Using Viewshed and Machine Learning to Model Visibility for a Terrain and Vegetation

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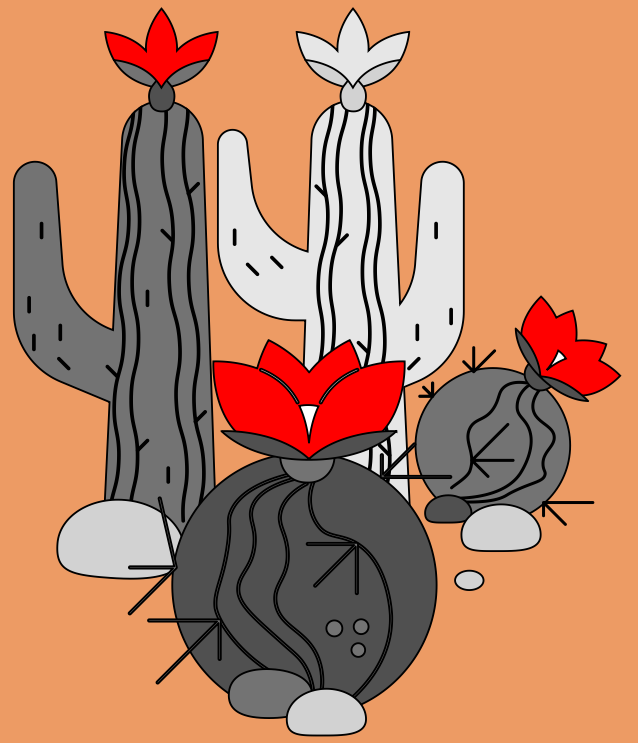
What is visibility?

- Visibility – seeing up to a certain amount of distance
- Calculated using computationally intensive viewshed models
- Visibility is relative to the perspective of one position along a terrain



What dictates Visibility? - Abundance

Figure 1

Figure 2

What dictates Visibility? - Arrangement

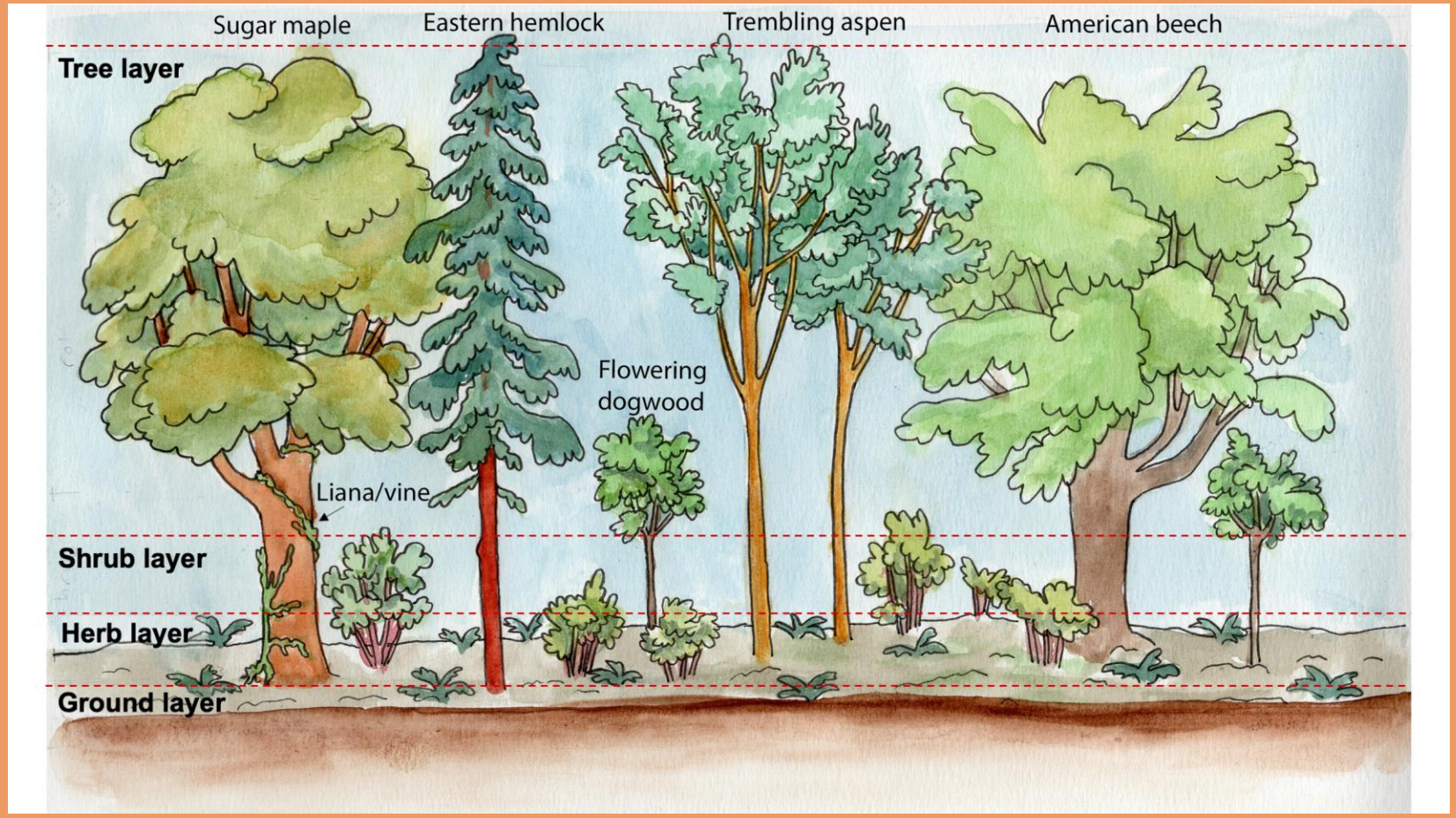


Figure 3

What dictates Visibility? - Height of Vegetation

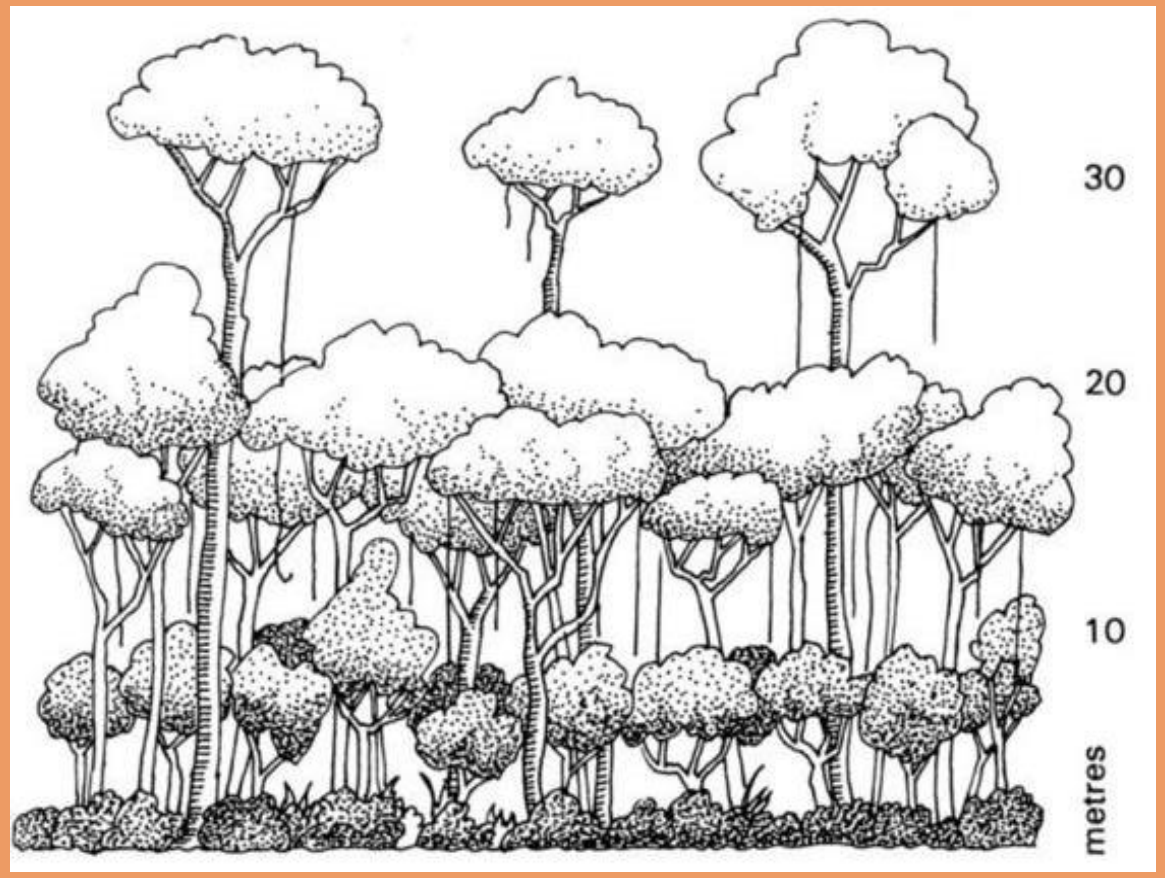


Figure 4

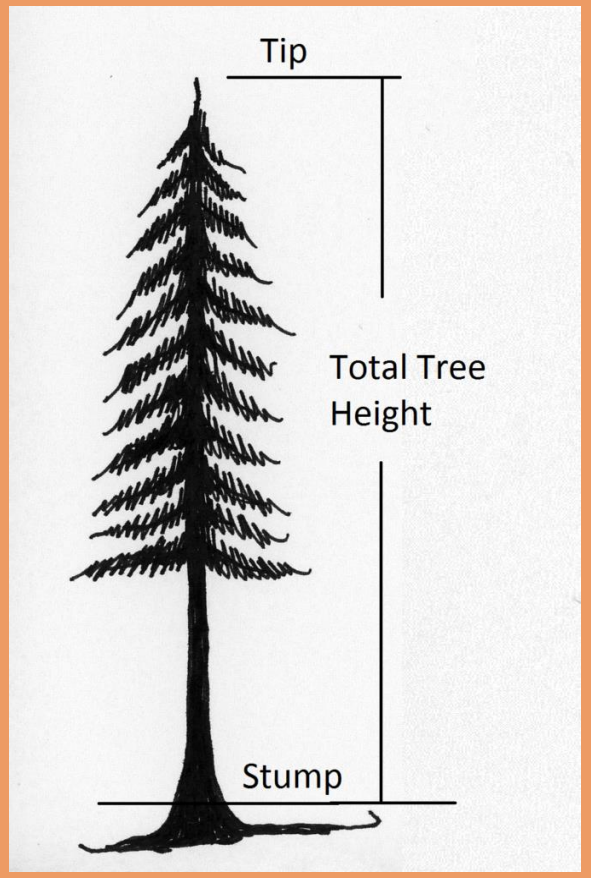


Figure 5

What dictates Visibility? - Placement

Figure 6

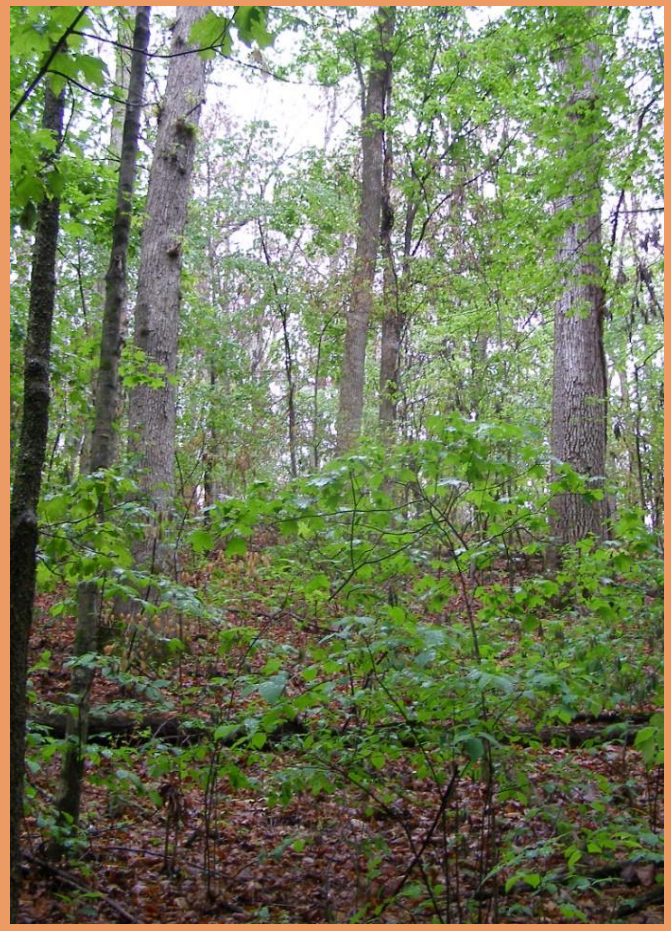


Figure 7

Figure 8

What dictates visibility? - Topography

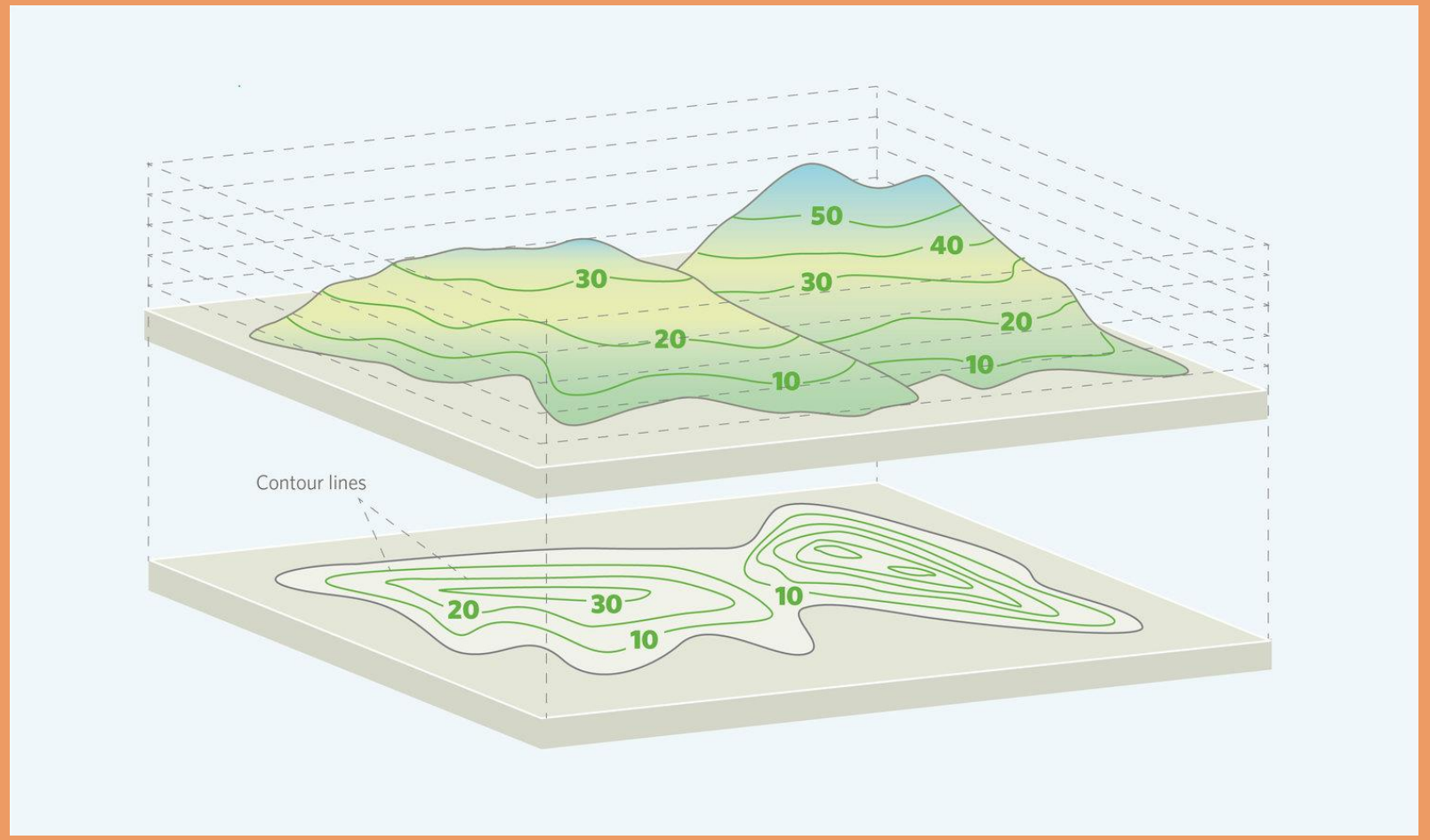


Figure 9

Relevant background information

- In the 20th century fire towers were used for detecting fires
  - Visibility research was used for fire detection
- Now we use technology for fires
  - Visibility research is now used for firefighter safety
- However, this technology can still be improved
  - Need more research for wildland firefighter safety

LiDAR point cloud

- Light Detection and Ranging (Lidar) - is a remote sensing method that takes measurements of the Earth's surface
- It uses a laser, GPS, and an Inertial Measurement Unit (IMU)
- It can be used to create 3D models and maps of the environment.

- It is generated from waveforms
  - Each point shows the returned energy
- The points have x, y, and z values.
  - The z value can be used to estimate canopy height

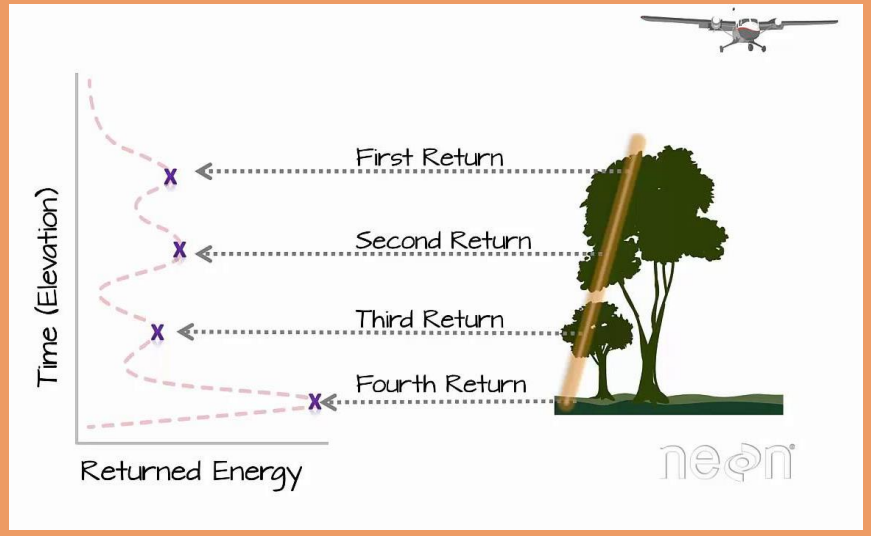


Figure 10

LiDAR point cloud

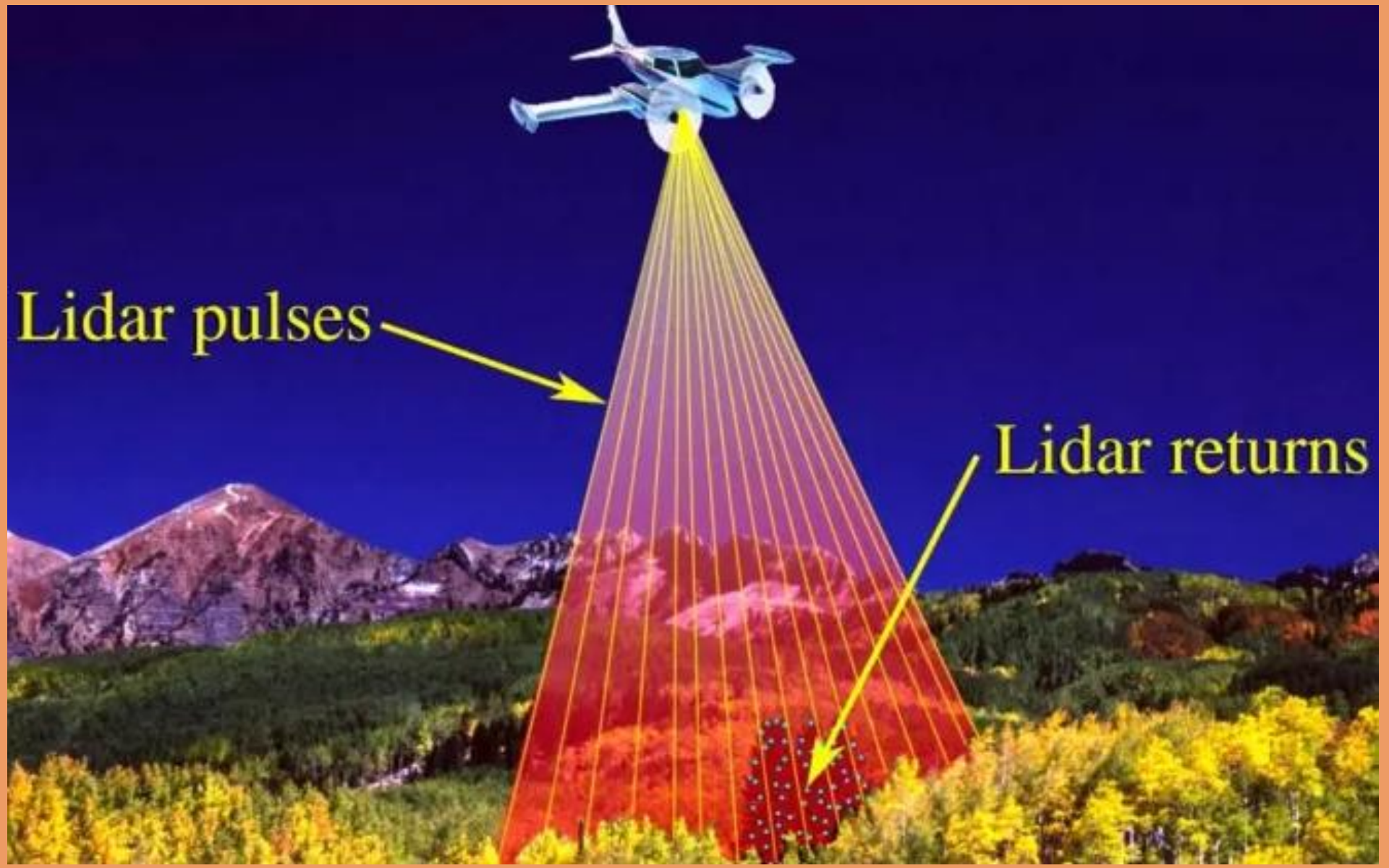


Figure 11

The goal of this project is to ….

Develop a machine learning model that comprehensively predicts visibility on a pixel-by-pixel basis across large landscapes

Data acquisition

- First go to the National Map Government website
  - https://apps.nationalmap.gov/downloader/
- Click on the Lidar Point Cloud data tab
- Put in coordinates of plot location
- Select the tiles
- Download all the tiles

What is a Digital Surface Model?

- Digital Surface Model (DSM) is when the pulsed light from the LiDAR system hits its first return
- It contains the terrain and objects above ground level

Figure 12

What is a Digital Terrain Model?

- Digital Terrain Model (DTM) is when the pulsed light hits the surface of the terrain
- This doesn't apply to buildings and dense vegetation
- Smoothed to remove structures and dense vegetation

Figure 13

How do you create a CHM raster?

- Create a DSM and DTM raster
  - 1 meter resolution

- Calculate canopy height model (CHM)
  - DSM – DTM = CHM

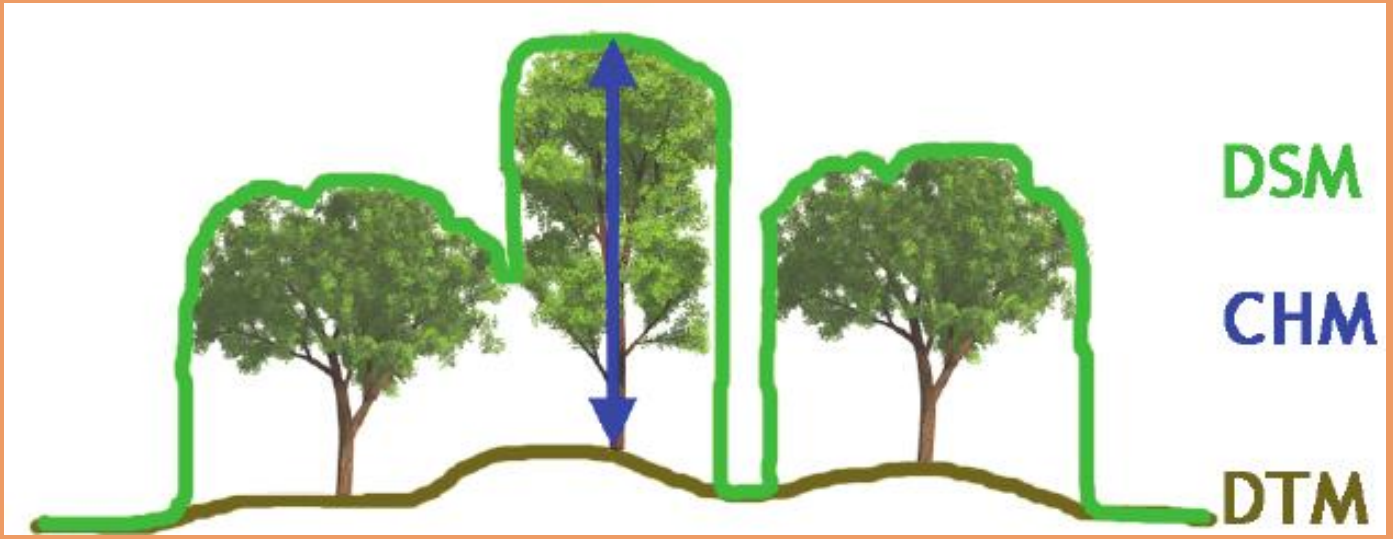


Figure 14

What are the steps in Generating a Viewshed?

1. Create random points within the given area
   - Same size as the plot
2. Each point will be generated separately using the tool Geodesic Viewshed tool
   - It is a highly computational tool
3. Use the DSM raster as an input raster

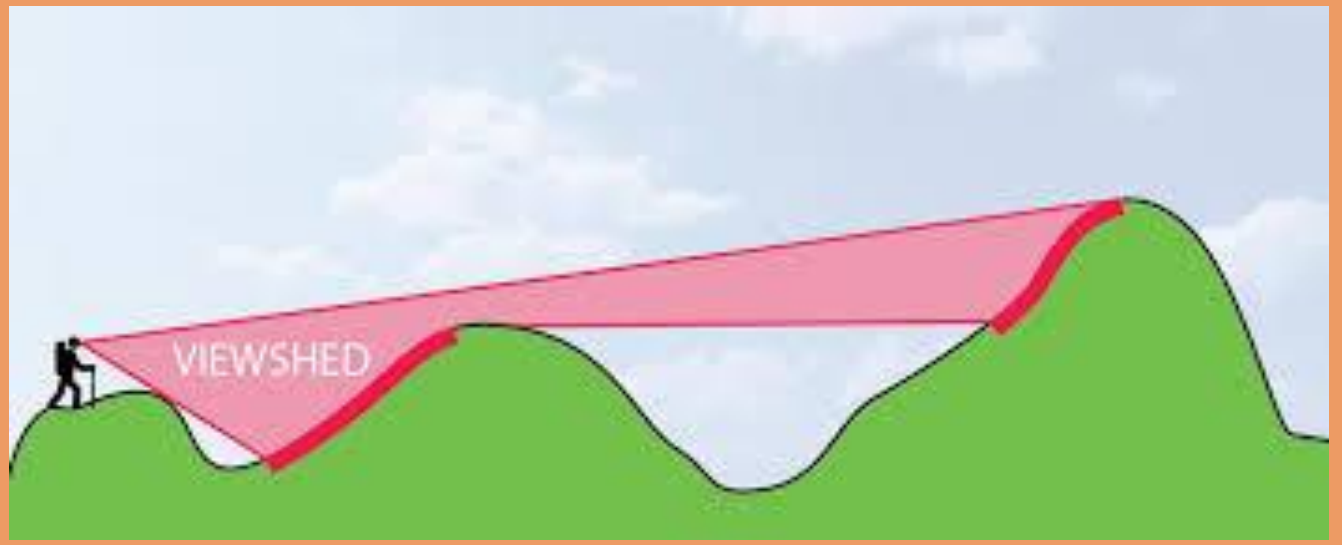


Figure 15

Why is a viewshed important?

- Viewshed – is a computer-generated model from a specific point on a plane
- Meaning that it can determine how much can be seen from one point

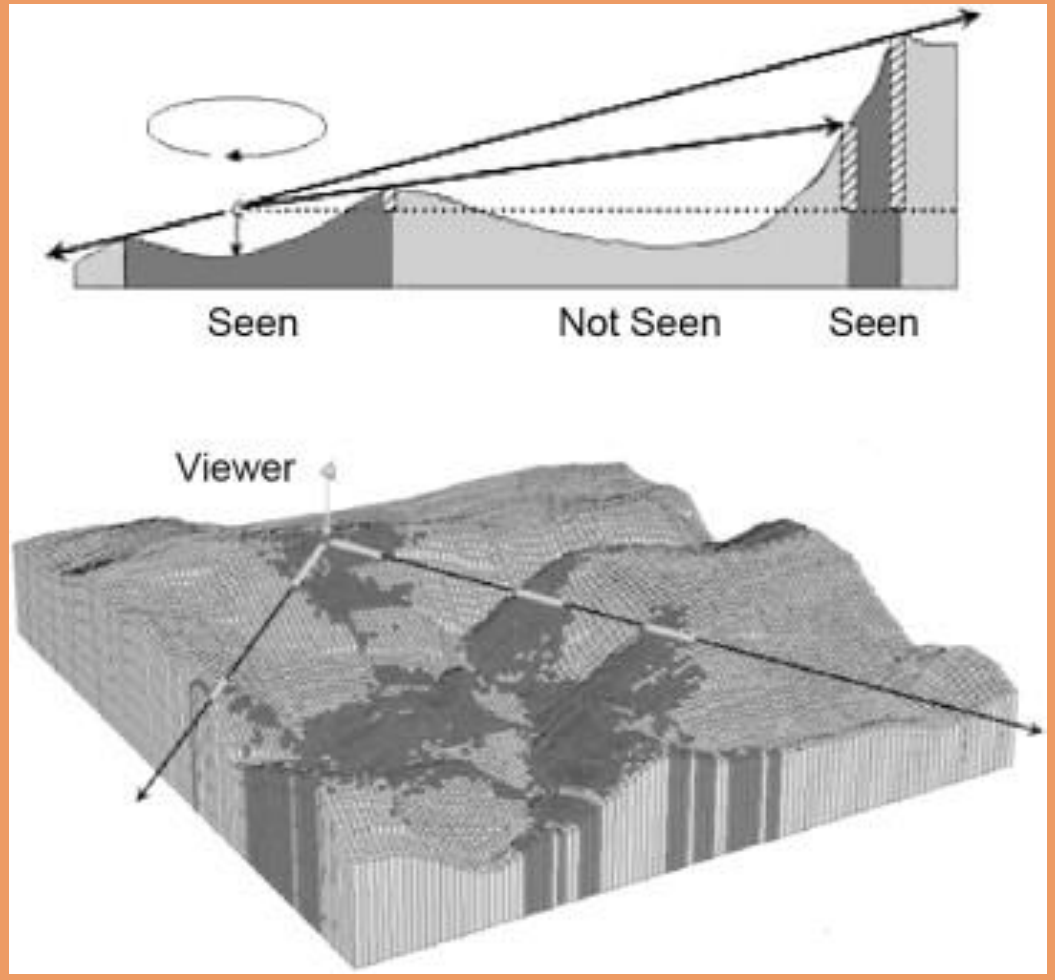
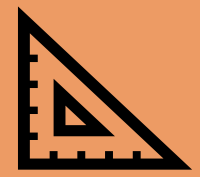
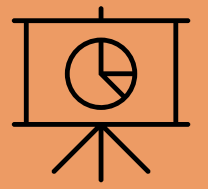


Figure 16

What are the next steps?

1. Create a buffer of 1000m for each point
   - Buffer Tool
2. Using the all the viewsheds to calculate thel sum of each point
   - Zonal Statistic Tool
3. Calculate the area of every point
   - meters^2
4. Find the visibility index (VI)
   - (Zonal sum for each point/ area for each point)

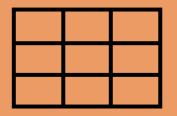




Expected Results

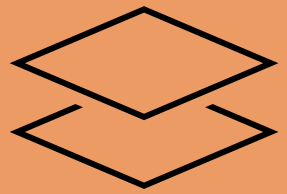
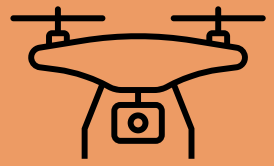
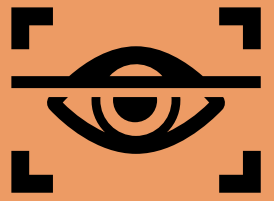
- Have visibility index for all the points
- Calculate the percentage of visibility from the points
- Use this research towards developing a machine learning model that comprehensively predicts visibility on a pixel-by-pixel basis across large landscapes
- To be able to compare results to traditional viewshed models of an assortment of environments



What is the importance of Visibility Index?

- Can show the percentage of a visible area within a certain radius
- Contributes towards train a Machine Learning Model to map Visibility
- Allows us to use this tool towards all landscapes.
- By creating predictor layers

Problems that happened

- The point cloud data was large and needed a lot of space on the drive
  - 100 tiles are 5 GB total
- ArcGIS Pro had problems of shutting down and not saving my work
  - Once it updated there were no more issues
- Viewsheds are highly computational and require a lot of time to process
  - A batch of 20 point took about 12 hours to complete

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Photo References

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- **Figure 16** - https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.researchgate.net%2Ffigure%2FDiagram-of-how-a-viewshed-analysis-maps-visible-areas-dark-gray-and-those-not-seen_fig5_265731622&psig=AOvVaw0jBT8_folYAWSb7sB5TyIJ&ust=1669681334400000&source=images&cd=vfe&ved=0CA8QjRxqFwoTCMiZ6ejNz_sCFQAAAAAdAAAAABAE