Comparing Shallow Landslide Risk Hazard Map Using LiDAR and 10 m Digital Elevation Model (DEM) in Mukilteo, Washington

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Background

Research Question

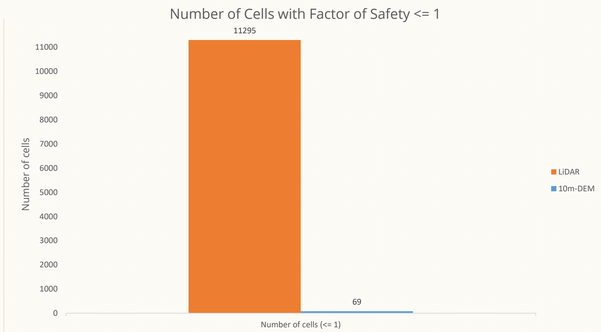
This project compares the risk of landslide in the Mukilteo region, a city in the Snohomish county, using two different datasets of different resolutions. The first dataset contained the 6 feet-LiDAR data that was acquired in 2006 and the second data is consisted of the 10-m DEM. This study is trying to compare the differences of potential landslide hazards between the two datasets.

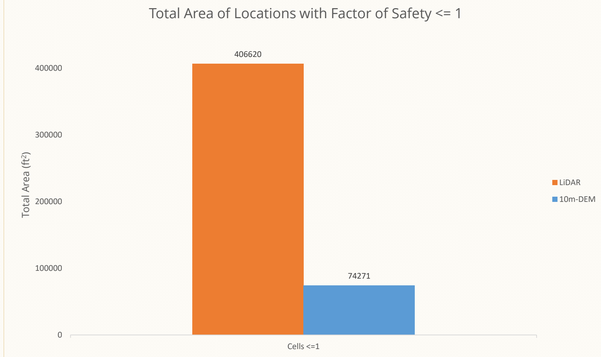
Hypothesis

The mapping of shallow landslide using high-resolution LiDAR data will likely reveal a greater potential for landslide compared to the DEMs because of the greater detail in LiDAR data.

Methods

The risk of landslide in the study area is assessed by looking at the factor of safety (FoS) maps created using a simple infinite slope model. This model uses lidar derivatives such as the slope created via the ArcGIS software to compare the ratio between the shear strength and the shear stress in the study area.



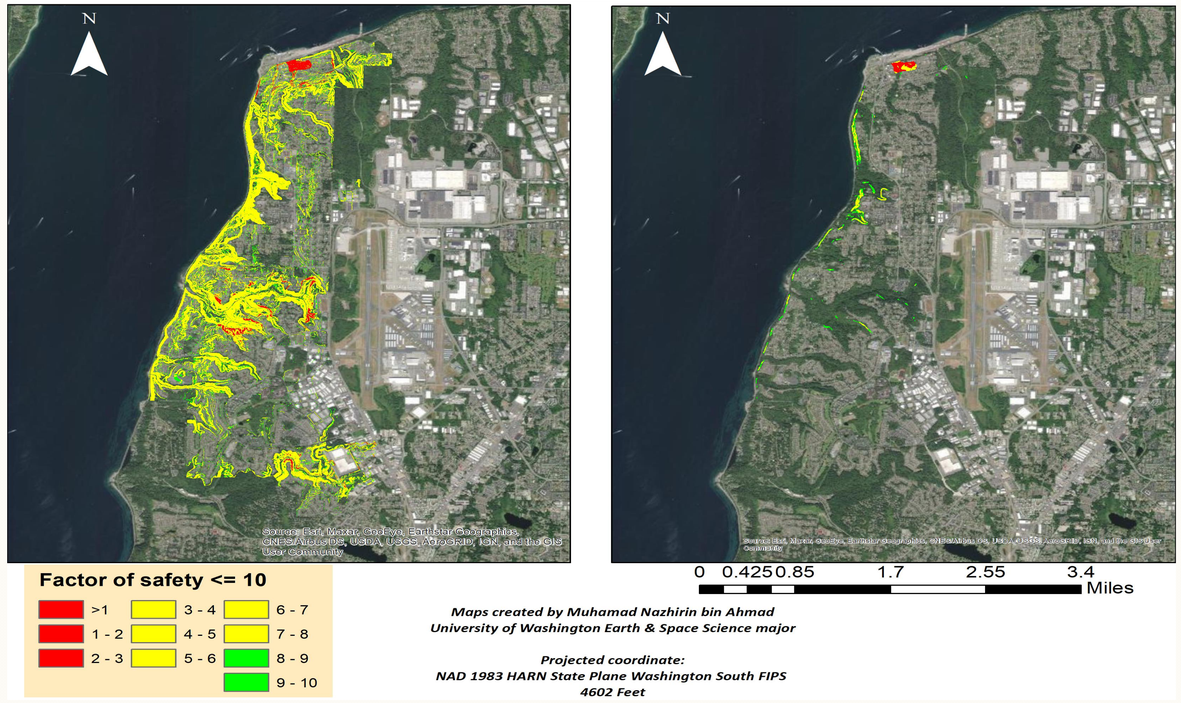


Results

Comparing the resultant FoS maps from both datasets, I found that:

- The total area of locations that have a FoS less than 1 is bigger using the LiDAR datasets (406620 ft^2) vs the 10-m DEM (74271 ft^2).
- The total number of cells that have a FoS less than 1 is also greater when using the LiDAR (11295) compared to the 10-m DEM (69).
- Both datasets show consistent results in term of the locations that are the most susceptible to landslide, which are located on the north of the Mukilteo region.
- The locations that have the highest susceptibility to landslides have its soil composed of glacial lake sediments.
- The locations that have FoS less than 1 for the 10-m DEM are also more concentrated on the northern and the western side of the study.

Mukilteo Region Factor of Safety Map



Maps created by Muhamad Nazhirin bin Ahmad
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Projected coordinate:
NAD 1983 HARN State Plane Washington South FIPS
4602 Feet

Discussion

- The higher number of cells for the locations that have FoS less than 1 in the LiDAR dataset is largely caused by the greater detail captured in the data.
- The LiDAR dataset has a resolution of 6x6 ft, which is a lot higher than the DEM which has a resolution of 33x33 ft. LiDAR datasets can fit more information for the same pixel size, thus increasing the accuracy of the model.
- The smaller total area value from the DEM datasets are likely caused by the exclusion of larger hazard area per pixel size, while LiDAR is excellent in terms of pinpointing region where hazards exist.
- The smaller total area value associated with the DEM data could potentially underestimate landslide susceptibility since the data is being under cautious in indicating hazards.
- The LiDAR datasets is also more capable of assessing FoS for larger area because it can evaluate hazards for smaller pixel size, revealing finer details on the map.

Conclusion

- The FoS map generated using the LiDAR dataset reveal a greater accuracy and bigger area for locations that have a FoS less than 1 compared to the DEM.
- The DEM dataset is useful in determining the general locations that are susceptible to landslide, but often underestimate in mapping a smaller location of interest.
- If all else are equal, LiDAR data should be used for assessing landslide hazards as a preliminary caution step for city planners and the communities in general.

References

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