NH21B-0658: RAINFALL CONDITIONS OF POST-FIRE DEBRIS FLOWS BETWEEN 2013-2023 ACROSS ECO-REGIONS IN CALIFORNIA

Silvana Castillo*, Charles Jones
Department of Geography, UC Santa Barbara

*Contact: s_castilloguerra@ucsb.edu
Abstract ID: 129393

Introduction

Post-Fire Debris Flows (PFDFs) are the result of the interaction between wildfire and precipitation events, that when occur consecutively or as cascading events can lead to extreme impacts.

The need to understand better rainfall conditions triggering debris flows in previously burned areas is increasing as wildfire activity rises across California, especially for regions not extensively studied such as Central and Northern California. Therefore, this study seeks to analyze the statistical distribution of rainfall variables associated to PFDFs across ecoregions in California to determine their relevance in the definition of rainfall thresholds.

Methods

- Compilation of post-fire debris flows (Fig 1) from existing inventories (e.g. California Geological Survey, 2021; Kirschbaum et al., 2010) and classified them into any of the 13 ecoregions in (Griffith et al. 2016).

- Associate PFDFs to nearest station to compute rainfall variables such as duration, antecedent rainfall and intensity at 15, 30, 60 min.

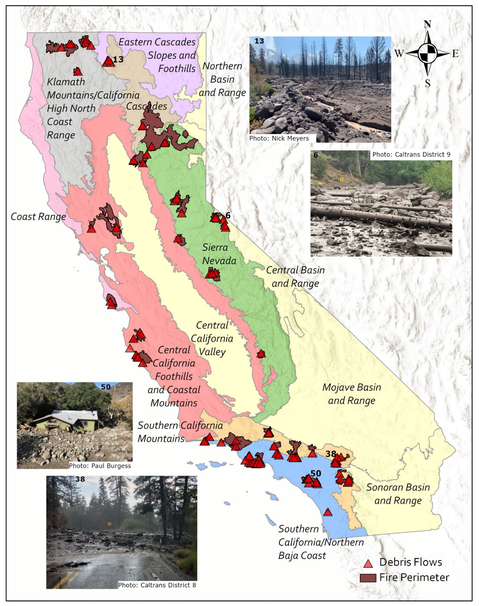

Fig 1. Post fire debris flow events documented in ecoregions in California

- Kruskal-Wallis and Wilcoxon rank-sum tests were used to find statistical significance in the distribution of rainfall variables among and between regions.

- Identification of precipitation clusters of daily antecedent rainfall using Daymet dataset (Thornton et al. 2014) by assuming the number of precipitation events in a time window was above the 95th percentile of the Binomial distribution (Becvaqua et al., 2021).

Results

- 72% of the post-fire debris flows were concentrated in fall and winter months while the remaining in the spring and summer months with no occurrences in April and May.
- Duration values of storm events were lower in summer and spring months contrary to average rainfall intensity values which were found higher in the summer, followed by fall and winter seasons.
- Storm duration values are similar in Southern CA Mountains, Sierra Nevada and Klamath Mountains (Fig 2a).
- Cumulative rainfall can be used to differentiate southern regions from all others except Klamath Mountains (Fig 2b).
- Hypothesis testing of same distributions in average intensity values among regions in California was found not significant (p- value >0.05) i.e., could not be rejected (Fig 2c).
- Central California has peak 15, 30 min intensity values as events in Sierra Nevada and Southern CA Mountains (Fig 2d, 2de).

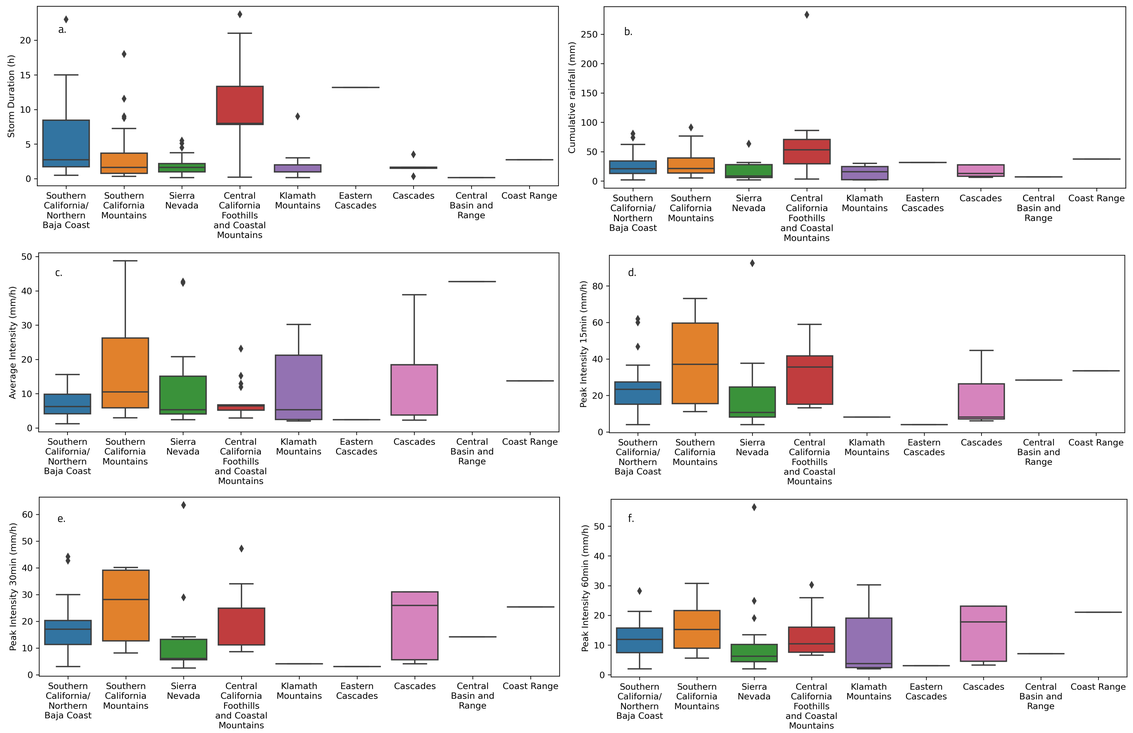

Fig 2. Statistical distribution of a. Storm duration, b. Storm cumulative rainfall, c. Storm average intensity, d. Peak 15 min intensity, e. Peak 30 min intensity, f. Peak 60 min intensity

- Antecedent 24h and 48h rainfall values prior to initiation of PFDFs in Sierra Nevada are similar to those in Southern California regions.
- Precipitation clusters are rare in the summer season, with 94% predominant occurring in the cool season (October-March).
- ~70% of PFDFs were preceded by precipitation clusters of ≤ 5 days, especially in Southern CA.
- Precipitation clusters were mostly found in Southern regions (68%) as well as Central California (19%) with the longest (24 days) located in the latter area and in the Eastern Cascades (Fig 3).

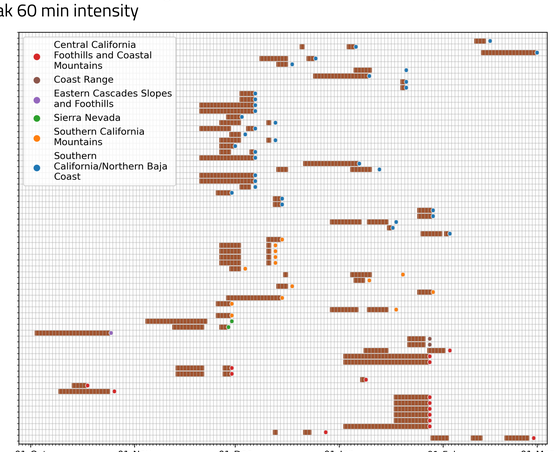

Fig 3. Precipitation clusters of daily antecedent rainfall prior to PFDF occurrence date

Conclusions

- Storm average intensity is not a good indicator to differentiate the occurrence of PFDF in regions in California.

- Storm duration, cumulative as well as antecedent rainfall could be useful metrics to distinguish events in Southern California and Sierra Nevada regions from other geographical areas in the state.

- Similar peak 15,30 min intensity distributions in Sierra Nevada, Central and Southern CA Mountains opens the discussion to consider using analogous values for thresholds in these regions.

- Precipitation clusters of antecedent rainfall are relevant in the fall and winter months with durations of ≤ 5 days, mostly in Southern CA.

Acknowledgments

This research was funded by the University of California Office of the President Laboratory Fees Program (Grant ID: LFR-20-652467) and by the 2021 Colombian Fulbright Commission-Minciencias grant sponsored by the U.S. Department of State. The contents are solely the responsibility of the authors and do not necessarily represent the official views of the Fulbright Program, the Government of the United States, or the Colombian Fulbright Commission.

References

Bevacqua, E., De Michele, C., Manning, C., Couasnon, A., Ribeiro, A. F. S., Ramos, A. M., et al. (2021). Guidelines for Studying Diverse Types of Compound Weather and Climate Events. Earth's Future, 9(11), e2021EF002340. https://doi.org/10.1029/2021EF002340

California Geological Survey, California Department of Conservation. (2021). Reported California Landslides Database https://services2.arcgis.com/zr3KAIbsRSUyARHG/arcgis/rest/services/Reported_Landslide_Events_Web_Service/FeatureServer. Accessed November 7 2022.

Griffith, G.E., Omernik, J.M., Smith, D.W., Cook, T.D., Tallyn, E., Moseley, K., Johnson, C.B. (2016). Ecoregions of California (poster): U.S. Geological Survey Open-File Report 2016–1021, with map, scale 1:1,100,000. http://dx.doi.org/10.3133/ofr20161021

Kirschbaum, D.B., Adler, R., Hong, Y., Hill, S., Lerner-Lam, A. (2010). A global landslide catalog for hazard applications: method, results, and limitations. Natural Hazards, 52, 561-575. https://doi.org/10.1007/s11069-009-9401-4

Thornton, P.E., M.M. Thornton, B.W. Mayer, N. Wilhelmi, Y. Wei, R. Devarakonda, and R.B. Cook. (2014). Daymet: Daily Surface Weather Data on a 1-km Grid for North America, Version 2. ORNL DAAC, Oak Ridge, Tennessee, USA. Accessed June 27, 2023.