Analysis and Mapping of Wildfire Severity Utilizing Advanced GIS Techniques in Colorado, USA

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Introduction

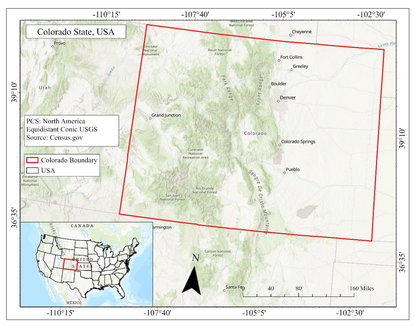
Over the past decades, the intensity and frequency of wildfires have increased in the western part of the United States, especially in Colorado (Wright & Roy, 2022). The wildfires pose serious dangers to the ecosystem, water, property, and lives (Gannon et al., 2019). Increasing temperatures, declining snow cover, and increased droughts have made fires more active by fueling and prolonging the fire seasons, which creates the necessity of wildfire management (Prichard et al., 2020; Zong et al., 2024). The research will be applicable for monitoring and land management, and community preparation plans to increase resilience to wildfire hazards.

Aim and Objectives

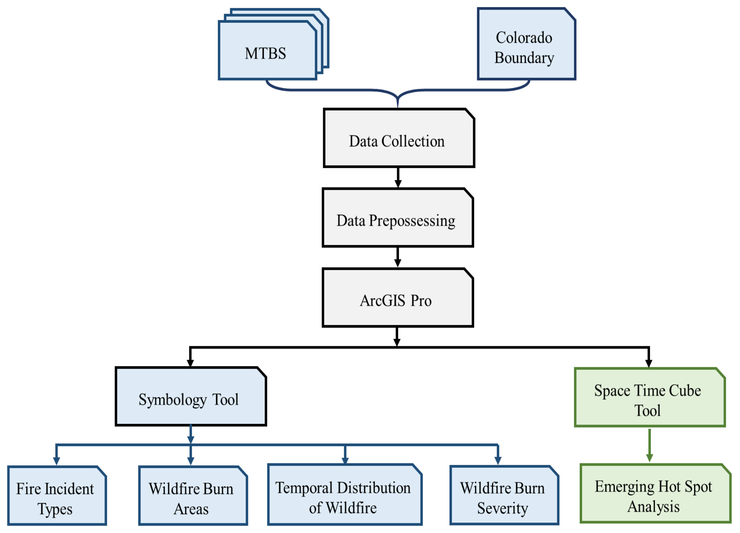
This study aims to determine the spatial-temporal patterns of wildfire frequency and intensity over the period 1984-2024 in Colorado. The study also aims to categorize the types of fire events, which include wildfires, prescribed fires, wildland fire use, and unknown events, to understand their relative contribution. Besides, the study seeks to identify and map wildfire hotspots through the Emerging Hot Spot Analysis (EHSA) tool utilizing the Monitoring Trends in Burn Severity (MTBS) data.

Study area

This study is focused on the wildfire-prone areas of Colorado, USA, primarily, the Colorado Front Range, north-central Colorado, and the western mountains, and it is characterized as rugged terrain, dense forests, and climatic variability that intensify the fire risks.

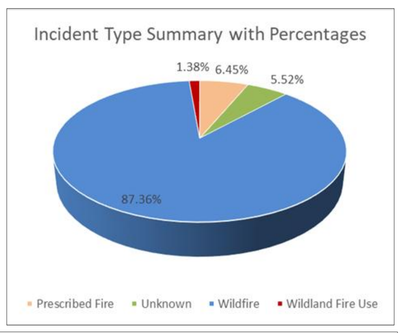


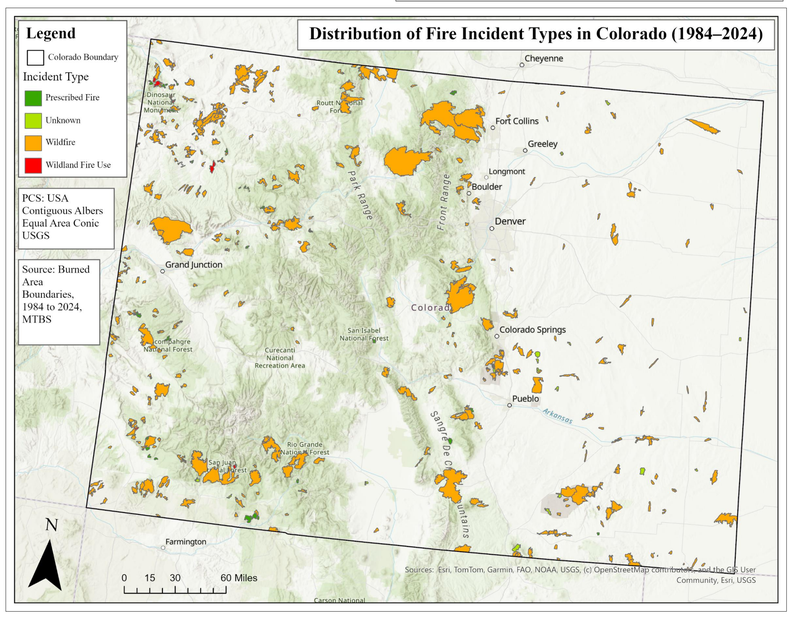
Methodology



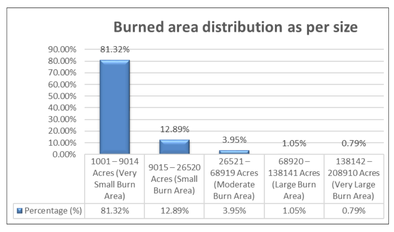
Results and Discussion

Fire Incident Types: Most of the fire events in Colorado were composed of Wildfires (87.36%), indicating that most fire events were uncontrolled and mainly driven by natural or man-made factors.

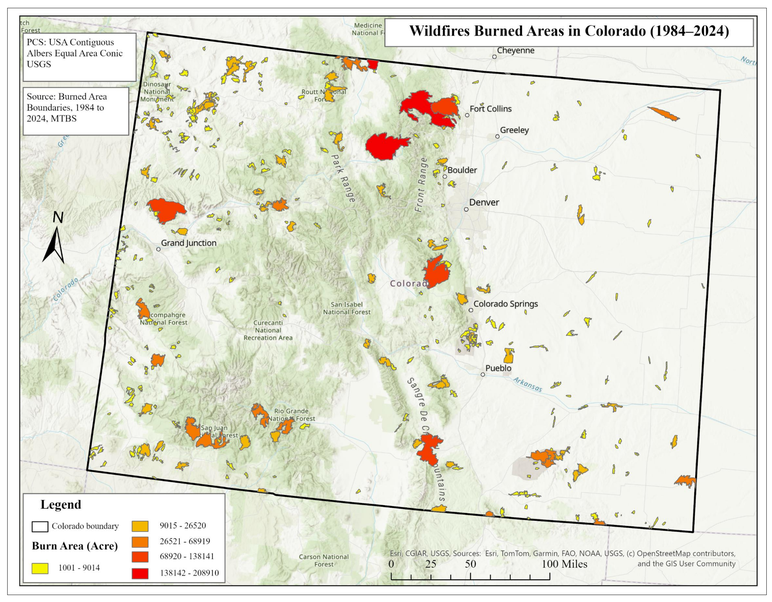




Wildfire Burn Areas: The majority of the wildfires (81.32%) ranged between 1,001 to 9,014 acres; thus, they were generally small or medium.

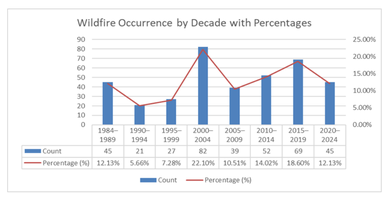


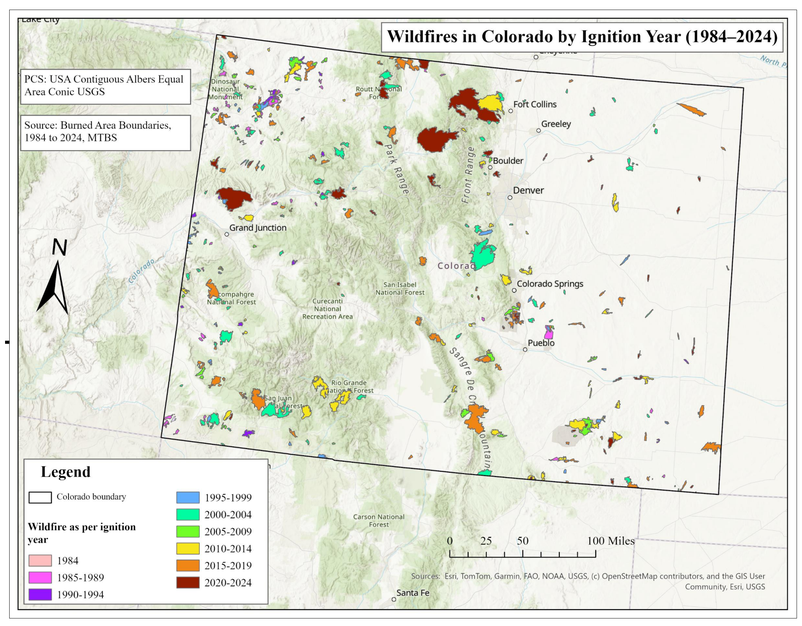
There were only a few large fires (0.79%) that burned more than 138,142 acres, and they accounted for the majority of the overall burned area.

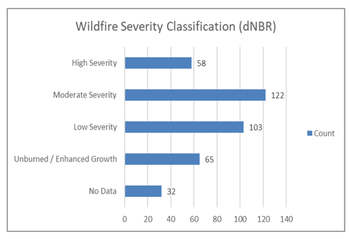


Temporal Distribution of Wildfire:

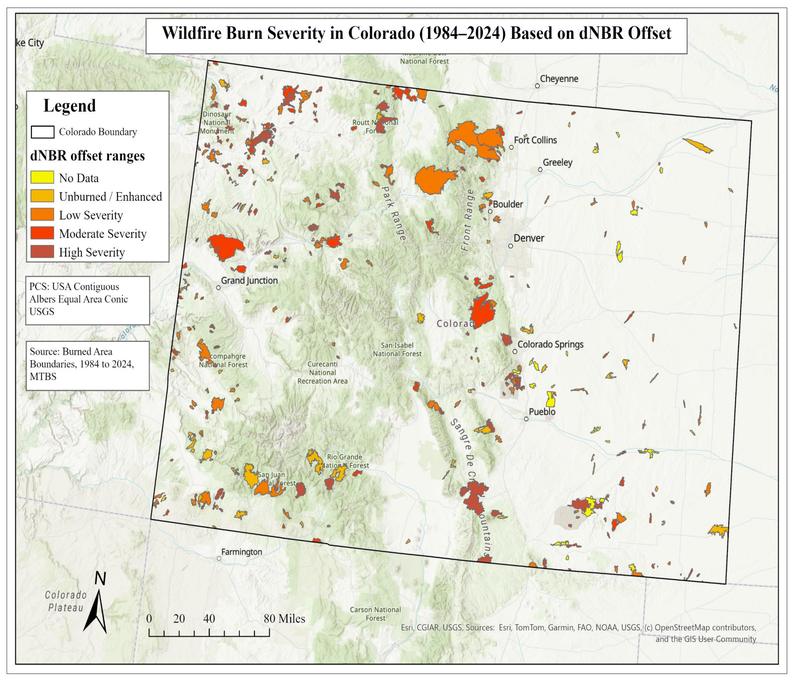
The frequency and extent of wildfires increased sharply after 2000, with the peak between 2000-2004 (82 wildfires or 22.10%), due to the impact of climatic and land-use changes (Huang et al., 2015).



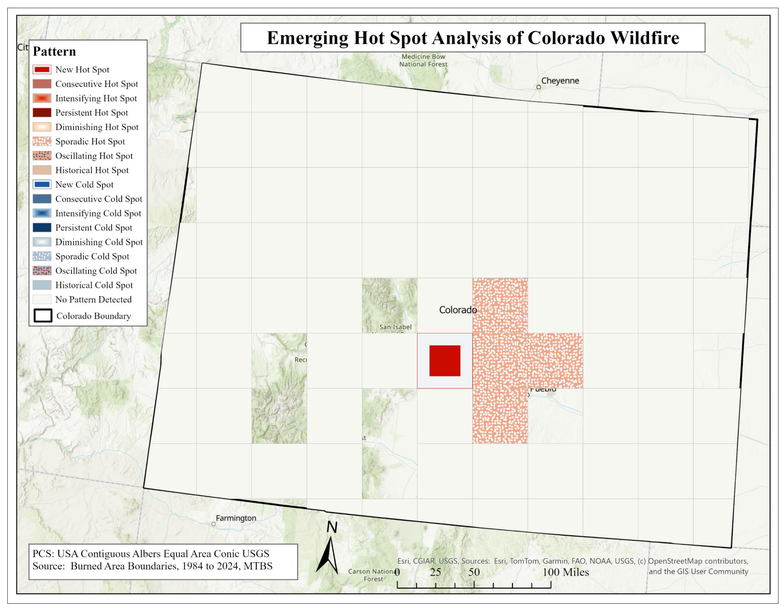




Wildfire Burn Severity: Most fires were of the low (27.10%) to moderate severity (32.10%), and the high-severity (15.26%) burns were clustered in the western and central parts of Colorado.



Emerging Hotspot Analysis: EHSA observed a new wildfire hotspot in south-central Colorado (the Pueblo region) and parts of the Front Range, Grand Junction, Durango, and Colorado Springs. This hotspot is statistically significant ($p = 0.038$ at the 95% confidence level), which means that fire activity is not random and is getting worse in these areas.



Limitations

This study depends exclusively on MTBS fire data, which could exclude smaller and undocumented fires. This study does not incorporate environmental factors such as climate change, vegetation characteristics, or land uses that cause wildfires.

Recommendations

The monitoring systems and emergency response in Pueblo and Front Range and western Colorado regions should be improved. The authorities should establish fuel reduction and land-use planning systems in high-risk areas and consider climate and socio-economic factors into future predictive wildfire models.

Conclusion

The frequency and intensity of wildfires in Colorado have been on the rise in the last decades with many of them taking place in forests and mountain areas. Small to medium fires are widespread whereas a few large fires contribute to most of the burned area. The last few years indicate greater activity and new hotspots, which are caused by mixture of climatic conditions, land cover and human activity.

References

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