LANDSLIDE RISK ASSESSMENT IN YOSEMITE NATIONAL PARK

Edna Rodriguez

December 1st, 2016

Final Project

Table of Contents

Introduction

Landslides and rockfall are a dangerous natural hazard common in Yosemite National Park in central California. In 2015, there were 66 documented rockfall events within the park (National Park Service) . As a risk to park visitors and wildlife, predicting landslides in common areas such as roads and camping sites is necessary for protection.

The goal of this project is to provide a landslide risk assessment throughout Yosemite park using GIS's Spatial Analysist at a resolution of 30 m^2. That is, where is it most likely for a landslide to happen within Yosemite? To do this, we need to identify what triggers landslides. Geologic processes such as erosion and earthquakes are important factors to consider.

To account for erosion in the area, several factors need to be considered such as slope, geology, and loss of vegetation. A study by the USGS correlated higher temperatures to higher chances of rock fall (USGS, 2016). This is due to cracking of the rock under high temperatures.

Data Collection

The following files were collected for the landslide risk assessment of Yosemite National Park.

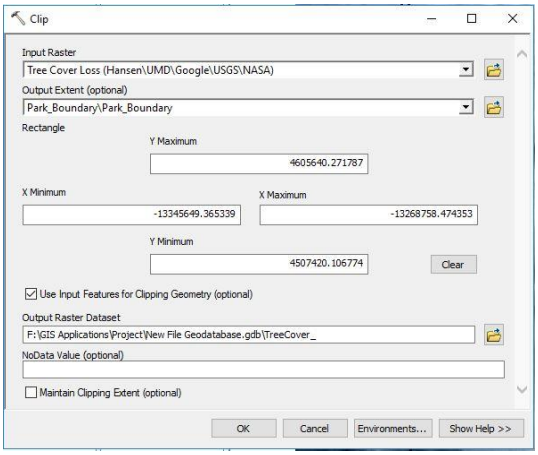
Layer Name	Source	Description	File Type
Yosemite Park Boundary	ArcGIS Online	A simple boundary layer.	Shapefile
Tree Cover Loss	ArcGIS Online, NASA	This data set provides a disaggregation of total forest loss to annual time scales between 2001-2014.	Raster
Geology of California	USGS	A conversion of the published 2010 Geologic Map of California for publication online. The original map and data are prepared and published for use at a 1:750,000 scale.	Shapefile
DEM	USGS National Elevation Dataset (NED)	This is a combination of two 1 arc-second resolution tiles from the National Elevation Dataset (NED). The NED provides basic elevation information for earth science studies and mapping applications in the United States	Raster
Mean Temperature	WorldClim – Global Climate Data	Compilation of observed mean temperatures in the area representative of 1960-1990. Chose the month of August, the hottest month in California.	Raster
Earthquake probability	USGS National Seismic Hazard Maps (NSHM)	The NSHM display earthquake ground motions for various probability levels across the U.S. It is derived from seismic hazard curves calculated on a grid of sites across the U.S. that describe the annual frequency of exceeding a set of ground motions. It depicts probabilistic ground motions with a 2 % probability of exceedance in 50 years.	Shapefile

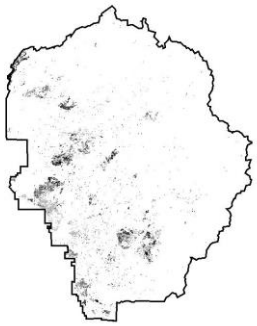
Data Preprocessing

Most of the files had a different spatial reference from each other so I used the Project and Project Raster (Data Management) tool to change them all into the NAD_1983_California_Teale_Albers Projection.

Tree Cover Loss

1) Clip (Data Management)

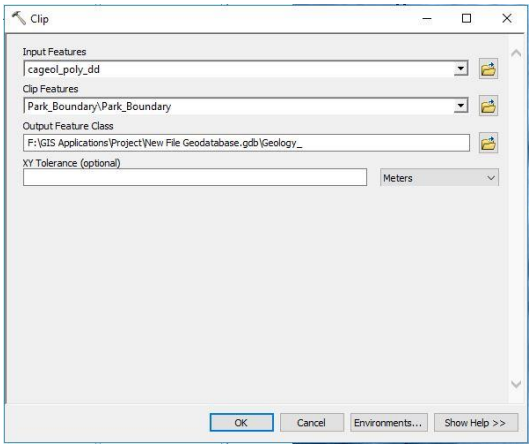


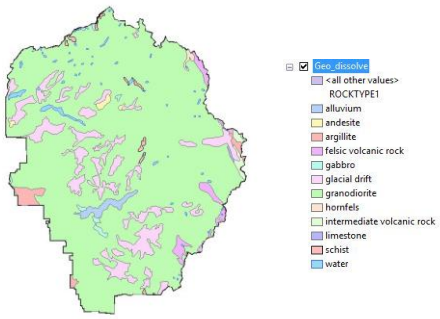


2) Resampling tool. Changed cell size to 30x30.

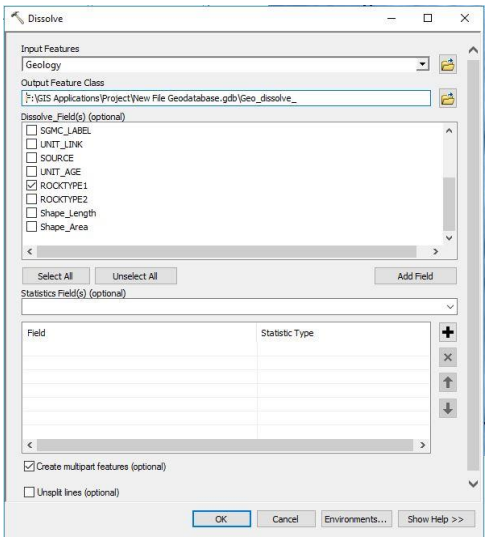
Geology of California

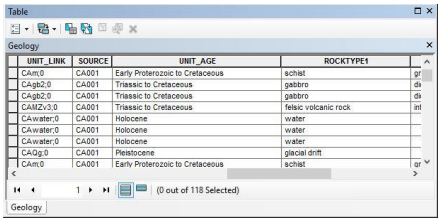
1) Clip (analysis) tool

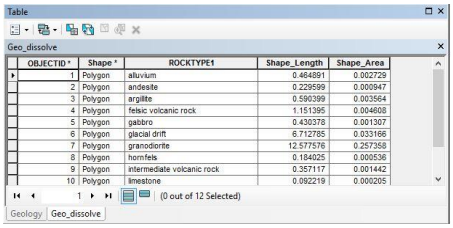




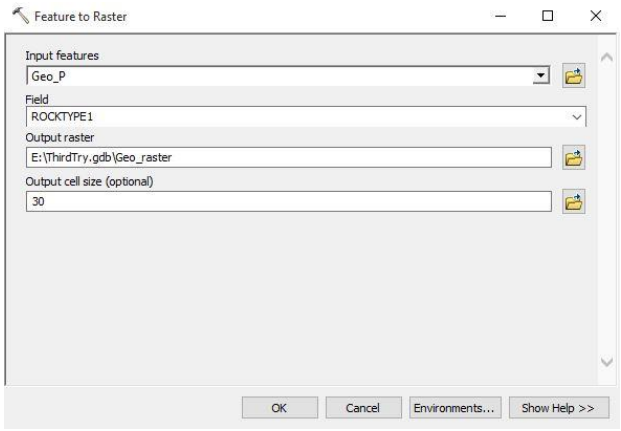
2) Dissolve tool. Went from 118 attributes to 12 attributes. This will work well when reclassifying the data.





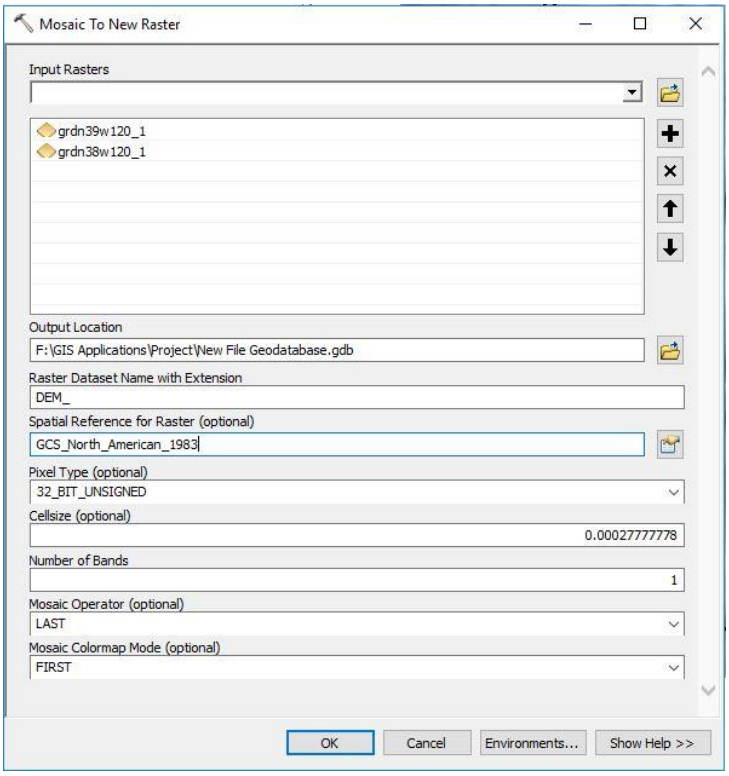


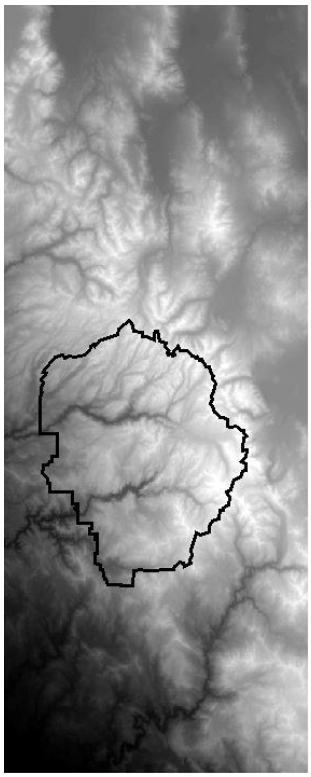
3) Feature to Raster tool. Output cell size needs to be 30.



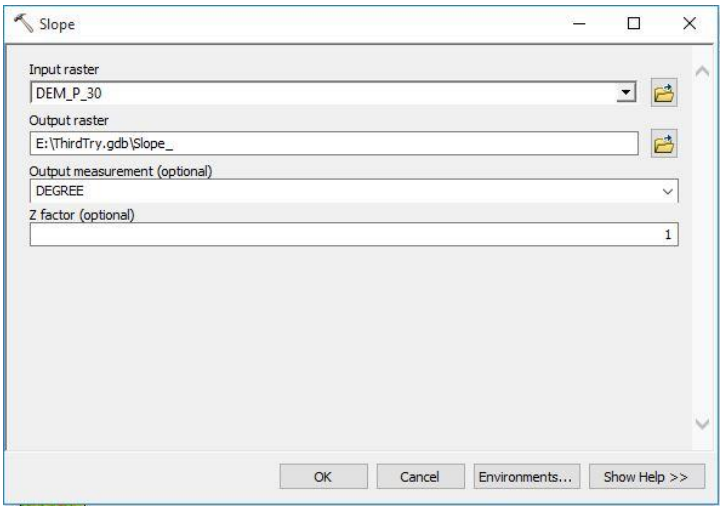
DEM

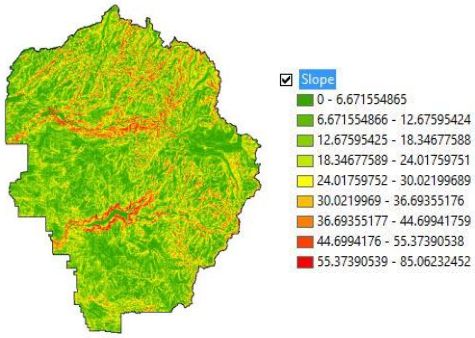
1) Mosaic to New Raster tool. I downloaded USGS NED grdn38w120 and grdn39w120 grids because not just one grid covered the entirety of the park. So, I needed to mesh the two together.





2) Slope tool, using Park boundary as mask.

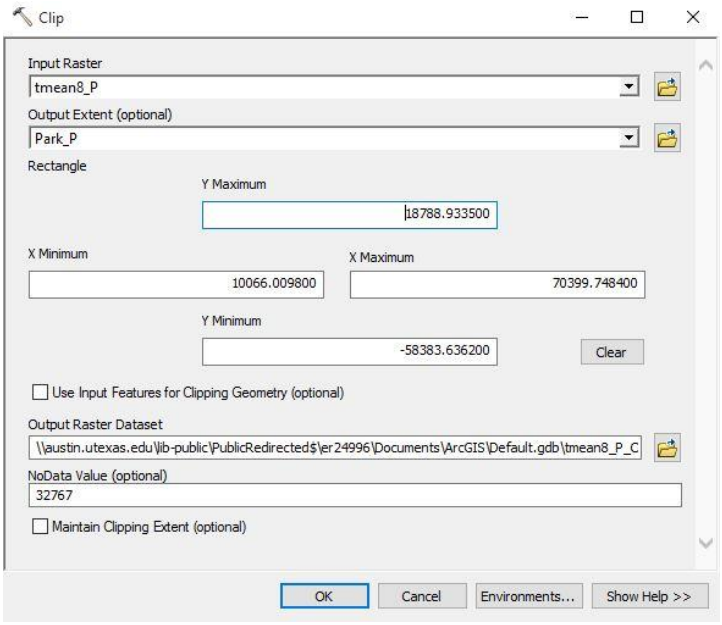


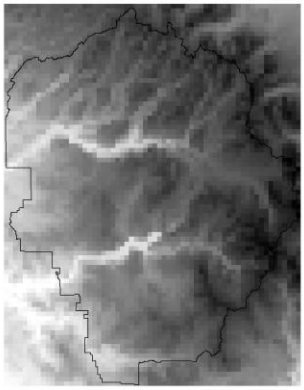


3) Resampling tool. Changed cell size to 30x30.

Mean Temperature

1) Clip (data management) tool

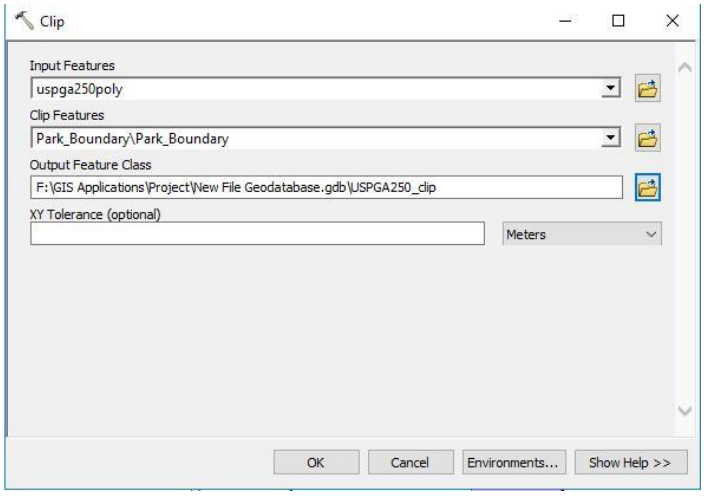


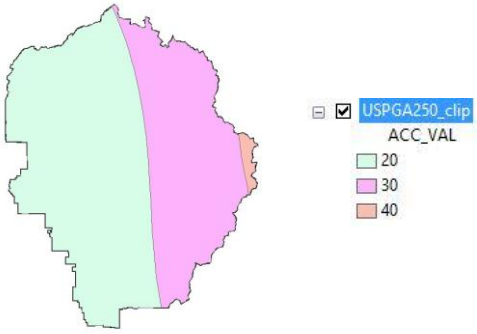


2) Resampling tool. Changed cell size to 30x30.

Earthquake Probability

1) Clip (analysis) tool.





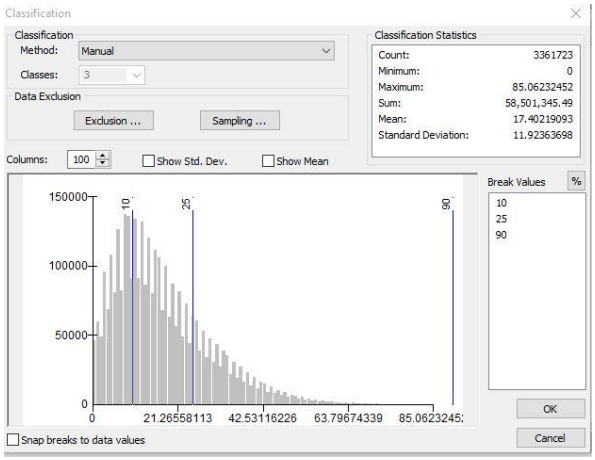
2) Feature to Raster tool. Output cell size needs to be 30.

ArcGIS Processing

Now, for the fun part. The following table describes the ranking schematic I created to understand the risk assessment for landslides in Yosemite, followed by a brief explanation.

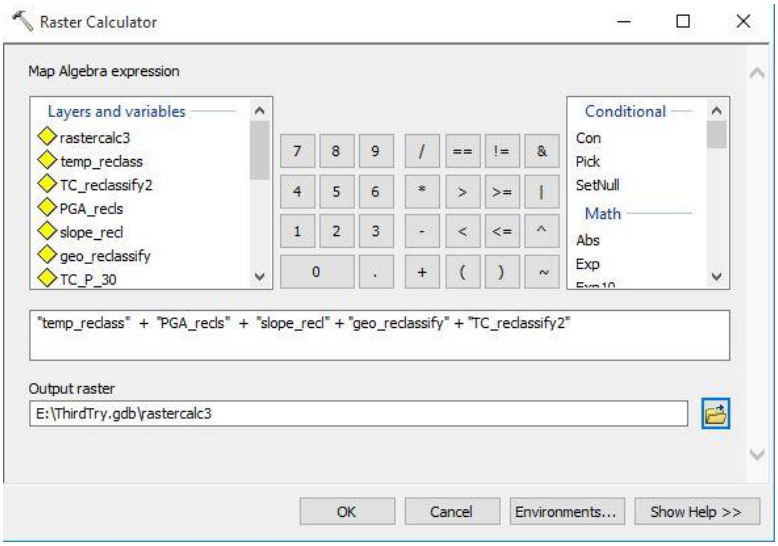
Rank	Tree Cover Loss	Geology	Slope	Mean Temperature (°C)	Earthquake Probability
0	No	Water	--	--	--
1	--	Gabbro, granodiorite, argillite, hornfels, schist	<10°	5.7 – 12.0	20
2	--	Andesite, intermediate volcanic, volcanic rock felsic, Limestone	10° - 25°	12.0 – 17.0	30
3	Yes	Alluvium, Glacial drift	25° -90°	17.0 – 25.0	40

1) **Tree Loss Cover:** No loss means that there is vegetation still in the area, and thus has no effect on landslides (Rank = 0).
2) **Geology:** For this, I gave the intrusive and metamorphic rocks the least effect on landslides, since they are more resistant to erosion. Then, the extrusive igneous and sedimentary rocks follow under rank 2. Finally, the most susceptible to erosion would be the unconsolidated material.
3) **Slope:** Since I am only working with three rankings, I decided that the best way to represent slope would be to separate the data according to its distribution. Refer to the figure below.



4) **Mean Temperature:** A similar step to 3) done here.
5) **Earthquake Probability:** There were only three categories. In fact, I decided to split everything into 3 meaningful rankings because of this file.

After using the Resampling tool on each file following the ranking system, I used the raster calculator tool to add the layers together. I assumed all five layers weighted the same.



Conclusion

The resulting map showed some interesting results. Even before starting the project, it was obvious that Yosemite Valley would be an area of high landslide risk. Seeing these results on the map I created increments the credibility of other sites that exhibit similar high risk behavior.

It's good to see that most roads and campsites within Yosemite park are at the lower side of risk potential. However, there are some that do not. For instance, the campsite at the foremost right lies within a medium risk potential. This area is known as Tuolumne Meadows through the Tioga road. If they haven't been implemented already, extra security measures on potential landslides should be provided.

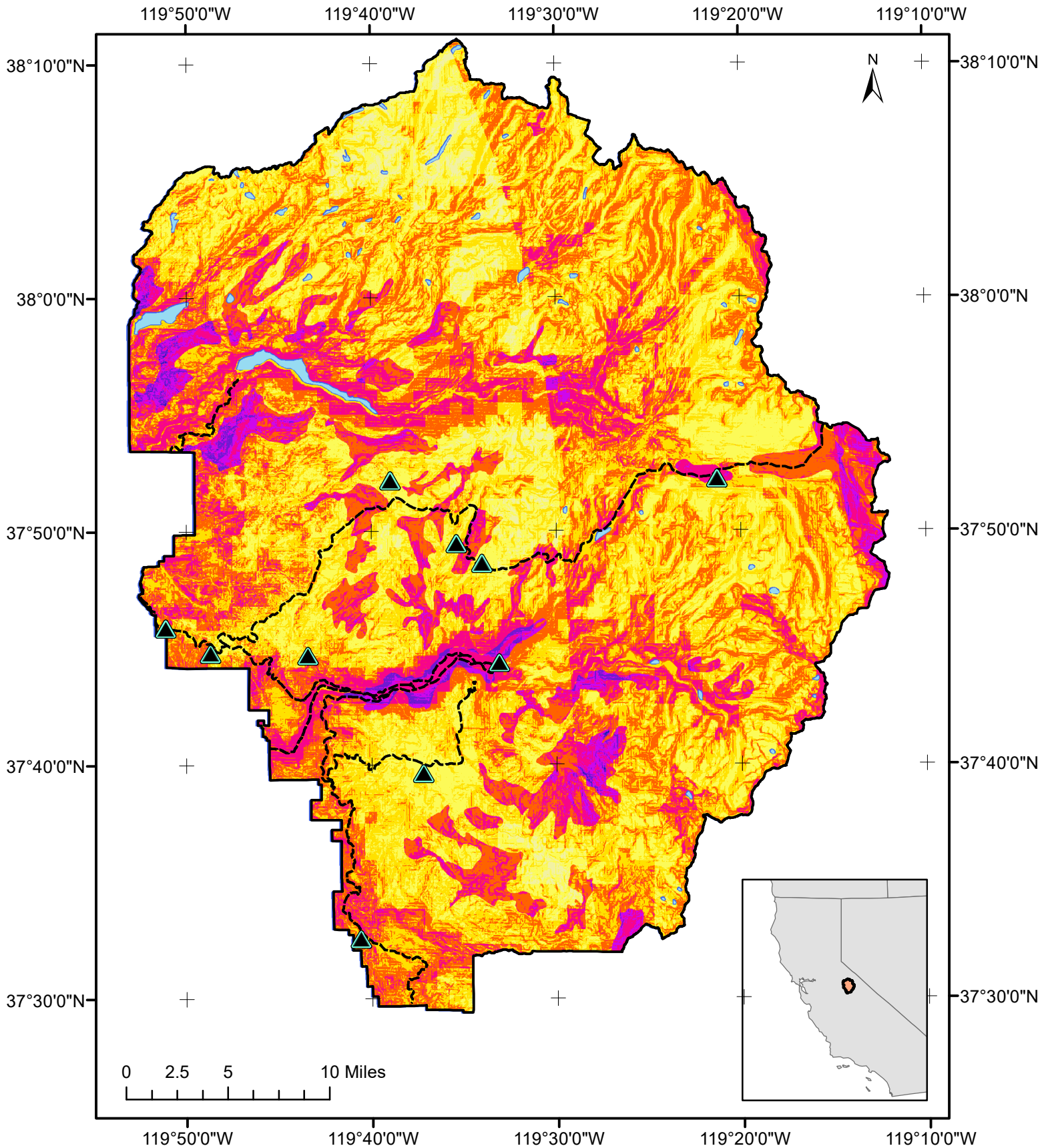
Further analysis would be to include a trail hike shapefile to the map. I was not able to find one, so perhaps I could create one from a preexisting map found in the Yosemite National Park website.

Works Cited

National Parks Service. "Rockfall." U.S. Department of the Interior, n.d. Web. 01 Dec. 2016. <https://www.nps.gov/yose/learn/nature/rockfall.htm>.

USGS. "Hot Days Can Trigger Yosemite Rockfalls." *Hot Days Can Trigger Yosemite Rockfalls*. N.p., 28 Mar. 2016. Web. 01 Dec. 2016. <https://www.usgs.gov/news/hot-days-can-trigger-yosemite-rockfalls>.

Landslide Risk Assessment For Yosemite National Park, California



Risk Assessment

Park Boundary

Lakes

Roads

Camping Sites

Low → High

Absolute Scale:
1:400,000

Coordinate System: NAD 1983 California Teale
Projection: Albers
Datum: GCS North American 1983

Edna Rodriguez