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Authors

Ermagun, Alireza

Thompson, Diego

Vahedifard, Farshid

et al.

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Emergency Managers' Challenges with Wildfires and Related Cascading Hazards in California

Alireza Ermagun¹, Diego Thompson², Farshid Vahedifard³, Roxane Cohen Silver⁴

¹Department of Geography and Geoinformation Science, George Mason University, 4400 University Dr., Fairfax, VA, 22030, USA. Email: aermagun@gmu.edu

²Department of Sociology, Mississippi State University, 465 Hardy Road, 207 Bowen Hall, Mississippi State, MS 39762, USA

³Department of Civil and Environmental Engineering, Tufts University, 200 College Avenue, Anderson Hall, Medford, MA 02155, USA

⁴Department of Psychological Science; Department of Medicine; Department of Health, Society, and Behavior; and Department of Population Health and Disease Prevention; University of California, Irvine, Irvine, CA 92697, USA

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Emergency Managers' Challenges with Wildfires and Related Cascading Hazards in California

ABSTRACT

This study investigates the complexities faced by emergency managers in wildfire-prone areas to uncover pressing issues and potential solutions. Four themes are discerned through three focus group discussions with emergency managers from nine counties across California. First, there is unequal access to resources for both risk assessment and response, with counties that have fewer resources facing significant challenges in effectively managing wildfire risks. Second, effective risk communication depends on the available resources and the unique characteristics of each community. Participants stress the need for improved communication tools to reach vulnerable groups (e.g., seniors, individuals with disabilities, non-English-speaking residents). Third, the complexity and confusion surrounding multi-level collaboration in wildfire management is a recurring theme. Participants note that unclear roles and responsibilities between state and federal agencies hinder response efforts, underscoring the need for better coordination and transparent communication at all levels. Fourth, innovative responses (e.g., creative evacuation strategies, collaborative efforts) are recognized as imperative for managing wildfires and their cascading impacts in resource-constrained areas. The findings highlight that achieving equitable and effective preparation, response, and resilience for vulnerable communities requires a comprehensive understanding of wildfire severity and community susceptibility, coupled with active collaboration among emergency managers, policymakers, and both governmental and non-governmental organizations.

Keywords: Wildfires, cascading hazards, emergency managers, emergency response, communities, disadvantaged communities, risk communication

HIGHLIGHTS

- Unequal resource access poses challenges in wildfire risk assessment and response.
- Effective risk communication requires tailored tools for vulnerable populations.
- Multi-level collaboration suffers from unclear roles, hindering wildfire response.
- Innovative evacuation strategies are essential in resource-constrained areas.
- Collaboration is key to equitable and effective wildfire management and resilience.

INTRODUCTION

The spread and impact of wildfires in California continue to increase at an alarming rate. While the annual number of wildfires has varied since the inception of records in 1980, the 5-year average of total acres burned has increased nearly threefold, from 672,280 acres in 1991 to 1,667,011 acres in 2024 (CalFire, 2024). The California Department of Forestry and Fire Protection reported 7,934 wildfires that burned 1,049,452 acres, prompted 573,757 emergency responses, damaged 397 infrastructures, and destroyed 1,680 structures (CalFire, 2024). Echoing the trend of the 2020s, the increase in climate hazards in 2024 is surpassing that of previous years, featuring a high frequency, high cost, and wide range of extreme events. This trend is expected to persist and become the “new normal” for climate-induced events.

The intensification of wildfire activity, driven by climate change and alterations in land-use patterns, has disproportionately impacted socioeconomically disadvantaged communities (Davies et al., 2018; Akter & Grafton, 2021; Auer & Hexamer, 2022). Approximately 12 million of the over 29 million individuals residing in high-risk, fire-prone regions of Northern California belong to communities with limited capacity to withstand the impacts of wildfires (Zuzak et al., 2024). This challenges emergency managers to assess the severity of wildfire risks, identify vulnerable communities, and implement timely and appropriate responses. The challenges in managing wildfires are substantial, as any error can lead to human disaster or trigger cascading events (Vahedifard et al., 2024). Against the backdrop of challenges, the decision-making process is confronted with (i) managing species-at-risk, (ii) competing land uses (Donovan et al., 2017; Skatter et al., 2017), (iii) non-market benefits (Venn & Calkin, 2011), (iv) wildland-urban interfaces, industrial developments, and critical infrastructure (Johnston & Flannigan, 2017), (v) concerns regarding smoke management (McLenna & Pankratz, 2017), (vi) climate change’s reverberations (Flannigan et al., 2009), and (vii) the evolving variability of management costs (Stocks & Martell, 2016). The challenges might mount further as the intricacy and scale of wildfires are expected to amplify; long-term projections of a warming climate predict more extended and fiercer fire seasons (Flannigan, 2013), marked by increased frequency and intensity (Jolly et al., 2013).

With the increasing number of acres burned each year in some regions and the growing population residing in or near wildfire-prone areas, managing emergency responses has become increasingly complex (Tymstra et al., 2020). The challenge of managing wildfire risks requires careful risk assessment and timely warnings for communities. Federal resources (e.g., Federal Emergency Management Agency, National Wildfire Risk Assessment) provide wildfire risk data to local and state administrators, yet effectively communicating these risks to communities remains a persistent challenge. Effective communication is necessary for coordinating large-scale decisions (e.g., mobilizing and distributing resources for fire suppression). This requires understanding the challenges faced by emergency managers in coordinating responses, overcoming resource constraints, and ensuring that response strategies are both timely and effective in improving wildfire management.

Previous research emphasizes that (i) community engagement is integral to successful wildfire risk planning at the community level, and (ii) collaboration and comprehension from communities grappling with wildfire risk are motivated by reciprocity and trust, developed through interactions characterized by “openness,” “mutual commitment,” and “willingness to share” (Goldstein & Butler, 2010). The present qualitative study draws on existing literature identifying specific challenges and opportunities to confront difficulties related to risk assessment and communication during wildfires and related cascading hazards. We seek to analyze the experiences and perspectives of emergency managers of nine counties across California through focus groups, with two specific objectives. First, we offer a focused examination of the challenges and opportunities associated with risk assessment and communication in the context of wildfires and cascading hazards. This contributes to a nuanced understanding of how risk perception, resource limitations, and institutional dynamics intersect to shape preparedness and response strategies. Second, we identify obstacles and avenues for enhancing efficacy and feasibility of emergency readiness, responses, and strategies for such communities.

The remainder of this article is organized as follows: (i) a review of the literature to provide background on the concept of social vulnerability and the challenges associated with risk perception, preparedness, mitigation, and recovery; (ii) an introduction to our study area; (iii) a summary of the methodology used; (iv) an analysis of focus group discussions to

explore the perspectives of emergency managers regarding risk assessment, risk communication, and lessons learned; and (v) a discussion of the study's implications, along with suggestions for future research.

BACKGROUND

Risk perception and preparedness are intricately intertwined, exerting an influence on the social vulnerability of communities to wildfires. How individuals perceive the potential risks associated with wildfires shapes their willingness to engage in preparatory measures and follow evacuation orders (Thompson et al., 2017). Communities with heightened risk perception are more likely to proactively prepare for wildfires by adopting mitigation strategies, participating in evacuation drills, and staying informed about emergency protocols. On the other hand, lower risk perception can lead to complacency and reduced preparedness efforts, rendering communities more susceptible to the devastating impacts of wildfires. The synergy between risk perceptions and preparedness can then be used to determine socially vulnerable communities (Champ & Donovan, 2013; Lambrou et al., 2023).

In vulnerable and disadvantaged communities, a paradoxical dynamic often unfolds, wherein residents perceive themselves as being at high risk to wildfires yet face significant barriers to preparedness. This dichotomy arises from a complex interplay of demographic and socioeconomic factors and systemic challenges. While these communities may be acutely aware of their heightened susceptibility to wildfire hazards, their capacity to translate this awareness into concrete preparedness actions is hampered by limited access to resources. Economic constraints can impede residents' and communities' ability to invest in protective measures such as fire-resistant infrastructure, evacuation kits, and insurance coverage (Brodie et al., 2006; Collins, 2008; Cutter et al., 2012). In addition, the misallocation of resources by officials can exacerbate the vulnerability of these communities, diverting funds away from their specific needs and leaving them ill-equipped to cope with the impending threat of wildfires (Méndez et al., 2020; Ojerio et al., 2011). One example is the neglect of the needs of undocumented Latino and Indigenous immigrants in California's Central Coast during the Thomas Fire, where local advocacy groups had to fill the gap by distributing masks and translating emergency information into Spanish and Indigenous languages (Méndez et al., 2020). Another example is the allocation of resources by federal wildfire mitigation programs based on biophysical risk while underfunding socially vulnerable populations, as seen in Arizona, where socially disadvantaged communities often do not participate in mitigation programs despite being at high wildfire risk (Ojerio et al., 2011). For this reason, the dissonance between perceived risk and actual preparedness emphasizes the urgent need for targeted interventions that empower vulnerable communities to bridge this gap and enhance their resilience in the face of wildfires (McWethy et al., 2019).

Vulnerable communities, burdened by economic constraints and resource scarcity, often find themselves disproportionately excluded from mitigation efforts that could bolster their resilience. Mitigation measures (e.g., defensible space creation, vegetation management, retrofitting structures) demand financial investments that may be beyond the means of these communities. Consequently, their vulnerability persists, perpetuating a cycle where the lack of resources hampers their ability to implement effective mitigation strategies, leaving them exposed to the full brunt of wildfire impacts (Anderson & Plantinga, 2020; Moritz et al., 2022; Ojerio et al., 2011). The allocation of resources often prioritizes areas with higher economic or political value considering cost-benefit analyses that focus on maximizing return on investment. This approach can unintentionally overlook the needs of vulnerable communities, as officials weigh the density of valuable infrastructure against the necessity of mitigating risks in underserved areas. While this is not inherently a systemic bias, it does create challenges in striking a balance between maximizing resource efficiency and addressing the needs of the most vulnerable. This tension is a common issue in wildfire mitigation, where political and economic considerations may shape priorities.

The repercussions of inadequate preparedness and deficient mitigation strategies extend far beyond the immediate wildfire event. The absence of effective preparedness measures can amplify the difficulties of post-wildfire recovery, leaving individuals and communities struggling with the arduous task of rebuilding their lives. The process of physical reconstruction is underscored by emotional hurdles as residents must learn to rekindle a sense of comfort and belonging in an environment once considered their haven, now blemished by the scars of disaster. Equally crucial is the journey

toward rebuilding trust and relationships with emergency responders and officials who bear the responsibility of safeguarding the community (Rasch & McCaffrey, 2019).

STUDY AREA

Our efforts, supported by the National Science Foundation (NSF) and the U.S. Department of Agriculture (USDA), enabled the research team to establish a close collaboration with community partners, emergency responders, and public officials in California. We conducted face-to-face and virtual meetings with the California Office of Emergency Services, the Access and Functional Needs Division, and the Sacramento Police Department to help define at-risk communities. Nine counties (Lake County, Mendocino County, Humboldt County, Siskiyou County, Contra Costa County, Placer County, Yolo County, Santa Barbara County, and San Bernardino County) were identified as vulnerable communities with dwindling resources and growing multi-hazard threats, which was ideal for the scope and focus of our research. These counties are geographically dispersed across northern, central, and southern California. Lake, Mendocino, Humboldt, and Siskiyou Counties are located in the northern part of the state, approximately 100–250 miles (160–400 km) north of San Francisco and within 50–80 miles (80–129 km) east of the Pacific Ocean. Contra Costa, Placer, and Yolo Counties are situated in the central portion, roughly 20–90 miles (32–145 km) northeast of San Francisco and surrounding Sacramento. Santa Barbara County lies along the central California coast, approximately 100 miles (160 km) northwest of Los Angeles, while San Bernardino County spans the southern portion of the state, approximately 60 miles (97 km) east of Los Angeles. These nine counties are home to over 4.7 million residents. Their demographic composition reveals considerable diversity, with over 39% of the population identifying as Hispanic or Latino. The median household income is \$49,187, and 9% of the population lives below the poverty line. Reflecting additional challenges, 6% of individuals live with disabilities, and 8.7% of the population is aged 65 or older. The rate of individuals with a bachelor's degree or higher is 31.7%, indicating that these counties exhibit key characteristics of an at-risk community, with a significant portion of its population facing socioeconomic vulnerabilities.

California has experienced 386 federal disaster declarations since 1953, with 113 (30%) occurring after 2015. The primary emergencies have been wildfires (289), floods (41), and severe weather storms (23). The state has been severely affected by wildfires, with over 75% of the counties burned since 2015. Such a trend accentuates the pressing necessity for well-structured strategies in disaster preparedness and response. The state finds itself in the crosshairs of multiple significant hazards, further exacerbated by the shifting climate. Wildfires, debris flows, droughts, and floods loom as imminent threats.

According to the Federal Emergency Management Agency (FEMA) National Risk Index (Zuzak et al., 2024), community resilience, social vulnerability, and annual loss are key factors in assessing fire risk. California has a community resilience score of 33.31, a social vulnerability score of 58.77, and an expected annual loss score of 30.46. These scores indicate low resilience, high annual loss, and high vulnerability, suggesting that the risk of wildfires in this region is relatively high. The spatial distribution of wildfire risk across California and the selected nine counties is illustrated in Figure 1. The figure illustrates the spatial disparities in wildfire risk across the nine counties, with Lake, Siskiyou, and Mendocino exhibiting the highest levels of wildfire vulnerability, positioning them in the upper range of risk. Among the high-risk counties, Lake County is particularly notable. With a population exceeding 68,000, it has faced a recent population decline, primarily driven by wildfire-induced housing loss. Lake County has endured 14 major wildfires since 2015, resulting in over 60% of its land area burned, underscoring its heightened susceptibility to fire hazards. These vulnerabilities arise from a combination of factors, including a significant population of seniors, individuals with disabilities, and those with Access and Functional Needs (AFN), along with remote and isolated communities, rugged terrain, and a struggling local economy. A changing climate increases the potential for more severe firestorms, a risk further amplified by high fuel loads and geographic features that facilitate both natural and human-caused fires. This confluence of factors, combined with the typical weather conditions (e.g., droughts, high temperatures, low humidity, gusty winds) creates a volatile environment, heightening the risk of frequent and catastrophic wildfires.

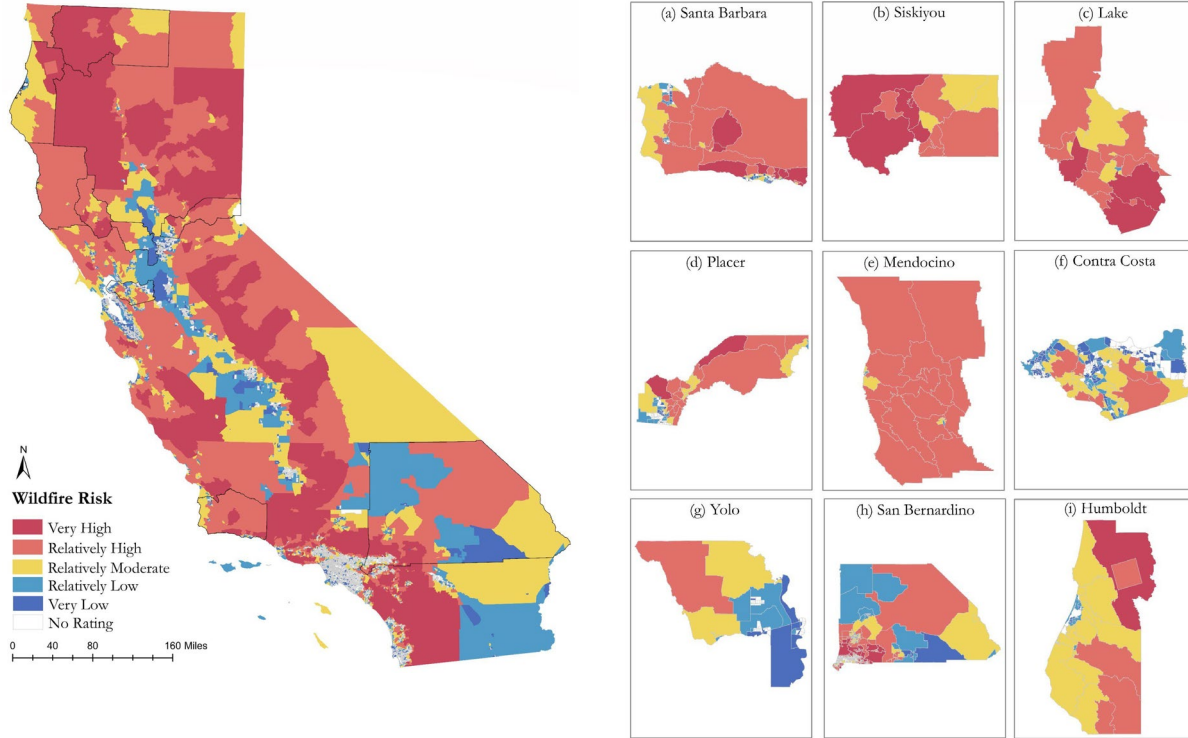


Figure 1 Spatial distribution of wildfire risk in nine counties of California: (a) Santa Barbara, (b) Siskiyou, (c) Lake, (d) Placer, (e) Mendocino, (f) Contra Costa, (g) Yolo, (h) San Bernardino, (i) Humboldt. The information is extracted from the national risk index (Zuzak et al., 2024).

METHODOLOGY: A QUALITATIVE STUDY

We employed an exploratory qualitative approach to investigate the multifaceted challenges faced by emergency managers actively engaged in managing wildfires and associated cascading hazards, including debris flows and landslides, within California. To recruit participants, we collaborated with the Sacramento Police Department and the Lake County Sheriff's Office, which assisted in identifying relevant personnel. Additional emergency managers were also contacted using a compiled list of professional networks, leveraging resources such as the U.S. Chamber of Commerce, local disaster recovery professionals, and economic advisory organizations. Invitations to participate in focus group interviews were extended via telephone and email.

Emergency personnel from nine counties across California volunteered to participate in three focus group sessions. Table 1 provides an overview of the participants, including their roles and the distribution across the focus groups. The decision to divide participants into three groups was informed by two key considerations: (i) ensuring the discussions remained focused and manageable to allow for in-depth engagement, and (ii) accommodating the varying availability of the emergency managers. The focus group sessions were conducted during the winter of 2020–2021.

At the outset of each session, participants were provided with a full explanation of the study's purpose and scope. Informed consent was obtained, including agreement to record the discussions. Emergency managers were asked a comprehensive list of questions developed by the research team. Table 2 depicts the questions. During the sessions, participants reflected on their experiences, sharing insights on key challenges related to risk assessment, communication with vulnerable communities, and strategies for responding to wildfires and linked hazards.

Table 1 Summary of the focus groups

Group No.	No. Participants	Participant Roles
1	4	Emergency Manager Emergency Coordinator Emergency Manager Director of Office of Emergency Management
2	3	American Red Cross Volunteer Logistics Chief Director of Operations and Emergency Management
3	7	Emergency Manager Emergency Manager Assistant Director of Emergency Management Emergency Manager Emergency Manager Emergency Manager Deputy Director of Emergency Management

Table 2 Inquiries for focus group discussions

Question No.	Inquiry
1	What information do you and your team use to assess the risk of wildfires and related hazards in your jurisdiction?
2	Once you assess that a community is at risk, how specifically do you go about communicating that risk information to residents? <ul style="list-style-type: none"> • That is, do you enlist traditional media, engage social media, or some other way of communicating? • Do you use radio messages, mass text, reverse phone calls, or email notifications? • Who writes the message? Do you test the message for understanding? • How much time before the expected hazard do you release the message? • How do you ensure that residents have received and understood the messages you send? • Do you do any debriefing after the risk has passed? That is, do you ever explain to the community why the initial risk assessment might have been inaccurate or incomplete?
3	How can we make disadvantaged communities less vulnerable to negative effects of cascading hazards? <ul style="list-style-type: none"> • Can you name specific social (e.g., emergency protocols, institutional coordination, more education or risk awareness) and technological (e.g., software, monitoring systems, modeling tools) resources? • What are the main challenges that communities experience as they cope with wildfires and connected hazards?
4	Could you share specific examples or stories from your jurisdiction where creative responses worked successfully to reduce risks and solve problems from natural hazards? <ul style="list-style-type: none"> • What groups and organizations were engaged in making creative responses to happen?

The analysis of focus group sessions followed a four-step process. First, each focus group session was recorded and transcribed verbatim to create a comprehensive dataset for analysis. Second, the transcripts were systematically coded according to the overarching themes of the study: (i) risk assessment, (ii) risk communication, and (iii) innovative response strategies. Supplementary insights and observations were documented as analytical memos during this phase to capture additional context. Third, two members of the research team independently analyzed the transcripts to ensure the reliability of the coding process. This independent review minimized potential biases and enhanced the consistency of the analysis.

Fourth, preliminary results were shared with community partners engaged in the project to strengthen the validity of the findings. A feedback session, held in Lake County during the summer of 2022, allowed individuals actively involved in disaster response to review and comment on the findings. This collaborative exchange not only validated the study's conclusions but also enriched the insights by incorporating practical perspectives from emergency management practitioners in the region.

This study was reviewed and approved as exempt by the Institutional Review Board (IRB) (Protocol ID: IRB-20-254) for the Protection of Human Subjects at Mississippi State University. The IRB exemption ensured that the research adhered to ethical guidelines for human subject protection while enabling the collection of rich qualitative data to understand the complexities of wildfire risk management.

FINDINGS FROM FOCUS GROUP DISCUSSIONS

This section examines the perspectives and experiences of emergency managers in (i) risk assessment, (ii) risk communication, (iii) disadvantaged communities vulnerability, and (iv) innovative response strategies they have employed in past emergencies.

Risk Assessment

The synthesis of risk assessment discussions responds to the question: What information do you and your team use to assess the risk of wildfires and related hazards in your jurisdiction? Several key themes emerged, reflecting the complexity of wildfire risk assessment and the diverse factors influencing emergency management decisions.

First, participants underscored their reliance on hazard mitigation plans and external risk assessment tools (e.g., Lake County Sheriff's Office of Emergency Services, 2023). Emergency managers emphasized the importance of resources such as FEMA guidelines and state-provided tools like the Fire and Resource Assessment Program (FRAP) for ongoing risk evaluation. These tools provide essential data (e.g., fire severity zones, population density, vegetation conditions) that are integral to assessing wildfire risk (Vahedifard et al., 2019). One participant explained: "We rely heavily on FRAP and Cal Fire's annual plan. It takes into account urban interfaces and vegetation risk, which are crucial for planning." This demonstrates how state-level tools inform the understanding of wildfire risks, particularly by incorporating local land-use characteristics and vegetation factors.

Second, the built environment emerged as a primary consideration in wildfire risk assessment, particularly in relation to evacuation routes and shelter accessibility (Ermagun & Janatabadi, 2024). Participants highlighted how geographical challenges (e.g., isolation, topography, narrow roads) complicate emergency response and evacuation efforts. One emergency manager noted: "When you start looking at your communities and your building planning, development, your types of residents within those communities, and other planning factors... that's an additional risk that isn't specific to the actual probability of fire." This statement underscores the importance of factoring in infrastructure constraints when assessing wildfire risk. Road conditions, limited access routes, and the lack of reliable transportation were identified as substantial barriers to timely evacuations. The long distances between evacuation routes and shelters posed particular difficulties for marginalized groups. One participant pointed out: "The distance is felt acutely by certain minority communities and by the elderly and people with disabilities as it is compounded by factors such as not having reliable personal vehicles or an ability to drive long distances." This statement exemplifies the challenges faced by disadvantaged communities during wildfires. The lack of personal transportation options and limited public transport exacerbates vulnerabilities, particularly when other evacuation routes are rendered impassable.

Third, participants emphasized that wildfire risks and outcomes are influenced by both the location and timing of the fire. Early risk identification was highlighted as essential for mitigating fire impacts, with one respondent describing the use of video cameras stationed on mountain tops to "identify small fires sooner, so resources can get to it faster." Ground-based camera systems, such as those used in ALERTWildfire, have been tested and deployed to assist firefighters and first responders in (i) discovering, locating, and confirming fire ignition, (ii) scaling fire resources up or down quickly, (iii) monitoring fire behavior during containment, (iv) enhancing situational awareness to aid evacuations, and (v) observing

contained fires to detect flare-ups. Many communities in California have access to wildfire cameras, which are monitored by Cal Fire around the clock. The timing of wildfire events introduces additional complexities for emergency management. Nighttime fires, in particular, pose unique challenges for response efforts due to communication delays and limited resource mobilization. As one emergency manager explained: “Any event that happens after dark, between dark and 6 a.m., is going to be a fast-moving event.” This insight underscores the heightened vulnerability during nighttime hours, when slower response times can exacerbate risks. Consistent with findings from previous studies (Grajdura et al., 2022), these observations reinforce the importance of early detection systems and timely communication strategies to facilitate faster evacuations and reduce the impacts of wildfires in high-risk situations.

Fourth, the role of collaborative networks in enhancing risk assessment was frequently mentioned. Participants discussed how cooperation among local, state, and tribal partners strengthens the robustness of their wildfire risk assessments. One participant explained:

“We brought in all the stakeholders, and the consultant facilitated a complete hazard identification and risk assessment process. Wildfire was a key component of that plan, ranked and assessed with input from the operational partners and tribes.”

This collaborative approach, integrating multiple stakeholders, is essential for providing a comprehensive understanding of the risks facing the community. By engaging diverse perspectives, emergency managers are able to incorporate broader expertise, leading to more robust risk assessments and more informed decision-making.

In sum, the synthesis of risk assessment discussions highlights a multi-dimensional approach to understanding wildfire risk, which takes into account hazard data, infrastructure limitations, and collaborative efforts. By leveraging state-provided resources, improving infrastructure, and fostering collaboration, emergency managers are better positioned to assess and mitigate the risks posed by wildfires and related hazards.

Risk Communication

The synthesis of risk communication discussions directly responds to the question: Once you assess that a community is at risk, how specifically do you go about communicating that risk information to residents? Participants emphasized the multifaceted approach to communication, underscoring how effective communication methods and tools influence the ability to reach at-risk populations.

First, the use of multiple communication channels served as a primary strategy for conveying risk information. Emergency managers rely on a range of platforms (e.g., radio broadcasts, public alert systems, social media) to disseminate wildfire risk information to residents. One participant stated: “I believe all the messages that are put out at this point... most of the messages that go out from the Emergency Operations Center are in English and Spanish.” This highlights the importance of ensuring inclusivity and accessibility in risk communication to guarantee all residents, including non-English speakers, receive the information. However, there was a mixed response regarding language accessibility. One emergency manager expressed no concerns with Spanish and English communication, stating that most messages were bilingual. In contrast, another participant noted: “I don’t know in terms of bilinguals, and we’re predominantly Spanish bilingual here, how much of that goes out, in other languages, just don’t know.” This comment reflects the ongoing challenge of adequately serving diverse language groups, particularly when communication efforts are limited to only English and Spanish, despite the presence in the community of groups who speak other languages.

Second, limitations in communication infrastructure, particularly the scarcity of reliable technology, hinder effective risk messaging in remote or rural communities. A primary concern raised by participants was the lack of cellphone service in certain areas. One emergency manager pointed out: “When you have a fast-moving event, as soon as you realize, essentially, you don’t have the resources to let people know, because... it doesn’t work.” This lack of infrastructure exacerbates the challenge of disseminating information during wildfire events in areas where connectivity is limited. Such gaps in communication infrastructure obstruct the timely distribution of important safety messages, further jeopardizing residents in high-risk areas.

Third, the importance of community-based communication strategies was highlighted throughout the discussions. Participants emphasized that, while technological tools are useful, fostering community engagement remains essential for ensuring risk information is both understood and acted upon. As one participant noted:

“The neighborhood, they all came together and realized that there’s an elderly lady that lives on the corner, and she’s going to get cut off, and the neighborhood kind of came together to take care of each other.”

This grassroots involvement enhances the effectiveness of risk communication by ensuring that even vulnerable populations who may not receive official alerts are looked after. Collaborative networks (e.g., community meetings, local emergency plans) also enable residents to act as intermediaries to help communicate and assist each other during emergencies. One participant added:

“Each neighborhood could kind of have an emergency planning meeting, and they would identify the at-risk residents within each one of these zones.”

This emphasizes the importance of integrating community-driven efforts into formal risk communication strategies, ensuring that all individuals, especially those most vulnerable, are supported.

The discussions underline that effective risk communication is not only about the transmission of information but also about tailoring the approach to the unique needs of vulnerable populations. This requires a combination of technological solutions and community engagement, which ensures that at-risk populations receive, understand, and act on risk messages. For example, in Lake County, several communities have implemented warning sirens, and the Sheriff’s Office utilizes LakeCoAlerts to send simultaneous voice calls, text messages, and emails. Nonetheless, technological limitations (e.g., inadequate cell tower coverage in certain areas) can still hinder timely communication. In such cases, community-based strategies (e.g., neighbor-to-neighbor checks, door-to-door evacuations) become essential. These combined approaches emphasize the need for both technological tools and neighbor-to-neighbor efforts to ensure effective risk communication during wildfire events.

Disadvantaged Communities Vulnerability

The synthesis of discussions related to how to make disadvantaged communities less vulnerable to the negative effects of cascading hazards reveals key strategies for addressing the multifaceted challenges faced by these communities in the context of wildfires and related hazards. The discussions pointed to the need for enhanced social and technological resources and identified barriers that hinder effective risk mitigation.

First, participants underscored the importance of social resources, particularly emergency protocols and institutional coordination, to improve community resilience. A key aspect identified was the need for comprehensive preparedness training for residents. One participant explained:

“Educating the community about what to do when a wildfire occurs is critical. It’s not just about informing them but also ensuring they understand and act on the information, especially those in vulnerable areas.”

This highlights the need for proactive education to equip residents with the knowledge and resources necessary to respond effectively in times of crisis. The integration of community engagement strategies was also emphasized as essential in fostering collaboration between residents and local authorities. One participant pointed out:

“We’ve learned that community participation is essential, not just for preparedness, but for response. When the community is actively engaged, they can better support their neighbors, especially in times of crisis.”

As highlighted in discussing the risk communication, effective communication strategies that integrate community participation are fundamental for empowering residents and building their capacity to respond to cascading hazards.

Second, technological tools were identified as integral for enhancing hazard management effectiveness. Emergency managers noted the value of software, monitoring systems, and predictive modeling tools that provide real-time data for emergency decision-making. One participant emphasized the role of real-time weather data: “Having access to real-time weather data, including wildfire risk predictions, can make a huge difference in our ability to warn and mobilize communities.” However, the challenge of ensuring equitable access to these technologies for all residents, particularly those in underserved areas, was also noted. One participant explained: “We have these tools, but not all of our residents have access to the technology or infrastructure to receive these warnings. That gap makes our efforts less effective.” This insight underscores the need for improving access to technology and infrastructure in disadvantaged communities to ensure that early warning systems are effective and inclusive.

Third, logistical challenges such as inadequate transportation and resource constraints emerged as barriers in managing cascading hazards. Participants noted that low-income residents, particularly those without reliable vehicles, face severe disadvantages during evacuation. One emergency manager highlighted: “Our low-income residents, especially those without reliable vehicles, are at a severe disadvantage during evacuation. It’s a logistical nightmare to ensure they can get out of high-risk areas in time.” This situation is exacerbated in rural areas, where resources are more limited, and manpower is stretched thin during peak wildfire season. As another participant explained: “In rural areas, we struggle with limited manpower, and during peak wildfire season, we’re stretched thin. We often don’t have enough personnel to reach all areas that need attention.” Addressing these gaps requires strengthening infrastructure, improving transportation networks, and ensuring more robust institutional support to effectively mitigate the impact of cascading hazards in disadvantaged areas.

Innovative Response Strategies

The synthesis of responses to the question, could you share specific examples or stories from your jurisdiction where creative responses worked successfully to reduce risks and solve problems from natural hazards? reveals several strategies that emergency managers have implemented to address the challenges posed by wildfires and cascading hazards. These examples underscore the adaptability and resourcefulness required to address the unique needs of communities at risk.

First, emergency managers shared creative evacuation strategies when traditional methods were insufficient. One notable example in a community near a lake involved evacuating by boat when roads were rendered impassable due to wildfire hazards. As one participant explained:

“We had to evacuate by water because the roads were cut off... the sheriff’s office and the community itself just gathered up to get people out of danger.”

This example demonstrates the resilience and quick thinking of local agencies and residents who devised an alternative strategy to evacuate at-risk individuals when standard procedures were unfeasible and notes that wildfire management requires flexible decision-making across varied geographic and temporal contexts, particularly when confronted with unanticipated challenges (Thompson & Calkin, 2011). The use of available resources in a novel way showcases the ability to respond effectively even when conventional methods are not feasible. Emergency managers noted in follow-up discussions that this approach is not broadly applicable as: (i) conditions that exacerbate wildfire risk may also generate lake conditions similar to those found in oceanic environments, (ii) evacuating entire neighborhoods with 2-6 people per boat is inefficient, and (iii) the possibility of using boats for future evacuations has been considered in internal discussions, but this method is not currently included in community planning frameworks.

Second, multi-level collaboration emerged as a critical strategy, although participants also noted the complexities of coordinating efforts across various levels of government. The overlap and confusion between federal, state, and local authorities can result in delays. One participant explained:

“One of the big confusing factors is the variety of different Federal and State funding sources that are made available after a major disaster. But what they don’t explain to you is that they’re dependent on one another.”

Navigating complex institutional frameworks, particularly when different levels of government have varying procedures and responsibilities, can lead to inefficiencies and delay critical disaster responses. Despite these challenges, participants acknowledged the importance of inter-agency collaboration, which remains fundamental to enhancing the effectiveness of disaster management and ensuring timely responses to wildfires and cascading hazards.

Third, technological tools were cited as important assets in improving evacuation processes and facilitating more effective responses. Emergency managers discussed the use of tools like Zone Haven, which enables them to create specific evacuation zones for neighborhoods. This tool improves resource allocation, ensuring targeted evacuations where they are most needed. As one participant noted:

“We used Zone Haven to create specific evacuation zones for each neighborhood, making it easier to identify at-risk individuals and coordinate evacuations more effectively.”

The integration of such tools enables more precise identification of high-risk areas and enhances the overall management of resources during wildfire events.

Fourth, community-driven solutions were emphasized as a powerful tool in addressing challenges related to vulnerable populations. One emergency manager shared an example where the neighborhood banded together to assist an elderly resident during a wildfire:

“The neighborhood, they all came together and realized there was an elderly lady who would get cut off. The neighborhood took responsibility for her evacuation, ensuring that someone checked on her and helped her get out when needed.”

This example illustrates the crucial role of local knowledge and grassroots efforts in supporting vulnerable populations when formal infrastructure may fall short. Community collaboration enhances disaster response efforts, particularly in regions where resources are limited and traditional emergency management systems may not fully address the needs of all residents.

These creative responses demonstrate that managing wildfire risks effectively requires a multi-pronged approach, involving local knowledge, inter-agency collaboration, technological tools, and community engagement. While challenges related to resource limitations and coordination persist, these strategies underscore the potential for more effective disaster management. By leveraging a combination of these resources, emergency managers can mitigate the risks posed by wildfires and cascading hazards, ultimately enhancing community resilience.

FINAL REMARKS

This study deepened the understanding of the challenges and opportunities that confront emergency managers when addressing wildfires and related hazards in vulnerable communities. In a landscape where research on this topic remains relatively scant in the United States, the findings presented herein adds to the existing literature on decision, risk, and management sciences. Our study revealed a recurring theme of emergency managers contending with disparities in resource distribution and availability, impinging on their efficacy in emergency response. While standardized tools for gauging risk and facilitating communication find application across states and counties, the local nuances of hazards and the vulnerabilities of specific groups result in notable variation. Consequently, there arises a call for locally tailored mechanisms (e.g., bilingual or multilingual communication resources, continuous monitoring of both anthropogenic and natural activities). Amidst the focus group outcomes, multi-level collaboration brings with it a suite of challenges: misinformation, communication breakdowns, and issues of coordination. Irrespective of such challenges, emergency managers emphasized the lessons garnered from past encounters with wildfires – lessons that reinforce the resilience of communities in marshaling locally accessible resources to tackle the blight of wildfires and their repercussions.

Emergency managers emphasized that the studied counties would not have succeeded in addressing previous wildfires and related hazards without the presence of existing hazard mitigation plans and ongoing efforts. However, additional measures

are underway to tackle region-specific challenges in wildfire risk management. One example is the ongoing effort to install route signs in Soda Bay in Lake County, where road congestion and dead-end streets complicate evacuations, guiding residents to safety. Another example is the implementation of year-round educational programs in Lake County aimed at enhancing community preparedness. These programs focus on ensuring that residents understand how to access alerts, obtain critical information, and develop personal emergency plans—empowering them to handle both anticipated and unforeseen challenges. Emergency managers in the region are committed to ensuring that no one is left behind, with a focus on both proactive planning and real-time response. This includes different communication strategies, such as providing instructions on receiving alerts and warnings. In addition, counties often rely on multiple communication channels (e.g., social media, traditional media, and official websites) to inform residents of incoming or ongoing emergencies. Effective communication is paramount, as the timely delivery of evacuation orders and the enforcement of compliance with these orders are essential to the success of emergency response efforts.

The lessons gathered from this study offer insights for addressing the challenges of wildfires and their cascading impacts. Achieving equitable and effective preparation, response, and resilience for vulnerable communities hinges on fostering active collaboration between emergency managers, policymakers, and both governmental and non-governmental organizations. First, the observations underscore the need for allocating resources more equitably, particularly in underserved areas, and ensuring access to communication tools that bridge language barriers and overcome technological limitations. Effective communication must encompass all community members, including the elderly, non-English speakers, and individuals experiencing homelessness. Second, the importance of multi-level collaboration is evident. Emergency management efforts must be coordinated across local, state, and federal levels, with a focus on aligning resources, responsibilities, and actions to enhance operational efficiency. Third, policymakers should consider these findings to inform decisions that empower vulnerable communities and integrate their needs into policy development. A shift toward inclusivity and responsiveness, driven by the lessons learned here, can significantly improve governance and resource allocation during emergencies. Fourth, working with community organizations, both governmental and non-governmental, is indispensable. Building community resilience requires a comprehensive approach that includes fostering engagement, promoting education, and cultivating a culture of preparedness. Initiatives focused on training and education not only strengthen individual readiness but also build collective resilience, helping communities withstand the effects of future hazards.

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