Spatial Distribution Pattern Analysis of Forest Fires in California

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Abstract

The 2017 fire season in California was the most destructive on record. There were nearly 9,000 fires that year that burned an amount of land the size of Delaware, destroyed 10,800 structures, and killed at least 46 people (Tierney, 2018). We used Getis-Ord Gi* and Kernel Density in ArcGIS to examine the occurrence, spatial distribution, and cluster patterns of forest fires in California between 1950 and 2016. We found that there has been have been significant clusters of forest fires in southern California consistently over the study time frame, while an increasing amount of clusters have occurred in northern California. Additionally, we see an increase in fire density with a northward trend over the study time frame in 20 year intervals. Results from this study shed light on where fires may emerge in the future, and explain that 2017 was an part of a continuing trend of increasing fire damage that could be even more destructive in the years to come.

Objectives

Our objective is to examine the occurrence, spatial distribution, and cluster patterns of forest fires in California in its recent history (1950-2016). We will utilize ArcGIS for our spatial analysis because we want to investigate spatial distribution and spatial patterns such as clustering of fires, not just the occurrence or frequency of fires. We hope to find meaningful spatial patterns that could be used as a resource for future fire prevention or management.

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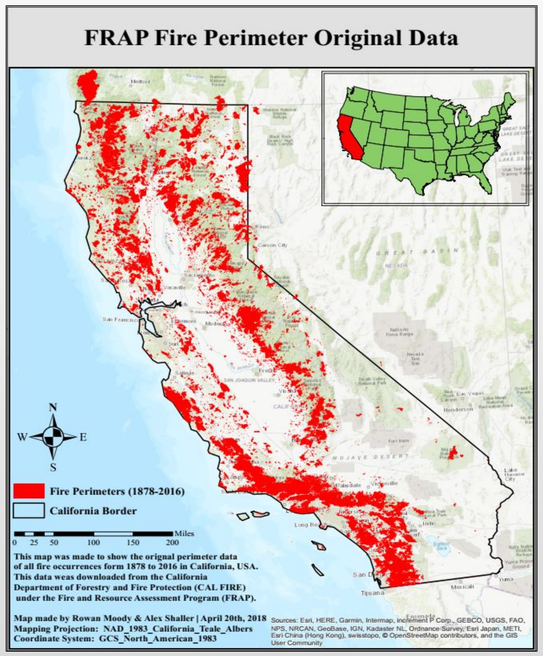
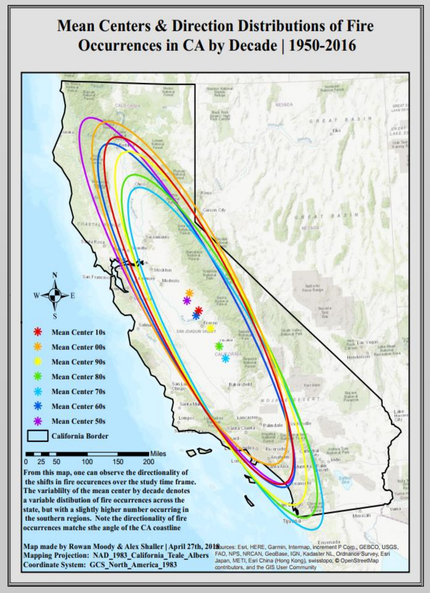
Data

Fire Perimeters 1878-2016

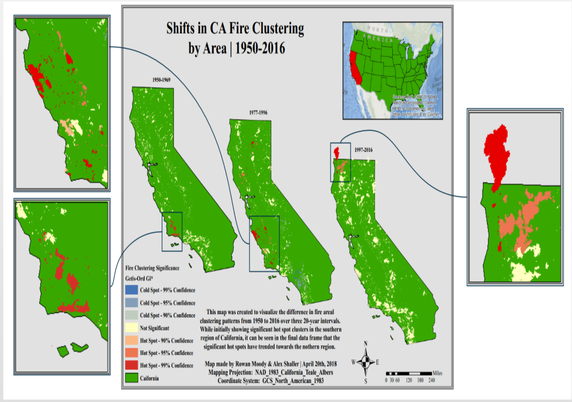


Mean Center and Standard Deviation Ellipse

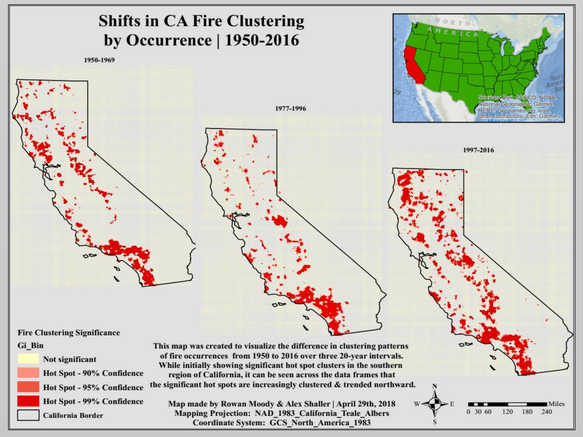


Hotspot Analysis

To assess clustering based on fire size, we ran the hot spot analysis (Getis-Ord Gi*) tool in ArcGIS on each twenty year period grouping of fires. We used areal extent of the fire as the input field, and we used the fixed distance band conceptualization of spatial relationships.

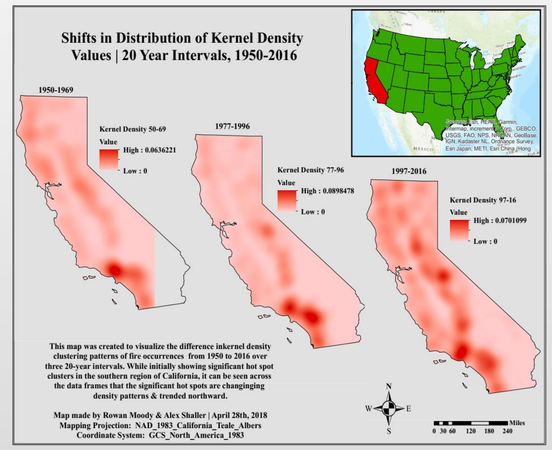


To assess clustering of fires based on their number within a given area we used the “Create Fishnet” tool to create a 5 km by 5 km fishnet over the whole state of California. After creating the fishnet, I used the spatial join tool to add to the fishnet the count of fires within each cell of the fishnet for each twenty year period (1950-69, 1977-96, 1997-2016). Then I used the hot spot analysis tool (Getis-Ord Gi*) on the number of fires in each cell using the fixed band distance conceptualization of spatial relationships to create the cluster maps shown.



Kernel Density

The outputs of our kernel density analysis showed regions of high fire occurrence density. While the 1997-2016 interval has a lower maximum density value than the 1977-1996 interval, we can observe a much larger amount of areas showing dense clusters across the entire state.



Conclusions

Overall, we observed a consistently increasing trend in the number and size of fire occurrences from 1950 to 2016. Additionally, we found evidence of an increasing values and general northward trend of fire occurrences, fire areas, and fire occurrence densities. From these results, we can state that there have been non-random cluster patterns in fire occurrences, with areas at higher fire risk, and that these risk areas are increasing in size and have consistent long-term northward directionality overall. In future research, we could investigate why these trends are occurring: the northward trend of clusters in particular. Possibly this is related to climate change. Another idea would be to consider other variables that are related to clustering of fires such as elevation and slope. This may help explain the patterns we are seeing.