Deforestation in the Rainforest of Sumatra:
Mapping Site Vulnerabilty and Evaluating Vegetative Change

Introduction

The Indonesian Tropical Rainforest Heritage of Sumatra was inscribed as a UNESCO World Heritage Site in 2004. The Rainforest is known for its incredible biodiversity. The island is home to 10,000 different plant species, 200+ mammals, and 580 bird species, many of these either endangered or endemic to this region. The Sumatran Rhino, Tiger, Elephant and Orangutan are a few of the most well-known animals that roam this island. UNESCO has identified several critical risks to the Rainforest site including illegal logging, palm oil plantations, road construction, and wildlife poaching.

The goal of this project was to look at a few of these threats to determine areas that are especially vulnerable to deforestation. The results offer suggestions for where policy decisions and conservation resources might be focused in order to help mitigate the environmental impacts of these threats.

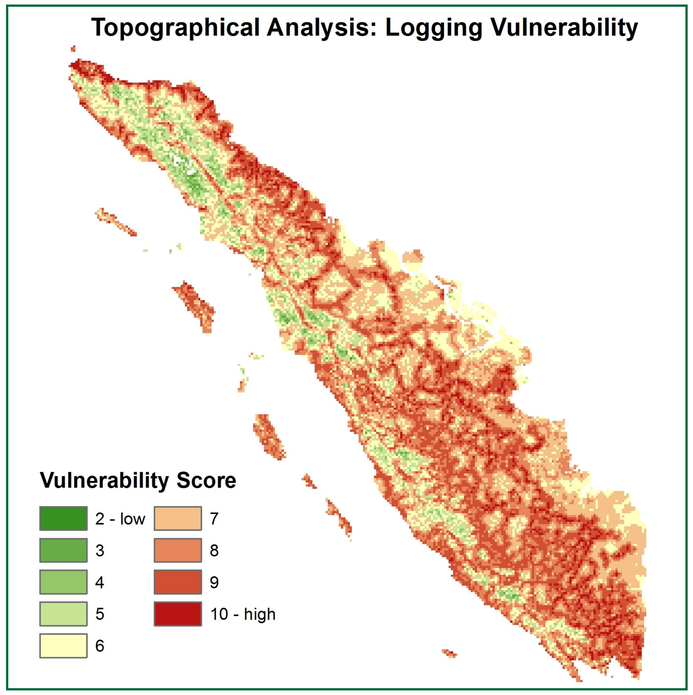
Methods

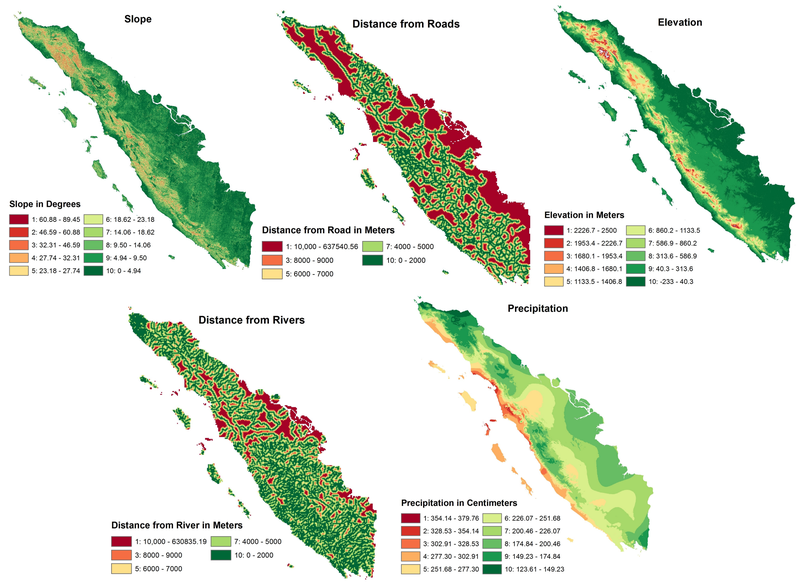
The data analysis for this project was performed in two parts. The first part consisted of generating a suitability map to evaluate the topographical vulnerability of various parts of the island using slope, elevation, distance from roads, distance from rivers, and precipitation. Steep slopes make it harder to maneuver logging equipment and transport logs out of the forest, so areas with more gradual slopes are more vulnerable to deforestation. Similarly, high elevations pose a challenge to loggers. Areas that are in close proximity to rivers or roads make for easier log transport, and are therefore at greater risk for deforestation. In the tropics, areas that get heavy rain year-round make wood extraction more difficult, so logging is more likely to be concentrated in less rainy locations. The vulnerability model assigned different weights to different factors based on their relative importance as identified in the literature. This table shows the weights that each layer was given:

Variable	Weight
Slope	30%
Distance from Road	25%
Elevation	20%
Distance from River	15%
Precipitation	10%

The second part of the analysis sought to explain some of the deforestation that Sumatra has seen in recent years (2000 – 2015) and locate areas that might be especially vulnerable. Data about primary forest, logging concessions, oil palm concessions, mineral mining sites, and the vulnerability score derived from the first part of the analysis were compared with MODIS EVI (Enhanced Vegetation Index) data showing the change in forest cover over the past fifteen years. The project evaluated relationships between these layers using statistical regression and bivariate Moran's I analysis.

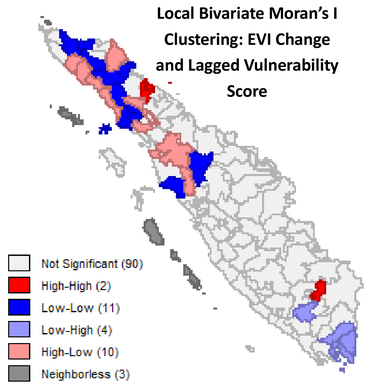
Vulnerability Model Results



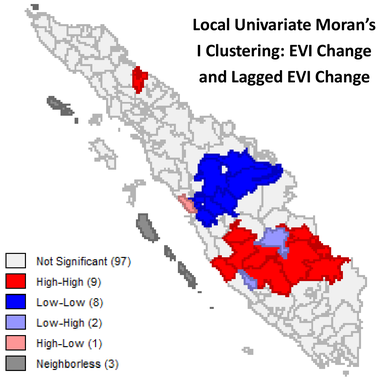


Results

The vulnerability map reveals that Sumatra may be more vulnerable in the southeast and along the northwest coast, given the topographical features of these regions. A local bivariate Moran's I analysis of this vulnerability score and the actual vegetation change observed since 2000 indicates very little clustering between the two variables, which means that the physical characteristics of that land may not have much influence on deforestation after all.



A statistical OLS regression and spatial lag regression (of primary forest, logging concessions, oil palm concessions, mineral mining sites, and the vulnerability score regressed on change in EVI) each yielded no statistically significant results. A local univariate analysis of change in EVI, however, showed significant clustering of both districts with high deforestation rates (in the southeast as predicted by the vulnerability model) and those of low deforestation rates.



Interestingly there was almost no clustering in the map of oil palm concessions and change in EVI which may indicate that the oil palm industry is less of a threat than previously believed. Alternatively, it could mean that the data is too coarse, is incomplete, or is out of date.

While the findings are not as clear or significant as hoped, there is still valuable information here for policy makers. Based on the findings of this study, it seems that focusing policy initiatives toward better forest protection and management in the southeast might be the best use of conservation resources.

References

- Primary Forest Layer: Landsat, *Indonesia Primary Forest*, (via Global Forest Watch), 2000.
- Logging Concessions Layer: Indonesia Ministry of Forestry, *Indonesia Logging Concessions*, (via Global Forest Watch), 2012.
- Oil Palm Concessions Layer: Indonesia Ministry of Forestry, *Indonesia Oil Palm Concessions*, (via Global Forest Watch).
- Mining Sites Layer: USGS, *Major Mineral Deposits of the World*, 2009.
- EVI Layers: *NASA, MODIS79 A7: EVI,* (via EarthData), March 5, 2000 and March 6, 2015.
- Elevation (and Slope) Layer: USGS, *ASTER Global DEM*, (via EarthExplorer), 6455.
- Roads Layer: Diva-GIS, *Inland Water*.
- Rivers Layer: Diva-GIS, *Roads*.
- Precipitation Layer: WorldClim, *Global Climate Data*, 2005.
- Administrative Boundaries Layer: GADM, *Gobal Administrative Areas*, 2015.

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