

Surface Analysis

1. Problem overview

1) Slope

Slope analysis is very important to forest management plans. Slope is a major determinant with regard to what equipment must be used on site as well as what species will be replanted after harvest. Potential for slope failure is also largely dependent on slope. You are required to provide slope information for the proposed harvest blocks.

Provided base information on slope for proposed harvest blocks should be broken down to categories. These categories are based on operational considerations

2) Aspect

Information on the aspect of the cutting blocks is also important as this influences the amount of sunlight, snow depth, water level, etc. at location. These factors influence replanting decisions as well as aid in the analysis of potential slope failure. Aspect reporting for each block should be based on regions facing the 8 traditional compass directions: N, NW, E, SE, S, SW, W and NW.

3) Visual Impact

Several assumed camping sites are located in this area. These camps are used extensively for recreation purposes, and therefore, require careful consideration. A complete visual impact assessment must be conducted with respect to the visibility of the proposed block from these two camps. This includes visibility analysis from the camping sites and development of visual products perspective views.

Data location: L:\labs\geog413\data\surface

<i>contours</i>	Contour lines
<i>spotht</i>	Spot Elevation
<i>streams</i>	Stream
<i>lakes</i>	Lake
<i>rivers</i>	River
<i>roads</i>	Road
<i>blocks</i>	Proposed cutting blocks
<i>campsites</i>	Camping Sites
<i>aleza_bndy</i>	Aleza boundary
<i>bndy</i>	Study boundary
<i>slope_class.csv</i>	Lookup table for slope classes
<i>aspect_class.csv</i>	Lookup table for aspect classes

2. Building a better 3D surface

In order to perform the analysis, the first thing we need to do is to create a surface for the area. Two major types of Surface are TIN and Raster DEM. Raster provides tools for both simple and complex cell based analyses. It represents space from a locational perspective and can accurately portray continuous surfaces. We'll address raster surface analysis in this lab.

The surface can be created from many sources with elevation information available.

- Point, line, and polygon feature class
- Contour maps
- Stereoplotter data
- Randomly distributed points in ASCII files
- Breakline data in ASCII files, existing TINs...

Because each facet summarizes a certain surface behaviour, it is important to ensure that the sample points are selected adaptively to give the best possible surface fit.

- Open a new map file and add datasets listed above
- Make sure you have 3D Analyst and Spatial Analyst extensions enabled.
- Set the raster analysis environment as the following:

Current/ScratchWorkspace:	Your local folder
Processing Extent:	Same as <i>bndy</i>
Cell Size:	10

Create a raster DEM

- Create a raster DEM with the following datasets with **Topo to Raster** tool
- Set the parameters as the following for each dataset

Feature Layer	Field	Type
<i>contours</i>	CONTOUR	Contour
<i>spotht</i>	ELEVATION	PointElevation
<i>streams</i>		Stream
<i>lakes</i>		Lake
<i>rivers</i>		Lake
<i>bndy</i>		Boundary

- Set 10 for Output Cell size and set Tolerance 1 to 10
- Save the output as *dem* in your local folder
- Leave everything else as they are.

This DEM will be used for the rest of analysis

- Create a hillshade, slope and an aspect raster from *dem* and save it as *hsd*, *slope*, and *aspect* respectively

4. Providing slope information for the proposed cutting blocks

As we discussed in the previous step, slope is a major determinant regarding to what equipment must be used on site as well as what species will be replanted after harvest.

Produce a map showing the slope categories within the proposed blocks

Based on operational considerations, the slope has to be classified into categories as showing in the table

Reclassify slope

- With **Reclassify** tool, classify the *slope* raster based on the range values listed in the table at right and save it as *slope_class*

Slope Class	Slope Range
5	0 <= slope <=5
10	5 < slope <= 10
15	10 < slope <=15
20	15< slope <=20
25	20< slope <=25
30	25< slope <=30
35	30 < slope <=35
90	slope >35

Create a summary table on the area and percentage of each slope category within the cutting blocks.

Examine the dataset *blocks* which contains proposed cutting blocks boundary. We want to know the area and percentage of each slope class within cutting block. This information will be useful in decision making on what equipment should be for each cutting block

This can be done in two ways:

- 1) By applying analysis mark or
- 2) By using Extract by Mask tool under Spatial Analyst->Tools->Extraction

We will use the first method to get the slope class within the proposed blocks. You can try the second method for Aspect in later lab.

- With RASTER CALCULATOR, get the slope class with the following expression
 "*slope_class*"
- Click the Environments button at the bottom and set **blocks** as the raster analysis mask. (Note: this setting only apply to current operation)
- Save the output raster as **slope_block**. This raster contains the only slope class inside the cutting blocks.

Open the attribute table of **slope_block**, the information we need are stored in two data fields: VALUE and COUNT. The VALUE field tells the slope class while the COUNT field provides the total number of cells that have the slope class value. This information can be used to calculate the area and percentage of each slope class within the block boundary

- Add two data fields in the attribute table of **slope_block**: AREA and PERCENT with Double type, precision at 15 and scale at 2

Calculate the AREA and PERCENT with Field Calculator

- Calculate AREA using Field Calculator (Count * cell size * cell size)
- Calculate PERCENT using Field Calculator with the expression: $[AREA]/total\ AREA * 100$

The total AREA here should be replaced by the real total area of the block. This table shows the information of the area and percentage of each slope class within the cutting blocks. (**Note: values might be different**)

This table provides useful information. But it would be better to know the slope class information for each block. This can be done with Tabulate Area tool under Zonal Analysis. Tabulate Area tool calculates cross-tabulate areas between two raster datasets

Create a table to show slope class for each proposed cutting blocks.

ArcToolbox->Spatial Analyst Tools->Zonal-> Tabulate Area

Input raster or feature zone data	blocks
Zone field	blocks_id
Input Raster or Feature Class	slope_class
Class field	VALUE
Process Cell	10

- Click the Environments button at the bottom and set **blocks** as the raster analysis mask.
- Save the output table as **block_slp_area.dbf**

The resulting table shows the **block_id** in VALUE field. The fields **VALUE_5, VALUE_10, VALUE_15, VALUE_20, VALUE_25** ...show the total area for each slope class

Clearly you can tell the block #2 is located in steeper area than others. This table can be joined to **blocks**

- Produce a map showing the slope categories within the proposed blocks

5. Providing information on aspect for the proposed blocks

In the same way provide the base information on aspect. Classify aspect information based on compass direction.

- First remove analysis mask.
- Reclassify *aspect* based on compass direction and save it as *aspect_class*
- Generate an aspect class raster for the proposed cutting blocks and save it as *aspect_block*
- Calculate AREA and PERCENT for each aspect class within cutting blocks
- Create a tabular area table to show the total area of each aspect class for each cutting block
- Produce a map showing the Aspect categories within the proposed blocks.

Aspect Class	Compass	Aspect Range
1	Flat	aspect = -1
2	N	0 < aspect <= 22.5
3	NE	22.5 < aspect <= 67.5
4	E	67.5 < aspect <= 112.5
5	SE	112.5 < aspect <= 157.5
6	S	157.5 < aspect <= 202.5
7	SW	202.5 < aspect <= 247.5
8	W	247.5 < aspect <= 292.5
9	NW	292.5 < aspect <= 337.5
2	N	337.5 < aspect <= 360

6. Performing a visibility analysis for the proposed harvest blocks

The shape of a terrain surface dramatically affects which parts of the surface people standing at a given point can see. What is visible from a location is an important element in determining the value of real estate, the location of telecommunications towers, or the placement of military forces. 3D Analyst and Spatial Analyst both allow you to determine visibility on a surface from point to point along a given line of sight, or across the entire surface in a viewshed.

Viewshed identifies the cells in an input raster that can be seen from one or more observation points or lines. Each cell in the output raster receives a value that indicates how many observation locations can see the location. If you have only one observation point, each cell that can be seen from the observation point is given a value of 1. All cells that cannot be seen from the observation point are given a value of 0. If there are more than one observation points, the cell value will be by the number of times the cell can be viewed.

There are several camp sites (*campsites*) in this area. The visibility of the potential harvest blocks from each of these campsites forms the basis for the visibility analysis. Consider if any given location may be visible from more than one campsite. These locations of the harvest blocks that are visible from camping site are clearly worse in terms of the visibility than those only visible from one site.

Generate a viewshed surface to show the visibility of block area in terms of the number of campsites that can see the area

- Using VIEWSHED tool, generate a viewshed surface with observer set to *campsites* and save the result as *viewshed*
- The Value field indicates the number of times that area can be seen from *campsites*. Symbolize the *viewshed* using Unique value that gives the number of campsites can see the location.

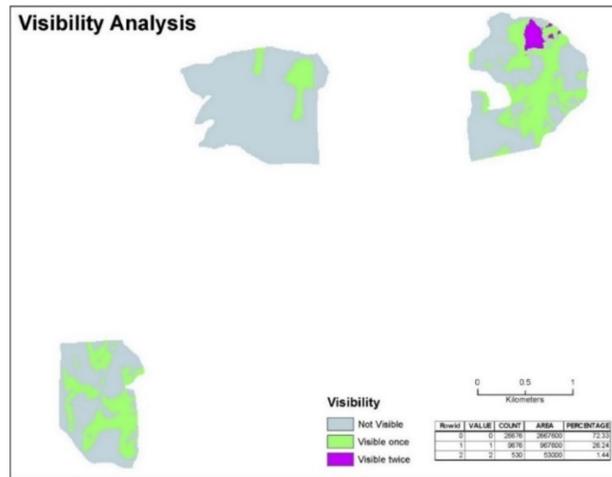
Provide a table showing the breakdown of the cutting blocks in terms of visibility by number of campsites including an indication of percentage in this table

- Now use EXTRACT BY MASK tool to extract *viewshed* for just inside cutting block

Input Raster: *viewshed*
 Input Raster : *blocks*
 Output Raster: *view_block*

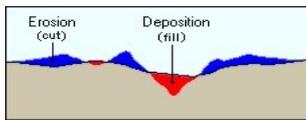
Row id	VALUE	COUNT	AREA	PERCENTAGE
0	0	26676	2667600	72.33
1	1	9676	967600	26.24
2	2	530	53000	1.44

- Produce a map to show the result of visibility analysis.



The slope, aspect and visibility analysis provide decision maker valuable information and help in decision making for the field operation

7. Volumetric Analysis (Cut/Fill)



The volumetric or Cut/Fill analysis summarizes the areas and volumes of change between two surfaces. It identifies the areas and volume of the surface that have been modified by the removal or addition of surface material.

By taking two surface raster of a given area from two different time periods, the Cut/Fill tool will produce a raster of regions where material was removed, added, or where the surface did not change. The attribute table of the raster contains the volume and area of each of the connected regions. In the attribute table, in regions where material was cut the value in the Volume field will be positive. In regions where material was filled, the Volume is negative.

The first surface is the surface before cut/filled, while the second surface is what we want. *dem* is used as the before surface and we have to create a surface for the second one. Assume that we want to a surface that has 700 elevations.

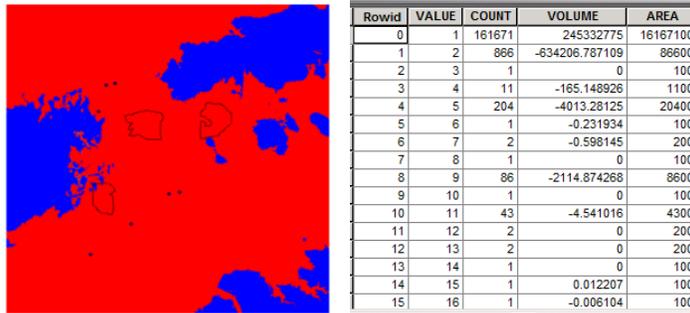
Now you need to create the second surface with elevation value of 700 using Raster Calculator.

- Clear Raster analysis Mask if any
- With **Raster Calculator** , generate a raster with value of 700 for all cell and save the output as *dem700*.
- In ArcToolbox, click **Spatial Analyst-> Surface ->Cut/Fill**

Input before raster surface: *dem*
 Input after raster surface: *dem700*
 Output raster: *cutfill700*

Open the attribute table of *cutfill700* and examine the data field. The VOLUME field tells you the volume of the surface need to be added or removed. The negative values indicate the areas need to be filled while the positive values indicate the areas that will be removed. The zero values indicate no change on surface, this means, no cut or fill is required. The values in AREA tell you the total areas.

- Open the properties of *cutfill700* and click Symbology tab. The raster is classified based on the VOLUME field by default.



We want to know the total volumes and areas that need to be filled with materials. To answer this question, we just need to select all records that have negative values in VOLUME field and calculate the total volume and the area for the selected cells.

- In the attribute table of *cutfill700*, select all the negative values
- Now check the Statistics on VOLUME and AREA respectively to find the total volume and area need to be filled up.

Q. What is the volume and area?

8. Produce a 3D perspective view map

Use the *dem* for the surface base height for 3D map

1. In ArcScene, create a perspective view from the groups of campsite (observer location to the center of one of the harvest blocks (target location)). Use vertical exaggeration if desired. Save the ArcScene file to **3d.sxd**.
2. Produce a perspective view that places the potential blocks within the context of the surrounding region. Include the potential harvest blocks as extrusions of the surface. The harvest block should appear as cut (sunken into the regular surface). First, this requires creating a raster that has the area of the block coded with values for height, perhaps 20 meters, and all other area with value of 0. You can then subtract this raster from the existing height values (raster *dem*) in the original DEM. When this surface is displayed, the blocks will appear 'cut' in the surface. A raster representing the heights of the forest coverage polygons could be added to the original surface in similar manner to create a surface that shows how tree heights might affect the view or visibility from a location.

Save the map to **final.sxd**

~~~~~ **The End** ~~~~~