Improving Forest Fire Prediction Techniques in California

Christopher P . Gardner

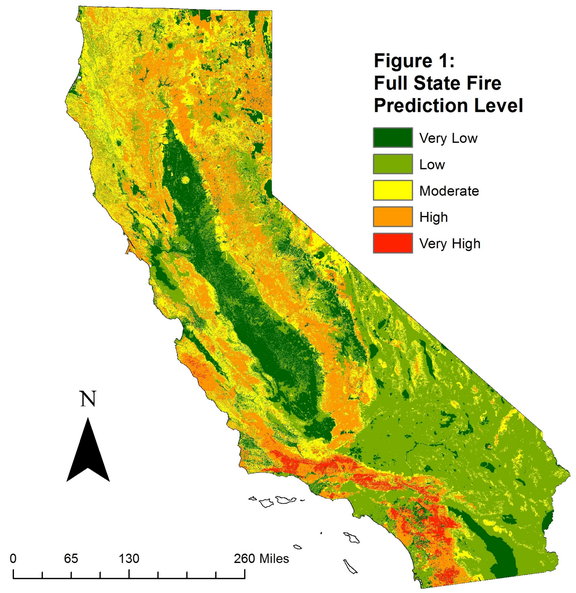

Figure 1: Full State Fire Prediction Level

Introduction

Every year, forest fires destroy thousands acres of forest across the entire planet. They not only affect the environment, but also the citizens and infrastructure that stand in their way. Unfortunately, there really is no way to prevent all forest fires. Therefore, the best way to handle the destruction that wildfires can cause is to be ready to mitigate the overall damage that can be caused. To use the limited resources provided by local, state, and federal resources most effectively, it is important to know where they are most likely to happen and concentrate those resources in those zones with the greatest risk.

In the United States, California is one of the most effected states due to the large area of forest that cover a variety of climates. The parts of the forest on the inland side of the Sierra Nevada Mountains are some of the most affected since they have some of the lowest precipitation and densest growth. The California Department of Forestry and Fire Protection is the agency that is responsible for managing the response and planning for these disasters. Their current system for producing fire warnings is mainly based on recent precipitation and historical data. The current average warning levels for fires will be compared to how the actual likelihood of fires happening in those zones to see if wildfires are more or less likely than predicted.

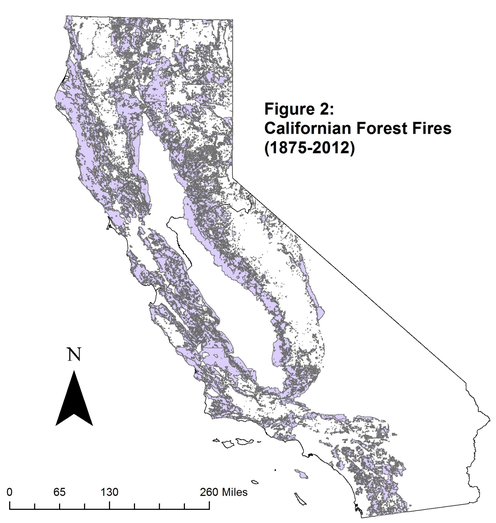

Figure 2: Californian Forest Fires (1875-2012)

Objective

This GIS project aims to see if their system can become more accurate by including more variables including fuel ratings for the types of vegetation in the forests and the vicinity to fire protection services. Once this data is aggregated, there will be a weighted to see if the difference between warning level and actual likelihood can be minimized.

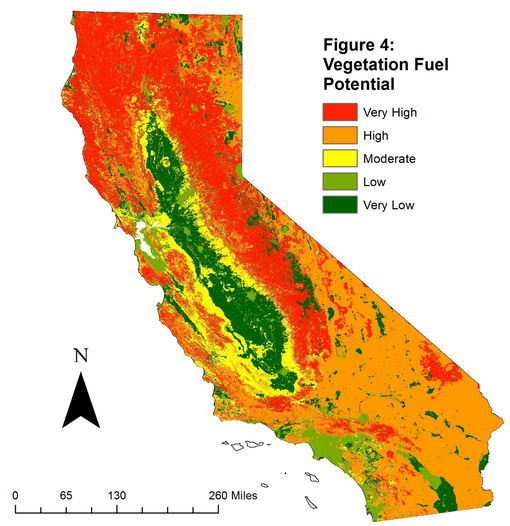

Figure 4: Vegetation Fuel Potential

Methods

In order to achieve this goal, some advanced GIS techniques were used to organize the data to portray the accuracy of the current data and to create the better system for their prediction techniques.

To show the accuracy of the current techniques, the data was converted from the qualitative fire warning system into a quantitative data set using the field calculator in the data table. This data was then joined with the historical fire locations using spatial joining with the value being equal to the average warning for that area. The data was then converted back into the qualitative range of very low to very high. To finally create the map on the top left of this poster, I created another field in the data table that showed the difference between the average warning and the actual likelihood.

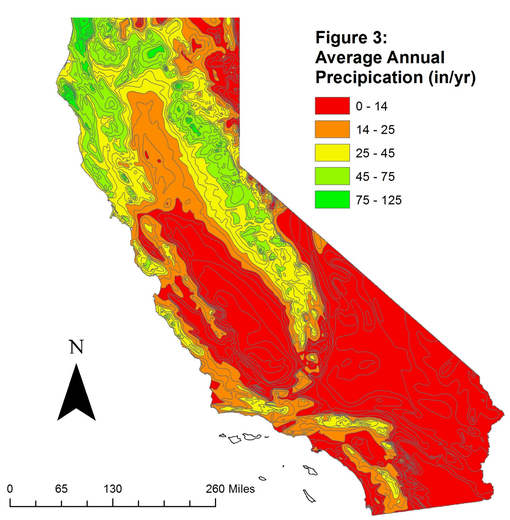

Figure 3: Average Annual Precipication (in/yr)

To create the better system for prediction, the polygon data of the hazard codes and precipitation was converted into raster data and then weighted using the weighted overlay tool. The weights were set to be 60% for the current system, 30% for the vegetation type, and 10% for average annual precipitation. To create the final map, the raster calculator was used to see the difference between the newly created fire prediction technique and the actual likelihood of a wildfire.

Results

Figure 5 clearly shows the current system has a large area of California has a discrepancy between the actual wildfires and the predictions. However, it is only by a very small deviation, which shows that the current system is fairly accurate. If you compare that map for the final product of the weighted analysis, shows that with the additional data, the predictions become more accurate. If there is a discrepancy it tends to have fires be less likely than predicted than more likely, which is the safer side to be on. The results also show that vegetation type plays a large role in the wildfires as hardwoods and other old growth are more likely to become fuel in a larger forest fire than smaller shrubs and grasses.

Conclusions

The results are only as accurate as the data that was inputted into the equations that were used to develop the data. Since the current warning system only has five levels, I had to rank the level of warning from 1 – 5, which only allows for a small variation. If there were more levels that allowed for greater distinction between the risk for wildfires, the averages could be more powerful and distinctive between the actual risks.

Sources of Data

California Department of Forestry and Fire Protection's Fire and Resource Assessment Program's GIS Data

United States Department of Agriculture – Forest Service's Maps and Publications

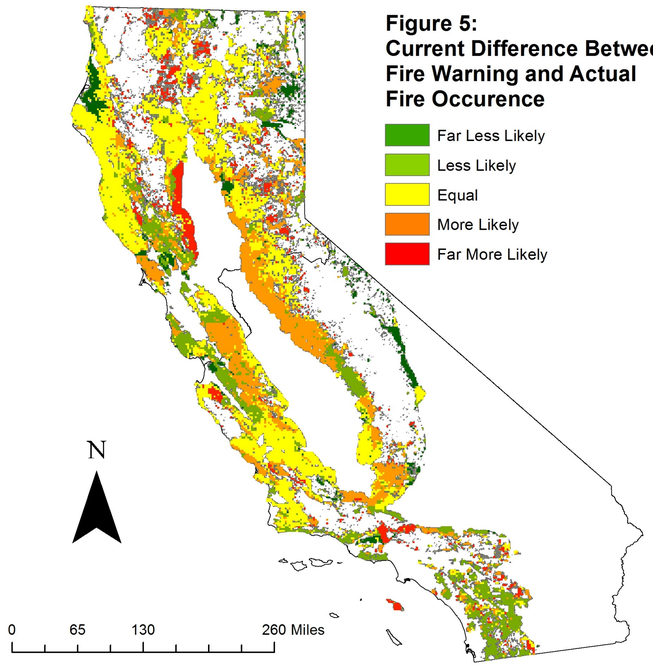

Figure 5: Current Difference Between Fire Warning and Actual Fire Occurence

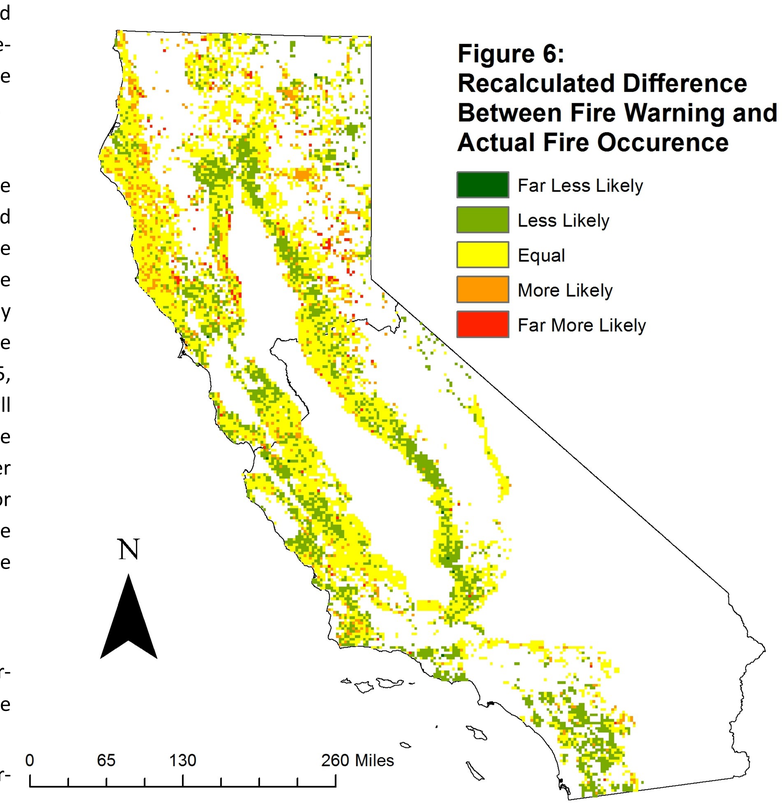

Figure 6: Recalculated Difference Between Fire Warning and Actual Fire Occurence