DIGITAL TERRAIN ANALYSIS
Using 3D Analyst in ArcGIS 10

PURPOSE
This exercise introduces digital terrain analysis using ArcGIS 10. You will become familiar with manipulating a digital elevation model (DEM), generating derivatives of elevation (e.g., slope, aspect), and visualizing surfaces within ArcGIS.

DATA
The following data are found in the workshop data directory. Raster data have been co-registered 30m x 30m pixels:

demgridDEM for Mt. LeConte quadrangle (Great Smoky Mountains, Tennessee), 1:24,000, source: USGS. Downloaded and converted to Arc GRID format.
natural_leconte98.imgLandsat Thematic Mapper 3-band composite for Mt. Leconte, September 15, 1998
mlec_trailsrds.shptrails and roads shapefile from USGS 1:24,000 DLG
Trail_Points.shptrailhead and selected points along trails
Summit.shpPoint file of summit of Mt. LeConte

PROCEDURE
1. Launching and Configuring ArcMAP for Terrain Analysis
Launch ArcMAP and make sure that the following extensions are activated:
3D Analyst
Spatial Analyst

2. Begin your Project
A) Add the DEM for the Mt. LeConte quadrangle (demgrid). You may want to adjust the color ramp.

Q1: On the answer sheet, Enter the following parameters:
minimum elevation ______ m
maximum elevation ______ m
mean elevation ______ m
Number of pixels in the image ______
Area (extent of the image) ______

Q2 What datum and coordinate system is used for this DEM?

3. DEM Derivatives

A) With the DEM Layer active, go to the Spatial Analysis menu and open the 3D Analysis Tools in Arc Toolbox. Choose the Raster Surface – Slope tool.

Slope angle in degrees or percent can be calculated. Accept the defaults, save the Output Raster as MT_LC_Slope and click OK.

View the output slope raster and examine the pattern of steep slopes from the summit of LeConte. You may also visually identify flat ridgelines, including “The Boulevard,” a spur off the Appalachian Trail that connects to the eastern summit of Mt. LeConte. Refer to the map at the end of this lab for point locations.

B) Turn the slope theme off.

Next, return to the 3D Analysis tools and compute Aspect (using the DEM as your input).

Name your output
MT_LC_Aspect. View the resulting aspect theme.

C) Hillshading is often used to better visualize topography by simulating illumination of a surface. Turn off the aspect theme and make the DEM active. Under the 3D Analyst-Raster Surface tools, compute a hillshade using the following parameters regarding the sun’s

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position in the sky:

Azimuth = 315 degrees (NW - a cartographic norm)
Altitude = 35 degrees

View the hillshade theme. Now, you can probably better identify the summit and majors ridges and coves flanking this peak.

D) Deactivate the hillshade theme and make the DEM active. The final derivative we will calculate is generating a series of contours. These will be interpolated isopleths among the pixels of the DEM, the reverse process of interpolation from contours to a surface.

E) Create contours under the 3D Analyst Tools → Raster Surface - Contour.

Specify “100” (meter) intervals. Name your output MT_LC_Contour.

Once created, change the contour symbology to a graduated color ranging from yellow(low) to red(high). The Value Field = Contour.

You can now see a gradient of contours draped on top of the DEM, or any other theme you might have.

4. 3D Analysis/Visualization using ArcScene
Pseudo-3D visualization is achieved in GIS by rendering surfaces in a perspective view, animating these displays, and draping other geographic features or images.

Launch ArcScene using the icon to the right on the 3D analyst toolbar (do not ArcMAP) and load the following extensions:
3D Analyst
Spatial Analyst

A) Add the Landsat TM satellite image of Mt. LeConte (natural_leconte98.img) provided in the workshop directory.

This is a small portion of a Landsat Thematic Mapper image having 30m x 30m pixels and showing a composite of three spectral bands close to human eyesight (green is vegetation, bright areas are rock outcrops, pinkish areas are developed urban areas such as Gatlinburg, TN.)

B) At this point, the image is flat, as there is no surface specified upon which to drape it.

C) To add a surface, go to the properties for the Landsat image and select Base Heights. Next to “Floating on a custom surface”, click the folder and navigate to the DEM and select the file (demgrid) to obtain base heights (elevation values).
Click on “Raster Resolution” and change the base surface cell size values to 30 to match the original surface.

Sight” (LOS) analysis uses DEMs or TINs to determine whether a target is visible to an observer, as well as what may be obstructing such visibility.

Your objective in this procedure is to determine the visibility of the Mt. LeConte summit from the trailhead of Alum Cave Bluff Trail.

Note: these points are represented by the two shapefiles Trail_Points.shp and Summit.shp, add them to ArcMAP.

A) To perform an LOS analysis, you will begin with the Mt. LeConte DEM grid active in ArcMap. You will also need to add the trails theme, mlc_trailsrds.shp.

B) Activate the 3D Analyst toolbar. From the pull-down to select the Line of Sight tool. Then, in the dialog that appears, set the observer height and target offsets to 0.0.

C) Click on the spot for the observer location, at the trailhead.

Note: it may be helpful to use the Identify tool to determine what each point represents. Then, with the cursor still depressed, drag to the target location, the summit of Mt. LeConte.

This will result in a straight line being added to the view. Portions of the LOS that are visible will be drawn green; portions not visible will be shown as red.

D) Now, you have the image draped upon the DEM. You can try manipulating the display for the best perspective, zoom in, zoom out, fly through etc. using the basic Toolbar.

E) Explore the image. Next, return to the theme properties and change the Z-unit conversion (vertical exaggeration) to 2.0. You will see more apparent relief as a result. After examining, return your Z conversion value to 1.

5. Intervisibility / Line of Sight Analysis

Return to ArcMAP. Intervisibility or “Line of
D) Now click the **Interpolate Line** tool and recreate or trace your LOS line. This will assign Z values to the line.

Next, you can summarize the results in a **Profile Graph**, a kind of cross-section diagram for the LOS. While your LOS is selected click on the **Profile** tool to create a graphic representation of your LOS line. Right click the graphic and change properties as needed (e.g., Title, Advanced). It should be similar to the above.

E) Now, make sure that the LOS line is selected and then from the MAIN menu click **Edit - Copy**. Return (for now) to **ArcScene** and **Edit – paste** the line in the view. The LOS line is now draped over the 3D Landsat Image. You may have to manipulate the orientation of the image in order to see the line.

**Q3:** Is the summit of Mt. LeConte visible from the Alum Cave Trailhead? Besides the elevation surface, what other physical features of the landscape in this national park could be factors in visibility? If you think it’s advisable, you can redo the LOS analysis by clicking on the LOS button and entering a viewer offset (e.g., 20, 30, or 40 feet). Are there any obstructions along your line-of-sight? If so, what are they? You may consult a topographic map.

F) Still in **ArcScene**, add the trails, and the two point shapefiles. They will not be visible until you set the base heights to those of the DEM. In order for your points to be visible, you may need to increase their symbol size to 100.

G) From the **3D Analyst** tools select **Raster Surface Analysis - Viewshed**. Viewshed Analysis is similar to LOS analysis, but instead of a line of sight, the results represent a 360° view of visibility from a point, or set of points.

H) Input surface = **demgrid**, Observer Points = **Summit.shp**, click OK
ANSWER SHEET

Q1: Enter the following parameters:
  minimum elevation ________ m
  maximum elevation ________ m
  mean elevation ________ m
  Number of pixels in the image ________
  Area (extent of the image) ________

Q2: What earth coordinates system is used for this DEM?

Q3: Is the summit of Mt. LeConte visible from the Alum Cave Trailhead? Besides the elevation surface, what other physical features of the landscape in this national park could be factors in visibility? If you think it’s advisable, you can redo the LOS analysis by clicking on the LOS button and entering a viewer offset (e.g., 20, 30, or 40 feet). Are there any obstructions along your line-of-sight? If so, what are they? You may consult a topographic map.

Challenge Question

1. If a 40-meter observation tower is constructed at the summit, which of the trail points (Trail head, Lodge, Gracie’s Pulpit), if any, will be visible from the top? How would you determine this?
Mt. LeConte: Alum Cave Bluff Trail

1) Trailhead - Parking Lot
2) Walker Camp Road and Alum Cave Creek Bridges
3) Three Rock Steps
4) First of Four Footlogs
5) Arch Rock
6) June 1993 Washout
7) Dolly Parton Peaks
8) Inspiration Point and View of Dolly Parton Peaks and Myrtle Point
9) View Eye of The Needle
10) Eye of The Needle and Little Big Duck Hawk
11) View Little and Big Duck Hawk Ridges
12) Alum Cave Bluff
13) View Little Duck Hawk Ridge
14) Gracie’s Pulpit
15) The Saddle
16) Old Man’s Stump
17) Shirley’s Rock
18) Upper Steps
19) Bust @ss Rock
20) Lu’s Pulpit
21) Trout Branch
22) Grassy Slide
23) West Point View
24) Cliff Top
25) Site of Old Horse Gate
26) Le Conte Lodge
27) Shelter
28) Apollo Point
29) High Top
30) Myrtle Point

mtleconte.com

Summit
Summit