Identifying Wildfire Risk Areas in Western Washington State

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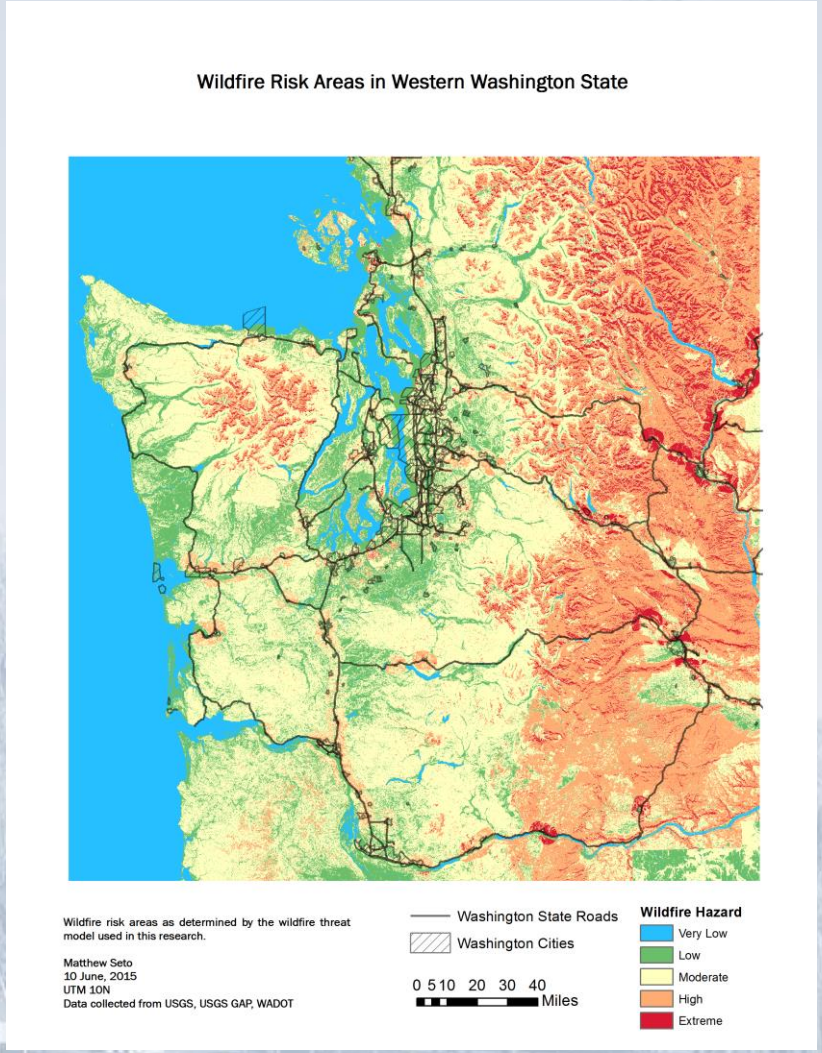
URISA 2015 Undergraduate
Geospatial Skills Competition



Introduction

- 2014 & 2015 saw several large fires in the Cascade Mountain region of Washington State
- There is an imminent threat of increased wildfire activity in this region in the coming years
- This region is home to many towns as well as large swaths of agricultural land
- We need to find a way to predict areas where wildfires are likely to occur
- Using this wildfire prediction model, we should allocate wildfire mitigation and containment equipment and personnel

Research Preparation and Data Collection

- Fire index modelling has been performed in the past, this research was based off of previous research
- Data Layers required:
  - Vegetation Species or Type
  - Elevation
  - Slope
  - Aspect
  - Proximity to roads and towns

- Data was collected from USGS and Washington State DOT

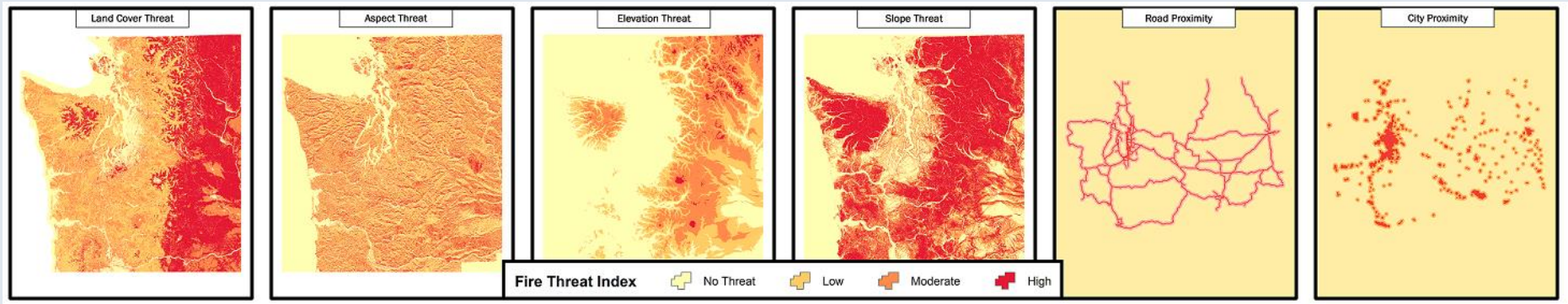
Data and Tools Preparation

- All data acquired from freely accessible government sources
- All analysis and cartography completed using ArcMap
- Data Preparation
  - Generated a local Geodatabase using UTM 10N for the entire state view
  - A feature dataset was used to hold any vector layers that we included
- Tools Preparation
  - ESRI ArcMap tools were used exclusively for this research
  - Spatial Analyst tools were heavily relied upon

Raster Creation

- Generate 6 individual threat rasters on a 0-8 scale
- From the 30m DEM raster create:
  - Aspect
  - Elevation
  - Slope

- Land cover was generated from the USGS GAP raster
- Roads and cities were multi-ring buffered and then reclassified. The buffers were converted to rasters



Completing the Analysis

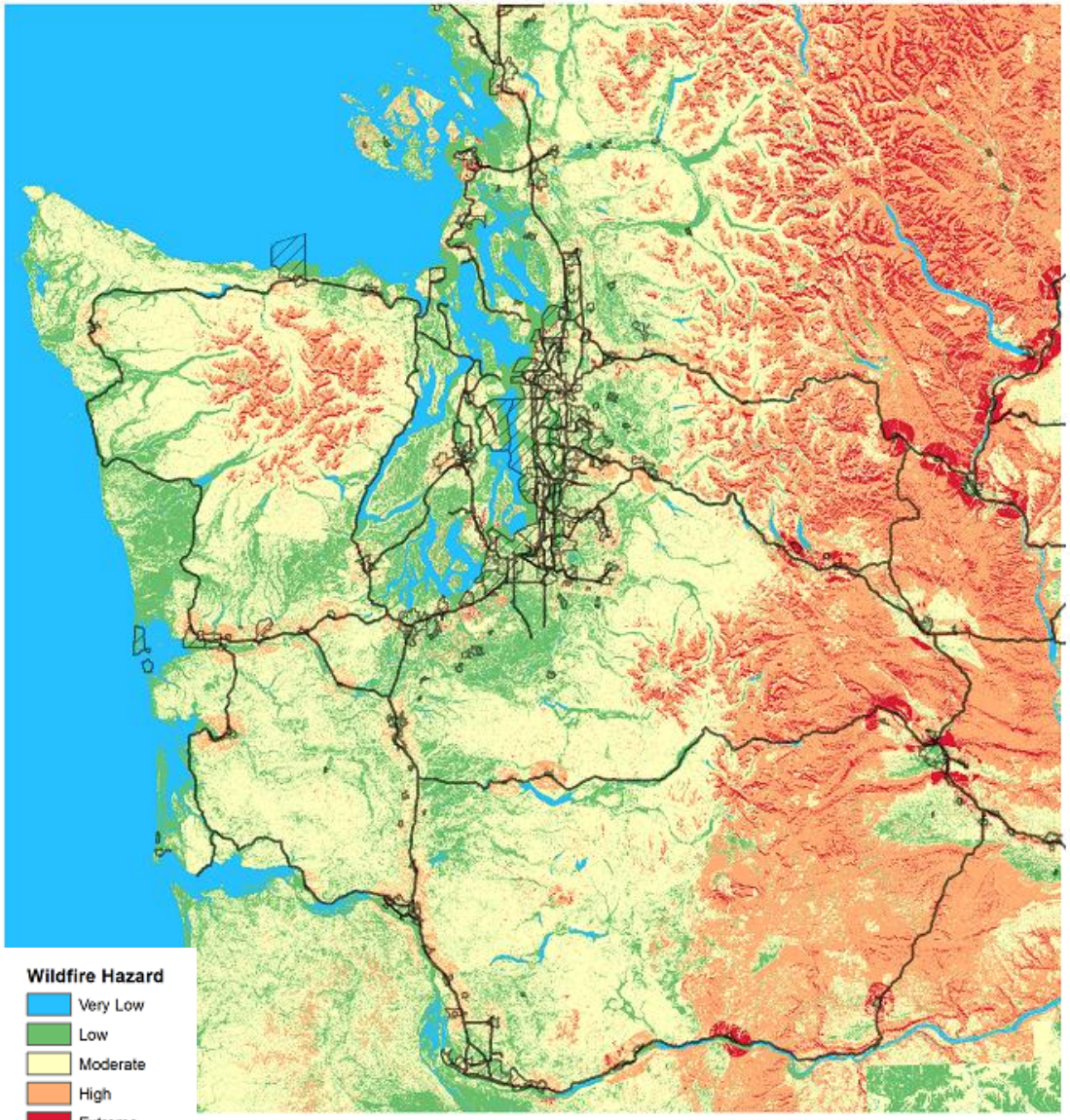
- Once all of the rasters were generated I could use raster algebra to find high-risk areas
- Weight of each variable mattered, and was incorporated into the final formula

$$(Slope_{reclass} * 0.5) + (Elevation_{reclass} * 0.3) + (Aspect_{reclass} * 0.2) + (LandCover_{reclass}) + (RoadsProximity * 0.2) + (CitiesProximity * 0.2)$$

- **Weighting**:
  - Landcover 100%
  - Slope 50%
  - Elevation 30%
  - Aspect 20%
  - Roads Proximity 20%
  - Cities Proximity 20%

Wildfire Threat Index Map

- Trends in the output:
  - Hazards on the eastern Cascades
  - Little to no-threat west of Mt. Rainier
  - Hazards centralized in obvious areas along the US-2 and I-90 highways



Wildfire risk areas as determined by the wildfire threat model used in this research.

Matthew Seto
10 June, 2015
UTM 10N
Data collected from USGS, USGS GAP, WADOT

Washington State Roads
Washington Cities

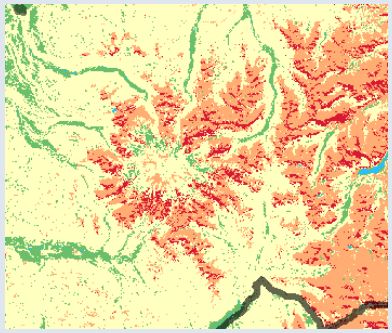
0 5 10 20 30 40
Miles

Wildfire Hazard
- Very Low
- Low
- Moderate
- High
- Extreme

Validation of Results

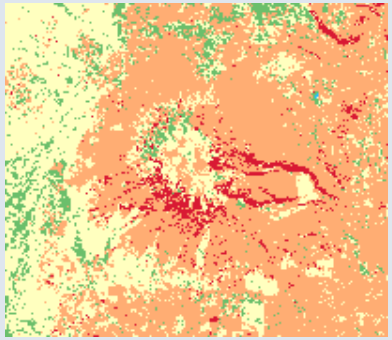
- Validation took place in two steps

1. Common sense validation
   - Checking for expected results

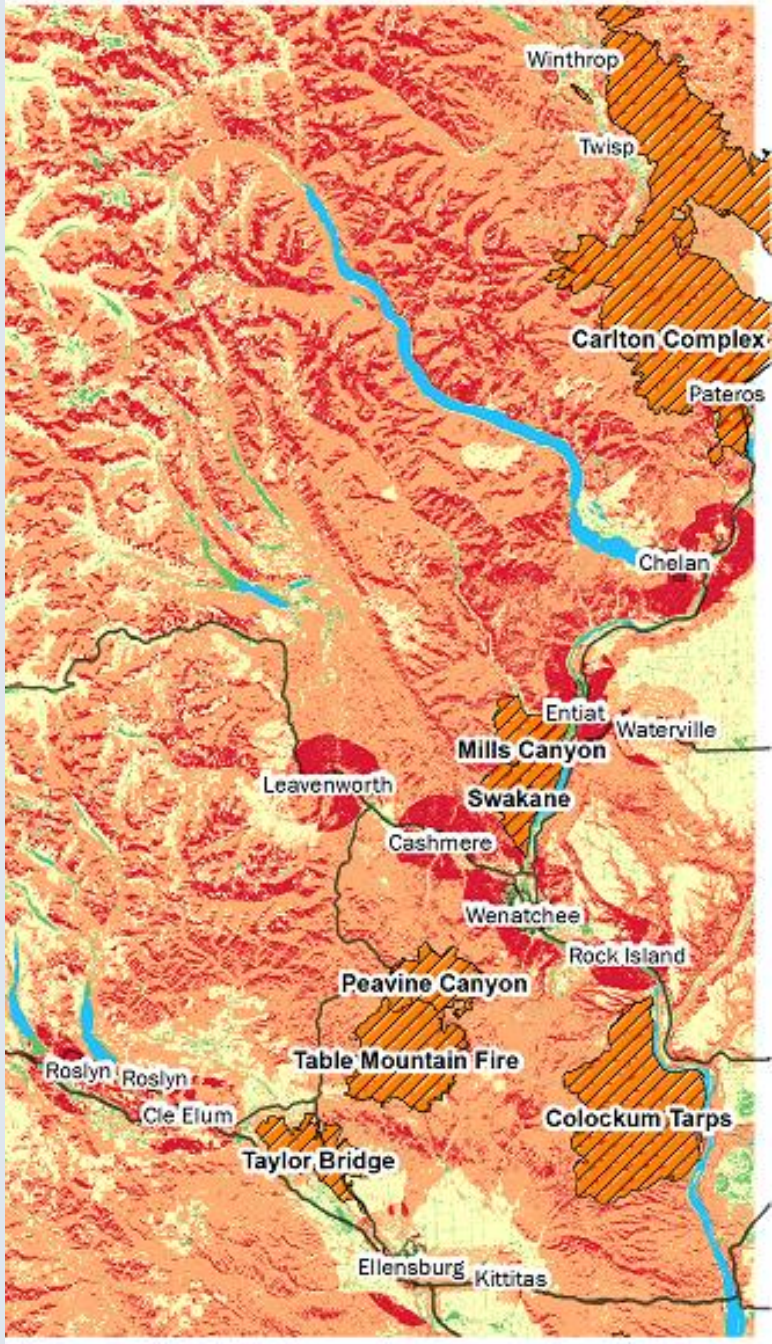


Mt. Rainier

2. Historical validation
   - Comparing results against historical fires over the last 5 years
   - Large fires only >10,000 acres burned



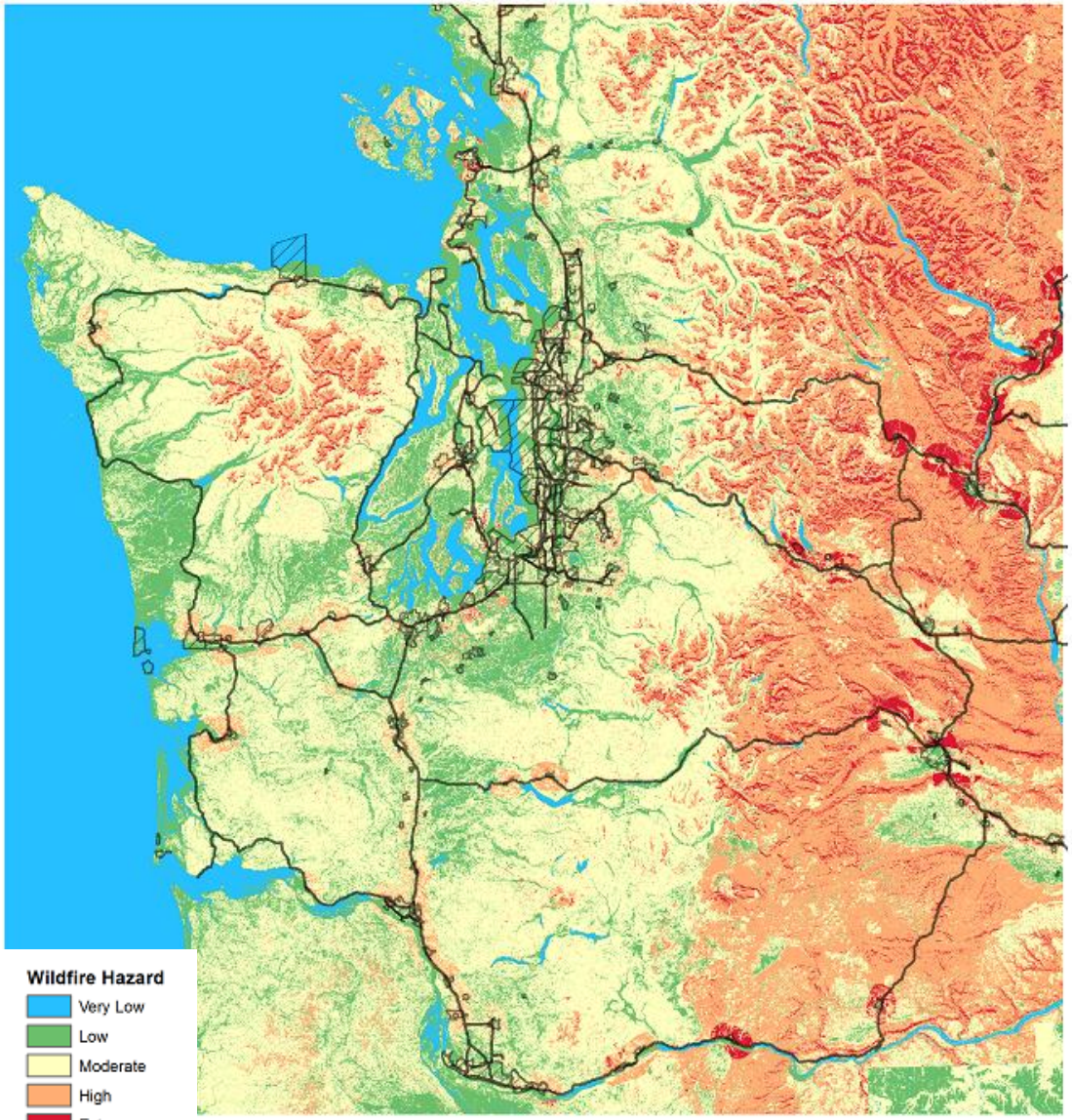
Mt. Adams



Analysis of Results

- Two main areas of concern:
  - Around the US-2 and I-90 corridors
  - Around Yakima, WA

- Applications
  - Improved locations of equipment and personnel
  - Improved observation of high threat areas



Putting it all Together

Wildfire Risk Areas in Western Washington State

Matthew Seto
UWT GIS-Certificate Program 2014-2015

Purpose:

This analysis is intended to identify areas of the Washington State Cascade Mountain Range that are highly susceptible to wildfire. In particular, this research will generate a fire index model for the entirety of the Cascade Range as it passes through the state. There have been several large fires in close proximity to urban areas over the last 5 years. This fire threat index model will serve to identify areas where large fires may be imminent.

Objectives:

The primary objective of this research is to compile a fire index map of the Cascade Mountain Range that identifies areas where wildfires are more likely to occur. There are several factors that are used to determine a fire threat index; this analysis attempts to combine them into one map for easy reference and quick analysis. Following established fire threat index models from previous research around the globe, this analysis has succeeded in identifying at-risk areas.

Generating this threat index model will allow fire response and mitigation organizations to be better prepared in regions where there is a high likihood of a wildfire event.

Procedure:

The six variables used for fire index modeling are displayed below. Each of these variables plays a part in determining how likely a region is to propagate a wildfire. This research combined all of these variables and weighted them against established wildfire research. The output was a complete fire threat index map of the region.

All generated variable models were translated to a flammability model ranging between 0 and 8 (0 indicating non-threatening, 8 indicating extreme threat). The models were then merged using raster algebra to produce a final threat model.
A 30m DEM raster was used to generate each of the Slope, Aspect and Elevation models. These rasters were then reclassified according to the flammability index provided by previous research (Cáceres, 2011). These layers were created using out-of-the-box ESRI GIS software.
In order to generate the land-cover threat layer, a land-cover raster was obtained from the USGS GAP analysis program. This layer was reclassified according to assumed flammability, generally ranging from non-threatening to very-threatening. There were rare cases of moderate fire threat with regards to the land cover in Western Washington State.
Finally, the human factor layers were introduced. These include major Washington State roads and highways, and Washington State population centers. Proximity to the population is directly correlated to increased fire risk (Chuvieco, 2009), and this model accounts for that by buffering each road and population center and assigning increased fire threat levels to those areas in close proximity.
In order to produce the final threat model, raster algebra was performed using the following formula:

$$(Slope\_reclass * 0.5) + (Elevation\_reclass * 0.3) + (Aspect\_reclass * 0.2) + (LandCover\_reclass) + (RoadsProximity * 0.2) + (CitiesProximity * 0.2)$$

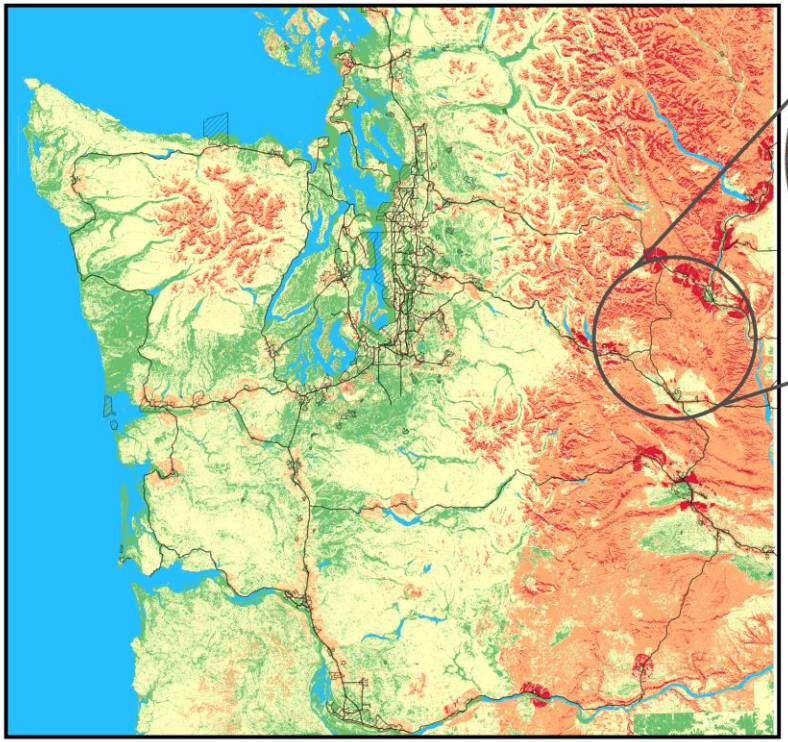
This formula weighs each variable according to its influence over the final fire threat model. Land cover is by far the leading threat indicator for wildfire (Cáceres, 2011).
The output raster was divided into 5 standard deviations and symbolized according to threat.

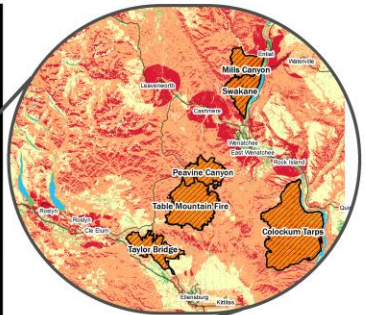
Results:

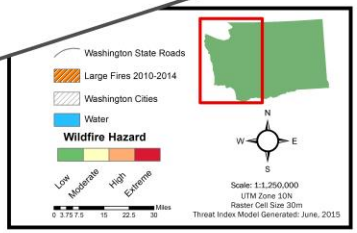
There is an obvious trend that the eastern slopes of the Cascade Mountains are highly susceptible to wildfire. This is expected, as historical large fires are also found in these regions. The threat model also indicates that the area near Wenatchee, WA is generally extremely prone to wildfire. These areas are coincidental to many large scale fires that have occurred in Washington State over the last 5 years. These coincidental areas are validation of the threat model's accuracy.

Using this model, we can also identify some potential hazard areas to the south of the state, in proximity to Yakima and Ellensburg, WA.

This analysis goes to show that there are large swaths of land in the eastern Cascade Mountain range that are highly succeptible to wildfire. Moreover, some of these areas are located close to major urban areas and should be considered extremely-threatening. Careful observation and quick response to incidents will be required in these areas.







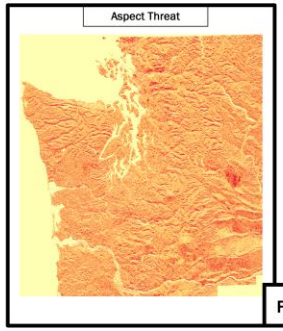
References, Special Thanks and Citations

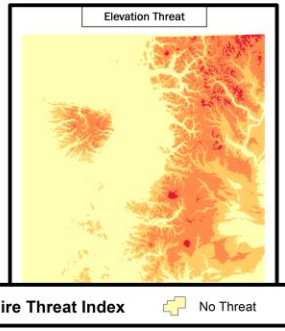
Special Thanks to Dr. Matt Kelley, and Greg Lund, GIS gurus and idea-generating machines.

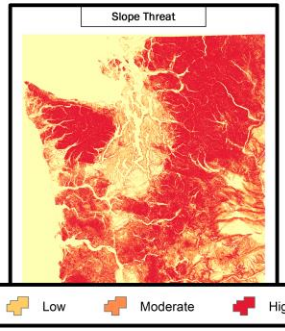
Cáceres, C. (2011). Using GIS in Hotspots Analyses and for Forest Fire Fisk Zones Mapping in the Yeguare Region. Southern Hondouras. Retrieved from Saint Mary's University of Minnesota University Central Services Press: http://www.gis.smumn.edu/GradProjects/CaceresC.pdf

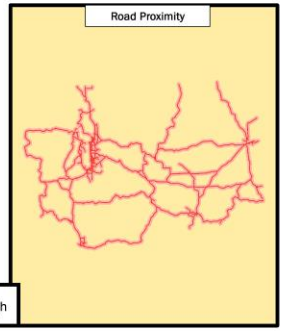
Chuvieco, E. e. (2009). Retrieved from Development of a framework for fire risk assessment using remote sensing and geographic information system technologies: http://www.researchgate.net/profile/Marta_Yebra/publications/222218660_Development_of_a_framework_for_fire_risk_assessment_using_____remote_sensing_and_geographic_information_system_technologies/links/0fcfd5072737423a69c000000.pdf

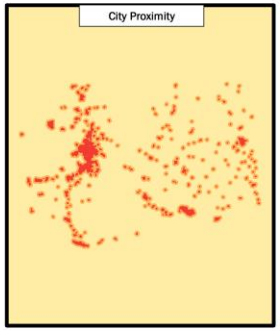
Chuvieco, E., & Congalton, R. G. (1989). Retrieved from Application of Remote Sensing and Geographic Information Systems to Forest Fire Hazard Mapping: http://www.researchgate.net/profile/Emilio_Chuvieco/publication/222447961_Application_of_remote_sensing_and_geographic_information_systems_to_forest_fire_hazard_mapping/links/02e7e522475fb7de9000000.pdf











Fire Threat Index — No Threat — Low — Moderate — High

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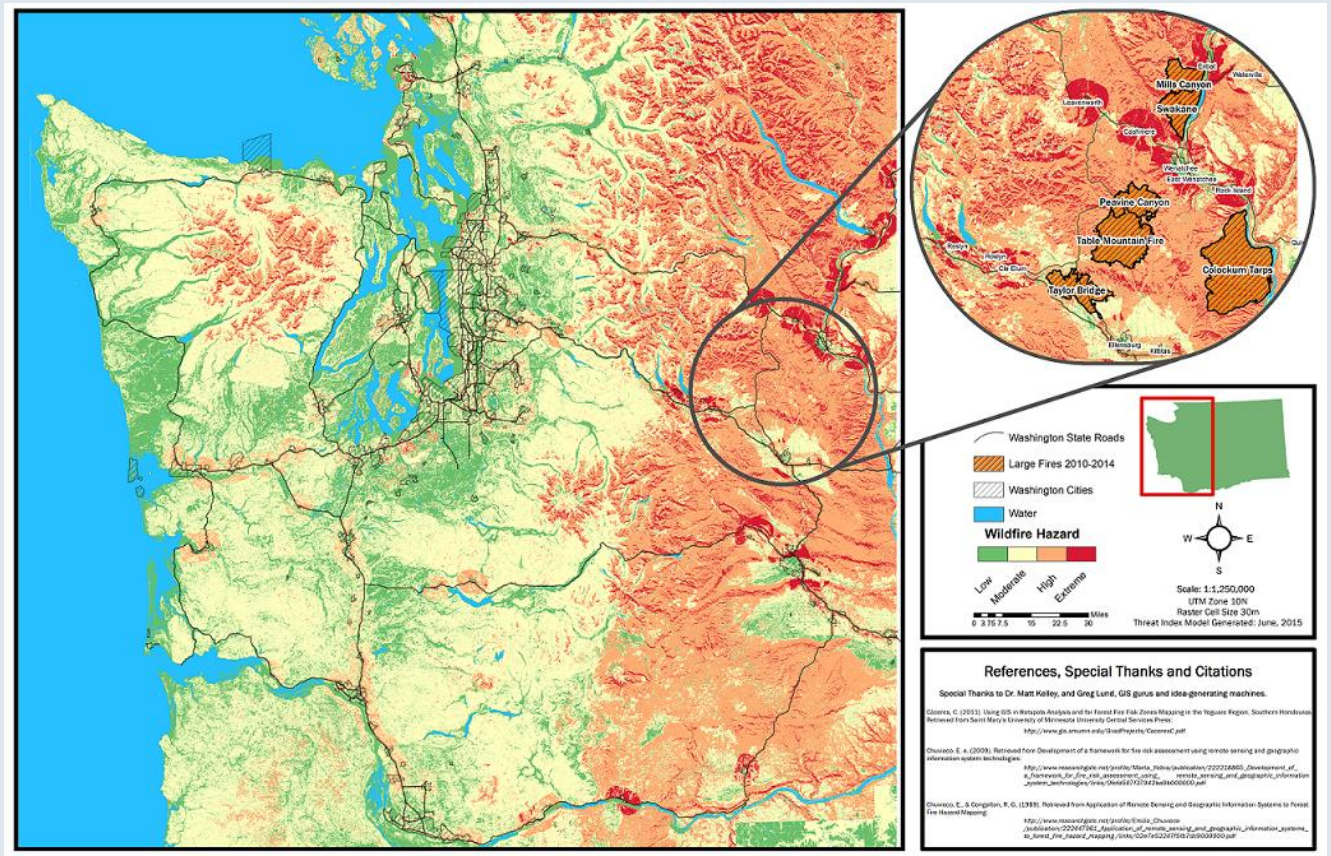
Summary

- This research should be implemented in any state-wide fire planning
- At a minimum it is essential for proving that the eastern Cascade Mountains are susceptible to threat
- In practice, this method of fire modeling has proven to be effective in the past and should be considered in future fire modelling



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Data Attribution

All data collected from freely available US Government sources. Variable layers were derived from the following data sources:

- **30m DEM raster:**
  - USGS
  - http://ned.usgs.gov/
- **Land cover raster:**
  - USGS GAP Analysis program
  - http://gapanalysis.usgs.gov/gaplandcover/data/download
- **Historical large fires**
  - Washington State Department of Natural Resources
  - https://fortress.wa.gov/dnr/adminsa/DataWeb/dmmatrix.html#Wildfire and Prevention
- **Roads and Urban Areas**
  - Washington State Department of Transportation
  - http://www.wsdot.wa.gov/mapsdata/geodatacatalog/