

# Surface Analysis

In this lab, you will demonstrate your understanding on surface and spatial analysis skills.

## 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 (slope, aspect, visibility 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 (dividing space into discrete units called cells) and can accurately portray continuous surfaces. We'll address raster surface analysis in more details 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.

- Create a folder **surface** in your local geog413 folder for today’s lab
- Open a new map file and add datasets listed above
- Make sure your have 3D Analyst and Spatial Analyst extensions enabled. Turn off background geoprocessing (Geoprocessing->Goeprocessing Options)
- Set the raster analysis environment as the following:

Current/ScratchWorkspace: Your local **surface** folder  
 Processing Extent: Same as **bndy**  
 Cell Size: 10  
 Analysis Mask: **bndy**

**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 **surface** 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.

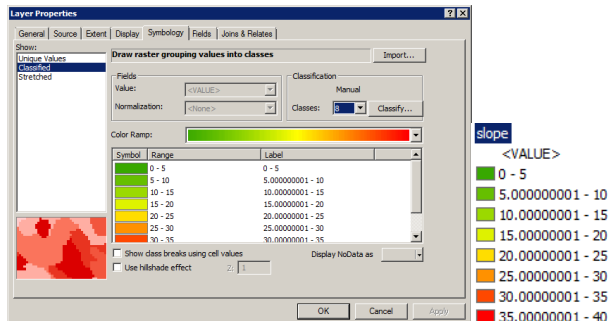
**Produce a map showing the slope categories within the proposed blocks**

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 below and save it as **slope\_class**

Slope Class	Slope Range
1	0 <= slope <=5
2	5 < slope <= 10
3	10 < slope <=15
4	15< slope <=20
5	20< slope <=25
6	25< slope <=30
7	30 < slope <=35
8	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 used for logging.

This can be done in two ways:

- 1) By applying analysis mask 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.

- Click Geoprocessing->Environments and set *blocks* as the raster analysis mask
- With RASTER CALCULATOR, get the slope class with the following expression

*"slope\_class"*

- 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 with the expression as the following

[COUNT] \* 10 \* 10      (the cell size is 10)

- 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 as there are three blocks. 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	<i>blocks</i>
Zone field	<i>blocks_id</i>
Input Raster or Feature Class	<i>slope_class</i>
Class field	VALUE
Process Cell	10

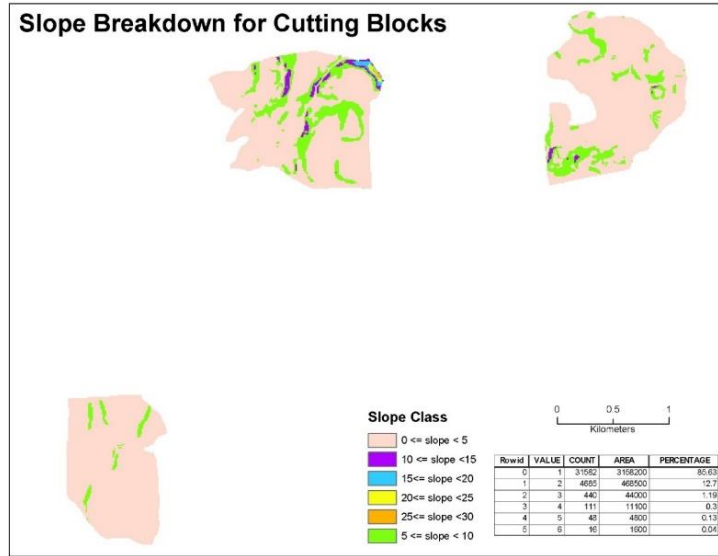
- Save the output table as **block\_slp\_area.dbf**

The resulting table shows the **block\_id** in VALUE field. The fields **VALUE\_1**, **VALUE\_2**, **VALUE\_3**, **VALUE\_4**, **VALUE\_5** show the total area for each slope class

Rowid	VALUE	VALUE_1	VALUE_2	VALUE_3	VALUE_4	VALUE_5
1	1	1150400	180200	4300	0	0
2	2	1112300	239200	23700	10100	2400
3	3	939700	25900	0	0	0

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

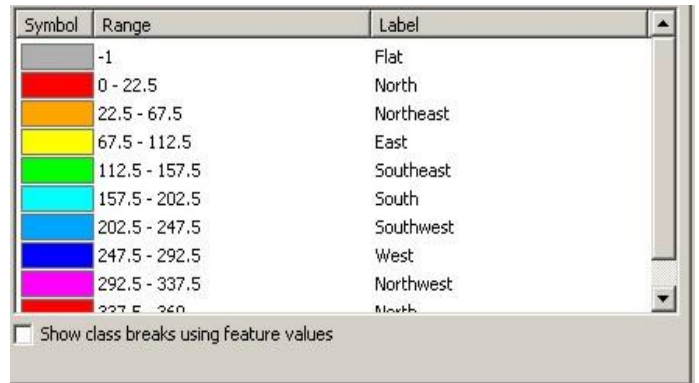
- Produce a map showing the slope categories within the proposed blocks



### 5. Providing information based on aspect for the proposed blocks

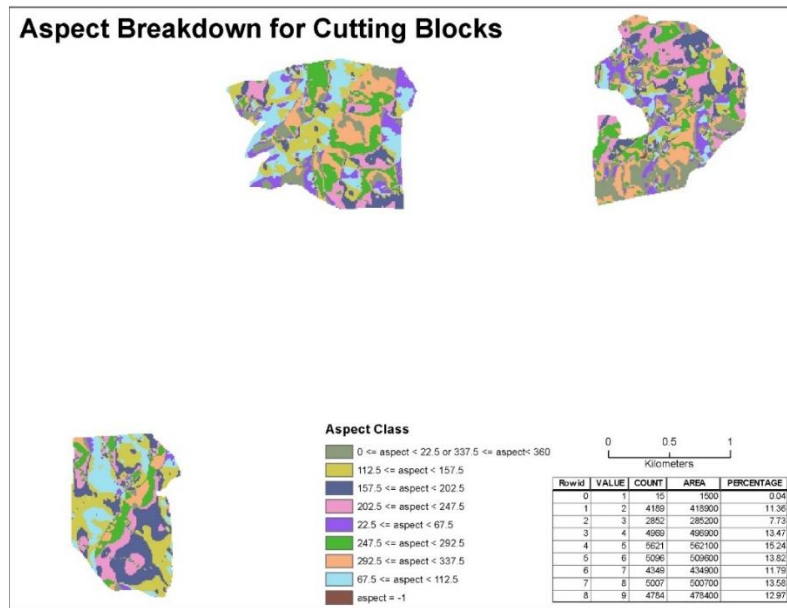
In the same way provide the base information on aspect. Classify aspect information based on compass direction.

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



- 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.



## 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 campsites. Those 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.

Environment

Working directory: your local folder **surface**  
 Processing Extent **dem**  
 Cellsize: Same as **dem**  
 Analysis Mask:

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

ArcToolbox->Spatial Analyst ->Surface Analysis->Surface->Viewshed

Input Surface: **dem**  
 Input Point **campsites** (observer locations)  
 Output Raster: **viewshed** (in your local folder)

- The Value field indicates the number of times that area can be seen from **campsites**. Symbolize the output raster 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 on this table

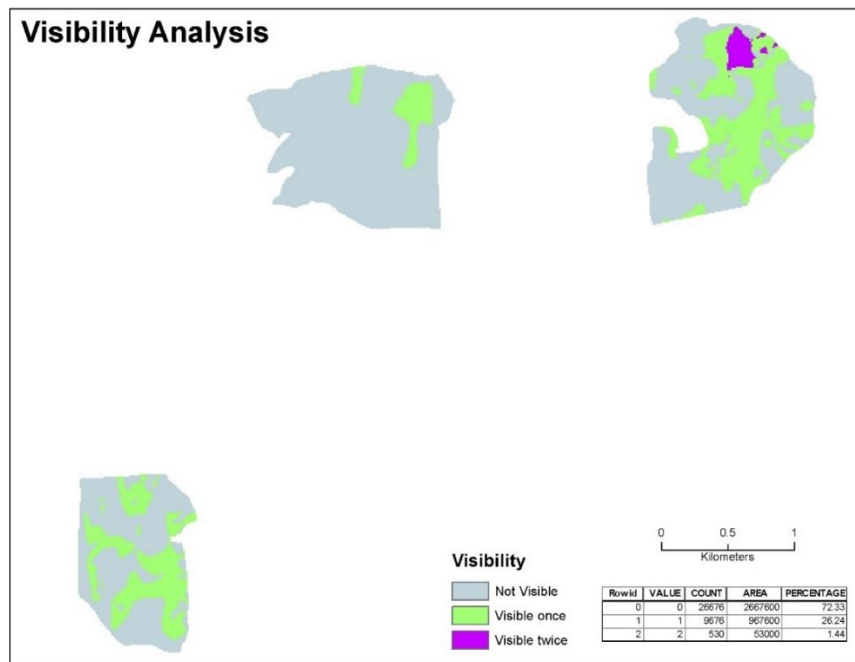
- Now use Extract by Mask tool to extract *viewshed* for just inside cutting block

ArcToolbox->Spatial Analyst->Extraction->Extract by Mask

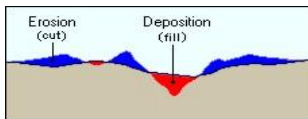
Input Raster: *viewshed*  
 Input Raster / Feature Mask: *blocks*  
 Output Raster: *view\_block*

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

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 Raster Calculator.

- Clear Raster analysis Mask
- In ArcToolbox, click **Spatial Analyst->Map Algebra->Raster Calculator**
- Type in the raster expression like the following:

700

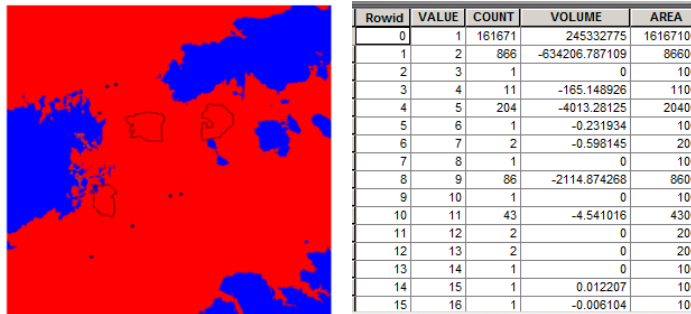
- Save the output as **dem700**.

This expression will create a new raster **dem700** in your local folder and all cells have the same elevation 700.

- In ArcToolbox, click **Spatial Analyst-> Surface ->Cut/Fill**  
 Input before raster surface: **dem**  
 Input after raster surface: **dem700**  
 Output raster: **cutfill700** in your local folder

The negative cell values are the areas that need to be filled with material (Net Gain); the cells in blue are the areas that need to be cut off (Net Loss).

- 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**, click the first button from left at the top of the table and choose Select by Attributes and build a query expression like the following:

"VOLUME" < 0

This will select all the cells with negative values in VOLUME field. 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?*

Assume that the river was dry due to some reasons and we want to fill the river bed in.

*Q. How much of the material would be required to fill the surface at elevation 700 meters?*

## 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** under your **surface** folder.

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** in ArcScene and close all the programs and logoff

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