GIS Primer Table of Contents

Launching ArcCatalog and ArcGIS, making a new ArcMap

Launching ArcCatalog

- Go to Start and click on All Programs. Click ArcGIS.
- Double click on ArcCatalog to open. ArcCatalog is the electronic filing cabinet that organizes all of the data that you will manipulate in ArcGIS.
- The Table of Contents (TOC) in the left hand part of the window show you the organization of folders and files and allows you to copy, paste, rename, and remove files (see sections below).
- You can **Preview** a file by clicking on the Preview tab in the right hand window. Make sure that the pulldown menu at the bottom is set to **Geography**. In the Preview window, you will see a preview of what the file looks like, although you won't be able to do anything with it.

Where to Save Your Maps and Files

- You should create a folder dedicated to your current project for your data and maps. In other words, **when prompted to save something,** it should go into a folder for that project so that files aren't scattered or mixed in with those from other projects.
- The crucial thing about folder and file names is that you must ***be absolutely certain that there are NO SPACES in folder or file names and no oddball characters.*** If you want a space in your folder or file name, you must put in an underscore. ***MAC USERS BEWARE.*** Spaces are OK in Mac file and folder names. They are ***not*** OK in ArcGIS. If you have trouble getting something to work in ArcGIS, the very first troubleshooting thing you should do is check all of your file/folder names to make sure that they have ***no spaces and no long names.***
- In Windows Explorer, the default location for saving files is a folder titled Documents and Settings, which, unfortunately, has spaces in the name. Even if you are careful to eliminate spaces in your file names, saving to the default folder means that you are dead in the water. That's why it's important to set up new folders that are not in the Documents and Settings folder and that have **no spaces in the names** into which you can save your files.
- And, **don't make a folder on the Desktop** – ArcGIS does not like folders or files on the desktop.
- When you create a new file based on an existing file, ArcGIS commonly suggests a file name. Unfortunately, this name *can* be too long and too complex (such as *DEM_to_raster_0479343.tif*). If you find that things aren't working, check to make sure that the file name is ***short*** and with no spaces.

Making a new ArcMap

- Launch ArcMap, and select **A new empty map**.
- **Saving Relative Pathways in ArcMap.** Before saving an ArcMap .mxd file to your folder, make sure that you will be saving **relative**, rather than absolute, path names. Go to File, Document Properties, Data Source Options, and click "Store relative path names" before saving your file.
- Name and save your new file. The crucial thing about folder and file names is that you must ***be absolutely certain that there are NO SPACES in folder or file names and no oddball characters.*** If you want a space in your folder or file name, you must put in an underscore. ***MAC USERS BEWARE.*** Spaces are OK in Mac file and folder names. They are ***not*** OK in ArcGIS. If you have trouble getting something to work in ArcGIS, the very first troubleshooting thing you should do is check all of your file/folder names to make sure that they have ***no spaces and no long names.***
- In Windows Explorer, the default location for saving files is a folder titled Documents and Settings, which, unfortunately, has spaces in the name. Even if you are careful to eliminate spaces in your file names, saving to the default folder means that you are dead in the water. That's why it's important to set up new folders that are not in the Documents and Settings folder and that have **no spaces in the names** into which you can save your files.
- And, **don't make a folder on the Desktop** – ArcGIS does not like folders or files on the desktop.

Adding Spatial Analyst and 3D Analyst Extensions

- If you intend to do hillshades, area and volume calculations, and so on, the **Spatial Analyst** and **3D Analyst** extensions must be added.
- If you find items such as **hillshade** grayed out, you probably have not added these extensions.
- If you have tried to do an analysis and ArcMap tells you that you don't have a license for that operation, you probably have not added these extensions.
- Go to the **Tools** menu, and select **Extensions**. 3D Analyst and Spatial Analyst must be turned on. If the two boxes are not checked, check them both. If they are checked, leave them checked. Click Close.
- You can then go to **View, Toolbars**, and click these two extensions to bring up the toolbars. You can then dock each toolbar by dragging it to the gray bar above the main window, or you can leave the toolbar floating.

Managing the Windows – mostly for Mac Users!!

- Clicking the red X box at the upper right of the active window quits the program. Mac users have to remember that clicking this box closes the window ***and*** quits the program, unlike closing a window on a Mac.

- Clicking the middle box lets you toggle between a full frame view of the window (which can't be moved around), and a view that shows more than one window and in which windows can be moved around.
- Clicking the box with the minus sign closes the window without quitting the program. The window can be opened up again by clicking the name at the bottom of the screen.

To view folders and files in ArcCatalog

- Launch ArcCatalog. Click the **Connect to Folder** icon (the folder with the right-pointing arrow over it).
- In the dialog box that comes up, replace the words **My Computer** with **\\software\academic\geology\.** Be sure to use back slashes, rather than forward slashes. Click OK.
- In the ArcCatalog Table of Contents column at left, expand **\\software\academic\geology,** and expand your course folder.
- Locate your files by expanding either your own folder or your course **Data** folder.

To add data in ArcMap

- Launch ArcMap. Click the **Add Data** button. Click the **Connect to Folder** icon (the folder with the right-pointing arrow over it).
- In the dialog box that comes up, replace the words **My Computer** with **\\software\academic\geology\.** Be sure to use back slashes, rather than forward slashes, and don't put in any spaces. Click OK.
- "**\\software\academic\geology**" will now be one of the available drives. Double click it, and then expand your course folder.
- Locate the data you want to add by expanding either your own folder or your course **Data** folder.

To save to your folder inside your course folder

- Before saving your file to your folder, make sure that you will be saving **relative**, rather than absolute, path names. Go to File, Map Properties, Data Source Options, and click "Save relative path names" before saving your file.
- Go to the File menu and select **Save As**.
- Type **\\software\academic\geology** in the File name box.
- Scroll down **Geology**, open the folder, scroll to your course folder, and select your personal folder (you may need to drag the corner of the list box to the right to see your name), and double click on the directory listing with your name to put it into the File name box.
- **Set the cursor at the very end of the listing following your name,** and type a single backslash (if there isn't one there already) and add your file name. Keep your file name itself short, **NO SPACES** and **NO SPECIAL CHARACTERS.** Click OK.

Naming Files and folders in ArcGIS

- The crucial thing about folder and file names is that you must ***be absolutely certain that there are NO SPACES in folder or file names and no oddball characters.*** If you want a space in your folder or file name, you must put in an underscore. ***MAC USERS BEWARE.*** Spaces are OK in Mac file and folder names. They are ***not*** OK in ArcGIS. If you have trouble getting something to work in ArcGIS, the very first troubleshooting thing you should do is check all of your file/folder names to make sure that they have ***no spaces and no long names.***
- In Windows Explorer, the default location for saving files is a folder titled Documents and Settings, which, unfortunately, has spaces in the name. Even if you are careful to eliminate spaces in your file names, saving to the default folder means that you are dead in the water. That's why it's important to set up new folders that are not in the Documents and Settings folder and that have **no spaces in the names** into which you can save your files.
- And, **don't make a folder on the Desktop** – ArcGIS does not like folders or files on the desktop.
- **Saving Relative Pathways in ArcMap.** Before saving an ArcMap .mxd file to your folder, make sure that you will be saving **relative**, rather than absolute, path names. Go to File, Map Properties, Data Source Options, and click "Save relative path names" before saving your file.

Renaming files and folders

- If you want to rename a file, do so **in ArcCatalog** so that all of the related files are renamed at the same time. In **ArcCatalog** (not ArcMap), right click on the file name, and select **Rename** from the menu.
- You can also do this by bringing up **Layer Properties** (either by double-clicking on the layer name in the TOC of ArcCatalog or by right-clicking on the layer name in ArcCatalog and selecting **Layer Properties**. Click the **General** tab, and type a new name in the layer name box, and click OK.

Deleting files and folders

- If you want to delete a file entirely, do so in **ArcCatalog** so that all of the related files are deleted at the same time. In ArcCatalog, right click on the file name, and select **Remove** from the menu.

Adding data to your ArcMap file

- Click on the **add data icon** (yellow diamond with a plus sign), and, in the **Add Data** dialog box, navigate to the file you want to add, and click OK.

- The new layer appears in the ArcMap TOC

Managing data layers

- **To hide and show layers.** Next to each layer name in the TOC, you'll see a box with a check mark. Clicking in that box allows you to toggle the visibility of a layer
- **Rearranging the order of layers.** If you decide that you want to have the layers in a different order, simply click and hold on the name of the layer and drag it above or below any other layer in order to switch its position. **The check box must be checked in order for you to actually see a layer, regardless of its position,** although you may not be able to actually see a layer if it is obscured by an opaque overlying layer.

Changing the display to lat/lon

- Right click on the word **Layers** in the TOC, and select **Properties** to open the **Data Frame Properties** window. Click on the **General** tab, and, under Units/Display, select the units to whatever you want (e.g., **Degrees Minutes Seconds,** or **meters**). Click OK.
- Moving the cursor over the map will now give coordinates in the new units, and the measure tool will measure in those units.

Renaming *layers* in ArcMap

- This is different from renaming a file. Renaming a layer in ArcMap changes the name only in the ArcMap TOC. You'd do this if the original file name is cryptic and you want to have something more descriptive in your ArcMap TOC, or if you want the names in a legend to be more descriptive than the file names (the map layout will use the layer names in the legend).
- Right-click on the layer name, and select Rename. Type in a new name. Unlike most places in ArcMap, length and spaces don't matter. Remember, too, that this is the name that ArcMap will put into a legend, if you choose to make one.
- **Just as deleting a layer in the TOC doesn't delete the original data file, renaming the layer in ArcMap TOC doesn't change the name of the original data file in ArcCatalog.** If you rename something and can't remember what the original file name is, just double-click on the new layer name to bring up the Layer Properties dialog box (or right-click and select Layer Properties**), and click the** Source **tab. Under** Data Source**, you'll see the location and name of the file that your layer is made from.**

Deleting *layers* in ArcMap

- This is different from deleting a file. Deleting a layer in ArcMap only removes it from your map – it's still there in ArcCatalog.

- Right-click on the layer name, and select Remove.
- **Just as renaming a layer doesn't alter the name of the original data file, deleting the layer in ArcMap doesn't delete the original data file in ArcCatalog.** If you delete something, you can always add it back in.

Making a new shape file

- Open **ArcCatalog** (not ArcMap!!!). In the TOC of **ArcCatalog**, navigate to the folder into which you want to save a new shapefile. Highlight the folder.
- Go to the **File** menu in the main menubar, and select **New,** and **Shapefile**. Give your shape file a name (*e.g.*, roads, and remember! **Short! No spaces!**). in the **Feature Type** pulldown menu, choose the right type of file (for points, pick **Point**; for lines, such as roads, pick **Polyline**; for areas, pick **Polygon**). **You cannot change the shapefile type later**, so be sure to choose the right kind of file when you create the shapefile.
- Be sure to specify a coordinate system by clicking the Edit button and choosing a coordinate system.
- Click OK to create the new shape file. Your new shape file should appear in the list.

Making a copy before you edit a data file using ArcMap Editor

- If you intend to **edit** a shape file in ArcMap using the ArcMap Editor, be sure to save a copy of the file in your own folder before editing. **Do not** edit the file in the original data folder.
- **Be sure to use ArcCatalog to make copies of files that you want to edit.** Don't just go to the data folder and copy the file to your data folder, or you won't have all of the necessary yassociated "hidden" documents that go with the file.
- **To copy a file in Arc Catalog:** Locate the file of interest in the ArcCatalog Table of Contents (the left hand window). Right click on the file name, and select **Copy**. In the ArcCatalog Table of Contents window, navigate to the folder where you want to paste the file (this must be one of your own folders, not the original data folder). Right click on the folder name, and select **Paste**. Doing this in ArcCatalog automatically copies all of the associated documents that go with the file.

A Digital Elevation Model (DEM) is a way of visually portraying elevation data. Each piece of data consists of location information (lat and lon) plus elevation for a given small area on the Earth's surface. ArcMap takes the location and elevation data that are stored in the files and arranges them in their appropriate relative positions to create a map view of the data. That map can then be manipulated lots of ways electronically using ArcMap and the tools 3D Analyst and Spatial Analyst.

The kind of data behind a DEM is called *raster data*. In raster data, information is stored for every pixel in the area of interest. Resolution is governed by the size of each pixel footprint. If each pixel represents the average elevation of a 10 m x 10 m square, the resolution of the image (ability to see fine detail) is better than if each pixel represents the average elevation of a 1 km x 1 km square. As resolution goes up for a given area, so does file size, because the number of pixels increases.

Elevation data can be digitized from existing topographic maps, with elevations interpolated between contour lines. DEMs can also be created from surface elevation data measured from space by the Shuttle Radar Topography Mission (SRTM).

Downloading Shuttle Radar Topography Mission DEMs

The SRTM data base is a remarkable worldwide digital elevation data set for about 80% of the Earth's land surface. It took 10 days (only 10 days!!) to collect all of the data! The data set covers all land areas between 60°N and 56°S latitude (higher latitudes were excluded because of the inclination of the Shuttle orbit, which was 56°. The resolution of SRTM data is 30 m/pixel for the highest resolution data. The mission was flown in February of 2000, and one of the mission specialists, Janet Kavandi, was also on the mission that flew in July 2001 that flew the Hamilton College banner that's hanging in the Geo Department.

The CGIAR/Consortium for Spatial Information has processed Shuttle Radar Topography Data for the world to eliminate any blank pixels, etc. It's much easier to get the data from this site than to go to the USGS site and deal with the raw data, which you would have to process to remove blank pixels before you could do, for example, a hillshade. If you were doing a research project, you'd want the original data, but, for what we're doing, this is a great and fast way to get SRTM data to work with. Go to the CGIAR site at http://srtm.csi.cgiar.org/

In the left hand link list, click on **SRTM Data Search and Download**

- On the page that comes up, you'll see a map of the world with a grid on it (http://srtm.csi.cgiar.org/SELECTION/inputCoord.asp), This grid outlines tiles of SRTM data. **Select the server JRC(IT). Note**: CGIAR has five servers, three in

the US, one in Italy, and one in the UK. The folks at CGAIR say that data on the Italian server is most frequently updated and quality checked. The other servers eventually get the updates, but not immediately following changes to the Italian server.

- Check to make sure that the **GeoTIFF** radio button is checked. After you select the server, a second line allows you to select a method of data selection. **Multiple Selections** allows you to choose multiple tiles, even non-adjacent ones. **Enable Mouse Drag** allows you to drag a selection. **Input coordinates** highlights the lat/lon input fields.
- Choose your tile(s), and click on the tile(s) that you want.
- If you blunder or want to change your mind, click **Clear Area.** Once you're satisfied, click **Search**. Another page will come up with tile details and a location map. If the area isn't what you want, just go back and try again.
- When you're happy, click the **Data Download** button for each tile, and save the zipped file to your folder. **Do not save the file to the desktop, because ArcGIS does not like files saved to the desktop.**
- To unzip the data, navigate to the folder, and right click on the folder. Select **Extract all**, and save it to your folder.
    - The data files should have a WGS84 coordinate system associated with it. Check to make sure in ArcCatalog under Metadata > Spatial tab.
- If you have more than one adjacent tile, you must mosaic your SRTM data ***before*** projecting it. It's easy to remember **mosaic before projecting**, because "m" comes before "p" in the alphabet.
    - In ArcCatalog, use Mosaic to New Raster tool.
    - Data Management Tools > Raster > Raster Dataset > Mosaic to New Raster
    - SRTM data Pixel Type is 16 bit Signed.
    - **Do NOT specify a new projection for this raster in this step.**
- ***You must now project your SRTM DEM.** The locations of pixels in your DEM are specified in decimal degrees. The mathematical equation that ArcMap uses to create a hillshade, however, assumes that pixel locations and elevations are all in the same units. In WGS84 the elevation is in meters while the X,Y values are in decimal degrees. If you try to make a hillshade from the unprojected SRTM DEM data, it will be all screwy. So, you need to project the DEM first so that X, Y, and Z are all in meters.
    - In **ArcCatalog**, open **ArcToolbox,** select **Data Management Tools, Projections and Transformations, and Raster.** Select the **Project Raster** tool.
    - For **Input Raster**, browse to your SRTM tiff file or mosaic if created. You can leave the output raster name as it's automatically put in, although you should check to make sure that the name is **short** and without spaces. **If the name is too long, shorten it.**

- Click on the button to the right of **Output coordinate system**, and choose **Select**. Select **Projected Coordinate Sytems/Utm/Wgs1984.** Now, you'll need to find the right UTM zone. Use the map on page 61 to determine the UTM zone, and select N, if you are north of the equator, and S if you are south (*e.g.*, Cairo is UTM Zone 36N). Select the correct zone, and click OK, then OK again.
- Change the Resampling Technique from **NEAREST** (default) to **BILINEAR.**
- ******Scroll down to check the Output Cell Size box.***** Once the output coordinate system is entered, the Output Cell Size box should show a number in the range of 85-110 meters or so. If it isn't, you've done something wrong. Click **OK again** for all your selections and again to project the raster. Wait while the **Executing Project Raster** dialog box is busy. Close when done.

- Your DEM is now ready to add to an ArcMap.

Downloading New York State DEMs from the CUGIR site

The Cornell University Geospatial Information Repository has DEMs at 10 m resolution for all of New York State. To download NYS DEMs:

- Go to http://cugir.mannlib.cornell.edu/
- Click the Map Browse tab. Click the 1:24,000 quads tab, and select the county you're interested in.
- Roll the cursor over the quads until you find the quad you want, and click on it. A listing of the data sets available for the quad at the CUGIR site comes up. It lists three data sets: 7.5 minute topographic maps, elevation (DEM data), and hydrography. **We're interested in the DEM data.**
- Put a check in the box in the far left column next to **elevation.** At the top right of the data list, click on the button labeled **Add Checked Data Files to Basket**. A new window opens showing the number of items in the basket, the size of the basket in megabytes, a button to update the basket, and a button to download selected.
- Click **Download Selected,** and a new window will appear listing the file to download with a name starting with *CUGIR* followed by the date, time, and a file number, such as CUGIR_2007-02-03-11-22-35-690.zip.
- Click on the red CUGIR file name. A **file download** dialog box will open. Click the **Save** button. A **Save As** dialog box will open. Navigate to your folder on the C:/ drive, and click **Save.** Be sure that the folder name is **SHORT** and has **NO SPACES. ****FOR GIS work, remember that file and folder structure will be very important as we work this semester.**** It's very easy to get a whole long list of files in your folder on the server that you can't navigate around.** Close this box once the download is complete.

The DEM data that you just downloaded from CUGIR are compressed (zipped) files. The CUGIR data require a two-step decompression process.

- **To unzip the DEM folder from CUGIR** in your folder:
    - In Windows Explorer (not ArcCatalog) navigate to your folder on the C:/ drive.
    - Right click on the zipped folder and scroll down to **Extract All.**
    - Extraction Wizard opens, click **Next**, and the Wizard creates a default folder to extract the files to. This folder will have the same name as the original folder without the .zip extension and will automatically be placed into your folder.
    - Click **Next,** and the extraction progress bar appears, and the files are extracted.
    - When the extraction is done, click **Finish**. The default when clicking Finish is to show the decompressed folder, which looks exactly like the original one without the zipper. Double click this folder to open it.
    - The unzipped folder will have several documents in it, including a .gz file, which is another type of compressed file. You must now decompress the .gz file before you can use the DEM data in ArcGIS.

- **To decompress the .gz file from CUGIR** that is now in your unzipped CUGIR folder:

    - Right click on the **.gz** file, select **7-Zip**, and select **Extract Here**.

Once you have decompressed your DEM data, launch ArcCatalog, and navigate to your folder on the C:/ drive.

- Explore the folder that you have just downloaded, and preview the DEM. Remember to say "yes" to pyramids, if it asks to build them. Pyramids improve the speed at which ArcCatalog and ArcMap can display data.
- But, yikes! Your DEM looks like a plain black rectangle! No worries. This is because ArcGIS cannot read USGS DEMs directly, and the data need to be converted to a format that ArcCatalog/ArcMap can display. Fortunately, this is quick and easy.
    - In ArcCatalog, find the red Toolbox icon in the ArcCatalog menu bar, and click on it to open ArcToolbox (if it is not already open).
    - Expand the **Conversion Tools** by clicking on the **+ sign**. Expand the **To Raster** toolbox by clicking on the **+ sign**. Double click on the **DEM to Raster** tool to open it.
    - In the **DEM to Raster** tool, browse to your DEM for conversion by clicking on the folder next to the field titled **Input USGS DEM file.** This will be the xxxelu.dem file in the unzipped folder. A default path and

name for the output DEM will be automatically entered in the **Output raster** field.

- Here is where you should change the xxxelu.dem to a more meaningful name. Click on the browsing folder on the right side of the Output raster field, and navigate to the top level of your working folder (i.e., you don't have to bury this inside the nested CUGIR folders). Name the file something appropriate and ***short***. Rasters with no suffix on them are called GRID files and can have a maximum of 13 characters in the name. Don't add any extensions (e.g., don't add .dem at the end – you can have _dem, but ***not*** **.**dem). Leave the defaults as set, (FLOAT and Z factor of 1), and click OK.
- A dialog box will open showing that the tool is running, and the new file will appear in the folder.
- When it's done, preview the file in ArcCatalog, and it will look fine! You may need to go to the **View** menu and choose **Refresh**, if your file does not appear. This is the file that you will add to create your ArcMap.

Downloading ASTER Global Digital Elevation Model (GDEM) data

Japanese researchers have created a new global DEM data set using ASTER satellite imagery. This data set is unique in a number of ways. ASTER DEMs

- extend to higher latitudes (up to 83° north and south) than the SRTM DEMs, which extend only to about 58° north and south.
- have 30 meter/pixel resolution worldwide. SRTM DEMs outside the United States are at 90 meters/pixel.
- are derived from visible imagery and have better data in high relief areas than SRTM data, which has "holes" due to loss of radar return signal.

The ASTER DEM data, called GDEM for Global Digital Elevation Model, is currently only available for download at www.ersdac.or.jp/GDEM/E/index.html To access and download the data, go to the website and click on the ASTER DEM button.

- You must be registered to select and download data (registration and data download is free). In the left hand column under **Operation** heading, click **Register,** and follow the instructions.
- Once you are registered, **log in,** and click the **Search** button in the Operation list. A typical map based browser opens. Click on the **Select tiles directly** tab.
- Use the scroll arrows to move around the map, and use the zoom bar to zoom in and out. The **# Grid** button turns on & off a grid of tile locations.
- Click **Start** to begin selecting tiles. With you tiles selected, click the **Next** button, and a list with your selected tiles appears. At this point, you can uncheck any files that you do not want to download. Click **Next.**
- From the pull down menu, select a purpose (it doesn't matter what you chose). Read the End User Agreement, and click **Agree.** A list of tiles appears.

- You can download individual tiles by clicking the **download** button beside each individual file, or you can use the **Download** button at the bottom right to download all tiles in the list as a single zipped file. Do not download more than 100 tiles at a time.
- Expanding the zipped file labeled "Tiles…." creates a folder containing zipped folders for each of the downloaded tiles. Each of these folders must be unzipped as well.
    - Each tile folder is named with the lat/long of the lower left corner of the tile.
    - Each individual folder contains two files, a _dem.tiff and a _num.tiff. The _dem.tiff file is the one that is used.
- If you have downloaded more than one GDEM tile, mosaic them as described under the SRTM data section on page 16. Remember the "M before P rule" (**M**osaic before **P**rojecting) .
- GDEMs, like SRTM DEMs, are in the GCS WGS 84 geographic coordinate system and must be projected before they are used to create hillshades. Refer to the SRTM section on page 16 on projecting DEMs. **Note that GDEMs are 16 bit signed data.**

Mosaicking your DEMs (Mosaic SRTM data before Projecting, See section on downloading SRTM data)

Open a new ArcMap, and add all of your DEMs. You now need to mosaic them together so that they behave as one unit for hillshading and colorizing.

- Click on ArcToolbox (the red toolbox in the menubar). Scroll down to **Data Management Tools**, **Raster**, **Raster Dataset**, and select **Mosaic to new raster**.
- In the dialog box, click the down arrow under **Input Rasters**, and add your first DEM. Click the arrow again, and add the second DEM. Continue until you have all of your DEMs in the list.
- **This mosaicking tool mosaics all of the DEMs to a new DEM.** Click on the folder next to Output Location, and choose a folder to put your mosaicked DEM into. Wait until the folder name appears in the box. Enter a name into the Raster Data Set Name box (remember: **short, no spaces**). Then, scroll down until you see the **Pixel Type** pulldown.
    - **If you have an SRTM DEM (e.g., one downloaded from the CGIAR site):** select 16_BIT_SIGNED
    - **If you have a NYS DEM from CUGIR (NOTE!!!** "CUGIR" is ***NOT*** the CGIAR site where you can download SRTM DEMs!): select 32_BIT_FLOAT
    - **If you have another type of DEM:** go back to the TOC and right click on the DEM name, select **Properties**, and choose the **Source** stab. Scroll down to find the **Pixel Depth** and the **Pixel Type**. In the **Mosaic to New Raster** dialog box, select that pixel type.

Click OK. Your new mosaicked DEM will be automatically added to your ArcMap. You can delete all of the other DEMs.

Making a hillshade of a DEM

- **Be sure that you have projected your DEM first** if you are using an SRTM DEM (see previous header). If you are using a CUGIR DEM, you're all set.
- Check to be sure that the **Spatial Analyst** extension is turned on. Go to the main menu and select **Tools,** then **Extensions.** Make sure there is a check mark in the Spatial Analyst box. You'll also need to add the **Spatial Analyst toolbar** by going to the **View** menu, and selecting **Toolbars** and then **Spatial Analyst**.
- Click on the word **Spatial Analyst** in the toolbar, select **Surface Analysis**, and then **Hillshade**. If the word "Hillshade" is grayed out, you forgot to add the **Spatial Analyst extension**.
- In the Hillshade dialog box, choose your DEM from the Input Surface pulldown, and leave all but the last setting at the default values. **You must now replace <Temporary> in the Output raster box with a permanent file name, or your hillshade will not be saved.** Click the folder icon next to the Output raster box, and navigate to your own data folder. Call this new file something simple and descriptive. **Remember!!! NO spaces, NO odd characters, and SHORT.** Use the default file type (ESRI GRID). Click OK, and then OK again in the Hillshade menu.
- **Note: choosing your DEM from the pulldown list (rather than navigating to it via the folder icon next to Input) and naming your new hillshade by using the folder icon next to Output (rather than just typing a name into the box) are crucial!!** If your hillshade fails to execute, you may have failed to do one of both of these things.
- In the TOC, you'll see your new layer (with the name you called the file) appear at the top of the list. You'll also see the map view of your layer, this time as a shaded relief image. Notice that your lat/lon coordinates still work. You can toggle this layer on and off, and you can move it around just like you did with the other layers.

Creating a color ramp DEM with a semi-transparent hillshade

- Make sure that, in the TOC, the hillshade is above the DEM. If that's not the order you have, rearrange by dragging and dropping.
- Right click the **hillshade** layer, and scroll down to Properties. Click the **Display tab,** and change transparency to 30% by typing in **30**. **Do NOT click OK.** Drag the properties window partly out of the way so that you can see most of the map. Click **apply**, rather than OK. This allows you to try out various transparencies before committing yourself. Once you have what you like, and can see the DEM through the hillshade, click **OK**. You can always go back and change this later, if you change your mind as you go along.
- This is a better image, but it's still a little blah. Let's colorize it!

- **For the next steps, be sure that you're working with the DEM, not your hillshade!!** Right click on the DEM, and select **Properties**. Click on the **Symbology** tab. Make sure that **Stretched** is highlighted in the left column, and right-click on the black-to-white color ramp bar. Select **Graphic View** to uncheck it, and the color ramp should now have text instead of a color gradation in it.
- Scroll down to **Elevation #1**, and select it. Set the **Stretch type** to **None**.
- Click **apply**, and drag the Layer Properties window out of the way to see what you've done. You can check out other color ramps as well. When you have what you like, click **OK**, and save.
- To see what the DEM looks like all by itself, you can turn off the hillshade. If you do this, you'll see why both the hillshade and the colorized DEM are necessary for the full 3D effect.
- Your map may look a little faded with the transparency of the hillshade set to 30%. That's because you're looking through a hillshade that is only 30% transparent. You can adjust the transparency of the hillshade so that you can see more of the color of the DEM through it.

Viewing a hillshade in 3D using ArcScene

- The extension 3D Analyst allows us to view a hillshade in 3D and rotate the 3D view. Check to be sure that the **3D Analyst** extension is turned on. Go to the main menu and select **Tools,** then **Extensions.** Make sure there is a check mark in the 3D Analyst box. Check to be sure that your **3D Analyst toolbar** is visible.
- If your hillshade is partially transparent, go to **Display** under **Layer Properties**, and reset the transparency so that your hillshade is opaque.
- Locate the ArcScene icon in the 3D Analyst toolbar. It's the one second from the right hand end of the toolbar and looks like a circle with two yellow Post-Its (if you hold the cursor over an icon without clicking, a box will appear telling you what the icon does – if you have the right one, the box will say **ArcScene**).
- Click the **ArcScene** icon, which launches ArcScene and brings up a new window that has elements that look a lot like ArcMap except that the TOC is headed by the words **Scene layers**, and the menu bar is a bit different.
- Use the **Add Data** icon to add a hillshade file. Save your new ArcScene map to your data folder.
- Locate the icon in the ArcScene toolbar that looks like a globe with four arrows. This is the **Navigate** icon. Click on it. The cursor will now look like the Navigate icon, and clicking and dragging the cursor across the map window will tilt and rotate the hillshade that you've added. Right-clicking will let you zoom the image in and out. The center wheel of the mouse also zooms the image in the map window.

- Notice, though, that you only have the *illusion* of 3D. Although the hillshade makes it look 3D, the scene is a flat sheet when you rotate it to look at it edge on. So, we need to extrude each pixel according to its real elevation.
- Start by tilting and rotating the scene until it looks like it originally did – clicking the "world" resets to the original view.
- Right click on the layer name in the TOC, and select **Properties**. Choose the **Base Heights** tab, and click the radio button next to **Obtain heights for layer from surface**. You want ArcScene to get the elevations from your original DEM, so you a have to direct ArcScene to find the right file that has the original elevations for your hillshade. Click the folder icon, and navigate to the original raster image data file. Click **Add.** Don't change the other defaults, and click OK.
- Now, get the **Navigate** tool from the toolbar, and tilt and rotate. You can even view it from below!! Just be sure that you obtained the heights from the correct **original data** layer, not from a hillshade layer.
- If you want to increase the vertical exaggeration, right click on **Scene Layers** at the top of the TOC (not on one of your individual layers). Choose **Scene Properties**, and click the **General** tab. Under vertical exaggeration, choose something other than **None**. Click OK. If the scene disappears from view, you've chosen a vertical exaggeration that is too great. If that happens, go back and select a vertical exaggeration of 1.5 or 2. If the vertical exaggeration creeps you out, repeat the process, and change it back to **None**.

Flying through a 3D model in ArcScene

- Get the **Fly** tool (looks like a seagull).
- Left click flies you toward the scene. The more clicks, the faster you go. Right clicking slows you down until you stop. Then, right clicking more flies you away from the scene etc. etc. If you get going too fast, click the other button repeatedly until you slow down and stop (the seagull stands on the ground).
- If all hell breaks loose and you go at warp speed through the model, hit the Esc button on the keyboard. If you've lost your model, just click on the globe tool to center the model again. Moving the seagull right, left, up, and down lets you fly up or down and turn right or left. Play around a bit. If you want to stop, just click the right button a few times until you stop moving.

Creating a new shapefile

- Open **ArcCatalog** (not ArcMap!!!).
- In the TOC of **ArcCatalog**, navigate to the folder where you want to save your shapefile. Highlight the folder.
- Go to the **File** menu in the main menubar, and select **New,** and **Shapefile**. Give your shape file a name (*e.g.*, roads, and remember! **Short! No spaces!**).
- In the **Feature Type** pulldown menu, choose the right type of file (for points, pick **Point**; for lines, such as roads, pick **Polyline**; for areas, pick **Polygon**). Once you have created a shapefile, you cannot change the file type. So be sure to pick the file type you want.
- Click the **Edit** button to navigate to and select a coordinate system that matches the coordinate system of the ArcMap to which you will add this shapefile. OK the coordinate system, and click OK again to create the new shape file. Your new shape file should appear in the list.

Adding points to a point shapefile

- ******Very important!!!****** You are about to edit the shapefile. **Anything that you do in ArcMap to edit the shapefile changes the original shapefile.** If you want to keep a copy of your original, unaltered shapefile, you should go back to **ArcCatalog**, right click on the shapefile in the TOC, choose **Copy**, and navigate to the folder where you want to store your original. In order to paste, the destination folder must be highlighted. Once your destination folder is highlighted, select **Paste** from the **Edit** menu of the main menubar. You can rename the file you have just pasted by right clicking on the name in the TOC of ArcCatalog and selecting **Rename.**
- Once you are sure you're about to edit the right file, navigate to ArcMap, and add the shapefile.
- Locate the Editor toolbar, and click on the triangle to expand it. Select **Start Editing**. If you don't see the **Editor** menus, go to **View**, **Toolbars,** and make sure that the **Editor** toolbar is checked.
- Click on the **Pencil**, and make sure that **Create New Feature** is chosen in the **Task** box. In the **Target Layer** pulldown, select your new shape file.
- Each time you click on the map, a new point will be added and will appear in sequential order in the attribute table.
- You can save your edits at any point by going to the **Editor** pulldown and selecting **Save Edits**. When you are done adding points, **you must choose Stop Editing**. If you haven't saved, ArcMap will prompt you to save your edits.
- You can edit the size and color of the symbols by left clicking on the symbol in the TOC.

Adding lines to a line shapefile

- ****Very important!!!**** You are about to edit the shapefile. **Anything that you do in ArcMap to edit the shapefile changes the original shapefile.** If you want to keep a copy of your original, unaltered shapefile, you should go back to ArcCatalog, right click on the shapefile in the TOC, choose **Copy**, and navigate to the folder where you want to story your original. In order to paste, the destination folder must be highlighted. Once your destination folder is highlighted, select **Paste** from the **Edit** menu of the main menubar. You can rename the file you have just pasted by right clicking on the name in the TOC of ArcCatalog and selecting **Rename.**
- Once you are sure you're about to edit the right file, navigate to ArcMap, and add the shapefile.
- Make sure that your map units are set to a conventional distance unit of measure (e.g., meters, feet, or km, rather than degrees). Right click on the Data Frame name in the TOC, select **Properties, General**, and set the display to the units you want. Click OK. Now, as you move the cursor, you should see the right units at the bottom of the screne.
- **Creating a line by streaming**
    - The instructions below are for creating a line by **Streaming**, which is an easy way to draw a smooth curve. As you move the cursor, ArcMap will automatically add control points at whatever distance interval (the **stream tolerance**) you select. If you want to create a line by point and click, go to the next set of instructions.
    - Locate the Editor toolbar, and click on the triangle to expand it. Select **Start Editing**. If you don't see the **Editor** menus, go to **View**, **Toolbars,** and make sure that the **Editor** toolbar is checked.
    - Click on the **Editor** menu again, and select **Options**. Click the **General** tab. Enter a value for stream tolerance **in map units**. You **must** enter a value other than 0 (which is the default). The value that you choose will tell ArcMap how close together the control points will be for the curve, and it uses **map units**. This is why it was important to change the display units to something more meaningful than degrees. You can experiment around with this and even change it after you have started to draw a line. Type in a value for stream tolerance and type in a value for "Group". This will tell ArcMap how many points to delete at the same time if you click the **Undo** arrow (the curved arrow located left of the yellow **Add** icon). Try 20. Again you can change this on the fly. Click OK.
    - Click on the **Sketch** tool (looks like a pencil) in the Editor menu bar, and make sure that **Create New Feature** is chosen in the **Task** box. In the **Target Layer** pulldown, select your new shape file.
    - Use your left hand to press the F8 key to start streaming, and keep your left forefinger hovered over the F8 key. Click where you want to start the line, and trace the curve. ArcMap will add control points for you. If you

make a mistake or need to stop, immediately press the F8 key to stop streaming. As long as you don't click the mouse again, you can move the cursor to various menu bar items and click them without hurting your new partially completed line. You can undo with undo arrow, you can scroll the window, you can click on the Editor pulldown and save edits or change your streaming settings.

- When you are ready to add another portion of your line, press F8 again, and click and drag the next part of the curve. **Just be sure not to click directly on the last point of the previous section**, or it won't work. ArcMap will automatically connect your new section to your old one. **Save Edits often**, because you an always undo a huge blunder. To save edits, go to the Editor dropdown menus, and select **Save Edits**.
- When you are ready to finish your line, double click the mouse. **Be very careful not to double click until you are completely done.**
- Once you have double-clicked, the line will be a wide, bright cyan feature. That means that it is selected. If you draw another line and double click at the end, the first one becomes de-selected in favor of the second one. Don't worry at this point if you don't like the color or weight of the line.

- **Creating a line by point and click**
  - If you don't want to stream, you can make a line by clicking individual control points. ArcMap will draw straight lines between each of the control points (called vertices).
  - Locate the Editor toolbar, and click on the triangle to expand it. Select **Start Editing**. If you don't see the **Editor** menus, go to **View**, **Toolbars,** and make sure that the **Editor** toolbar is checked.
  - Click on the **Sketch** tool (looks like a pencil) in the Editor menu bar, and make sure that **Create New Feature** is chosen in the **Task** box. In the **Target Layer** pulldown, select your new shape file.
  - Click once where you want your line to start, move the mouse a little, and click again. Keep moving and clicking until you get to the end of the line you want to draw, at which point you must double-click. The straighter the line, the fewer the points you need. On the other hand, if you have a really curvy line and you click only a few points, it will be a bit herky jerky. **As you are doing this, be very careful to single click only** – as soon as you double click, ArcMap will finish your line for you. Save your edits often. To do this, you must go to the Editor dropdown menu and click **Save Edits**.
  - Once you have double-clicked, the line will be a wide, bright cyan feature. That means that it is selected. If you draw another line and double click at the end, the first one becomes de-selected in favor of the second one. Don't worry at this point if you don't like the color or weight of the line.

- Each line that you add will appear as a separate item in the attribute table.
- You can save your edits at any point by going to the **Editor** pulldown and selecting **Save Edits**. When you are done adding lines, **you must choose Stop Editing**. If you haven't saved, ArcMap will prompt you to save your edits.
- You can edit the size and color of the symbols by left clicking on the symbol in the TOC.

Adding a polygon to a polygon shapefile

- If you don't already have a shapefile to add a polygon to, go to page 23 and create a new shapefile.
- ****Very important!!!**** You are about to edit the shapefile. **Anything that you do in ArcMap to edit the shapefile changes the original shapefile.** If you want to keep a copy of your original, unaltered shapefile, you should go back to ArcCatalog, right click on the shapefile in the TOC, choose **Copy**, and navigate to the folder where you want to story your original. In order to paste, the destination folder must be highlighted. Once your destination folder is highlighted, select **Paste** from the **Edit** menu of the main menubar. You can rename the file you have just pasted by right clicking on the name in the TOC of ArcCatalog and selecting **Rename.**
- Once you are sure you're about to edit the right file, navigate to ArcMap, and add the shapefile.
- Make sure that your map units are set to a conventional distance unit of measure (e.g., meters, feet, or km, rather than degrees). Right click on the Data Frame name in the TOC, select **Properties, General**, and set the display to the units you want. Click OK. Now, as you move the cursor, you should see the right units at the bottom of the screne.
- **Creating a polygon by streaming**
    - The instructions below are for creating a polygon by **Streaming**, which is an easy way to draw a smooth curve. As you move the cursor, ArcMap will automatically add control points at whatever distance interval (the **stream tolerance**) you select. If you want to create a polygon by point and click, go to the next set of instructions.
    - Locate the Editor toolbar, and click on the triangle to expand it. Select **Start Editing**. If you don't see the **Editor** menus, go to **View**, **Toolbars,** and make sure that the **Editor** toolbar is checked. Select the right folder that contains your shapefile.
    - Click on the **Editor** menu again, and select **Options**. Click the **General** tab. Enter a value for stream tolerance **in map units**. You **must** enter a value other than 0 (which is the default). The value that you choose will tell ArcMap how close together the control points will be fore the curve, and it uses **map units**. This is why it was important to change the display units to something more meaningful than degrees. You can experiment around with this and even change it after you have started to

draw a polygon. Type in a value for stream tolerance and type in a value for "Group". This will tell ArcMap how many points to delete at the same time if you click the **Undo** arrow (the curved arrow located left of the yellow **Add** icon). Try 20. Again you can change this on the fly. Click OK.

- Click on the **Sketch** tool (looks like a pencil) in the Editor menu bar, and make sure that **Create New Feature** is chosen in the **Task** box. In the **Target Layer** pulldown, select your new shape file.
- Right click where you want to start the polygon outline, and select **streaming**. Trace the curve. ArcMap will add control points for you. If you make a mistake or need to stop, click on the map to pause streaming. As long as you don't click the mouse again, you can move the cursor to various menu bar items and click them without hurting your new partially-completed polygon. You can undo with undo arrow, you can scroll the window, you can click on the Editor pulldown and save edits or change your streaming settings.
- When you are ready to add another portion of your polygon, make sure that the pencil tool is selected, and simply click on the map again, and drag the next part of the curve. **Just be sure not to click directly on the last point of the previous section**, or it won't work. ArcMap will automatically connect your new section to your old one. **Save Edits often**, because you can always undo a huge blunder. To save edits, go to the Editor dropdown menus, and select **Save Edits**.
- When you are ready to finish your polygon, double click the mouse, and ArcMap will connect your last point with your first one with a straight line and fill in the polygon. **Be very careful not to double click until you are completely done.**
- Once you have double-clicked, the line will be a wide, bright cyan feature. That means that it is selected. If you draw another polygon and double click at the end, the first one becomes de-selected in favor of the second one. Don't worry at this point if you don't like the color or weight of the line.

- **Creating a polygon by point and click**
  - If you don't want to stream, you can make a polygon by clicking individual control points. ArcMap will draw straight lines between each control point.
  - Locate the Editor toolbar, and click on the triangle to expand it. Select **Start Editing**. If you don't see the **Editor** menus, go to **View**, **Toolbars,** and make sure that the **Editor** toolbar is checked.
  - Click on the **Sketch** tool (looks like a pencil) in the Editor menu bar, and make sure that **Create New Feature** is chosen in the **Task** box. In the **Target Layer** pulldown, select your new shape file.
  - Click once where you want your polygon outline to start, move the mouse a little, and click again. Keep moving and clicking until you get to the

end of the polygon you want to draw, at which point you must double-click. The straighter the line, the fewer the points you need. On the other hand, if you have a really curvy line and you click only a few points, it will be a bit herky jerky. **As you are doing this, be very careful to single click only** – as soon as you double click, ArcMap will finish your polygon for you. Save your edits often. To do this, you must go to the Editor dropdown menu and click **Save Edits**.

- Once you have double-clicked, the line will be a wide, bright cyan feature. That means that it is selected. If you draw another polygon and double click at the end, the first one becomes de-selected in favor of the second one. Don't worry at this point if you don't like the color or weight of the line.

- Each polygon that you add will appear as a separate item in the attribute table.
- You can save your edits at any point by going to the **Editor** pulldown and selecting **Save Edits**. When you are done adding polygons, **you must choose Stop Editing**. If you haven't saved, ArcMap will prompt you to save your edits.
- You can edit the size and color of the symbols by left clicking on the symbol in the TOC.

Fixing blunders

If you try to fix something, and you can't, remember that you have to **Start Editing** before you can add or modify. Just be sure to **Stop Editing** when you are done and be sure that you have saved your edits.

- If you make a mistake and want to delete a point, line, or polygon, **Start Editing**, switch to the **Selection tool** next to the pencil tool on the editor toolbar. Right click on the item you want to remove, and select **Remove**.
- If you want to move an item, **Start Editing**, switch to the **Selection tool** next to the pencil tool, Click and hold on the item, and drag it to the new location.
- If you just want to reshape a line or polygon by moving one of the points around a bit, **Start Editing**, and switch to the **Selection tool** next to the pencil tool, select **Modify Feature** from the **Task** menu, click on the line to highlight it and bring up the control points, and drag whatever control points you want to reshape the line or polygon. If you need to add a control point, right click on the offending segment, and select **Insert vertex**. Click and drag to move it where you want it.
- ***Be sure to switch back to **Create New Feature** and the **Pencil** tool when you want to add another item.
- **Be sure to Save Edits and Stop Editing when done.**

Labelling items in a shapefile

- If your shapefile already has a field that you want to use for labeling attributes, you don't need to do the following. If you need a field for labeling, then follow the instructions below.

- If you are still editing, start by selecting **Stop Editing** and saving your edits.
- Go to the TOC, and right click on your shapefile layer name. Select **Open Attribute Table**.
- From the **Options** pulldown in the lower right, select **Add Field.** If **Add Field** is grayed out, you forgot to Stop Editing before opening the attribute table. Just close the attribute table, Stop Editing, and then open the attribute table again.
- In the **Add Field** box, type a **short** name for the field in caps, no spaces (*e.g.,* NAME). From the **Type** pulldown, select **Text**. In the **Length** box, type 25 (that's the maximum number of characters that the field will hold, and it's a pain if it's too long and a disaster if it's too short – this cannot be changed later!!).
- Click OK, and you'll see a new field. **To add anything to the new field, you have to Start Editing again.**
- Click in each box of the new field, and add the name. Be sure to add the right names to the right features! To make this easy, you can alternate between adding a feature to the map and adding its name to the attribute table. When you are done, select **Stop Editing** from the **Editor** menu. Close the attribute table.
- The names don't appear, because you haven't yet added them as labels. Remember that you can do this by right clicking on the layer name, selecting **Properties**, and **Labels**. Be sure to check **Label features in this layer**, select the correct field name from the **Label Field** pulldown, and make whatever choices you want in the fonts area. Click OK. If your labels don't appear, you forgot to check **Label features in this layer**.

Opening an attribute table

- Right click on the shapefile in the ArcMap TOC, and select **Open Attribute Table**. This will bring up the attribute table for the layer.
- Each column is called a **Field**.

Selecting by attributes

Selecting individual items in an attribute table

- Make sure nothing is already selected on the map by choosing **Selection** from the main menu, and **Clear Selected Features.**
- Make sure also that you have **Stopped Editing**.
- In the attribute table, click in the space to left of the row containing the item(s) that you want to select. Features associated with this row in the attribute table will appear with cyan highlights on the map.

Selecting a range of pixels in a DEM by their elevations

- Start by making certain that there is nothing selected in your map. Go to the main menu at the top of the screen, under **Selection**, and choose **Clear Selected Features.**
- Make sure also that you have **Stopped Editing**.
- Go to **ArcToolbox**, **Spatial Analyst Tools, Extraction,** and **Extract by Attribute.**
- For the **Input Raster**, select your original DEM (**not** the hillshade!!).
- Click on the box to the right of the **Where Clause** field. Double click **Value** to enter it into the query box.
    - If you want all pixels less than or equal to a certain elevation, single click the **<=** button. Click the **Get Unique Values** bar, and double-click on value you want **in the list** (e.g., 134). You should now have a statement in the query box that says Value<=134. If it doesn't say this, select what's in the query box, delete it, and start over. When you have it right, click OK.
    - If you want all pixels equal to a certain value, single click on the **=** button and follow the instructions above.
    - If you want all pixels greater than a certain value, single click on the **>=** button and follow the instructions above.
- Click the folder icon to the right of the **Output raster** field, navigate to your own folder, and name your new raster ExtractminXXX (**no spaces!**). Click OK. If your ExtractminXXX layer is not at the top of the TOC list, drag it to the top.

- ArcMap should now have extracted all of the pixels that you have specified, but they are color shaded by elevation. In order to see them better, you can make all of these pixels one color.
    - Open the layer properties for your ExtractminXXX layer.
    - Select the **Symbology** tab, and choose **Classified** instead of **Stretched.**
    - Change **Classes** to **1**. Double click on the color square in the list under the word Symbol, and select the color you'd like. You can always change this later if you don't like it.

Adding a field to an attribute table

- Start by making certain that there is nothing selected in your map. Go to the main menu at the top of the screen, under **Selection**, and choose **Clear Selected Features.**
- Make sure also that you have **Stopped Editing**.
- Open the attribute table, click **Option** in the attribute table window, and select **Add Field.** Name the field something short with no spaces (e.g., AREA).
- Select the type of field you want from the **Type** menu.
    - Short integer: numbers with no decimal points and ranging from -32,768 to 32,767.
    - Long integer: numbers ranging from -2,147,483,648 to 2,147,483,647 and with no decimal points.
    - Float vs Double: both have decimal points. Use Float for smaller numbers with less precision.
    - Text: for entering names or other text; specify character length. **Plan ahead in your estimate.** This cannot be changed later, and making it too long is as bad as too short.
- Select the precision and the scale
    - Precision specifies the maximum number of digits allowable in the field (e.g., 15).
    - Scale specifies the number of digits to the right of the decimal point.
- Click OK.

Adding data to an attribute table

- Open the attribute table; add a new field if you need to by following the directions above.
- Go to the Editor, and **Start Editing**. **Note:** if you Start Editing, and then try to add a field to the attribute table, it won't work. If this happens, Stop editing, add the field, and then start editing again.
- Click in the field, and type what you need to. **Save edits**, and **Stop editing**.

Calculating in an attribute table

- Open the attribute table; add a new field into which your calculated values will be entered (directions for adding a field appear above).
- Go to the Editor, and **Start Editing**. **Note:** if you Start Editing, and then try to add a field to the attribute table, it won't work. If this happens, Stop editing, add the field, and then start editing again.
- Click the header in the new calculation field. Select **Calculate Values.**
- Use the formula builder to add fields and operations. Type in any constants that you need. Click OK.
- **Save** Edits, and **Stop Editing**. Your new field will fill with calculated values.

Measuring elevations, distances, areas, and volumes, and calculating evaporative losses

Finding the elevation of a point

- Select the **Identify** tool (the one with the "I").
- In the pulldown menu of the Identify Results dialog box, select the layer that has your elevation data**. If you do not do this, ArcMap will automatically select the topmost layer, which could be anything.** If you fail to select the DEM, the values that you determine may not be elevation data.
- Click on a location, and the elevation will be returned in whatever units you have the Units/Display set to.

Measuring distances

- Right click on the word **Layers** at the top of the TOC, and choose Properties. Click the **General** tab, and check to see what the units are. If necessary, change to whatever units you need.
- Select the **measure** tool in the toolbar (looks like a ruler). Center the cross of the cursor at one end/side of what you want to measure on the map, click, and drag to the other end/side. Double click to end. The length appears in the lower left of the screen.

Measuring areas

ArcMap can calculate the area of a polygon in a shapefile, provided that the projection of the shapefile matches that of the map. ArcMap cannot calculate area on a raster image. If you have a raster image, the simplest thing to do is to create a new shapefile and draw a polygon outlining the area that you wish to measure.

- Start by making a new shapefile, add it to your ArcMap, and draw a polygon of the area (pages 25 and 28-30).
- **Be sure that you have Stopped Editing and saved your edits before going on to the next step.**
- Start by looking at the attribute table for your polygon layer (right click in TOC and select Open Attribute Table). You'll notice that each polygon you've drawn is a separate polygon listed in the order in which you added them (Lake 1 is 0, Lake 2 is 1, etc.), but that there are no data associated with any of the polygons. You need to tell arc map to calculate the areas and create a new attribute table.
- Go to **ArcToolbox**, open **Spatial Statistics Tool**s, and then **Utilities**. Select **Calculate Areas.**
- Input your new polygon layer (scroll down and select it). Under Output Feature Class, navigate to your folder and save the output file as area (or something like that). The new file automatically adds as a layer.

- Open the attribute table for this new layer. Voila! The area of each polygon appears in square units (actual units depend on how you have set the units/display).

Calculating evaporative losses

In order to calculate evaporative losses, you'll need to **create a new field in the attribute table:**

- Start by making certain that there is nothing selected in your map. Go to the main menu at the top of the screen, under **Selection**, and choose **Clear Selected Features.**
- Make sure also that you have **Stopped Editing**.
- Open the attribute table for the area layer that you created above. In order to add a new field where you will calculate evaporative losses, click **Option** in the attribute table window, and select **Add Field.** Name the field **EVAP**.
- Select **Double** from the **Type** menu, and type 15 into Precision and 0 into Scale. This will allow up to 15 digits in this field (precision) with no digits to the right of the decimal point (scale). Because of the huge uncertainties in what we're doing, we certainly don't need anything to the right of the decimal point….Click OK.
- Go to the Editor, and **Start Editing**. Select your area shapefile. **Note:** if you Start Editing first, and then try to add a field to the attribute table, it won't work. If this happens, Stop editing, add the field, and then start editing again.
- Right click the header in the evaporation field (the word **EVAP**). Select **Field Calculator.**
- Double click on **F_AREA** in the Fields list. It will be automatically added to the formula box. If you blunder, just select what's in the box, delete it, and start over again. Use the formula-builder to add the rest of the formula, typing in any constants you need. Click OK.
- **Save** Edits, and **Stop Editing**. Your new field will show the calculated evaporation losses in whatever units you've used for your Units/Display.

Measuring volumes

ArcMap can calculate the volume above or below a particular elevation on a DEM. Unless you mask a smaller portion of the DEM by the instructions below, this operation will calculate for the entire coverage of the DEM.

If you need to extract elevation pixels from the DEM for a particular area:

- You'll need a shapefile for the area that you want to extract. If you haven't already made one, follow the instructions above under **calculating area**.

- Make certain that there is nothing selected in your map by going to the main menu at the top of the screen, under **Selection**, and choosing **Clear Selected Features.**
- Make sure also that you have **Stopped Editing**.
- **Go to ArcToolbox, Spatial Analyst Tools, Extraction**, and **Extract by Mask**. This operation will use your shapefile outline as a "mask" and instruct ArcMap to get only those pixels of the DEM covered by the mask and extract them into a new layer.
- Under **Input Raster**, choose your original DEM (that's where you want to get your elevations from).
- Under **Feature Mask Data**, choose your new shapefile.
- Name your **Output raster** something like maskXX (with XX being the elevation of your shapefile), and save it to your folder. Click OK.
- Now, turn off all of your layers except your new extracted layer, and you'll see that your new layer consists only of the pixels in the DEM that are contained within the area of the shapefile that you drew.

To calculate the volume above these extracted pixels, we'll ask ArcMap to figure out the volume between the elevation of your shapefile level and the DEM.

- Go to **3D Analyst, Surface Analysis**, and select **Area and Volume**.
- Navigate to you **new mask raster** (not the original DEM!) for the input surface, set the height of the plane at your shapefile level (e.g., 137.00, or whatever it is).
- If the DEM lies **below** the shapefile level (e.g., a valley or basin), click the button **Calculate statistics below plane**. If the DEM lies **above** the shapefile level (e.g., a mountain), click the button **Calculate statistics above plane.**
- Click **calculate statistics.**
- ArcMap presents the stats for 2D area, 3D area (as a curved surface), and volume in whatever units you have specified in Units/Display.

Downloading Regional Earthquake Data and Portraying it in ArcMap and in 3D in ArcScene

Downloading the Data

Go to the USGS earthquake site at http://earthquake.usgs.gov/

From the **Earthquake Center page** above, select **Scientific Data**, and **Scientific Data** again on the Research and Monitoring page. Choose **Earthquake Catalog Search.** Then choose **Rectangular area.**

Set the search parameters for:

- Spreadsheet format
- USGS/NEIC 1973-Present
- Choose latitude and longitude range values, year range, and magnitude range. **Notice that SOUTH latitudes and WEST longitudes are entered with a negative sign before the degrees.**

Click Search and wait for the data. Click and drag to select all of the records, and Copy.

- Open **Excel**, and **Paste** everything into the first cell.
- Go to **Data**, **Text to columns**, and. Select **Delimited** in the first dialog box, and **Comma** in the second dialog box. Click finish.
- Select the latitude, longitude, magnitude, and depth columns (**be sure to select the WHOLE COLUMN for each**, not just the top cells). Choose **Format** from the main menu, **Cells**, and **Number**. Set the decimal places to **4**, and OK.
- ***Critical step!!!** Before you save the file, **click once in cell A1**. Then, select **Save As**, and scroll down to the format **DBF4**. Give your .dbf file a **SHORT** name, no spaces, and click OK, and Yes.
- ****Another critical step!!! YOU MUST CLOSE EXCEL BEFORE YOU CAN ADD THE DATA TO ARCMAP!!!***

The Data in ArcMap

You'll need to add a base map to ArcMap so that you can see where your earthquakes plot geographically. The following instructions are based on using a world map of continents that is included in the 5 DVD set from ESRI called *ArcGIS 9 Data and Maps Media Kit*. The continents map used here is on the *Data and Maps and US Street Maps* DVD. It is located in the World folder, Data folder, continents.sdc. This file can be added directly to ArcMap. If you want a .shp file, simply Export Data as a shapefile. If you use a different base map, the Coordinate System may not be the same as in the instructions here, and you'll probably also have to play with the scaling factor for depth in ArcScene.

Start a new ArcMap, and add continents.shp plus your .dbf file (you can find the continents.shp file in the GIS folder on the Academic Software Server). **Be sure that Excel is closed**; don't just minimize the window.

- You need to do one thing before your data will show up. If you look at the tabs at the bottom of the TOC in ArcMap, you'll see that the TOC has switched from Display to Source mode. Right click on the .dbf file, and select **Display XY data.** Be sure that the **X Field** pulldown says **Longitude**, and the **Y Field** pulldown says **Latitude**. If it doesn't, select the correct ones from the pulldowns.
- The **Coordinate System of Input Coordinates** will say **Unknown Coordinate System**. You need to define a coordinate system for your data so that it will plot properly on the map of the continents. Click **Edit**, **Select**, and select **Geographic Coordinate Systems**, **World**, **WGS 1984.prj** (the last option). Click OK. Now, the coordinate system should read **Geographic Coordinate System Name: GCS_WGS_1984**
- Click OK.

Now your earthquakes should show up on the map. But you won't be able to do anything with them in ArcScene quite yet. You need to first convert this **Events** layer to a shape (.shp) file.

- Right click on the events layer, and select **Data**, **Export Data**. All of the defaults are OK. Click on the folder icon, and navigate to where you want to save your new shape file, and give it a name. Remember: **SHORT, no spaces.** Click OK. If this fails to execute, check to see if Excel is open. **Excel must be closed (not just the windows minimized) in order for this to work.**
- You can now delete your original events layer and return to the Display view (click the **Display** tab at the bottom of the TOC).

Open the attribute table for your new shape file (right click on the name in the TOC, and select **Open attribute table**. All your data will be there. Close the attribute table.

In map view, select the **Information** tool (the "i"), and you can click on any earthquake on the map and find out information about it. It's all the information in the attribute table that allows you to display the data by various attributes.

- To change the symbols:
    - Go to Properties for your earthquakes layer, and select **Quantities.** Choose either graduated colors or graduated symbols In the value field, choose **DEPTH**. Choose the number of classes you want, and select a color ramp. Click OK.
    - Add the earthquakes layer again several times, and color-code different properties on each layer.

To view your quakes in 3D in ArcScene

The following instructions are tailored for the ESRI continents.shp map base added in the previous instructions. If you use a different map base, you'll need to fiddle with the conversion factor.

- Open to ArcScene. Add the continents layer and the earthquakes layer.
- Go to the Properties for the earthquake layer, and select the Base Heights tab. Click the icon to the right of the box under Height. This is the "Expression Builder". Double click on DEPTH then single click on * (multiply) and single click on – (minus) then .005, so that your expression looks like:

  [DEPTH]*-.005

- This will tell ArcScene to take the values in the earthquake depth column and multiply them by a factor to place them at the correct depth in the scene (because the map coordinates are not in kilometers, we need this conversion factor). This conversion factor is pretty good and doesn't exaggerate the vertical. If you want to exaggerate the vertical, change the conversion to -.01, but realize that this will exaggerate the dip of a Benioff Zone.
- You can also go to the Symbology page and code the quakes by color or symbol, and you can make the continents layer partially transparent so that you can see the earthquakes better as you rotate the scene.

Downloading Orthoquads from the NYS GIS Clearinghouse

Downloading the data

Although you can access these and other GIS data sites on a Mac, some of them do not work well, if at all, when using Mac based Internet browsers. So, do all your data acquisition on a PC with a stable Windows based-browser such as Internet Explorer.

- Go to the New York State GIS Clearinghouse site at **www.nysgis.state.ny.us/**

This is a gateway to an enormous set of GIS data for New York State. Most states now have web-accessible GIS clearinghouses of some sort, and a Google search will bring up URLs for them. Data may be free to download, have a charge associated with the download, or be restricted to some users. The NY State GIS clearinghouse has all three types of data. As members of the GIS Data Sharing Cooperative, Hamilton College faculty and students can access restricted data on this site, but a specific user ID and password are required to retrieve restricted data sets. Fortunately, the data you will be downloading are not restricted and do not require a password.

- On the main page of the NYSGIS Clearinghouse site, click **GIS DATA** in the top blue bar. This window shows the types of data sets available.
- Under **Imagery Data Sets,** click **Raster Imagery**. This opens a window listing the types of maps available.
- Under the heading **1:24000 NYS DOT and USGS,** click **View By Quad Map.** A map of New York overlain by an index of USGS 7.5 minute quads opens. The names of individual quads are not shown, but if you place the cursor over a rectangle, the name and DOT code for the map appears. You can also display a list of the quads, arranged by name, NYS code, or USGS code by clicking on the appropriate links at the top of the map page.

Maps downloaded directly from the NYSGIS clearinghouse site are ***collared***, meaning that all of the information in the border around the printed map is included (e.g., scale, lat/lon, titles, magnetic declination, etc.). When you're using individual maps (as we are in this exercise), having the collared maps is fine. So, you'll download your map from this site. Other sites have quads with the collars removed, which is convenient for mosaicking. We'll learn how to do that some other time.

- On the **View By Quad Map** page, find the quad you want. Quad names appear if you rest the cursor over an individual quad.
- Once you locate your quad, click on the quad to open its main page. This page lists the available files associated with the quad. Two types of map data are listed, a 7.5 minute Department of Transportation (DOT) map and a 7.5 minute USGS topographic quadrangle map.

- The DOT map consists of two layers, one with just roads and one with just streams. All hydrologic features and urban area tinting are removed from these maps. ***This is not the one we want.***
- The USGS quad is exactly that, a scan of the printed USGS 7.5 minute topographic quadrangle map. It isn't just a simple scan, though. The data include an associated file (a **World File** with a **.tfw suffix)** that allows ArcGIS to display it in the proper global space when it is brought into ArcMap.

- We want to download the USGS DRG topographic quadrangle. **This is likely not the first listing on the page,** so be sure that you look carefully to find the correct download hot link. You can use **Preview** to make sure that you have the correct map. Under **the header USGS Digital Raster Graphic Quadrangle**, find **download quad**, and click the link. When prompted to save, navigate to your **XXX_doq** folder, and save. This is a zipped file and won't appear in ArcCatalog yet. We will unzip it after we have downloaded the rest of the data we want.

- At the bottom of the page where you clicked the download link, you'll see **Additional Coverages**, which provides a direct link to your quad's data at the CUGIR site (Cornell's Geospatial Information Repository). Click this link. If this link is not working, you can go directly to the CUGIR site at http://cugir.mannlib.cornell.edu/. A listing of the data sets available for your quad at the CUGIR site comes up. It lists three data sets: 7.5 minute topographic maps, elevation (DEM data), and hydrography. If you want instructions on how to download and decompress DEM data from CUGIR, go to that section in this primer.

To decompress the DOQ

- **To decompress the topo map** in your **XXX_doq** folder:
  - In Windows Explorer (not ArcCatalog) navigate to your **XXX_doq** folder on the C:/ drive.
  - Right click on the zipped folder and scroll down to **Extract All.**
  - Extraction Wizard opens, click **Next**, and the Wizard creates a default folder to extract the files to. This folder will have the same name as the original folder without the .zip extension and will automatically be placed into your XXX_doq folder.
  - Click **Next,** and the extraction progress bar appears, and the files are extracted.
  - When the extraction is done, click **Finish**. The default when clicking Finish is to show the decompressed folder, which looks exactly like the original one without the zipper. Double click this folder to open it. The data downloaded from NYSGIS will appear as three files, your topo quad with a .tif extension and two additional files of metadata.

- Once you have all of your data sets, you can do some housekeeping in ArcCatalog to make the finished data more accessible. The topo quad should be at the top level of its respective folder XXX.doq). Use ArcCatalog to move it to that level. You can also use ArcCatalog to change the name of the topo quad to a meaningful name, rather than a number.

- Once you've used ArcCatalog to move your finished topo quad, you can then use ArcCatalog to delete all of the original downloads, although it doesn't hurt to keep them until you make sure that your files are working correctly so that you don't have to go back and download everything again. If you're working on an important project, it's a good idea to back up the original data folders or burn CD/DVDs of the data before deleting the original folders.

Working with Digital Orthoquads, Orthophotos, and Geologic Maps

DEMs (Digital Elevation Models) do not have geographic or cultural information, and, unless you are really familiar with an area, you may not recognize individual geographic features just by looking at the DEM. We can combine a DEM with other kinds of data such as satellite images, air photos, or map data (e.g., a digital orthoquad, which is a digital version of the standard USGS topographic map) to create a composite map with different layers contributing various components to the final map. The composite map, with variably transparent layers, will let us locate geographic features while still being able to visualize the 3D shape of the land surface.

Combining the DEM with a quadrangle map is made possible because the data files are ***georeferenced***. In other words, there is information in the files (the metadata) that tell ArcMap exactly where in the world the map is, what its scale is, what the units of measure are, and what technique was used to project that portion of the Earth's sphere to a flat map surface. If any of these pieces is missing (or if the projection method of the DEM doesn't match the projection method of the orthquad), you may have difficulty combining the maps successfully, although ArcMap will try to project a new data layer on the fly. This is not a trivial issue.

Projections

- If you want to combine several types of data in one map, all files must have a coordinate system and projection.
- ArcGIS will attempt to project "on the fly", fitting the files to the current coordinate system and projection of the map. If a file doesn't have a coordinate system, you will get a dialog box saying that the layer can be drawn, but not projected, and ArcGIS will guess what the projection of the file is, although this may mean that features drawn on the map are not accurately located.
- You should be able to find out what the coordinate system and projection of the data is by checking the files spatial metadata in ArcCatalog. Unfortunately some data sets, such as shape files, may not have metadata tied to them, depending on how careful the creator of the file was to document the metadata.

Superimposed topo features on a DEM hillshade

Add the orthoquad and the DEM as data layers, and make a hillshade from the DEM layer. You'll now see the hillshade layer in the TOC. Rename it, if you like. You can use one of two techniques to combine a topo map and a hillshade:

- Putting the hillshade on top and making it partially transparent:
    - Order the layers so that hillshade is above the topo layer.

- Go to the Hillshade layer **Properties**, and change the Display options to make the hillshade partially transparent. Increasing contrast and brightness of the hillshade can help improve appearance.

Putting the topo map on top, and deleting unwanted colors

- Re-order the layers in the TOC so that the orthoquad is the top layer.
- An orthoquad is raster image, and ArcMap knows what color every pixel is in the file. We can selectively replace pixels of a particular color with a new color or with no color, in order to make the pixel transparent.
- **Making the white background of the map disappear**. Zoom out using the globe tool. Expand the orthoquad layer by clicking on the plus sign next to the layer name. Right click in color box #1, and select **No color**. Zoom in, and admire how you can now see a whole lot of the hillshade below. But, there are still some patches we'd like to get rid of, while still keeping some of the geographic features on the map.
- Do the same for color boxes 5, 6, 7, 9, 10, and 11. Don't do 4, 8, and 12!!! This will turn off all of the aspects of the map that are colored any other color except brown (topo lines), red (roads), blue (water), and black (labels, buildings, etc.). Use the magnifier tool (you can dock the floating tool bar, if you want) to browse around and check to see whether the streams lie in the bottoms of the valleys on the DEM.
- If you reassign a color to an item and want to reconstruct the colors, here are the standard USGS colors that you can use to get back to exactly the original colors. In the TOC, double-click on the color square, click on the **Color** tab, and type in the following numbers:

USGS Digital Raster Graphic Color Palette

Digital Number	Color	Red	Green	Blue
0	Black	0	0	0
1	White	255	255	255
2	Blue	0	151	164
3	Red	203	0	23
4	Brown	131	66	37
5	Green	201	234	157
6	Purple	137	51	128
7	Yellow	255	234	0
8	Light Blue	167	226	226
9	Light Red	255	184	184
10	Light Purple	218	179	214
11	Light Grey	209	209	209
12	Light Brown	207	164	142

Proving to yourself that the orthoquad is in the right place

Did ArcMap put the digital orthoquad in the right place geographically? You can easily check this. Zoom in on the lower right hand corner of the image until you can read the lat/lon coordinates on the digital orthoquad. Position the cursor so that it lies right at the corner of the quad, and check to see if the lat/lon value for the cursor (shown in the information box at lower right) matches the values printed on the map. They should!!

Checking orthophotos for proper placement

If an orthophoto file has correct metadata (coordinate system and projection), ArcGIS will "project on the fly" and place the orthophoto in the correct geographical position on the existing map, regardless of the coordinate system and projection being used on the map.

ArcGIS is almost magical in how it handles data in various projections and coordinate systems, so much so that you may not pay as close attention as you should when it displays data.

- Always look at data once they is added to the map. Do they make sense? Do features line up with features on other layers? If not, is there a consistency to how they are not lining up? The same feature mapped in NAD 27 and NAD 83 coordinate systems and overlaid on top of each other can be offset approx 100 m (in our area this tends to be to the NW). If you see this kind of offset, be thinking it is a Datum problem.
- When checking placement of orthophotos by comparing features on the photos to those on, say, a topo map, be careful what features you use to compare. Orthophotos are recent (typically within the past few years), whereas topos have been around for quite a while. For example, the local Rome quad was last revised in 1955. Roads, buildings, and even streams may have changed significantly over the time between the map and the orthophoto. Check a number of features before deciding that something does not line up.

Adding GPS waypoint data to an ArcMap

We can download the GPS data directly from the Garmin unit to a shapefile that can be added a map.

Downloading the data from the Garmin unit

- Make sure that you don't have a "low battery" message on the Garmin unit. If you do, replace the batteries. You don't want to run out of power while you're transferring data.
- Plug the cable into the Garmin unit and into the computer.
- On the computer, launch DNR Garmin. In the window that comes up, make sure that it says **Connected** in the lower left corner.
- Click the **GPS** tab, and check to make sure that **Set Port** is set to **Port 1** and that **Set Baud Rate** is set to **9600**.
- Due to a bug in DNR Garmin, use the following procedure to set the projection before downloading waypoints

  File> Set Projection

  - Choose a projection you will not use, e.g., NAD 27 UTM 14 N. Set this, and click OK.
  - Reopen the window **File> Set Projection**, set the correct projection NAD 27 UTM 18 N, and click the **Load PRJ** button.
  - Navigate to correct projection, **Projected Coordinate Systems > UTM > NAD27> NAD27UTM18N,** and click open.
  - You'll be returned to the DNR Garmin dialog box. **Click OK**.
  - The projection window on main screen should show NAD 27 UTM 18 N
- Click the **DataTable** bar, which brings up a data table screen.
- Click the **Waypoint** tab in the main menu bar (not the radio button in the data table), and select **Download**. Woo woo! There are your waypoints!
- Click on the **File** tab in the main menu, and select **Save To** and **File**. Navigate to your data file, name the file (remember! **short! no spaces!!**). Scroll down to **ArcView Shapefile Projected** in the **Save as type** box. Click **Save. Check in ArcCatalog under the Spatial tab to make sure that the projection is attached.**

Adding your GPS waypoints to your map

- Open ArcCatalog, and check to make sure that you know where your waypoints shape file is.
- Launch ArcMap, and open your ArcMap.
- Add the waypoints shape file (using the **Add Data** button). All of your waypoints should plot instantly!! Much easier than plotting by hand!! Zoom in and look

around to see if ArcMap has plotted your stations where you think they ought to be.

Opening an Attribute Table

- Let's look at the data behind the **Waypoints** layer.
- Right click on the waypoints layer in the ArcMap TOC, and select **Open Attribute Table**.
    - Each column is called a **Field**. Locate the field with your station names in it, and notice that the name of this field is **IDENT**. This is important to know, because you'll want to label your waypoints on your map, and you'll need to know the name of the field that contains the station names.
    - **LAT** and **LON** fields: these fields contain the lat/lon data from the Garmin unit in decimal degrees (rather than in degrees, minutes, and seconds).
    - **Y_PROJ** and **X_PROJ** fields: these are the fields that ArcMap uses to put the waypoints in the proper place. When you set up DNR Garmin, you selected a datum and a projection. That choice allowed DNR Garmin to decide what to do with the lat/lon data to convert it to a number that ArcMap can plot **and plot correctly**. If you had inadvertently chosen a datum and projection that didn't match the one for your ArcMap file, the waypoints would not plot in the correct place on the map.
    - Close the Attribute Table.
- As you did with the towns, add labels to your waypoints so that they're not just symbols (Properties, Labels, Label features in this layer, and, in the **Label** field, be sure to select the field name for your stations). You can also change the station symbol style, size, and color (left click on the symbol itself in the TOC).

Viewing the layout

- Below the regular ArcMap window, you will see two icons, a globe icon and a page icon. The globe icon takes you to the regular global view where you add and modify layers in ArcMap. The page icon takes you to the Layout view.
- Toggle back and forth to see the difference.
- In Layout view, clicking on your map will bring up a **Data Frame**. The colored outline and boxes of the Data Frame must be visible any time you want to modify the Data Frame.

Selecting what will appear in Layout View

- Whatever appears in the ArcMap window will be what you'll see in Layout view.
- Zoom to the portion of the file that you want to show, or zoom all the way out to include the entire file in the view.

Moving around in the layout view

- **If you use the regular zoom and pan tools in the layout view, you will change what appears in the Data Frame.** Remember that only what appears in the data frame will print. **If you accidentally do something you regret, click the big blue left arrow to return to the previous extent.**
- If you want to zoom your layout view **without** changing what's in the Data Frame, you have to uses the layout Zoom and Pan tools in the layout menu bar (the ones with the little page icon under the Zoom and Pan icons).

Setting the Page Set-up for your Layout View

- Go to the **File** menu and select **Page and Print Set-up.**
- In this dialog box, you can select a printer, page orientation (landscape or portrait), and paper size. **Be sure to check the box labeled *Scale Map elements proportionally to changes in Page Size*** (this is at the bottom of the dialog box). Select the paper size you want. And **be sure to also click Use Printer Page Settings** in the Map Page Size.
- Click OK.

Changing the size and position of your Data Frame

- Be sure that your data frame is selected. Clicking and dragging will **move** the data frame.
- Clicking and dragging a side handle will make the data frame shorter/taller or wider/skinnier (e.g., if you want to bring the border closer to the object inside the frame).

- Clicking and dragging a corner handle will scale both height and width of the frame and what is in the frame.

Adding scale, north arrow, etc. to your Data Frame

Any of the items that you add below can be removed by selecting them a hitting the delete key. **Start by selecting the data frame in the layout view using the selection tool (black arrow) in the main toolbar.**

- **Adding a neat line**
  - From the **Insert** menu, select **Neatline**. Choose the kind of border you want, and click OK.

- **If you don't want to have either a neat line or a frame around the object.**
  - Even if you don't add a neat line, the default setting will put a black frame around the data frame. If you don't want this, right click on Layers in the TOC, and select **Frame**. Under **Border**, scroll up to None. Click OK.

- **Adding a north arrow**
  - From the **Insert** menu, select **North arrow**. Choose the kind of north arrow you want, and click OK.
  - The north arrow appears in your Data Frame. To move it around, click on it to highlight it, and move it or scale it by dragging the handles.
  - To modify your north arrow, double-click on it, and choose a new color or a new style.

- **Adding a title**
  - From the **Insert** menu, select **Title**.
  - The easiest way to add and modify a title is to click anywhere outside the title to deselect it, and then double-click on it to bring up the properties box.
  - Type your title into the text box.
  - To select fonts, sizes, and colors, go to the bottom of the main screen to make selections.. Clicking apply instead of OK lets you test out options.
  - When you're happy with what you have, click OK.
  - To move the title around, click on it to highlight it, and move it where you want it to be.

- **Adding a scale bar**
    - Go to the Layer Properties, and select the General tab. Choose the display units that you want. Choose something practical, because this is what will appear on your scale bar.
    - From the **Insert** menu, select **scale bar**. Choose the kind of scale bar you want, and click OK.
    - The scale bar appears in your Data Frame. To move it around, click on it to highlight it, and move it or scale it by dragging the handles.
    - To modify your scale bar, double-click on it, and make new choices.

- **Adding a callout box**
    - In the drawing menu, click on the down arrow next to the Text tool (the A). Select the callout box (looks like a cartoon caption). Click on the map layout and drag. Type your text into the textbox, and format it using the text formatting tools in the Drawing toolbar.
    - Hit Enter.
    - To move the end point, select the callout box, and click and drag the end point. Ditto for the box.
    - If you want to change the text in the box, double click on the text in the box, and enter the text in the dialog box.

- **Adding a text box (this kind of a box won't have a leader)**
    - From the **Insert** menu, select **Text**. Again, it's easiest to click outside to deselect it and then double click to bring up the options box.
    - **Text does not wrap in this option**. You will have to add returns where you want them.
    - Type what you want in the **text** box, and use the bar at the bottom of the main window to make choices about text font, size, and color. Click OK.
    - The text appears in your Data Frame. To move it around, click on it to highlight it, and move it or scale it by dragging the handles.
    - To modify your text, double-click on it, and make new choices.

- **Adding a leader or a line with an arrow**
    - Find the Drawing icons at the bottom of the main window. Click on the line icon, and select the line tool.
    - Draw your line, and double-click to end the line. Double-click on the line to bring up the properties box, and, if you want an arrow, go to **Change Symbol** and scroll to the bottom. Click OK.

- **Adding the Hamilton GIS logo**
    - If you want to add the Hamilton GIS logo to your map, from the **Insert** menu, select **Insert Picture**. Navigate to the main level of the Geosc103_Data folder, and find geoGIS.tif. Select it.
    - It's big, and you can modify its size by click on it and dragging the handles.

Map with multiple windows (Data Frames)

You can make a map with multiple windows that show zoomed-in portions of your main map, and you can even link the windows together!! Very fancy. **Save often as you are doing this!! It's easy to do something that you will regret.**

Creating the base map

- Zoom in to whatever you want to have on your main base map.
- Switch to layout view.
- Add scale bar, north arrow, neat line, title, key, whatever you want.

Adding new windows (Data Frames)

- The new windows are called **Data Frames**.
- If you want to have a second data frame, go to the **Insert** menu, and select **Data Frame.** You'll see a new listing in the TOC, and you'll see that your new Data Frame doesn't have anything in it. Go to your TOC, and left click and hold on the title of the layer you want to have in the new data frame, and drag it and drop it in your new data frame. You can drag as many layers as you want from the original menu. If you select the magnifier or pan tools from the **regular menu** (not the layout menu), you can zoom in to what you want in the new data frame. Pretty cool!!!
- **Rename your new data frame with a descriptive name.**

Linking your new Data Frame to the original window

- Right click on the **original Layers** in the TOC, and get the Data Frame Properties. Select the **Extent Rectangles** tab. Click on your original Layers in the Other Data Frames, and click the right arrow to move it to the right hand list.
    - Click the Frame button, and choose the color and size of the framing rectangle. You can always change this if you don't like it. You can see what it looks like by clicking Apply before you OK everything.
    - To connect your new frame to the extent rectangle with a leader, check the Show Leader box, and choose Leader Symbols. When you're happy,

click OK. You should now have a rectangle on your original map window that is connect to your new data frame.

- If you move your new data frame, just click the refresh icon (next to the page layout icon), and the leader will re-draw.
- If you don't like the frame or leader, just go back to the Properties again and change them.

- If you use the regular zoom and pan tools (not the ones for the layout view), you'll see that the rectangle changes size and location as you pan and zoom. Extra cool!!!
- You can add separate titles and neat lines for your new data frame.
- You can add as many new data frames as you want and link them to the original window. Just remember that you need to go to Layer Properties for the **original Layers** to make the extent rectangle show up on the original window. If you add several, you'll see why it's so important to rename each one!

Exporting your map

- When you are happy with your map, go to the File menu, and select **Export Map**. Under **Option,** click the **General** tab, and set the resolution to 200.
- You can select either jpeg format or pdf. For best printing, select **pdf** format. Then, click the **Format** tab, and click in the box to **Embed all document fonts.**
- Name your map file. Navigate to your own data folder, and click Save.

If you want to do a map layout, with title, scale bar, etc., follow the instructions in the previous section. If you just want **to print or export a portion of your ArcMap**, **follow these instructions.**

Printing from ArcMap

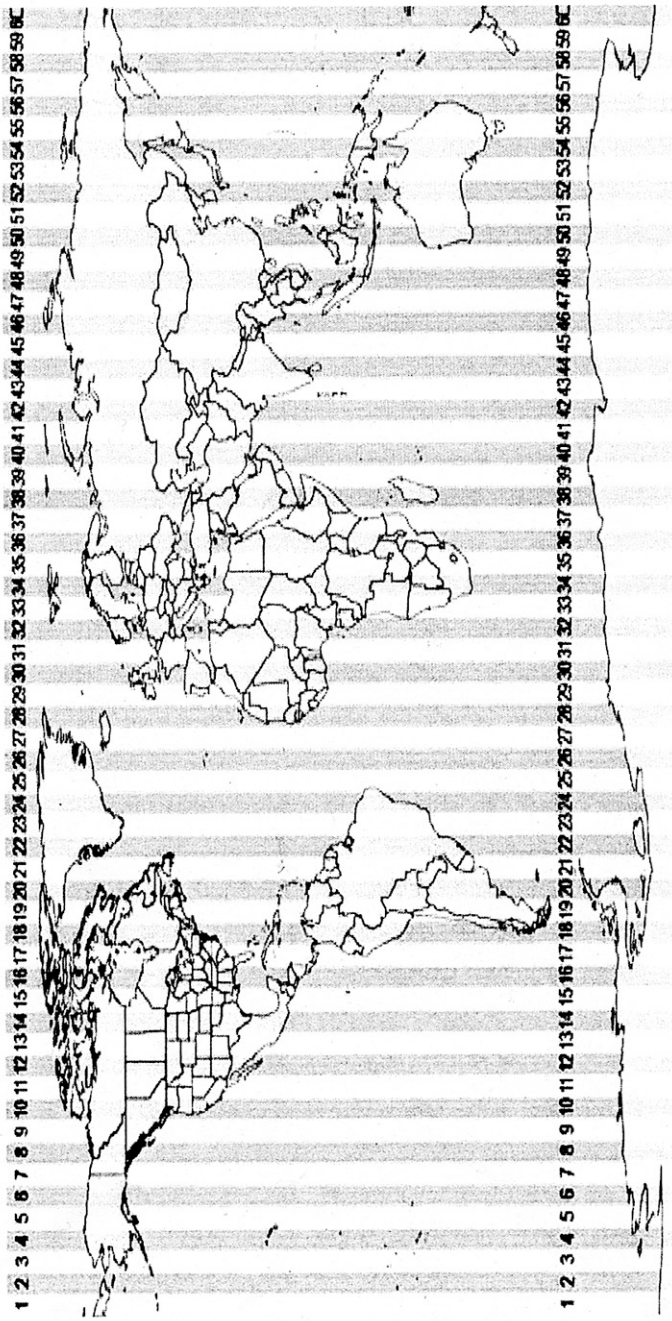
- Start by turning off the layers you don't want to have on your printout. ArcMap will print only the layers that are visible (i.e., that have check marks next to the layer names)
- Then, in Map View (not Layout View)zoom in or out to what you want to have on the printed page. ArcMap will print whatever shows in the map window.
- From the main **File** menu, select **Page and Print Set-up**. Make sure that the paper size is set to the size you want, and choose either **Portrait** or **Landscape**. Be sure that the box **Scale Map Elements...** at the bottom is checked.
  Click OK.
- Under **File**, you can **Preview** the page, if you want.
- When you are ready to print, select **Print** from either the **Preview** window or from the main **File** menu.
- If you want to print in color, export your map as a jpeg or pdf (under the main File menu), and add insert it into a Word file or open it in Acrobat Reader.

Exporting from ArcMap

- Start by turning off the layers you don't want to have on your export. ArcMap will export only the layers that are visible (i.e., that have check marks next to the layer names).
- From the main **File** menu, select **Page and Print Set-up**. Make sure that the paper size is set to the size you want, and choose either **Portrait** or **Landscape**. Be sure that the box **Scale Map Elements...** at the bottom is checked. Click OK.
- Then, in Global View, not Layout View, zoom in or out to what you want to have on your export. ArcMap will export whatever shows in the map window.
- When you are happy with your map, go to the File menu, and select **Export Map**. Under **Option,** click the **General** tab, and set the resolution to 200.
- You can select either jpeg format or pdf. For best printing, select **pdf** format. Then, click the **Format** tab, and click in the box to **Embed all document fonts.**
- Name your map file. Navigate to your own data folder, and click Save.

UTM Zone Map

UTM Zone	Central Meridian	Longitude Range
1	177W	180W-174W
2	171W	174W-168W
3	165W	168W-162W
4	159W	162W-156W
5	153W	156W-150W
6	147W	150W-144W
7	141W	144W-138W
8	135W	138W-132W
9	129W	132W-126W
10	123W	126W-120W
11	117W	120W-114W
12	111W	114W-108W
13	105W	108W-102W
14	99W	102W-96W
15	93W	96W-90W
16	87W	90W-84W
17	81W	84W-78W
18	75W	78W-72W
19	69W	72W-66W
20	63W	66W-60W
21	57W	60W-54W
22	51W	54W-48W
23	45W	48W-42W
24	39W	42W-36W
25	33W	36W-30W
26	27W	30W-24W
27	21W	24W-18W
28	15W	18W-12W
29	9W	12W-6W
30	3W	6W-0
31	3E	0-6E
32	9E	6E-12E
33	15E	12E-18E
34	21E	18E-24E
35	27E	24E-30E
36	33E	30E-36E
37	39E	36E-42E
38	45E	42E-48E
39	51E	48E-54E
40	57E	54E-60E
41	63E	60E-66E
42	69E	66E-72E
43	75E	72E-78E
44	81E	78E-84E
45	87E	84E-90E
46	93E	90E-96E
47	99E	96E-102E
48	105E	102E-108E
49	111E	108E-114E
50	117E	114E-120E
51	123E	120E-126E
52	129E	126E-132E
53	135E	132E-138E
54	141E	138E-144E
55	147E	144E-150E
56	153E	150E-156E
57	159E	156E-162E
58	165E	162E-168E
59	171E	168E-174E
60	177E	174E-180E



Technical Reference Guide: UTM Zone Map