Alternatives to Evacuation—Protecting Public Safety during Wildland Fire

Travis Paveglio, Matthew S. Carroll, and Pamela J. Jakes

ABSTRACT

Remaining inside fire-safe structures or at designated safety zones to actively defend against wildland fire events is an underrepresented area of scholarship. Although research on chemical spills and tornadoes has long advocated a similar practice of shelter-in-place during certain types of emergency situations, its applicability to the field of wildland fire management appears only infrequently in conferences and necessitates a more active view of participants in ensuring their safety. This article suggests that the Australian model of fire response, "prepare, stay and defend, or leave early," may emerge as a viable alternative to evacuation in some, but not all, wildland–urban interface (WUI) fire situations. Several communities in the West have begun to explore opportunities for alternatives to evacuation during wildland fire. Because of the lack of US experience with these types of responses during fire events we attempt to draw lessons from disaster and risk communication literature related to other types of hazards. An overview of associated fire literature will provide background and situate these concerns in a larger social context. We maintain that this literature provides insight into the considerations, precautions, and initial steps needed for testing the applicability of the Australian model of "prepare, stay and defend, or leave early" during wildland fire events threatening WUI populations.

Keywords: wildfire, evacuation

One of the most socially disruptive consequences of uncontrolled fire in the wildland–urban interface (WUI) is the evacuation of potentially large numbers of people, frequently with little or no warning, for undetermined periods of time (Taylor et al. 2005, Carroll et al. 2006). This disruption not only occurs in response to the actual movement of people from their homes to shelters or to the homes of friends and family, but also from being on evacuation standby for days or weeks at a time (Cohn et al. 2006).

No agency or group records the number of evacuations or number of people evacuated each year because of wildland fire, but there are reports from individual fires. For example, during the March 2003 Texas Panhandle Fire, eight towns with a total population of more than 4,000 were evacuated (Zane et al. 2006). The Southern California Fire Complex of 2003 included the evacuation of more than 100,000 people (Blackwell and Tuttle 2003). Early stories coming from the October 2007 California fires estimated that one million people were evacuated (MSNBC 2007).

Threats to WUI resident safety from wildland fire are unlikely to decrease anytime soon; in fact, forecasts of an expanding WUI and recent fire statistics point toward an increased prevalence (Stewart et al. 2006, National Interagency Fire Center 2007). As wildland fires continue to pose a threat to WUI residents, evacuations will continue to be a possibility for thousands of communities. However, a debate has begun over alternatives to evacuation as a means of protecting the lives of homeowners, business owners, residents, visitors, and firefighters in areas threatened by wildland fire. There is a small but growing body of literature indicating that evacuation may not always be the ideal strategy, because mass migration can create traffic problems or subject the affected population to more risk than if they stayed at home (Cova and Church 1997). Our intent in this article is to highlight those arguments against evacuation and advance recommendations for alternatives to this process.

Travis Paveglio (travispaveglio@wsu.edu) is graduate student, and Matthew S. Carroll (carroll@wsu.edu) is professor, Washington State University, Department of Natural Resources Sciences, Johnson 183, Pullman, WA 99164-6410. Pamela J. Jakes (pjakes@fs.fed.us) is senior research forester, US Forest Service, Northern Research Station, 1992 Folwell Ave., St. Paul, MN 55108.

One possible alternative to evacuation that deserves additional review is the Australian model of "prepare, stay and defend, or leave early," which we will refer to as the Stay or Go model. Stay or Go is the practice of staying in buildings or other designated "safe areas" during a disaster event and actively combating spot fires to ensure resident and structure safety (Handmer 2007, McCaffery 2007, Rhodes 2007). The related method of shelter-in-place (SIP) is a recognized alternative in the US disasters such as chemical spills and the long-running standard during tornadoes (Mannan and Kilpatrick 2000, Hammer and Schmidlin 2001). The primary difference between these approaches is the level of resident involvement before and during the hazard event: SIP is a passive process of refuge while the Stay or Go model is a multistage process in which proper home/neighborhood standards and resident efforts to combat fire are both needed to ensure resident safety and reduction of fire damage (Handmer 2007). This does not mean that the Stay or Go model can work in every situation, and it would not always be the primary choice, but it has been proven effective in certain situations that warrant its use. Stay or Go is recommended in certain Australian bushfire situations where proper planning eliminates most safety risk (Bushfire CRC 2006), while some US communities are beginning to promote SIP as an alternative to evacuation when wildland fire threatens WUI communities (Thorp et al. nd, Rancho Santa Fe Fire Protection District 2004, Santa Fe Fire District 2006). Professional organizations involved in wildland fire and natural resource management have sponsored events to further the discussion about how to best protect life and property during wildfire events (National Fire Protection Association [NFPA] 2005, International Symposium on Society and Resource Management 2006, International Association of Wildland Fire 2007). In response to this increased interest, we wish to review existing literature on alternatives to evacuation during wildfire and supplement existing gaps with lessons from other hazard literatures. We will then recommend steps to improve the effectiveness of alternatives to evacuation during wildfire and introduce possible barriers to their implementation. Our undertaking here does not presuppose that the Stay or Go model can automatically apply to wildfire in the same way SIP does in other disasters. The use of SIP during chemical spills and tornadoes is the result of numerous studies on other alternatives and specific characteristics such as ability to evacuate a disaster area in time (tornadoes) or the lack of structure damage caused in chemical spills. Research and experience also show that wildfire is a particularly unpredictable event contingent on a number of biological, physical, and social factors. Furthermore, effective protection of life and property during fire events must include active work by homeowners both before and during the event to reduce the chances of structural ignition during the fire event. Recommendations for research and managerial, community action, or experimentation will conclude our discussion.

Literature Review

Research on Evacuations for Public Safety. Evacuation has been widely studied in the disaster field, and a common finding is the inability to evacuate safely or in a timely manner during disasters such as hurricanes and floods. For example, many residents encountered significant traffic problems while attempting to evacuate before or return after Hurricanes Andrew (1992) and Floyd (1999; Lindell et al. 2000, Dow and Cutter 2002). Models of evacuation behavior during the 1997 floods in the Red River Basin, Canada, highlighted the importance of warning timing and the number of households evacuating in determining whether communities can effectively mitigate impact on communities during an oncoming disaster (Simonovic and Ahmad 2005).

Issues for wildland fire evacuation are the same as those for other disasters: notification, timing, evacuation of pets and livestock, ingress and egress, and people who refuse to leave or delay leaving (Carroll and Cohn 2007). Research on evacuations in the WUI also focuses on barriers to effective evacuation (Cova and Church 1997). Cova (2005) used geographic information system modeling to argue that western communities in areas with frequent fires often do not have sufficient traffic infrastructure to facilitate timely evacuation. He went on to suggest models that could help emergency managers identify how long it would take for communities to evacuate and their ability to do so given the proximity of the fire. These "trigger points" could help reduce conflicts during evacuation events (Cova et al. 2005). Wolshon and Marchive (2007) simulated traffic flow conditions in the WUI under a range of evacuation notice lead times and housing densities. To safely evacuate more people, they recommended that emergency managers (1) provide more lead time to evacuees, (2) control traffic levels during evacuations so that fewer vehicles are trying to exit at the same time, and (3) locate subdivision exits more strategically to reduce egress time, paying particular attention to the proximity and location of and the potential traffic load from feeder routes.

Natural resource social scientists have explored wildland fire evacuations in case studies of specific fire events. For example, those interviewed during a case study of the 2002 Hayman Fire (Colorado) talked about the hardships of evacuation, including the loss of income and mental anguish. Some indicated that they would be reluctant to evacuate if they found themselves in another fire event (Graham 2003). Similar sentiments appear in research about other disasters such as hurricanes and floods (Whitehead et al. 2000, Dash and Morrow 2001). However, residents involved in the Hayman Fire stated that "The shared experiences of . . . the evacuation process created opportunities for people to get to know each other and work together" (Graham 2003, p. 358).

More recently, natural resource social scientists have studied the impacts of wildland fire evacuation on local populations. Cohn et al. (2006) studied evacuations during three fires—the Hayman Fire, 2002 Rodeo-Chediski Fire (Arizona), and 2000 Cave Gulch/Bucksnort Fires (Montana). They found that homeowners and managers involved in wildland fire evacuations experienced conflict due to differing views of fire risk, interpretation of or access to information about fire damage, and delays in allowing residents to return to their homes. While public safety officials wrestle with how to handle people who refuse to leave, some residents who have experienced evacuation say they will stay the next time. They indicated that the worst part of the evacuation process is the uncertainty surrounding the condition of their homes. Also, of concern is the safety of pets and livestock. Residents see a real potential for staying behind during an evacuation (1) because they do not feel they are actually at risk and (2) if they are at risk, they feel they can protect their homes and property.

The desire to stay rather than evacuate during a disaster has been found in studies across multiple disasters (Dash and Morrow 2001). Fifty percent of rural residents affected by the 1997 Red River Flood in Canada favored voluntary evacuations and were

bitter about being forced from their homes because they were unable to establish defenses (Rasid et al. 2000). Perceived traffic delays during hurricane evacuation or return also can lead some residents to favor voluntary evacuations or make residents more apt to stay at home during future hurricanes (Whitehead et al. 2000, Dash and Morrow 2001). The decision to evacuate or stay and defend may not be a choice for some residents—disabled or elderly populations may not always be able to evacuate during disaster situations (Lach et al. 2005). These findings show that evacuation often can create additional problems during and after disasters. Our next section will outline the current uses of SIP as a way of introducing its Australian Stay or Go model as an alternative to evacuation when evacuation (especially last minute evacuation) would be more dangerous to residents. It also has the potential of application where the twin objectives of protecting life and property are best achieved by staying and defending.

SIP as an Alternative to Evacuation. American experience with SIP is primarily limited to disasters of short duration such as tornadoes and chemical spills, where it has proven effective in reducing injury and saving lives (Wilson 1991, Mannan and Kilpatrick 2000). SIP is the recommended response during tornadoes because of the short warning time available during these disasters, and government specifications for tornado shelters have proven effective in reducing fatalities during the last century (Simmons and Sutter 2005).

Emergency management officials will recommend that local residents SIP during short-duration chemical spills (National Institute of Chemical Studies 2007). Research on SIP during chemical spills has resulted in decision aids outlining procedures and conditions where SIP is a viable alternative to evacuation (Mannan and Kilpatrick 2000, Raber et al. 2002), although no one aid has been widely accepted based on validity, utility, and effectiveness (Sorensen et al. 2004). These decision aids are supported by a large body of research on building standards for SIP and the dispersal of chemicals under various conditions. This research is similiar to studies on the combustibility of homes or conditions in the home ignition zone (Cohen 2000) and chemical dispersal studies are not unlike models predicting the spread or intensity of wildland fires (Kalabokidis et al. 2002, Vakalis et al. 2003). For these reasons, it seems logical to explore the existing SIP

literature to advance similar concepts such as the Stay or Go model for use during fire.

Evacuate or Not during Wildland Fire in the United States. No community in the United States has implemented an SIP or stay and defend plan during a wildland fire. At a recent conference in Denver, a panel discussed the decision to stay or go when a wildland fire approaches (NFPA 2005). Panel members identified problems with evacuations, including fires that prevent safe passage along planned evacuation routes, the need to move individuals who are unable to evacuate, inefficient planning, and a poorly informed public. They also acknowledged benefits of alternatives to evacuation: safer buildings for firefighters and property owners, homeowners participating in the defense of their own homes, limited traffic on local roads allowing access by emergency vehicles, and wildland firefighting crews and equipment freed to protect natural resources.

Several communities are actively discussing plans that include the option of remaining at home or in safe zones during fire and intend to implement these if conditions permit. In Santa Fe, New Mexico, remaining in a fire-hardened structure is described as a "last resort" (Santa Fe Fire Department 2006). However, some experts in the Santa Fe Fire Department believe that local construction practices and the type of wildfire expected for the local types make remaining in fire-hardened structures during a fire a viable alternative to evacuation (Thorp et al. nd).

In southern California, the Rancho Santa Fe Fire Protection District is actively promoting SIP. In their literature they explain,

> Typically, when a wildfire threatens homes, evacuations are ordered. Evacuations will shelter residents away from danger during a catastrophic event. During evacuations though, panic and chaos ensue, causing traffic collisions, blocked roadways, injuries, and deaths. In fact, most wildfire-related deaths occur during evacuation efforts.
> Your community, however, is designed to shelter you inside your home, far away from these congested evacuation routes. . . . This means that you will not need to evacuate during a wildfire (Rancho Santa Fe Fire Protection District 2004, p. 2).

The Rancho Santa Fe literature describes the local construction features that allow for SIP, outlines what a resident should do when a wildland fire approaches, and stresses the importance of maintenance

as a key to preserving SIP qualities in the community. Although this idea is similar to the Stay or Go model, it lacks the appropriate citizen component of actively defending the home in the event that residents stay during a fire event. It is also important to note that not all communities will have the resources or the community or local government standards in place to implement the ordinances and restrictions needed to accomplish planning related to the Stay or Go model. Likewise, retrofitting existing communities is difficult. But Rancho Santa Fe does show than certain communities can implement the physical components necessary for the Stay or Go model to be effective.

The SIP standards in Rancho Santa Fe recently were put to the test during the complex of fires in October of 2007 that destroyed a number of homes in Southern California. Although 55 other structures in the Rancho Santa Fe area burned in the Witch Fire, none of them were in the five communities designated "shelter-in-place" by the local fire district. Residents of these communities *were*, however, issued a mandatory evacuation order (Welch 2007).

We also should note that apparently not everyone in Rancho Santa Fe is supportive of the alternative to remaining in fire-hardened structures during fire events approach—a local website charges that "The County has officially decided to leave children behind in a wildfire" (llcfire 2007). This is indicative of our larger claim: that it is ultimately just as important to create a social infrastructure, increase citizen knowledge and procure their support for alternative strategies. For Rancho Santa Fe fire officials, the option of remaining in protected structures during fire events is "a modern approach to living safely in a woodland-urban interface community" (Steinberg 2005).

Recommendations

> But there is too much government intervention in our lives. And that is the same way with my house. If I want to defend my house, that is my right as a U.S. citizen and homeowner to defend my property. So, if that meant staying behind or being able to go out for a couple hours in the morning and dropping a few trees, I should have been given the right to do that (Colorado resident quoted in Cohn et al. 2006, p. 43).

Evacuation will likely continue to be a frequent response to disaster situations such as wildland fire. However, any uniform disaster response is too simplistic to apply to varied fire situations influenced by vegeta-

tion, geography, community infrastructure, and the social context. SIP has a long and proven history in disaster situations such as chemical spills and tornadoes, the Stay or Go model is being applied under certain bushfire conditions in Australia, and both are being considered in the United States for use in wildland fire situations. In the following sections, we present recommendations that could move forward the study and implementation of the Stay or Go model. We realize that the potential actions imbedded in the recommendations we are about to make need to be carefully thought through before being applied in any given situation (McCaffery 2007). They are offered as a means to stimulate discussion, additional research, and, hopefully, some careful, real-world experimentation.

Recommendation 1: Adapt Tools and Practices from other Disasters for Use during Wildfire Situations. Evacuation trigger points, developed for use in hurricane events, have been successfully adapted for wildland fire. For example, multiple evacuation trigger points were used during the Hayman Fire (Graham 2003). Similarly, the decision aids used to determine SIP viability during chemical spills could be adapted to wildland fire situations. Checklists, decision trees, and detailed analyses have all been used in decisionmaking regarding evacuation or SIP for chemical spills (Sorensen et al. 2004). Adapting these decision aids for the Stay or Go model used in wildland fires would establish common procedures while allowing for local differences.

Recommendation 2: Build an Understanding of the Social Knowledge and Organization Needed to Support Alternatives to Evacuation. We know the construction characteristics that support the Stay or Go model, including construction with fire-resistive materials, boxed eaves, residential fire sprinklers, "Class-A" noncombustible roofs, dual pane or tempered glass windows, and a well-maintained, fire-resistive landscape (Rancho Santa Fe Fire Protection District 2004). We do not know the social elements that need to be in place, including stakeholder relationships and education programs. Sorensen et al. (2004) discuss the importance of different emergency planning elements informing decisions on evacuation and alternatives such as the Stay or Go model. However, we would expect that there also are different levels the networks and relations that allow groups of stakeholders to work together to accomplish

goals (Flora 2003) and that will influence the successful implementation of the Stay or Go model. For example, one element of community capacity is social capital—the networks and relations that allow groups of stakeholders to work together and accomplish goals (Flora 2003). We would expect that a high level of social capital would need to be used to implement any alternative to evacuation during wildland fire. Social scientists can identify the critical social characteristics for SIP and how these characteristics can be developed or enhanced in communities.

Recommendation 3: Explore How Organizational Structure and Culture Influence Adoption and Use of Management Strategies such as the Stay or Go Model. Successful implementation of alternatives to evacuation will necessitate an increased understanding of the way new ideas spread within organizations responsible for fire management and how different organizational cultures influence the implementation of alternatives such as leave early or stay and defend. Organizational culture is an important component in the implementation of the type of decisionmaking inherent in the Stay or Go model (Kaufman 2006). Studies indicate that federal, state, and county land-management agencies maintain shared cultures, socialization practices, and strict adherence to established practices to facilitate consistent behaviors among geographically dispersed managers (Davenport et al. 2007). This can be especially important when innovations such as the Stay or Go model conflict with previously held beliefs by those managing public safety—in some cases threatening officials' views about their role in disaster mitigation. Thackaberry (2004) suggests that creating organizational cultures that encourage local officials to make adaptive decisions about public safety can reduce these issues (Thackaberry 2004).

Resistance to new strategies in disaster mitigation also can stem from a fear of accountability. As Davis (2006) indicated in his content analysis of *The New York Times* stories about wildfire, managers' administrative shifts often are driven by media attention or public outcry about current management strategies. Similarly, studies of various hazard managers show that personal accountability is a major concern and may influence their willingness to advocate more adaptive decisions such as SIP (Denis 2001). As Crichton et al. (2005) point out in their

study of decisionmaking among on-site incident command personnel at nuclear reactors, these considerations include evaluations of uncertainty and available procedures.

Recommendation 4: Develop and Test Different Approaches to Education and Communication about Alternatives to Evacuation. Citizens need to understand and support the Stay or Go model to insure successful communitywide implementation. Education is especially critical for the necessary maintenance to keep landscapes and buildings ready. Efforts to educate WUI residents about wildland fire risk and the adoption of defensible space have been widely studied (see, e.g., Nelson et al. 2005, Monroe et al. 2006). Programs such as the multiagency Firewise Communities/USA Program and Fire Safe Councils have been effective in providing readily accessible knowledge about reducing fire risk (Sturtevant and McCaffrey 2006). These programs provide hands-on learning opportunities that increase the adoption on defensible space practices and support for wildland fire management (Parkinson et al. 2003, McCaffrey 2004). Researchers can test the use of existing programs or create new approaches to inform and build support among local residents for SIP initiatives.

Recommendation 5: Develop Collaborative Frameworks and Relationships That Facilitate Stay or Go Adoption among Diverse Community Groups. Perhaps the largest barrier to the implementation of the Stay or Go model as an alternative to evacuation during wildland fire is the cooperation and coordination it requires between a diverse group of landowners, governments, land-management agencies, and other stakeholders in the WUI. Collaborative planning at the neighborhood and community level has been shown to reduce miscommunication and potential conflicts about public safety by informing residents' about defensible space requirements and educating them about the precautions taken during fire, including alternatives such as the Stay or Go model (McCaffery 2004, 2007).

The ability to reach a shared vision of appropriate actions before and during fire events through collaboration is not an easy task. For example, Monroe et al. (2003) studied collaborative efforts to create defensible space guidelines in Florida. Shared goals, communication among those creating guidelines, and the need for local knowledge

in fire planning were found to be critical for collaborative action.

Collaboration is recognized as a critical component of fuels and natural resource management planning (Wondolleck and Yaffe 2000, Sturtevant et al. 2005). However, research indicates that land-management agencies have had a difficult time fully adopting a collaborative approach to decisionmaking and wildland fire management (Machlis et al. 2001, Davenport et al. 2007). Adopting alternatives to evacuation in WUI wildfire situations would require organizational change at a number of levels in federal state, county, and local governments.

Conclusion

The Stay or Go model is certainly no silver bullet for minimizing the extent of human injury and infrastructure damage from wildfire events. However, in an era of increasingly stretched government resources, an increased emphasis on citizen agency, and greater reliance on the use of local place-based knowledge in land-management decisionmaking, we argue the time has come to discuss openly and test alternatives to evacuation for some wildfire events. Another argument in favor of the Stay or Go model is that even in situations (i.e., such as the case of extreme fire behavior) in which the "leave early" option is ultimately followed, the physical and social preparation involved in adopting the approach will likely result in greater human safety and reduced property loss. More research and real-world experience with alternatives to evacuation are necessary if we are to learn more about what is needed in terms of community preparedness and organizational coordination to realize the potential of these alternatives during wildland fire events.

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