# Michigan Technological University
# School of Forest Resources and Environmental Science

## Introduction to Geographic Information Systems and Remote Sensing for Natural Resource Management FW 3540

## Spring Semester 2009

## Laboratory Exercise 3
## DEM Import and Display; Generation of Slope, Aspect, Hillshade and Viewshed Layers

**Introduction**
This lab is designed to teach you how to analyze Digital Elevation Model (DEM) data in ArcMap: how to find DEM data online, import it into a format the GIS software can use, symbolize it for easier interpretation, and how to create new thematic layers (remember this is the major distinguishing characteristic of a GIS when compared to a CAD or DBMS). Derived layers include slope, aspect, shaded relief (hillshade), and viewshed models, which are often used in zoning, vegetation studies, timber harvest planning, site selection, and as cartographic backgrounds.

Create a "lab3dem" directory in your class directory before you download any files. It is important to keep your layers organized. Also, you **should not be using spaces** in your directory or file names, particularly when working with raster data in ArcGIS. ArcGrid file names cannot contain spaces – either in their names or in the associated directories. Names are also limited to 12 characters

**Downloading DEMs**
Log into the GIS Data Depot and using the steps from last week's lab, locate the 1:24,000 DEMs for Indiantown. Download both the 10 and 30 meter data sets.

SDTS format DEM files are partitioned by 7.5-minute quadrangle just as the DLG data is. If you are working in an area that is larger than a quad, you need to download multiple files, import them, and mosaic them to obtain a DEM that covers your entire study area.

**Decompress and Convert the Trapper's Lake DEM files to grids**
As you know from last week, SDTS format data is not usable directly by ArcMap. You will need to convert the SDTS-format DEM information to ESRI grids- a raster data format. Use PowerArchiver to decompress the two (10 and 30 meter) files into your lab3 folder.

Import the files as ArcGrids using the SDTS Wizard found in Arc Toolbox. This is the exact same tool you used to import the DLG files. Refer to the lab 2 handout for detailed instructions and illustrations if needed. Be sure to process both the 10-meter DEM file and the 30-meter DEM file. You may select any one of the DDF files as input to the tool. Rename your output files from their default names to something more intuitive such as indian_10m and indian_30m.

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**A Note About Color Schemes and Surface Elevation Data**
A common color scheme employed with continuous data, such as elevation, is ROYGBIV (red, orange, green, blue, indigo, violet): also known as a spectral color scheme. This color scheme differs from the one employed with the hypsography DLG vector data.

We associate certain colors with various features. For example, blue for water, red for drier sites or higher elevations, green for moist aspects, *et cetera*. Hence, it is important to take the time to develop a meaningful color scheme in the Table of Contents and save it. ArcMap presents color schemes to the user with a small graphic depiction (shown below). If you would rather see the *name* associated with the color scheme, right-click on the color ramp (drop-down arrow or colors) and deselect Graphic View. You will then be presented with the color scheme name instead of the colors themselves:

**Display and Evaluate the DEMs**
Start ArcMap and open a new empty map. Load both DEMs with the add data button. 

By default DEMs are displayed in shades of gray, from dark (low elevations) to light (high elevations). As indicated above, you will probably miss some details in the landscape if you use the default color scheme as the contrast is minimal.

Double click on the layer name to open the **Layer Properties** window. Take a moment to look at the information presented under the **General** and **Source** tabs.

What coordinate system is the data registered to? _____

Is this a projected or geographic coordinate system? _____

What are the minimum and maximum elevation values for 10 m DEM (be sure to include the units)? _____

What are the minimum and maximum elevation values for 30 m DEM (be sure to include the units)? _____

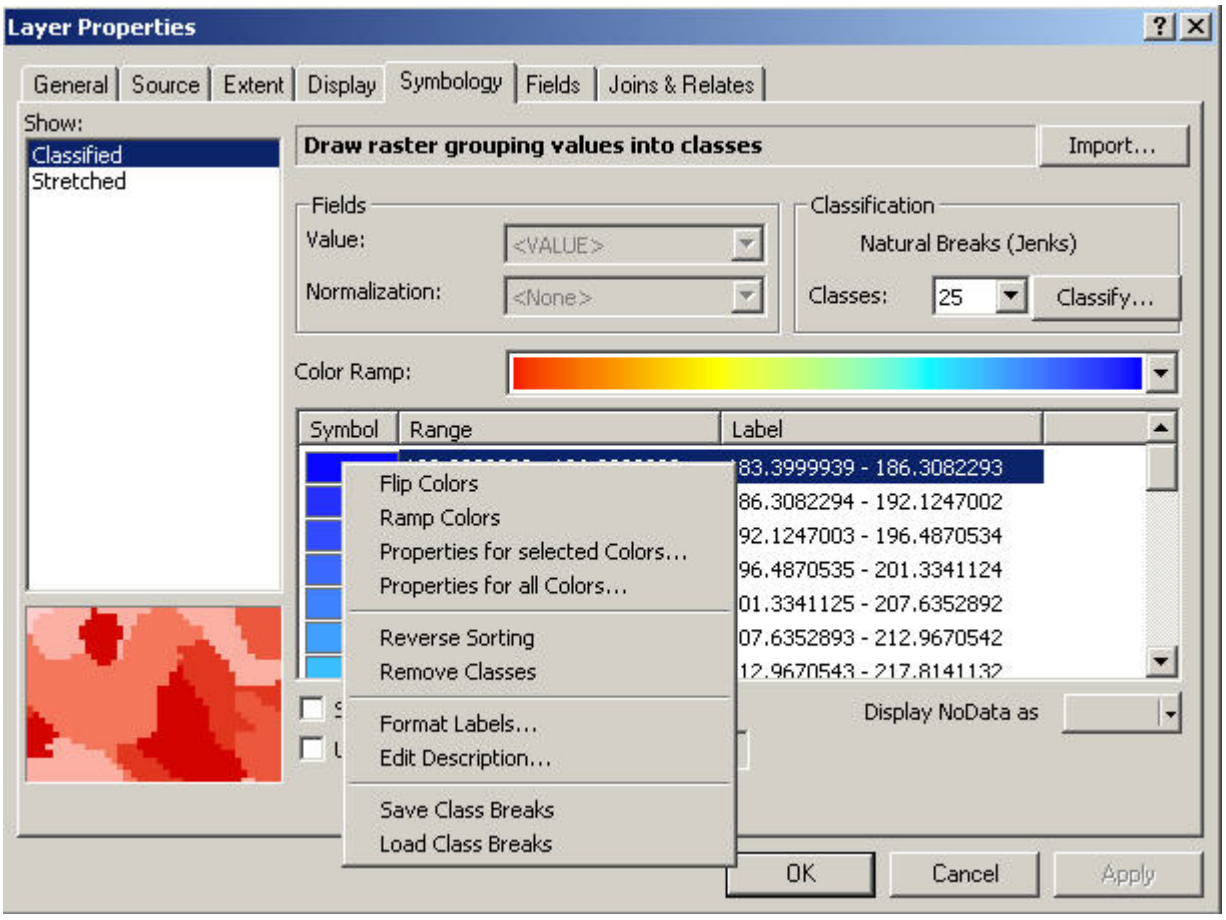
How many rows and columns are in the 30 m DEM? _____

How many rows and columns are in the 10 m DEM? _____

Why does the file size vary between the two DEMS?_____

_____

**Construct Legends**
Select the **Symbology** tab. Setup a spectral color legend using the ROYGBIV color scheme. Create a legend for the **30-meter DEM** with 25 classes, and select the appropriate color scheme. Be sure to select **Classified** in the **Show**: window. You are creating intervals that change how the layer is symbolized; you are **not** generating contour lines.




Note the color ramp will, by default, color the lowest elevation red and the highest blue. Therefore, right click on the color symbol and when the drop down menu appears (see above), choose **Flip Colors.**

Repeat the process for the 10 meter DEM.

## Utilizing ArcMap's Surface Analysis Functions

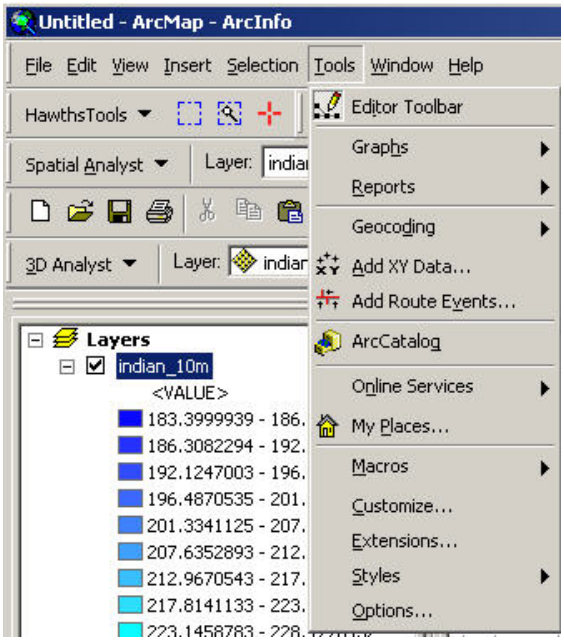
### Z-Factor

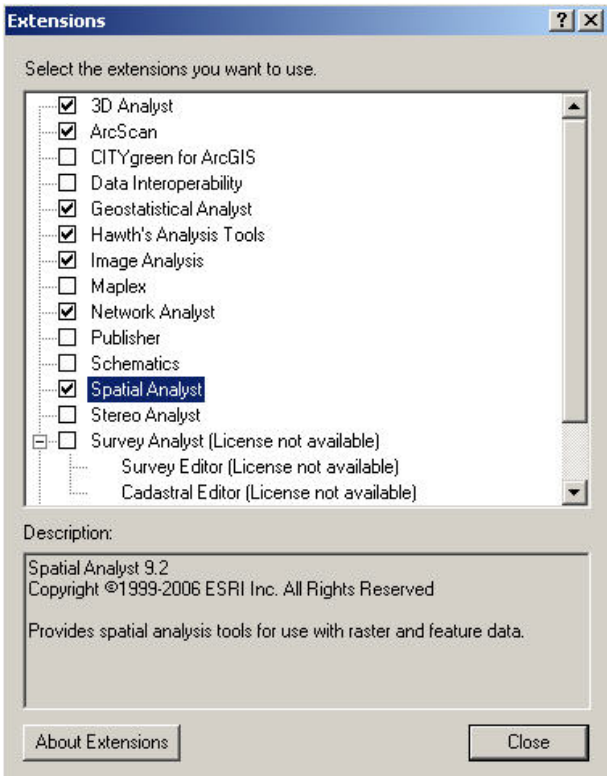
If the map units (x, y coordinates) and the z-value (elevations) units differ, it's important to use the Z factor option to ensure slope, hillshade and viewshed thematic layer are calculated correctly. If you are working with the 10-meter DEM file, both the elevation values and map units are in meters and the Z factor option is unnecessary. However, the 30 meter DEM has x, y coordinates in meters (UTM coordinate system) but the elevation values are in feet.

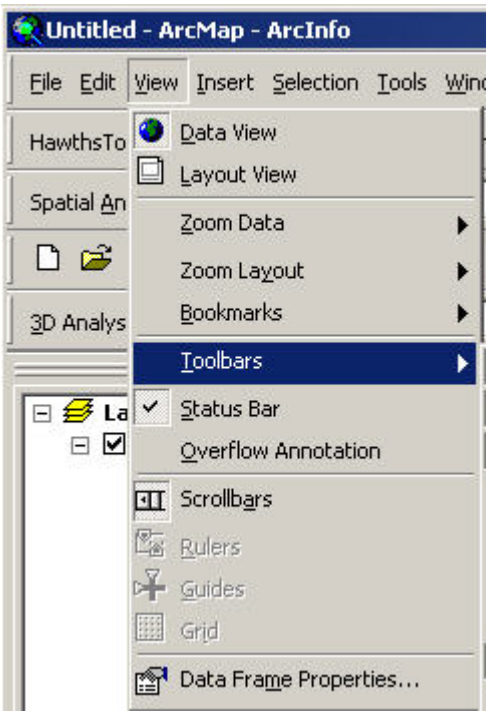
The z-factor is the number of ground x,y units in one surface z unit. The Input surface values are multiplied by the specified z-factor to adjust the input surface z units to another unit of measure. It is important to specify a z-factor if the z units are not in the same unit of measure as the x,y units. For instance, if your x and y units are in meters and your z units are in feet, you would specify a z-factor of 0.3048, since there are 0.3048 meters in one foot.

**Slope Calculation**

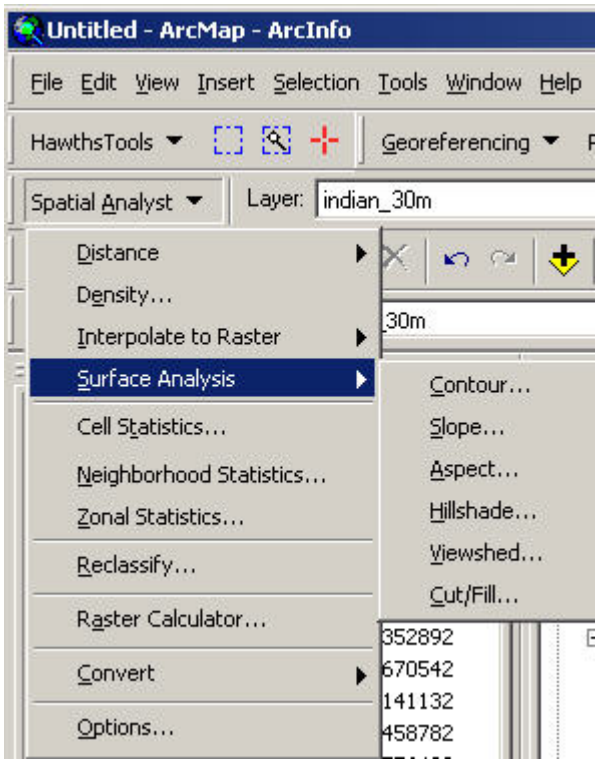
A DEM shows you elevations for a portion of the Earth's surface, but additional information may be generated with just a few menu choices. *Slope* is useful for predicting landslide potential, determining areas unsuitable for building, and identifying forest stands with harvest restrictions. To calculate slope and aspect using the 10-meter DEM, turn on **Spatial Analyst** by clicking **Tools/Extensions…** and checking the **Spatial Analyst** box (see illustration below). If you don't see the Spatial Analyst toolbar, go to **View/Toolbars** and select **Spatial Analyst** from the list of available toolbars (again, see illustration below).



Click on the arrow to the right of **Spatial Analyst** in the toolbar for a drop down menu. Choose **Surface Analysis>Slope** to generate a slope layer (see illustration below).




**Aspect Calculation**

*Aspect* is the direction land surface faces. Houghton, in general, has a northern aspect. Mont Ripley and Hancock have a southern aspect. Aspect is defined as the direction of the maximum rate of change in elevation between grid cells – essentially adding a direction component to slope. Aspect is expressed as an azimuth clockwise from north (0 degrees) back to north (360 degrees). Flat areas (such as Lake Superior) have a slope of zero and are assigned an aspect of –1.

To calculate aspect for your DEM, select **Spatial Analyst > Surface Analysis > Aspect.** Ensure that the 10-meter DEM is selected as the input layer (your slope layer may be the default). Change the Temporary output grid to a permanent one and save it in your lab3dem directory.

**Hillshade Construction**

You should also create a hillshade layer from the 10-meter DEM. The hillshade function is typically used to create a shaded relief map from a DEM. Shaded relief gives a 3-D look to a landscape. The default azimuth and altitude values work well for graphical display. For analysis, you may wish to modify these values. Azimuth is the angular direction of the sun; the default angle of 315 degrees is NW. Altitude is the slope or angle of the illumination source above the horizon. The default is 45 degrees above the surface.

Select **Spatial Analyst > Surface Analysis > Hillshade.** Ensure that your 10-meter DEM is selected as the input layer (it will probably be your aspect layer). Change the Temporary output grid to a permanent one: save it in your lab3dem directory with an intuitive name.

After processing, the hillshade will be displayed at the top of the layer list.

For more of a visual impact, drag your 10-meter DEM to the top of the layers list in the table of conetents and open its layer properties window (right-click on layer/properties… or double-click the layer name). Change the color scheme to "elevation # 2" (found under the Symbology tab). Choose the Display tab and type 40 in the Transparent box. Click OK.

**SOMETHING FUN:** if you add or subtract 180 to the azimuth (thereby changing the azimuth to southeast, or 125) you will see inverted topography. Try it!

**Viewshed Construction**
A *viewshed* is what can be seen from a specific location on the landscape. Creating a viewshed model produces a thematic layer that identifies those areas that can and cannot be seen from a given point (or points). Use ArcCatalog to copy the file highest.shp from p:/fw3540/lab3 to your lab3dem directory. This is a point shapefile that represents the highest location in the Trapper's Lake quadrangle. Add the shapefile to your map. This layer is used as the starting point ("what can I see from here?").

Select **Spatial Analyst > Surface Analysis > Viewshed.** Be sure that your 10-meter DEM is selected as the input surface and that highest is selected as your observer points layer. Change the Temporary output grid to a permanent one and save it in your lab3dem directory with an intuitive name.

After processing, the viewshed will be displayed at the top of the layer list. If you wish, you may adjust the colors for readability. You may also wish to turn off the DEM layer and adjust the viewshed grid so it's 50% transparent (displaying the viewshed on top of the hillshade may help explain why some portions of the landscape are obscured).

Be sure to save your map document. If you have been diligent about checking where your output files have been written, they should all be in your 'lab3dem' folder where you can easily find them in the future. If they are not in the correct folder, use ArcCatalog to move them to the correct location.

**Due in lab next week** (well actually in two weeks, as we do not have lab next week)
Flowchart on downloading and importing DEM data into ArcMap
Flowchart on the construction of a ROYGBIV color scheme
Flowchart on slope, aspect, hillshade and viewshed construction. Be sure to include a note about the Z-factor.