Institute of Transportation Studies
UNIVERSITY OF CALIFORNIA

Wildfire Evacuation Planning Can Be Greatly Enhanced by Considering Fire Progression, Communication Systems, and Other Dynamic Factors

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November 2021

Issue

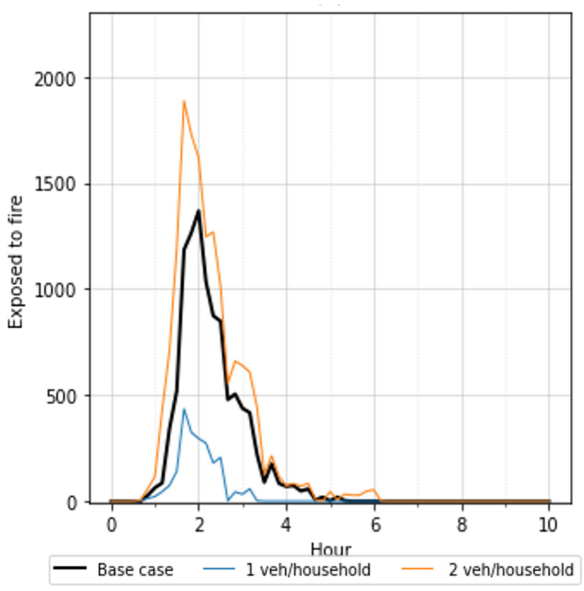
Wildfires have become a perpetual crisis for communities across California. For life-threatening wildfires, mass evacuation often becomes the only viable option to protect lives. Yet, looking back at recent events, including the devastating 2018 Camp Fire in Northern California, there are significant challenges associated with the evacuation process, such as multi-agency coordination, agency-resident communication, and management of extraordinarily high amounts of traffic within a short period of time.

Currently, emergency planners use evacuation models that are typically based on existing traffic simulation models; however, it is increasingly clear that other factors need to be considered, such as fire progression and communication systems. To address this gap, UC Berkeley researchers constructed a framework and set of models that include the combined impacts of three dynamic processes on evacuations – fire progression, communication systems, and traffic flow. The framework and models were applied to two case studies in California: the town of Paradise and the unincorporated community of Bolinas. In the Paradise case, the scenarios were based on the 2018 Camp Fire event. For the Bolinas case, the scenarios were based on hypothetical wildfire events.

Key Research Insights

Maintaining safe and normal operations on key evacuation routes should be the top priority. In the case of Paradise, with a population of 26,682, there are 4 to 5 roads that connect the town to the outside. If critical evacuation routes are closed due to fire-induced hazards, it is almost impossible to safely evacuate the whole town when faced with a rapidly progressing fire. Preemptive actions should be taken to maintain safe and normal operations on these routes, such as removing dead trees and/or securing electric lines that might fall and block the roads. Reducing the number of vehicles participating in the evacuation will also help maintain normal operations (Figure 1). This

Figure 1. The number of vehicles used by each household to evacuate affects how many vehicles are exposed to fire overall and how long they are exposed



may entail educational campaigns targeted to residents on the importance of packing only essential belongings in order to save vehicle space for household members and/or neighbors.

Communication infrastructure is critical for evacuations, but often overlooked. Wildfires can cause significant damage to cellular communications infrastructure or its power supply. A loss in agency-to-resident communication or cross-agency communication can quickly derail evacuation plans if not considered in the planning process. As an example, the 2018 Camp Fire significantly damaged cellular communications, which undermined cross-agency communication. In turn, certain strategies, such as adjusting traffic signals or initiating contraflow (i.e., allowing vehicles to travel in the opposite direction of a lane's normal traffic flow), were too difficult to implement or coordinate. In addition, evacuees were unable to access valuable real-time information during the evacuation process[1]. Also, in one of the scenarios created for Bolinas, a wildfire was assumed to cause a 50 percent reduction in cellular communications capacity, which increased the time needed to notify the public to evacuate by 150 minutes. In a scenario with no cellular communications (i.e., 100% reduction), the time increased by 330 minutes.

Evacuation planning should consider how many residents may need to shelter-in-place. Some residents may not be able to evacuate or may be stuck in gridlock. In the case of Bolinas, if the one evacuation route out of town is blocked, then the whole population will need a safe place to shelter. The capacity and location of safe shelters, such as parking lots or fire-proof structures, should be included as part of scenario planning.

Evacuation strategies are context specific. A significant danger unique to Bolinas is the close proximity of the evacuation route to flammable eucalyptus trees. If a fire develops rapidly within the community while the only evacuation route is blocked by burning or fallen trees, the evacuation simulation showed a buildup of vehicles being trapped between the fire front and the blocked roads. Another unique consideration for Bolinas is the large number of recreational visitors, who may not have the same access to local communication networks as the residents.

More data on evacuee behavior will improve evacuation planning. Simulation and modeling tools are only as good as the input data. To improve the usefulness of these tools, it would be helpful to have more accurate data on how long it takes for households to evacuate once an order is given and received, the number of vehicles a household uses to evacuate, evacuees' routing preferences, and evacuees' choices for safe destinations. Some of these unknowns could be obtained by survey information. Other behavior, particularly choice of evacuation route, is harder to predict due to the lack of both a viable theory of individual routing decisions in emergency evacuations, and empirical data needed to validate any such assumptions.

More Information

This policy brief is drawn from the report " Integrating Traffic Network Analysis and Communication Network Analysis at a Regional Scale to Support More Efficient Evacuation in Response to a Wildfire Event", authored by Kenichi Soga, Ph.D.; Louise Comfort, Ph.D.; Bingyu Zhao, Ph.D.; Paola Lorusso, MSc.; and Sena Soysal of the University of California, Berkeley. The report can be found at www.ucits.org/research-project/2020-29. For more information, contact Kenichi Soga at soga@berkeley.edu.

[1] Comfort, Louise, Kenichi Soga, Mark Stacey, Millard McElwee, Chiara Ecosse, Jillian Dressler, and Bingyu Zhao. "Collective Action in Communities Exposed to Recurring Hazards: The Camp Fire, Butte County, California, November 8, 2018." Boulder, USA: University of Colorado Natural Hazards Center, 2019. https://hazards.colorado.edu/quick-response-report/collective-action-in-communities-exposed-to-recurring-hazards.

Research presented in this policy brief was made possible through funding received by the University of California Institute of Transportation Studies (UC ITS) from the State of California through the Public Transportation Account and the Road Repair and Accountability Act of 2017 (Senate Bill 1). The UC ITS is a network of faculty, research and administrative staff, and students dedicated to advancing the state of the art in transportation engineering, planning, and policy for the people of California. Established by the Legislature in 1947, the UC ITS has branches at UC Berkeley, UC Davis, UC Irvine, and UCLA.

Project ID UC-ITS-2020-29 | DOI: 10.7922/G23T9FJG