Literature review of societal perceptions of wildfire risk and mitigation behaviours.

A report for the RESAS Strategic Research Programme project 'The impacts of climate change on Natural Capital (JHI-D5-2)

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Summary:

- The aim of this review is to explore information on risk perception relevant to wildfires arising from climate change in Scotland.
- This literature review provides information on:
- Common theories of risk perception and methods for its analysis.
- Insights on the relationships between risk perception and risk behaviour.
- The objective is to provide information informing responses to four key questions: What factors influence the perception of risk; What are the actions taken to mitigate this risk; What are the factors that incentivise individuals and communities to take specific mitigation actions; How does communication change behaviours?
- The purpose of this review is to help inform the development of research activities on wildfire and climate change risk perception within Work Package 3 in the project 'Climate Change Impacts on Natural Capital'.
- Through assessing risk perception and mitigation behaviours in the context of wildfires, we aim to develop an improved understanding of the theories of risk and mitigation behaviour that can then be utilised in the broader context of climate change impacts, particularly in respect of Natural Capital and Nature Based Solutions.

Key findings and observations:

- There is a low representation of literature relevant to wildfire risk in Europe and the UK.
- The focus of the literature reviewed is on wildfire risk to humans and property, rather than Natural Capital.
- There is a dominance of analysis of households' risk perception and mitigation strategies in the literature.
- Of the risk aspects considered as key drivers of risk behaviour, risk perceptions (e.g. to climate change or wildfire, was the most frequently cited Risk perception alone, however, is not the only factor that has an influence on individuals' risk mitigation decisions. Information on the risks of wildfire may not lead to an increased perception of risk, but information on how to mitigate risks may lead to completion of mitigation behaviours.
- In developing further research plans, it would be appropriate to fulfil the objectives of the project to target land use owners, managers, decision makers, and public and private investors adopting a mixed methods approach by integrating elements coming from several theories of risk perception and analysing the economic implications for society and investors decisions in land restoration under different risk perceptions. A suitable approach to risk perception and mitigation strategies will be discussed through interviews and workshops with relevant stakeholders in those areas projected to be impacted by climate change.

Contents

Citation

This report is to be cited as:

1. Introduction

This report is an output of the RESAS project "Climate Change Impacts on Natural Capital", reference JHI- D5-2[1], and is prepared to accomplish the goal of WP3 dealing with the analysis of risk perception and behaviour in natural landscape or wildland urban interface (WUI) influenced by climate change, with a particular focus on wildfires. The aim of this review is to explore the literature informing responses to the following questions:

- What are the factors that influence the perception of risk in situations characterised by hazards, with particular focus on wildfires?
- What are the actions taken to mitigate this risk?
- What are the factors that incentivise individuals and communities to take specific mitigation actions?
- To what extent do communication (e.g., social media or mass media campaigns) and other forms of knowledge exchange (e.g., peer-to-peer strategies) change the behaviours of people facing wildfires, and what elements of communications must be addressed to incentivise people to change attitude towards fire risk?

To answer these questions, we will be considering the most common theories dealing with the analysis of risk behaviour under scenarios of wildfire extreme events with the aim to draw down approaches for the valuation of wildfires risk perception in those areas of Scotland that are projected to be impacted by climate change. We then explore how to construct novel mitigation strategies and revise risk communication approaches.

These theories are principally developed in the USA and Australia with much more limited implementation in Europe. A recent ongoing attempt to enrich and share knowledge perceptions of wildfires at European scale is made through the EU funded project FirEUrisk (https://fireurisk.eu/) for which we are partners and involved in the analysis of public attitudes and perceptions of causes and impacts of wildfires by means of a dedicated survey and participatory workshops. This research collaboration has developed an attitudinal analysis going across scales: Scotland - the UK - EU levels, and deliberative approaches being put at the core; therefore, linking this project to JHI-D5-1, which is on incorporating of participatory approaches into natural capital valuation.

The rationale for this review and the role of risk perception evaluation within the Climate Change Impacts on Natural Capital project, is that future projections indicate an increasing probability of wildfire risk. It is thus important to understand the societal perceptions of risk and how this can inform communication of mitigation options. The context within this review is climate change and wildfire risk, but our hope is that the insights gained can also be informative for a broader range of impacts on Natural Capital and therefore risk perception responses by individuals (especially land managers) and society. Of particular interest is the increased risk of wildfires in relation to Natural Capital that has high potential for climate mitigation, such as peatlands and woodlands, and how this impacts the viability of Nature Based Solutions as a mitigation approach. This risk impact can be perceived differently by several stakeholders. For instance, investors willingness to pay on land restoration can be a significantly modified change under additional information on wildfire risk, affecting the development of innovative funding schemes such as the blended private and public

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investment on peatlands (Petland Code), Woodland (Woodland carbon code) and landscapes (Reed et al., 2022).

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Text Box 1: Notes on Terminology:

The terms risk and threat are often used interchangeably within the literature, but for the purposes of this review and its use with the D5-2 Climate Change Impacts on Natural Capital project, it is important to distinguish the differences between the two. Within the project, the concept used is that Risk (and opportunities) to a Natural Capital asset and impacts on its ability to provide ecosystem services is a function of its Vulnerability and how Exposed it is to a range of Threats (R=VET).

Vulnerability: is defined as "The degree to which a system [asset] is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation [Threat] to which a system is exposed, its sensitivity, and its adaptive capacity". Vulnerability is an indication of asset resilience and includes its adaptive capacity (with or without human intervention), reflecting its ability to cope with or withstand different types of Threat (e.g., extreme events) or exceedance of variation (climate trends). Vulnerability can be sub-divided into biophysical and social dimensions requiring different approaches. Assets may have vulnerability tolerance thresholds (tipping points) beyond which it cannot or is unlikely to recover. Cascading vulnerability refers to inter-connection with other assets: one asset may have low direct vulnerability to CC but relies on another that has high vulnerability.

Exposure: "The nature and degree to which a system is exposed to significant climatic variations" (IPCC 2001). Exposure is concerned with the spatial extent and quantity of an asset (abundant versus rare) and sensitivity to different threats and their probabilities (frequency and spatial distribution of droughts).

Threat: encompasses different types of threat (climate, social, biological) an asset is exposed to and whether it is direct (climate extreme event, flood, drought, storm) or indirect (fire susceptibility due to drought, altered energy and nutrient transformation in food webs). This includes the nature and severity of the climate threat, its spatial extent, frequency and intensity and or duration.

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2. Method

This review was limited to studies in English-language peer-reviewed sources published until June 2022. Searches for reports of quantitative research about wildfire risk perception and mitigation behaviour were made using the Web of Science and Science Direct catalogue.

The approach used to prepare this report cannot be considered a systematic review; therefore, it is not based on the definition of a standardised protocol. Due to relatively low search returns which were specifically targeting wildfire mitigation behaviour of land managers in the UK peatlands and forests, the scope of the search was broadened to include social and psychological evidence in the wildfire context targeting households and communities in wildland urban interface (WUI) and forest landscape of three continents: the US, Australia and Europe.

Key strings used to search papers of interest are (wildfire OR bushfire) AND (risk perception) AND (risk behaviour). Twenty four papers were returned by Science Direct and 42 documents by Web of Science. All papers were screened by title and abstract. After removal of replications and of those studies that were not strictly relating to the perception and attitude of people and community to wildfire risk, 35 sources were selected. The key strings selected for this review were chosen to select papers that can be considered complementary to recent research made in 2021 by SRUC, the

University of Newcastle and The James Hutton Institute that carried out a rapid evidence assessment on land manager mitigating strategies in relation to wildfires occurring in the UK uplands (Stewart et al., 2021). We are confident that the integration of the two studies will be able to address the objectives of the project JHI-D5-2 analysing risk perception and responses of stakeholders and land users, and providing recommendations for improving risk related behaviours including novel risk communication approaches.

Text Box 2: Fire Risks:

Climate change has been cited as one of the major influences in increased wildfire occurrence globally (Arnell et al, 2021). Specifically for the UK, mean summer temperatures are anticipated to rise by as much as 2.5°C by 2050 increasing wildfire risk, which can be further exacerbated by potential decreases by over 15% in annual rainfall over the same period (Grau-Andres et al, 2018). Increases in the frequency of drought will most likely lead to more frequent wildfires occurring across the UK, which can be more severe in nature, occur more extensively across landscapes and exhibit more variable seasonality (Albertson et al, 2010; Davies et al, 2013).

Most wildland fires in the UK are usually small in nature - usually under a hectare in size (Arnell et al, 2021) and are most likely to occur in arable, grassland or mountain and heath environments (de Jong et al, 2016, Gazzard et al, 2016). Furthermore, wildfires also occur frequently on remote upland peatland environments (Albertson et al, 2010). Although peatlands may be rare globally, covering roughly 2–3% of the Earth's land surface, between 9% and 15% of Europe's peatlands are located in the UK, with 77% of those occurring in Scotland (Bain et al, 2011).

Wildfires can be destructive for seminatural habitats (Whitehead et al, 2021); they can cause peatland degradation (Carroll et al, 2009; Bain et al, 2011) and reduction of carbon storage; the release of toxic metals into the atmosphere (Turetsky et al, 2006); and extensive damage of sensitive habitats such as Sphagnum vegetation communities (Grant et al, 2012). Overall, it is expected that increased occurrence of wildfires, especially on remote upland area and peatlands, will be costly to fight, cause damage to freshwater catchments and other ecosystem services and require costly restoration (Albertson et al, 2010).

Extract from: Aitkenhead M, Pakeman R, Gagkas Z, Rivington M (2022) Deliverable D1.2 for Project JHI-D5-2 'Climate Change Impacts on Natural Capital': A literature review of climate change impacts on Scotland's Natural Capital, mitigation opportunities and associated socio-economic and policy contexts.

3. Results

3.1 Descriptive statistics of the sample

As expected, the majority of studies were produced in the USA (23), followed by Australia (7), and the remaining originated in Greece (2) Sweden (1) and China (1). One study (a literature review) does not target any specific country. It is immediately evident how Europe seems much less dominant in the sector of wildfire impacts and the analysis of the social dimension of risk.

Target of the selected papers are mainly households (25), while only five studies are tackling the same problems at scale of community: three papers are tackling forest landowners and two papers are directed to explore wildfire risk behaviour in the workplace context. More in details, one paper explored risk perception of workers and the others addressed that of professionals in wildfire management, researchers and other engaged stakeholders such as local government officials, non-government organizations, and community members.

The methods used to carry out the reviewed research are interviews (five), in one case accompanied also by the development of a statistical model; two studies are implementing economic analysis via choice experiment and contingent valuation methods, while the majority of them (25) build on different theories and implement a questionnaire survey accompanied by different statistical analyses to depict relations between behaviours and risk mitigation such as factor analysis, logistic regression, structural equations and simultaneous equation models. The remaining papers (three) are studies based on mixed methods such as survey and interviews and survey with interviews and focus group.

Papers based on primary research were produced following different theories: the majority (detailed below) followed well consolidated approaches such as the Protection Motivation Theory (PMT) (five), with some deviations to the main theory to assess the role of psychological shortcuts. Other studies applied the Theory of Planned Behaviour (TPB), the Protection Action Decision Models (PADM), and a few of them mixed the above-mentioned theories. In particular, two papers combined PMT and TPB theory and one paper mixed the PMT and PADM approach. Other papers refer to approaches based on the mediation model (one); the objectivist and constructivist theory (one); the evacuation behaviour model (two); the model of behavioural adaptation (one); and analysis of preferences through willingness to pay (two). Finally, a few of them are based on empirical model that do not follow any theory but are based on empirical models (five). A synthesis of these approaches with variables used and reference to the main studies reported in the literature is proposed in Table 1. What follows is a synthesis of relations between risks perception and mitigation strategies articulated around the main theory depicted in Table 1.

3.2 Theoretical model of risk

3.2.1 Protection motivation theory

Part of the literature investigating risk perceptions builds on the protection motivation theory (PMT). According to this theory, higher perceptions of risk among individuals are believed to be associated with individuals' greater desire to reduce their exposure to risk (McCaffrey, 2006). PMT suggests that individuals are more likely to mitigate risk according to their perceptions of the probability and severity of an event and associated outcomes and their ability to take protection actions (Rogers 1983). PMT examines two cognitive appraisals (threat and coping appraisals) as key elements to shape the decision to protect oneself from a given threat (Rogers, 1983).

The threat appraisal includes perceived severity (how bad the consequences of a threat will be) and perceived vulnerability (the probability of a threat occurring). The coping appraisal includes response efficacy (the belief the mitigation action taken will reduce risk), self-efficacy (the belief in one's capacity to carry out the action), and response costs (how much will it cost to implement the action) (Larsen et al., 2021; Liu and Jiao, 2018).

Risk perception alone typically is not the only factor that has an influence on individuals' risk mitigation decisions. There are examples in the literature (Champ et al., 2013) showing that in different communities the analysis of risk perception is related to different mitigating behaviours. Champ et al. (2013), for example, suggest that homeowners' wildfire risk perceptions and mitigation decisions are jointly determined by a combination of characteristics pertaining to homeowners and their home sites. However, this relation is not always found. For instance, Koksal et al. (2019) experienced limited correlation in some communities in Australia between perception and mitigation. Some possible explanations offered by the authors are: (a) lack of householder knowledge about how to mitigate wildfire risk; (b) moderating effects of other influences such as

social vulnerability, place dependence, and characteristics of the property; (c) acceptance of risk; and (d) the moderating effect determined by conserving preferred environmental amenity values (reducing fuel and vegetation is seen as an approach that alters landscape and reduces biodiversity).

Olsen et al. (2017), building on Champ et al (2013), proposed a hybrid model according to which homeowners' perceived wildfire risk is a function of factors such as hazardous fuel conditions near the home site, as well as the homeowners' past experiences with wildfire, and the social context (or networks) in which homeowners' beliefs, attitudes, and norms are formed. The authors found homeowners' wildfire risk perceptions to be positively correlated with hazardous conditions predicted by fuel models, but weakly predictive of mitigation behaviour (contrarily to what is proposed by the PMT). Wildfire risk perceptions also were found to be correlated with past wildfire experience. In addition, advice from friends, family, and local government agencies had little if any influence on wildfire risk perceptions among the homeowners examined, while advice from local government and fire awareness groups had a positive influence on whether homeowners undertake risk mitigation activities (Olsen et al., 2017).

Liu and Jiao (2018) in exploring the effect of cognitive factors and risk attitude on three fire mitigation behaviours (maintenance and cautions, structural building measures, and fire insurance policy), found that coping appraisal and risk attitudes are important variables in explaining risk mitigation behaviour. In particular, response efficacy and risk attitudes significantly contribute to the models that explain fire risk mitigation behaviour.

Larsen et al. (2021) via a questionnaire survey designed to measure each of the processes described by PTM, included also physical risk measures as factors that may influence residents' wildfire mitigation behaviours such as the influence of acreage, fire proximity, and vegetation on individuals' risk perceptions and mitigation actions as also proposed by Olsen et al. (2017). The inclusion of physical measures in risk perceptions and mitigation behaviours is also discussed by Meldrum et al. (2019), who accounted for potential direct feedbacks between risk perceptions and parcel-level conditions, while Short et al. (2016) considered wildfire hazards to property assessed by burn probability and intensity fire level assessed by geospatial fire simulation. Meldrum et al (2019) found also that residents' decisions to reduce their wildfire risk through mitigating behaviour are not only influenced by their perceptions of wildfire risk but, but as these variables are endogenous, i.e., each can be cause of the others, mitigating actions can in turn influence risk perceptions.

In the studies proposed by Larsen et al (2021) and Liu and Jiao (2018) information on the risks of wildfire may not lead to an increased perception of risk, but information on how to mitigate risks may lead to completion of mitigation behaviours. These insights provide important recommendations for the development of a fire risk communication strategy. They indicate which information should be emphasized in risk communication strategies, such as the likelihood of fire accidents, the effectiveness of risk mitigation measures, as well as providing practical guidelines for the implementation of those measures, or assistance in adopting those measures to reduce the response cost of homeowners.

The possibility to investigate risk perceptions and behavioural approaches to mitigation has been further extended to take into account a series of shortcuts that can be important from a psychological point of view. Ghasemi et al. (2020) went beyond the central tenets of the protection motivation theory (i.e., that perceived risk and perceived response effectiveness would guide protective action), building on the work done by Slovic et al. (2000) on the determinants of hazard risk perception, and considering also cognitive heuristics and emotional bonds such as social trust in wildfire management, past experiences with wildfire, and perceived effectiveness of institutional

management strategies implemented in programs such as the FIREWISE USA ®. Ghasemi et al. (2020) found that cognitive heuristics (i.e., trust and past experience) and emotional bonds to place (i.e., home attachment) can be successfully integrated into a rational, evaluative model of decision-making under risk (i.e., protection motivation theory) to better predict homeowners' decisions to mitigate wildfire risk. Specifically, above and beyond the perceived wildfire risk and effectiveness of the FIREWISE activities, emotional bonds to home increased respondents' intention to mitigate risk along with their past experience with wildfire and trust in agency information.

3.2.2 Theory of planned behaviour

This theory is based on the idea that there are three main predictors of behavioural intention: attitude toward the behaviour, subjective norm, and perceived behavioural control (Fishbein & Ajzen, 2010). Behavioural beliefs determine an individual's attitude toward performing the behaviour; normative beliefs determine the subjective norm, or social pressure, to perform or not perform a behaviour; control beliefs are "beliefs about personal and environmental factors that can help or impede their attempts to carry out the behaviour" (Fishbein & Ajzen, 2010). Understanding the underlying behavioural, normative, and control beliefs of landowners may provide information about the motivations and intents that influence private wildfire mitigation behaviour (Nox and Myles, 2017).

The theory of planned behaviour (TPB) also specifies two other antecedents to behavioural intention. The first, perceived behavioural control, refers to one's perception of how difficult or easy is to perform a given behaviour (Hall and Slothower, 2009). It is reasonable to expect that the ease of implementing fire mitigation measures should affect homeowners' willingness to do so. The second is about the effectiveness of perceived mitigation at reducing damage from wildfire in influencing mitigation behaviour (Martin et al., 2009; McGee et al., 2009), that in turn depends on people experience with past fires.

Subjective norms and social pressure can describe the reason why neighbours and associations can affect residents' decision to mitigate, suggesting that homeowners feel a sense of responsibility not only to reduce the risk for themselves but also for their neighbours (McCaffrey et al., 2011). In contrast, some residents feel it would be futile to perform mitigation measure if their neighbours do nothing to reduce risk (Weisshaupt et al., 2007).

Behaviour control can be associated with perception of cost of action (McFarlane et al., 2011), limits on physical capability (Collin and Bolin, 2009) and lack of time or knowledge (McCaffrey et al., 2011). A study controlling for all these factors was carried out by Nox and Myles (2017) who examined the difference between behavioural intention and behavioural approach to wildfire mitigation. Mitigation behaviour was classified in three groups of action, and the behavioural variables were measured for each of these groups. Only intention and subjective norms were predictors for certain mitigation strategies such as keeping gutters and roof free of leaves, needles, and branches, while only intention and behavioural control were predictors for other mitigation strategies such as keeping tree limbs pruned at least 10 feet from the roof; finally, only intention was a predictor for mitigation for keeping dead vegetation cleared within 30 feet of the house.

As expected, attitude was the most important variable (40.6% of total variance) relating to behavioural intention, followed by subjective norm (10.1%), and behavioural control (1.3%). Risk perception explained an additional 2.2% of the total variance (Nox and Myles, 2017).

3.2.3 The protective action decision model

The protective action decision model (PADM) was proposed to analyse the behaviour and decision making of people subject to threats from a range of hazards and has acquired the status of a theory of hazard decision-making (Lindell and Perry, 2012). It focuses more on emergency responses than long-term risk management, so depicts people's short-term responses to environmental hazards and disasters such as earthquakes, hurricanes, and flooding.

A series of factors that influence householders' protective responses to threatening events are considered such as environmental and social signs, information and warnings (Lindell and Perry, 2012). These elements are at the core of threat (to be considered as perception of hazard caused by fire, flood, etc.)that becomes the basis of decisions in which decision-makers consider whether a real threat exists, the need for protective action, the availability of protective options, the best protective alternative, and the timing of its implementation (Lindell and Perry, 2012). Recently, the PADM was used as a theoretical and analytical framework in two Australian studies carried out by Strahan and Watson (2019) to model the choice of evacuating or remaining (short-run hazard adjustment) during a bushfire. Eight variables predicted the evacuation strategy, with perception of the effectiveness of evacuating or remaining (hazard related perceptions) as the strongest predictor. Although the model reflects the short-term strategy chosen according to the hazard related perception, it can be adapted to consider also long-run hazard adjustments such as property maintenance and preparation, equipping for fire-fighting and self-protective actions as factors that in turn may influence evacuating or remaining strategies.

3.2.4 Hybrid models

The different models above were proposed to explain risk perception and mitigation behaviours. However, not all of the studies strictly follow the theories proposed. Some deviation from the standard model were mentioned in the previous section, mainly to account for social attitudes and network relations (Slovic et al., 2000; Ghasemi et al., 2020) or physical risk measures (Larsen et al., 2021; Meldrum et al., 2019; Olsen et al., 2017). In addition, combinations of the above theories are also proposed. The literature presents combinations of PMT and TPB (McLennan et al., 2014) and PMT with PADM (Eriksson, 2017).

Although TPB posits that attitudes about an action influence whether it will be undertaken, PMT focuses on how beliefs about the nature of risk directly motivate behaviour. To the extent that people perceive wildfires as a serious risk, they may be more motivated to take action (Hall and Slothower, 2009). Both TPB and PMT focus on beliefs about the outcomes of action. However, PMT is more specific than TPB about the types of beliefs that best predict behaviour (Lindell and Perry 2000), identifying two types of beliefs relevant to reduce risk: beliefs about self-efficacy and about response efficacy (Rogers and Prentice-Dunn 1997).

Hall and Slothower (2009) used constructs from TPB and PMT considering also past experience to predict homeowners' willingness to implement defensible space and their interest in a consultation program aimed at reducing their risk from wildfire. In predicting willingness to act (implementing a defensible space), response efficacy and attitude contributed significantly and approximately equally, although the model explained only 12% of the variance. Interest in adopting a mitigation program was predicted by risk perception, confidence in defensible space, and past experiences with fire that explained 19% of the variance. The results illustrate that combining variables from both TPB and PMT was useful in predicting landowners' behavioural intentions. From PMT, response efficacy was an important factor in both intention models. It seems clear that people must believe an action

to be effective before they will undertake it. Also, from PMT, risk perception was the strongest contributor to generate interest in the mitigation program, although it was not a significant predictor of willingness to adopt a defensible space program.

McLennan et al. (2014) found that TPB was a useful predictor of the intention to leave versus stay and defend the property compared to PMT. Householder efficacy and self-characterisation were important contributors, whereas perceptions of severity and susceptibility to threat were not found to be significant contributors. Neither model performed well in predicting strength of intention to stay and defend.

Combination of theories is implemented also for the case of PMT and PADM. Eriksson (2017) considers threats appraisal and coping appraisal under the two theories. Despite some differences, these conceptualizations stipulate that threat and coping appraisals are core psychological drivers of responses to threats. For instance, with respect to coping appraisal, the PADM focuses more on the actions involved in coping with risk, whereas PMT rather considers the individual's abilities to deal with the threat (Lindell and Perry 2012).

Eriksson (2017) examined appraisals of threat (cognitive and emotional), personal resources (cost and self-efficacy), and strategies (response-efficacy) as predictors of proactive management responses (past behaviour and future intention) among forest owners in Sweden affected by storms, damages by moose and climate change. A path analysis revealed that threat appraisals and response-efficacy were direct predictors of past risk management behaviour and the intention to respond in the future. The cognitive appraisal was not a significant predictor of responses among owners less involved in forestry.

3.2.5 Other models
Approaches based on objectivists and constructivist theory

Under the objectivist approach people are motivated by objective facts about risk, while the constructivist theory focuses on personal construction of meaning by learning through experience. That meaning is influenced by prior knowledge and new events (Elliot et al., 2000). This theory supports the ideas that learning can be considered a cultural evolution and complex system towards improving our understanding of behaviours that lead to greater societal resilience in the long term. This can be thought of a process based on strengthening of adaptive capacity that in turn contributes to higher adaptation, although Mortreux et al. (2020) found a weak relationship between adaptive capacity and adaptation, such that high adaptive capacity does not clearly result in a correspondingly high level of adaptation. Three factors appear for Mortreux et al. (2020) to mediate the relationship between household adaptive capacity and adaptation: their attitude to risk, their experience of risk, and their expectations of decisions from authorities. Ultimately, we can see the latter aspect of adaptation as a shift towards a transformative adaptation, defined as a process that may involve institutional reforms, cultural changes and the challenging of assumptions. Large-scale changes that are new to a location or system, generate long-term impacts and changes to the social-ecological system (Wilson et al., 2020).

From the previous sections it emerged that psychological concepts such as cognition and risk perception have been used widely to explain attitude and adaptation to wildfires. However, social context is also critical in promoting adaptive action (Wilson et al., 2020), for example through social norms (Fishbein & Ajzen, 2010; Olsen et al., 2017), community strength (Gordon et al., 2010; 2012) and institutional support (Ghasemi et al., 2020).

Combining both information coming from objective knowledge and constructed information mediated by social learning and interaction is the position taken by Fischer et al. (2014) who tried to answer two questions for policymakers seeking to influence private forest landowners towards greater mitigation of wildfire risk: (i) to what degree do landowners act to mitigate the risk of wildfire based on their perceptions of risk and (ii) what role does actual wildfire risk play in landowners' decisions relative to other factors? Empirical results suggest that landowners' perceptions of wildfire risk and propensity to conduct fuel treatments are correlated with hazardous fuel conditions on or near their parcels, whether they have housing or timber assets at risk, and their past experience with wildfire, financial capacity for conducting treatments and membership in forestry and fire protection organisations. The influence of personal experience and values at risk on landowners' perceptions of risk is not surprising. Notable is also that landowners who are members of forestry or fire protection organisations are more likely to be concerned about wildfire risk and conduct fuel reduction treatment activities. The finding supports the notion that wildfire risk perceptions are formed and shaped, in part, through social interaction and networks. Social networks (i.e., patterned interactions among people or organisations) may amplify perceptions of risk derived from objective knowledge and personal experience.

Similarly, Paveglio et al. (2016) emphasize how unique local contexts of populations at risk from wildfires may influence differential adaptation strategies. By local context, the authors mean the relationships among residents at risk of wildfire, the history and relationships residents have with the landscape, ongoing demographic changes, and social norms. The authors suggest that a more holistic view of local contexts can help explain contradictions across cases. Failure to account for the interconnections between influences can generate a misinterpretation of the current barriers to fire adaptation and potential leverage points for more proactive preparation in communities.

The constructivist theory is verified also by Brenkert-Smith et al. (2012) who in the analysis of behaviour of communities affected by wildfires in Colorado explored the importance of variables from five categories suggested by the literature (demographic and parcel characteristics, risk perception, wildfire experience, efficacy, and wildfire information sources and social interactions) in modelling wildfire mitigation behaviour. They found that having experienced a wildfire within 10 miles of the property did not seem to affect the mitigation level. In addition, with respect to the three measures of self-efficacy (time, physical difficulty, and lack of specific information), it was observed that only lack of specific information had a negative statistically significant coefficient estimate. This finding may indicate that some portions of the populations were either not recipients of the education efforts made or that they required more tailored information regarding their parcel's risk or more personalized information about how to implement generic recommendations. Conversely, obtaining wildfire information from the county specialist had the strongest positive effect on mitigation level as well as obtaining information from the local fire department. In addition, having talked with a neighbour about wildfire was found to have a positive and significant effect on mitigation level.

These results confirm the importance of outreach programs during which owners can receive personalized information specific to their properties. County specialists attending community meetings to discuss wildfire risk and mitigation options with property owners provide opportunities for sharing personalized and specific wildfire information.

Dickinson et al. (2015) examined the ways in which homeowners' social connections and engagement with neighbours and other social reference groups are linked to perceptions of wildfire risk and responses to that risk. Social interactions can serve to amplify or attenuate perceptions of and beliefs about risks. For example, an individual might get information from a neighbour about

weather conditions favouring fire and may learn about ''fire science'' from other social groups (Dickinson et al., 2015). Social interactions can also help people learn about mitigation options; for example, seeing examples of mitigation on neighbours' property can provide concrete information about its benefits and costs, including diminished or enhanced aesthetic value from reducing vegetation. Strong evidence points to a positive relationship between fire-specific social interactions and heightened perception of wildfire probability, which is in turn positively linked to vegetative mitigation strategies. Relationships among social interactions, beliefs, and wildfire mitigation behaviours can be understood as a case of mediation (Martin et al., 2009). In other terms, different types of social interactions (independent variables) shape the mitigation behaviours (dependent variable) via the mediation of variables such fire-related beliefs.

The importance of knowledge of wildfire risk is analysed by Martin et al. (2009) as a mediating factor in the relationship between risk perception and mitigation behaviour. Variables such as direct experience, knowledge of wildfire risk, and self-efficacy better explain the underlying process that motivates individuals to adopt private risk reduction strategies to protect themselves and their property from natural hazards, specifically wildfires. The authors found that knowledge is mediated by homeowners' risk perceptions and that beliefs of self-efficacy have a direct influence on risk reduction behaviours. Surprisingly, direct experience with wildfire does not directly influence the risk perception–risk mitigation process. The authors suggest that understanding this process will aid decision makers in untangling the factors that directly influence the risk perceptions of various stakeholders, and in influencing actual behaviour on private property by designing incentives aimed at mitigating the risk of individuals and communities.

3.2.6 Approaches based on evacuation theory

The theory of evacuation behaviour was developed to model the attitude of people in deciding to evacuate or stay and defend their property. Paveglio et al. (2014), in aiming to help policymakers to better understand whether and why residents intend to evacuate or stay during wildfire events, investigated different types of evacuation plans residents were considering or alternative strategies to evacuation. This included whether residents with different evacuation preferences differed in their performance of individual fuel reduction mitigations or other wildfire mitigations; and what characteristics (e.g. risk perceptions, sex and mitigation behaviours) correlated with stated evacuation preference. Results suggested that relatively high proportions of residents were interested in staying and defending their homes, with smaller proportions favouring evacuation or passively sheltering in their homes during wildfire. Vegetation management behaviour differed significantly among residents with different evacuation preferences, including significantly higher rates of forest thinning among those intending to remain at home and actively defend their residence. Other results suggested that sex, part-time residency, income and attitudes towards loss from fire were statistically associated with differences in evacuation preferences.

Results demonstrated that residents intending to employ active strategies alternative to evacuation were more likely to perform vegetation management. Additional vegetation management among residents planning to adopt the stay and defend strategy were implemented by residents owning more land or having an understanding of forest health or the ability to perform thinning.

Similar conclusions were proposed by Stasiewicz and Paveglio (2021) who found that those who opted for the stay and defend policy were significantly more likely to establish a water supply for firefighting and to clear their driveways for emergency vehicle access than those who supported evacuation. In addition, the stay and defend group was more likely to purchase a generator of

electricity than the group interested in evacuation, install sprinklers that can reach up to 50 feet (15 m) from the home, or retrofit their home with fire resistant materials. All of these are seen as strategies for home defence during active suppression or for mitigating property damage in the absence of firefighter response.

Collectively, these results demonstrate that residents and property owners interested in more active forms of evacuation behaviour, are more likely to take on additional mitigation responsibilities to enhance firefighter safety and effectiveness in the wildland-urban interface, potentially because they perceive of themselves as being in a firefighter's position.

Table 1: summary of main reported theories of risk behaviour with some relevant variables modelled and references

Theory	Some important variable modelled	References
Protection motivation theory	Threat (consequences, and risk attitude-probability an event occurs) and coping appraisals (response efficacy, self-efficacy, response cost)	Rogers (1983); Larsen et al. (2021); Liu and Jiao (2018)
	Perception function of fuel conditions, experience with wildfires and norms	Olsen et al. (2017),
	Physical risk measures (influence of acreage, fire proximity, and vegetation)	Larsen et al. (2021); Olsen et al. (2017); Meldrum et al. (2019); Short et al. (2016), Koksal et al. (2019); Champ et al. (2013)
	Cognitive heuristics and emotional bonds such as social trust in wildfire management, past experiences with wildfire, perceived effectiveness of institutional management strategies	Slovic et al. (2000); Ghasemi et al. (2020)
Theory of planned behaviour	Attitude toward the behaviour, subjective norm, and perceived behavioural control	Fishbein & Ajzen (2010); Nox and Myles (2017);
	Perceived behavioural control	Hall and Slothower (2009)
	Effectiveness of perceived mitigation; past experience	Martin et al. (2009); McGee et al. (2009)
	Subjective norms and social pressure	McCaffrey et al. (2011); Weisshaupt et al. (2007);
	Perception of cost of action	McFarlane et al. (2011); Nox and Myles (2017)
	Limits on physical capability	Collin and Bolin (2009); Nox and Myles (2017)
	Lack of time or lack of knowledge	McCaffrey et al. (2011); Nox and Myles (2017)
Protective Action Decision Model	Focuses on emergency responses looking to environmental and social signs, information and warnings	Lindell and Perry (2012);
	Model the choice of evacuating - effectiveness of evacuating or remaining (hazard related perceptions); Property adjustments from hazard, such as property maintenance and preparation, and also equipping for fire-fighting and self-protective actions as factors influencing evacuation or remaining strategies	Strahan and Watson (2019)

Theory	Some important variable modelled	References
Hybrid models	Combination of PMT & TPB (response efficacy, attitude, past experience, risk perception, confidence in defensible space)	McLennan et al. (2014); Hall and Slothower (2009)
	Combination of PMT and PADM through actions involved in coping (PADM), and individual's abilities to deal with the threat (PMT) Appraisals of threat (cognitive and emotional), personal resources (cost and self-efficacy), and strategies (response-efficacy)	Eriksson (2017)
Objectivist and constructivist theory	Objective fact and personal construction of meaning	Elliot et al. (2000)
	Adaptive capacity and adaptation process mediated by attitude to risk, experience of risk, and their expectations of authorities	Mortreux et al. (2020)
	Objective knowledge and constructed information mediated by social learning and interaction	Fischer et al. (2014)
	Unique local contexts (relationships among residents at risk of wildfire, the history and relationships residents have with the landscape, ongoing demographic changes, and social norms)	Paveglio et al. (2016)
	Demographic and parcel characteristics, risk perception, wildfire experience, efficacy, and wildfire information sources and social interactions	Brenkert-Smith et al. (2012)
	Homeowners' social connections and engagement with neighbours	Dickinson et al. (2015)
	Knowledge of wildfire risk	Martin et al. (2009)
Evacuation theory	Evacuation preferences; characteristics of residents (e.g. risk perceptions, sex and mitigation behaviours)	Paveglio et al. (2014); Stasiewicz and Paveglio (2021)

3.3 Economic models

A small part of the literature explores the utility or benefits people get when informed by fuel reduction programmes (Sanchez et al., 2016) or wildfire risk maps (Mozumder et al., 2009). Both studies revealed the willingness to receive higher information through new programmes or risk maps with marginal values that are considered at least sufficient to cover the cost of producing the information needed to reduced wildfires risks.

Sanchez et al., 2016 used a choice experiment to estimate the willingness to pay of homeowners, living in subjectively perceived high-risk areas, for new wildfire risk mitigation programs. The survey used three attributes to construct choice alternatives: risk of the respondents' house being damaged by wildfires in the next 10 years (this attribute varied over five levels, from 1% to 5%, where 5% was the baseline risk and respondents were told this percentage was associated with no new investments in wildfire protection programs); (2) monetary damage (loss) to respondents' property from a wildfire (dollar amounts varied over 10 levels and ranged from $10,000 to $100,000, where $100,000 was the baseline loss and respondents were told this was the monetary amount of damage associated with no new investments in wildfire protection programs); and (3) one-time per decade lump sum cost to the household for the ten year program (the cost of the programs varied over 10 levels ranging from $25 to $1500 for the public program and 9 levels from $50 to $1500 for the private program). These variables were organized into three alternatives, a public program, a private program, and the status quo "do nothing additional".

Results indicated that homeowners with lower income/education levels were more likely to ignore risk factors in making wildfire mitigation decisions, and generally preferred the status quo to paying the costs of new wildfire risk mitigation programs. Homeowners with lower levels of income and education would generally require financial incentives to participate in individual and community wildfire risk mitigation, respectively. These results suggest that many low income/education level homeowners require accessible and persuasive information on wildfire risk as well as significant financial incentives to undertake private wildfire risk mitigation efforts on their property and to support broader public efforts to protect communities.

In the second study, Mozumder et al (2009) proposed an integrated empirical approach made of a system of equations that involves estimation of willingness to pay (WTP) values by a contingent valuation method, along with measures of a respondent's risk perception and risk mitigation behaviour. They found that the median estimated WTP was around US $12 for the annual wildfire risk map, which covered at least the costs of producing and distributing available risk information.

Providing an analysis of the monetary utility arising from the production of a wildfire risk map can help emphasize the importance of information and to consider what worth the investments required have to address preventively measures mitigating the effects of wildfires.

3.2.1 Studies based on empirical modelling

Not all studies seem to be built on a strong theoretical basis, although some of the examples found in the literature seem to be related to the planned motivation theory. We found two main topics addressed by this empirical research: 1) relationships between risk perception and mitigation taking into account the influence of real risk as measured and communicated by the relevant authority; 2) climate change and how this can affect the perception of fire risk.

Because policies and programs are often based on objective measures of behaviour, it is important to understand whether observed relationships between risk preferences and self-reported

behaviours extend to objective measures of behaviour. In Champ et al. (2013), respondents were asked to rate the wildfire risk of their home using the objective risk rating provided by the competent authority. Consistent with the more recent literature on objective and perceived risk (Champ et al., 2020), the participants generally underestimated their homes' wildfire risk ratings. However, those who accessed the information on risk communicated by the relevant authority through their official website were more likely to express a more correct state (e.g., aligned with objective measures) of their home's wildfire risk. To measure the wildfire risk-mitigating behaviours, respondents were also asked if they had undertaken wildfire risk mitigation actions such as scheduling a consultation with the Colorado Springs FireWise program coordinator, thinning vegetation on the property, removing pine needles and debris from the ground, keeping grass and weeds mowed and moving firewood 15 feet or more away from the house (Champ et al., 2013). Variables that measured the physical characteristics of the property such as proximity to dangerous topography and dense vegetation were included as well as demographic characteristics of the respondents such as sex, income and age. Likewise, the authors included variables that measured previous experience and knowledge about wildfire. Results showed that compared with individuals with low subjective risk ratings, those with moderate, high, very high and extreme risk ratings had completed more wildfire risk-mitigating actions.

More recently Champ et al. (2020) empirically examined whether the relationship between risk aversion and self-reported risk mitigating behaviour is similar to the relationship between risk aversion and an objective measure of risk mitigating behaviour. Despite higher levels of risk mitigation in the self-reported measure relative to the objective measure, the authors found that aversion is similarly correlated with both measures of wildfire risk mitigation. In addition, the authors decided to study the relationship between risk aversion and home hardening against wildfires. Results showed no correlation between these two variables, probably reflecting the high expenses requested and the difficulty of hardening a home. Finally, the authors were interested in discovering the presence of moral hazard associated with structure protection provided by the local fire department, finding no evidence. Individuals who thought that the fire department would save their home reported better defensible space rather than reducing the levels of mitigation.

Another theme that is treated using an empirical approach is the relationship between climate change and wildfire risk perception and mitigation. We found only three papers providing a common understanding of this relationship. In Schulte and Miller (2010), climate change is explored as a driver of risk perception and mitigation behaviour. The authors found that climate and weather impacts are positively related to wildfire risk perception. However, while many people consider climate impacts a good motivation for initiating mitigation actions, this variable is only marginally significant as a determinant of mitigation effort.

Similar results were found by Brenkert-Smith et al. (2015) who examined the relationships among climate change beliefs, environmental beliefs, and mitigation actions in the context of wildfire. Expectation of environmental catastrophe was strongly positively correlated with belief in climate change. The study participants were asked whether they had completed 17 specific fire risk-reduction activities related to reducing vegetative fuels or improving structural conditions to reduce home ignition. Yard work and maintenance-type actions were more common than structural changes, which tend to be more permanent but also more costly. However, the extent to which a respondent believes in climate change is not significantly related with any mitigation actions, with the exception of cleared leaves between 30 and 100 feet from home.

Bardsley et al. (2018) found that there was no significant relationship between recognition of the climate change risk and the perceived likelihood of bushfire within short timeframes (1 to 5 years).

However, those households with higher level of vegetation on their properties were more likely to recognize climate change as a general risk and those who perceived that climate change was altering the wildfire risk were more likely to thin vegetation. Different groups may perceive different actions to take according to the relevance of wildfire risk alteration caused by climate change. These range from minor adjustments in the implementation of the current landscape vegetational practices to stronger actions supporting vegetation burning and clearance to mitigate risk even at the expense of biodiversity values. Overall, the authors found no evidence to suggest that wildfire risk perceptions due to climate change have passed a social threshold after which the majority of residents will support dramatic collective or independent responses to reduce fuel-loads without consideration of local environmental values.

An opposite perspective is taken by Millar et al. (2015) who rather than exploring if climate change may have an influence on wildfire risk perceptions investigated if risk perception was able to change opinion on climate change. The authors concluded that people's experiences of recent consecutive wildfire events did not necessarily influence their views on climate change as a causal agent of wildfire events, although there was a general agreement that weather conditions had been extreme in recent times. Likewise, the nature of people's wildfire experience in terms of severity on property, income loss, or emotional impact did not appear to influence their perceptions of climate change. This can be explained by the complexity, uncertainty and controversy around climate change information and debates. Climate change was not tangible as climate is highly variable over time, and information about climate change is received externally and can be exaggerated by the media and politics.

Like in Brenkert-Schmidt et al (2015), Millar et al (2015) explored a range of perceptions across sector groups including those who did not believe climate change was related to fire events (mostly long term landholders); those who observed more extreme weather and disaster events, but were not sure if it was caused by climate change or if it would continue (some landholders and business owners); and those who believed climate change was causing more frequent natural disasters (most government representatives and newcomers). Finally, Millar et al (2015) and Spence et al (2011) proposed that prior experience with natural disasters can increase disaster awareness, preparedness and/or adaptive behaviours regardless of perceptions of climate change. However, this is not always verified (Martin et al., 2009).

4. Discussion

In this review we have investigated a specific segment of the literature dealing with risk behaviour and perception in relation to wildfires and how this can induce or hinder mitigating strategies. The relations between risk perception to wildfires and mitigation behaviour can be handled under different theoretical perspectives. The two most common are the protection motivation theory and the theory of planned behaviour approach. This is confirmed by a recent review addressing only case studies from the USA (Dupéy and Smith, 2018). Our review proposes other similarities with the Dupéy and Smith (2018) study. An interesting observation is that among the several aspects considered as a key driver of risk behaviour (such as attitudes proposed by the theory of planned behaviour), risk perceptions e.g. to climate change or wildfire, as declined by the protection motivation theory, was the most frequently cited.

The theoretical models proposed in this literature review showed the complexities of the relations between risk perception and mitigating behaviours. While we could expect that perceived risk would

be associated with higher mitigating strategies, this is not always verified (Koksal et al., 2019). The direct relationships between these two variables are not straightforward to model and it is necessary to consider several other variables. The protection motivation theory suggests that two cognitive appraisals (threat and coping appraisals) are key elements to shape the decision to protect oneself from a given threat ((Larsen et al., 2021; Liu and Jiao, 2018). However, more recently investigated mechanisms such as building knowledge by strengthening social interaction between communities, and communities and institutions dealing with wildfire risk management were considered important in mediating the mitigating strategy (Martin et al., 2009; Dickinson et al., 2015).

In addition, changes towards a better implementation of mitigating strategies can be sustained by several policy tools such as capacity-building, primarily seen in efforts to build awareness (about risk and mitigation options) and supply of external resources (direct assistance, grant funding, and/or guidance from local fire officials) (Stidham et al., 2014). The idea behind these types of tools is that providing information and economic resources will inspire independent actions throughout the community, which in turn reduces collective risk. Thus, diffusion of innovations suggests that strong evidence of interpersonal networks between the community and with wildfire management officials may be particularly useful in eliciting widespread adoption of defensible space in wildland-urban interface communities (Stidham et al., 2014).

In addition to the role played by social capital, other elements such as psychological shortcuts can be important to address attitude towards risk mitigation behaviour. Ghasemi et al. (2020) found that cognitive heuristics (i.e., trust and past experience) and emotional bonds to place (i.e., home attachment) can be successfully explored to better predict homeowners' decisions to mitigate wildfire risk. Specifically, above and beyond perceived wildfire risk and the effectiveness of the USA Firewise ® management wildfires programme (https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Firewise-USA), emotional bonds to home increased respondents' intention to mitigate risk along with their past experience with wildfire and trust in agency information.

Several variables explored by different models of risk behaviour responsible for addressing risk perception at households' level do not necessarily work at community scale. As also emphasised by Dupéy and Smith (2018), our literature has evidenced a high proportion of studies targeting a specific ecosystem (the wildland urban interface) and operating at scale of household. Only three papers are targeting different stakeholders such as: forest landowners (Fischer et al., 2014) to describes their likelihood to take actions to mitigate wildfire risk; employees in workplace to understand their perceptions of their workplaces' preparedness for climate change-related natural hazards (Sadiq et al., 2016); and professionals in wildfire management (i.e., local government officials, non-government organizations, community members, etc.) to analyse the barriers to improving wildfire risk governance in Greece (Palaiologou et al., 2021). Referring to the goal of dealing with risk for an entire community, the mitigation strategies working for household must be complemented with a broader institutional strategy that enhances social relations, interpersonal networks (Stidham et al., 2014), and the formulation of a socio-ecological planning (Ager et al., 2015). This can be achieved by: (1) characterizing wildfire exposure from large fires and mapping firesheds to define the biophysical risk container around communities; (2) identifying risk transmission and constraints on mitigating transmitted risk to private lands; (3) assessing and mapping the social potential to mitigate in relation to fire transmission patterns; and (4) identifying optimal risk management options, including strategies to improve social fire networks and community capacity, fuel management to reduce risk transmission, and enhanced suppression response where necessary.

Finally, as also observed by Dupéy and Smith (2018), the majority of studies did not address policies used in wildfire mitigation or adaptation, other than mentioning them briefly in the introduction.

5. Final considerations emerging from the literature review

Although the papers reviewed cannot represent a complete panorama of the studies available in the literature about the relations between risk perception and mitigation, a few considerations can be made to prepare for researching the community and mainly landowner risk behaviour and mitigation strategies of interest in the project JHI D-5-2.

Considerations provided so far are mainly based on people's perceptions and a bias can emerge compared to a situation where risk is assessed by objective criteria as policy would like to consider (Liu and Jiao, 2018; Meldrum et al., 2019). The majority of the studies reviewed consider the subjective dimension of the risk, focusing on self-report mitigation behaviours (Meldrum et al., 2019). This is potentially problematic as research in other contexts has found a "social desirability bias" from using self-reported data (Brenkert-Smith et al., 2015; Meldrum et al., 2019; Sanchez et al., 2016). Thus, it is recognised by some authors for the need to work with objective dimension of risk including bio/physical measures such as estimates of burn probability or conditional flame intensities (Liu and Jiao, 2018; Meldrum et al., 2019).

Second, there might be a disparity between reported and assessed actions. In some research it is difficult to capture whether or not the respondent ''partially'' or "fully" implemented wildfire mitigation measures (Brenkert-Smith et al., 2015). Likewise, even though a homeowner reports, for instance, to thin vegetation, it is not clear that a wildfire specialist would deem his or her efforts adequate to reduce wildfire risk. Future research exploring disparities between homeowners' reported actions and assessments by a professional is necessary, as it is needed research on whether homeowners maintain their mitigation efforts over time (Champ et al., 2013). In other words, wildfire mitigation measures do not necessarily measure changes in risk, and when mitigation actions are self-reported, a wildfire mitigation specialist might not agree whether these activities have effectively lowered risk (Larsen et al., 2021).

In addition to that, most studies on wildfire mitigation behaviour do not differentiate between intention and actual behaviour when implementing mitigating measures. It would be beneficial to add observations of actual behaviour that measure behavioural intention of self-reported actions (Hall and Slothower, 2009). This would allow researchers to validate homeowners' assessments of their own actions.

It is critical to understand what influences an individual's perception of risk, and how these perceptions influence the type of risk reduction behaviours they undertake. This understanding can influence choices of how to effectively communicate risk information to address the desired action or outcome (Martin et al., 2009). By educating people (influencing their subjective knowledge) on the risks associated with a natural hazard will in turn affect their perceptions of vulnerability and the severity of the risk, thus encouraging them to protect themselves, their property, and by default, their community (Martin et al., 2009). However, knowledge of whether mitigation is underperformed because the actual behavioural controls prevented the mitigation actions from occurring has important implications for any program trying to encourage mitigation behaviour (Nox and Myles, 2017).

Because climate change is not seen as a straightforward driver of risk perception, building a communication strategy with people at risk of fire based on climate change information (e.g., 'it is only going to get worse due to climate change') may not be the most productive tool to improve mitigating behaviour. Conversely, focusing on locally relevant hazards and their changing characteristics may be a useful tool for galvanizing awareness, concern, and risk-reduction actions (Brenkert-Smith et al., 2015).

Fire risk communication should emphasize that household fire risk mitigation measures can effectively reduce fire risk and damage. Moreover, practical advice on how to implement those measures should be provided. Response cost (which includes time, effort, money, and, importantly, coordination of family, friends, neighbours, and governments) also has a significant influence on the deployment of daily maintenance and cautions (Liu and Jiao, 2018).

Finally, trust building plays a crucial role in perceived action effectiveness and risk beliefs among homeowners (Ghasemi et al., 2020). This introduces a further dimension of exploring wildfire risk moving from household to community scale. Moreover, shared social norms and strong social networks can help in information sharing, mutual aid and other reciprocal relationships with important implications for individual and community resilience. These social structures can affect the information that individuals receive about climate-related threats, and shape perceptions of risk and the capacity to respond (Wilson et al., 2020).

Acknowledgment

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