A Provisional Conceptual Model of Human Behavior in Response to Wildland-Urban Interface Fires

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Abstract

With more frequent and destructive wildfires occurring in the growing wildland-urban interface (WUI), the ability to ensure the safe evacuation of potentially large groups of people is of increasing importance. This is a challenging task made only more difficult by the fact that there is often little warning and that evacuations often need to take place in a short period of time. The creation of credible and effective evacuation models is needed within the fire safety engineering community to help address this challenge. Although potentially difficult to represent, a critical component in developing such models is the consideration of what people will do in response to a WUI fire. In this literature review, research relating to WUI fire evacuations was collected to identify the factors that influence protective action decision-making and response during these events, specifically whether someone chooses to evacuate or not. To supplement the findings, related hurricane evacuation literature was also reviewed for such factors. The factors that were identified relate to sociodemographic factors, social and environmental cues, preparation and experience, familial responsibilities, location, and credible threat and risk assessment. These factors were organized according to the Protective Action Decision Model (PADM) to create a conceptual model of protective action decision-making. This is the first step in being able to incorporate such factors and their corresponding impact on public response into comprehensive WUI evacuation models.

Keywords: Wildland urban interface, Wildfires, Hurricanes, Evacuation, Human behavior, Conceptual model

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1   Introduction and Purpose

The danger posed by wildfires and the damage they can cause are issues of growing global concern. Environmental changes such as warmer temperatures, increased drought and earlier snowmelt are contributing to an increased wildfire threat and a longer fire season [1–3]. The increasing likelihood of more extreme weather as a result of climate change is also playing a role in the growth of wildfire potential [2]. In some countries, previous fire management strategies with a focus on complete fire suppression have led to a build-up of fuels which contribute to the increased risk of wildfire [1, 4]. As the number of large wildfires continues to increase in many parts of the world as a result of these factors, the degree of destruction these fires can cause is intensified by changes in land use and socioeconomics [5].

A growing proportion of these wildfires threaten communities living nearby or within the wildlands, known as the wildland-urban interface or the ''WUI''. WUI communities exist ''where humans and their development meet or intermix with wildland fuel'' [6] and as such, the WUI is a complex area comprised of diverse groups of people and geographical areas. It includes both intermix and interface communities, with varying densities, levels of remoteness, and interaction with the wildland [7]. Intermix communities include areas where wildland vegetation and housing intermingle, and interface communities are those that are in close vicinity to areas of large, dense wildland vegetation [8]. Given their proximity to the wildland, WUI communities are generally the most vulnerable to wildfires and the subsequent property damage and physical, social, environmental, and psychological impacts as a result [8]. In addition, other vulnerabilities such as fewer and more dangerous egress routes and a lack of easily accessible firefighting resources contribute to the additional challenges faced by WUI communities [9].

The 2016 Fort McMurray Fire in Canada [10] and the 2016 Haifa Fire in Israel [11] each resulted in the evacuation of tens of thousands of people. The California Wildfires of 2017 and 2018 resulted in numerous fatalities and the evacuation of tens and hundreds of thousands of people respectively [12, 13]. These fires, in addition to the deadly 2017 Portugal Wildfires [14] and the 2018 Greece Wildfires [15], bring attention to the fundamental need to protect people before and during response to WUI fire[1] events. While it is the policy in many countries for people to evacuate areas at risk during WUI fires [16–18], many times the public evacuates only minutes before the fire reaches their communities, if they are able to evacuate at all [19]. Additionally, a large percentage of WUI fire deaths have occurred during evacuation itself [20], as was the case during the 2017 Portugal Wildfires. It is therefore of growing importance to have comprehensive tools to aid in the planning and execution of safe and effective WUI fire evacuations.

Modeling tools are available to simulate components of evacuations; however, some gaps in capabilities exist. Current modeling tools are either statistical or empirical in nature and/or feature only one aspect of the incident; e.g. the fire development, the emergency response, the

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[1] WUI fire refer to wildfires/bushfires/forest fires that infringe upon the wildland-urban interface.

evacuation response, etc. [21]. As such, these models are incapable of explicitly representing the temporal nature and the highly coupled nature of an incident. Having a type of time-based, inclusive simulation approach would better enable the vulnerability of communities to be assessed. This would not only be beneficial for WUI evacuations, but for other types of community evacuations as well.

Additionally, current evacuation simulation tools focus primarily on people or traffic movement, and in turn, neglect to simulate evacuation decision-making and behavior that would prompt or prohibit evacuation movement to take place. Instead, a model often represents the probability of a particular response rather than representing the decision-making process through which an individual passes before selecting a response. In order to create such comprehensive evacuation tools, it is necessary to understand what factors affect evacuations and what information is necessary for evacuation models to be useful and effective. This understanding of evacuee decision-making comes from exploring existing research on public response to WUI fires and other disasters.

The majority of current and past research on the factors that affect WUI fire protective action decision-making—sociodemographic factors, social and environmental cues, preparation and experience, risk assessment, etc.—available to the authors in English originates from the United States and Australia. Behavioral research on WUI fires is relatively new compared to research studying other disaster types, and therefore a smaller amount of data has been collected. Fortunately, despite the differences among disaster types, there are a number of similarities which enable our understanding of WUI fire evacuations to be enhanced through an understanding of public response to other disaster types. For example, with respect to evacuations, there are similar challenges among longer-duration (or slow-onset) disasters regarding notification, timing, ingress and egress decisions and actions [22]. There is a substantial body of research that looks at such challenges and the factors that affect them with respect to disasters in general [23–27]. Additionally, the overall process that one goes through to make decisions and respond to natural or technological disasters is ultimately the same [28]. As such, looking at research relating to other disasters can further our understanding of how people will act and behave during WUI fires.

While looking in detail at research from all disaster types (floods, earthquakes, man-made disasters, etc.) would provide the most comprehensive understanding of evacuation factors, it was within the scope of this study to compare two disaster types. Relevant U.S. and Australian WUI fire research was identified and reviewed along with hurricane research from the United States to determine potential environmental and social factors that affect protective action decision making and response. Hurricane evacuations were chosen so as to maximise the amount of information available for comparison given the wealth of United States' hurricane literature (available in English). Focusing on American studies also meant that additional cultural and political influences would not need to be considered within this review. Although there are

differences between wildfires and hurricanes, there are many similarities that makes their focus in this review a reasonable exercise, e.g.:

the movement of wildfires and the track of hurricanes are dependent on many factors, making prediction difficult

both hazards provide similar timeframes for notification—including public alerts and warnings, in that they begin in one location and have the potential

(over time) to negatively impact communities in its path

both hazards have the capacity to displace large groups of people

both hurricanes and wildfires have the potential to change course or direction without warning, therefore potentially decreasing the time available to make protective action decisions

The purpose of this literature review is to identify the factors that have an impact on household protective action decision-making in the context of WUI fires. This is done by looking both at U.S. and Australian wildfire research,[2] as well as U.S. hurricane literature. The factors identified by this review are organized according to the Protective Action Decision Model (PADM) to better understand what factors affect the different stages of the decision-making process [28]. From these factors, and their organization in the PADM, the authors have developed a conceptual model of protective action decision-making for WUI fires. It is the intent that the collection and analysis of this information, and the development of the conceptual model, will help to inform the development of broad and all-inclusive WUI fire evacuation models.

2   Background

2.1   Evacuation Modeling

In any WUI evacuation model, certain key components need to be addressed in order to simulate WUI fire scenarios to an acceptable degree of detail. In reference to the evacuation model, vehicle evacuation, including both private vehicles and public transportation, is the primary transport mode for affected populations during WUI fire incidents. This reliance on vehicles is often due to the scale of these incidents, the distances that need to be covered, the trend in household units to evacuate together, and the fact that the transport of goods/provisions (in addition to the residents) are often required during evacuations. Therefore, WUI evacuation models should be capable of simulating the movement, route choice, and route destination of vehicles of varying capacities, which is covered in depth by the field of traffic modeling (see [21] for more details).

It is important to understand that traffic performance (and modeling) is not independent of the actions of individuals (referred to here as pedestrians). Pedestrian decision-making and

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[2] Wildfire research include that which referred to bushfires and forest fires.

preparation will determine the time at which household units decide to initiate their evacuation as well as the time that they move from their starting location (e.g., home, business, hospital, school, etc.) and eventually enter the traffic system. This aspect of individual/household decision-making in WUI fire events is less developed, and in turn, not well represented in current large-scale WUI (or disaster-based) evacuation models. What is required are largescale evacuation models that account for individual/household protective action decision-making before vehicular evacuation begins. Protective action decision making is defined here as the process by which people make decisions based on the cues/information available (i.e., threat conditions) to protect themselves, others, and/or their property in the event of a WUI fire. Furthermore, current evacuation and traffic models such as those reviewed by Ronchi et al. [21] would be significantly improved if they were better able to account for behavioral choices of individuals/households based not only on threat conditions, but the interactions between individuals as well. A number of studies have previously explored the benefits of including such components into existing models [27, 29–33].

The first step in accounting for individual/household decision-making during WUI fires is made in this paper. From a review of WUI fire and hurricane literature, the authors have developed a conceptual model of decision-making for WUI fires. The PADM is used as the foundation for the development of this model, and is discussed in the following section.

2.2 Behavioral Modeling

Over the last 50 years, numerous empirical studies have sought to systematically chart the social processes involved in human response to emergency incidents [34– 36]. Of these, the Protective Action Decision Model (PADM) is selected here as it provides a framework to understand how people protect themselves and one another in response to cues from a disaster event [28, 37]. This model was deemed most appropriate for the task of categorizing the factors affecting the different stages of the decision-making process in an attempt to create a behavioral conceptual model for WUI fire evacuations.

The PADM asserts that the process of protective action decision-making begins when people are first presented with any kind of environmental cue, including physical and social cues and information. The introduction of these cues initiates a series of stages through which an individual passes prior to performing protective actions; e.g., initiating evacuation or deciding to stay and protect one's home. These stages are split into pre-decisional processes, which determine whether a decision-making process commences (PRE-DECISION in Fig. 1), and into the key components of the decision-making process itself (CREDIBLE THREAT, RISK ASSESSMENT and PROTECTIVE ACTION DECISION in Fig. 1).

Initially, the individual needs to receive a cue, pay attention to it, and comprehend the meaning associated with the cue (e.g., hearing an alerting signal, seeing flames, or smelling smoke). These represent the three pre-decisional stages of the PADM (PRE-DECISION 1–3 in Fig. 1), the stages that determine whether external information is processed such that it can inform the decision-

making process [28]. Given that this information is processed, it then needs to be assessed to determine whether the information provided is credible (CREDIBLE THREAT in Fig. 1). At this stage, the individual decides if there is actually something occurring that may require action.
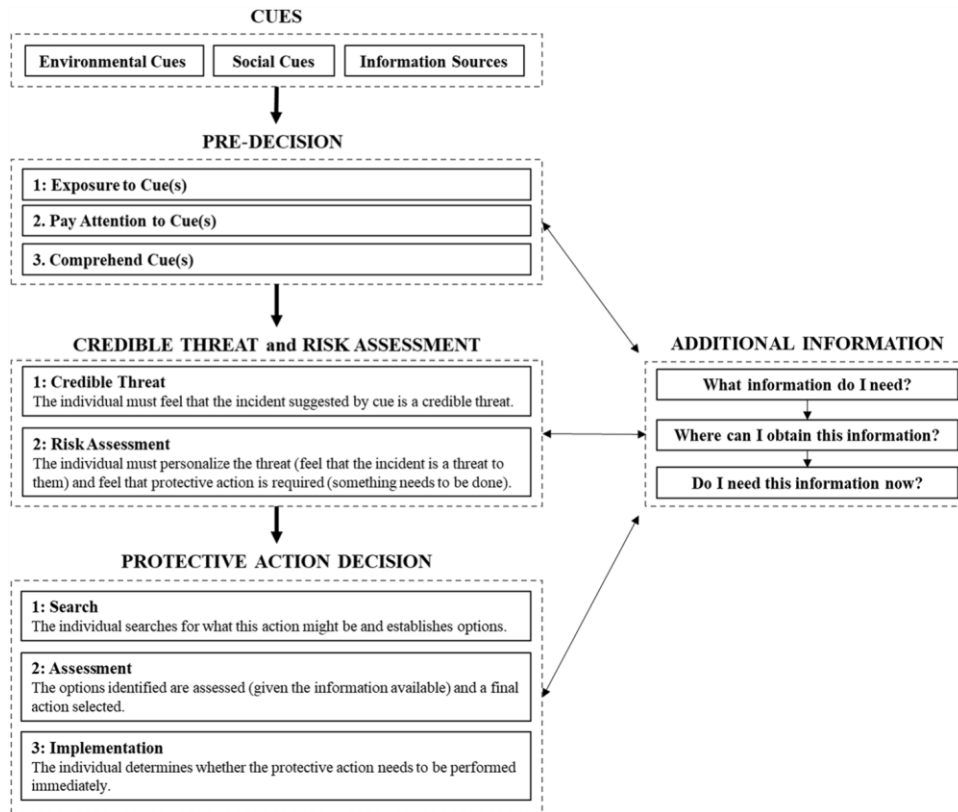

Figure 1. Protective Action Decision Model Framework (adapted from [28]).

If the individual considers there to be a threat, they next determine whether the threat is relevant to him/her (RISK ASSESSMENT in Fig. 1), known as personalizing the threat (or risk). Research has shown that a person's perception of personal risk, or ''the individual's expectation of personal exposure to death, injury, or property damage'' is highly correlated with taking protective action [28, 35, 38, 39]. The individual tries to gain insight on the potential outcomes of the disaster and what those potential outcomes mean to his or her safety. If the cues are deemed to relate to them, the individual then determines whether it is relevant and pressing. This then requires the individual to determine the nature of the response required at that point in time.

At this stage (PROTECTIVE ACTION DECISION in Fig. 1), the individual engages in a decision-making process to identify a set of possible protective actions from which to choose. When it comes to taking protective actions in response to a WUI fire threat, there are ultimately two choices, to stay or to leave. Within the option of staying, households may choose to actively defend their home and property, or passively shelter in place (SIP), i.e., in their home, another location on their property or in their community. After establishing at least one protective action option, an individual engages in protective action assessment of these options and their current action.

If at any stage the individual is uncertain about the situation, the individual engages in additional information-seeking actions or they simply wait until additional information is provided to them. If seeking information, they may search for other sources of information (e.g., websites, media, etc.) and/or reach out to other people to discuss the situation and what to do (also known as the milling process) [40, 41]. The greater the ambiguity involved in the situation, the more likely that individuals will search for additional information that can guide their actions [42, 43]. Information seeking is especially likely to occur when individuals think that time is available to gain additional insight. The individual continues in this action until sufficient information is available or time runs out (the threat reaches them) [28]. During an incident, information received can be incomplete, ambiguous, or contradictory, causing uncertainty in understanding the nature of the event and the actions necessary [44, 45]. In these cases, progress in the stages of the PADM can be significantly delayed and/or promote inefficient or unsafe protective action behavior.

3   Methodology

This paper is based on a review of literature related to evacuation decision-making during WUI fires and hurricanes. It includes literature from various databases including Web of Science, Google Scholar, the NIST Research Library, and the Carleton University Library. The literature was obtained from peer-reviewed journal articles, conference proceedings, book chapters, government agency and university reports. A set of key search terms was identified, and additional terms were added as the research progressed. These terms include: Wildfire, Bushfire, Forest Fire, Wildland-Urban Interface, WUI, Hurricane, Evacuation Behavior/Decisions/Actions/Alternatives, Decision Making, Evacuation Modeling, Shelter-In-Place, Protective Actions, Affecting/Influencing, and Risk Perception. The review includes primarily post-2000 literature as the majority of related research for WUI fires and hurricanes was conducted during this time, however, a small number of commonly referenced hurricane research papers from the 1990s were also included. The selected studies were reviewed to identify the factors deemed influential in the protective action decision-making process. The literature includes both qualitative and quantitative studies, as well as related literature reviews and compendiums.

WUI fire literature from both the United States and Australia has been included, while the hurricane literature was limited to the United States. It is important to note that Australia and the United States have historically had very different approaches to wildfire policy. Australia's policy of ''prepare, stay and defend or leave early'' and later ''Prepare. Act. Survive,'' allows for the practice of staying and defending one's home. Conversely, in the United States, evacuating all people threatened by wildfires has been the long-accepted practice. Given these differences between Australian and U.S. wildfire policies, it is acknowledged that the findings given in the respective literature would have been influenced by the varying perspectives about wildfire safety and the role of evacuations. It is also understood that additional factors, both technical

and non-technical, may exist that have an impact on the protective action decision-making process. This is beyond the scope of this paper.

The methodologies employed in the reviewed material differed, as some studies collected purely qualitative data, quantitative data, or a combination of both. Within these studies, some conducted correlation analysis, while others also utilized regression analysis. Varying sampling techniques and strategies were used, including surveys, questionnaires, interviews and focus groups. The size and nature of the samples also varied, with some sample groups having a greater awareness and interest in the risk posed to them by the hazard in question. Some studies collected post-disaster data, whereas others looked at intended actions. The definition of terms such as evacuation, as well as other aspects of the process, may have been different and in turn, measured differently between the studies. In addition, each paper discussed its own limitations within the context of the individual study. Commonly mentioned limitations included the accurate representation of a target population, survey response rate, hindsight bias, and issues related to the reliability of behavioral intention studies.

The factors included in this paper are those that were found by the authors of the reviewed literature to be significant based on each study's own criteria. In the case of quantitative studies, these include factors that were deemed statistically significant. For the qualitative studies, these factors included those that were deemed notable by the researchers, based on the analysis methods employed. The identified factors for WUI fires and hurricanes are presented in Sects. 4 and 5 respectively. Each section is broken up into the stages of the PADM discussed in Sect. 2.2. In addition to these, individual/household delay and actions processes relevant to the proposed conceptual model were also identified and incorporated in each section. The presented factors are discussed in greater detail in Sect. 6, along with conceptual model considerations and recommendations for future work. The paper is concluded in Sect. 7.

4   Factors Influencing Protective Action Decision-Making During WUI Fires

This section details the factors identified in the literature relating to protective action decision-making during WUI fire events. A summary of the identified factors can be seen in Sect. 6.1, Table 1. Section 4.1 focuses solely on the factors affecting threat identification and risk assessment, since minimal to no data was found relating to the pre-decisional phases of the PADM (i.e., perception, attention, and comprehension). Next, Sect. 4.2 addresses factors affecting the decision to evacuate (or not). Finally, Sect. 4.3 details additional factors relevant to delay, delay time and the specific types of actions undertaken.

4.1   Credible Threat and Risk Assessment
WUI fire literature was identified that discussed factors that affect the following PADM processes: identification of a credible threat and risk assessment. A few studies identified sociodemographic and cue-related factors, but the majority of factors were related to location, preparation and experience.

One WUI fire study identified sociodemographic factors and their impact on threat and risk identification. Mozumder et al. [46] found that having a higher income or level of education was related to an increased level of concern that one's home may be threatened by a wildfire. Additional studies explored the role of environmental and social cues in decision-making. In several studies, a fire cue was often noted to be a trigger that indicated a credible threat and high level of risk inciting evacuation. This trigger could be the sight of others leaving [47]; sensory cues such as visible smoke, embers or flames; or information from trusted sources about the location and intensity of the fire [47, 48].

Studies also identified residence, location, knowledge and experience with WUI fires as influential to threat identification and risk assessment. First, the length of time a household lived in the area; i.e., residence time, was found to relate to the level of perceived wildfire risk. Newer residents were more likely to be concerned that their home was endangered, whereas long-term residents were more likely to feel that their property was safe [46, 49]. However, if a household had experienced previous property damage due to a wildfire, they were more likely to be concerned that their home would be endangered again [46]. Similarly, a household's knowledge of previous fires in their community and area led to greater concern that wildfire may endanger their own home, impacting their assessment of risk and leading to a higher likelihood of evacuation [46, 50]. In a review looking at post-Black Saturday Fires research, it was noted that one's location had an impact on risk perception, as many people living in suburban locations had not considered themselves at risk to wildfire [51].

4.2 Protective Action Decision
The vast majority of WUI fire literature focused on identifying the factors that influence the protective action decision itself; i.e., the decision to stay or go. These factors were grouped into categories relating to sociodemographic factors, environmental and social cues, experience and preparation, familial and societal responsibilities, place/location, and credible threat and risk assessment.

4.2.1 Sociodemographic Factors

One of the most commonly cited demographic factors affecting the likelihood of evacuation was gender. Numerous pre-and post-disaster studies indicated that women were more likely than men to decide to evacuate, and that men were more likely than women to stay in place [46, 51–57]. On a similar note, Proudley [58] found that the roles people play within a family had a large role in how people respond and behave during a WUI fire event. With respect to reasons for wanting to stay, Benight et al. [49] found that women were significantly more likely than men to report that their ''love for the forest'' made it difficult to leave. Among those who chose to stay, women were more likely to report that they thought it was too dangerous to leave or that their attempt to leave had been unsuccessful [54]. The study found that protecting property was more often cited by men as their reason for staying, however, this was also a major reason for women as well.

Additional sociodemographic factors that influenced evacuation decisions include political leaning, age, income and occupation. Mozumder et al. [46] found that in the United States, Democrats were more likely than Republicans to evacuate under both voluntary and mandatory evacuation orders. The average age of those who chose to stay and defend during the 2009 Black Saturday Fires was slightly higher than those who evacuated (51.5 years vs. 48.4 years), suggesting that age could be a potential factor [57]. One study found that people with a higher income were more likely to evacuate, and those employed by the wood products and insurance industries were more likely to stay and defend (implied by the authors as being potentially a result of having greater knowledge or skills related to wildfire management or damage) [56].

4.2.2   Environmental and Social Cues

The nature and number of cues received about a wildfire threat have been found to influence the protective action decision made. Rates of evacuation have been found to be higher when people receive multiple warnings from more than one source [50], and receiving advice to leave from friends, family, neighbors and emergency services was also found to influence evacuation (more so for women than men) [54]. However, Strawderman et al. [50] found that these sources had less impact than a more formal warning from authorities. McLennan et al. [57] found that a greater percentage of those who chose to evacuate had received information about the fire from neighbors or emergency personnel in a face-to-face setting. Similarly, receiving a voluntary or mandatory evacuation order was found to increase the likelihood of evacuating, with the latter having a greater effect [46]; however, this may not always be the case [59].

4.2.3   Preparation and Experience

Preparation for WUI fires and experience with these events can also influence protective action decisions. Commitment to a previously developed plan to stay and defend, coupled with a belief that preparations taken were sufficient to meet the perceived level of risk, was a principal factor in staying and defending [47, 48, 57, 60]. Similarly, a lack of preparedness and planning to stay has been found as influential on evacuation decisions, showing that levels of wildfire preparedness and knowledge were higher among those who chose to stay and defend versus those who evacuated [57]. Taking this further, having a plan to evacuate made people less likely to consider staying and defending and more likely to evacuate [56, 61]. Additionally, studies found that those who intended to stay and defend had greater confidence in their perceived physical readiness and ability to successfully defend their homes than did those who intended to evacuate [57, 62, 63].

In reference to previous experience, Whittaker and Handmer [51] found that previous false alarms—i.e., evacuations or evacuation orders later deemed unnecessary—led people to be less likely to evacuate in the future, while Benight et al. [49] found that such experience did not have a negative impact on future evacuation intentions. Other studies found that those who had evacuated in previous WUI fire events were more likely than those without such experience to evacuate in the future [50]. This variation in the influence of previous evacuations was also noted

by Cohn et al. [52], who found that for some, previous experience motivated immediate evacuation; for others, it resulted in evacuation after a longer period of time, and for others still, it made them less inclined to evacuate at all as they deemed it unnecessary.

4.2.4   Familial and Societal Responsibilities

Various studies show that there are a number of factors related to familial and social roles and responsibilities that influence protective action decisions. It was found that having children in a household not only influenced evacuation behavior, but it also prompted a quicker response—either immediately upon threat awareness or under a voluntary evacuation order [57, 63]. Conversely, those with pets or livestock were more likely to wait and see or stay and defend than those without [46, 57, 63]. The impact that having livestock had on decisions to stay was found to be stronger than the impact of pets [46]. As noted by Tibbits and Whittaker [60], focus groups revealed that for many farmers and people whose livelihoods depend on their livestock, there was a feeling that they had no choice but to stay and defend, for economic reasons as well as for the welfare of their animals.

For those who choose to stay and defend, connections to their community and emotional attachment to their property were found to be motivating factors [48, 57, 61]. Studies found that concerns about personal and family safety were motivating factors for people intending to evacuate [61, 63], whereas a desire to protect property with the acceptance of some personal risk was found to motivate those intending to stay and defend [52]. Another reason Cohn et al. [52] identified for staying was the concern about an inability to return for an extended period of time. According to Tibbits and Whittaker [60], people's confidence in their own ability to defend their property was influenced by active emergency and firefighting officials in the area, as well as by having more than one able-bodied person in the home to help defend; however, other studies found no such evidence [57]. Paveglio et al. [56] found that the belief that residents who live near forests should accept the likelihood of some level of potential property damage was found more commonly among those who choose to stay and defend [56]. Similarly, McLennan et al. [48] found that some of those who chose to stay and defend during the Black Saturday Fires of 2009 were more likely to believe that they were to some extent responsible for protecting their own property, as opposed to relying entirely on emergency personnel.

4.2.5   Place/Location

The decision to evacuate has been shown to be influenced by the location and length/frequency of residence. Some residents of rural areas have been found to decide to stay in place as they deem it impractical given the time and distance required to reach a safe area [56, 60]; however, other studies found no effect of property location on protective action decision-making [57]. In a more general sense, the belief that evacuation was no longer safe was found by McLennan et al. [47] to be a factor contributing to the decision to stay and defend in some cases. Conversely, Strawderman et al. [50] found that those living in a rural area or on a farm were more likely to

evacuate than those living in subdivisions or urban areas. Paveglio et al. [56] noted that full-time residents were less likely to evacuate than part-time residents.

4.2.6   Credible Threat and Risk Assessment

The assessment of risk was identified by various studies as being an important factor in the decision to evacuate [46, 50, 61], though not universally across all studies [56, 62]. For those who intended to evacuate, ''risk'' could be defined as a concern that one's life and home would be endangered [46, 61]; for those who intended to wait and see or stay and defend, ''risk'' corresponded to danger associated with leaving unnecessarily and having to drive through hazardous conditions [61, 64]. McLennan et al. [61] noted that while those intending to leave were more likely to report higher levels of concern about wildfire danger, they were no more likely than those intending to stay to believe that they were at greater risk than others.

4.3   Delay and Actions

A number of factors have been identified which affect the time it takes to make a decision. It has been indicated by Paveglio et al. [56] that in the United States, those planning on employing shelter in place are likely to 'wait and see' how bad the fire gets, and potentially evacuate if conditions degrade. McNeill et al. [66] found that the biggest cause for decision delay is a lack of distinct attractiveness of one decision option over another. That is, both the option of evacuating or staying and defending are similarly appealing. They found this to have more of an impact on decision delay than a lack of perceived risk, sociodemographic or responsibility avoidance. Additionally, Rhodes [64] notes that 'waiting and then leaving when threatened' is seen by some to be an acceptable strategy that allows for the increased chances of protecting property and life safety. Individuals who 'wait and see' do not necessarily see their actions as being risky [65]. In their review of literature from the United States, Canada and Australia, McLennan et al. [67] found that many people are likely to delay leaving (because they want to protect their property or avoid the costs of evacuating—financial burden, dangers during evacuation) and therefore it should not be assumed that all those threatened by a WUI fire will evacuate immediately upon receiving an evacuation order or warning.

There are also a number of factors that influence the actions people take once they have decided to evacuate. Often times people prepare, including collecting their belongings and packing vehicles, before evacuating. This is seen even among those who originally chose to stay and defend, but considered evacuation as a last-minute possibility [60]. Having to manage belongs has been found to slow down an evacuee's response time [49]. Also, families tend to leave together as a group, sometimes with neighbors and extended family as well (the authors did not specify what was meant by extended family) [52]. Evacuees will often search for others and inquire about what they have heard about the event before packing up and leaving [52]. These actions have the potential to increase the time it takes to evacuate.

5   Factors Influencing Protective Action Decision-Making During Hurricanes

This section details factors influencing protective action decision-making during hurricanes as found in the related literature. Table 1 in Sect. 6.1 provides a summary of these factors in comparison to those identified in the WUI fire literature. As with the WUI fire data discussed in Sect. 4, there was no discussion of factors affecting the pre-decisional phases of the PADM, and because of this, only those factors that influence threat identification and risk assessment are discussed (Sect. 5.1). Additionally, Sect. 5.2 discusses factors that influence the decision to take action, i.e., stay or go (Sect. 5.2). Finally, factors relating to delay, delay time, and specific types of actions taken are discussed in Sect. 5.3.

5.1   Credible Threat and Risk Assessment
Literature was found that identified factors that influence threat identification and risk assessment. These factors include sociodemographic factors, as well as those relating to environmental and social cues, place/location, and experience.

First, sociodemographic factors were identified as influential to threat identification and risk assessment. In their analysis of gender roles in hurricane evacuations, Bateman and Edwards [68] found that women were more likely than men to perceive higher levels of risk. Even more complicated is that studies have found perception of risk to be a mediating variable between gender and evacuation behavior—in that while men were less likely to perceive risk, men who did perceive risk were more likely than women (with comparable levels of risk) to evacuate.

Environmental and social cues have been identified by several studies as playing a role in the identification of a credible threat and assessment of risk. Storm intensity and severity were found to be of primary concern and were seen as key indicators of personal risk [69, 70]. Additionally, the perceived potential for flooding was found to influence perception of risk more than forecasts for high winds [70]. Huang et al. [72] found that in addition to environmental cues, social cues also had an impact on risk assessment. Official warnings were determined to have a positive effect on both the identification of a credible threat and risk assessment.

Studies also identified location and experience in hurricanes as influential to threat identification and risk assessment. The location of those threatened by a hurricane can influence how the threat is perceived. Surprisingly, it was found that those farther from the coast perceive more severe storm characteristics, potentially as a result of the types of environmental cues faced by residents in different locations [72]. For example, Stein et al. [71] found that there was a heightened perception of risk due to wind rather than flooding or storm surge for residents outside of the evacuation zone. Additionally, having previous hurricane experience has been shown to increase perception of credible threat and risk [72]. However, experience with unnecessary evacuation was found to have an impact on lowered risk levels, leading to the belief that previous positive outcomes indicated perceived positive outcomes in the future.

5.2 Protective Action Decision

As was found when looking at the WUI fire literature, the majority of the factors discussed in the hurricane literature were found to influence the actual protective action decision. These included sociodemographic factors, and those relating to environmental and social cues, experience and preparation, familial and societal responsibilities, place/location, and credible threat and risk assessment.

5.2.1 Sociodemographic Factors

 It was noted by a number of researchers that females were more likely than males to evacuate [73–76]. However, other studies found that when other factors, such as roles and responsibilities within the family and location within the risk areas were taken into account, the effect of gender on evacuation decision was insignificant [68, 72]. In general, the likelihood of evacuating has been found to be higher among younger individuals [68, 74], with the exception of those who classified themselves as retirees who have been found to be more likely to evacuate [68, 77] (even more so with women than with men [68]). It should be noted that other studies found no significant association between age and evacuation [77, 78]. Conflicting results have been found for other socio-demographic factors such as income, education, marital status, and race. Some studies have found these factors to have a significant influence on evacuation [70, 73, 78– 81], while other studies have found that these factors do not play a significant role [68, 77, 82].

5.2.2 Environmental and Social Cues

Receiving information about a hurricane threat or an evacuation notice from a trusted source, particularly from family, peers or authorities, tended to lead to a higher likelihood of evacuation [74, 80]. Other sources of information such as national television stations, were also identified as influential and, depending on the situation, could have a greater impact on evacuation decisions than other information sources [82]. One of the most influential social cues on the decision to evacuate was receiving an official evacuation order or warning [72, 74, 77]. Both voluntary and mandatory evacuation orders have been found to increase the likelihood of evacuation, with the latter having a greater effect [70, 79, 80, 83, 84].

It has been found that one's location inside or outside of an evacuation zone can impact the outcome of such evacuation orders. For example, those located outside of the evacuation zone were less likely to evacuate, unless they received information about the evacuation order from the media, which then prompted them to evacuate unnecessarily [71]. The effect of the news media was found to have a minimal impact on those inside evacuation zones. Conversely, Lazo et al. [75] noted that perceived evacuation zone did not have a significant impact on evacuation behavior.

The type of information disseminated about the storm was also found to play an important role in the decision to evacuate. Dow and Cutter [83] noted that the probability and location of hurricane landfall were important factors affecting evacuation decisions. Information on wind

speeds [84], storm strength [76, 79, 82] and storm severity [77, 83] were also identified as influential to the decision to evacuate. However, location, such as coastal proximity, and the fact that public officials tend to disseminate stronger messages during stronger storms, can mediate the influence of such storm indicators [74, 77]. The mediation effect caused by other factors was also noted when it came to the effect of observing others. Observing neighbors and peers leaving, or the absence of neighbors who have already left, has been shown to increase the likelihood of evacuating [68, 74], particularly in the case of residents in non-evacuation zones [71]. However, other research found that neighborhood evacuation was strongly related to high-risk areas and with actions taken by officials, therefore making it difficult to identify the independent strength of this factor [77].

5.2.3   Preparation and Experience

Previous experience with hurricanes and hurricane evacuations is a potential influential factor in hurricane evacuation decisions [73]. Numerous studies have found such experience to lead to increased likelihood of evacuation [69, 75, 78, 81, 82]. Petrolia and Bhattacharjee [84] found that past storm experience had a significant impact on future evacuation intention; however, the nature of the experience determined whether the person was inclined to stay or go. For example, past experience has been found to negatively impact evacuation in instances where past evacuations were viewed as unnecessary [72, 80]. It should be noted that other studies have found the impact of past experience to be insignificant [74], though others point out that it can contribute to awareness of the hazard and potentially produce a greater appreciation for the danger it may pose [77]. Murray-Tuite et al. [78] noted a level of consistency between previous evacuation actions, with 70% of study respondents making the same protective action decisions for both Hurricane Katrina and Hurricane Ivan.

People who had created a household evacuation plan were more likely to evacuate [68, 75] and those who had spent more money on household storm preparation and planning were less likely to evacuate [82]. An increased knowledge about hurricanes was not found to impact evacuation decisions [77].

5.2.4   Familial and Societal Responsibilities

The strength and viability of one's social network has been found to have an impact on evacuation decisions, with those who have stronger social support being more likely and able to evacuate [81, 85]. Riad et al. [81] noted that it was a weaker social network, and not poverty, that was the greatest obstacle to evacuation for those with fewer resources.

The desire to keep one's family safe was identified as being one of the strongest influences on evacuation intention [75]. In line with this, research has found family size and the presence of children to impact the decision to evacuate. However, this impact varies. Studies have found that having children in the household can positively impact evacuation [74, 76, 80, 82], negatively

impact evacuation [78], or have no effect at all [68, 77]. Similarly, the impact of family size is unclear [68, 78, 82].

Work responsibilities (requiring people to stay) and the potential loss of income due to evacuating have been found to significantly impact the decision to stay [80, 83]. Additionally, wanting to protect property from the storm and/or from looters [77, 79] and having pets or livestock decreased the likelihood of evacuation [70, 79, 82]. Concerns regarding perceived evacuation impediments, including traffic congestion, reduced the likelihood of evacuation [72, 83]. In line with this, people tended to consider a wide variety of indirect costs associated with evacuation such as travel costs, care for pets, and potential difficulties with re-entering the evacuation zone [83].

5.2.5   Place/Location

The vulnerability of one's home to hurricanes has been shown to impact the likelihood of evacuation, though the strength of this factor varies depending on the study. In the case of hurricanes, vulnerability is most often classified as living in a mobile home, and for those who do, studies show that they are more likely to evacuate [68, 76–78, 82, 84]. Conversely, some research indicated an insignificant correlation between evacuation and mobile home residence [74].

Other research on place and location has found that living in multi-family dwellings can increase the likelihood of evacuation [78]; however, not all studies agree [79]. Homeownership, compared with renting, is also identified as an influential factor for non-evacuation in some studies [76, 80, 82], with longer-term residents being less likely to evacuate than shorter-term residents [81]. However, not all studies found significant results [77]. The belief that one's home was a safe place was identified by Dow and Cutter [83] as being the first consideration in deciding to stay, followed by traffic, work responsibilities and the likelihood that landfall would be nearby. In line with this, living near the coast or bodies of inland water, or in flood areas has been shown to lead to increased levels of evacuation [68, 72, 74, 77, 82]. However, context matters here, of course. The factors of the population within the coastal communities, e.g., income and other demographics, should also be taken into account [78].

5.2.6   Credible Threat and Risk Perception

As the PADM model shows, risk perception is a critical factor that influences protective action decisions. Those who feel safe in their home are more likely to stay, and those who feel unsafe were more likely to leave [69, 77, 81]. Individuals who were concerned about costly damages favored evacuation [77, 79], as did those who perceived personal vulnerability to wind and storm surge [75].

5.3   Delay and Actions

Some research found that those living farther from the coast were more likely to wait before making their decision to evacuate compared to those closer to the coast [84]; however, they were

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more likely to take less time to prepare—i.e., spending less time protecting their property, packing and securing their home [74, 86]. Not having an evacuation destination identified ahead of time (pre-storm) was identified as contributing to added confusion and subsequent delay as a result of not knowing what protective action decision to make [84]. Additionally, large households tended to evacuate later and took more vehicles, whereas older adults tended to evacuate earlier [86].

6   Discussion

6.1   Similarities and Differences Between WUI Fire and Hurricane Factors

For this paper, the factors mentioned in Sects. 4 and 5 above, for WUI fire and hurricane events respectively, are structured according to the PADM framework. This allows for a more comprehensive understanding of how a given factor will affect the evacuee decision-making process and how this effect might propagate through this process, potentially affecting the time it takes to respond and the outcome of the response. As will be shown in the discussion below, it was often found that a particular factor influenced more than one stage of this process. A summary of the identified factors is presented in Table 1. Factors that were identified solely in qualitative studies are denoted with an asterisk (*), all other factors were found in quantitative studies or in both qualitative and quantitative studies. For detailed information about the methodologies used in each study, readers are directed to the sources noted in the table beside the respective factors.

For both hurricanes and WUI fires, very little research was found that identified the factors affecting the pre-decisional phases (i.e., receipt of, attention paid to, and comprehension of cues and information). The only study identified discussed how hot weather may have prevented awareness of the Black Saturday Fires as the heat prompted some people to stay indoors [53]. Identifying additional factors that affect the pre-decisional phases will enable WUI evacuation models to more effectively and comprehensively represent potential obstacles to resident fire threat awareness.

With respect to the threat identification and risk assessment stages of the PADM, similar factors were identified in the hurricane and WUI fire case studies. Within the sociodemographic factor category, income, education and gender were identified as having potential impacts on the assessment of threat and risk in both the WUI fire and hurricane literature. Similarly, within the environmental and social cue category, triggers were important factors identified for both hazards. For instance, for WUI fires, environmental cues consisted of seeing or feeling the heat from flames and embers, and seeing or smelling smoke; and for hurricanes, environmental and social cues consisted of storm intensity and severity, as well as the risk of flooding due to heavy rain or storm surge. Both data sets found that social cues, such as observing others leaving, receiving information from trusted sources, or receiving an evacuation order increased the credibility of a threat and the perception of risk. Place and location as well as preparation and experience were also factor categories found to play a role in threat and risk assessment in both

hazards. However, in both cases, it is important to note that previous experience alone was not sufficient to influence behavior. This factor is more nuanced in that the type of experience (e.g., positive or negative), is what actually influenced threat identification and/or risk assessment.

Table 1: Hurricane and WUI Fire PADM Factors

PADM stage	Wildfire	Hurricane
Pre-decision	Weather [53]*	Not Applicable
Credible threat and risk assessment	Income/Education [46]	Coastal proximity [71, 72]
	Trusted sources [47, 48]*	Environmental cues [69–71]
	Length of time lived in area [46, 49]	Gender [68]
	Location [51] *	Previous hurricane experience,
	Observe others [47]*	unnecessary evacuations [72]
	Previous experience with wildfires,	Social cues [72]
	knowledge of other fires [46, 50]	Trusted sources [72]
	Sensory-environmental [47, 48]*	
Protective action decision	Sociodemographic Factors [46, 49, 51–58]	Sociodemographic Factors [68, 70, 72–82]
	Age	Education
	Gender	Gender
	Income	Income
	Occupation	Marital status
	Political leaning	Race
		Retired
	Environmental/social cues [46, 50, 54, 57, 59]	Environmental/social cues [68, 70–72, 74–77, 79, 80, 82–84]
	Evacuation order	Environmental cues
	Multiple sources	Evacuation order
	Telling other people	Observing neighbors
	Trusted source	Trusted source
	Wait and see	

Preparation/experience [47, 48, 50–52, 56, 57, 60–63]

    Belief in capacity/survivability

    Commitment to plan

    Preparation and knowledge

    Previous evacuation/fire experience

Preparation/experience [68, 69, 72–75, 77, 78, 80–82, 84]

    Plan

    Previous experience (hurricane and/or evacuations)

Familial and societal responsibilities [46, 48, 52, 56, 57, 60, 61, 63]

    Attachment to home/community/desire to protect property

    Children

    Pets/livestock

Familial and societal responsibilities [68, 70, 72, 74–83, 85]

    Keep family safe (children, family size)

    Pets/livestock

    Protect property (from storm and looters)

    Social network

    Work responsibilities

Place/location [50, 56, 57, 60]

    Distance to neighbors

    Full time vs. part time residents

    Rural vs. suburban

Place/location [68, 72, 74, 76–84]

    Dwelling type (mobile home, multi-family)

    Coastal/water proximity

    Home as a safe place

    Home ownership and length of residence

Risk assessment/credible threat [46, 50, 56, 61, 62, 64]

    Assessment of effectiveness

    Concern

    Risk/danger (staying or leaving)

Risk assessment/credible threat [69, 75, 77, 79, 81]

    Risk of flooding, high cost damages

Delay and actions

Families stay together [52] *

Gathering physical possessions [49, 60]

Indecision [66]

Wait and see [56, 64, 65, 67]

Age [86]

Evacuation destination [84]

Household size [86]

Location [74, 84, 86]

*Indicate factors identified solely in qualitative studies

The vast majority of the factors identified in this literature review played a role in the protective action decision-making stage of the PADM. With respect to sociodemographic factors, gender was found to be the most commonly discussed factor for both WUI fires and hurricanes. In both cases, it was predominantly the case that women were identified as being more likely than men to evacuate. These findings must be put into context; however, when other factors associated with gender roles were taken into account (e.g., roles and responsibilities within the home), the impact of gender became insignificant. Moving forward, it would be beneficial to delve further into the role of gender in evacuation decision-making and response. Additional sociodemographic factors such as age and income were mentioned in both WUI fire and hurricane research, but they were identified less often and/or their influence was often contradicted by findings from other studies.

In a general sense, environmental and social factors that influenced evacuation decision-making were similar in both the WUI fire and hurricane literature; i.e., observing others; receiving warnings from multiple sources, especially from trusted sources; and receiving evacuation orders (especially those mandatory in nature) tended to result in a decision to evacuate. Another category, i.e., place and location, was identified in both data sets as influential to evacuation decision-making. Influential factors identified were locations (i.e., rural versus suburban), residency, neighbor proximity, home vulnerability (i.e., home type), home ownership, length of residence, and proximity to the hazard (i.e., the coast in reference to the hurricane studies and proximity to the fire front in a WUI fire). It is important to note; however, that the findings were not consistent across the studies, making it ever more important for additional research to be performed on evacuation behavior in response to hazards.

Researchers identified that preparation and previous experience influenced protective action decision-making for both WUI fires and hurricanes. Similar to its impact on threat identification and risk assessment, the effect of previous experience is more complicated, requiring understanding of the type or nature of the experience (i.e., positive or negative) and its impact on future behavior (i.e., evacuating or staying). Familial and societal responsibilities also affected decision making in both WUI fires and hurricanes. Having children, a need to protect the family, family size, and owning pets and livestock were found to influence evacuation behavior. The influence of pets and livestock on staying (or sheltering in place) might be further influenced by restrictive shelter policies on accepting pets and/or boarding facilities requirements of proof of vaccination (which evacuees are unlikely to have with them). Additionally, having a connection to one's community, wanting to protect property, and believing that one could successfully do so were also factors that were discussed along with the impact of one's social network and work responsibilities. Similarly, factors highlighting the important role of threat credibility and risk perception in evacuation decision-making was found in both data sets. The risk to life versus property, as well as the likelihood of evacuation being the safest option (versus being potentially dangerous), were examples of risk assessment impacts on WUI fire evacuation. The hurricane

data showed that the risk of varying types of storm-related impacts such as flooding, storm surge and wind influenced people's likelihood of evacuating.

Lastly, factors influencing delay, delay time, and specific types of actions included confidence in one's capability to defend one's home in the face of a WUI fire, coastal proximity, age, family size and having (or lacking) a destination choice. Post-decision actions were identified by a few WUI fire papers and these included collecting belongings, checking on and waiting for family/friends, and deciding on the evacuation destination and travel routes to get there.

The factors identified in Table 1 aid in the development of a conceptual model of protective action decision-making in WUI fires. Factors have been linked with various stages of the PADM to create the framework for a model that can conceptually explain eventual decisions to evacuate or stay in place (either to defend the home or to shelter in place). The factors identified from the hurricane studies fill in gaps left behind by the WUI fire studies to develop a more comprehensive model. The framework, or conceptual model presented in Table 1, can be further developed, quantified, calibrated and validated with additional data on protective action response from a WUI fire event to eventually create a computer simulation model of WUI fire evacuation.

6.2   Conceptual Model Considerations
The conceptual model presented here has several limitations. First, individual study conditions can vary by hazard conditions, populations, and community environment, which in turn, can affect the factors identified as influential to evacuation decision-making and response. Also, the WUI fire studies reviewed focused on U.S. and Australian populations, which can differ greatly by evacuation policy, preparedness and experience. Within both Australia's former wildfire evacuation policy (Prepare, Stay and Defend) and its current one (Prepare. Act. Survive.), there is a greater acceptance of staying and defending, while in the U.S., community officials almost exclusively disseminate mandatory (and sometimes voluntary) evacuation orders to threatened communities.[3] Delays (or ''wait and see'' behaviors) still occur in U.S. fire evacuations; however, issues of data applicability lie in the final decision to stay or go. Policies in one country may affect evacuee perception of viable evacuation alternatives and/or their experience or knowledge with such evacuation alternatives (which then influences the eventual decision). Little data is available on evacuation decision-making and behavior during WUI fires in countries other than the United States and Australia. Studies of WUI fires in other countries would strengthen and broaden the scope of the conceptual model developed here.

6.3   Future Model Development and Research Needs
As mentioned earlier, Table 1 provides the framework or conceptual model of protective action decision-making in WUI fire (and hurricane) events. Factors are identified as influential to each

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[3] Despite the practiced policy of evacuation in the United States, a number of studies suggest a growing number of people do not want or intend to evacuate automatically in the event of a wildfire and a small number of communities have looked into implementing a version of evacuation alternatives, primarily shelter in place [46, 59, 88, 89]. With that said, such cases are rare and such methods are still typically seen as a last resort if evacuation is not a possibility.

step of the PADM (noting that there is little research that identifies influential factors of the pre-decisional phases). The next step in conceptual model development is to identify the ways in which the factors that influence the same decision-making phase interact with one another in a more integrated manner. In reality, many of these factors are highly coupled and this may affect the outcome in complex ways (i.e. additive, counteractive and multiplicative). Reconciling these interactions is not a trivial task (and one that requires additional empirical support), but it is necessary for the continued development of this type of conceptual model. For instance, Dash and Gladwin [73] identified risk perception as having a greater impact on hurricane evacuation than negative past experience such as traffic delays. Similarly, it was found that risk perception could have a bigger impact than evacuation warnings if people believed their homes were safe as they were less likely to interpret such warnings or orders as being directly applicable to them and their situation [77]. This was also shown to apply in the reverse where environmental cues led people to evacuate even when they were not under an evacuation order [71]. For these reasons, understanding factor interactions at each decision-making phase of the PADM will be vital when translating these concepts into a quantitative model.

This work has focused on establishing a qualitative framework identifying the social and environmental factors to be considered within a WUI evacuation model. For implementation within a computational platform, this framework would need to be quantified. Work is currently underway to create a quantitative modeling framework (based on the framework adopted and developed here) to simulate householder risk perception given a WUI fire event and to predict householder protective actions [87]. Such predictions could be embedded within a simulation tool to make time-based estimations of the consequences of the decisions made by residents in conjunction with the resources available, the fire incident conditions and the existing physical infrastructure. An understanding of such consequences would be of great benefit in planning and design, in emergency response, and in post-incident investigations when attempting to assess the effectiveness of the emergency plans enacted. Provided here is a list of research gaps that need to be addressed to facilitate the development and validation of the conceptual model described above and the subsequent implementation within a simulation tool:

1. The factors that influence the three pre-decisional phases, including perception, attention, and comprehension.

2. The relationship between previous experience and PADM processes (e.g., threat identification, risk perception, and the protective action decision), and mediating factors.

3. A more current representation of the relationship between gender and PADM processes (e.g., threat identification, risk perception, and the protective action decision), and mediating factors.

4. The factors that influence specific actions taken before evacuation movement begins, as well as the time to complete these actions.

5. The factors that influence evacuation decisions, such as route choice and choice of final evacuation destination.

6. An understanding of the interaction of factors and their resulting outcomes.

7. Data from studies on WUI fires from populations in countries outside of the

U.S. and Australia.

8. The influence of changing demographics of people living in the WUI on evacuation decision-making and response (e.g. new WUI residents and long-term aging WUI residents).

9. The influence of a changing WUI landscape (e.g. environmental conditions) on evacuation decision-making and response, especially where communities are now vulnerable to WUI fires for the first time.

7   Conclusion

The increasing prevalence of large and destructive wildfires is an issue of growing concern. With more people living in the wildland-urban interface, being able to evacuate potentially large groups of people with little warning and in a short period of time will continue to become a more pressing and challenging task. One of the ways to address this more credibly and effectively is through the development of comprehensive WUI fire evacuation models.

A key component that must be considered in these models is protective action decision-making and behavior in the WUI; i.e. what people do in response to the fire. Choosing to evacuate or taking another protective action is a complex process influenced by a number of diverse factors including sociodemographic factors, social and environmental cues, preparation and experience, familial responsibilities, location, and credible threat and risk assessment. Although challenging, it is important to represent these factors within WUI fire evacuation models, as they influence if/when people choose to evacuate and where they will go. At this stage, identifying the factors that influence evacuee decision-making during WUI fire events and characterizing the nature of this impact is a key step—a step that has been addressed in this article. The authors collected and categorized the factors identified as influencing evacuee decision-making and response to WUI fires and hurricanes according to the PADM framework. The conceptual model developed represents a qualitative description of the evacuation decision, delay and actions taken before vehicular movement begins. This represents an important foundation on which to build.

Overall, the development of a comprehensive and credible conceptual model of resident response to WUI fire incidents has a number of important benefits. It will allow us to develop simulation tools that better account for resident response and to quantify the impact of this response. Such tools could be used by urban and emergency planners to assess the impact of new construction and mitigate against such impacts. Similarly, first responder training may be updated to address the implications of such a conceptual model, enabling their interventions to

be sensitive to expected resident responses. An understanding of resident response will allow authorities to better prepare guidance and allocate resources to meet current population's expectations, vulnerabilities, and capabilities. Additionally, regulations regarding WUI safety can be updated to account for expected resident response.

Broadening the scope of this conceptual model to include research from WUI fires and hurricanes was necessary given the limited information available; it also generated ideas for future research into the factors influencing the decision to evacuate or not in WUI fires. This approach provided the opportunity to see how factors might vary given different incident scenarios, strengthened the findings that some factors were particularly influential, and identified gaps in our current understanding that should be explored in future research.

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