# Using LiDAR data

1. Generate a canopy height with DEM and DSM
2. Calculate the average canopy height with Zonal statistics
3. Calculate percent difference between VRI stand height and LiDAR stand height ((VRI-LiDAR)/VRI)
4. Identify the potentially dangerous slope area
5. Display the area in 3D
6. Assignment 9

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**LiDAR** (**<u>L</u>ight <u>D</u>etection <u>A</u>nd <u>R</u>anging**) is an optical remote sensing technology that can measure the distance to, or other properties of a target by illuminating the target with light, using pulses from a laser. Lidar produces mass point cloud datasets that can be managed, visualized, analyzed, and shared using ArcGIS.

The point data are post-processed after the LiDAR data collection survey into highly accurate georeferenced x,y,z coordinates by analyzing the laser time range, laser scan angle, GPS position, and INS information.

### LiDAR laser returns

Laser pulses emitted from a LiDAR system reflect from objects both on and above the ground surface: vegetation, buildings, bridges, and so on. One emitted laser pulse can return to the LiDAR sensor as one or many returns. Any emitted laser pulse that encounters multiple reflection surfaces as it travels toward the ground is split into as many returns as there are reflective surfaces.

The first returned laser pulse is the most significant return and will be associated with the highest feature in the landscape like a treetop or the top of a building. The first return can also represent the ground, in which case only one return will be detected by the LiDAR system.

Multiple returns are capable of detecting the elevations of several objects within the laser footprint of an outgoing laser pulse. The intermediate returns, in general, are used for vegetation structure, and the last return for bare-earth terrain models.

LiDAR data essentially consists of a massive point cloud detailing the ground environment. This point cloud details the X,Y, and Z coordinates of every point but usually nothing else.

**Data** L:\labs\300\ancient_forest\

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## 1. Generate a canopy height with LiDAR DEM and DSM

The working area for this lab is Ancient Forest Provincial Park, the newest BC park. As DEM and DSM generation from LiDAR points cloud is a bit complicated and time consuming, we have them ready under our lab directory. The canopy surface mode can be generated by subtracting DEM from DSM with raster calculator.

- Open a new map file and add ***boundary, dem*** and ***dsm*** from ancient_forest directory
- ***dem*** is the digital elevation model and ***dsm*** is the digital surface mode
- Set working environment as

| | |
|---|---|
| Workspace: | Your local folder |
| Processing Extend: | ***boundary*** |
| Cell size: | same as ***dem*** |

- First make sure you have Spatial Analyst extension enabled by clicking Customize->Extensions. Place a check mark beside Spatial Analyst if necessary. Close the window
- Run raster calculator through ArcToolbox

ArcToolbox->Spatial Analyst->Map Algerbra->Raster Calculator

- Build the expression ***dsm – dem*** and save the output raster as ***canopy***

Examine ***canopy***, you may notice that it comes with negative value that is not supposed to be there. This is usually caused by data error.

- Run Raster Calculator with the following expression to get rid of negative value

  Con("canopy" >= 0," canopy", 0)

- Save the result as ***canopy_clean.*** This expression means that if the canopy raster is greater and equal than 0, then the output cell value will be assigned using the canopy value otherwise the output cell value will be 0

## 2. Calculate the average canopy height with Zonal statistics

- Add forest cover data (***forest***)
- Examine the stand height field (PROJ_HEIGH)
- With Zonal Statistics Table tool, perform a zonal statistics on ***canopy_clean*** with ***forest*** as the zone boundary (zone field set to **Feature_ID**)
- Save the output table as **canopy_stat.dbf**
- Join **canopy_stat.dbf** to ***forest*** based on **Feature_ID**.
- Examine the data field PROJ_HEIGH and MEAN field (the average of canopy). You may notice the difference. One is from ***forest*** and the other one is from LiDar.

## 3. Calculate percent difference between VRI stand height and LiDAR stand height ((forest-LiDAR)/forest * 100)

- To save the difference, you need to create a new field **(pct_diff**)
- First export the ***forest*** to your local folder (save it as ***my_forest***) and use the local copy to create the field
- Add a new field **pct_diff** to ***my_forest*** with double type and precision at 15 and scale as 2
- Perform a field calculation on **pct_diff** with the formula:

  ([PROJ_HEIGH] – MEAN)/ [PROJ_HEIGH] * 100

- Identify the area with pct_diff <= -30% or pct_diff value >30% by querying the field **pct_diff** and export the selection as ***pct_diff30.shp***

## 4. Identify the potentially dangerous slope area

The dangerous slope area are defined as Slope > 50% and the area > 1000$m^2$

In order to identify the potential dangerous slope, you need first generate a slope model from DEM

- With Slope tool in ArcToolbox, generate a slope in percentage and save it as ***slope_pct***
- Run the reclassify tool to classify slope to two classes <=50% and > 50%. Assign new class value as 50 and 1000. Save the output slope class as ***slope_class***
- Convert the selected slope class to polygon with **Raster to Polygon** tool.

  ArcToolbox -> Conversion Tools -> From Raster -> Raster to Polygon

- Set Input raster as ***slope_class*** and save the output as ***slope_class_poly.*** Examine the field GRIDCODE which carries the slope class value (50, 1000)

- Open the attribute table of ***slope_class_poly***. Create a field AREA with double type and precision set to 15 and scale to 2. Calculate AREA.
- Select the area greater than 1000m$^2$ and GRIDCODE = 1000 from ***slope_class_poly.*** Export the selected the selection as ***slope_steep1000***
- With Zonal Statistics tool, perform zonal statistic on elevation (***dem***) with the ***slope_steep1000*** as zone boundary and zone field set to FID. Save the resulting table as **slope1000_dem_stat.dbf**
- Join **slope1000_dem_stat.dbf** to ***slope_steep1000*** (FID in ***slope_steep1000*** and OID in ***slope1000_dem_stat.dbf)***
- Export the polygons with elevation <u>range</u> value >30m and save it as ***danger_slope***

## 5. Display the area in 3D

- Generate a hillshade from ***dem*** and save it as ***hsd***
- Open a ArcSence and add ***dem, trails, rivers, hsd, danger_slope***
- Turn off ***dem.*** Symbolize layers properly (trails based on name)
- Set the base height to ***dem*** for the layer ***trails, rivers***, ***hsd,*** and ***danger_slope***
- Set the Layer offset to 1 for the layer ***trails, rivers,*** and ***danger_slope***
- Remove the outline for ***danger_slope.***
- Pick a good location of the view and export the view to a 2D image by clicking File->Export Sense->2D
- Save the image as a JPG file

# Assignment 9: (5%) <u>due next week Nov. 13,14,15</u>

- Produce following maps showing the result together with ***trails*** and ***rivers***. ***trails*** should be symbolized based on Name. The map should come with proper title, legend, scale, your name and good layout
  - A map showing the result of percent difference between VRI stand height and LiDAR stand height(show the positive and negative range in difference color)
  - A map showing the potentially dangerous slopes.
  - A screen shot showing the 3D view of dangerous slope

**Deliverable:**

- Make a title page with the course name, assignment number, your lab session, your name and studentID.
- Insert all maps to WORD file
- Save the file as **lastname_firstname_geog3002018_A9.** Email the file to your TA with subject “Geog300 A9”

**NOTE: Please name the file correctly. <u>Assignment is due next week Nov. 13,14,15</u>**
**NO late assignment is accepted**

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