Michigan Technological University
School of Forest Resources and Environmental Science
Introduction to Geographic Information Systems for Natural Resource Management
FW 3540

Spring Semester 2007

Laboratory Exercise 4
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). Dreived layers include slope, aspect, shaded relief, 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. Note all files should be kept in your h: directory, not the desktop.

Downloading DEMs

Log into the GIS datadepot and locate the 1:24,000 DEM for Trapper's Lake. Click on Michigan in the map graphic, then select Alger County. Click on DEM 24k. You will be presented with a list of the 1:24k quads that are in Alger County. Download both the 10 and 30 meter DEM data.

SDTS format DEM files are partitioned by 7.5-minute quadrangle. 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. Fortunately, the USGS is now distributing DEM data in "seamless" forma. You can identify an area of interest and the server will custom-generate a data layer for you to download. The server is http://seamless.usgs.gov. This site has the "best available" large-scale DEM files for the U.S. For today, you will work with only a single quad.

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) archives: in Windows Explorer, right-click on each archive and select "extract here.

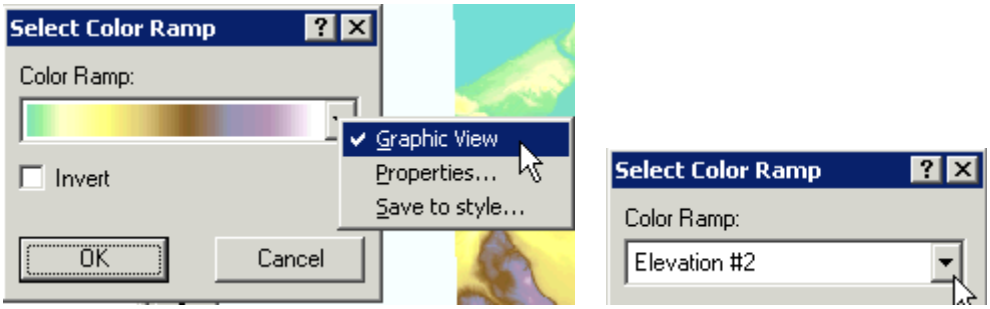
Import the files as ArcGrids using the SDTS Wizard found in Arc Toolbox. This tool may be run from either ArcCatalog or ArcMap and may be found under "Coverage Tools / Conversion / To Coverage / Import from SDTS". Be sure to process both the 10-meter DEM file (1698458.dem.sdts.tar.gz) and the 30-meter DEM file (1643472.dem.sdts.tar.gz). You may select any of the DDF files as input to the tool. Rename your output files from their defaults (1009 for the

10-meter DEM and 7797 for the 30-meter DEM) to something more intuitive: trap_10 and trap_30. Close the Toolbox after you successfully import the two DEM layers.

FYI: ArcGrid file names cannot contain spaces – either in their names or in the directories above and are limited to 12 characters.

A Note About Color Schemes and Surface Elevation Data
The human eye can only detect about 21 shades of gray. It can, however, see several hundred shades of color. A common color scheme employed with continuous (elevation) data is ROYGBIV (red, orange, green, blue, indigo, violet), also known as a spectral color scheme.

Humans 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 the DEMs and modify the legend in ArcMap
Initialize ArcMap and open a new empty map. Load both DEMs by clicking 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 some features will be "hidden" in the grays.

Setup a spectral color legend. 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 are the map units for the 10-meter DEM? _____
What are the minimum and maximum elevation values? _____
What units are the elevations reported in? _____ (Hint: Lake Superior is at 602 feet)

What is the coordinate system (spatial reference) of the 30-meter DEM? _____
How many rows and columns does it have? _____
What are the minimum and maximum elevation values? _____
What units are the elevations reported in? _____

Make a visual comparison of the two DEM files. Do you see any substantial differences between them? _____

Why? _____

Select the Symbology tab. Here you may modify the legend colors and number of classes. Create a legend for the **30-meter DEM** with 25 classes and class breaks at 605 ft and then every 20 feet (625, 645…). Use a spectral (ROYGBIV) color scheme. You are creating intervals that change how the layer is symbolized; you are **not** generating contour lines.

When your legend is complete, have your TA initial here. _____

Utilizing ArcMap's Surface Analysis Functions

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* may be 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**. If you don't see the Spatial Analyst toolbar, go to **View/Toolbars** and select **Spatial Analyst** from the list of available toolbars.

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.

Ensure that your 10-meter DEM is selected as the Input surface. Change the output measurement to Percent. Click the folder next to Output Raster: <Temporary> and navigate to your lab3dem directory. Name the output grid pct_slope and click Save. If you omit this step, a temporary grid is created that gets deleted when you quit ArcMap.

FYI: if your map units and your z-value units differ, it's important to use the Z factor option to ensure slope is calculated correctly. If you are working with your 10-meter DEM file, both your elevation values and map units are in meters and the Z factor option is unnecessary. More information is available in the online help – search for "slope".

Click OK. ArcMap will process your request and the new grid will appear at the top of your layers list shortly. Flat and gentle slopes will be displayed in shades of green; intermediate slopes in yellows and oranges; and steepest slopes in red.

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 – back to north – 359.9. Areas of zero slope (flat) 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.

After ArcMap finishes processing, the aspect layer will be automatically displayed. To better interpret the results view the histogram. A histogram is simply a graphic depiction of each of the "slope classes" in your aspect layer. In the Spatial Analyst toolbar, and click the Histogram button on the toolbar  . Be sure the aspect thematic layer is selected before doing this operation.

Note the colors in the histogram don't match those in your map layer. You can get more information on the histogram classes by clicking on the color bars in the histogram itself.

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 an elevation raster. 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 is NW. Altitude is the slope or angle of the illumination source above the horizon. The default is 45 degrees above the surface.

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!

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 a little more "wow" effect, drag your 10-meter DEM to the top of the layers list 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. Hillshading can give map readers a nice picture of the landforms in an area.

Viewshed Construction

A *viewshed* is what can be seen from a point on the landscape. Creating a viewshed model produces a 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: 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 hillshade in the background may help explain

why some portions of the landscape are obscured).

Open the histogram for your viewshed. Are more areas visible or obscured from your vantage point ("highest.shp")? _____

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.