Opportunities to Improve Evacuation Compliance and Alert and Warning in Rural Communities to Increase Successful, Timely Evacuation During Wildfires

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Abstract

Public interest in wildfire and its potential effects on residential properties has increased following a series of high-profile wildfires involving loss of life and significant property damage, including the 2018 Camp Fire, 2020 Oregon Labor Day Fires, and 2021 Dixie Fire. The ability to evacuate rural residents in a timely and efficient manner is critical for their safety and public information officers must be prepared to support effective evacuation notifications. In rural areas, barriers to evacuation can include social characteristics, such as age, gender, and time in residence, that make residents less likely to evacuate, as well as technological limitations related to emergency alerts. This paper presents research supporting the need for public information officers to: understand the demographics of their communities; review local communications infrastructure and related risk factors; advocate for disclosure of the true efficacy of emergency alerting tools; and develop an alert and warning plan tailored to their communities' needs and the available infrastructure.

Keywords: wildfire, evacuation, IPAWS, emergency alerting, alert and warning

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Overview

Public information officers play an important role in emergency evacuations. In the western United States, they should be prepared to provide evacuation notification and support for emergency alerting during wildfires. Through literature review and a survey, this paper will explore two types of barriers public information officers must overcome in order to increase the successful and timely evacuation of rural residents during wildfire: individual barriers based on social characteristics and limitations of the emergency alerting system. The paper will outline the methodology used to reach the conclusions below, present results and findings based on the literature review and survey, reveal lessons learned, and summarize the key points for public information officers to consider.

Methodology

A literature review of existing research into the attitudes and behaviors of people during evacuation and the performance of emergency alert systems in rural areas is coupled with survey results collected following tests of the emergency alert system in rural areas of Lane County, Oregon.

Literature Review

When possible, the literature referenced in this paper is focused on wildfire evacuation and rural residents; however, the majority of existing literature covers different evacuation circumstances. A review of three reports related to the Integrated Public Alert & Warning System (IPAWS) was also conducted.

Survey

Lane County Emergency Management conducted a test of emergency alert tools in partnership with multiple rural fire districts in 2021 and 2022. A survey link was included in the test alert messages and 3,791 responses were collected. Of those respondents, 2,174 had an opportunity to identify barriers to taking immediate action. A review of the open-ended responses found six general evacuation barriers identified by respondents: animals, information confirmation, lack of transportation, delay to gather household or family members, general lack of preparedness to leave quickly, and health issues. Those responses were tallied and used to calculate which barriers were more prevalent among the responding residents.

Results and Findings

An analysis conducted by The Washington Post (Muyskens et al., 2022) shows nearly 16%, or 1 in 6, U.S. residents live in areas at risk of wildfire. The risk is expected to increase to 21% over the next 30 years. A report by Radeloff et al. (2018, p. 3314) defines the wildland-urban interface as "the area where houses and wildland vegetation meet or intermingle, and where wildfire problems are most pronounced." The report also found the number of homes in the wildland-urban interface grew from 30.8 million to 43.4 million between 1990 and 2010 – a 41% increase in only 20 years.

According to Booz Allen Hamilton (2015, p. iii), alongside more people living within the wildland-urban interface, climate change is affecting the length and severity of wildfire season:

> Driven largely by rising greenhouse gas emissions, climatic change across regions of the United States is driving increased temperatures— particularly in regions where fire has not been historically prominent … These factors are not only driving an increasing

prevalence of fire, but also are resulting in fires that increasingly exhibit extreme behavior.

The incidence of wildfires of 1,000 acres or more on federal lands managed by the U.S. Forest Service and Department of Interior in western states increased 1.7 times between 1980 and 2014. The incidence of wildfires of 25,000 acres or more across the same states increased 3.5 times (Booz Allen Hamilton, 2015).

The increasing number of people living in the wildland-urban interface, coupled with the growing size and severity of wildfires, requires emergency response officials to become more familiar and comfortable with evacuating growing numbers of people, including in areas with little to no communications infrastructure and with significant terrain challenges. In order to conduct successful evacuations, public information officers must understand two types of barriers to evacuation: the attitude of the people at risk toward evacuation, as well as the true ability to send emergency alerts.

In reviewing existing literature, it appears the majority of previous studies have focused on evacuation related to hurricanes and hazardous materials incidents.

In recognition of the gaps in research, the increase in wildfires in the wildland-urban interface, and the growing number of people at risk each fire season, this paper will focus on creating better understanding of barriers to evacuation for rural residents living in mountainous regions of the Pacific Northwest in order to better inform public information efforts related to evacuation.

The findings are organized into two sections. The first section focuses on barriers individuals face during an evacuation. The second section focuses on barriers to timely

emergency alerting in rural, mountainous areas. Understanding both is critical to public information officers' ability to craft effective evacuation communication plans.

Individual Barriers to Evacuation

Dash & Gladwin (2007, p. 74) point out: "people come to realize their risk and take protective measures" through a combination of personal and event variables and risk perception. Cohn et al. (2006) note evacuation is one of the most disruptive things to occur during a wildfire outside of death and the destruction of property. The first barrier public information officers must overcome is understanding what motivates the people in their communities to take action when an evacuation notification is issued. Timely evacuation not only saves the lives of residents, but it also reduces the hazard to first responders who may be forced to put their own lives at risk to assist those who delayed or refused evacuation. In Australia, evacuation deaths during wildfires are most likely to occur among people who "left just before the fire front arrived" pointing toward the importance of early and timely evacuation compliance (Cohn et al., 2006, p.48).

Delay in evacuation can also have less-than-fatal effects. As noted by Ansell (2013), "decision delayers" are likely to spend more time trying to choose a course of action during an emergency than those who decide in advance whether they will comply with evacuation notifications. Additionally, "decision delayers" are also less likely to have prepared to either defend their homes or to evacuate (Ansell, 2013).

Evacuation Behaviors Based on Social Categories

Eight studies focused on social categories (gender, age, education, etc.) and their effects on evacuation behavior were reviewed for this paper. Overall, those studies found evacuation behaviors differ based on social categories; however, the studies considered here do not address

how an individual's evacuation behavior may be affected by the intersection of multiple social categories.

A review of studies, including evaluation of age related to evacuation behavior, found age likely plays less of a role than parental status, although studies have resulted in conflicting findings. According to Gray-Graves (2009), studies conducted in the 1980s and early 2000s found older adults to be less likely to evacuate while other studies conducted during the same time period found no statistical difference. Fischer et al. (1995, p. 35) indicates:

> households were more likely to evacuate if dependent children were present in the home during the time of the emergency. Most of those with children (9%) left, while a majority (54%) of those who did not have dependent children in the home failed to evacuate.

Looking solely at evacuation behaviors within the older adult category does provide emergency response officials with insight to help increase evacuation compliance. The population of people 65 years or older in the United States continues to increase as Baby Boomers age. The overall population of people 65 years old or older was 16% in 2019 and is expected to increase to more than 21% by 2040 (Administration for Community Living, 2021). A 2009 study found older adults were more likely to evacuate if the order was mandatory rather than voluntary (Gray-Graves, 2009). Further, the study found older adults were most likely to comply with mandatory evacuation orders issued by a fire department, the military or law enforcement. Trusted sources of evacuation information included television and radio news, followed closely by church officials. It is important to note the lack of emphasis on newer emergency alerting technology among older adults in these studies. The Integrated Public Alert & Warning System (IPAWS) was not functional until after this study was conducted. It remains

unclear how much older adults rely on alerts sent via IPAWS; however, these findings indicate older methods should remain an important part of the alerting plan.

Gender appears to have a significant effect on a person's willingness to evacuate. In two studies designed to evaluate evacuation behavior during wildfires, men were found to be statistically significantly less likely to evacuate than women. In Roberson et al. (2012), in spite of only a little more than 6% of study respondents noting they had refused to comply with evacuations in the past, it was noted men were statistically less likely to evacuate than women. In *Preparing for wildfire evacuation and alternatives: Exploring influences on residents' intended evacuation behaviors and mitigations* (Stasiewicz & Paveglio, 2021), which breaks down evacuation behaviors into multiple categories including "stay and defend" and "shelter in place," men were 3.5 times more likely to stay and defend rather than evacuate and nearly twice as likely to shelter in place than women. Further, Gray-Graves (2009, p. 10) cites five studies indicating men are less likely to evacuate than women.

Time in residence may play a role in evacuation decision-making. People who have lived in their homes for 10 years or fewer are more likely to evacuate when ordered (Roberson et al., 2012). Beyond time in residence, part-time versus full-time residency was found by Stasiewicz & Paveglio (2021) to be a factor with part-time residents indicating they were likely to evacuate while full-time residents indicated they would be more likely to stay and defend their homes.

Access to mass transit systems differs greatly from community to community. Rural communities rely primarily on individual transportation. Access to individual transportation allows residents to self-evacuate without transportation-related delays. Wolshon (2010, p. 42) highlights studies conducted by the Federal Transit Administration showing "the percentage of the population without access to personal transportation ("carless" populations) in cities like

New York and Boston is about 50–60 percent." Those large cities, however, are more likely to have mass transit options for residents than rural communities. Wolshon (2010, p. 42) further identifies self-evacuation as the most common: "In most areas of the United States, self-evacuators make up the vast percentage of an evacuating population, particularly in locations outside of major cities where few transit resources exist." Emergency response officials should familiarize themselves with the characteristics of rural communities within their jurisdictions. It should not be assumed that an evacuation in a rural area can be accomplished entirely through self-evacuation. It is possible a rural community without comprehensive or even regular mass transit opportunities may have a large population of people who still do not have access to personal transportation. This lack of access may be related to low-income households or to the number of disabled, elderly, and medically fragile residents in the area. Public information officers should strive to understand the demographics of their communities that could lead to lack of access to transportation.

While many of the studies cited above did not focus solely on rural evacuations, a study conducted among residents of Pend Oreille County – a small, rural county in northeast Washington – illustrated potential challenges and behaviors specific to rural residents (Stasiewicsz, 2021). Stasiewicsz (2021, p. 1) found "support for SD [stay and defend] actions is particularly prevalent in rural areas." Characteristics of rural residents making them less likely to evacuate in a timely manner include:

> Rural residents may be more apt to "wait and see" during fire events due to a lack of short- or long-term housing options, disruptions to livelihoods (e.g., potential loss of crops, equipment or infrastructure), difficulty finding places to board or keep livestock

> and large animals, and concerns about accessing health care or other services in rural regions. (Stasiewicz & Paveglio, 2021, p. 2)

Stasiewicz & Paveglio (2021) further note rural residents may be more likely to evacuate in a timely manner if they receive a mandatory evacuation notice that includes clear directions.

Evacuation Behaviors Based on Perception of Risk

A review of two studies regarding how perceived risk affects whether people evacuate and, if so, how quickly was conducted. To start, Li (2014, abstract) found the decision to evacuate is affected by the level of concern people have for "the threats to their personal lives and costs and dangers on their evacuation trips." The example provided by Li illustrates this concept by pointing out if people believe they will face the biggest cost (monetary or otherwise) through property loss they may spend more time attempting to protect critical assets between when an evacuation notification is issued and when they actually leave (Li, 2014).

Dash & Gladwin (2007, p. 70) also highlight perception of risk as an important factor in evacuation behavior: "If individuals do not believe warnings are valid or the risk real, then the likelihood of response is decreased."

It falls on public information officers to ensure evacuation messages convey an appropriate and accurate statement of risk in order to help residents understand the potential consequences of their evacuation decisions. If risk is downplayed in messaging, it may result in non-compliance with the current evacuation. If risk is overstated, it may result in non-compliance during future evacuations as residents may be less likely to trust officials' assessment of risk.

Evacuation Behaviors Based on Level of Individual Preparation

Perceived preparedness and the perceived ability of firefighters to defend homes affects evacuation behavior according to both Stasiewicz & Paveglio (2021) and Roberson et al. (2012).

Stasiewicz & Paveglio (2021) point out a correlation between residents who say they are likely to stay and defend (SD) or shelter in place (SIP) and their level of preparedness. According to Stasiewicz & Paveglio (2021, p. 9):

> Respondent perceptions of their ability to protect their property from wildfire impacts was a highly significant influence on SD or SIP intentions when compared to evacuation intentions. This relationship hints that SIP/I don't know group members may be waiting to see whether the fire is going to overwhelm their abilities before deciding to evacuate, a similar mindset (in this case) that many SD members might have but in a more active (e.g., intending to engage the fire front) context. Similarly, individuals who believed their property was well prepared and would not need firefighting were less likely to evacuate and more likely to stay and defend, which substantiates existing literature.

Roberson et al. (2012, p. 345) found one group in the study area noted its reluctance to comply with evacuation notifications was tied to not having "taken significant steps toward wildfire preparedness." When looking further into the group there is a notable difference between perception of property preparedness due to wildfire prevention measures during voluntary versus mandatory evacuations. More people noted their reluctance to evacuate when evacuation orders were voluntary – the number was reduced by approximately 27% when the evacuation orders were mandatory (Roberson et al., 2012).

Local survey results (see Appendix) in rural Lane County, Oregon mirror several points discovered during the literature review. When asked to provide reasons they may be delayed in

evacuating (with no predetermined prompts) one of the most common categories at 16% was pets and livestock. Lack of transportation was specifically noted in 3% of responses. A significant portion of respondents at 9.8% noted they were simply unprepared to evacuate and listed the gathering of items as a delay. A further 5.3% noted age or disability would delay their evacuation. The largest category was those who seek additional verification or information before taking action. A total of 17% shared they would seek to verify information and confirm whether they felt the threat was significant enough to comply. At nearly one in five respondents, this is a warning to public information officers to provide as much context as possible in alert and warning messages, even if it means including a link to a webpage for more information within the confines of a 90- or 360-character Wireless Emergency Alert.

Barriers to Effective Emergency Alerting

In addition to the importance of understanding what motivates rural residents to heed evacuation notifications, it is critical to understand emergency alerting tools may not work in rural, mountainous areas – and information regarding their efficacy is not readily available.

The Integrated Public Alert & Warning System (IPAWS) sends emergency alerts over cellular, Internet, radio, or television networks. Emergency Alert System (EAS) messages are those sent over television and radio networks. Wireless Emergency Alerts (WEA) messages are sent over cellular and Internet networks. Non-IPAWS alerts include subscriber-based SMS text messages, emails, mobile phone application notifications, and phone calls sent to either mobile phones or landlines. (Landlines may be powered by fiber Internet connections rather than the plain old telephone service relying on analog connections.)

A mobile wireless coverage map provided by the Federal Communications Commission (FCC) indicates there is at least some level of coverage across most of the United States (Federal

Communications Commission, 2018). The map does not indicate the quality or speed of the coverage. The map also shows large swaths of land, primarily in the mountainous regions of the West, with no coverage. A similar map focused on residential fixed Internet access shows almost no areas without Internet access, although the number of connections per 1,000 households varies (Federal Communications Commission, 2022).

Considering only these maps, it would appear even the most remote communities have ample access to cellular and Internet services capable of supporting emergency alerts. This is an inaccurate and dangerous assumption. According to the National Association of Counties (2020, p. 2), "connectivity data provided to the FCC is often inaccurate and inflated – leaving many communities overlooked and disconnected." A study conducted by the National Association of Counties found these discrepancies in Internet connectivity data, including approximately half of counties having Internet speeds below federal minimum standards and more than half of counties reporting service levels below what was reported by service providers (National Association of Counties, 2020). The report found, in summary:

> The FCC requires providers to report areas where they are "currently providing or could… without an extraordinary commitment of resources." By requiring providers to report on the speculation of maximum service — even if no one is currently connected — leads to overstated data as an unintended consequence. Anecdotal evidence suggests an entire census block is often marked as "served" with broadband if just one home has coverage. As a result, the FCC routinely classifies these markets as connected and competitive when reality tells a very different story. (p. 2)

Reports from the FCC also confirm similar discrepancies between mobile wireless coverage maps and reality on the ground. In particular, physical obstacles can obstruct

connectivity as can “severe weather, topographical features ... between your phone and the nearest cell site” (Federal Communications Commission, 2019, p. 1). Rural residents, especially in mountainous and forested areas, are likely to experience these gaps in coverage.

The discrepancies between reported availability and what rural residents are able to access likely contribute to the connectivity divide between urban and rural adults. In general, rural adults own fewer devices, spend less time online, and are more likely to report a major problem accessing high-speed Internet (Vogels, 2021).

In addition to service- or terrain-related issues, a lack of testing and transparency from carriers creates barriers to effective alert and warning. A report by the U.S. Department of Homeland Security (2016) identified time delays of up to 12 minutes as a significant issue when relying on WEA messages. The report does clarify that the lack of comprehensive testing on live carrier networks leaves questions about what level of delay might occur in a live environment.

The ability to accurately geographically target WEA messages is questionable. In 2019, carriers participating in the WEA program were required to improve geographic targeting to ensure WEA messages were not broadcast more than one-tenth of a mile beyond the identified alert area (Fowlkes, 2018). In my direct experience in Lane County, Oregon, fires along the Highway 58 corridor in 2021, 2022 and 2023 required sending WEA messages to affected rural communities. In each instance, people living many miles away from the alert areas called the non-emergency call center to report receiving the WEA messages and professed confusion about why they had received the alert.

There is also a lack of accountability in reporting post-emergency. Nearing the first anniversary of the 2020 Holiday Farm Fire, Lane County Government was unable to provide local journalists with information regarding the success rate of the numerous WEA messages

sent during the evacuation period. Konexus, the third-party IPAWS service provider used to send the WEA messages, informed Lane County Government that carriers never release the number of phones successfully reached and there is no requirement for carriers to share delivery information with federal, state or local agencies (M. Groner, personal communication, August 13, 2021).

Finally, there is the issue of the damage those systems can sustain during an emergency. During the devastating 2018 Camp Fire, cell towers and fiber optic Internet lines were destroyed by the fire, eliminating the ability to send emergency alerts relying on mobile wireless or Internet coverage and taking down the radio system law enforcement depended upon to communicate (St. John et al., 2018). Similar damage occurred during the Holiday Farm Fire when the only cell tower serving the fire area burned within the first few hours of the fire – leaving first responders and residents without the ability to communicate and receive information (Lane County Government, 2020).

Lessons Learned

Based on the results and findings, it is clear there are individual and technological barriers to evacuating people living in rural, mountainous areas. Public information officers can use this information to be better prepared to assist with wildfire evacuations. Public information officers should:

- Assess the demographics of their community to better understand who lives in what areas and how their social characteristics may affect their willingness to evacuate.
- Conduct a review of the communications infrastructure in their area to determine what resources are available and what vulnerabilities might exist due to terrain, rate of

technology adoption in the community, and likelihood of catastrophic failure during a wildfire.

- Use their knowledge of demographics and infrastructure to develop an alert and warning plan that appropriately conveys risk levels, provides clear direction, and includes alerts that rely on a variety of methods to reduce the chance of technology failure.

In the future, more widespread research related to wildfire evacuations would improve the ability of public information officers to develop specific alert and warning protocols more effective at prompting rural residents to take protective action during a wildfire. Further, public information officers and other local and state emergency response officials should advocate for new rulemaking by the Federal Communications Commission to require carriers to disclose the success rate of WEA messages to individual devices. Such disclosure would allow public information officers to better understand – and plan around – gaps in cellular coverage.

Summary

Wildfire and its effect on the places where people live and recreate is increasing in severity. Recent megafires and accompanying loss of life and infrastructure have brought fire response and evacuation to the forefront of community awareness, along with calls for increased accountability.

Rural residents can face significant barriers to timely evacuation, including lack of cellular and Internet coverage, lack of transportation, or social characteristics that make them less likely to heed emergency notifications.

Public information officers must develop a better understanding of evacuation barriers and the capabilities of emergency alerting technology in order to effectively support the successful evacuation of rural residents.

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Appendix

Lane County Government Emergency Alert Test Survey Results

To view or download the survey results, please visit https://bit.ly/AlertTestSurveys.