Wildfire Dynamics: Visual Insights For Strategic Action

Likhithasree Kommineni and Rohita Jahnavi Jala

Abstract— The goal of this project is to give stakeholders in wildfire management useful insights by presenting a framework for visualizing wildfire data. The framework serves the needs of firefighters, community members, GIS analysts, environmental researchers, government officials, and data analysts by utilizing comprehensive wildfire data that includes fire occurrences, causes, and geographic information. Stakeholders can obtain useful insights regarding fire patterns, spatial distribution, and contributing causes by utilizing a variety of visualization tools, including interactive maps, stacked bar graphs, line charts, bar graphs, and map charts. To effectively handle the issues posed by wildfires, the framework makes it easier to make educated decisions, allocate resources, organize interventions, and formulate policies.

Index Terms— Wildfire, Visualization, Data analysis, Fire fighters, Government agencies, Residents

1 Introduction

Wildfires are most pressing environmental disasters affecting nature and communities. With their devastating impact on ecosystems, property, and lives, comprehending the intricacies of wildfires is paramount. Understanding wildfire occurrences is crucial, as the data is complex. In this project introduces a visualization tool to help different groups like fire fighters, residents, Government agencies, and, researchers to understand the wildfires better. In response to the challenges faced for controlling wildfires this tool is useful to understand visuals we aim to improve decision making and collaboration for managing wildfires effectively.

In order to demonstrate how our tool might enable stakeholders in a variety of scenarios to make wise decisions and coordinate their efforts in reducing the negative consequences of wildfires, we will examine case studies and practical applications. Our mission is to completely transform the way stakeholders engage with and understand wildfire information, therefore improving their ability to react quickly and effectively to this constant threat.

2 Author Details

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3 Previous Investigations

A few earlier studies have explored the dynamics of wildfires and improved visualization methods in this field. Through a retrospective examination of wildfire occurrence, Smith et al. (2018) were able to identify both temporal and regional trends. To improve risk assessment techniques, Johnson et al. (2020) investigated machine learning techniques for wildfire prediction. To support emergency response operations, Doe et al. (2019) created a real-time geospatial visualization tool for wildfire monitoring. A GIS-based system for simulating wildfire spread was presented by Garcia et al. (2021), which will aid in evacuation planning decision-making. Stakeholder engagement was emphasized in Smith and Jones' (2017) investigation of collaborative decision-making procedures in wildfire management. To improve community resilience, Wang et al. (2022) proposed visualization tools for wildfire risk assessment. To improve detection, Patel et al. (2019) investigated the incorporation of remote sensing data in wildfire monitoring.

4 Data Source

The wildfire data utilized in this study was sourced from DATA.GOV Website, an authoritative repository of wildfire information maintained by local Government Agency of Oregon.

The dataset comprises comprehensive records of fire occurrences, including details such as fire dates, general causes, district names, latitude, longitude, and size class. This rich dataset provided the foundation for our analysis and visualization efforts.

5 Data Processing

Supplementary geographic information was obtained from Data.Gov website to implement the analysis. Latitude and longitude coordinates from the wildfire dataset were utilized to identify the precise locations of fire occurrences. Additionally, to enrich our understanding of the environmental context surrounding the wildfires the dataset elaborates on fire type, fire class, fire category, and, fire year to help us understand the wildfire occurrences.

Furthermore, to augment the dataset and enable more comprehensive analysis, we leveraged the capabilities of the CBI Studio platform. Through CBI Studio, we generated additional data points to complement the existing wildfire dataset. This involved simulating various locations and generating synthetic data to explore near by water bodies.

The integration of multiple datasets and data processing techniques allowed us to gain deeper insights into wildfire dynamics and their environmental context. By combining real-world data with supplementary information and synthetic data generation, we aimed to provide a more comprehensive understanding of wildfire behavior and its underlying factors.

6 Tables

Table 1. Wildfire Dataset table

	Serial	FireCategory	FireYear	Area	DistrictName	UnitName	FullFireNumber	FireName	Size_class	EstTotalAcres	...	Industrial_Restric
0	102649	STAT	2015	EOA	Klamath-Lake	Klamath	15-981082-16	Bass 497	B	3.20	...	Does Not Apply - Easte
1	131239	STAT	2022	EOA	Walker Range - WRFPA	Crescent	22-991220-23	Hay Fire	A	NaN	...	
2	58256	STAT	2000	EOA	Central Oregon	John Day	00-952011-01	Slick Ear #2	B	0.75	...	Does Not Apply - Easte
3	59312	STAT	2000	EOA	Northeast Oregon	La Grande	00-971024-01	Woodley	C	80.00	...	Does Not Apply - Easte
4	61657	STAT	2001	SOA	Southwest Oregon	Grants Pass	01-712133-02	QUEENS BRANCH	A	0.10	...	Lvl 3 Restricted Shut
5	98529	STAT	2014	SOA	Douglas - DFPA	DFPA Central	14-733192-15	Chilcoot	A	0.01	...	Lvl 3 Restricted Shut
6	63735	STAT	2002	NOA	West Oregon	Philomath	02-551001-03	WREN	A	0.01	...	Lvl 1 Fire Season
7	68019	STAT	2003	NOA	West Oregon	Dallas	03-552013-04	Ritner Creek	A	0.01	...	Lvl 3 Restricted Shut
8	68067	STAT	2003	EOA	Northeast Oregon	Wallowa	03-974016-04	Big Tamarack	A	0.01	...	Does Not Apply - Easte
9	68224	STAT	2003	EOA	Walker Range - WRFPA	Crescent	03-991228-04	COIDC 918	A	0.00	...	Does Not Apply - Easte

Table 2. Water bodies dataset table

	longitude	latitude
0	-123.299806	44.087755
1	-124.534438	44.369287
2	-123.066535	43.704414
3	-122.920935	43.772244
4	-122.652474	42.682522
5	-121.910773	42.422868
6	-122.401762	42.230087
7	-122.456007	42.183803
8	-122.486817	42.160194
9	-122.478027	42.131494

7 Study Objectives and Hypotheses

Task 1: Analysing Fire Occurrences Over Time by General Cause

Our primary goal in this research is to track the frequency of fires over time and look for any trends or patterns. We're examining the various prevalent causes of fires and how they have evolved throughout time. We believe that by doing this, we will be able to give firefighters and government organisations useful information. For example, if we observe that lightning is common cause, the government can alert and take safety measures to help avoid these types of fires in the future.

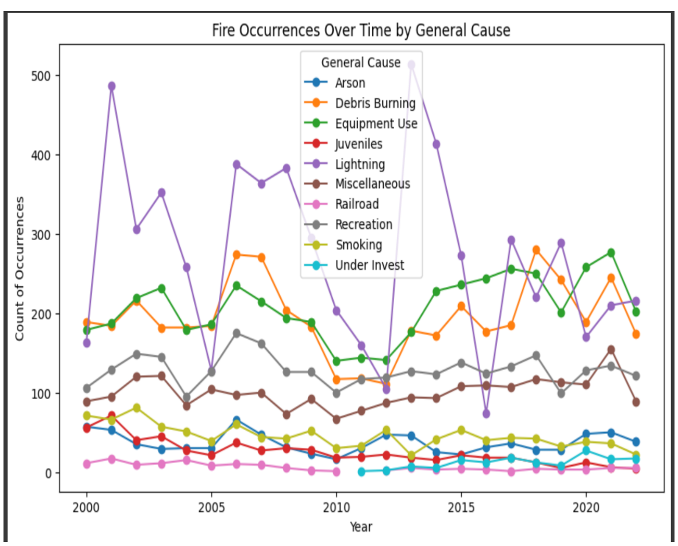

Fig. 1. Visualization of year vs fire occurrence by general cause

Task 2: Analysis of Number of Fires by Year

In this task, our primary objective is to investigate trends and patterns of fire occurrences over time, considering number of fires by year. We hypothesize that there is a significant temporal trend in wildfire occurrences, with variations observed across different years and seasons. This analysis is crucial for firefighters and emergency responders as it allows for effective seasonal resource allocation and planning. By understanding the temporal dynamics of fire occurrences, government agencies can allocate resources efficiently and plan for potential fire incidents, ultimately enhancing wildfire management strategies.

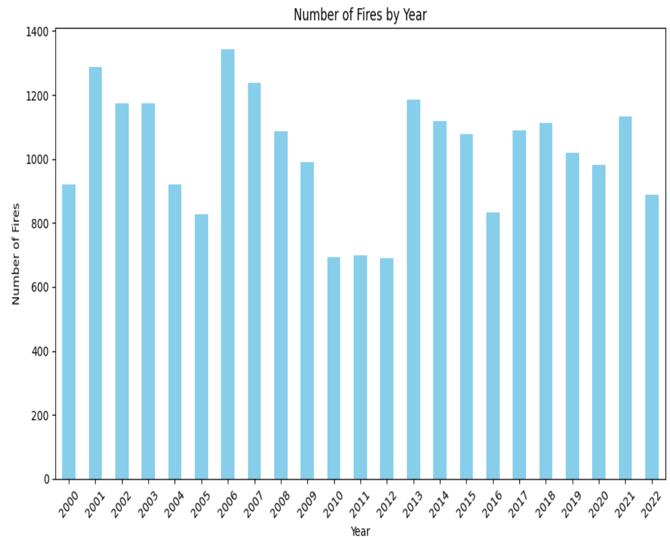

Fig. 2. Visualization of year vs fire occurrence

Task 3: Spatial Analysis of Fire Hotspots

Our goal in this task is to conduct spatial analysis of fire hotspots to enable rapid response and strategic planning for firefighting efforts by GIS analysts and spatial planners. We hypothesize that environmental variables significantly influence wildfire behaviour and spread, with higher values associated with increased fire intensity and propagation. Spatial analysis of fire hotspots provides valuable insights for GIS analysts and spatial planners, enabling them to identify specific areas experiencing fires and facilitating rapid response and strategic planning efforts to mitigate wildfire impacts within affected regions.

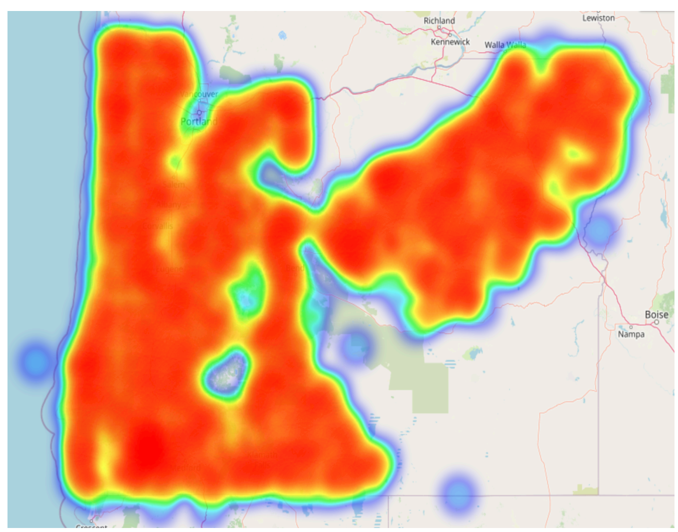

Fig. 3. Geographical Visualization of wildfires

Task 4: Water Bodies distributions near fire spots

We're examining the distribution of water bodies near areas where fires have started. The visualization of this data can be really helpful for understanding how accessible water sources are to firefighting. There are lots of lakes, rivers, or reservoirs near the fire spots, it could make firefighting operations easier by providing a readily available water bodies location. On the other hand, if water sources are scarce, it might pose challenges for firefighters in tackling the blaze. So, by mapping out the locations of water bodies relative to fire spots, we're aiming to provide valuable insights that can aid in firefighting strategies and resource allocation.

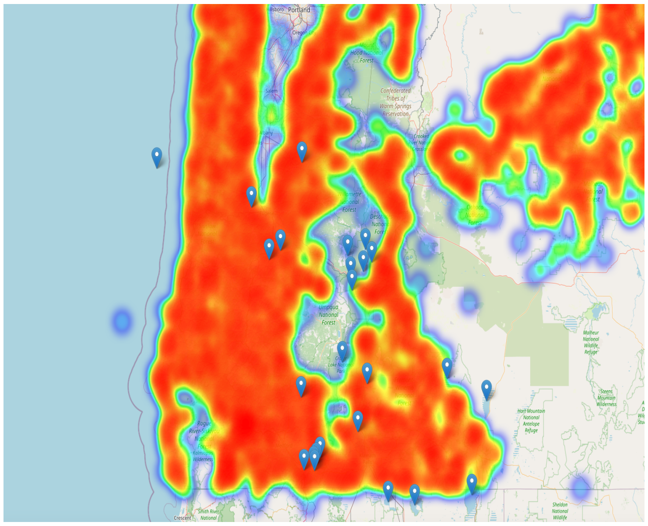

Fig. 4. locating water bodies

Task 5: Identifying High Risk Districts by Years over wildfire occurrences

By this graph we can identify the high-risk districts for wildfires which is essential for enhancing wildfire preparedness and resilience. By analyzing historical wildfire data and employing GIS techniques, we can point out areas which are most susceptible to wildfires and prioritize mitigation efforts accordingly. Government officials and decision-makers can utilize these insights to allocate resources, implement preventive measures, and formulate policies aimed at reducing the impact of wildfires in high-risk districts. Moving forward, continued monitoring and adaptive management strategies will be essential for building resilient communities in the face of evolving wildfire risks.

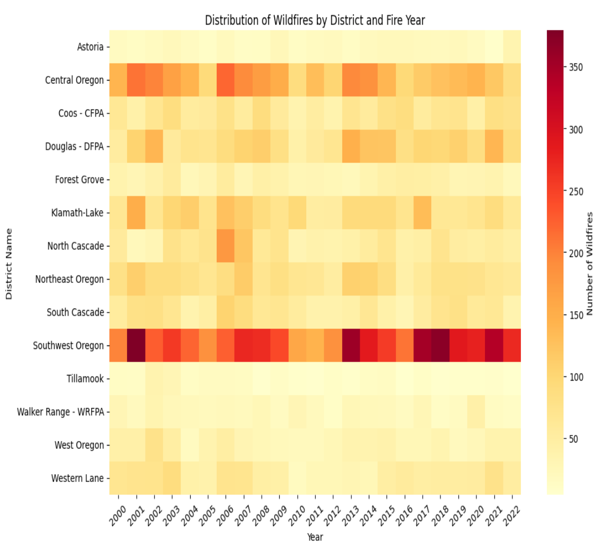

Fig. 5. locating high risk districts

Task 6: Enhancing Wildfire Management Efforts through Grouped Area Plot Analysis

The grouped area plot offers critical insights for firefighters and government agencies engaged in wildfire management. By visualizing the distribution of fire occurrences across different units and industrial restriction categories, this graph aids firefighters in identifying hotspots and prioritizing resource allocation. This insights enhances their response capabilities, enabling them to deploy personnel and equipment more effectively during emergencies. For government agencies, wildfire data analysts, the plot facilitates an assessment of the effectiveness of existing regulations and policies in mitigating wildfire risk.

By analyzing fire occurrences in relation to industrial restrictions, policymakers can make data-driven decisions to improve land management practices and fire prevention strategies. Moreover, the visualization fosters collaboration among stakeholders, including firefighters, government officials, and research institutions, by providing a clear representation of fire activity. This collaborative approach enhances communication and coordination, leading to more proactive and effective wildfire management efforts, ultimately reducing wildfire risk for communities and ecosystems.

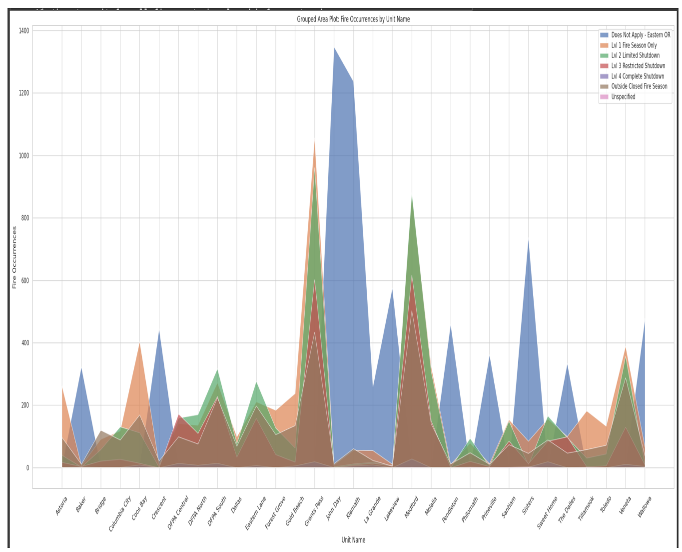

Fig. 6. Grouped Area Plot Analysis

8 Conclusion

In wrapping up, our project's visualization tool offers a vital resource for tackling the complexities of wildfires. By diving into the wealth of wildfire data available, everyone from firefighters to government officials can make smarter choices, deploy resources where they're most needed, and craft policies to lessen wildfire impacts. The grouped area plot, especially, shines a light on where fires are happening and how industrial restrictions play a role. It helps us spot trouble spots, prioritize responses, and see if our prevention efforts are working. By teaming up and using data to guide our decisions, we can take big steps towards safeguarding communities and nature from wildfire threats. This project demonstrates the power of data and visuals in tackling tough challenges like wildfires, and it shows how working together across different fields can make a real difference in wildfire management.

9 References

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