Analyzing and Identifying the Regions Affected by Fires in California

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ABSTRACT

The year 2019 was a fire season in California, US., with over 6,872 recorded incidents. After-effects included burning of more than 253,321 acres of land and destroying or damaging 732 structures.. These fires caused lot of people to relocate and there were many known incidents of the houses burning down to ashes. The research will be conducted to identify how factors like elevation and human involvement affect the fire in Califronia. The research will also help to identify locations affected by the fire in the previous years. This will help to identify the locations which are more susceptible to fire in the future case studies. Various tools using ArcGIS Pro will be used to come to conclusion.

KEYWORDS

California, Fire, Populated Region, Elevation, Clustering

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1 Introduction

The year 2019 was a year where wildfires were seen all throughtout the world. These fires not only affected the vegetation, humans but also the natural habitat of the animals and various local plant species. Some of the places affected by these fires are California, Australia, the Amazon, Russia, and these are only the ones known because of their severity[8]. These caused the people and the wildlife to migrate to a safer place and also put a strain on the resources.

Due to the devastating effect of these fires, it becomes a necessity to look into ways of preventing them or even taking actions to mitigate them. Some of the names of the famous California Fires are: Sandalwood, Caples, Getty, Kincade and others. These fires have been burning in the state almost throughout the year, causing the destruction of property and resources and hence it inspired me to take up this topic.

2 Problem Domain

The year 2019 was a fire season in California, USA., affecting more than 253,321 acres of land and destroying around 732 structures in its path [1]. In the earlier days, the fire was an integral part of the ecosystem in California, which assisted to reset the course of vegetation and limited the accumulation of dry plants and shrubs which served as fuel to the fire [2]. But the human-induced fires regardless of being intentional or not harm the ecosystem and the infrastructure of the state. Therefore, identifying the region's more susceptible to fire is a necessity by analyzing the locations most affected by fire. Fig 1 represents the area of study, the state California on the West Coast of USA.

The goal of this project is to analyze and determine the correlation between the spatial data to identify the region's most likely to be affected by fire. Doing so will not only help to preserve the human habitats but also the natural habitats of the wildlife like the flora and fauna of the local surroundings.

Figure 1 State California. The location of study Area.

2.1Objectives

The goal of this project can be achived by taking on the following objectives:

- Identify the spatial data which are relevant to fire especially in California, and
- Identify the spatial patterns using methods to predict fire to identify the locations most susceptible to fire by identifying the locations most affected by fire.

3 Peer Reviewed Literature Summary

The fire in 2019 destroyed open land as well as burned down houses destroying everything in its path, people were forced to relocate. [4] This becomes a major reason to identify the locations most susceptible to fire. Existing literature reviews talk about using logistic regression to find the probability of fire caused by humans. [5] The authors talk about using remote sensing techniques to find out the fuel which cause fire. [3]. The authors talk about different ways to help in fuel mapping [6], this will help to determine the spatial data which will affect the fire patterns. The authors talk about using new machine learning algorithm to determine the spatial patterns.[7]

4 Methodology

California has fire season which usually ranges between mid-summer to beginning or mid of fall every year. But mostly the fires tend to occur around the fall season because of the winds from the Diablo in the north side and the winds from Santa Ana in the south which blow across the land containing "fire-fuel". Fire fuel is the term used to describe dry grass, open grasslands, twigs, wood, forest area, and any other substance which might provide fuel to the fire. As mentioned in [1], fires in California were generally considered as the part of the ecosystem, but with the rise in population, pollution and especially with the rise in global warming, these fires are not only restricted to the usual fire season and might pose a threat to the state all year long.

Fig. 2 talks about the destruction of the resources in the state by fire since the year 1950, it can be noticed from the map that most part of the state has been affected by fire at atleast some point in these couple of years. There are various reasons for these fires, so lets discuss some of the factors which contribute to the fires in state of California.

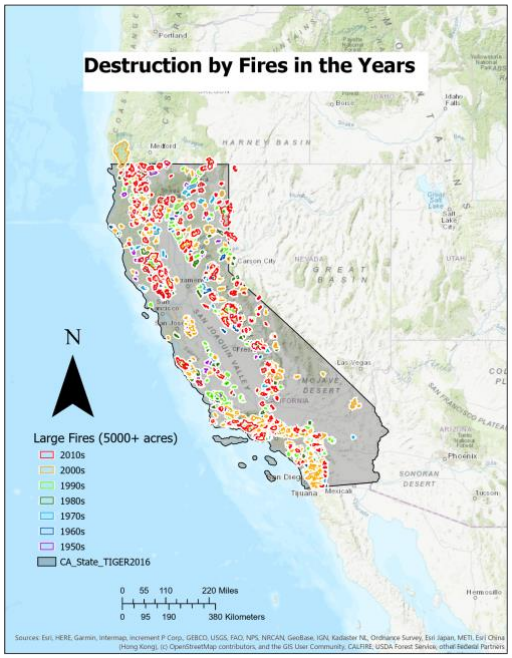

Figure 2 Destruction by Fire

4.1 Some factors

4.1.1 Climate Change

With the climate change, especially due to the rise of global warming, the temperatures have increased. The grass or the vegetation which contributes to fuel is drying up faster than ever, this increases the chance of the wildfire to spread.

4.1.2 Land Cover with Vegetation

The land cover consists of the trees, shrubs, waterlands and everything which is present on the earths surface. One of the major fuels to the fire is the vegetation which consists of wood, dry plants, grass. These rapidly catch fire and are the main fuel for the fire.

4.1.3 Elevation

The fire usually tends to spread faster up the slope than down the slope. Also, elevation tends to affect the weather conditions, i.e it might be cooler or might receive more rainfall as compared to the regions which are at a lower elevation. The plants tend to dry much faster at a lower elevation than the ones at the higher location. Hence, it can be said that the regions at a higher elevation have less chances of catching fire as compared to the lower elevation.

4.1.4 Wind

As the flow of the wind increases, it brings a supply of fresh oxygen. Oxygen is an element which aids in combustion and hence also acts as one of the fuels for the fire. Also, the direction of the wind gives a direction to the fire. This causes the fire to blow in the direction of the fire.

4.1.5 Human Intereferance

Increase in the population, has caused a rise in the number of industries, restaurents as well as living complexes. Nowadays, most of the fire in the region is the due to the known or unknown fault of the humans. A spark from the barbecue, fire from the industries or even cigarettes for that matter can help start a fire in the dry region. Due to the dry nature of the vegetation it is not very difficult for it to catch and spread the fire easily.

4.2 Objectives

Objective (1): The first objective was to curate the data set using relevant spatial data. For the research project, the spatial data like

- Elevation,
- Populated Regions, and
- Fire density, was chosen.

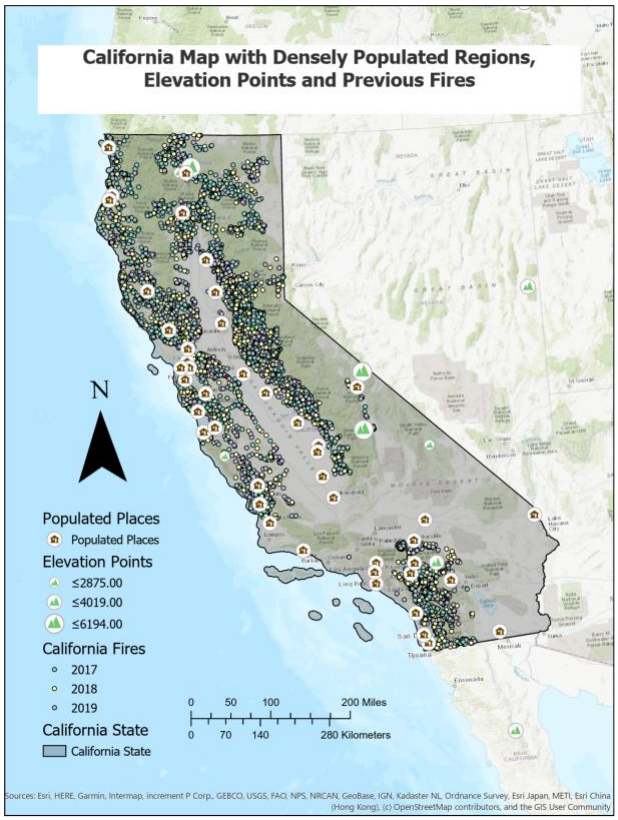

Figure 3 California with the Raster Datasets.

These topics were chosen as, I wanted to conduct the research on how elevation, populated regions affect the chances of fire in the region. If there is some relationship in between the past fire values and these values, then there is some possibility of these locations which were found to be affected by the factors.

Objective (2): For the second objective, the different methods will be implemented to get the spatial analysis. After obtaining some result which can be visualized, cartographic principles will be implemented to obtain the map representation of the result.

After doing some research, I decided to go ahead and implement the machine learning algorithm on the dataset, but I could not get nany results from it. Hence, after researching more on how to analyze these fire using the dataset, I followed the following steps to reach the results on map represented by Fig 3.

Step 1: Added all the shape files to the map on ArcGIS Pro.

Step 2: Added the California state boundary.

Step 3: As can be noticed, some of the datasets have been obtained from the natural earth website, the covered regions with points on regions all over the Earth's surface.

To obtain the elevation points from the North America Region, used the "Definition Query" in Properties, to set the "region" value equal to North America. There were no further column names to obtain the values of California, hence decided leave it at this.

Used the "Mountain" in "Symbology" tab to represent the values of the various elevation ranging from smaller icon to larger one.

To obtain the populated places in California, followed a similar approach and set the "Definition Query" to get the following values. This sql query was used to obtain the given value:

SOV0NAME = 'United States of America' Or (SOV0NAME = 'United States' And TIMEZONE = 'America/Los_Angeles' And ADM1NAME = 'California')

Used the "House" in "Symbology" tab to change the representation icon.

Step 4: Changed the fires from the given region to represent "Unique Values" using different colors rather than the single symbol. Used the field as "Year" to get these values.

5 Datasets

The datasets for the following raster data were obtained from the following:

Fire points in California:

https://koordinates.com/layer/96045-california-fires/

Elevation Points:

https://www.naturalearthdata.com/downloads/10m-physical-vectors/

Populated Places:

https://www.naturalearthdata.com/downloads/10m-cultural-vectors/

California State Boundary:

https://data.ca.gov/dataset/ca-geographic-boundaries

Destruction by Fire:

https://www.arcgis.com/sharing/rest/content/items/653647b20bc74480b335e31d6d81a52f/item.pitemx

6 Results

To obtain the results, firstly I tried to implement the Machine Learning, but because there was no image used or obtained in the dataset, this option did not seem to work out at all.

As explained earlier, if this approach failed and to obtain some sort of comparison, I had decided to implement the clustering and outliers to determine if there were any patterns of the fire.

To obtain the clustering of the dataset, the option of Clustering and Outlier Analysis tool was used from the Analysis tab, on the Califronia Fire to obtain some result. The visualization depicted some formation of clusters but there were mostly outliers in the map. Fig 4 was obtained after the following steps:

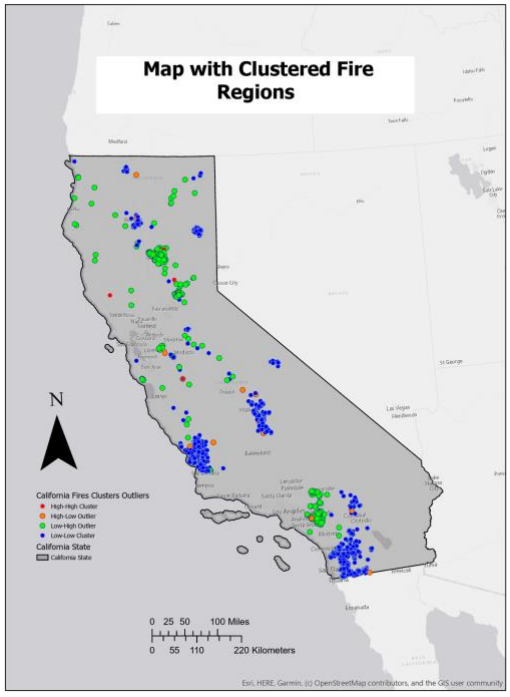

Figure 4 Map with Clusters of Fire Regions

The fig 4 depicts that there are some clusters formed in the diagram. The High-High clusters represents that the values represented in red have a higher significant value and they are closely related.
The High-Low outliers represents that the values represented in orange are high values of fire surrounded by values which have low feature.
The Low-High outliers represents that the value represented by green value are low values of fire surrounded by features of high values.
The Low-Low clusters represents that the values represented in blue are clusters with lower values.

To obtain the relation between the other spatial data and these clusters, the values were added to the map. As can be noticed in the Fig 5, the cluster values lie really closer to the populated regions.

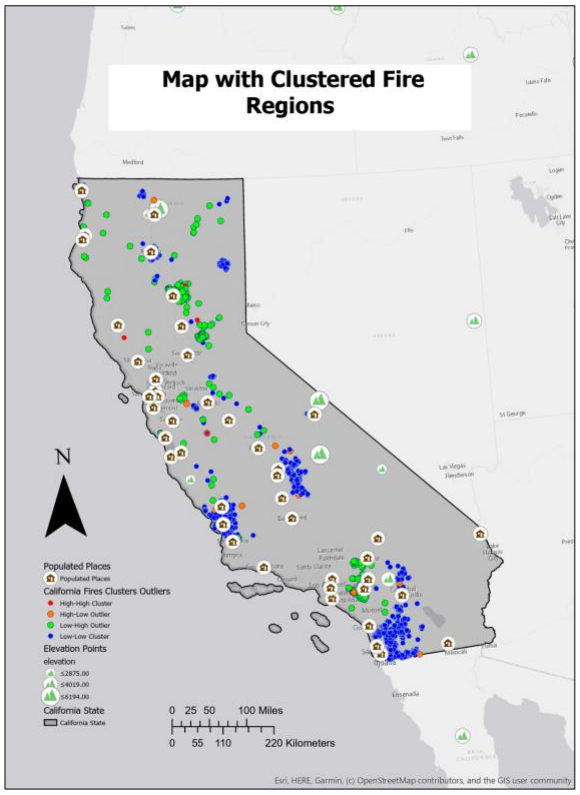

Figure 5 Comparison map with Clusters.

When comparing these values with the elevation points, no proper relation can be obtained from the figure.

Some sort of relationship can be obtained from the populated regions and the clusters. The clusters near the populated regions show that the fire might have been started by some sort of human involvement.
The regions which are affected by these fires are: Chico, Redding, Susanville, Santa Margarita, San Diego, Riverside and Corona. These regions seem to be majorly affected by the fires in the past.

7 Summary

The research was first conducted to obtain the raster data which influence the fire in California. After the dataset was gathered, some methods were tried to obtain the pattern. The clustering of the fire locations were analyzed using the spatial data to obtain some Some sort of relationship can be obtained from the populated regions and the clusters. Using the clusters the regions most affected by the fire were discovered.

8 Conclusion

It can be noticed that there is some relationship between the populated regions and the clusters of fire. The elevation points seem to not give any conclusive result for the dataset that I used. The research helped to locate the regions for which were the most affected by the fire in the previous years. It can be said that the human involvement near the populated areas plays a huge part in the spread of fire in California. The vegetation and land cover of this region should be managed carefully and extra care must be taken to prevent fires around here. The fire from was first conducted to obtain the raster data which influence the fire in California. After the dataset was gathered, some methods were tried to obtain the pattern. The clustering of the fire locations represent the locations affected by the fire, these values can be used to identify the region which are prone to fire in future.

9 Future Work

Due to lack of time and correct resources, only a part of the actual proposal could be implemented. Therefore, with the help of the clustered regions and additional spatial data, the locations most susceptible to data can be found.

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