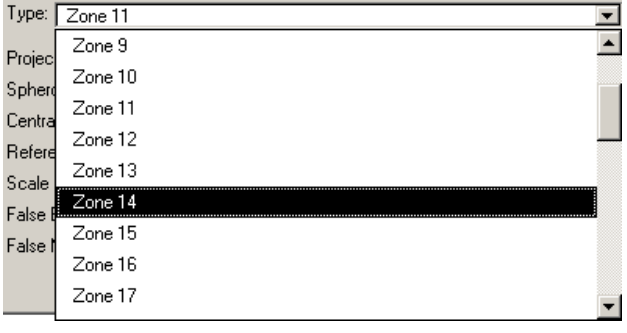


- Click the **Projection** button in the **View Properties** window. The **Projection Properties** window opens.
- Click on the pull-down **Category** menu and select **UTM** from the list. If your menu shows more than one entry for UTM, select the **UTM – 1983** entry.

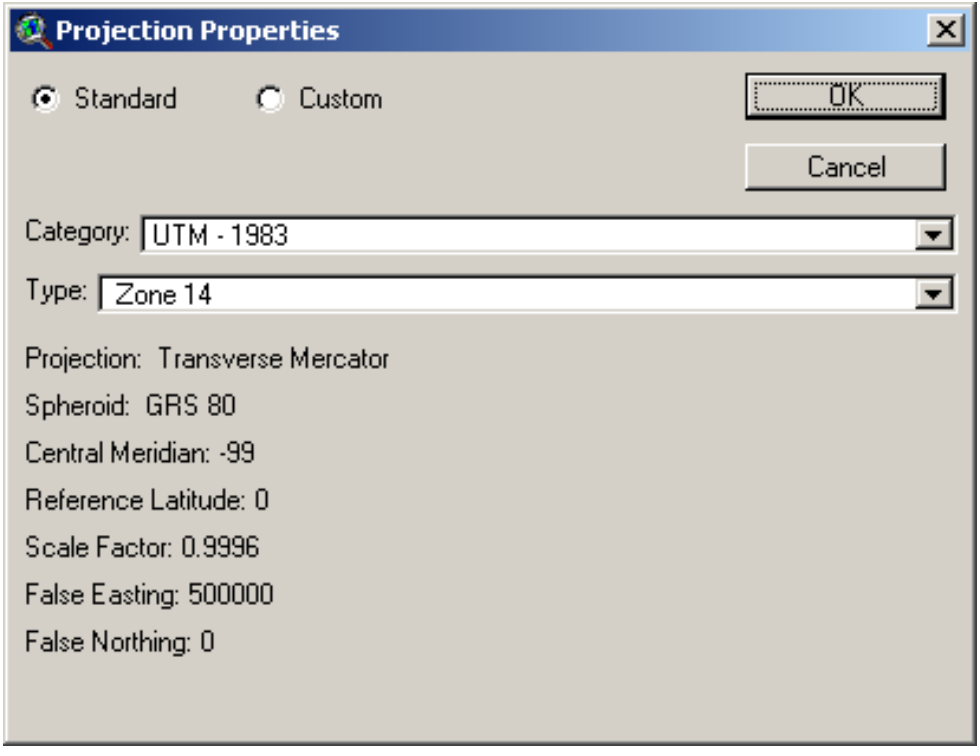


- From the **Type** pull-down menu, select **Zone 14** for the Corpus Christi image. Remember that your Zone is obtained from the *.prt* file that accompanies your image.



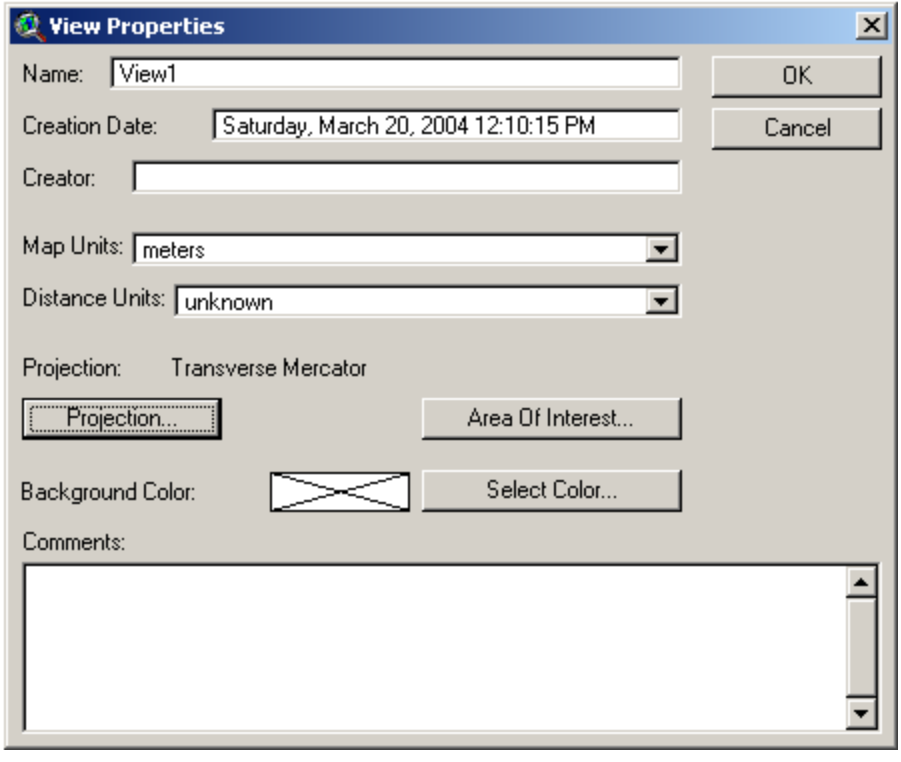


- The **Projection Properties** window should resemble the one shown below.



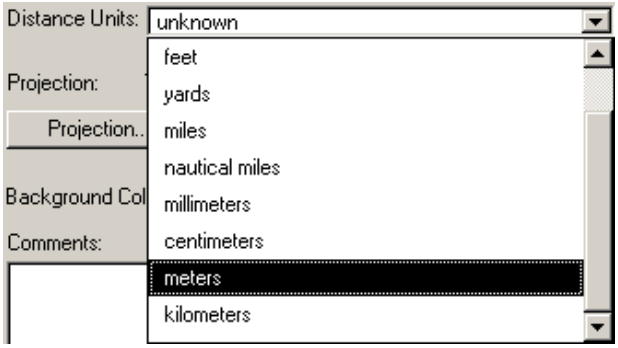
- Click **OK.**

- You are back at the **View Properties** window.

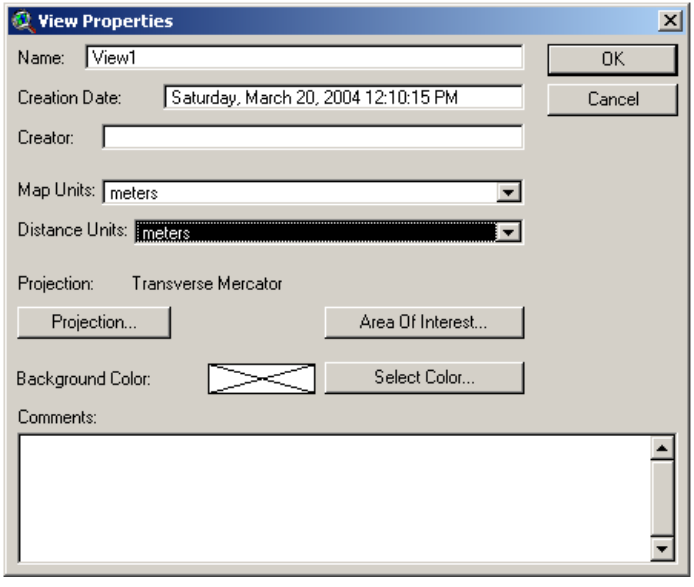


- Notice that the **Distance Units** window displays **unknown**. You must now tell the system what units to use in measuring distances in the **View**.

- From the **Distance Units** pull-down menu, select **meters**.



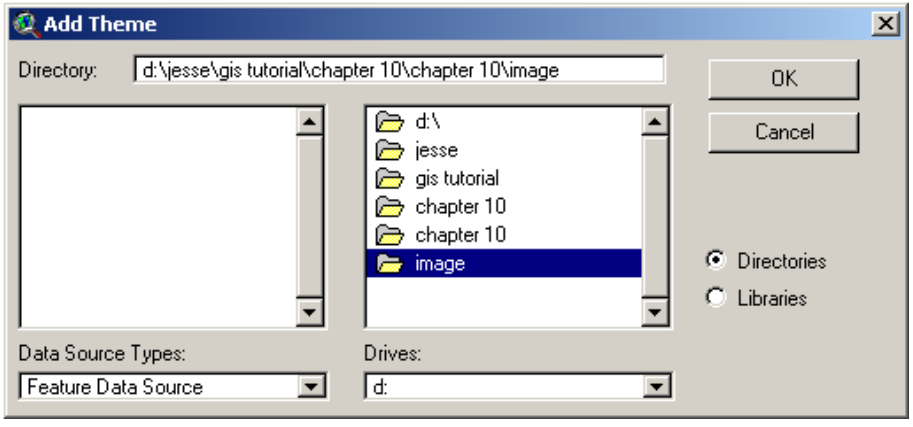
- The completed **View Properties** window is shown below.



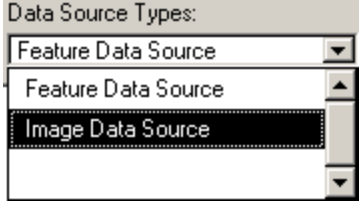
- Click **OK** to close the **View Properties** window.

Adding the Image to the View

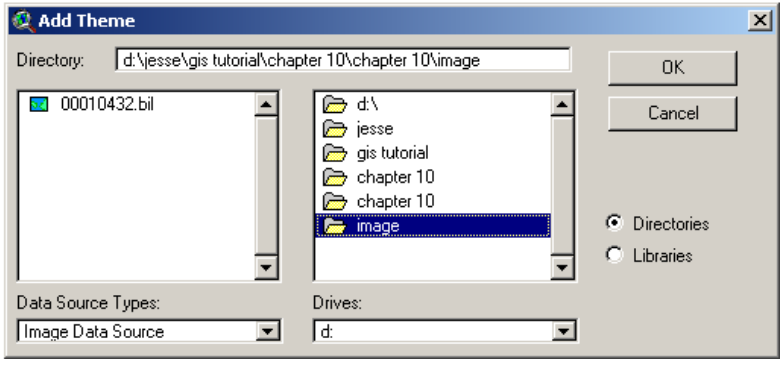
- Click the **Add Themes** button and navigate to the folder containing the *Chapter 10 data* files.
- Select the folder *Image*.
- As shown below, there do not appear to be any ArcView files in this folder. The image is there, but we must tell ArcView that we are looking for image-type data.



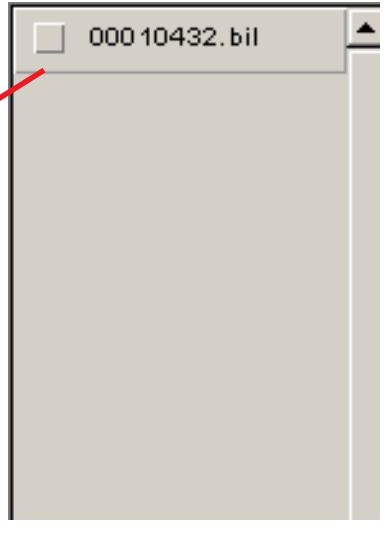
- From the **Data Source Types** pull-down menu, select **Image Data Source**.



- The window now lists the Corpus Christi image. Only the actual image (*.bil*) file is listed.

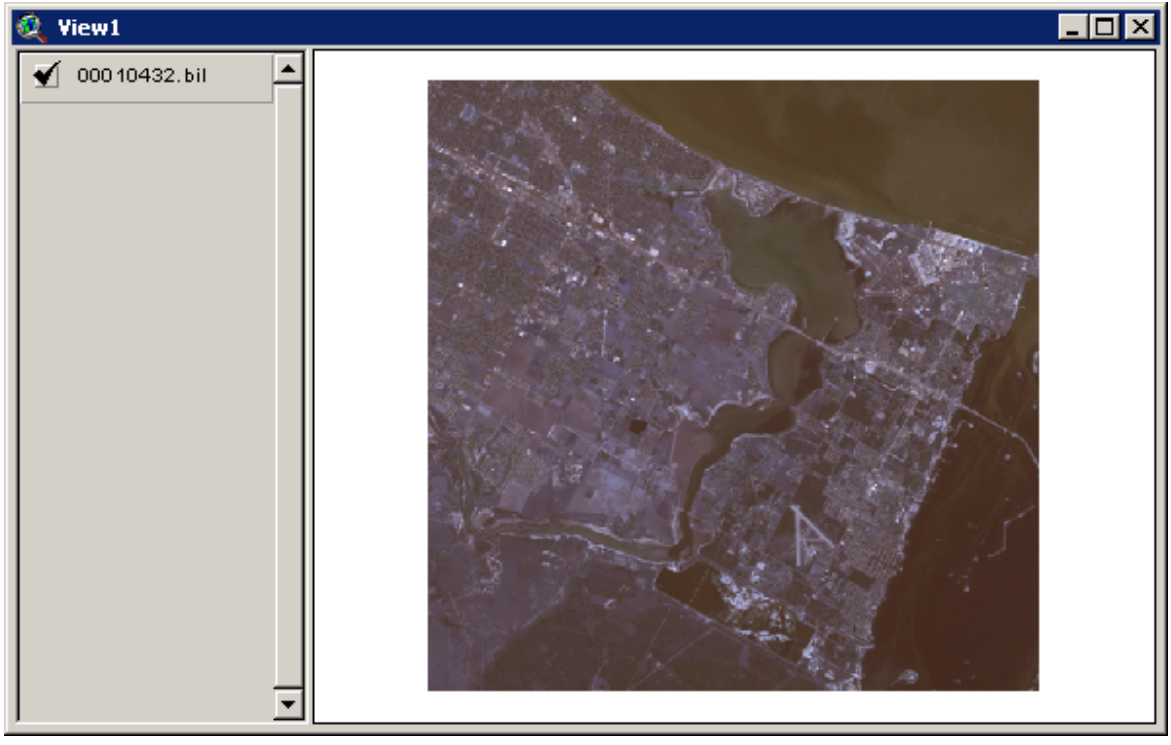


- Select this image.
- Click **OK**.
- The image is now added to the **View Table of Contents** as a **Theme**.



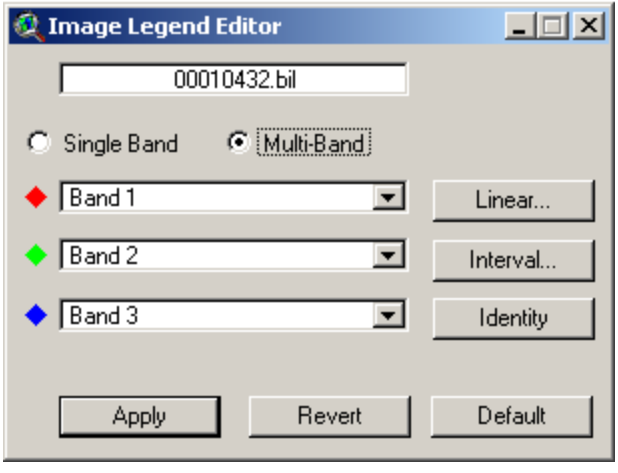
An Important Note: As stated earlier (Chapter 7) all themes in your View must be in the same projection. If the .prj file for your image indicates a projection other than UTM, you can still use your image in ArcView, but you will not be able to overlay data in normal geographic (latitude/longitude) format over the image. Also, images you may obtain from other sources may not be in UTM projection. It is important to know the projection of your image data.

- Activate the image theme.



- You can improve the appearance of the image by changing the monitor colors to which the channels in your Landsat image are assigned.

- Double click on the image **Legend** in the **View Table of Contents** (the name 00010432.bil). The **Image Legend Editor** opens.



The **Image Legend Editor** gives you the following information about this image:

a. This image is **Multiband**. All GLOBE images are provided with 5 bands, or channels:

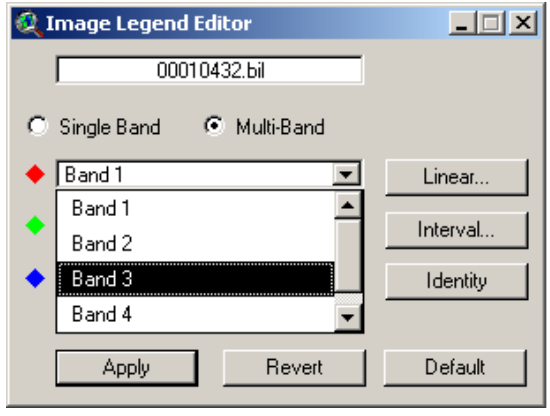
Channel	Color
1	Visible Blue
2	Visible Green
3	Visible Red
4	Near Infrared
5	Middle Infrared

b. By default, ArcView makes the following assignments:

Monitor Color	Channel Assigned
Red	1 (Visible Blue)
Green	2 (Visible Green)
Blue	3 (Visible Red)

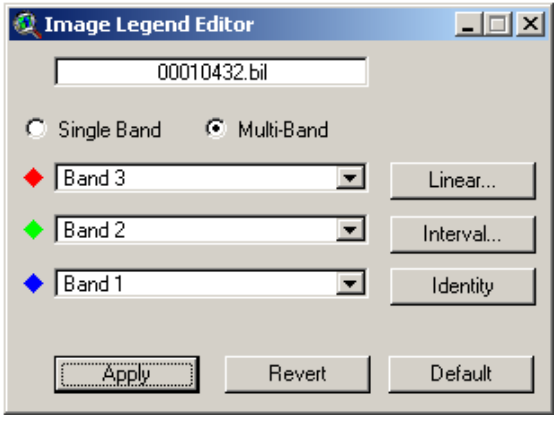
This is not a normal color assignment for a Landsat image. For more information on band assignments, see the **GLOBE MultiSpec tutorials** provided in your GLOBE Teachers Kit.

To change the appearance of the image:



- Use the pull-down menu next to the **Red** monitor symbol to select **Band 3**.

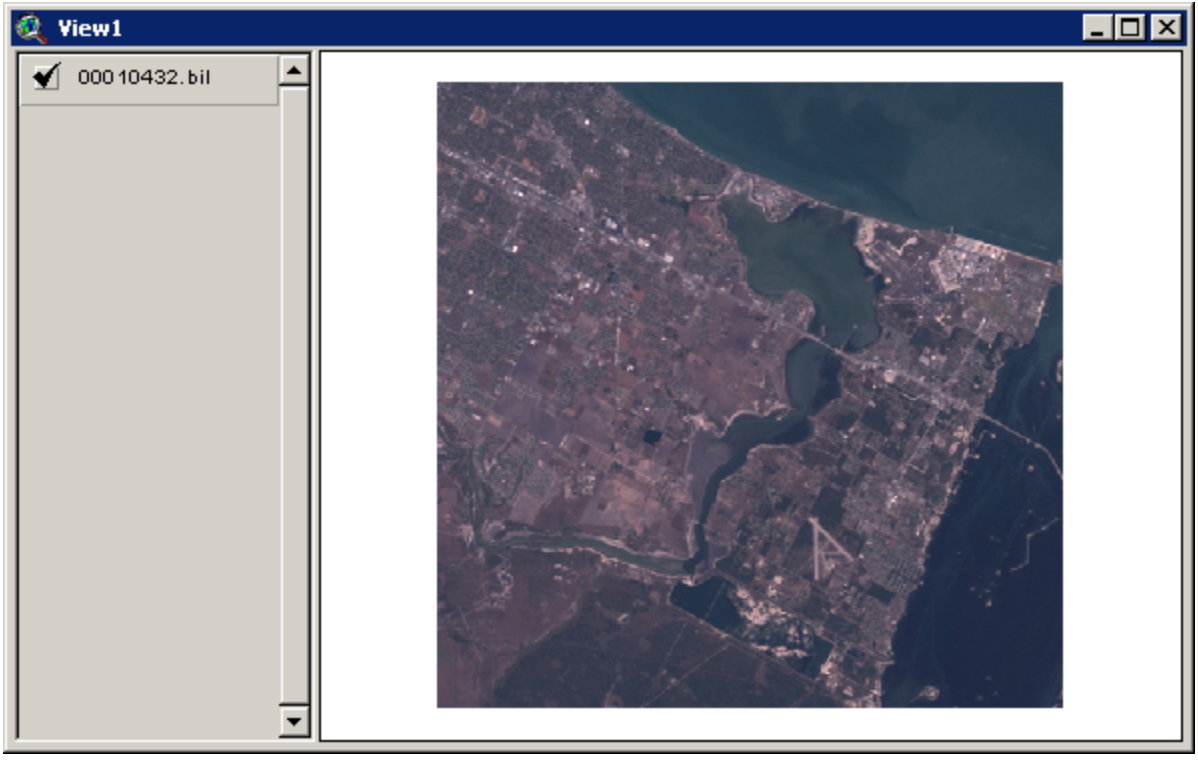
- Use the pull-down menus for the **green** and **blue** monitor colors to select the color combination below.



- Click the **Apply** button in the **Image Legend Editor**.

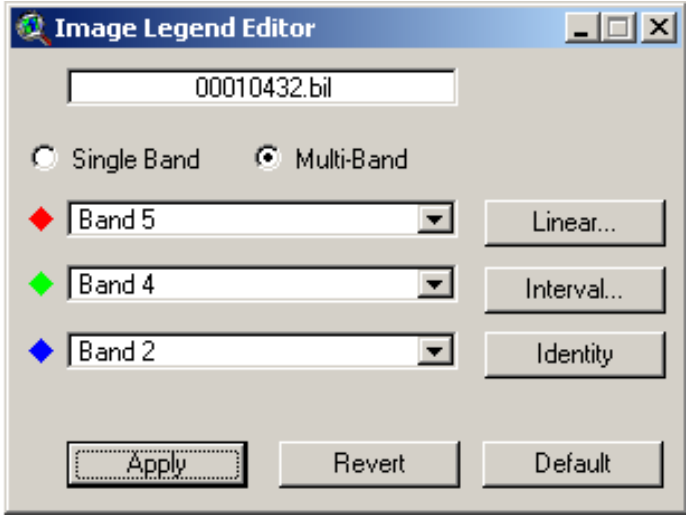
- Close the **Image Legend Editor.**

This should improve the brightness of the image and the visibility of features.



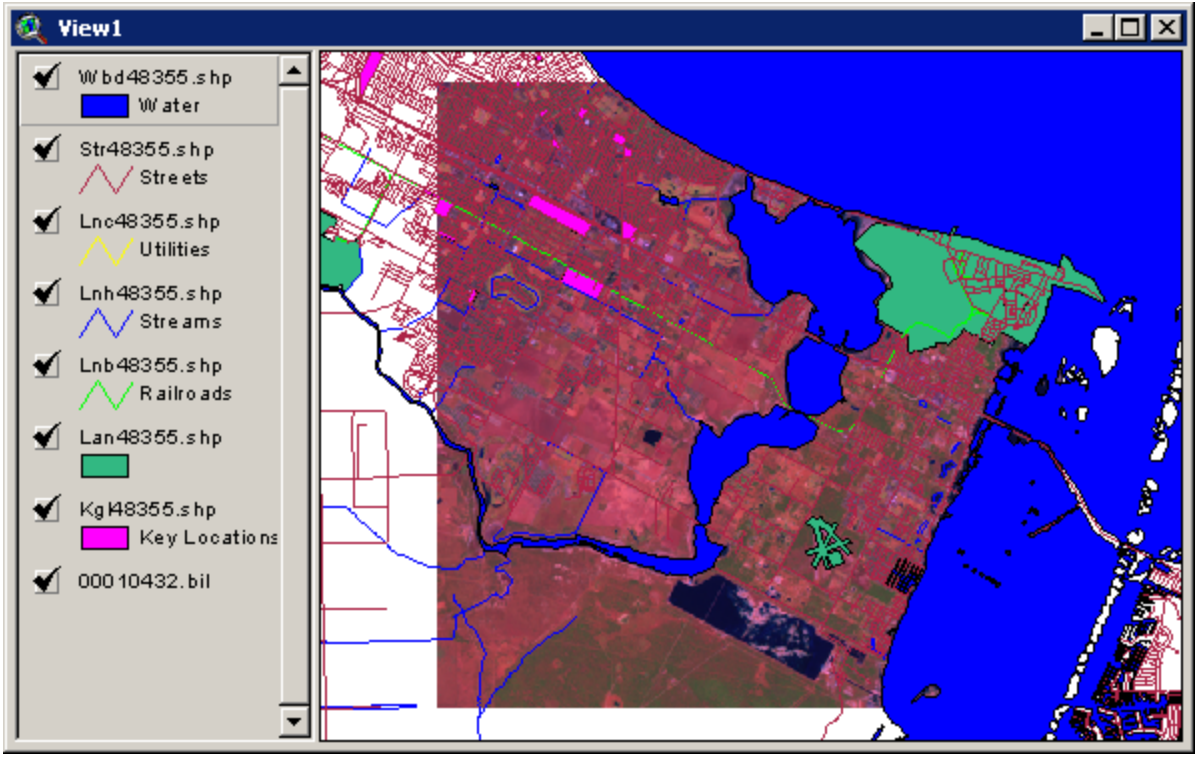
The amount of improvement will depend, to some degree, on the quality of your monitor, and the number of colors you have it set to display.

- You can also try the combination shown below. Although the colors in this combination are not the Earth's true colors, it may give you a significant increase in brightness.



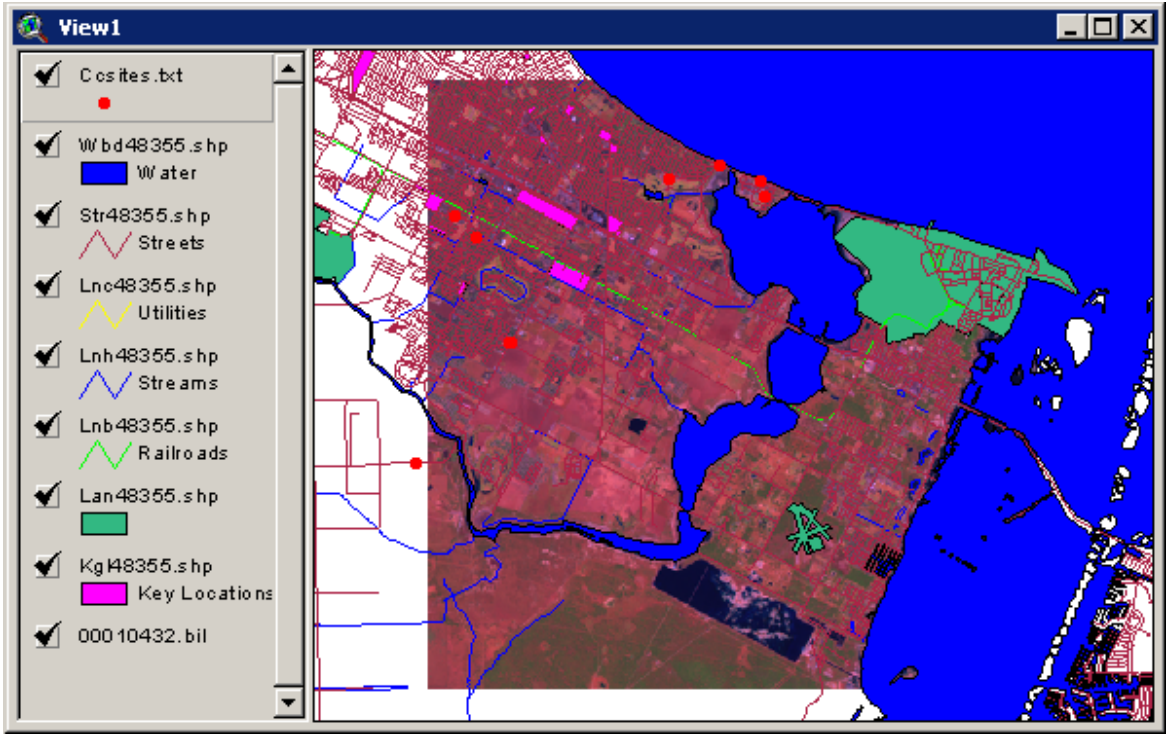
- Also contained in the *Chapter 10 data* folder is a set of GIS data for Corpus Christi. These are provided as shape files through the courtesy of ESRI.

- Add these **Themes** to your **View** and rename them.



- During a workshop in Corpus Christi, participants gathered Land Cover data from sites in the area. These data are included as a text file, *CCSites.txt*, which is also included in the *Chapter 10 data* folder.

- Add this file to the **View** as an **Event Theme**. The result is shown below.



Chapter Summary: In this chapter you have seen how to incorporate a Landsat image into a View and overlay vector data on top of it.

What Can I Do With This?

The ability to use your GLOBE Landsat image as the base layer for a GIS View is valuable in helping your students determine locations and land cover types in your GLOBE Study Site. If you and your students are performing the GLOBE Program land cover mapping and accuracy assessment protocols, your Land Cover Sample sites can be accurately located on your image. This can help improve the accuracy of the land cover maps your students produce.

In addition, local student investigations in social studies, geography, history, biology, environmental studies, and geology can all benefit from seeing how local environmental measurements are related to land cover features.

Chapter 11: Now What Do I Do With It And Where Do I Go Next?

Now that you have had a taste of what GIS software can do, the next question is "How do I apply this to my curriculum?" A number of possibilities have been suggested during this tutorial, but one of the best ways to address the question is to look at some projects that have been created by students.

ESRI maintains a library of student projects in its Community Atlas:

www.esri.com/communityatlas

The following images, sampled from the Community Atlas, show some of the possibilities of GIS in the classroom.

1. **Where Are We?** In this project students map the location of their school on a relief map of New England with water bodies and streams.

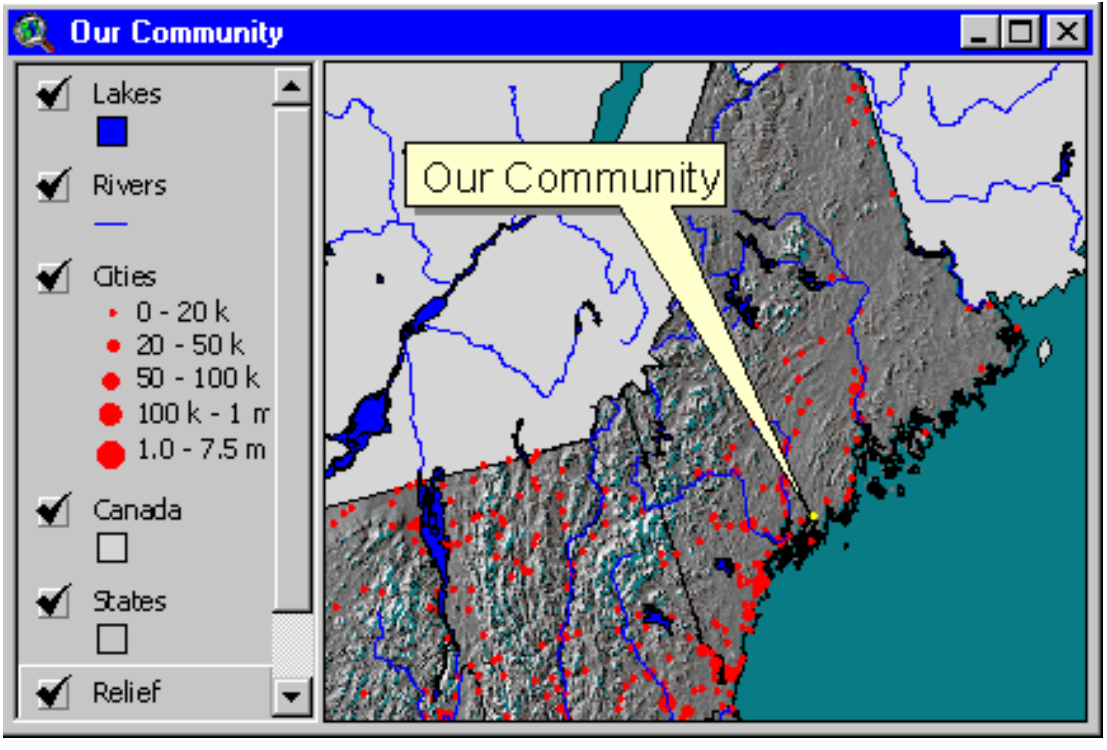


Image courtesy ESRI. © ESRI, 1999

2. **Our Watershed**: Students have shown their school location in the watershed of a local water body.

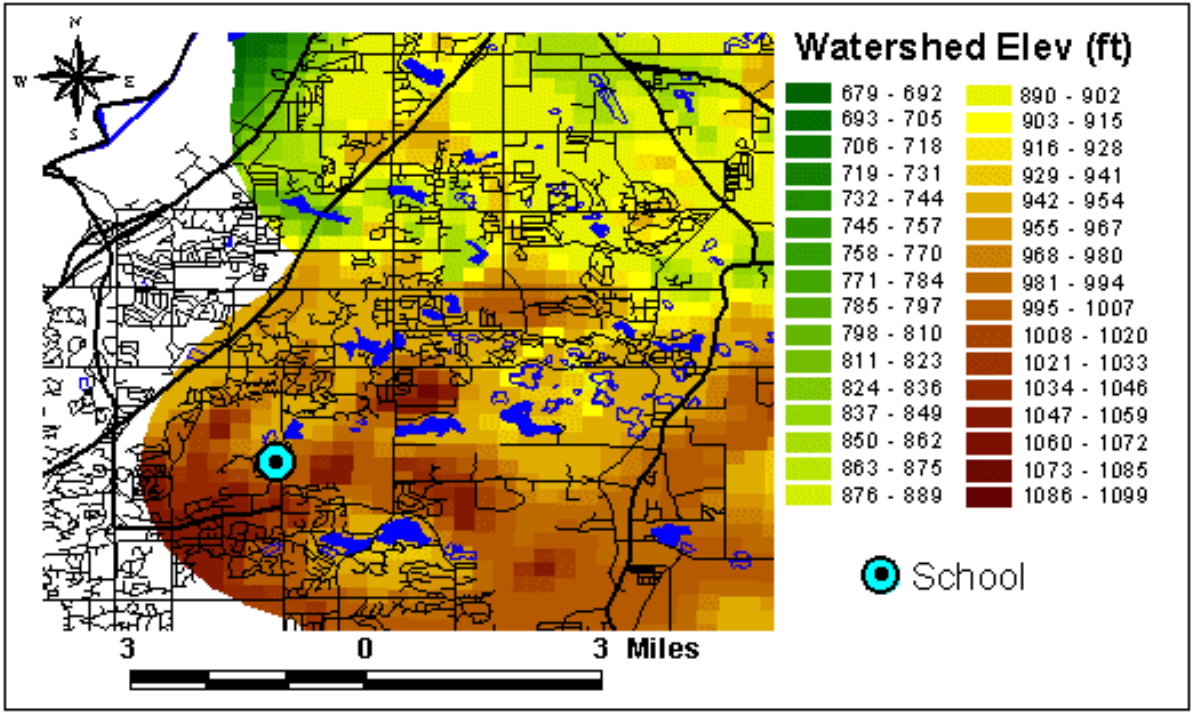


Image courtesy ESRI. © ESRI, 1999

References:

"Can Young Students Use GIS?" This article, written by Charlie Fitzpatrick, director of ESRI's Schools and Libraries Project, addresses using GIS with very young students. It can be found at:

http://www.esri.com/industries/k-12/hrynggis.html

ESRI also provides more than a dozen prepackaged lessons and projects designed for use with ArcVoyager that can be used with ArcView. These cover all grade levels, and can be downloaded from:

http://www.esri.com/industries/k-12/voyager.html#lessons

Summary:

GIS software provides students the opportunity to explore and interact with data that cross many disciplinary lines. The ability to access local, regional and national data on the Internet gives students the power to explore the relationships between phenomena and place. Students can explore geography with maps, tables and graphs that they create with world wide data and they can add local data to their projects.

Making "place" an important part of learning, especially in the sciences, reinforces the idea that knowledge develops in the context of time and place.

GIS also provides an educationally important use of computer technology and the Internet. The vast amount of free data available provides students with the raw material for meaningful exploration.

For questions about this tutorial contact the developer:

GLOBE Land Cover/Biology Team
LCBioTeam@globe.gov

Appendix I: Local Sources of GIS Data

Many local, regional, state, provincial or national groups use GIS data, and these are often willing to share such data with schools for educational use. A few suggestions for the types of agencies you might contact are given below.

- Local, county, state, provincial or national offices of GIS.
- Surveying organizations, both public and private.
- Mapping agencies.
- Environmental agencies.
- Local or regional governmental planning agencies.
- University departments of geography, remote sensing, natural resources and geosciences.
- Highway and transportation departments.
- Architectural firms.
- Urban and suburban planning agencies.
- Police and emergency services.
- Utility agencies such as electricity, water and telephone.
- Large local/state delivery firms: These companies often use GIS to dispatch vehicles or plan routes.
- Your local school districts.
- Forestry planning and management agencies.
- Farmers and farm organizations.

Some Reliable Internet Sites for GIS Data

http://www.esri.com/company/free.html
Run by Earth Systems Research Institute, the developers of ArcVoyager, there are links to free software and free GIS data.

http://www.geo.ed.ac.uk/home/giswww.html
This United Kingdom site has lots of links to many GIS related topics, including some data.

http://www.calmit.unl.edu/calmit/left_links/gisrs.htm
Most of these links are U.S. based.

http://www.census.gov/geo/www/tiger/
http://www.census.gov/geo/www/tiger/tigerua/ua_tgr2k.html
These links supply U.S. data on a county level from the U.S. Census Bureau.,

http://gislounge.com/ll/worlddata.shtml
A clearinghouse for world wide GIS resources.

http://www.gisdatadepot.com/
DataDepot has lots of international GIS downloads.

Appendix II: Importing Arc Export (E00) Files

Before You Begin:

- Some download sites, such as *Data Depot* (www.gisdatadepot.com) provide their files with the *.GZ* (gzip) extension. This is a Unix OS compression format. Other sites may provide data compressed in *.tar* format (another UNIX compression) and some may be in conventional *.zip* form. Before you can import the file into ArcView, you must uncompress it.

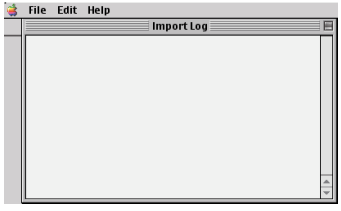
- *Tar, gzip* and PC *zip* files can all be decoded by *Stuffit Expander*. This is an easy-to-use decompression program that handles many different file formats. Simply drag the file's icon and drop it on top of the *Stuffit Expander* icon which is placed on your desktop when you download and install Expander. Expander is available for Macintosh, PC, Unix and Solaris platforms. It can be downloaded free from the Aladdin website at:

  http://www.stuffit.com/expander/

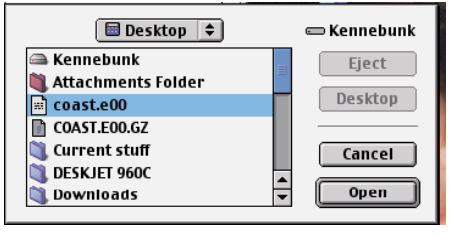
- Once you have unstuffed the *.GZ* file, you will have an *.e00* file.

Import for Macintosh Computers

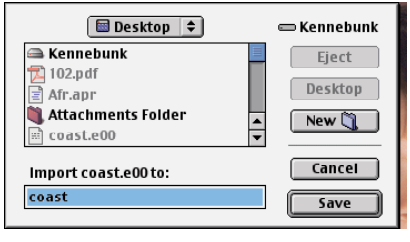
- For practice you will find a file named *Coast.e00* in the Appendix folder.
- Before launching *Import* move the *.e00* files you wish to import to the Macintosh desktop. It is a quirk of *Import* for the Macintosh that it prefers files on the desktop.
- Launch *Import*. Import's screen is very simple, as shown to the right.



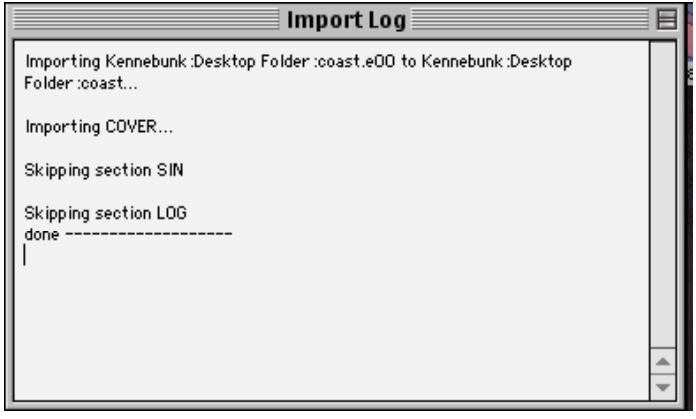
- From the **File** menu, select **Import**.
- Navigate to the location of your *.e00* file.
- Select the file and click **Open**.



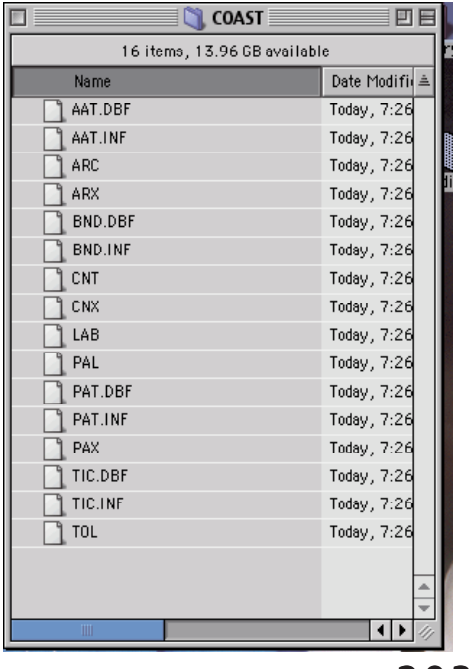
- *Import* will prompt you for a location to save the file. Use the default name that *Import* provides, and navigate to your destination folder.



- Import will do its work, and if the import is successful, you will see ascreen similar to the one below.



- The destination you selected will now have a folder, in this case *Coast*, with contents similar to those shown to the right. These data may now be used in ArcView.

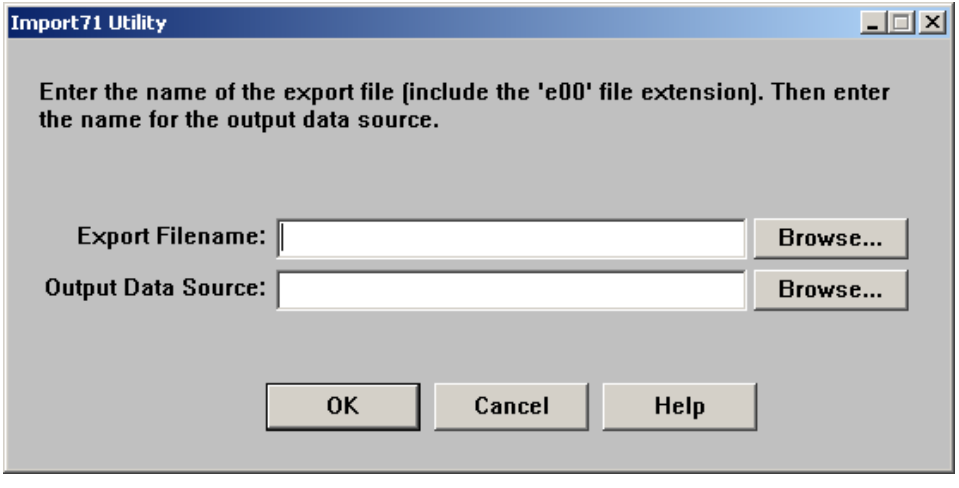


Import 71 for PC Machines

I*mport 71* is the PC version of the Import software. If you do not have *Import 71*, you must download the *Import 71 installer*. You should install *Import 71* in the same folder that contains your ArcView software.

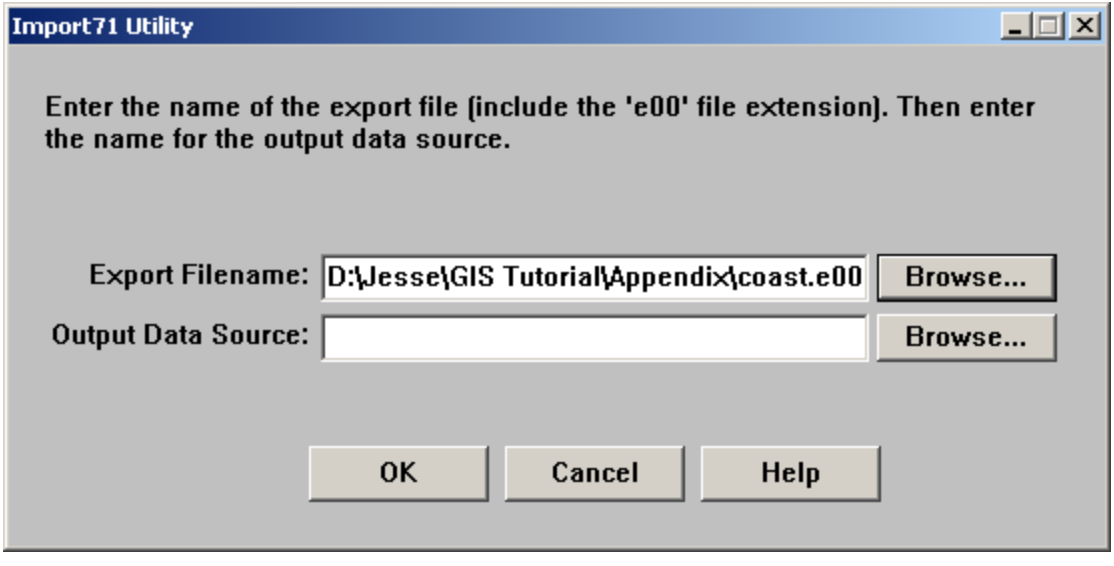
Importing the e00 file

- For practice, you will find a file named *Coast.e00* in the Appendix folder.
- Launch *Import 71*. You will see the dialog box below.

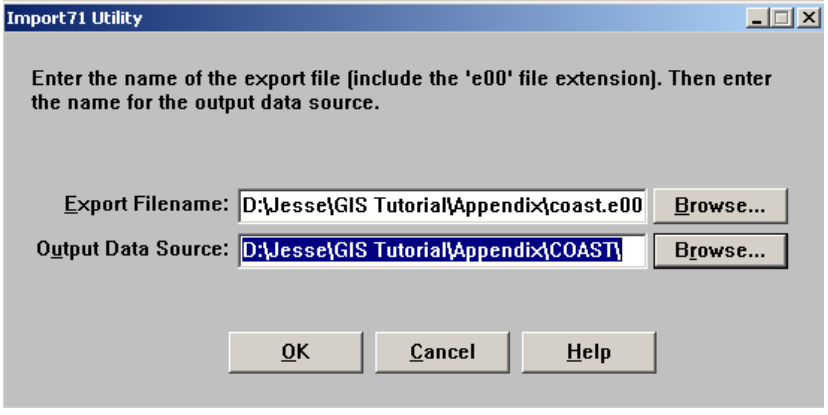


- There are no menus for *Import 71*. You simply specify the file to import, the destination of the imported file, and click **OK**.

- In the top line of the dialog box, specify the complete path for the location of your *.e00* file or use the **Browse** button to navigate to it. Be sure to include the extension *.e00*, as in the example shown below.



- In the second line, specify the complete path for the files destination. You should include a file name that is the same as the *.e00* file, so you know what feature the file contains, or use the Browse button.



- Click **OK**, and *Import 71* will import the file.
- Examining your directory, you will find a folder named *Coast* containing the new files.
- These files are now ready to be used in ArcView.
- *Import 71* quits after it has done its work. To import more files, you must relaunch *Import 71*.

A Cautionary Note: *Import 71* is particular about its location. The author has tried installing *Import 71* in directories other than the ArcView directory and on other disks with mixed results. For best results, you should install *Import 71* in the same directory as ArcView.

Appendix III: Image Registration

For any image to be used in a GIS program, it must contain location data. Such data **register** the image to the ground. These data are generally provided in a header file (*.hdr*) or a *world file*. Prior to 2001, GLOBE school images were provided without such information and could not be used unless one of these files was created.

To Register an Image

Create a World File from "scratch." The contents of a typical world file are shown below.

The lines of the world file provide the following data:

- Horizontal size of a pixel.
- Rotation term for a row of pixels.
- Rotation term for a column of pixels.
- Vertical size of a pixel.
- Longitude of the center of the upper-left pixel.
- Latitude of the center of the upper-left pixel.

You can create your own world files for images that are not registered. If you are using Landsat Thematic Mapper (TM) imagery, such as older GLOBE images, the following parameters apply:

Horizontal size of pixel	= 30.000
Vertical size of pixel	= -30.000
Rotation for row	= 0
Rotation for column	= 0

Note the value for the vertical size of the pixel is **negative**

The most important part of the world file is accurately locating the latitude and longitude of the center of the upper left pixel in your image. The greater the accuracy and precision of this value, the better your image will match other GIS data you use. Be sure to follow the GLOBE GPS protocol in taking your measurements.

Create the world file in any word processor, but be certain to save it as a text-only file. Using NotePad (PC) or SimpleText (Macintosh) will insure you have the proper file format.

Naming the world file: The world file name must follow a specific protocol. It consists of:

a. The file name must be the same as the image file name
b. The extension must contain the first two letters of the extension of your image plus the letter "w," for world file.

Example: If your image file is named *MyHome.bil*, then the world file has the name *MyHome.blw*. If your older image has the extension *.lan*, rename the file with the extension *.bil*. "Bil" stands for *band interleaved by line* and all older GLOBE images were actually in this format.

When you open a **View** that is to contain your image, be certain that both **Map Units** and **Distance Units** have been set to **meters** in the **View Properties** window (See Chapter 10).

Appendix IV: How Do I Get ArcView?

Schools may earn a full version of ArcView through the **Community Atlas** project of ESRI's **Schools and Libraries Program**.

You may purchase ArcView outright from ESRI. See their web page

www.esri.com

for details.

ESRI's US Community Atlas

Classes in K-12 schools are encouraged to compose a profile of their community, consisting of 10-20 maps (in GIF or JPG format) and 1000-2500 words (in HTML documents). After constructing and testing their group project, classes post the files on the ESRI Community Atlas web site, and create an entry in a searchable database.

http://www.esri.com/communityatlas

The Community Atlas is a great opportunity for teachers in science, social studies, English or language arts, and technology! Classes can choose between three main types of projects: general community profile, local conservation issue, or a historically focused presentation. Each arena offers broad flexibility, and suggestions are listed on the **Details** page of the web site.

Appendix V: Image Correction

Images in MultiSpec, ArcView and ArcVoyager

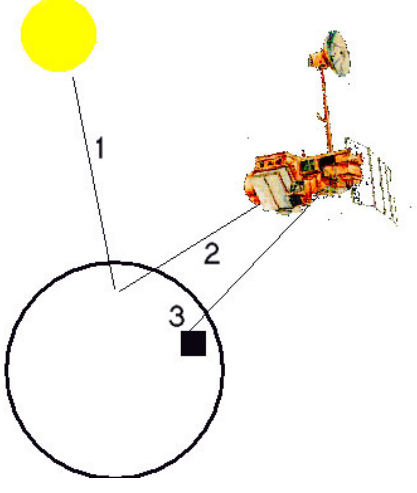
When you open your image in the free MultiSpec software used in the GLOBE program, your image will appear as shown below (an image of Durham, New Hampshire is used an example).

However, the same image opened in ArcView would appear darker and fewer details would be visible.

Why Does This Happen?

Every pixel in your GLOBE Landsat image contains 5 numbers that describe the brightness of that pixel in each of the 5 Landsat channels supplied by GLOBE. These values can range from zero (0) for no reflectance (which appears black) to a maximum of 255 for high reflectance (which appears white).

The data in your image however, do not make use of this full range of brightness. The diagram below illustrates the process that is responsible for this. Light from the sun passes through our atmosphere to the Earth's surface (1). It is reflected back through the atmosphere to the satellite (2), where sensors convert the light to digital data. It is these data that are recorded by a ground station (3).

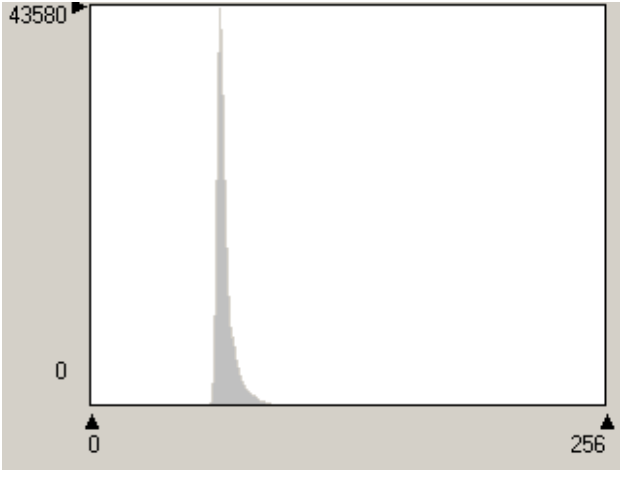


During its two passages through our atmosphere, significant amounts of light are scattered, absorbed and reflected, so the satellite actually sees less energy than it would if our planet had no atmosphere. The result is that much of the image data are compressed into the lower portion of the 0 - 255 scale of brightness so the image appears quite dark. To correct this, we must stretch the data in each channel so they use the full range of brightness.

The distribution of pixel values is illustrated in a graph know as a histogram." A histogram shows how many pixels in the image are represented by each value in the image's range of values. A tutorial on producing histograms in MultiSpec is available from the University of New Hampshire's GLOBE site at

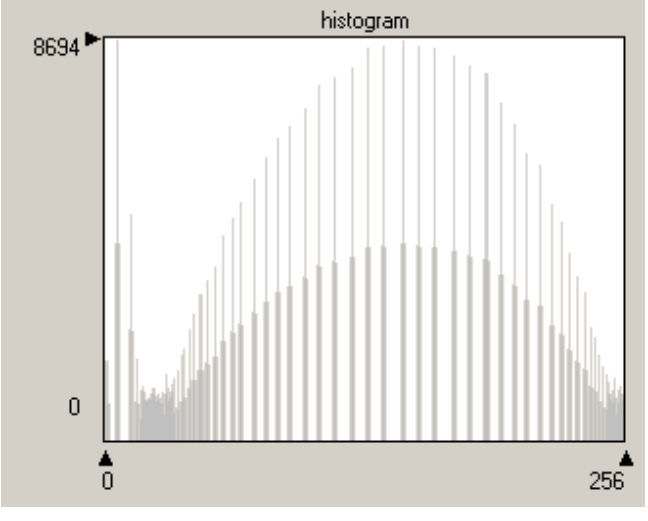
http://www.globe.unh.edu/MultiSpec/MultiSpec.html

The graph below is a histogram of Landsat channel 4, the Near Infrared channel, from the Durham image as supplied by GLOBE. Notice that the greatest number of pixels, shown by the large peak, is concentrated in data (called reflectance) values of about 60 - 100, with almost no pixels in the brighter (higher number) values. The limit of the reflectance values of 255 is shown by the blue line.



MultiSpec automatically “stretches” the data when the image is displayed. They literally grab both ends of the data and stretch it out to cover the full range of brightness values available. This is why the image displays properly. ArcVoyager does not have that stretching function so the user must do the job him/herself.

The graph below is the same channel from the same image after the stretching process.



The data now cover much more of the range of available Brightness values (0 - 255) and the resulting image will appear much brighter.

This image stretching can be done in MultiSpec, either on a Macintosh or PC computer. A detailed tutorial for doing this stretch can be found at the University of New Hampshire GLOBE site. The tutorial is entitled Blue Band, because it also corrects for extra reflection in the Landsat blue channel (channel 1) caused by atmospheric scattering. The tutorial is small (258 k) and is provided in Adobe's *.pdf* format. You will need Adobe's free *Acrobat Reader* software to view and print this tutorial. Most computers come equipped with *Reade*r, but you can reach Adobe's download page from the GLOBE home page, the UNH MultiSpec page, or directly at:

http://www.adobe.com

If you are using a PC computer, there is a small (65 k) supplement, **Blue Band PC**, which you will also need to download. It covers the slight differences in the process between the Macintosh and PC versions of the MultiSpec software. This document will not duplicate all the steps of the Blue Band tutorial, but will only list the changes you need to make to stretch your image and keep its ArcVoyager compatibility.

How Do I Do It?

- Begin by downloading the *Blue Band* tutorial (and the PC supplement if necessary) from the UNH GLOBE site.

- Familiarize yourself with the tutorial until you are comfortable with the process.

- Before you begin your stretching create a new folder or directory to hold your results.

- After you have completed the stretch, and are ready to save the new image, be certain to follow the instructions contained on page 18 of the *Blue Band* tutorial. These instructions are specifically designed for the newer georeferenced (containing position data) GLOBE images.