Investigating Wildfire Frequency Across the Western United States Using GIS

Rituraj Yadav (yadaritu@isu.edu), Keith T. Weber, and Kindra Blair
ISU GIS Training and Research Center

Introduction

Wildfires in the western United States have become larger, longer-lasting, more frequent, and more destructive in terms of lives lost and economic costs. Studies have found that 61% of the total area burned in the western United States occurred since the new millennia. Yet, only 11% of western US has experienced a wildfire (figure 1).

Objective

This study sought to determine the cause of increasing wildfires frequency between 1950 and 2017. This study focused on weather and climate variables to understand their effects on the changing wildfire regime.

Methods

- Wildfire GIS data was acquired from the USGS, USFS, BLM, and state sources to form the Historic Wildfires Database.
- Historic Wildfire Database is limited to 11 western states wildfire data from 1950 to 2017.
- The effects of climate variables were studied at three levels – Western US, Idaho Ecoregion 16, and Watershed Basin 16 (figure 2).
- These data were analyzed using Esri's ArcGIS PRO using tools such as Clip, Zonal Statistics, and SQL. Other software such as Excel, R, and Jmp were used for statistical analysis.

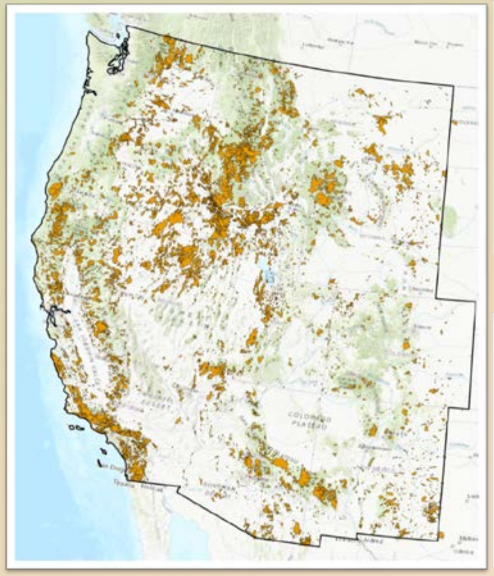


Figure 1: Spatial distribution of wildfires across the western US (1950-2017)

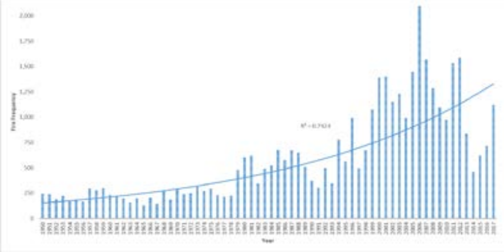


Figure 3: Fire frequency across the western US (1950-2017)

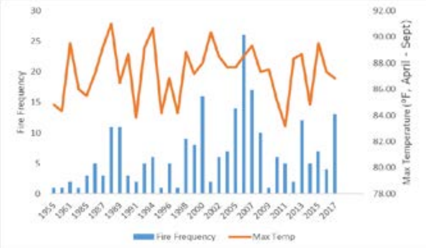


Figure 6: Correlation between T_{max} and fire frequency in administrative basin 77

Figure 4: Correlating the Pacific Decadal Oscilation with fire frequency

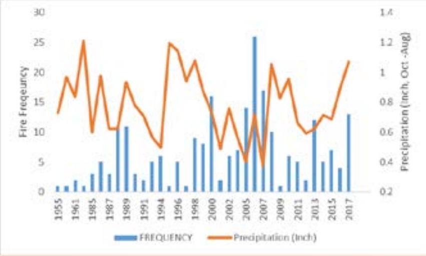


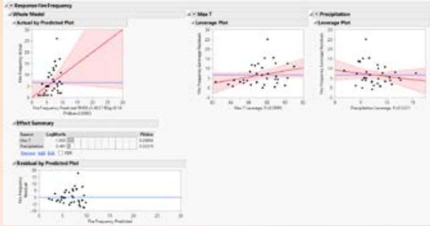
Figure 7: Correlation between precipitation and fire frequency in administrative basin 77.

Figure 2 : Distribution of wildfires in administrative basin 77, Idaho

All Fires 1950-2017	
Majority	PCT
Conifer	38%
Shrubland	44%
Grassland	12%
Riparian	0%
Hardwood	6%
Hardwood-Conifer	1%
Sparse	0%
	100%

Fires after 2000	
Majority	PCT
Conifer	42%
Shrubland	39%
Grassland	13%
Riparian	0%
Hardwood	5%
Hardwood-Conifer	1%
Sparse	0%
	100%

Figure 5: Vegetation Burned during the wildfire over the decades



Summary of Fit	
RSquare	0.141998
RSquare Adj	0.088372
Root Mean Square Error	5.402111
Mean of Response	6.6
Observations (or Sum Wgts)	35

Figure 8: Multiple regression of weather and climate variables and fire frequency in administrative basin 77.

SUSCEPTIBILITY	HAZARD	IGNITION SOURCE
Fuel (load, continuity)	Winter snow pack/SWE	Lightning
Soil moisture	Precipitation	Anthropic
Topography (aspect)	Temperature	
Other intrinsic factors	RH (approx. thresholds	
Past fire history	<15% day and <40% night)	

Figure 9: Essential conditions required for a wildfire to occur.

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Results

- Increase in mega-fires (>100,000 acres) (figure 3).
- Pacific Decadal Oscillation played a minor role in explaining changing fire frequency (R^2 = 0.000608) (figure 4).
- Coniferous forests showed an increase in fire frequency over time (figure 5).
- At the watershed scale, T_{max} best correlated with fire frequency (R^2 =0.11 (figure 6).
- Precipitation had the second highest correlation (R^2 = 0.06) (figure 7).
- Multiple regression between all weather/climate variables as drivers of fire frequency was relatively weak (R^2 = 0.14) (figure 8).

Conclusion

It can be concluded that weather and climate has a minimal effect on our changing fire regime. It is possible that land management practices are the primary cause of increasing wildfire frequency (figure 9).

Acknowledgement

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