Santa Clara and Santa Cruz Landslide Susceptibility

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Considering natural factors like vegetation, geology, slope, and wildfire burn scars, where in the San Jose area has the highest possibility of landslides?

Introduction

Landslides have become more prevalent in California because the increased numbers of natural disturbances occurring that causes soil erodibility. Intensity of these disturbances is the main factor in the potential severity of the landslide. Knowing potential areas that may be more susceptible to future landslides can allow for preventative measures to be put in place, minimizing the chances that life is lost, both human and nonhuman.

Study Area

The extent of our study is Santa Clara and Santa Cruz counties. These areas have historically been susceptible to landslides as well as had large fires recently.

Data

Data Source	Attribute	Last Updated
CALFIRE	Historic Fire Perimeters	1878 - 2020
CGS	Geology	2010
CALFIRE	Vegetation	2020
USGS	Elevation DEM	2019
CGS	Landslide Inventory	1950 - 2022
California Open Data Portal	California Counties	2016

Approach

A) Prepare Data

- Select last 5 years of fire data (Wittenberg et al., 2007, p. 76)
- Classify geology into five bedrock classes
- Convert DEM elevation data into slope data
- Create polygon of study area by dissolving the two counties
- Clip all data to extent of study area

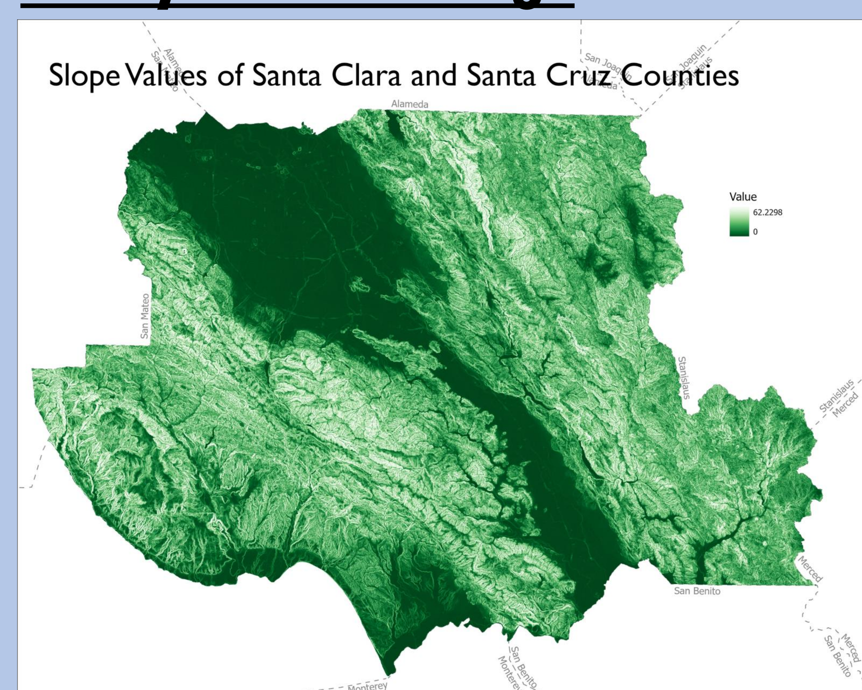
B) Classification of Landslide Predisposing Factors

- Overlay vegetation and bedrock factor maps with landslide inventory to calculate landslide densities of all classes of each factor map
- Use landslide densities to calculate suitability scores for geology and vegetation (Zêzere et al., 2017)

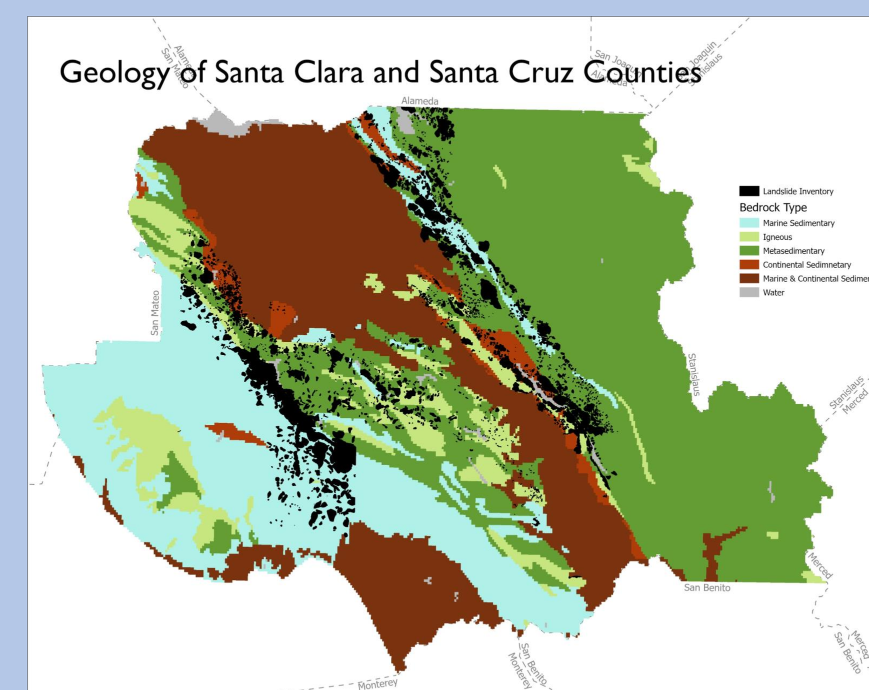
C) Suitability Analysis

- Combine vegetation, geology, slope, and fire burn scars into suitability map
- Use weights of 15% geology, 25% vegetation, 30% fire burn scars, and 40% slope (Sadisun et al., 2021, p.3)
    - Based on previous works ranking and personal educated discretion

Analysis & Findings



Map 1: Slope Values over S. Clara and S. Cruz Counties



Map 2: Geology Types of S. Clara and S. Cruz Counties

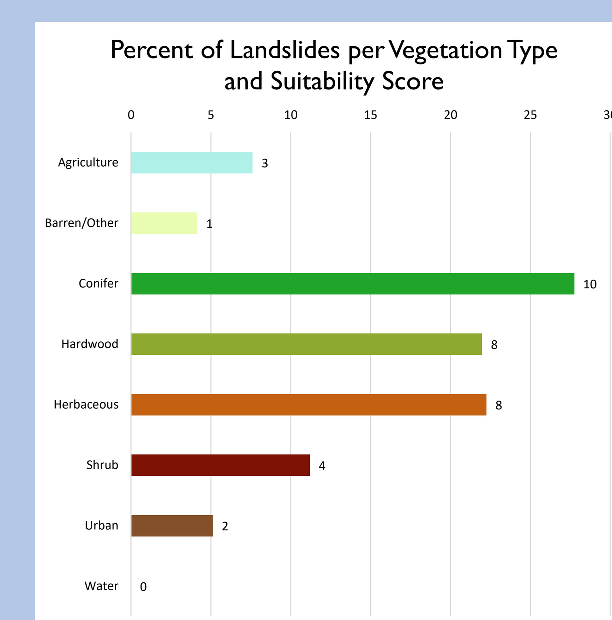
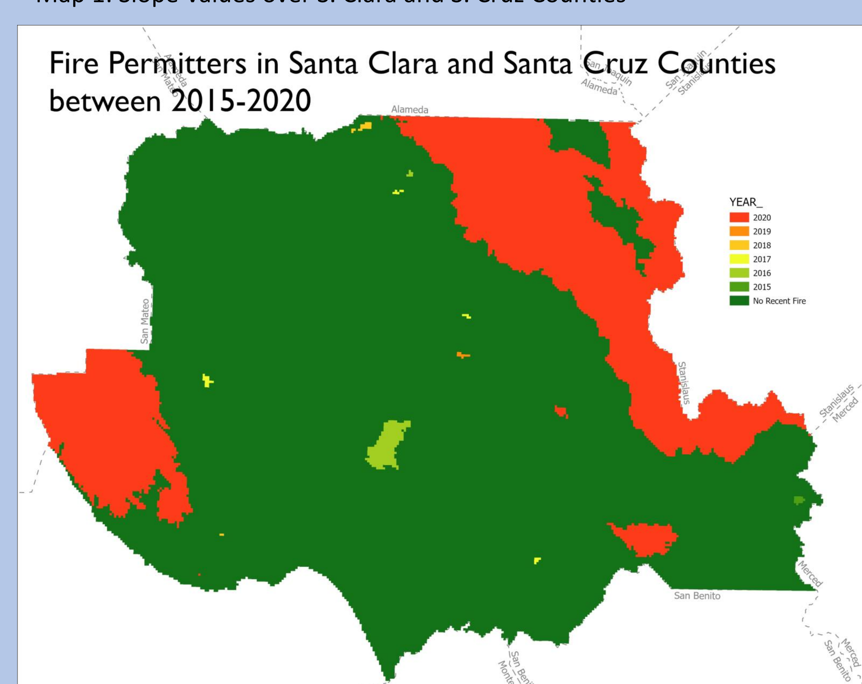
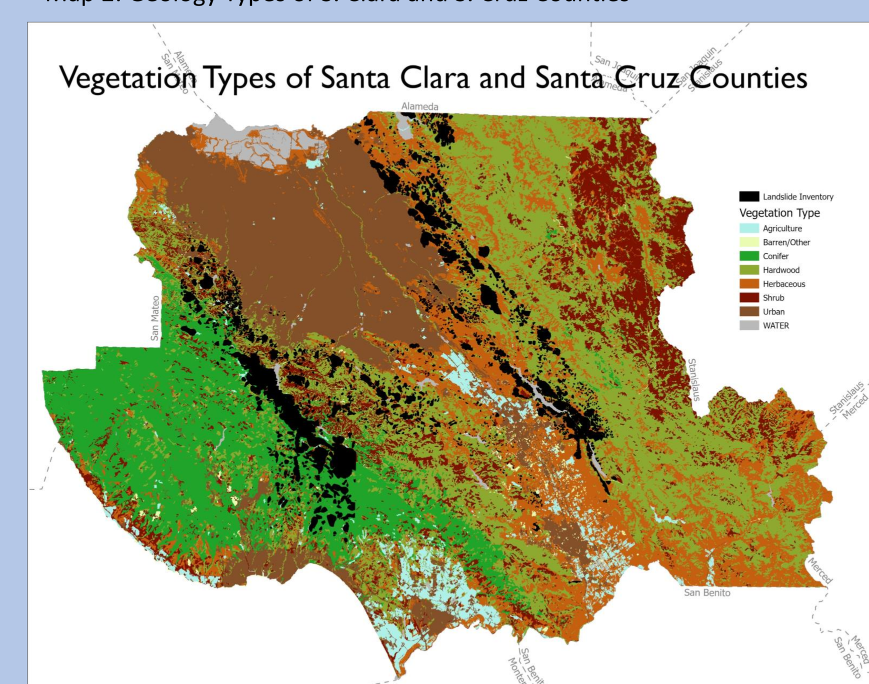


Chart 1: Landslide Percentages for Vegetation Types and Corresponding Suitability Scores



Map 3: Wildfire Burn Scars in S. Clara and S. Cruz Counties between 2015-2020



Map 4: Vegetation Types of S. Clara and S. Cruz Counties

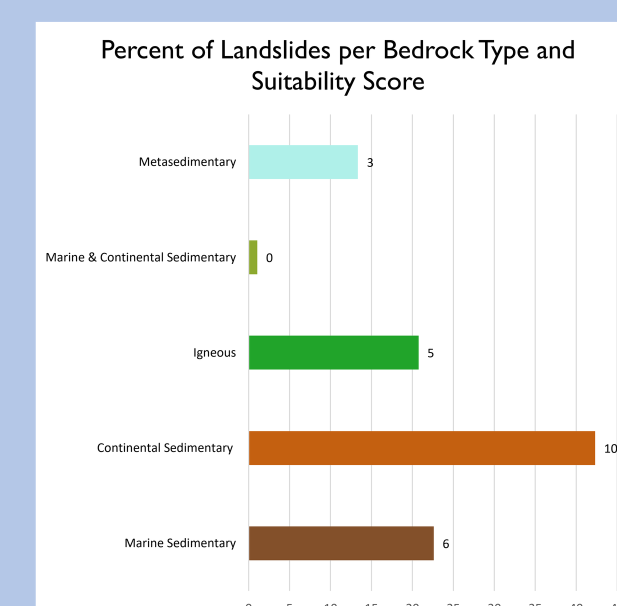


Chart 2: Landslide Percentages for Bedrock Types and Corresponding Suitability Scores

Map 1
- Maximum slope of 62 degrees

Map 2
- 5 bedrock types cover the study area

Map 3
- Two large fires occurred in the area in 2020

Map 4
- 8 vegetation types over the study area

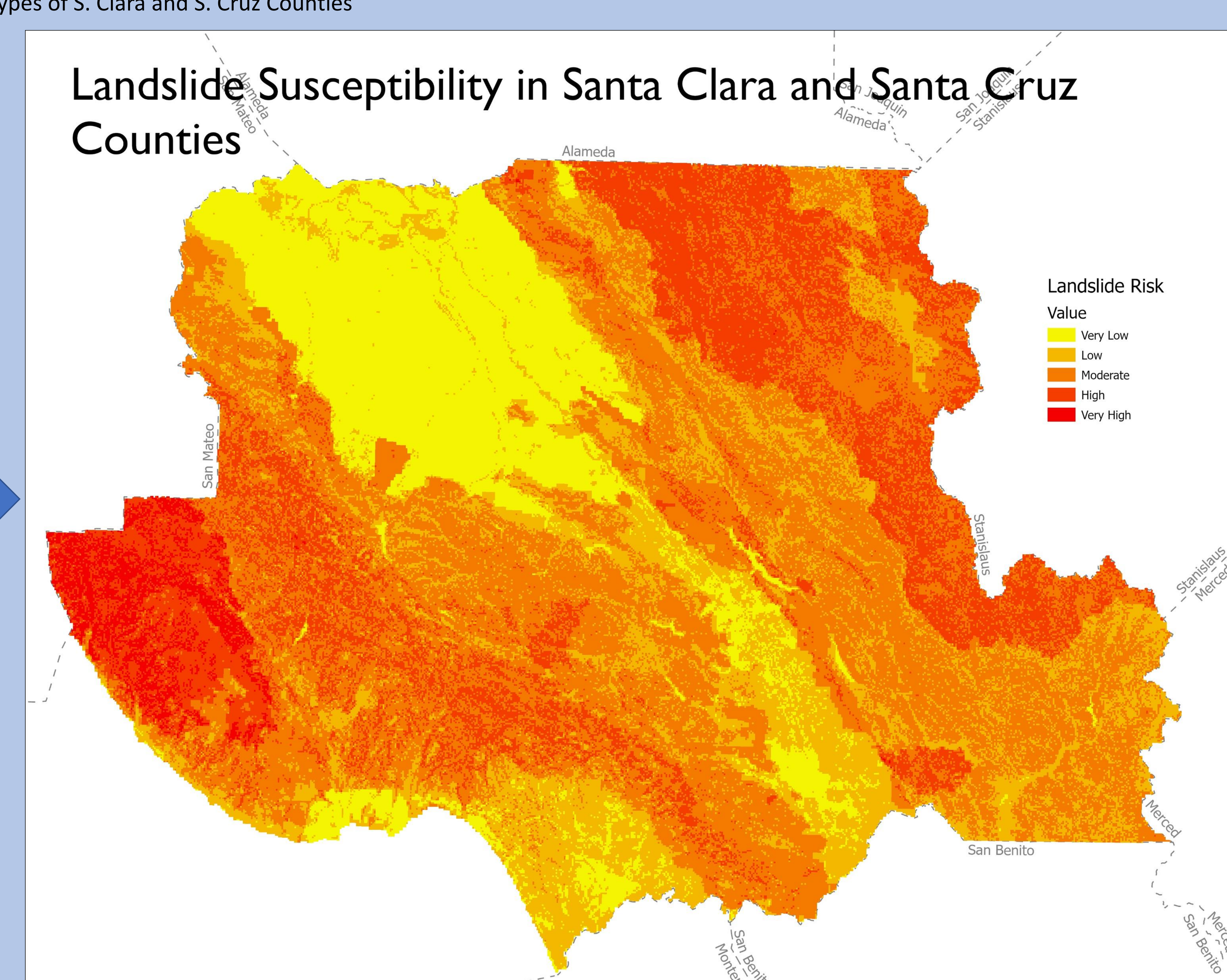
Chart 1
- Conifer had highest percent of landslides and got a score of 10
- Hardwood and herbaceous types also have high percentage
- Other scores were based on their percent relationship to Conifer's percentage

Chart 2
- Continental sedimentary had highest percent of landslides and got score of 10
- Other scores were based on their percent relationship to continental sedimentary's percentage

Remaining suitability criteria:
- Slope values used suitability scores from the MSLarge function of suitability modeler
    - Steeper slopes were given larger scores (Gupta, Shukla, & Thakur, 2018)
- Burn scar scores to the right:

Wildfire Year	Suitability Score
2020	10
2019	9
2018	8
2017	7
2016	6
2015	5
No Fire	0

Suitability Analysis



Conclusions

By combining the four factor maps above with different suitability scores and weights, the suitability map to the left was created. Areas with 0-20% chance of landslide were considered very low risk, 20-40% was low risk, 40-60% was moderate risk, 60-80% was high risk, and 80-100% was very high risk (Guzzetti et al., 1999, p.192). The eastern most region of the area has the very high risk of landslide. This area has high slope, igneous bed rock, as well as recently been hit by fires in 2020 called CZU lightning complex wildfires. The area has high soil erodibility due to the fire and will likely have a landslide if heavy rainfall hits the steep slopes. The northern center section of the area has very low risk due to the flat slopes and urban vegetation. This area will unlikely have a landslide.

Challenges and Limitations

A few limitations of this study deals with the extent of our project. More specifically, this study only focuses on the natural factors related to landslide risk. Human activities play a significant role in landslide risk, but we did not investigate this because it was difficult to find relevant data. We also chose not to include external and unpredictable factors, such as earthquakes and precipitation, in our spatial analysis because the type of data was not what we were looking for. We were given yearly and monthly precipitation averages but we wanted to look at smaller periods of intense rainfall within an area. Specifically, we didn't include a spatial analysis on monthly precipitation levels because it wouldn't accurately depict the true effect of rainfall in the area where the landslide occurred.

Future Directions

1. There are more variables that go into landslide risk. For example, we could look at land use data, specifically human interactions with the surrounding environment
2. Quantify the hazards associated with living in areas with high landslide risk. These hazards can include area affected, infrastructure damaged, monetary loss, etc.
3. Look at distance from stream and soil type to identify any relationships to landslide risk

References

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