Landslide Susceptibility Map for Tillamook State Forest: Using Weighted Overlay and Frequency Ratio Model

Stephanie Anderson, Saraah Campbell, Lisa Haskins, and Nathan Herzog

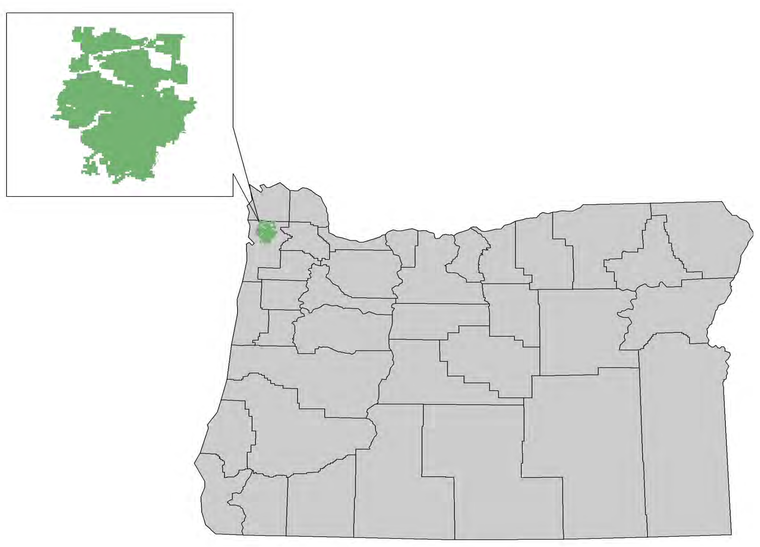
Introduction

Landslides are a significant disturbance in the Pacific Northwest region of the United States, exceeding $10 million in damages a year (Wang, et al. 2002). Being able to determine what factors contribute to the occurrence of landslides and how much these factors influence landslides is imperative for land managers and emergency responders in order to avoid a disaster from happening, like that which recently occurred in Oso, Washington.

Tillamook County has historically experienced many landslides according to DOGAMI and given its location along the coast of Oregon, we wanted to explore various factors that we thought were relevant to the county's physical geographic characteristics to build a landslide susceptibility map using GIS Weighted Overlay and a Frequency Ratio Model. Our study area ultimately consisted of Tillamook State Forest.

The factors that were weighed and calculated were based on available data and appropriate resolution relationships. These final factors included slope, aspect, distance to streams, and distance to roads. With the necessary steps taken, we were able to come up with a relatively useful probability map and frequency ratio values for all of the factors.

Landslide near Lee's Camp Tillamook Forest (2011)
http://www.katu.com/living/outdoors/Officials-are-keeping-a-watchful-eye-on-landslide-east-of-Tillamook-135213148.html



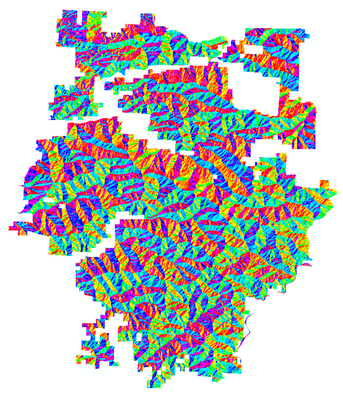
Methods

Tools Used: Multiple Ring Buffer, Slope, Aspect, Intersect, Clip, Extract by Mask, Int, Raster to Polygon, Feature to Raster, Dissolve, Spatial Join, Reclassify, Weighted Overlay and calculated Frequency Ratio

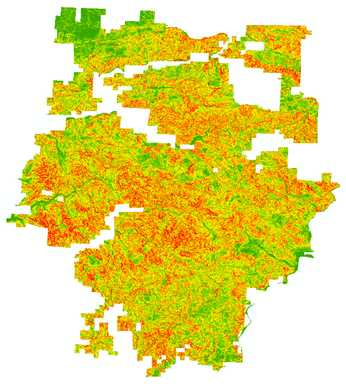
Factors Used: Distance from Streams, Distance from Roads, Slope, and Aspect. The roads, streams, and DEM layers were obtained from the Oregon Geospatial Data Clearinghouse. We obtained the Tillamook Forest shapefile from ODF and the Landslide points from DOGAMI.

The streams and roads layer had buffers created around them at 1000, 2000, 3000, 4000, and 5000 ft. Landslide points patterned very close to these features which was our reasoning for using a small distance unit. They were reclassed into 5 classes using Natural Breaks with 5 being the nearest buffer and 1 being the farthest buffer. They were then joined spatially with landslide point data.

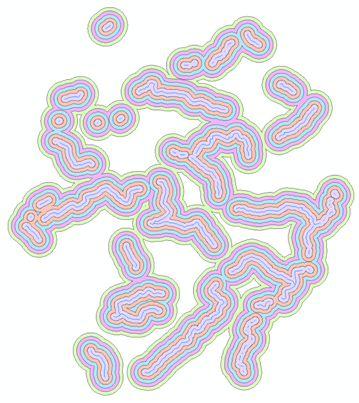
Slope and aspect were run on our 10m DEM and reclassed into 5 classes. They were dissolved and joined spatially with landslide point data.



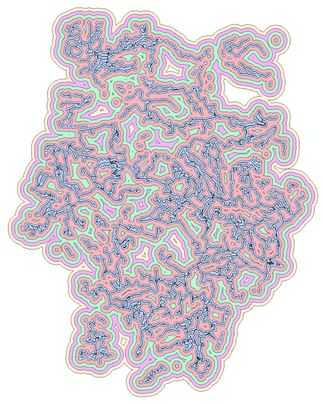
Aspect



Slope



Streams Buffer



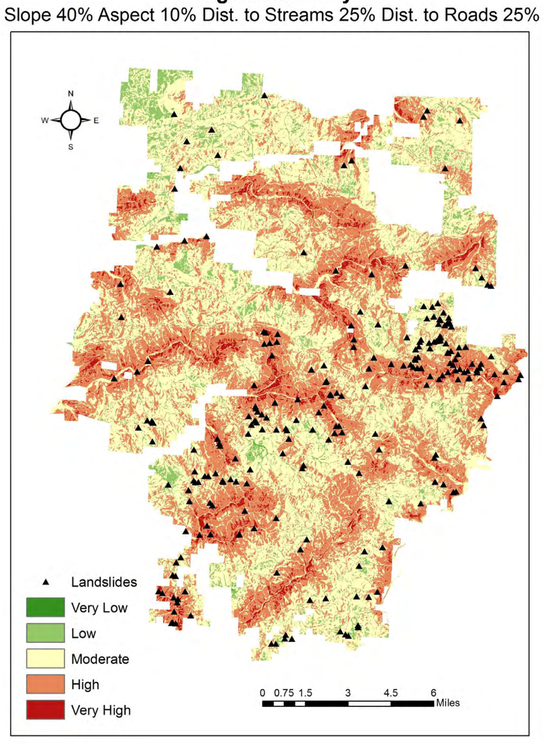
Roads Buffer

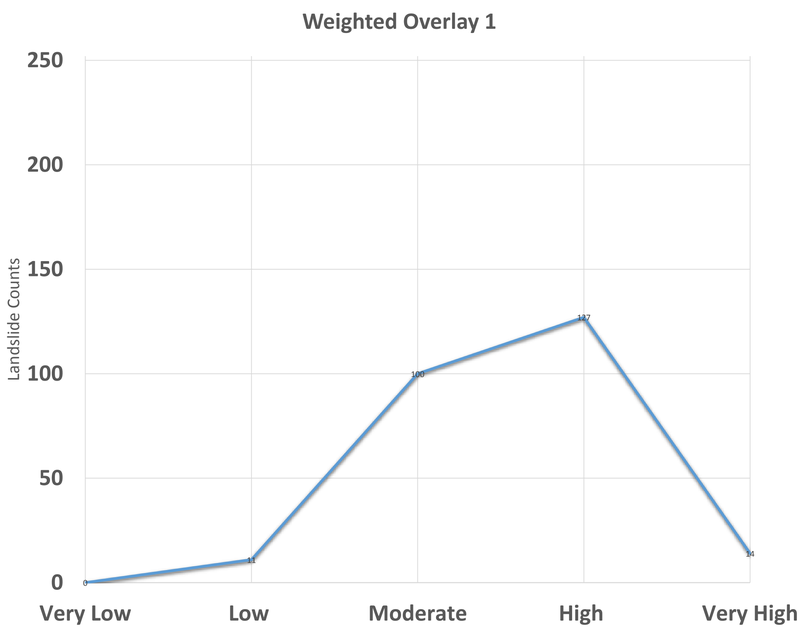
Results

Frequency Ratio Model

Factor	Class	# of Pixels	% Domain	# Slides	% Slides	Frequency
Slope(degree)	0-15	541201	20.75	16	6.3	0.3
	15-25	970930	37.23	26	10.3	0.27
	25-32	138330	5.3	49	19.4	3.66
	32-40	152837	5.8	85	33.7	5.81
	40-72	804443	30.8	76	30	0.97
Aspect	N/NE	105762	7.7	44	17.4	2.25
	E/SE	940717	68.6	53	21	0.3
	S/SW	107262	7.8	73	28.9	3.7
	W	110205	8	60	23.8	2.97
	NW	105523	7.7	22	8.7	1.12
Distance from Streams	Buffer 1000 ft	728219	18.5	55	31.9	1.72
	Buffer 2000 ft	816073	20.8	40	23.2	1.11
	Buffer 3000 ft	818560	20.9	30	17.4	0.83
	Buffer 4000 ft	798710	20.3	28	16.2	0.79
	Buffer 5000 ft	760148	19.3	19	11	0.56
Distance from Roads	Buffer 1000 ft	292850	2.5	185	73.4	29.36
	Buffer 2000 ft	1313656	11.5	51	20.2	1.75
	Buffer 3000 ft	4739408	41.8	15	5.9	0.14
	Buffer 4000 ft	1319389	11.6	0	0	0
	Buffer 5000 ft	3669816	32.3	1	0.39	0.01

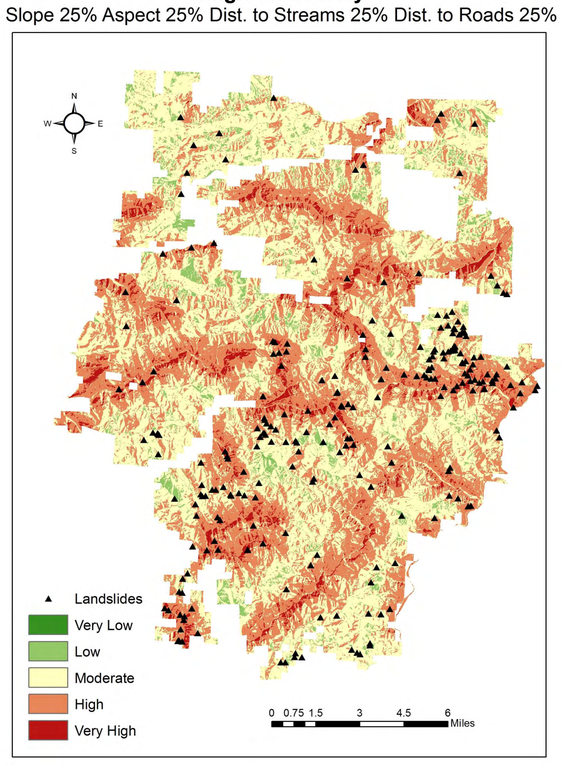
Weighted Overlay
Slope 40% Aspect 10% Dist. to Streams 25% Dist. to Roads 25%





55% of Landslides were accumulated for in the High/Very High classes.

Weighted Overlay
Slope 25% Aspect 25% Dist. to Streams 25% Dist. to Roads 25%



Conclusion & Future Suggestions

While the results using weighted overlay and frequency ratio showed a correlation between landslide susceptibility and the factors used and weighted, future analyses is needed for more precise results. Different models such as Logistic Regression would add a more accurately statistical influence to the results. Other influential factors should also be considered for future analyses such as land cover, precipitation, and soil.