GEOG3600. Geographical Information Systems

Lab 8. Digital Terrain Modelling

Objective

The exercise introduces the way in which ArcView Spatial Analyst and 3D Analyst may be used in digital terrain modelling. Students will practise techniques and procedures to derive geomorphic parameters such as slope and aspect from digital elevation data in both vector and raster formats.

Task 0 Creation of DTM

In the source data the LIC provided, a digital terrain model (DTM) is not typically provided, so that we need to create the DTM by ourselves using contour line and spots height.

1. Open ArcMap, and turn on the 3D Analyst Extension by clicking the 3D Analyst box in 'Extensions…' command under 'Tools' menu. Activate the 3D Analyst toolbar by selecting '3D Analyst' in 'Toolbars' command under 'View' menu.

2. Add the contour line feature class (should be named '11swa_cont_arc') and spots height feature class (should be named '11swa_spot_point') into your map.

3. Create a TIN from the above feature classes: select the 'Create TIN from features' command under 'Create/Modify TIN' by pressing the '3D Analyst' button from 3D Analyst toolbar.

   Use both layers and set parameters as below:

   11swa_cont_arc: Height source: CON_HT
   Triangulate as: mass points

   11swa_spot_point: Height source: SPOT_HT
   Triangulate as: mass points
   Tag value field: <none>

   Save the TIN (name it 11swa_tin) under your personal folder.

Task 1 Slope and Aspect

Civil Engineering Office of Lands Department want to set up some monitoring stations in this area as to collect information about landslide. Those stations should be placed in risky areas that should meet the following criteria:

i) slope is equal or steeper than 25^{o} AND
ii) slope is facing N, NW and W.

You are asked to produce a map which showing the distribution of those risky areas using GIS:

1. Derive the slope data from the TIN. Select the ‘Slope…’ command under ‘Surface Analysis’ by pressing the ‘3D Analyst’ button. Use ‘11swa_tin’ as Input surface, set the output measurement to be ‘degree’ and set the output cell size as 5(m). Save the result raster under your personal folder.

2. Reclassify the result raster, for value between 25 and 90; reclassify value to 1, otherwise, for value smaller than 25, reclassify value to 0.

3. Derive the aspect data from the TIN. . Select the ‘Aspect…’ command under ‘Surface Analysis’ by pressing the ‘3D Analyst’ button. Use ‘11swa_tin’ as Input surface, and set the output cell size as 5(m). Save the result raster under your personal folder. Reclassify the result raster in the same manner as point 2.

   (Remarks: North = 337.5^{o} – 360^{o} and 0^{o} – 22.5^{o}, NW = 292.5^{o} – 337.5^{o}, W = 247.5^{o} – 292.5^{o})

4. Overlay both results as to find out areas that fulfil both criteria.

   (Hints: Use the ‘Raster Calculator’ by pressing the ‘Spatial Analyst’ button. Try to work out the formula by your self this time).

   Make an appropriate layout and PRINT it out.

Task 2 Viewshed and Hillshade

Apart from the monitoring stations, the CEO also proposed to set up 1 or 2 observation stations.

You may find the location of the proposed stations in the spots height feature class (should be named ‘11swa_spot_point’), with SPOT_ID 3 and 4.

1. Create 2 feature classes, each contains the location of one proposed station.

   (Hints: You need to select the suitable record first using the ‘Select by Attributes’ command, then right-click the layer in the table of contents, and select ‘Data -> Export Data’)

2. Determine the visible area for the 2 stations by select the ‘Viewshed…’ command under ‘Surface Analysis’ by pressing the ‘3D Analyst’ button. Then please answer the following questions:

   i) Which station is better (i.e. has a larger visible area)?
   ii) If we set up both stations, how many percentage of area here is still not visible by these stations?

   (Hints: You need to overlay the two results as to answer this question. Use the Raster Calculator here. The principle of the overlay is similar with task 1 but the formula should be slightly different).

3. The hillshade may be used here to enhance the visualization of the surface. CEO asked you to create a shade enhanced picture that shows the 2 stations’ visibility.

Follow the procedure below:

i) Create the hillshade using the TIN. Select the 'Hillshade…' command under 'Surface Analysis' by pressing the '3D Analyst' button. Use the TIN as the input surface. Set azimuth as 315^{o} and altitude as 45^{o}. Z factor should be equal to 1 and the cell size should be 5(m). Save the hillshade.

ii) Place the result of step 2 (a map showing the visibility of 2 stations) on top of the hillshade, then making the map 70% transparent (right-click the map -> Properties… -> Display). What is the effect? You may try different level of transparency as to obtain a better result.

Make an appropriate layout and PRINT it out.

Task 3 DTM Conversion and 3D Mapping

(This process requires much computer resources. You may not be able to complete it on slow machines so that we set this task OPTIONAL. However, as this is perhaps the most fun part of DTM, so that it worth everything to try!)

1. You may convert the DTM from TIN format to grid format, please select the 'TIN to Raster…' command under 'Convert' by pressing the '3D Analyst' button.

2. Base on a surface (TIN or grid), you may create 3D features. Add the roads layer (11swa_roads_arc) and hydro layer (11swa_hydro_arc) into the map. Then convert the 2 layers into 3D feature (select the 'Features to 3D…' command under 'Convert' by pressing the '3D Analyst' button. Use the grid or TIN as the Raster or TIN surface).

3. You cannot view the 3D features in ArcMap, instead, open ArcScene (from the last icon in 3D Analyst toolbar), and add the 3D features into the ArcScene. You may use 'Navigate' tool to drag the 3D map and rotate it. Holding the right mouse button during navigate session allows you to zoom in and out. Moreover, you may use 'Fly' tool to adjust the view altitude.

4. You may add the TIN into the 3D scene to obtain a better visual result. However, this consumes much computer resources and will make your scene loading slowly.

5. After adjust the view angle and altitude, you may export your result into 2D image (probably JPEG or BMP) or 3D VRML file by selecting the 'Export Scene…' command under the 'File' menu.