An Introduction to GIS

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What is GIS

- "GIS is a system of hardware and software used for storage, retrieval, mapping, and analysis of geographic data. Practitioners also regard the total GIS as including the operating personnel and the data that go into the system. Spatial features are stored in a coordinate system (latitude/longitude, state plane, UTM, etc.), which references a particular place on the earth. Descriptive attributes in tabular form are associated with spatial features. Spatial data and associated attributes in the same coordinate system can then be layered together for mapping and analysis. GIS can be used for scientific investigations, resource management, and development planning" (Northwest GIS Services Inc., 1999, definitions).

GIS Uses

- "In a GIS, you can study not just this map or that map, but every possible map. With the right data, you can see whatever you want – land, elevation, climate zones, forests, political boundaries, population density, per capita income, land use, energy consumption, mineral resources, and a thousand other things – in whatever part of the world that interests you" (Ormsby et. al, 2004, p. 1).
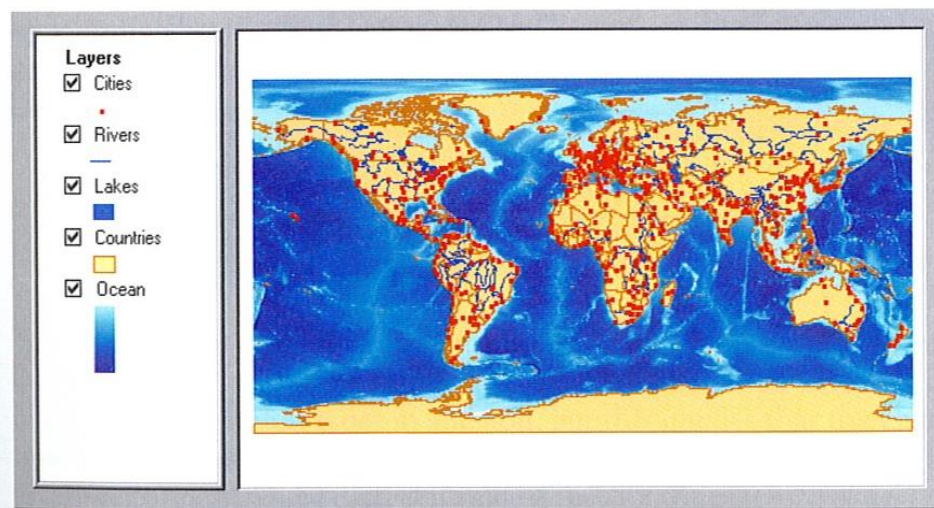
The map has a legend (or table of contents) on the left and a display area on the right.
(Ormsby, et al, 2004, p.1).

GIS Map Layers

- Layers are a collection of geographic items that are grouped together to represent visual data.
- Layers can be a collection of features or surfaces.

This world map is made up of five layers. It could have many more.
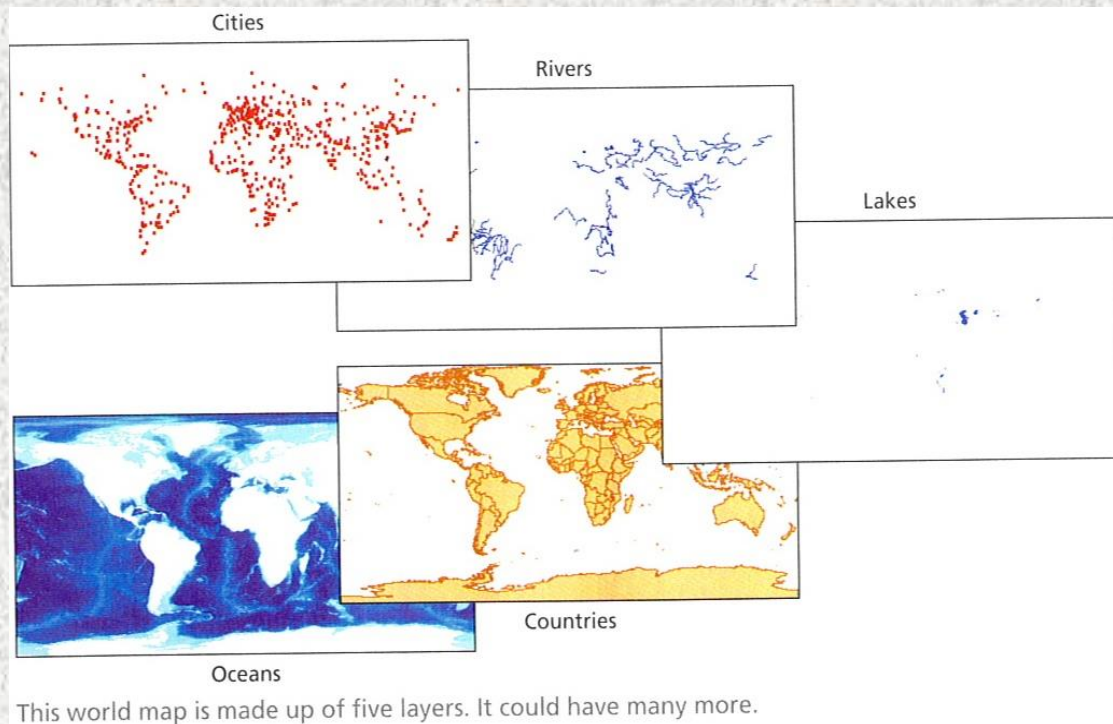
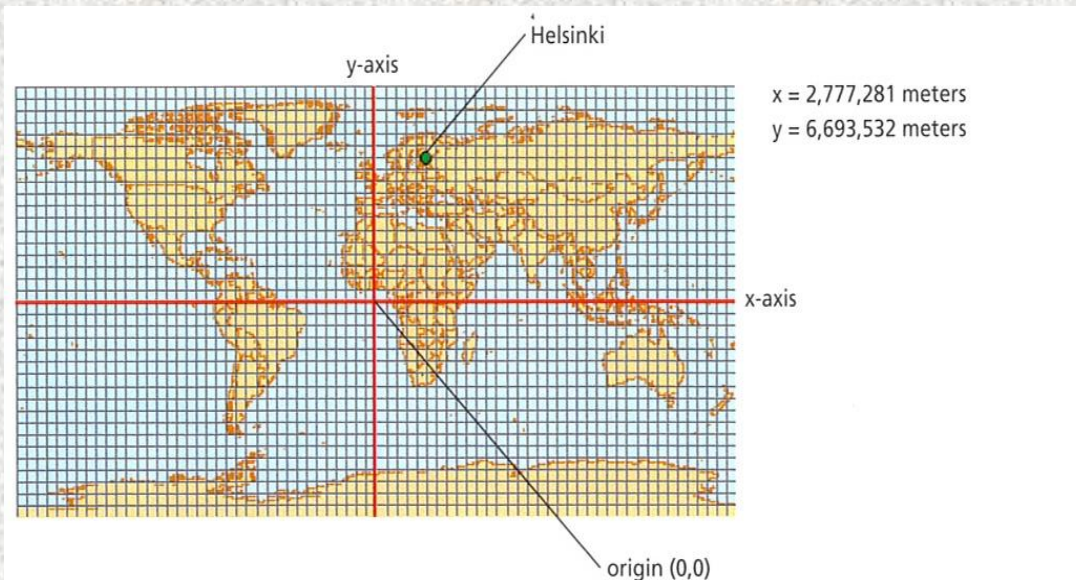(Ormsby, et al, 2004, p.2).

GIS Layer Features

- Features have shape and size and are categorized as vector data.

- A feature (vector data) has a shape of a polygon, a line, or a point.

Feature Layer

- Polygons
  - Large objects with boundaries such as rivers, land parcels, zip code areas.

- Lines
  - Objects that are long and narrow such as roads, rivers, pipelines, etc.

- Points
  - Objects that are too small to be polygons in the current scale of the map.
  - However, points in one map scale may be polygons in another map scale.

Features have Location

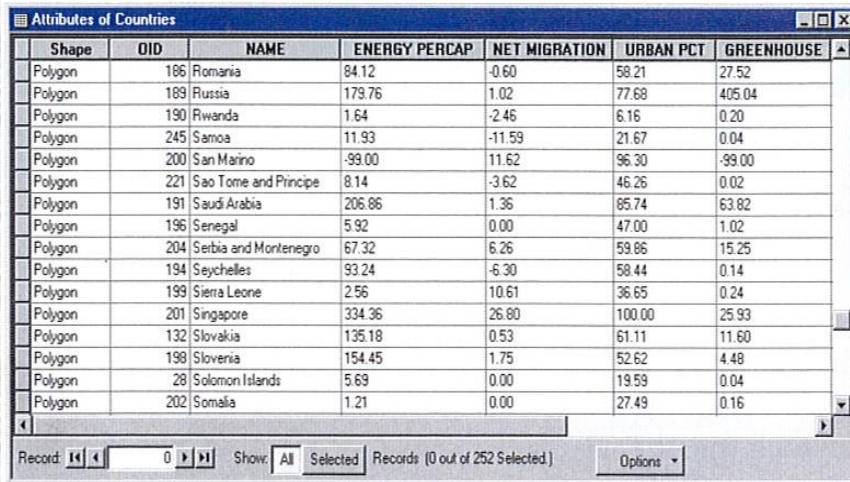- Features have location and are mapped by a coordinate system with an x-axis and a y-axis.

On a map, a coordinate system has an x-axis and a y-axis. The intersection of the axes is called the origin. Feature locations are specified by their distance from the origin in meters, feet, or a similar unit of measure.
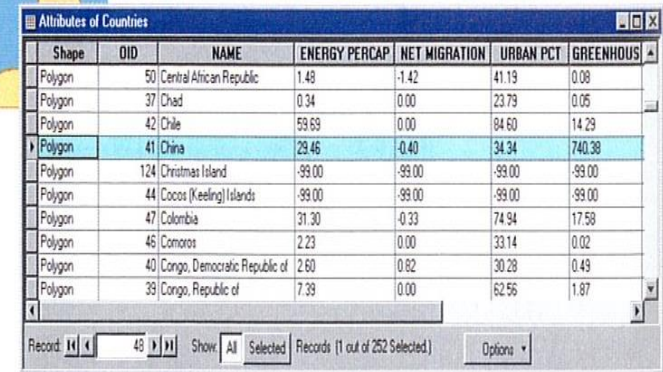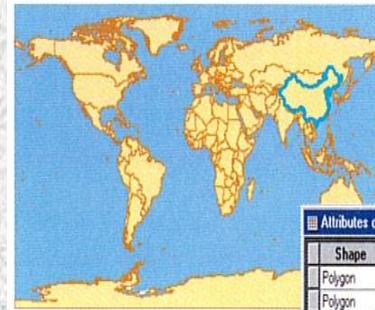
(Ormsby, et al, 2004, p.4).

Features and Attributes

- Features have attribute tables (data linked to a feature with a table of information).
- Attribute tables are spreadsheets or tables of information about the displayed feature.

Shape	OID	NAME	ENERGY PERCAP	NET MIGRATION	URBAN PCT	GREENHOUSE
Polygon	186	Romania	84.12	-0.60	58.21	27.52
Polygon	189	Russia	179.76	1.02	77.68	405.04
Polygon	190	Rwanda	1.64	-2.46	6.16	0.20
Polygon	245	Samoa	11.93	-11.59	21.67	0.04
Polygon	200	San Marino	-99.00	11.62	96.30	-99.00
Polygon	221	Sao Tome and Principe	8.14	-3.62	46.26	0.02
Polygon	191	Saudi Arabia	206.86	1.36	85.74	63.82
Polygon	196	Senegal	5.92	0.00	47.00	1.02
Polygon	204	Serbia and Montenegro	67.32	6.26	59.86	15.25
Polygon	194	Seychelles	93.24	-6.30	58.44	0.14
Polygon	199	Sierra Leone	2.56	10.61	36.65	0.24
Polygon	201	Singapore	334.36	26.80	100.00	25.93
Polygon	132	Slovakia	135.18	0.53	61.11	11.60
Polygon	198	Slovenia	154.45	1.75	52.62	4.48
Polygon	28	Solomon Islands	5.69	0.00	19.59	0.04
Polygon	202	Somalia	1.21	0.00	27.49	0.16

Record: 0 Show: All Selected Records (0 out of 252 Selected.) Options ▼

The attribute table for a layer of countries includes each feature's shape, ID number, and name, among other things.

Shape	OID	NAME	ENERGY PERCAP	NET MIGRATION	URBAN PCT	GREENHOUS
Polygon	50	Central African Republic	1.48	-1.42	41.19	0.08
Polygon	37	Chad	0.34	0.00	23.79	0.05
Polygon	42	Chile	59.69	0.00	84.60	14.29
Polygon	41	China	29.46	-0.40	34.34	740.38
Polygon	124	Christmas Island	-99.00	-99.00	-99.00	-99.00
Polygon	44	Cocos (Keeling) Islands	-99.00	-99.00	-99.00	-99.00
Polygon	47	Colombia	31.30	-0.33	74.94	17.58
Polygon	46	Comoros	2.23	0.00	33.14	0.02
Polygon	40	Congo, Democratic Republic of	2.60	0.82	30.28	0.49
Polygon	39	Congo, Republic of	7.39	0.00	62.56	1.87

Record: 48 Show: All Selected Records (1 out of 252 Selected.) Options ▼

(Ormsby, et al, 2004, p.6).

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GIS Surfaces

- Surfaces have numeric value and are represented as raster data.
- Raster data is a grid of cells where each cell represents a numeric value. (Examples would include elevation, slope, temperature, rainfall, etc.).
- Raster data has values for locations on the earth's surface.
- For the purpose of time, we will focus on features only.

Zip Code Shape-files

Steps to extract zip codes

Zip Codes

- How to down load a zip code shape file from the Census Bureau's website:
- **Step one**. Go to the Census Tiger Website. www.census.gov/geo/www/tiger/
- **Step two**. Click on the *Tiger/Line Shapefiles 2007*
- **Step three**. Click on the *Download 2007 Tiger/Line Shapefiles now*. (Located about ¾ down the page)
- **Step four**. Click on the *Census 2000 5 – Digit zip code Tabulation Area.*
- **Step five**. Click on the *save Shapefiles* – save to a specific folder (preferably a folder on the c: drive)

Zip Codes

- **Step 6**. Open up the file that you saved the zip files to.

- **Step 7**. On the zipped file, click *extract here.*

- **Step 8**. Now the file may be uploaded to ArcGIS.

- **Step 9**. Open up ArcGIS.

- **Step 10**. Click on the *Add Data button* (+ on top of a yellow diamond) on the task bar.

- **Step 11**. Scroll to the file you downloaded the shape-file to and open up the folder.

- **Step 12**. Click on the zip code shape-file. Now a shape-file of all zip codes in the United States should appear on your screen.

Clipping a Shape-File

Extract zip codes to State Level

- The zip code shape-file you have just uploaded represents zip codes nationally.

- To extract zip codes to a specific state, you need to have a state shape-file (may be downloaded in the same fashion as the zip code shape file was).

- When the State shape-file is uploaded into ArcGIS, the zip code shape-file may be extracted (clipped) to the boundaries of the state shape-file.

Extracting zip codes to state boundaries

- **Step one**. Make sure that both the state shape-file and the zip code shape-file are uploaded onto your active map.
- **Step two**. Open *Arc Toolbox* (toolbox icon on the task bar).
- **Step three**. Click on *Analysis Tools*, then on *Extract*, then on *Clip*.
- **Step four**. For the Input drop-down menu, select your zip code shape-file.
- **Step five**. For the output drop-down menu, select your state shape-file.
- **Step six**. For the output feature class, click on the folder and direct to the file folder you would like to save the new shape-file. Name the shape-file something you will remember.
- **Step seven**. Click yes to *add the new shape-file to your map*.

Extracting zip codes to county boundaries

- Now that you know how to extract zip codes to a state boundary, you can follow the same steps to extract zip codes to county boundaries or to any other boundary that you would like, as long as you have a boundary shape-file to extract zip codes to.

Downloading Census Data

Census Data and GIS

- Census data may be downloaded and added to a GIS map to identify data visually.

- For example, your boss is in the process of applying for a grant that would help high density Asian communities within Douglas County. Your boss would like you to map the total Asian population for Douglas County by Census Tract so your boss knows what areas of Douglas County to focus on.

Census Data

- **Step one**. Use Firefox (web browser) and go to www.census.gov
- **Step two**. Click on *American Fact Finder*.
- **Step three**. Click on *Data Sets* (on the left side of the screen).
- **Step four**. Click on *Decennial Census*.
- **Step five**. Make sure the box next to census 2000 Summary File 1 (SF 1) 100-Percent Data is checked.
- **Step six**. Click on *detailed tables*.
- **Step seven**. Select census tract, then for state select Nebraska, then for county select Douglas, then for tract select all census tracts (at the top of the box) then click on the *Add button*.
- **Step eight**. Now all the census tracts for Douglas County have been selected, click the next button.

Census Data

- **Step nine**. Now select P7. or Race (total population) and click the *Add button*.

- **Step ten**. Click on the *show results* button.

- **Step eleven**. Hover your mouse around the *Print/Download* section (blue section/ white writing) at the top of the page. A dropdown menu should appear when you do this.

- **Step twelve**. From the drop-down menu, select the *download* option.

- **Step thirteen**. Scroll down the bottom of the new page and check the box next to *Microsoft Excel (.xls),* then click on the OK button.

- **Step fourteen**. Click save to disk and then click the OK button. Now the zip drive for that information is on your desktop.

Census Data

- **Step fifteen**. Move the new zip-file from your desktop to a specific folder in your C: drive.

- **Step sixteen**. Right click on the zip-file and choose extract here.

- **Step seventeen**. After you extract the file, you should have two excel documents. These two files are the files you need to proceed.

- **Step eighteen**. You want to clean up the two documents and create one document to upload to your ArcGIS map.

Combining the two excel documents

Creating One Document

- Now that you have extracted the information that your boss has requested, you need to create one document before it can be uploaded into your ArcGIS map.

- This process can be done in one of two ways, which depends on if you use Microsoft Excel 2007 or the previous version Microsoft Excel 2003. We will discuss both methods of saving and extracting the document towards the end of this section.

Creating One Document

- **Step one**. Rename the document ending in data1 to just *data1*. Then rename the document ending in geo to just *geo*.

- **Step two**. Click on the data1 document and scroll over to column E (which is the first column where the race classification begins).

- **Step three**. Erase all columns prior to column E. This will help keep this step simple.

- **Step four**. Copy rows one and two to another excel sheet. Then erase the second row (the row with the names and titles of the columns). Make sure to keep the first row with the letters and numbers (ex. P007001).

- **Step five**. Copy the remaining document exactly as it is over to the end of the geo document (after the last column in the geo document).

Creating One Document

- **Step six**. Now that you have one document, you need to save the document in the same folder on the C: drive that you have been working with. However, you need to save the document as a *.dbf* file.

- **Step seven**. Saving as a *.dbf* file. If you are working with *Excel 2003*, you can simply save the document as a *.dbf IV* file in the save as type drop down menu.

- **Step eight**. If you have *Excel 2007*, you will need to save the document as an excel 97-03 workbook (If you have *Excel 2007*, you will need *SPSS*). Now that you saved the document as a 97-03 workbook, you will need to open *SPSS* and navigate to your saved document (remember to select the show all file types in the dropdown menu). After you open up your saved document you will need to save the document as a *.dbf IV* file in the save as type.

- **Step nine**. Now you can upload your new document into your ArcGIS map.

Joining Tables

Joining tables

- Now that you have uploaded your newly created *.dbf* file into ArcGIS, you can choose which layer you would like to join your *.dbf* file to.

- In order to join a table to an existing layer, there needs to be a common link between the two tables. For instance, each document should have a column with the same information. This column can be used to join the two tables together.

Joining tables

- **Step one**. Right click on the layer you would like to join your *.dbf* file to.

- **Step two**. Scroll down to Joins and Relates, then when your mouse cursor is over this section, click on join—it will pop up when the cursor is over the identified section.

- **Step three**. Select the *.dbf* file (under #2) that you created to be joined. Then under #1, select the column title of the existing layer to join the *.dbf* file to (remember, the data in the two columns needs to be identical in order for the join to successfully occur).

- **Step four**. Click the OK button. You will be prompted with a box asking if it is ok for an index to be automatically created for this join. Click OK to continue.

Joining tables

- **Step five**. Now your *.dbf* file should be joined to the layer. Right click the layer and go to open attribute table then left click on open attribute table.

- **Step six**. Scroll to the right of the document to see if the data is properly joined to the existing table. You should be able to see the information from the *.dbf* file on the right side of the attribute table.

- **Step seven**. If you scroll over and notice that the columns of the *.dbf* file you just joined say null, then you will have to remove the join and start the joining process over again. If this happens, be sure that the two columns of data that you are joining are identical.

- **Step eight**. If you need to remove a join, right click on the layer, scroll down to Joins and Relates and choose *remove all joins* and start the process over again.

Joining tables

- **Step nine**. Now that you have successfully joined data, you need to create a layer to save your creation (until you do this process, the join is only arbitrarily done).

- **Step ten**. Right click on the shape-file that you just joined and go to Data (when the mouse is on Data another box will pop up), then go to *Export Data* and click on it.

- **Step eleven**. Click on the little yellow folder icon off to the right side of the box and navigate to the folder (on your C: drive) you would like to save the new shape-file to. When you are in the proper folder, rename the shape-file to something you will remember (Use lower case letters and do not have spaces, you may use the _ symbol in lieu of spaces).

- **Step twelve**. After you save the shape-file to your C: drive folder, you will be asked if you want to add the shape-file to your map. Click OK.

Using Symbology to Illustrate Data on a Map

Symbology tab

- Now that you have successfully downloaded the proper data from the census tract, created a *.dbf* file, and joined the *.dbf* file to your existing map, you can create multiple different layers from the new data. This can be done by using the symbology tab in the properties section.

Symbology

- **Step one**. Right click on the layer that you just created and scroll down to *Properties* and click on it.
- **Step two**. Click on the *Symbology* tab (which is located on the top center portion of the data box).
- **Step three**. Click on *Quantities* (located on the left side of the data box).
- **Step four**. Find the *Fields* section (located close to the center of the screen) and in the Value drop-down menu, select the data column that you want to display on your screen.
- **Step five**. Choose how many classification breaks you would like for your map (On the right side of the data box).
- **Step six**. Click on the *Classify* button on the right side of the data box.

Symbology

- **Step seven**. Make sure that natural breaks is selected in the Method drop down box (at the top of the screen. Natural breaks does not always have to be selected, but for the purposes of this demonstration, that will be used). Then click OK.

- **Step eight**. Choose the color ramp that you would like to be displayed on your map. (This is done by clicking the drop down menu next to the color ramp and selecting the color that you want). Then click OK.

Creating A Final Map

Creating a Final Map

- Now that you have created the information that you would like to demonstrate, you need to create a title, add a legend, insert a text box with your name in it, choose a north arrow and select a measurement bar.

Creating a Final Map

- **Step one**. Until now, you have been working in *Data View Mode*. Now you need to select *Layout View Mode* to create the final touches to your map. There is a little icon that looks like a blank page at the bottom left corner of the map area (by the bottom scroll bar). Click on it. Now you are in *Layout View*.

- **Step two**. Pull the boundaries of the map close to the perforated section of the map (Not all the way to the edge of the map).

- **Step three**. Click on the *Insert tab* at the top of the screen. This is where you can add all the information for the final touches to your map. Now select the title box. After the title box appears on your map, you can choose the size of the fonts and can drag and drop the title in the location of your choice.

Creating a Final Map

- **Step four**. In the same Insert tab, you can select *North Arrow*. When the box pops up, scroll through and choose the *North Arrow* of your choice. You can drag and drop the arrow at the location of your choice. Continue this process with the measurement bar and other additional text boxes.

- **Step five**. To add a legend, click on the *Insert tab* and select *Legend*. From here, you will be prompted to select the data you would like to include in your legend. (Rule of thumb; keep it simple).

- **Step six**. For the purposes of this map, only include the layer that demonstrates the different color. At the bottom of the data box, it asks how many columns you want. For this map, select *one* then click the next button.

Creating a Final Map

- **Step seven**. Under *Legend Title*, you can choose something simple that explains what the layer represents. Click the size drop-down menu and select a smaller size (ex. 11 font). Then click Next.

- **Step eight**. Click Next again. Click Next. Then click Next one more time. You should be on the screen that asks you to set spacing. Until you have become an expert at map making, just click on the finish button at the bottom of the screen.

- **Step nine**. Now you can drag and drop your legend where ever you want.

- **Step ten**. Clean up your legend. Under the title of your legend, the name of the shape-file will appear. We want to remove the name of the layer file (this will make the legend look neat).

Creating a Final Map

- **Step eleven**. Click once on your *legend* to activate it. Then right click once on your *legend* to bring up a data box. In this box, click on *Convert to Graphics*.

- **Step twelve**. Once you clicked on *Convert to Graphics*, you need to right click once on your *legend* and go to *Ungroup*. Click on *Ungroup* (Be Careful, now every line in your legend is in a separate text box).

- **Step thirteen**. Now that everything in your *legend* is ungrouped, select the layer name (directly under the legend name, and above the color boxes) and click *delete*.

- **Step fourteen**. Now that you got rid of the layer name, click on the *legend* title and slowly use your directional arrow keys to lower the title closer to the color boxes. (PLEASE NOTE THAT YOU SHOULD ONLY USE THE ARROW KEYS TO MOVE THIS BOX. THIS WILL KEEP YOUR LEGEND NICE AND NEAT.)

Creating a Final Map

- **Step fifteen**. Now that you have lowered the *legend* title to your liking, regroup the legend together (This is to prevent any text box from being displaced and to keep the legend neat). Carefully hold down the Ctrl Key and click ONCE on each text box in your *legend*.

- **Step sixteen**. Now that every text box in your *legend* is highlighted, right click on your mouse and go to group. Now click *group.* Your legend is now grouped back together and you may move your legend to your liking.

- **Step seventeen**. Now that your map layout is complete, export your map. Click on *File* (at the top left of your screen) then go to *Export Map* and click on it.

- **Step eighteen**. Direct to the file you would like to save your map to. Then choose the name of the map. Make sure that the map is saved as a *PDF* (for the purposes of this activity, but you can save it as a *GIF* or *JPEG*). Then click save. Now you can close ArcGIS and view your map.

References

- *Northwest GIS Services Inc. (*1999). Retrieved June 16, 2008, from http://www.nwgis.com

- Ormsby, T., Napoleon, E., Burke, R., Groess, C., & Feaster, L. (2004) . *Getting to know ArcGIS, desktop: Basics of Arcview, ArcEditor, and ArcInfo.* Redlands, CA: ESRI Press.

Additional Resources For Shape-Files

Additional Resources

- USGS Seamless Data Distribution Website (aerials, NED, roads, and more)
  http://seamless.usgs.gov/
- USDA - NRCS Soil Data Mart (county SSURGO soils data)
  http://soildatamart.nrcs.usda.gov/
- USDA – NRCS Geospatial Data Gateway (County Aerials, Common Land Units, SSURGO Soils)
  http://datagateway.nrcs.usda.gov/GatewayHome.html
- Nebraska GIS Data Bank (Nebraska datasets by State, County, Quad, Quarter Quad, Drainage Basin…..) http://www.dnr.ne.gov/databank/spat.html
- UNL Conservation and Survey Division (NE statewide data sets)
  http://csd.unl.edu/ (click Nebr.Data Sets.)
- Iowa NRGIS website (Iowa Data by theme or county)
  http://www.igsb.uiowa.edu/nrgislibx/gishome.htm
- Nebraska Geographic Information Systems Steering Committee, Nebraska Geospatial Data Clearinghouse http://www.calmit.unl.edu/gis/geospatial.html
- Iowa DNR website (multiple thematic interactive mapping services – Ex. Watershed Atlas)
  http://csbweb.igsb.uiowa.edu/imsgate/introduction/home.asp

Additional Resources

- UNL Libraries, GIS Data Sites, A collection of websites organized to help you better find what you're looking for in the wide world of GIS information
  http://www.unl.edu/libr/gis/gisdata.shtml
- Nebraska View - The Center for Advanced Land Management Information Technologies (**CALMIT**) at the University of Nebraska-Lincoln.
  http://nebraskaview.unl.edu/neview02.php or http://neview.unl.edu/mserv/maps/viewer.htm
- Allows users to identify and copy images.
  (Resources compiled by University of Nebraska at Omaha lab instructors in the Geography Department)