California Wildfire Report

Graduation project | May 2025

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1. Project Description

This report offers a detailed analysis of California wildfires from 2014 to early 2023. Using a combination of data preprocessing in Python, exploratory visualization through Tableau, and in-depth analysis of the original dataset, it reveals critical patterns in wildfire incidents, damages, and causes. The goal is to derive actionable insights to support strategic decision-making for disaster response, urban planning, and climate resilience.

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2. Introduction & Objective

Introduction

Wildfires are one of California's most pressing environmental hazards, causing significant damage to homes, ecosystems, and human life. Understanding their trends, causes, and impacts is essential to mitigating future damage and strengthening community preparedness.

Objective

- Analyze wildfire incidents by year, season, month, and county.
- Examine causes and their relationships with destruction and injuries.
- Identify high-risk areas and contributing factors to damage.
- Recommend targeted prevention and response strategies.

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3. Data Cleaning & Preprocessing

Tools used:

- Excel (Taking a quick look at the data and exploring it)
- Python (Pandas, NumPy, Seaborn, Matplotlib)
- SQL (Store and query the dataset for analysis)

Initial Cleanup

- Removed duplicate rows and irrelevant columns.
- Standardized column names for consistency.
- Checking for missing and Null values.

Data Transformation

- Extracted date parts (Year, Month, Season) from date fields.
- Aggregated key metrics by time and geography (e.g., incidents per year/county).
- Ensured consistency in units (e.g., acres burned, millions of dollars lost).

Validation

- Ensured data integrity through visual inspection using Matplotlib.
- Verified consistency with Tableau outputs and filters.

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4. Business Questions

Basic Trends

- **Wildfire Frequency Over Time:** Tracking the number of incidents per year, quarter, and month to understand seasonal and long-term trends.
- **Financial Losses Over Time:** How wildfire-related costs have evolved, revealing peak loss periods.

Geographical Hotspots

- **Where Wildfires Strike Most:** Identifying counties with the highest number of wildfire incidents.
- **Most Devastated Regions:** Mapping areas with the largest burned lands (Acre) and worst destruction.
- **Costliest Wildfires by Location:** Pinpointing areas that suffered the highest financial losses.
- **Injury & Fatality Distribution:** Showing which locations have the most injuries and fatalities.

What's Causing the Damage?

- **What Sparks the Fires?** Analyzing the cause of wildfires and their impact.
- **Cause vs. Financial Loss,** which types of fires result in the highest costs?
- **Cause vs. Destruction,** comparing wildfire causes with:
  - Homes & businesses destroyed.
  - Vehicles damaged.
  - Injuries and fatalities.

Seasonal Patterns

- **When Are Wildfires Most Common?** Tracking fire incidents across spring, summer, fall, and winter.
- **Seasonal Fire Causes:** Identifying which causes dominate each season.
- **Deadliest Seasons:** Analyzing when fatalities peak and why.

Human Insights

- **High-Risk Areas:** Which counties should be prioritized for intervention efforts due to their high severity level, injuries and fatality counts?
- **Primary Fatality Causes:** What are the reported causes of fatalities, and what is the distribution among these causes.
- **Human loss Trends:** What were the trends over years for the human loss (injuries, fatalities, homes destroyed), and how did they vary across the months displayed?

Business Insights

- **Monthly Financial Loss Peaks:** In which months did the financial loss (in million dollars) reach its highest points, and what were those approximate values.
- **Leading Causes of Business damage:** What are the reported causes of business damage, and what is the approximate number of them associated with each cause.
- **County-Level Vehicles damage:** Which counties experienced the most significant number of Vehicles damaged, and what were those values.

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5. Business Insights

From the final Dashboard we find out that:

A. Wildfire Impact Overview

- **Incidents:** ~100 total wildfires from 2014–2023.
- **Damage:** $239.6 million in total financial losses.
- **Human Toll:** 4,000+ injuries, 900+ fatalities, and 2.65 million acres burned.

- **Destruction:** 94,000+ homes destroyed, peaking in 2018–2021.

B. Trends Over Time

- **High-Impact Years:** The years 2014, 2018, and 2021 recorded the highest numbers of wildfires.
- **Monthly Patterns:** Incident frequency consistently peaks in October, reflecting a pronounced seasonal trend.
- **Seasonality:** Wildfire activity is concentrated during the **Fall and Summer** months, suggesting the need for intensified preparedness during these periods.

C. Cause Analysis

- **Human Activity** is the leading cause (38%), followed closely by **Unknown** and **Lightning** causes.
- All three cause types result in significant home destruction and injuries.

D. Geographic Analysis

- **Most Affected Counties:** Shasta: 14% of total incidents.
- **Injuries:** Highest in Mendocino, Shasta, and Napa Valley.
- **Fatalities:** Highest in Shasta, Mendocino, and San Diego.
- **Homes Destroyed:** Highest in Mendocino, Shasta, and Sonoma.

E. Economic Loss & Asset Damage

- **Relationship between metrices:** Businesses and vehicles exhibit parallel damage trends along with financial loss, indicating a correlation between infrastructure concentration and economic exposure.
- **Primary Loss Driver:** Wildfires caused by **human activity** participates in total financial damage **of $85,355 million**, representing approximately **35.62%** of total recorded losses.

Tools used:

- Figma (For designing the Canvas and charts organization)
- Tableau (Dashboard implementation)

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6. Recommendations

A. Focused Prevention Programs

- Target **Mendocino**, **Shasta**, and **Butte** counties with education campaigns and controlled burn strategies.

- Launch season-specific alerts and preparedness programs during **Fall** and **Summer**.

B. Cause Investigation & Mitigation

- Improve classification methods for fires listed as “Unknown.”
- Strengthen policies addressing human-caused fires (campfires, electrical faults, arson).

C. Infrastructure & Community Resilience

- Invest in fire-resistant building materials in high-risk counties.
- Enhance evacuation planning and emergency response drills, especially in urban-wildland interface areas.

D. Smart Resource Deployment & Real-Time Monitoring

- Use predictive analytics and seasonal trends to proactively deploy firefighting and emergency teams in high-risk areas.
- Integrate real-time dashboards with live data feeds to monitor wildfire conditions, trigger automated alerts, and support rapid response decisions.
- Schedule regular data-driven strategy sessions to adjust resource allocation and enhance preparedness across counties.

Supportive Tools for Team-Work organization:

- GitHub
- Notion