California Wildfires

Project 3 - Group 3 Write-up

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Introduction

Wildfires in California have become increasingly frequent and destructive, posing significant environmental, economic, and public safety challenges. Given the rising intensity and impact of these fires, our group chose to analyze California wildfire data to identify key patterns and trends. Our dataset, sourced from Kaggle, initially contained wildfire records spanning multiple decades. However, after careful review, we limited our analysis to the years 2013–2019 to ensure consistency and eliminate anomalies, such as a misplaced 1969 entry.

To guide our analysis, we focused on three high-level questions:

1. **Which year had the highest number of wildfire incidents?**
2. **Which month experienced the most wildfire occurrences?**
3. **Which year saw the highest total acreage burned?**

By answering these questions, our goal was to identify critical trends in California wildfires and provide insights into their frequency, seasonality, and severity.

Data Cleaning and Preparation

The California Wildfires dataset contained 1635 recorded incidents that spread into the state of California boundary. The dataset focused on the years 2013-2019, therefore, two anomaly records from 1969 were removed. To better answer our high level questions we created two data columns: 1) “YearStarted” and 2) “MonthStarted”, these columns extracted and isolated the “year” and “month” data from the original “Started” column.

Queries

We loaded our transformed data into a new database in pgAdmin, ran a new query containing our schema and manually loaded our transformed .csv files into pgAdmin tables. Preliminary queries were run to help us better understand the dataset and assist in answering our high-level questions.

Year 2017 had the most wildfire incidents (874), this number is more than double the number of wildfire incidents recorded in 2016 (370). Years 2018 and 2019 trailed 2017 with the top 3 years with wildfire incidents. As time elapses there does not appear to be a linear increase in the number of fire incidents (Figure 1).

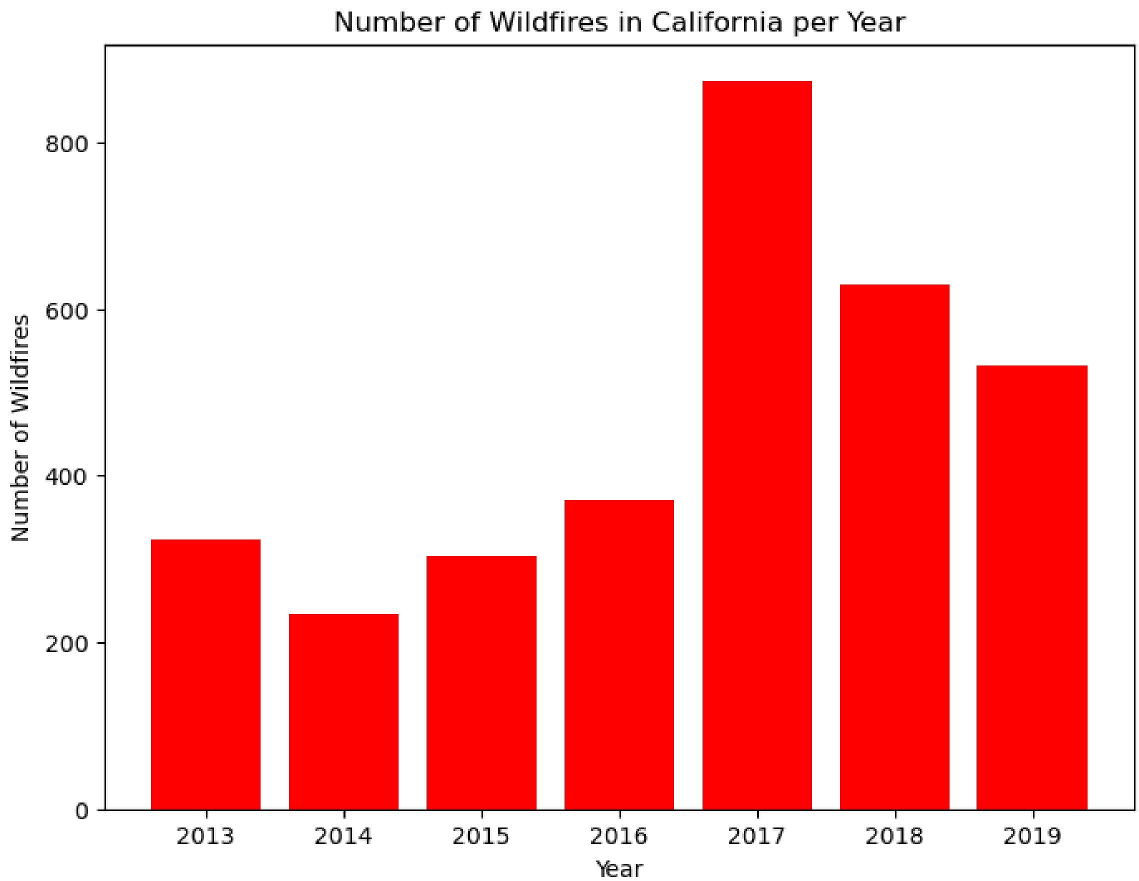

Figure 1: Number of wildfire incidents recorded in California by year from 2013-2019.

The month of July saw the most wildfire incidents recorded at just over 800. The summer months of June, July and August saw the most wildfires, followed by the fall months of September and October. Winter and spring months saw the least amount of wildfire incidents (Figure 2).

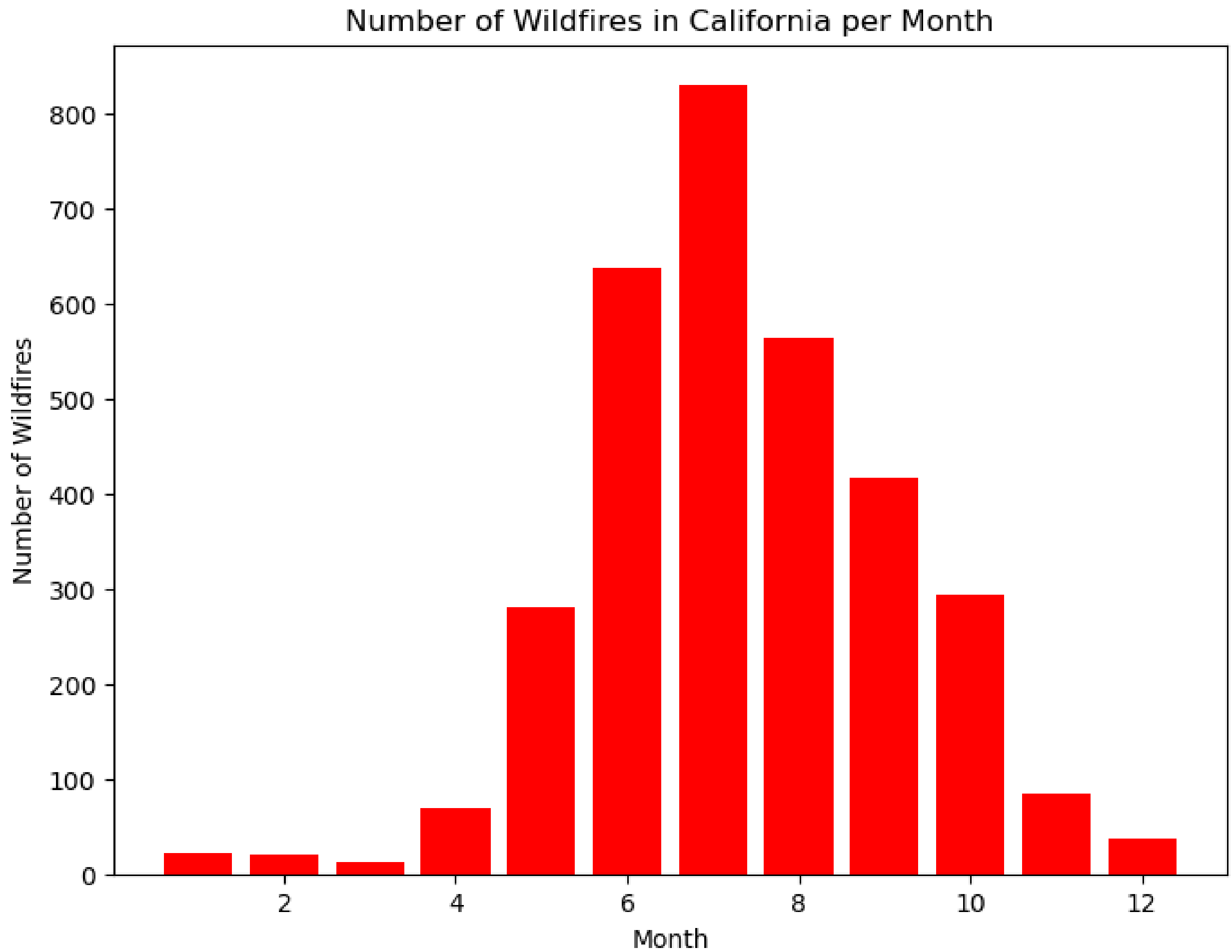

Figure 2: Number of wildfire incidents recorded in California by month from 2013-2019.

To assist with the map queries and filters for the web app, preliminary queries were run to observe data by county. We found Lake County to have sustained just over 100 wildfire incidents (Figure 3) but the most acres burned (Figure 4).

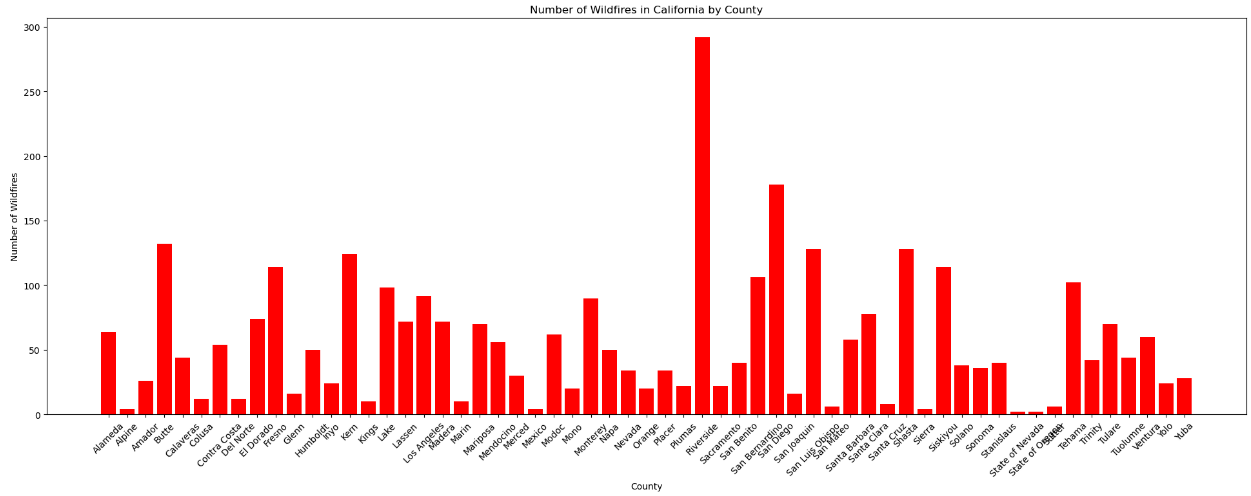

Figure 3: Number of wildfire incidents recorded in California by county from 2013-2019.

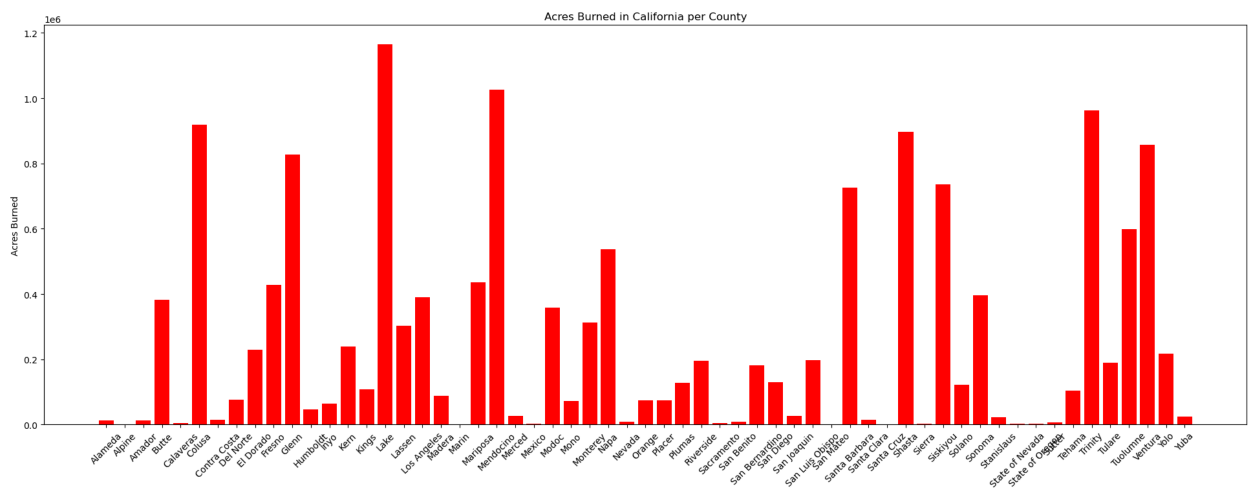

Figure 4: Acres burned per California county from 2013-2019.

Web App Development

The California Wildfires Web App offers an interactive experience for exploring wildfire trends in California. Starting off with the home page, there are five causes to the increase in wildfires and a picture of the iconic Smokey Bear (Figure 5). As for the code, we used the bootswatch superhero theme in our code, to have a universal style across the application. We found a way to embed a tenor-gif "Hello Bear" in the bottom right hand corner, so when the home page is pulled up, there is a bear waving at you.

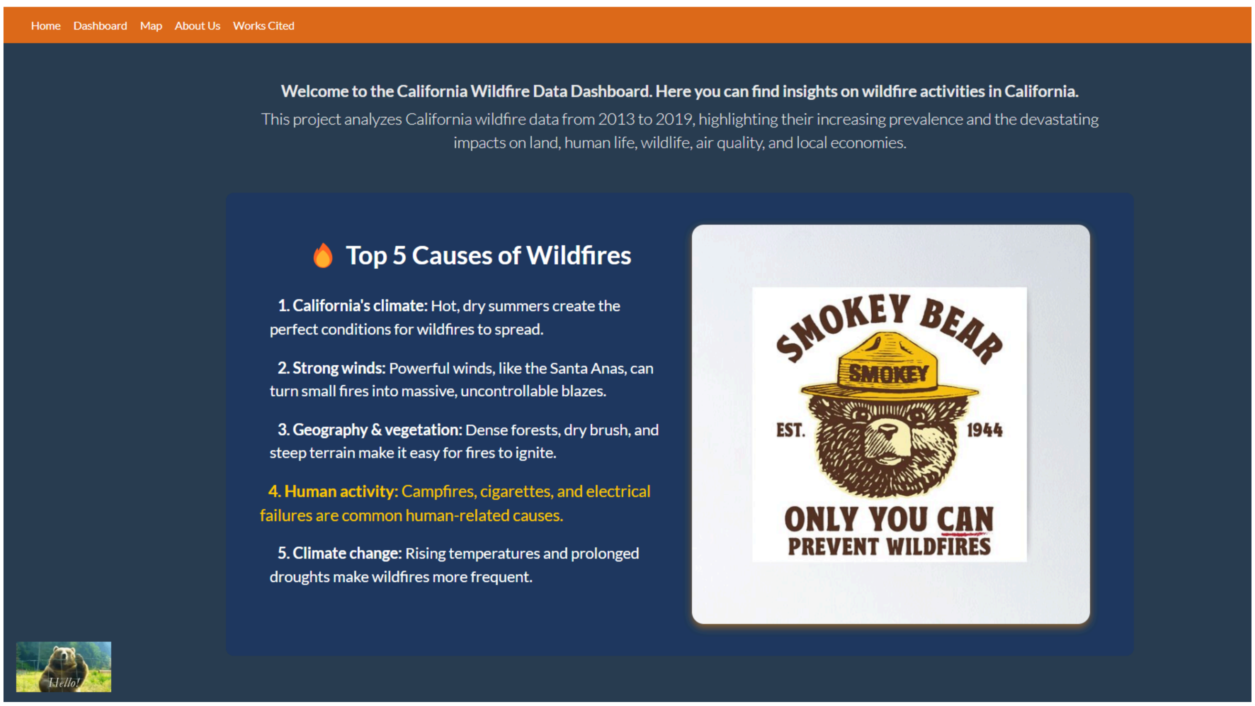

Figure 5: Homepage for the web application.

One of its key features is the interactive wildfire map (Figure 6), built with Leaflet.js, which allows users to visualize the geographical distribution of wildfires. The map enables filtering by year and county, providing a detailed view of wildfire locations and their impact across different regions. This feature helps users better understand the spatial patterns of wildfire occurrences and identify high-risk areas. This interactive Leaflet.js map provides an effective way to visualize California wildfires. It integrates multiple layers, real-time data retrieval, and user interactivity to help analyze wildfire trends over time.

The JavaScript code utilized multiple tile layers, clustered markers, GeoJSON overlay, and an API connection to retrieve the wildfire data. We opened TopoMap and StreetMap to have two different tile layers. The GeoJSON contained the California boundaries and loaded from the external URL and added to the map. We also created markers to add a popup for each wildfire, which included the name, acres burned, year, and county. We included an extra feature of a custom toggle bar to allow users to remove the legend if they chose to.

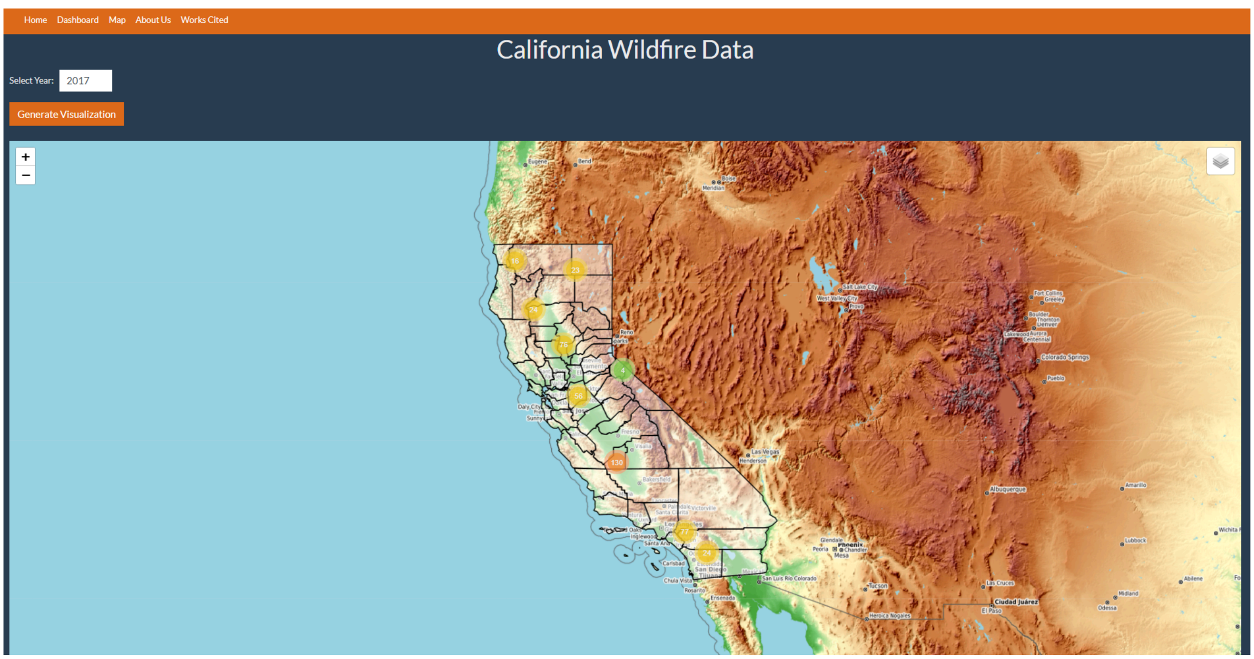

Figure 6: Interactive map to filter through years and acres burned.

In addition to the map, the app includes data visualization dashboards (Figure 7) powered by Plotly.js, which present wildfire trends through dynamic charts and graphs. These visualizations display key insights, such as the number of wildfire incidents per year and month and total acreage burned, making it easy to track trends over time. The integration of Bootstrap ensures a responsive and user-friendly interface, allowing seamless navigation across desktop and mobile devices. Along with Bootstrap for styling, the code uses D3.js, Plotly.js, and Leaflet.js to create dynamic data visualizations.

Key features from our dashboard HTML are the expandable navigation bar for mobile use, links to the other pages (About US, Work Cited, Map, Dashboard, and Home), and the data retrieval and rendering with the table that lists wildfire occurrences by county, sortable columns for enhanced user interaction, and expandable rows for better data visibility. A choropleth map updates dynamically based on wildfire data, visually representing burned areas with color-coded counties. The dashboard also features an interactive bar chart for wildfire trends across years and a map with marker clusters for spatial analysis. We created functions such as expandTable(), collapseTable(), toggleSortWildfires(), toggleSortAcres(), toggleSortCounty(), and toggleSortYear() to fetch the GeoJSON and use it to create the choropleth layer on the leaflet map.

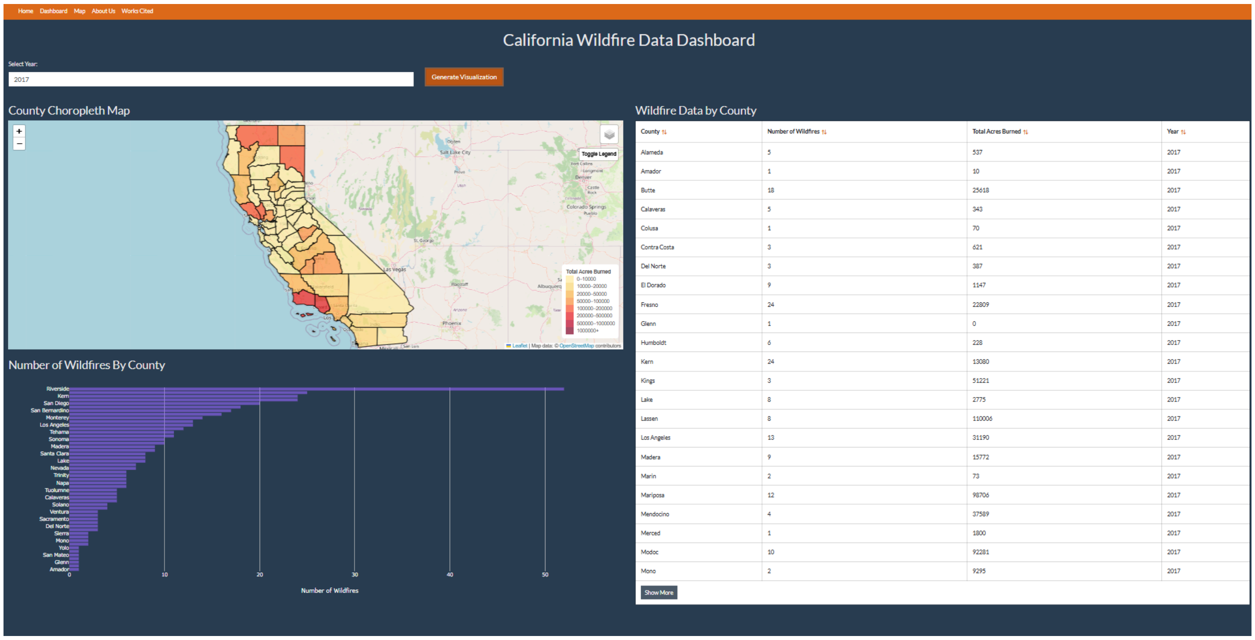

Figure 7: Interactive dashboards to help view the data easier.

The web app is powered by a Flask backend, which efficiently processes and serves wildfire data. This lightweight yet robust framework allows for smooth interactions and quick retrieval of filtered data. On the frontend, HTML, CSS, and JavaScript are used to create a clean and engaging user experience, with Bootstrap enhancing the layout and styling. By combining Leaflet.js for mapping and Plotly.js for interactive charts, the app effectively transforms raw wildfire data into meaningful visual insights, making it a valuable tool for researchers, policymakers, and the public.

Limitations and Future Improvements

The first limitation we recognized was the short range of data from 2013 to 2019. This limited range prevents us from staying current on any trends and patterns that would have occurred after 2019. The second limitation that was noted was the data excludes smaller wildfires that may not have been captured and wildfires that were not reported. The third limitation to point out is climate change and evolving environmental conditions could stray past wildfire trends which could alter future wildfire predictions. With these limitations considered, there are notable gaps in the dataset.

Future enhancements in wildfires can help improve the response of wildfires and fill in gaps for future datasets. One enhancement that can be made is integrating real time wildfires and weather data which can provide up to date insights to track the spread of wildfires and respond more effectively. Additionally, implementing predictive modeling to forecast future wildfires risks based on historical trends. Additionally, monitoring drought conditions and vegetation patterns to help understand wildfire susceptibility can be crucial.

Conclusion

In conclusion, our analysis of California wildfires from 2013 to 2019 provided valuable insights into the frequency, seasonality, and severity of wildfire incidents. From examining trends in wildfire occurrences, acreage burned, and geographical distribution, we identified key patterns that could be useful to wildfire management. The development of our website enhances accessibility to the data, allowing individuals to interactively explore wildfire trends through mapping and visualization tools. While the dataset had limitations, such as restricted data, exclusion of smaller fires, and unreported incidents, the gaps allowed us to find possibilities to enhance our website further. Understanding wildfires at a deeper level is pertinent for developing proactive strategies for responses within the community, ecosystems, and resources from the ever increasing threat of wildfires in California.

References

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