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ORIGINAL PAPER

As California burns: the psychology of wildfire- and wildfire smoke-related migration intentions

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Abstract

Climate change impacts and rapid development in the wildland-urban interface are increasing population exposure and vulnerability to the harmful effects of wildfire and wildfire smoke. The direct and indirect effects of these hazards may impact future mobility decisions among populations at risk. To better understand how perceptions and personal experience inform wildfire- and smoke-associated migration intentions, we surveyed a representative sample of 1108 California residents following the 2020 wildfire season. We assessed the associations between threat appraisal, coping appraisal, personal experience, migration intentions, the impact of wildfire and smoke on migration intentions and place satisfaction, and the potential likelihood of future migration. Results indicate that roughly a third of our sample intended to move in the next 5 years, nearly a quarter of whom reported that wildfire and smoke impacted their migration decision at least a moderate amount. Prior negative outcomes (e.g., evacuating, losing property) were associated with intentions to migrate. Perceived susceptibility and prior negative outcomes were associated with a greater impact of wildfire and smoke on migration intentions. For those intending to remain in place, prior negative outcomes were associated with a greater impact of wildfire and smoke on place satisfaction, which was in turn associated with a greater reported likelihood of future migration. Our findings suggest that perceptions of and experiences with wildfire and smoke may impact individual mobility decisions. These insights may be leveraged to inform risk communications and outreach campaigns to encourage wildfire and smoke risk mitigation behaviors and to improve climate migration modeling.

Keywords Climate migration · California · Risk perception · Personal experience · Wildfire · Smoke

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Introduction

Climate change impacts — including rising temperatures, prolonged periods of limited precipitation, and earlier snowpack melt — and a legacy of fire suppression in the American West have increased the number and size of wildfires over the last several decades (Abatzoglou & Williams, 2016; Dennison et al., 2014; Goss et al., 2020; Marlon et al., 2012; Westerling, 2016). This change alongside rapid population growth in the wildland-urban interface (WUI) (Hammer et al., 2009; Radeloff et al., 2018) results in a growing number of people facing the immediate threat of wildfire and wildfire smoke (hereafter, smoke), while those in urban areas are also exposed to the adverse impacts of wildfires as smoke travels hundreds of miles from its origin (Burke et al., 2021; Fischels, 2021; Moeltner et al., 2013). In response to these escalating threats, people may elect to remain in place, perhaps adapting in situ, or take the highly effortful step to migrate (Black et al., 2011a, b, c; McLeman & Smit, 2006; Nawrotzki et al., 2014; Sharygin, 2021). Acute-onset climate hazards such as storms and floods are persistently under scrutiny as motivating drivers of migration (Black et al., 2011a, b, c; Fussell et al., 2017; Hoffmann et al., 2020; McLeman, 2018). Despite wildfires resulting in an estimated 1.2 million new internal displacements worldwide in 2020 alone[1] (Bilak & Desai, 2021), we have an incomplete understanding of what prompts individuals to migrate or remain in place in response to wildfire and smoke.

Understanding the psychosocial factors that predict intentions to migrate or to remain in potentially risky areas is essential to developing behaviorally informed models of climate migration. Ultimately, better models of climate migration may enable us to identify unmoving households, providing an opportunity for more targeted engagement to encourage adaptation strategies enhancing resilience to climate hazards. We may be able to leverage these insights to inform where investment in services and infrastructure are needed, both in migration origin locations (for unmoving populations) and for communities expected to receive an influx of climate migrants (Hauer, 2017). Extant literature on the psychosocial factors predicting climate migration identifies mobility potential, place satisfaction, economic drivers, capacity to cope with climate shocks in place, and personal experiences as important drivers of mobility (Adams, 2016; Adams & Kay, 2019; De Jong et al., 1985; Islam et al., 2014; Jacquet et al., 2017; Koubi et al., 2016; Nawrotzki et al., 2014; Winkler & Rouleau, 2020). While illuminating, little is known about whether psychological processes that inform adaptation behaviors such as threat appraisal and coping appraisal are also associated with climate migration, particularly in the context of wildfire and smoke (Adams & Kay, 2019; Bardsley & Hugo, 2010; McLeman, 2018; Nawrotzki et al., 2014). Our work seeks to address two gaps in the literature: the limited research on migration associated with wildfire and smoke and the need to better understand the psychosocial factors associated with migration behavior.

[1] This metric of displacements triggered by wildfires in 2020 captures only internal (within country) displacement, which are not always permanent.

This study aims to assess the association between psychosocial factors — including threat appraisal, coping appraisal, personal experience, and place satisfaction — and intentions to migrate or to remain in place in response to the threat of wildfire and smoke. Threat appraisal refers to an individual's assessment of the probability and severity of a risk (Grothmann & Patt, 2005). Coping appraisal is one's evaluation of their ability to take action to mitigate the consequences of the threat and the efficacy of such actions in reducing harm (Grothmann & Patt, 2005). Using an adapted version of the Model of Private Proactive Adaptation to Climate Change (MPPACC) (Grothmann & Patt, 2005) as a framework for examining these relationships, we surveyed 1108 people in California about their wildfire and smoke perceptions, experiences, and behavioral intentions with respect to migration. We surveyed residents in December of 2020, following a record-setting wildfire season in California with the largest wildfire in California's modern history (the first gigafire), the August Complex (California Department of Forestry and Fire Protection, 2021). By investigating how these psychosocial factors relate to intentions to migrate, this paper will shed light on the current state of wildfire- and smoke-associated migration in California — an increasingly pertinent consideration as the population exposed to wildfire and smoke grows.

Case study — wildfire- and smoke-associated migration in California

California serves as an ideal case study for examining wildfire- and smoke-associated migration intentions given recent extreme wildfire seasons (Radeloff et al., 2018; Williams et al., 2019). Over the last half-century, California has experienced a fivefold increase in annual area burned (Williams et al., 2019). Climate change is estimated to have doubled the forest fire area burned over this period (Abatzoglou & Williams, 2016; Westerling, 2018). Recent work shows that some individuals temporarily leave their area during periods of heavy wildfire smoke (Burke et al., 2022); here, we seek to assess whether wildfire and smoke may be associated with long-term moving considerations. Environmental threats such as wildfire are one consideration among others — including political, demographic, economic, and social factors — that play a role in the migration decision-making process (Black et al., 2011a, b, c; Hauer et al., 2020). Uncontrolled wildfire and smoke in California present a litany of downstream consequences for affected communities that may serve to encourage out-migration to other parts of the state and beyond (Lee, 1966; Winkler & Rouleau, 2020). Direct impacts include property and land loss, loss of life, and health concerns associated with smoke extending far beyond the boundaries of a wildfire itself (Black et al., 2017; Cascio, 2018; Delfino et al., 2009; Diaz, 2012; Dohrenwend et al., 2013; Heft-Neal et al., 2022; Henderson et al., 2011; Johnston et al., 2002; Liu et al., 2016; Rappold et al., 2012; Reid et al., 2016; Schranz et al., 2010; Westerling & Bryant, 2008). Indirect impacts include mental health consequences, such as lower overall well-being, loss of connection with the landscape or community, and emotional fragility (Kulig et al., 2013; Paveglio et al., 2016); social consequences, such as hostility and aggression towards neighbors or emergency officials during evacuation (Carroll et al., 2006); and consequences for one's relationship with place, given how these events can alter the aesthetics and

recreation potential of the environment (Nawrotzki et al., 2014; Winkler & Rouleau, 2020). Furthermore, protective behaviors employed in response to wildfire smoke, like staying indoors during heavy smoke days, may not sufficiently limit dangerous exposure given the infiltration of smoke indoors (Burke et al., 2022; Liang et al., 2021). Recognizing the extensive repercussions of uncontrolled wildfire and smoke, and with no sustained funding pathway for future wildfire prevention (Wara, 2020), households in California knowingly or unknowingly may face a decision about the tenability of where they live.

Households seeking high levels of risk reduction or respite from the litany of impacts from wildfire and smoke may turn to migration as an adaptation strategy. Indeed, Winkler and Rouleau (2020) found that US counties (and neighboring counties) that experienced disaster-level fire or extreme heat had reduced net migration rates in the following year. This effect was greatest for counties with high recreational amenities, suggesting that the natural amenities (e.g., warm weather, mountains, proximity to outdoor recreation opportunities) previously acting as pull factors for in-migration may shift to "disamenities," encouraging out-migration, as a result of climate change (Winkler & Rouleau, 2020). We consider these insights to be particularly salient to California, as climate change shifts these natural amenities into disamenities such as wildfire evacuations, public safety power shutoffs, and water shortages (Diffenbaugh et al., 2015; Wong et al., 2020; Wong-Parodi, 2020). Despite these push factors, many elements contribute to individuals remaining in place, such as economic opportunities, kin and social networks, political factors, lack of objective adaptive capacity (e.g., money, time, institutional or social support) (see the segmented resilience hypothesis (Logan et al., 2016)), and personal attachment or bond with where one lives (Adams, 2016; Bardsley & Hugo, 2010; Black et al., 2011a, b, c; Khanian et al., 2019; Koubi et al., 2016). In an analysis of migration responses following a series of wildfires in Sonoma County, California, in 2017, Sharygin (2021) estimated that the vast majority of households affected by the fires remained in the area; only 6% of those displaced moved out of the county. Further study of how perceptions of these risks, behavioral responses to mitigate these risks, and satisfaction with where one lives despite these risks are related to migration intentions will enable us to better understand the tension between factors rooting households in place and those pushing and/or pulling them elsewhere.

Psychosocial factors and climate migration

Theoretical framework

Environmental psychology informs our study of the role of psychosocial factors in individual protective decision-making in the face of natural hazard events (Baker, 1991; Bubeck et al., 2012; Martin et al., 2007; McGee et al., 2009; Wong-Parodi & Feygina, 2018). Here, we use the MPPACC proposed by Grothmann and Patt (2005) as the foundation for our study. The MPPACC is mainly based on Protection Motivation Theory (PMT) (Rogers, 1975). It was developed to be more aptly suited to the context of climate change-related threats (PMT is health-focused),

adopting language from the climate community and removing various elements from PMT that were deemed not applicable in this context (such as perceived rewards of a nonadaptive response) (Grothmann & Patt, 2005). Prior studies have employed this framework to assess migration behavior at the individual level in the context of drought and changes in rainfall (Kniveton et al., 2011; Smith et al., 2011), heat stress (Zander et al., 2019), and a variety of other climate stressors (Martin et al., 2014).

This model seeks to identify the psychological rationale for differences in individual adaptive behavior in the context of climate threats according to several cognitive processes. Threat appraisal is the foundational process and encompasses an individual's evaluation of the probability that they will be exposed to a threat (*perceived susceptibility*) and the severity of the consequences were they to be exposed (*perceived severity*) (Grothmann & Patt, 2005; Rogers, 1975). If threat appraisal is high enough, the coping appraisal process begins, where individuals assess the effectiveness of protective responses in preventing harm from the threat (*response efficacy*) and their ability to carry out such a response (*self-efficacy*). These two processes determine whether an individual intends to engage in an adaptive response (e.g., fireproofing, fuels reduction) or instead engages in a maladaptive response (e.g., denial, wishful thinking). Note that intention is distinct from engagement itself, which necessitates objective adaptive capacity. Additional components in the MPPACC include risk experience appraisal (an assessment of the severity of a previous encounter with the risk), reliance on public adaptation, perceived adaptation costs, objective adaptive capacity, and cognitive biases, which we do not consider in this study. We draw upon the MPPACC to investigate how psychological processes, namely threat appraisal and coping appraisal, may be related to migration intentions associated with wildfire and smoke, as shown in Fig. 1. We extend this model by also considering personal experience (rather than an appraisal of its past severity) as a predictor of threat appraisal and migration intentions, and we examine place satisfaction as a predictor of the likelihood of future migration (hereafter, future migration potential) for those intending to remain in place.

From intention to behavior

We focus on expressed intentions to migrate rather than moving decisions reported retrospectively. While a gap exists between an intention to act and action itself, empirical studies (Bubeck et al., 2020; Seebauer & Babcicky, 2021) and meta-analyses of studies using the PMT framework demonstrate a moderate correlation between intention and behavior (Floyd et al., 2000; Milne et al., 2000; Sheeran, 2002). Despite the shortcomings of measuring intentions as our outcome of interest, these findings appear to suggest that measuring intentions is a reasonable approximation. Other studies similarly focus on behavioral intentions as a proxy for realized behaviors in both the migration (De Jong et al., 1985; Jacquet et al., 2017; McHugh, 1984; van Dalen & Henkens, 2008) and climate migration spaces (Kniveton et al., 2011; Martin et al., 2014; Nawrotzki et al., 2014; Zander

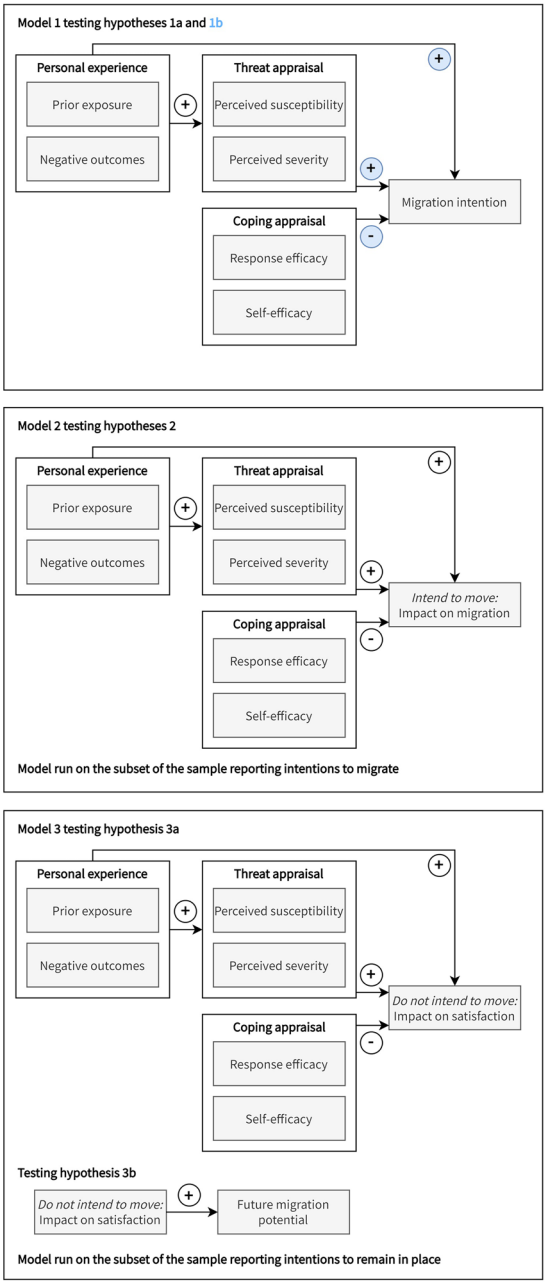

Fig. 1 Proposed conceptual models and hypotheses, adapted from the Model of Private Proactive Adaptation to Climate Change (Grothmann & Patt, 2005)

et al., 2016). Although intentions are not a perfect predictor, they provide some insight into factors that might relate to actual migration behavior. We posit that exploring intentions rather than revealed behaviors may be particularly appropriate for the investigation of wildfire- and smoke-associated migration given the recency of severe wildfire seasons, the lag time expected between intending to move and moving, and the capital (and time) required to carry out plans to move.

Personal experience

To date, most research investigating personal experience with wildfire examines its complex relationship with risk perceptions and protective behaviors (Becker et al., 2017; Lindell & Perry, 2000; McGee et al., 2009; Mockrin et al., 2015), but does not examine experience with smoke or migration as a protective response. Some studies suggest that personal experience with wildfire — or having previously evacuated from a wildfire (Brenkert-Smith et al., 2012) — encourages the adoption of wildfire risk mitigation measures such as on-property fuel reduction, structural home changes, and evacuation preparation (Bernardo et al., 2020; Christianson et al., 2012; Ghasemi et al., 2020; Larsen et al., 2021; McGee et al., 2009; McGee & Langer, 2019). Others have found no association between personal experience with wildfire (or evacuation from wildfire (Wolters et al., 2017)) and willingness to adopt or the adoption of mitigation behaviors (Hall & Slothower, 2009; Martin et al., 2009; Wolters et al., 2017). Of additional note are the inconsistent findings with respect to the relationship between personal experience and risk perception (as an important motivator of protective behaviors). Some research has found heightened perceptions of wildfire risk following personal experience with wildfire (Ghasemi et al., 2020) or as associated with wildfire smoke (Santana et al., 2021), while others found little to no impact on risk perception (Champ & Brenkert-Smith, 2016; Martin et al., 2009; McGee et al., 2009) or a reduction in risk perception following experience (Larsen et al., 2021; Mockrin et al., 2015). These conflicting findings emphasize the necessity of further research on the relationships between personal experience, threat appraisal, and protective behaviors, particularly given scant evidence in the context of wildfire, smoke, and migration.

Threat appraisal

Threat appraisal is a necessary precursor for individual proactive actions, as those who deem something as not risky are not likely to take protective measures (Weber, 2006). However, threat appraisal alone is insufficient to motivate action. Other factors like knowledge and response efficacy play crucial roles alongside threat appraisal in initiating behavioral intentions and subsequent behaviors (Ghasemi et al., 2020; Grothmann & Reusswig, 2006; Hall & Slothower, 2009; Wachinger et al., 2013). A diverse array of factors and biases influence the threat appraisal process, including the characteristics of one's personal experience of the threat (e.g.,

recency, intensity, outcomes), interactions with experts and non-experts (Brenkert-Smith et al., 2013), and coping appraisal (Budhathoki et al., 2020; Grothmann & Patt, 2005).

A small but growing body of research suggests there is a positive relationship between threat appraisal and intentions to migrate associated with environmental change. Threat appraisal was found to be a strong predictor of intentions to move due to heat among urban populations in maritime southeast Asia (Zander et al., 2019); for individuals threatened by sea level rise in Panama Beach, Florida (Song & Peng, 2017); and among wildfire- and cyclone-affected communities in the Philippines and Australia (specifically perceptions of future financial damage) (Zander & Garnett, 2020). Threat appraisal for floods and flood-related damages was a main motivator for households that accepted voluntary buyout offers in flood-prone regions of Austria (Seebauer & Winkler, 2020). In the context of wildfire, while threat appraisal has been shown to be associated with behaviors such as developing an evacuation plan and creating defensible space (Brenkert-Smith et al., 2012; Fischer, 2011; Martin et al., 2007; McCaffrey, 2002), there is extremely limited evidence concerning the relationship between threat appraisal and migration. In one of the few studies to examine migration decisions associated with wildfire, Nawrotzki et al. (2014) sought to identify socio-cognitive and demographic characteristics related to wildfire-associated migration intentions following the Fourmile Canyon fire in Colorado in 2010. This study found that individuals reporting wildfire-related reasons as important in their intention to move had significantly higher risk perceptions than those moving for other reasons. Greater risk perception was also found to significantly increase the odds of intending to migrate (Nawrotzki et al., 2014). Given growing evidence in the literature demonstrating how important threat appraisal is in motivating protective actions, including migration, understanding its relationship with other factors such as personal experience may help us develop better risk communication to leverage these insights. In particularly fire-prone communities or in those following wildfire disasters, this wider examination of the psychosocial factors associated with threat appraisal may provide insight relevant to designing wildfire and smoke mitigation policies or programs.

Coping appraisal

Here, we consider coping appraisal (i.e., perceptions of self- and response efficacy) as distinct from objective adaptive capacity (e.g., financial resources, social networks, access to transportation) (Burnham & Ma, 2017). Determinants of coping appraisal include knowledge about the threat and appropriate responses (Boillat & Berkes, 2013); prior impacts from hazards such as physical damage or revenue losses (Seara et al., 2016); general sentiments about changes in life (Lockwood et al., 2015); prior outcomes when employing coping strategies (Elrick-Barr et al., 2017); perceptions of the responsibility of other actors such as the government (or reliance on public adaptation (Grothmann & Patt, 2005)) (Elrick-Barr et al., 2017); and demographics like sex, age, and education (Saroar & Routray, 2012). On balance, coping appraisal appears to be positively associated with adaptive

behaviors and intentions in the face of climate hazards (Bubeck et al., 2012; Hall & Slothower, 2009). Self-efficacy has been shown to be positively associated with adaptive intentions and behaviors for individuals in climate hazard-prone areas (Burnham & Ma, 2017; Gebrehiwot & van der Veen, 2015; Regasa & Akirso, 2019; Ung et al., 2016). In some cases, response efficacy demonstrated the same relationship (Gebrehiwot & van der Veen, 2015; Regasa & Akirso, 2019). While the direction of this association appears to be relatively consistent across studies examining general protective behaviors, there is a limited understanding of how coping appraisal relates to migration behavior specifically.[2]

There is an important distinction between coping appraisal specific to migration (beliefs about one's ability to migrate and the effectiveness of migration in mitigating harm) (Song & Peng, 2017; Zander et al., 2019) and coping appraisal specific to dealing with the impacts of a hazard where one currently resides (beliefs about one's ability to take action to mitigate harm and the effectiveness of that action in reducing harm). Given the high economic and social costs of moving, in situ adaptation (remaining in place) serves as the default response to threats (Bardsley & Hugo, 2010). Migration has often been considered an act of last resort, only occurring when in situ adaptation is no longer possible (McLeman, 2018). Hence, in situ adaptation strategies to manage the potential consequences of wildfire and smoke — such as creating defensible space on one's property or reducing time spent outdoors during wildfire smoke events — are likely to be perceived as more feasible or lower cost than migration (Bardsley & Hugo, 2010; McLeman, 2018; Zander et al., 2019). Khanian et al. (2019) demonstrate that non-migrants in a drought-stricken region of Iran reporting high place attachment also reported greater coping appraisal in managing the drought, which itself served as a deterrent of migration. Hence, there might be a negative association between coping appraisal and migration intentions: individuals who feel they are able to appropriately and effectively mitigate the harms posed by wildfire and smoke with the options currently available to them (i.e., high in situ coping appraisal) may be unlikely to migrate as related to these risks. Or, individuals who intend to migrate might be expected to report low response efficacy as related to these in situ adaptations, given that they may have deemed them as insufficient to cope with the hazards.

Place satisfaction

Despite evidence highlighting the role of an individual's connection to their community in protective decision-making (Anton & Lawrence, 2016; Bihari & Ryan, 2012; Ghasemi et al., 2020; McGee & Langer, 2019; Paton et al., 2008), place satisfaction — one of many components related to place attachment, such as homeownership, tenure of residency, and rootedness — is still understudied in disaster and climate migration literature. Recent studies have examined place satisfaction or dissatisfaction as antecedents of migration, operating alongside place and community

[2] Although objective adaptive capacity and climate migration have been examined more thoroughly (Adams & Kay, 2019; Black et al., 2011a, b, c; McLeman & Smit, 2006; Nawrotzki et al., 2014).

attachment, mobility potential, and resource constraints in determining individual migration responses (Adams, 2016; Adams & Kay, 2019; Gustafson, 2001; Jacquet et al., 2017; Koubi et al., 2016; Nawrotzki et al., 2014; Ulrich-Schad et al., 2013). Furthermore, one's relationship and satisfaction with where they live can be affected by hazard experiences (Cox & Perry, 2011; Greer et al., 2020; Vallianou et al., 2020). Adams and Kay (2019) posit that changes in circumstances (such as those caused by climate hazards) may result in residential dissatisfaction, disrupting residents' relationships with their community and potentially initiating a migration process. Further study is needed to investigate how threat and coping appraisal related to wildfire and smoke and personal experiences inform one's satisfaction with where they live, which in turn may have implications for future migration decisions. Given our interest in the psychological antecedents of climate migration and the hypothesized relationship between place satisfaction, hazard experiences, and migration, we focus on place satisfaction as both an outcome impacted by wildfire and smoke and as a predictor of future migration.

Research aims and hypotheses

This study aims to better characterize the relationships between psychosocial factors — threat appraisal, coping appraisal, and personal experience — and migration intentions — including intentions to migrate, the impact of wildfire and smoke on this intention, and for those not intending to move, the impact of wildfire and smoke on place satisfaction and future likelihood of moving — at the individual level. We hypothesize (see Fig. 1) that:

H1a: Personal experience is positively associated with threat appraisal.

H1b: Personal experience and threat appraisal are positively associated with migration intentions. Coping appraisal is negatively associated with migration intentions.

H2: For those reporting intentions to migrate, threat appraisal and personal experience are positively associated with wildfire and smoke impact on migration. Coping appraisal is negatively associated with wildfire and smoke impact on migration.

H3a: For those reporting intentions to remain in place, threat appraisal and personal experience are positively associated with wildfire and smoke impact on place satisfaction. Coping appraisal is negatively associated with wildfire and smoke impact on place satisfaction.

H3b: Wildfire and smoke impact on place satisfaction is positively associated with future migration potential.

Research design and methods

Survey administration

A representative sample of 1108 adult California residents were surveyed using the AmeriSpeak Panel, a panel recruited and maintained by the National Opinion Research Center (NORC). The AmeriSpeak panel is designed to be representative of the US household population, and the sample used in this study was weighted to be representative of the California population. Respondents' residential locations are denoted in Fig. 2 alongside the WUI (Radeloff et al., 2017). The vast majority (89.4%) of respondents lived in non-WUI areas. In line with demographics for the state, 95% of respondents lived in urban areas (U.S. Census Bureau, 2012, 2021). The survey was fielded between December 10 and December 24, 2020. The survey was conducted in both English ($n=1082$) and Spanish ($n=26$), online ($n=1068$) and by phone ($n=40$). The survey was fielded to 4305 panelists, with 1108 completing the survey for a response rate of 25.7%. The survey took a median length of 19 min to complete. Participants were provided with a cash equivalent of $3 for their

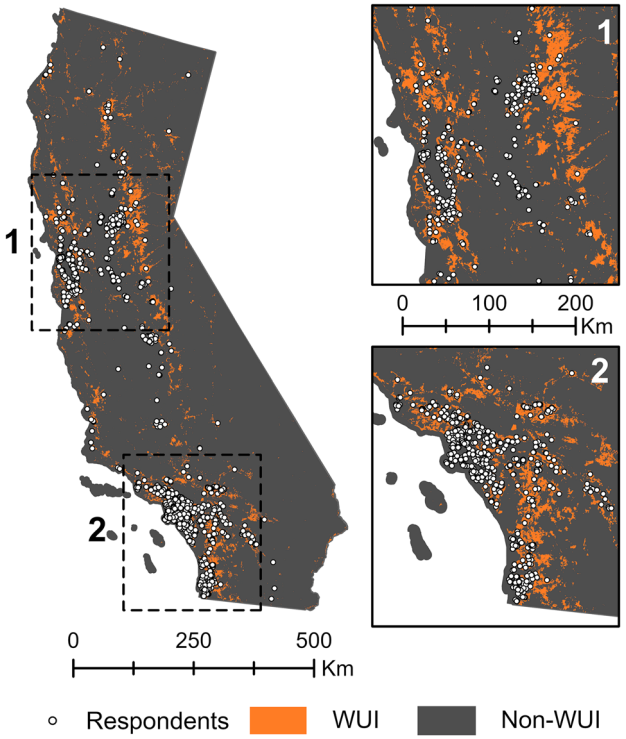

Fig. 2 Locations of the survey respondents and wildland-urban interface (WUI) designated across the state of California. Respondent locations are shifted to preserve anonymity. WUI data are from Radeloff et al. (2017) and here depict both intermix and interface WUI as of 2010

participation. Survey procedures were approved by the Stanford University Institutional Review Board and participants provided informed consent (IRB-51122).

Survey measures

Respondents completed a questionnaire assessing their perceptions of and experiences with wildfire and smoke, as well as COVID-19, and their behavioral intentions with respect to migration. Table 1 presents the dimensions, measurements, and coding schemes for the main variables of interest. The questionnaire was designed to measure dimensions outlined by the MPPACC and selected by the authors. Most questions were developed by the authors for this survey in consultation with experts from NORC, while a few were adapted from previous studies (Holman et al., 2020; Witte, 1992; Wong-Parodi & Garfin, 2022). Measures were refined according to feedback received during pre-testing ($n = 74$, fielded 11/25/2020). Questions were developed according to best practices for survey methodologies, including five-point scale response alternatives (shown to maximize measure validity and reliability for unipolar constructs such as likelihood); optimal rating scales (e.g., "not at all" to "extremely"); construct-specific response alternatives (to reduce survey satisficing and acquiescence bias) (e.g., "No, I do not expect to move away"); and not providing non-substantive response options (e.g., "I don't know") (Krosnick, 1999, 2018; Krosnick et al., 2001).

In line with the MPPACC, threat appraisal was measured along two dimensions: perceived susceptibility and perceived severity (Grothmann & Patt, 2005). To measure *perceived susceptibility*, respondents were asked how much they agreed that a major wildfire would happen near them in the next 5 years. *Perceived severity* was elicited by asking respondents about the harm to health posed by exposure to an unhealthy amount of wildfire smoke (air quality index greater than 150, the threshold at which exposure is considered unhealthy for the general population (US EPA, 2014). In situ coping appraisal was assessed along two dimensions: self- and response efficacy. *Response efficacy* was evaluated by asking how well certain protective behaviors such as wearing a mask to filter smoke when outdoors reduced the harmful effects of wildfire smoke. *Self-efficacy* was elicited by asking how well respondents believed they could perform these actions. Based on theory (Grothmann & Patt, 2005), composite scores of threat appraisal and coping appraisal (separately) were developed by averaging their respective dimensions; however, given low levels of internal consistency (Cronbach's alpha < 0.7), we elected to present results from the separate constructs (see Supplementary Information Table 2 for results from the models using threat and efficacy as composite scores). Personal experience was measured according to two dimensions: prior exposure and negative outcomes. *Prior exposure* to wildfire smoke was assessed by asking respondents whether they had ever experienced wildfire smoke lasting more than 1 week. To measure *negative outcomes*, respondents were asked to select whether they had experienced a variety of outcomes during the 2020 wildfire season and its aftermath, such as evacuating their home because of wildfire, losing property (e.g., vehicle, home) in a wildfire, or having their health harmed by wildfire smoke (e.g., lung irritation, congestion). The

Table 1 Survey questions associated with the Model of Private Proactive Adaptation to Climate Change

Model component	Dimension	Measurement	Coding scheme
Threat appraisal	Perceived susceptibility[a]	A major wildfire will happen near me in the next 5 years	5-point Likert scale: 1 (strongly disagree) to 5 (strongly agree)
	Perceived severity[a]	If you were exposed to an unhealthy amount of smoke from wildfires (Air Quality Index > 150), the smoke would harm your health	
Coping appraisal	Response efficacy[a]	How much do you think the following actions help to reduce the harmful effects of wildfire smoke? • Staying inside • Wearing a face mask that filters smoke when you go outside • Sealing cracks in doors and windows • Leaving your home temporarily to escape the smoke	5-point scale: 1 (not at all) to 5 (a great deal), responses across four questions averaged
	Self-efficacy[a]	How well do you think you could perform actions such as [top three actions selected from response efficacy question]?	5-point scale: 1 (not well at all) to 5 (extremely well)
Personal experience	Prior exposure	Have you ever smelled wildfire smoke that lasted more than one week?	Binary score: 0 (no) or 1 (yes)
	Negative outcomes[b]	As of December 2020, which of the following describes your experience with the 2020 wildfire season and its aftermath? • I evacuated my home because of wildfire • I lost property (e.g., vehicle, home, furniture) because of wildfire • I was injured in a wildfire or its aftermath • My health was harmed (e.g., lung irritation, wheezing, congestion, headaches) by wildfire smoke • Someone I know was negatively impacted because of wildfire • Other, please specify	Count score: 0 to 6

Table 1 (continued)

Model component	Dimension	Measurement	Coding scheme
Individual factors	Length of residency	How many years have you lived in the community where you live now?	Count score
	Homeownership	• Owned or being bought by you or someone in your household • Rented for cash • Occupied without payment of cash rent	Binary score: 0 (not a homeowner) or 1 (homeowner)
Medical conditions	Cardiovascular ailments	Have you ever been told by a doctor or other health professional that you had heart disease?	Binary score: 0 (no) or 1 (yes)
	Respiratory ailments	Have you ever been told by a doctor or other health professional that you had asthma or another disease of your lungs?	Binary score: 0 (no) or 1 (yes)
Migration intention		Do you expect to move away from your current residence in the next 5 years or do you not expect to move away?	Binary score: 0 (do not expect to move away) or 1 (expect to move away)
If respondent reports that they expect to move away:			
	Impact on migration	How much have wildfires and wildfire smoke affected your decision to move?	5-point scale: 1 (not at all) to 5 (a great deal)
If respondent reports that they do not expect to move away:			
	Impact on satisfaction	How much do wildfires and wildfire smoke affect your level of satisfaction with where you live now?	5-point scale: 1 (not at all) to 5 (a great deal)
	Future migration potential	How likely is it that you would move if wildfires or wildfire smoke become more frequent and severe in your area?	5-point scale: 1 (not at all likely) to 5 (extremely likely)

[a]Adapted from original measures in the Extended Parallel Process Model (Witte, 1992) and Wong-Parodi and Garfin (2022)

[b]Adapted from Holman et al. (2020)

Table 2 Descriptive statistics for main variables of interest

Variable	Obs	Mean/ Proportion*	S.E
Threat appraisal	1108	3.84	.036
Perceived susceptibility	1108	3.72	.044
Perceived severity	1108	3.95	.042
Coping appraisal	1108	3.55	.035
Response efficacy	1108	3.50	.040
Self-efficacy	1108	3.61	.044
Prior exposure*	1108	0.74	
Negative outcomes*	1108	0.56	
Intend to migrate*	1108	0.31	
Impact on migration	340	1.92	.087
Do not intend to migrate			
Impact on satisfaction	768	2.46	.054
Future migration potential	768	2.44	.055

*Statistics for variables indicated with an asterisk are proportions of the respective sample who reported prior exposure, negative outcomes, or migration intentions

total number of experiences participants reported was summed to create the negative outcomes measures. Prior exposure and personal experience were explored as separate predictors.

The survey then solicited information on migration intentions. Respondents were asked whether they expected to move away from their current residence in the next 5 years, hereafter referred to as *migration intentions*. Those indicating that they did expect to move away were then asked how much wildfire and smoke had affected their decision to move (*impact on migration*). For respondents who indicated that they did not intend to move, the survey elicited the amount that wildfire and smoke affected their level of satisfaction with where they currently lived (*impact on satisfaction*) and the likelihood that they would move in the future were wildfire and smoke to become more frequent and severe where they lived (*future migration potential*).

Prior research provides evidence of a dynamic relationship between individual differences such as length of residency (often as a proxy for place attachment), health, and demographics and migration behavior (Black et al., 2011a, b, c; Schwerdtle et al., 2020; Song & Peng, 2017). The survey posed additional questions related to these characteristics. Length of residency was measured by asking respondents how many years they had lived in the community in which they currently resided. Homeownership status was measured by asking respondents if they owned or rented their current residence. Participants responded to two questions regarding doctor-diagnosed medical conditions, specifically related to heart and lung disease, coded separately as two binary variables indicating cardiovascular or respiratory health ailments. While not the focus of this study, there is some research to suggest that migration responses may vary by key demographics such as age and sex

(Abu et al., 2014; Bernzen et al., 2019; Bohra & Massey, 2009; Bohra-Mishra et al., 2017; Feng et al., 2012; Koubi et al., 2016; Mueller et al., 2014; Zander et al., 2016, 2019). Thus, demographics were obtained, including age, sex, income, combined race and ethnicity, political ideology, and education.

Weighting

Study-specific post-stratification sampling weights were developed by NORC and used in all analyses and descriptive statistics to ensure the sample was representative of the population of California (see Supplementary Information for more information on weighting procedures).

Statistical analysis

Analyses were conducted in StataMP (version 16.1). To test H1a and H1b, a general structural equation model (GSEM) was conducted with prior exposure and negative outcomes predicting perceived severity and perceived susceptibility, and prior exposure, negative outcomes, perceived severity, perceived susceptibility, self-efficacy, and response efficacy predicting migration intentions (model 1). To test H2 and H3a, GSEM was used with the same factors as in model 1 predicting impact on migration (for those who reported intentions to migrate) (model 2) and impact on place satisfaction (for those who reported no intentions to migrate) (model 3), respectively. To test H3b, OLS regression was conducted with impact on place satisfaction predicting future migration potential for those who reported no intentions to migrate. Multiple imputation by chained equations with a total of 10 imputations (Fichman & Cummings, 2003) was used for all models to generate imputed estimates for missing responses in the data (see Supplementary Information for more information on imputations). All analyses controlled for demographics and cardiovascular and respiratory health ailments.

Results

Descriptive statistics

Table 2 displays descriptive statistics for the variables of interest. On average, respondents believed that a major wildfire would happen near them in the next 5 years (perceived susceptibility; $M = 3.72$, $SE = 0.044$), reported that exposure to an unhealthy amount of wildfire smoke would be very harmful to their health (perceived severity; $M = 3.95$, $SE = 0.042$), indicating high average threat appraisal (threat appraisal; $M = 3.84$, $SE = 0.036$). Respondents saw protective behaviors such as wearing a mask or staying indoors as moderately to a lot effective at mitigating the harm posed by wildfire smoke (response efficacy; $M = 3.50$, $SE = 0.040$), reported that they could perform such actions moderately to very well (self-efficacy; $M = 3.61$, $SE = 0.044$), indicating moderately high average coping appraisal (coping appraisal; $M = 3.55$, $SE = 0.035$). Nearly three-quarters of the sample reported

prior prolonged exposure to wildfire smoke (73.8%). More than half had at least one negative experience during the 2020 wildfire season (55.7%), with 30.9% reporting having their health harmed by wildfire smoke and 28.4% indicating that somebody they knew was harmed (negative outcomes; $M = 0.69$, $SE = 0.030$). Roughly a third of people reported that they intend to move in the next 5 years (migration intentions; 31.4%), on average indicating that wildfire and smoke affected their decision to move a little (impact on migration; $M = 1.92$, $SE = 0.087$); about half of those intending to move indicated that it did not affect their decision at all (50.5%), while a quarter (23.7%) said it affected their decision a little, 12.8% a moderate amount, 9.4% a lot, and 3.7% a great deal. For those not intending to move in the next 5 years, on average, they reported that wildfire and smoke affected their satisfaction with where they lived a little to a moderate amount (impact on satisfaction: $M = 2.46$, $SE = 0.054$) and indicated it was slightly to moderately likely that they would move away if wildfire and smoke became more frequent and severe in their area (future migration potential; $M = 2.44$, $SE = 0.055$) (see Supplementary Information Table 1 for a correlation matrix of key study measures).

Model results

Results from models 1–3 are shown in Table 3. Findings from model 1 are largely in support of hypothesis 1a. Both prior exposure to wildfire smoke ($B = 0.53$; 95% CI: 0.31–0.74; $p < 0.001$) and negative outcomes experienced during the 2020 wildfire season ($B = 0.16$; 95% CI: 0.06–0.27; $p = 0.003$) were associated with greater perceived susceptibility to wildfire. Prior exposure was also positively associated with perceived severity of the harms to health posed by wildfire smoke ($B = 0.25$; 95% CI: 0.04–0.46; $p = 0.020$). These relationships differed between the portion of the sample intending to migrate and those intending to remain in place. For those reporting migration intentions, prior exposure and negative outcomes were associated with greater perceived susceptibility (prior exposure: $B = 0.37$; 95% CI: 0.04–0.71; $p = 0.030$; negative outcomes: $B = 0.28$; 95% CI: 0.13–0.44; $p < 0.001$) and greater perceived severity (prior exposure: $B = 0.42$; 95% CI: 0.02–0.83; $p = 0.040$; negative outcomes: $B = 0.18$; 95% CI: 0.02–0.34; $p = 0.031$). In contrast, for those not intending to migrate, prior exposure was positively associated with perceived susceptibility ($B = 0.59$; 95% CI: 0.35–0.83; $p < 0.001$), while the other tested relationships showed no association.

Results demonstrate mixed evidence in support of hypothesis 1b. Negative outcomes were shown to have a direct association with migration intentions, with each additional negative outcome experienced associated with a 46% greater rate of reporting intentions to migrate ($IRR = 1.46$; 95% CI: 1.12–1. 91; $p = 0.005$). However, in contrast to expectations, there did not appear to be a direct association between prior exposure, threat appraisal, or coping appraisal and migration intentions.

Among the individuals in the sample who reported intentions to migrate, results from model 2 indicate that personal experience and a dimension of threat appraisal were related to the impact of wildfire and smoke on migration intentions, supporting

Table 3 Results from the general structural equation models

Model 1: Personal experience → threat appraisal[a]	***B***	**95% CI**	***p*-value**	
Prior exposure → susceptibility	0.53	(0.31, 0.74)	< .001	
Negative outcomes → susceptibility	0.16	(0.06, 0.27)	.003	
Prior exposure → severity	0.25	(0.04, 0.46)	.020	
Negative outcomes → severity	0.09	(−0.02, 0.19)	.113	
Model 1: Threat appraisal, coping appraisal, and personal experience → migration intentions[a]	***IRR***	**95% CI**	***p*-value**	**Effect size**
Personal experience → migration intentions				
Prior exposure	1.18	(0.72, 1.94)	.506	0.13
Negative outcomes	1.46	(1.12, 1.91)	.005	0.10
Threat appraisal → migration intentions				
Susceptibility	1.16	(0.93, 1.46)	.195	0.15
Severity	1.00	(0.73, 1.38)	.984	0.00
Coping appraisal → migration intentions				
Self-efficacy	0.96	(0.79, 1.16)	.650	−0.04
Response efficacy	1.18	(0.94, 1.49)	.150	0.17
Homeownership	0.64	(0.42, 0.98)	.042	−0.45
Length of residency	0.98	(0.97, 0.99)	.030	−0.02
Model 2: Personal experience → threat appraisal[b]	***B***	**95% CI**	***p*-value**	
Prior exposure → susceptibility	0.37	(0.04, 0.71)	.030	
Negative outcomes → susceptibility	0.28	(0.13, 0.44)	< .001	
Prior exposure → severity	0.42	(0.02, 0.83)	.040	
Negative outcomes → severity	0.18	(0.02, 0.34)	.031	
Model 2: Threat appraisal, coping appraisal, and personal experience → impact on migration[b]	***B***	**95% CI**	***p*-value**	**Effect size**
Personal experience → impact on migration				
Prior exposure	−0.49	(−0.85, −0.14)	.007	−0.39
Negative outcomes	0.44	(0.29, 0.60)	< .001	−0.21
Threat appraisal → impact on migration				

Table 3 (continued)

Susceptibility	0.23	(0.09, 0.38)	.002	0.23
Severity	0.09	(−0.05, 0.23)	.219	0.09
Coping appraisal → impact on migration				
Self-efficacy	−0.09	(−0.20, 0.02)	.117	−0.09
Response efficacy	0.12	(−0.02, 0.26)	.099	0.12
Model 3: Personal experience → threat appraisal[c]	***B***	**95% CI**	***p*-value**	
Prior exposure → susceptibility	0.59	(0.35, 0.83)	< .001	
Negative outcomes → susceptibility	0.09	(−0.04, 0.21)	.185	
Prior exposure → severity	0.19	(−0.02, 0.39)	.076	
Negative outcomes → severity	−0.03	(−0.14, 0.07)	.545	
Model 3: Threat appraisal, coping appraisal, and personal experience → impact on satisfaction → future migration potential[c]	***B***	**95% CI**	***p*-value**	**Effect size**
Personal experience → impact on satisfaction				
Prior exposure	0.09	(−0.15, 0.33)	.442	0.07
Negative outcomes	0.21	(0.08, 0.35)	.002	0.01
Threat appraisal → impact on satisfaction				
Susceptibility	0.08	(−0.04, 0.20)	.189	0.08
Severity	−0.08	(−0.24, 0.07)	.284	−0.08
Coping appraisal → impact on satisfaction				
Self-efficacy	0.05	(−0.06, 0.15)	.385	0.05
Response efficacy	0.05	(−0.09, 0.19)	.471	0.05
Impact on satisfaction → Future migration potential	0.37	(0.27, 0.48)	< .001	n/a

[a]Model run on full sample ($n = 1108$)

[b]Model run for all respondents who reported migration intentions ($n = 340$)

[c]Model run for all respondents who reported intentions to remain in place ($n = 768$)

All models control for length of residency, homeownership, age, sex, income, combined race and ethnicity, education, political ideology, and cardiovascular and respiratory health ailments. Full model results with covariates are included in the Supplementary Information

Results for models run with threat and efficacy as composite scores are in the Supplementary Information and mirror results shown here for the separate constructs

hypothesis 2. Negative outcomes ($B = 0.44$; 95% CI: 0.29–0.60; $p < 0.001$) and perceived susceptibility demonstrated a positive relationship with impact on migration ($B = 0.23$; 95% CI: 0.09–0.38; $p = 0.002$). Prior exposure was shown to have a negative association with impact on migration ($B = -0.49$; 95% CI: -0.85 to -0.14; $p = 0.007$), in the opposite direction than was hypothesized. Coping appraisal demonstrated no significant association with impact on migration.

For respondents who indicated that they did not intend to migrate, findings from model 3 suggest that elements of personal experience were related to the impact of wildfire and smoke on place satisfaction, and that impact on satisfaction is linked to future migration potential. Negative outcomes were directly associated with a greater impact on place satisfaction ($B = 0.21$; 95% CI: 0.08–0.35; $p = 0.002$). Threat appraisal, coping appraisal, and prior exposure were not shown to have an association with impact on satisfaction. In support of hypothesis 3b, ordinary least squares regression reveals that impact on satisfaction was associated with greater future migration potential ($B = 0.37$; 95% CI: 0.27–0.48; $p < 0.001$).

Migration intentions also appeared to be in part associated with personal characteristics (see Supplementary Information Table 3). Each additional year of residency was associated with a 1.6% reduced rate of intending to migrate ($OR = 0.98$; 95% CI: 0.97–0.99; $p = 0.030$), while homeowners were 36% less likely to report migration intentions as compared to renters (IRR = 0.64; 95% CI: 0.42–0.98; $p = 0.042$) (see Supplementary Information Table 2 for demographic results).

Discussion

We find that experiencing negative outcomes during the 2020 wildfire season was associated with an increased likelihood of intending to migrate. This pattern of findings supports recent work investigating the role of personal experience with wildfire in motivating adaptive behaviors (Bernardo et al., 2020; Brenkert-Smith et al., 2012; Christianson et al., 2012; Ghasemi et al., 2020; Larsen et al., 2021; T. McGee & Langer, 2019) and extends this relationship to migration intentions. Furthermore, among those intending to migrate, we find evidence that negative outcomes are related to a greater impact of wildfire and smoke on intention to migrate. Negative outcomes appear to operate as push factors motivating migration. Though we do not explore the specific rationale as for why these outcomes are linked to migration intentions, we hypothesize that both the direct (e.g., experiencing harms to health from smoke) and indirect effects (e.g., psychological distress and trauma, changes to one's relationship with to their community, disruptions to social network, concerns about recurring impacts to health) of one's experience during the wildfire season are related to this decision. This relationship warrants further exploration to determine qualitatively why such outcomes, particularly those unrelated to loss of property, appear to be positively associated with migration intentions, such as the amenities-to-disamenities shift described in Winkler and Rouleau (2020). Interestingly, prior smoke exposure did not demonstrate this relationship with impact on migration, suggesting that the valence of one's personal experience with wildfire and/or smoke is an important determinant.

We found that believing a major wildfire would happen in close proximity in the next 5 years was associated with a greater impact of wildfire and wildfire smoke on migration intentions, but not the belief that one's health would be harmed by smoke. Consequently, it may be that individuals are concerned about a more holistic sense of the threats posed by wildfire and smoke, rather than just one potential impact, resulting in the link between perceived susceptibility and impact on migration. Our findings help to isolate nearness to wildfire as a potentially important factor in motivating wildfire- and smoke-associated migration. This conclusion mirrors results from Nawrotzski et al. (2014), who found that wildfire-associated migrants reported greater risk perception than non-wildfire-associated migrants. This relationship may suggest that individuals' perceptions of the likelihood of major wildfires in their proximity is an important cue in mobility decisions, thus extending other scholarly research related to protective behaviors and wildfire threat appraisal (Brenkert-Smith et al., 2012; Fischer, 2011; Martin et al., 2007; McCaffrey, 2002).

Nearly a third of our sample reported intentions to move in the next 5 years. According to a 2013 Gallup poll, 24% of Americans surveyed reported moving (within the US) in the prior 5 years (Espiova et al., 2013). Nawrotzki et al. (2014) report that 14% of households surveyed in the aftermath of the Fourmile Canyon Fire intended to move in the next 5 years. These figures provide helpful context to consider alongside our results. While recent severe wildfire and smoke seasons may partly account for why a high proportion of people reported migration intentions in our study, other elements such as the gap between intentions and behavior (Sheeran, 2002) and the coronavirus pandemic likely also play a role (Haslag & Weagley, 2022; Ramani & Bloom, 2021) (see Supplementary Information for more on COVID-19 and migration).

Among individuals not intending to migrate, negative outcomes experienced during the 2020 wildfire season were associated with a greater impact of wildfire and smoke on one's satisfaction with where they live. This was found to be positively associated with future migration potential. In addition, we found that homeownership and length of residency — other components of place attachment alongside place satisfaction (Kasarda & Janowitz, 1974; Lewicka, 2011; Nawrotzki et al., 2014) — were negatively associated with migration intentions. Initial findings here are in support of recent studies emphasizing the importance of place satisfaction and place attachment in mobility decisions (Adams, 2016; Adams & Kay, 2019; Jacquet et al., 2017; Lewicka, 2011). How wildfire and smoke shape individuals' connections to their community and residential area and the downstream effect on migration warrants further study. Our findings concerning length of residency and homeownership support previously published data on migration trends in the US (Ihrke & Faber, 2012; US Census Bureau, 2021). Our results suggest that, even for those intending to remain in place, experiences with wildfire are impacting the extent to which individuals are satisfied with where they live, and that this, in turn, may impact future mobility decisions as individual tipping points with respect to risk tolerance are met given changing hazards

under climate change. This may increasingly be the case for residents living in wildfire and/or smoke-prone regions of the American West.

While the literature is mixed in terms of the link between personal experience and threat appraisal, findings here provide additional evidence of a positive relationship between personal experience and threat appraisal (as found in Ghasemi et al., 2020; Santana et al., 2021). Our results suggest that personal experience with wildfire and smoke is related to greater threat appraisal. However, the relationship between personal experience and threat appraisal differed according to migration intentions. There was a significant, positive association between both types of personal experience and both dimensions of threat appraisal among those reporting intention to migrate, while only one of those four relationships held among those intending to remain in place. While we are careful not to make any causal claims here, this difference could indicate that risk tolerance thresholds vary by migration intentions. Those intending to migrate may have integrated their personal experiences into their risk assessments, which may have amplified their concerns and motivated their migration decision, while those intending to remain in place may have not. This may have implications for the adoption of protective behaviors among those not intending to migrate. Lack of personal experience with these hazards or avoiding negative outcomes in their aftermath may foster low risk perceptions not reflective of the objective risks in one's environment, inhibiting motivation to mitigate risk. Given the relationship between wildfire risk perceptions and protective behavioral responses, further study is necessary to examine the causal role of personal experience in the context of migration behavior.

Finally, we find no evidence of a relationship between coping appraisal and migration intentions, impact on migration, or impact on satisfaction. It is interesting to note that beliefs about the efficacy of these actions and one's ability to perform them were not related to impact on migration or satisfaction — these findings are contradictory to our hypotheses. It may be the case that other factors related to objective adaptive capacity, such as financial resources, social capital, or employment sector and flexibility, would exhibit stronger relationships with migration intentions than in situ coping appraisal given the high costs of migration. This underscores the value of future research related to coping appraisal — both in situ coping appraisal and migration-specific coping appraisal — and migration behavior, as well as research examining institutional and structural forces at play in the migration decision-making process (and research related to trapped populations (Islam et al., 2014; Logan et al., 2016)).

Limitations

We recognize the limitations of this study. Our analysis is restricted to migration intentions. Migration incurs high costs and requires significant objective adaptive capacity. Barriers, such as low coping appraisal, lack of financial resources, health ailments, or social networks (e.g., caregiving duties), could prevent intentions from being realized (McLeman, 2018; McLeman & Smit, 2006; van Dalen

& Henkens, 2008; Wanner, 2021) In addition, households reporting intentions to remain in place could end up migrating due to unforeseen circumstances, including direct displacement due to a wildfire. The cross-sectional survey design prevents us from being able to make causal claims about the role of these psychosocial factors in informing migration intentions. Future research should strive to collect longitudinal data, ideally prospectively in advance of wildfire and smoke events, to enable deeper investigation. Longitudinal studies could also examine pre- and post-migration perceptions alongside objective indicators of wildfire and smoke exposure to assess the effectiveness of migration as an adaptation strategy. Our measure of coping appraisal was not migration-specific and instead examined in situ coping appraisal. This measure was also limited to assessing actions to cope with harms to health associated with wildfire smoke, separate from the wildfire itself and other concerns related to smoke. Explicit study of migration-specific self- and response efficacy in future studies would facilitate a more robust understanding of these relationships in the context of climate migration. While our study does highlight how threat appraisal and personal experience are related to wildfire- and smoke-associated migration, qualitative research on this subject could provide insight on the different pathways by which these appraisals manifest in migration. Additional research should aim to parse the differences between wildfire and wildfire smoke themselves given how these hazards vary (e.g., acute/chronic), perhaps using alternative conceptual frameworks such as a threshold model (Bardsley & Hugo, 2010). We might expect to see a variety of motivating factors, such as health concerns, insurance availability, psychological distress, concerns about public safety powers shutoffs, changes to recreation and amenities, disruptions to economic opportunities, and/or housing. While our sample is representative in terms of the geographic distribution of the population across the state, we capture a limited number of individuals living in rural areas and/or the WUI. Such households may have different experiences with wildfire than those living in urban areas (who are mainly exposed to wildfire smoke) or may have different risk thresholds, and thus might report different perceptions and behavioral intentions. Additionally, the subject of the survey (wildfire) may have been of more interest to certain respondents resulting in non-response bias (Berg, 2005), with greater representation of individuals more concerned with wildfire. The topic or question order may also have made wildfire and smoke more salient to respondents when answering migration-related questions.

Conclusion

This study provides insight on factors that root people in place or push them to consider moving in response to wildfire and smoke, threats that are expected to escalate with climate change and population growth in the WUI. These findings build on previous descriptive research on climate migration by applying a psychological framework to wildfire- and smoke-associated migration, which has yet to be explored in depth. This study highlights the relevance of social and behavioral research in studies of climate migration given the variety in behavioral responses

observed in the face of climate disasters (Richard Eiser et al., 2012). Should it be the case that individuals who exhibit higher threat appraisal or who have experienced negative outcomes from wildfire and/or smoke tend to leave their communities, we might expect to see a greater proportion of individuals assessing wildfire and smoke as lower risk among those who remain (Nawrotzki et al., 2014). Because threat appraisal is positively associated with wildfire risk mitigation behaviors, these households could be less inclined to undertake wildfire risk mitigation behaviors (Brenkert-Smith et al., 2012; Fischer, 2011; Martin et al., 2007; McCaffrey, 2002). Proactive outreach about wildfire and smoke risks could help residents develop risk perceptions aligned with the true risks they may face to prevent inaction and in turn reduce negative outcomes. Furthermore, it would be prudent for communities welcoming households from wildfire- and smoke-affected areas to take steps to ensure new residents are apprised of new risks — wildfire and smoke or otherwise — in their area. Future research on migration in this context will broaden our understanding of how wildfire and smoke impact population dynamics, with the potential to improve models of climate migration to inform policymaking and urban planning.

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Declarations

Competing interests The authors declare no competing interests.

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