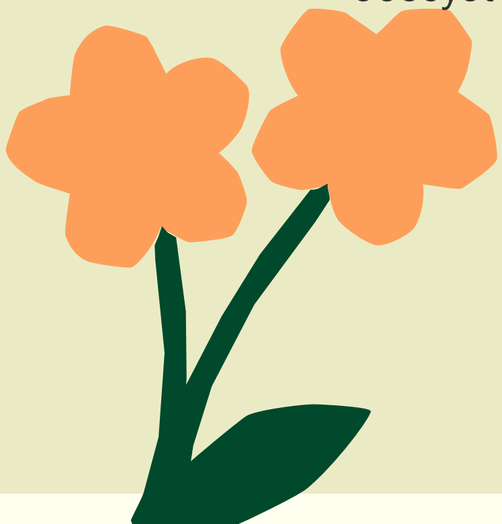
Mapping the Fire Line

Using NASA Data to Analyze Wildfire Risk and Response in Alberta

Introduction

Wildfires in Alberta: A Growing Concern

Wildfires are a recurring environmental challenge in Alberta, a province known for its vast forests, grasslands, and diverse ecosystems. The frequency and intensity of wildfires in regions like Grande Prairie, Cold Lake, and Spruce Grove have significant implications for local communities, ecosystems, and air quality.



This presentation explores wildfire trends in these areas, with insights derived from NASA's MODIS satellite data.

The analysis focuses on:

- Wildfire occurrences over time
- Factors contributing to the frequency and severity of wildfires
- Insights from satellite data, including Fire Radiative Power (FRP) and brightness temperature
- Regional impacts, including human and environmental factors

METHODOLOGY

Used k nearest neighbours to assign cities to data points.

Divided data based on Albertan cities and labelled it.

Conducted literature review on existing models and research papers.

combined all the month climate data of Alberta province in year 2023

Made pivot tableand general visualizations on Excel and Tableau
.

use date and location cordinates to merge data

understanding the overall climate of Alberta in 2023

Cleaned Data: Lat and Long Boundary of Alberta and type 0 (wildfires).

finding correlation between forest fires and climatic conditions

dropping missing values and feature engineering for better analysis

Background

Key Research Findings (Source: Li et al., 2025):

1. Increasing Wildfire Frequency

- Wildfire frequency has increased since the 21st century, despite a decrease in the total burned area.
- More frequent, smaller wildfires could be due to improved wildfire management and increased human activities.

2. Human-Caused vs. Lightning-Caused Wildfires

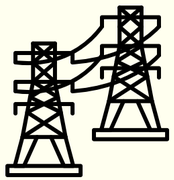
- Human-caused fires are spatially clustered, especially in high population density areas and recreational zones.
- Lightning-caused fires are more dispersed, consistent with random lightning strikes across the landscape.

What causes forest fires?

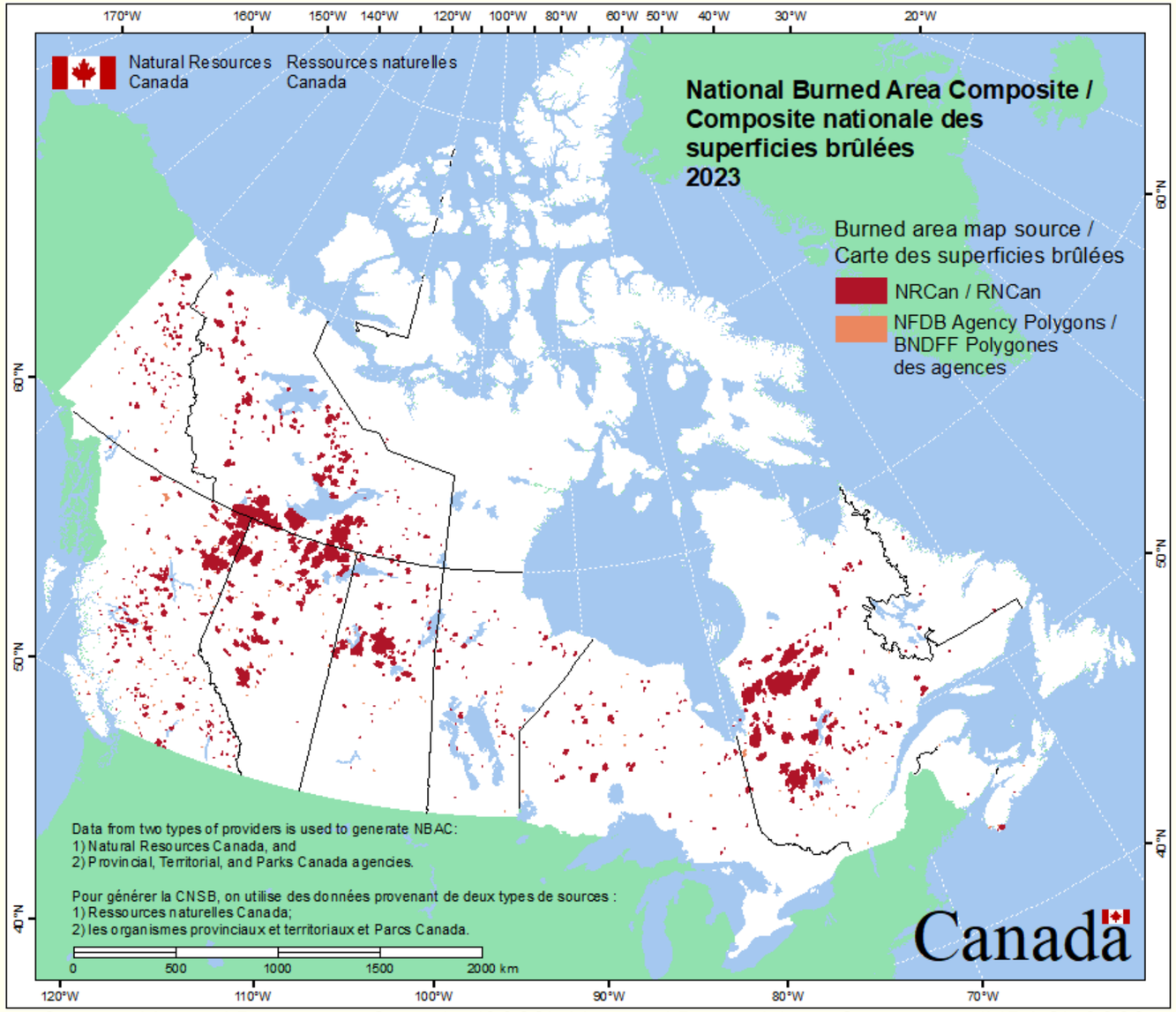
Lightning Strikes- Especially dry lightning, which occurs without significant rainfall, is a major natural ignition source.

Drought and Heatwaves- Extended periods of dry weather dry out vegetation, turning it into easily ignitable fuel.

Spontaneous Combustion - Under the right conditions, organic materials like compost or peat can self-ignite due to heat buildup.



Power Lines and Infrastructure Failures - Downed power lines or electrical malfunctions can lead to ignition, especially in dry conditions.

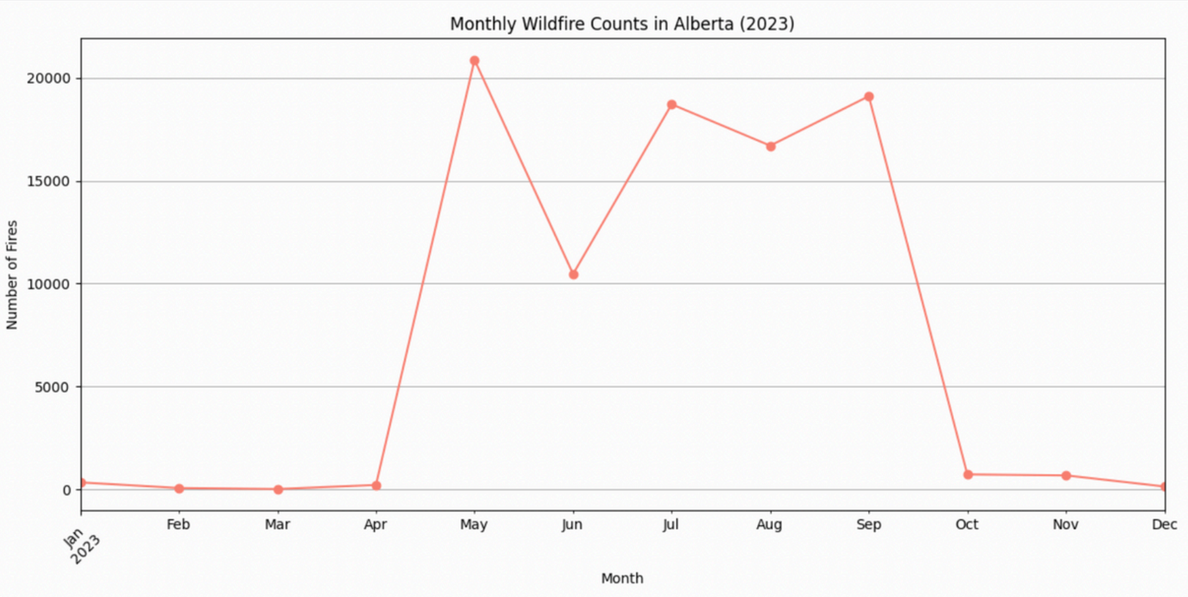


Source: Natural Resources Canada. (2023). National Burned Area Composite (NBAC): 2023. Government of Canada. https://cwfis.cfs.nrcan.gc.ca/interactive-maps/national-burned-area-composit

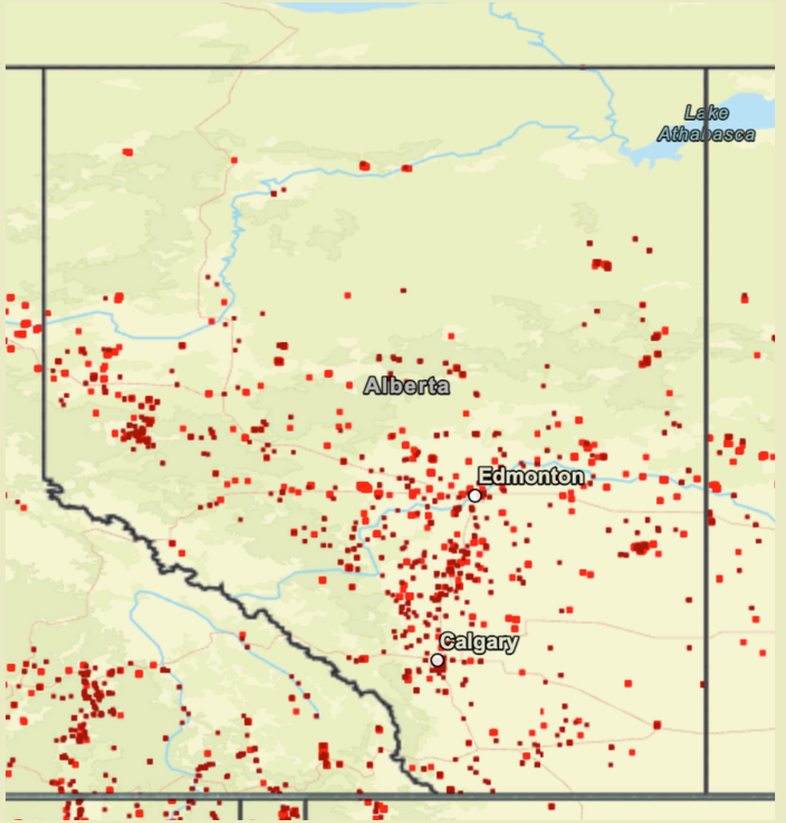
Burnt Areas in Alberta

1. Red Polygons represent areas that burned in 2023, as recorded by provincial, territorial, and Parks Canada agencies (referred to as "NFDB Agency Polygons").
2. Brown Polygons show burned areas recorded specifically by Natural Resources Canada (NRCan).
3. High concentrations of burned areas are visible in Alberta in 2023.

Monthly Wildfire Count



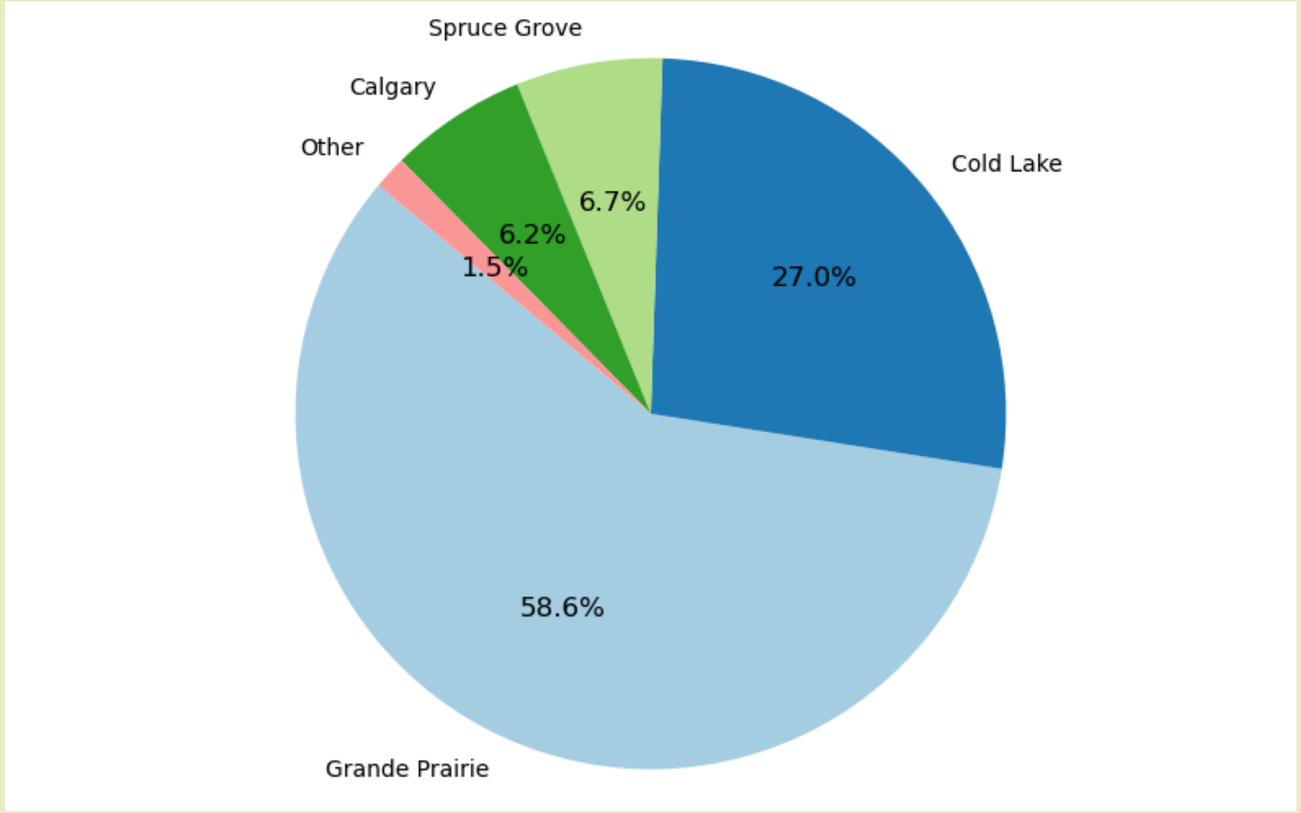
Monthly Wildfire Count
Data source: NASA's Fire Information for Resource Management System (FIRMS), 2023.



Wildfire Spread in May
NASA/LANCE/FIRMS. (n.d.). FIRMS US/Canada Fire Map. NASA Earth Observing System Data and Information System (EOSDIS).

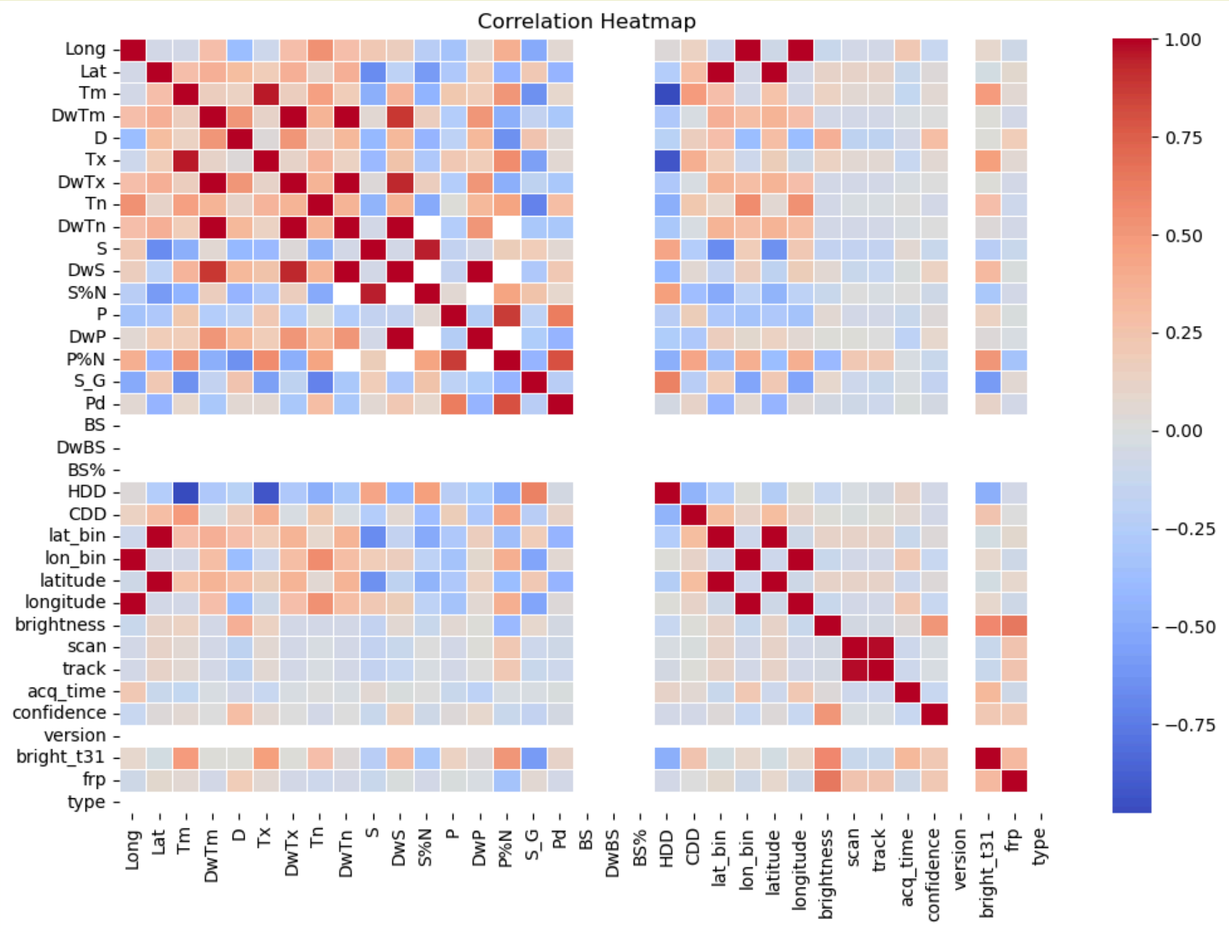
- Highest wildfire activity observed in May.
- Notable drop in wildfires during February and March.
- Indicating that Alberta is more prone to wildfires during the summer season when temperatures rise.

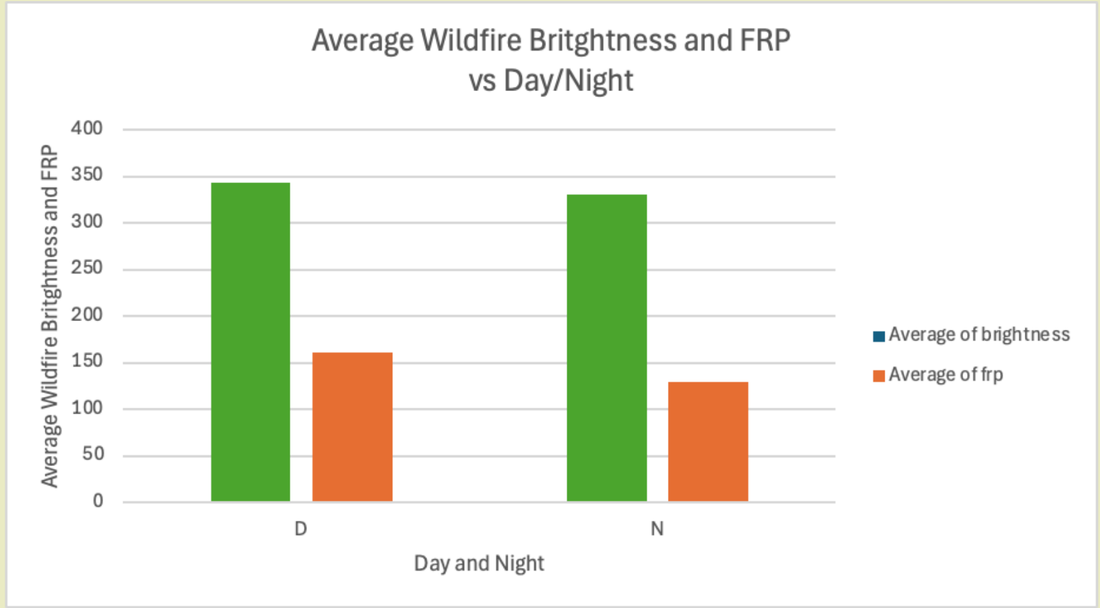
Wildfire Count vs Area



- Grande Prairie has the most number of wildfires followed by Cold Lake Spruce Grove.
- Grande Prairie has hotter, drier conditions during summer months make this area prone to wildfires.
- A major cause of wildfires in this region is lightning strikes, which are frequent in the area.
- Cold Lake experiences intense summer heat, which dries out vegetation, especially in the forested areas around the lake.

Correlations





- Higher wildfire activity observed during the day as daytime temperatures/wind patterns might be more conducive to spread of fires + more human activity.
- While the fire's intensity (FRP) remains constant, external factors like solar radiation affect how the fire’s brightness (hotness) is recorded at different times of day.

Understanding the conditions during the wildfires

- High precipitation causes increased wildfires; maximum seen in June and July.
- High temperature causes increased wildfires; maximum seen in July.
- Places with high temperature and percipitation in Alberta see the most wildfires.

Environmental Contributors

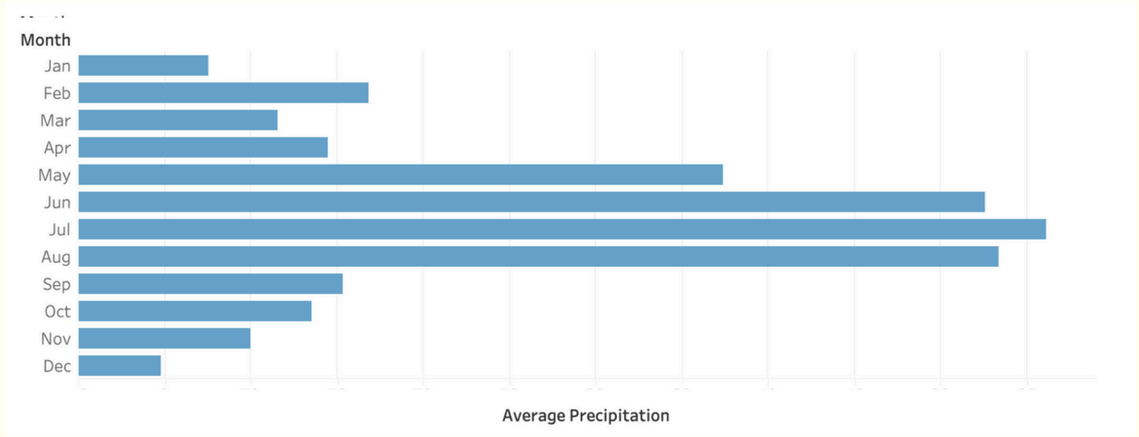
Accumulation of Dry Vegetation -Dead leaves, branches, and other fuels build up in forests if not cleared.

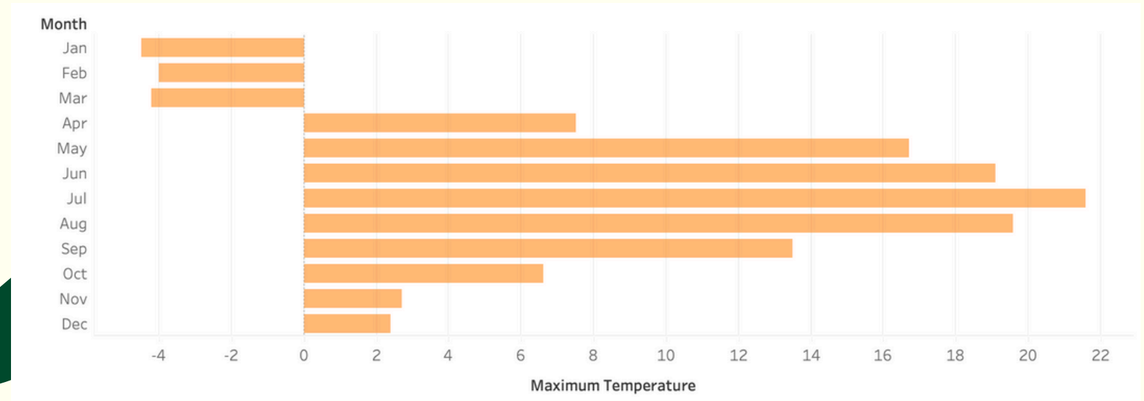
Wind- Spreads fire quickly and unpredictably, making suppression harder.

Low Humidity & High Temperatures- Create perfect conditions for ignition and spread.

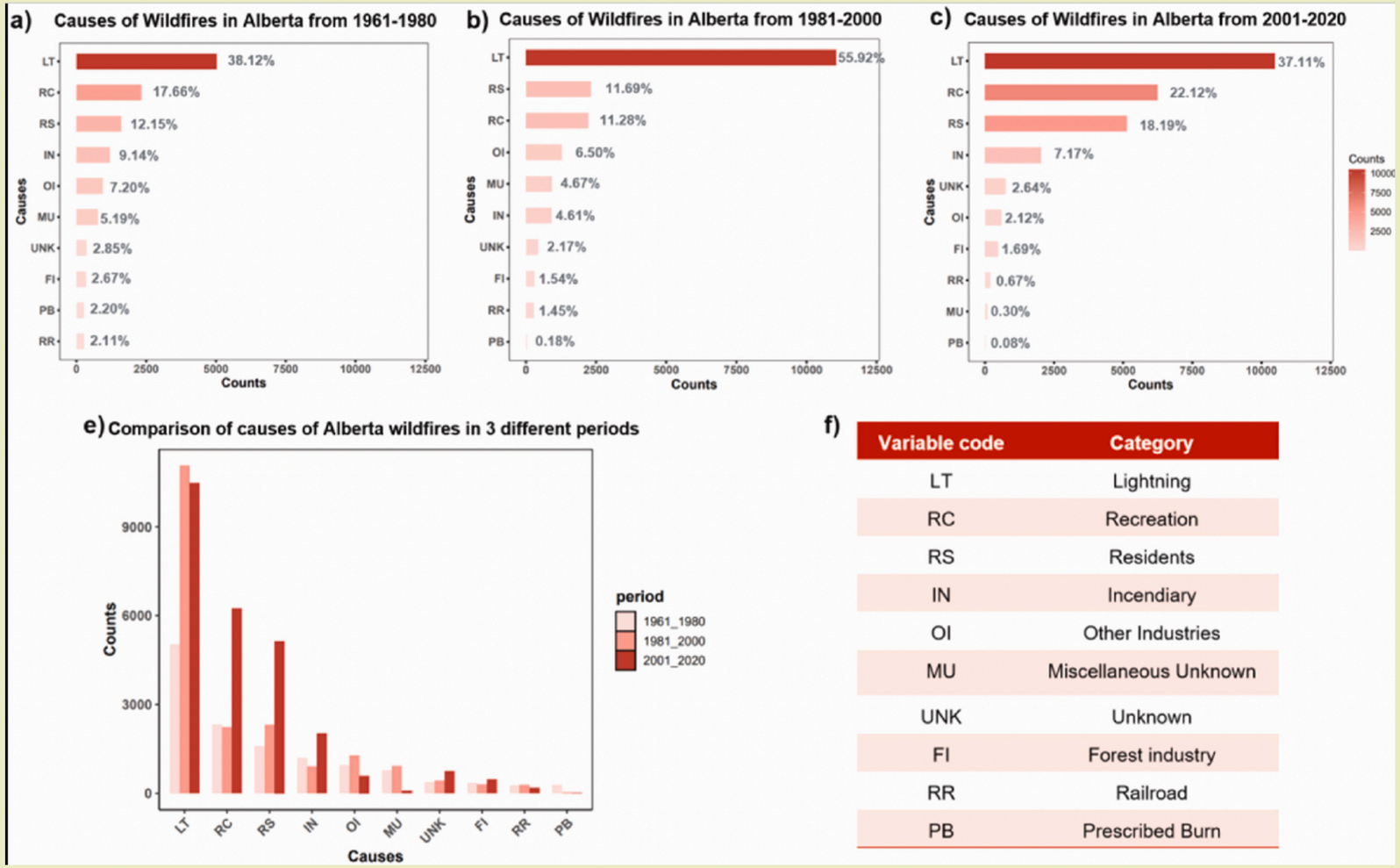
Row Labels	Average of Tm	Average of P
HENDRICKSON CREEK	7.2	196.95
EDSON	14.13809524	175.8166667
EDSON CLIMATE	14.24285714	174.1833333
ATMORE AGDM	16	115.3
JEAN COTE AGCM	15.2	97
VALLEYVIEW AGDM	14.17078652	75.21498127
HOLDEN AGDM	10.75	73.1
RED DEER REGIONAL A	13.53333333	72.63333333
LEGAL AGCM	11.26666667	72.46666667
ROMA	13.52	69.90666667
PEACE RIVER A	12.58	69.07333333
BALLATER AGCM	15	68.1
ISPAS	16.65	67.75
CARROT CREEK	12.68955224	66.96641791
KINIKINIK	16.4	63.5

Row Labels	Average of Tm	Count of type
SAVANNA AGCM	14.13056042	1142
HIGH PRAIRIE AGDM	13.49909502	663
GARDEN RIVER	16.88299817	547
CARROT CREEK	12.68955224	402
VALLEYVIEW AGDM	14.17078652	267
KEG RIVER AGCM	17.17745098	204
FORT CHIPEWYAN RCS	15.25681818	176
FORT CHIPEWYAN	15.15681818	176
EVANSBURG2 AGCM	9.651470588	136
TOMAHAWK AGDM	13.98701299	77
FAIRVIEW AGDM	7.996721311	61
CLEARDALE AGDM	14.72363636	55
GRANDE PRAIRIE A	14.13958333	48





Past data and category



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Variable code	Category
LT	Lightning
RC	Recreation
RS	Residents
IN	Incendiary
OI	Other Industries
MU	Miscellaneous Unknown
UNK	Unknown
FI	Forest industry
RR	Railroad
PB	Prescribed Burn

The three most significant factors influencing wildfire occurrence in Alberta are:

- Lightning (LT)
- Recreation (RC)
- Residents (RS)

LT has been a consistent major factor in wildfires over the past 60 years.

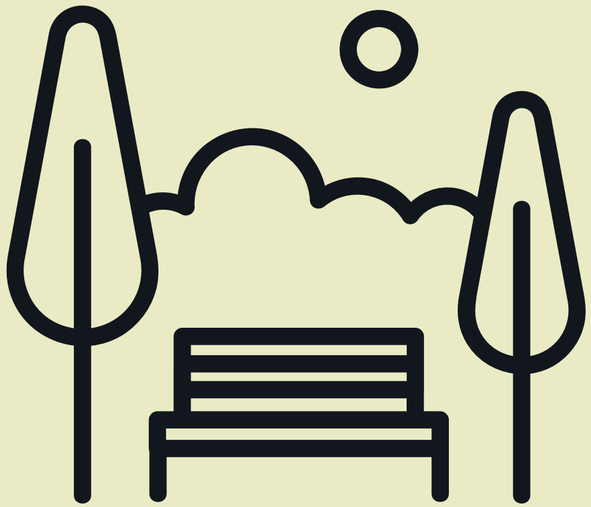
From 1981 to 2000, wildfires caused by LT accounted for 55.92% of total wildfire incidents.

Human factors have caused a significant increase in wildfire occurrences.

Source: Li, W., Bai, Y., Chen, Z., Lou, S., & Liao, Y. (2025). Spatiotemporal analysis of wildfires in Alberta, Canada over the past sixty years: Increased wildfire frequency by human activities. Journal of Environmental Management, 380, 124963. Add a little bit of body text

Solution 1:

Targeted strategies for high-risk zones (wildland-urban interfaces, parks, and recreational areas).



1. Wildland-Urban Interfaces (WUIs)

- Increase firebreaks to protect populated areas from wildfires.
- Improve emergency infrastructure (e.g., water supply, access roads) for rapid response.
- Implement community education programs on fire safety and prevention.

2. Parks & Recreational Areas

- Limit access during high-risk periods to prevent human-caused fires.
- Enforce fire bans and implement strict regulations on campfires and outdoor burning.
- Increase monitoring through satellite data and on-ground patrols.

3. Collaboration & Planning

- Local authorities and agencies should collaborate on wildfire risk assessments.
- Create fire-resilient zones around recreational and park areas.
- Public awareness campaigns to promote safe practices during peak fire seasons.

Solution 2:

Fire prevention measures should include stricter regulations on recreational activities and land use changes.

1. Stricter Regulations on Recreational Activities

- Control activities that increase wildfire risk, such as open burning and campfires.
- Enforce fire bans during high-risk periods, especially in recreational and park areas.
- Implement visitor capacity management in fire-prone areas to reduce human-caused ignitions.

2. Land Use Changes

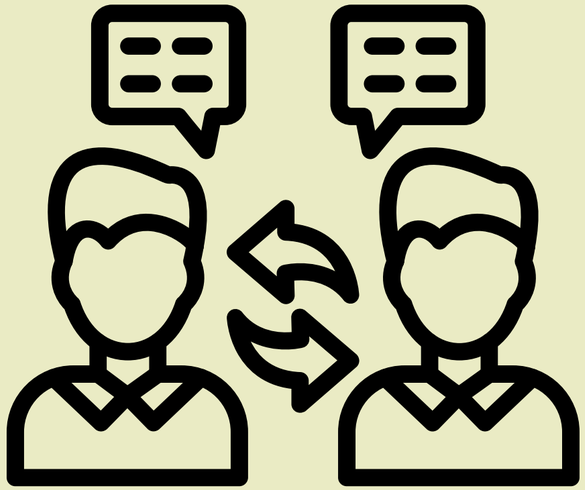
- Monitor urban development near forested areas and wildland-urban interfaces.
- Restrict construction in high-risk wildfire zones, especially areas with flammable vegetation.
- Promote fire-resistant building materials and fire-resilient landscape designs.

3. Public Education

- Raise awareness on the risks of wildfire through community outreach and information campaigns.
- Encourage safe outdoor practices and proper disp

Solution 3:

Investment in emergency infrastructure and early warning systems to enhance wildfire response efforts.



1. **Emergency Infrastructure**
   - Develop and maintain firebreaks in high-risk areas to prevent the spread of wildfires.
   - Improve firefighting equipment and resources, such as water storage systems and aerial water drops.
   - Strengthen emergency response teams and ensure rapid deployment to affected zones.
2. **Early Warning Systems**
   - Implement satellite-based monitoring to detect early signs of wildfires.
   - Use real-time data to predict wildfire behavior and provide timely warnings.
   - Establish communication networks for rapid coordination and evacuation alerts.
3. **Preparedness and Response**
   - Prepare local communities through training and emergency drills to minimize damage.
   - Ensure swift evacuation procedures and provide adequate shelter and resources for affected populations.

Riddle, & HeinOnline U.S. Congressional Documents Library. (2024). *Funding for wildfire management: FY2024 appropriations for the forest service and department of the interior (IF12398)* (1239th ed.)

Conclusion

1. Satellite imagery gives us a powerful lens into Earth’s surface—capturing data that is otherwise invisible or inaccessible.
2. Throughout this presentation, we’ve seen how resolution, coverage, and spectral range define a satellite image’s usefulness.
3. Whether for mapping, monitoring, or responding to real-world events, the choice of satellite imagery depends on the task at hand.
4. As access to satellite data continues to expand, so do the opportunities to apply it creatively and impactfully.
5. Ultimately, satellite imagery is not just a tool—it's a critical layer of insight in how we observe and interact with the world.

Resources

- NASA. (2023). Fire Information for Resource Management System (FIRMS): Active fire data for Canada. Retrieved from https://firms.modaps.eosdis.nasa.gov/country/

- Li, W., Bai, Y., Chen, Z., Lou, S., & Liao, Y. (2025). Spatiotemporal analysis of wildfires in alberta, canada over the past sixty years: Increased wildfire frequency by human activities. *Journal of Environmental Management, 380*, 124963.

- Riddle, & HeinOnline U.S. Congressional Documents Library. (2024). *Funding for wildfire management: FY2024 appropriations for the forest service and department of the interior (IF12398)* (1239th ed.)

- Environment and Climate Change Canada. (n.d.). *Canadian Climate Summary.* Government of Canada.