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Little Fisherman's Cove Landslide Risk Assessment

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Introduction

Little Fisherman's Cove, the road leading into the USC Wrigley Institute for Environmental Studies and connecting it to the rest of the island, curves around a steep hill covered in grasses, trees, rockfaces, and dirt. It is susceptible to wash outs during heavy rains and as the only road into the USC Wrigley institute, the consequences of a landslide are severe; lack of access in an emergency is especially a concern. According to McInnis and Pinter (2021), 23% of Catalina's coastal zone shows evidence of landslide deposits. Moreover, 85% of all mapped landslide deposits on the island occur within the coastal zone. The USC Wrigley Facility falls withing one of these deposits.

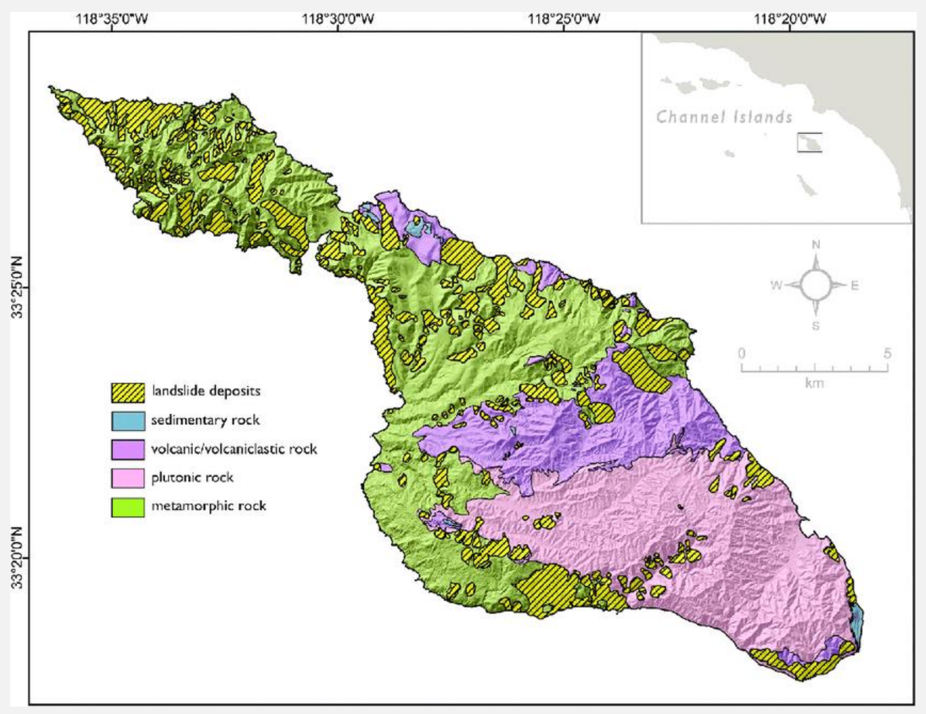

Figure 1: Catalina Geology (McInnis and Pinter, 2021)

According to Forbes and Broadhead (2013), vegetation plays an important role in soil stabilization which helps reduce the risk of landslides. Root matrices anchor soil while dense vegetation will physically block debris from falling downslope. Due to gravity, steeper slopes are more likely to form landslides.

By analyzing vegetation and slope, we aim to identify which areas of the road into Wrigley are most susceptible to landslide. We believe the most vulnerable areas will be those where vegetation is scarce along the road and at points where slope is the greatest.

Study Area

The study area was defined by creating a 45-meter buffer around a stretch of Little Fisherman's Cove near the USC Wrigley Institute that visually appeared to be at risk of landslides and has historically experienced wash-outs during heavy rain.

Figure 2: Study Area

Data Collection Methodology

Global Navigation Satellite System:

- An Arrow 100 was used to map the road section and collect on-road vegetation points
- Additional off-road vegetation points were manually added in ArcGIS Online using a satellite imagery base map

Drone Imagery:

- Aerial imagery was captured with a phantom quadcopter drone in a cross-hatch pattern to visualize slope
- Data Imagery was processed in Drone2Map and ArcGIS Pro

Figure 3: Land Cover

Figure 4: Vegetation Density

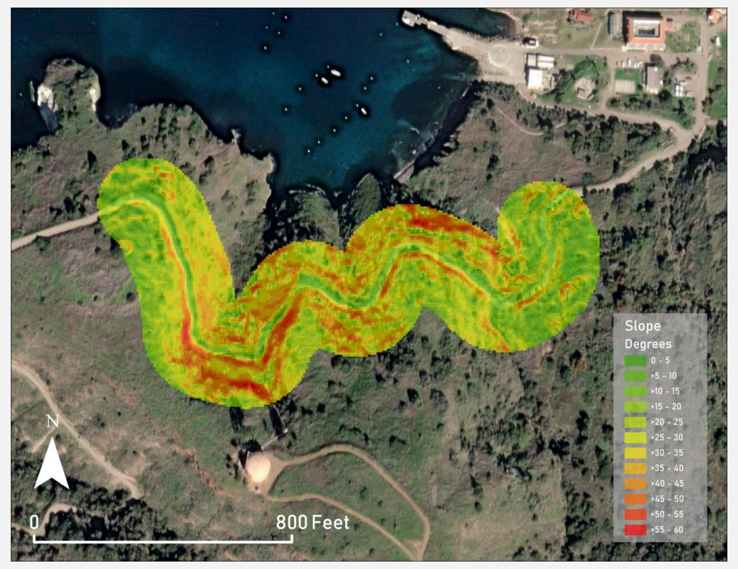

Figure 5: Slope

Input Raster	Weight
Vegetation Density	20%
Land Cover	25%
Slope	55%

Figure 6: Raster Weights

Analysis Methodology

Image Classification:

- New schema was created to create vegetation and non-vegetation land cover types using supervised, object-based classification with training samples from an orthomosaic image (figure 3)

ArcGIS Online Calculate Density:

- Vegetation points were assembled, and the Calculate Density analysis tool was used to create a vegetation density map (figure 4)

Topo to Raster and Slope Tool:

- Drone-derived contours were converted to a DEM with the topo to raster tool and then to a slope layer (figure 5)

Raster Calculator:

- A map algebra expression was used to reclassify the vegetation density raster, land cover raster, and slope raster to a common 0 to 1 scale

Weighted Overlay:

- Each raster layer (figures 3, 4, and 5) was assigned a weight (see figure 6) and combined to output a singular raster layer which described landslide risk (figure 7)

Results

The map below shows landslide risk within our study area along Little Fisherman's Cove near the USC Wrigley Marine Science Center. Green areas indicate low landslide risk while red areas indicate a high landslide risk. The three circled areas represent the three most at-risk sections and should be of focus when implementing landslide mitigation techniques.

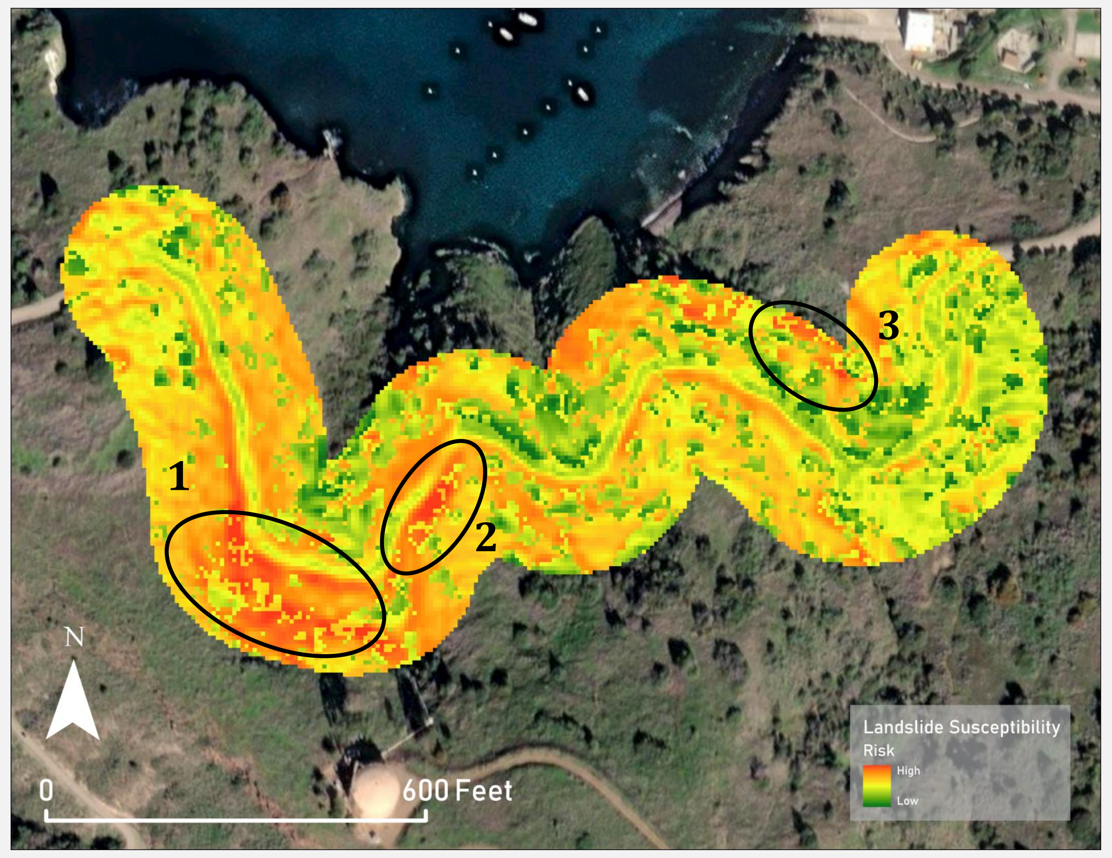

Figure 7: Map of landslide risk

Discussion and Conclusions

Site 1

Site 2

Site 3

Site 1: Risk can be mitigated with additional vegetation planting

Site 2: Risk can be mitigated by the installation of a mesh or wire net to cover the loose rock face

Site 3: Risk can be mitigated with additional road drainage

Considerations for future research:

- Conduct a study across the entire road or island
- Include additional landslide factor layers (soil condition, geology, precipitation, etc.)
- Determine optimal vegetation species to plant and design new infrastructural techniques

References

Forbes, Keith and Jeremy Broadhead. 2013. *Forests and landslides: The role of trees and forests in the prevention of landslides and rehabilitation of landslide-affected areas in Asia: Second edition*. Bangkok: Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific.

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Special thanks to the Wrigley Marine Science Center, Dr. Andrew Marx, Isaiah Mack, Luis Leal and Karl Huggins