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Representations of wildfires in academia

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In response to intensifying wildfire seasons, scholars call for new wildfire policy and management approaches. Based on the assumption that science, policy, and management are integrated spheres of meaning-making, this article aims to contribute to reflective and creative research conversations about fire policy and management by directing analytical attention to the role of science. Using Causal Layered Analysis, we unpack scientific representations of three wildfire events/seasons in Sweden, the US, and Australia. The analysis illustrates that scientific representations of wildfires are contextual and promote particular policy recommendations and management interventions. Furthermore, the review identifies a discrepancy between dominant, more simplistic representations and the dynamic and complex representation emerging from an interdisciplinary reading of the literature. To address this discrepancy, we argue that there is a need to continuously renegotiate the boundaries of wildfires through rethinking the process underpinning the scientific representations to account for the complexity inherent in wildfire events.

Keywords: wildfire; representations; risk; transdisciplinary research; complexity

1. Introduction

Recent years have seen record-breaking wildfire seasons across the world. Uncontrolled fires are becoming more intense and ravaging larger areas, transforming terrestrial ecosystems and causing death and destruction in human landscapes (Kelly *et al.* 2020; Cochrane and Bowman 2021). In early 2022, the United Nations Environmental Programme (UNEP) launched a report projecting a global increase in extreme fires, even in areas previously unaffected, suggesting that the world is faced with a "global wildfire crisis." The report urges governments to rethink their approach to extreme wildfires and outlines a roadmap to mitigate the risk of wildfires to human health, livelihoods, biodiversity and the global climate (United Nations Environment Programme 2022). The UNEP report reflects an ongoing discussion in academia, where researchers increasingly call for a paradigmatic shift in fire management in response to changing fire activities worldwide (Essen *et al.* 2021). Cochrane and Bowman (2021) argue that

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it is not the fires themselves that need management but the land- and fire management policies and practices that counterproductively cause ecosystem changes that exacerbate wildfires. Tedim *et al.* (2020) suggest that we may have to ask how societies can "thrive with fire" in ways that benefit both humans and the environment. Thriving with fire, however, not only requires more proactive and creative fire policy and management recognizing how present action shapes landscapes and fires of the future. It also demands research that considers how existing research paradigms, institutions, relationships and practices co-produce wildfires as particular events and, from there, assesses alternative ways of engaging with wildfires (Tedim *et al.* 2020).

This review aims to make visible how we as researchers co-produce wildfires as particular phenomena requiring particular intervention and simultaneously co-shape fire policy and management and future wildfires. An essential point of our departure is that any attempt to change how wildfires are understood, governed and managed requires us to think through how we research wildfires and represent these events (causes, impacts, solutions, responsibilities), and if, how and why academic knowledge is/is not integrated into fire policy and management at different scales. Theoretically, we reject the linear model of science-policy-practice relations and recognize the multiple and dynamic interactions between processes of knowledge production, decision making and environmental management practices (cf., Wesselink *et al.* 2013). From this perspective, illuminating how we collectively reproduce wildfires in the realm of science is a step toward creating new conceptualizations of wildfires and management interventions fit for contemporary and future challenges.

To unpack scientific representations of wildfires, we analyze peer-reviewed articles focusing on three specific wildfire events that took place in countries characterized by different ecological, socio-cultural, policy and land management traditions: namely the Black Saturday (Australia), the Västmanland fire (Sweden) and the California fire season in 2018 (US). Drawing on Causal Layered Analysis (CLA), an analytical framework developed in the late 1980s to analyze and create transformative spaces for alternative futures (Inayatullah 2019), we systematically unpack the literature asking: how are wildfires represented and delineated (e.g. conceptually, spatially, temporally)? What implications for actions emerge from these representations? What norms and worldviews underpin them? By addressing these questions, we seek to stimulate cross-contextual reflections and discussions that can generate "alternative" relationships to wildfire to benefit people and ecosystems in a time of changing fire regimes.

1.1. *Wicked wildfires*

Fire is a natural process that has shaped the history of the Earth, and since humans mastered the flames, the relationship between people and fire has served both parties. Humans have helped fire reach all corners of the world. Fire has helped humans modify the physical environment for their benefit, changing both fire regimes and vegetation cover (Pyne 2007). Multiple ecosystems and individual species, beyond humans, depend on fire for their survival, sometimes even extreme wildfires (Shlisky *et al.* 2007; Smith *et al.* 2016). Wildfires thus interact with human land use (e.g. forestry, agriculture, urbanization), including humans' intentional suppression of, or starting, fires and biodiversity (Kelly *et al.* 2020). However, today's altered land covers, combined with a changing climate, amplify the risk of extreme wildfires (Cochrane and Bowman 2021). The changing nature of fire activity causes death and destruction in human settled landscapes and transforms terrestrial ecosystems, threatens biodiversity, and accelerates climate change (Kelly *et al.* 2020).

As such, wildfires and their management are complex socio-ecological challenges spanning multiple spatial and temporal scales, land-use sectors, and policy areas.

Extreme wildfires demonstrate complexity, which Bateson (2017) points out is "recognizable in situations which have characteristics of multiple variables in ever-shifting contexts of interdependency." The constant shifting contexts and the multiple interdependent variables generate problems so complex that people disagree about how to define and solve them, which is a typical characteristic of wicked problems. In the case of wildfires, Carroll *et al.* (2007) points out the difficulties in coming to a shared understanding of the nature of the problem. Likewise, Chapin *et al.* (2008) applies a wicked problem framework to the wildfire regime in Alaska's interior and draws attention to the importance of unpredictable feedback loops inherent in complex systems. Rittel and Webber (1973) also eloquently capture this point, arguing that societal problems addressed through planning are different from complicated linear problems addressed by engineers. In short, extreme wildfires lack an apparent, coherent root problem, as the different contexts from which they emerge are interdependent and ever-shifting.

The wickedness of wildfires is reflected in discussions of different fire regimes and management practices. The traditional model of excluding and fighting fires, i.e. the "war" on fires, has led to wildfires so significant they cannot be resisted. A phenomenon referred to as the fire paradox where fuels are allowed to build up through the exclusion of flames, thus increasing the fire hazard in many places. A growing body of literature is critical of this traditional fire management model and advocates for new management regimes (Tedim *et al.* 2020). Charnley *et al.* (2015) argue that conventional fire management approaches are unlikely to be effective in the future, suggesting that fire management needs to adapt to a new landscape of changing settlement patterns, warming climates and altered vegetation. Tedim *et al.* (2020) present alternatives identified in the current literature, including, e.g. strategic fuel management, the establishment of holistic frameworks allowing fire management interventions to draw upon social, economic, and ecological principles, and proposals for entirely new fire management paradigms. Essen *et al.* (2021) note that much wildfire management draws upon simple conceptualizations of risk and suggests that future management approaches have to take account of the multiple social and ecological drivers that contribute to wildfire dilemmas.

Paton *et al.* (2015) argue that the interaction between the ecology of forests, dynamic environmental conditions, history, psychology, social dynamics, culture, economics, politics and organizational factors create complex risk management contexts. We agree with Paton *et al.* (2015) that wildfire events must be understood as an interaction between biophysical phenomena and social ecology. As such, wildfires are not first and foremost about flames but about the way the flames, heat, and wind interact with and alter social landscapes and, in the process, exacerbate vulnerability (often asymmetrically).

In sum, what constitute alternative fire management models is still being debated. The article feeds into this ongoing debate on future fire management by illuminating how the research community generally represents the complexity and interdependence of extreme wildfire events and their normative underpinnings.

2. Methodology

2.1. *Analytical framework*

To unpack the scientific representations of wildfires, we draw on Sohail Innayatullah's work with CLA. CLA is a methodological framework rooted in a poststructuralist

research tradition developed in future studies in the late 1980s with the intent to analyze and create transformative spaces and alternative futures (Inayatullah 2019). In this paper, we draw on the CLA framework to unpack wildfire literature by creating a systematic coding framework that helps illuminate how research co-constructs wildfires as events of a particular kind. However, we have not used the CLA to create alternative future imaginaries.

In contexts that deal with wicked problems such as wildfires, CLA can help to maintain the necessary depth of analysis required to meet the inherent complexity (Bishop and Dzidic 2014). The depth stems from the four levels of CLA – litany, social/systemic causes, worldview, and myth/metaphor. The litany level represents trends, quantitative data, concepts and unquestioned "futures," which can usually be repeated in a newspaper-style headline (Inayatullah 2019; Heinonen *et al.* 2017). The social, technological, economic, environmental, and political level, sometimes referred to as the systemic level, demands a deeper and more complex reading of the studied phenomena by analyzing the data or concepts and situating them in relation to other contexts (historical, economic, political) that fabricate reality (Inayatullah 2019; Heinonen *et al.* 2017; Bishop and Dzidic 2014). At the worldview level, the focus turns toward unpacking assumptions and making sense of the underpinning values that have informed the systemic interpretations of reality (what worldviews are hidden in the analytical lenses?) (Inayatullah 2019; Heinonen *et al.* 2017; Bishop and Dzidic 2014). The fourth and final level attempts to understand the emotional dimensions of the issue and the deep stories that give the world around us coherence and meaning (Inayatullah 2019; Heinonen *et al.* 2017). The method allows scrutinizing the phenomena or problems with increasing complexity as the analysis moves through the layers (Bishop and Dzidic 2014).

2.2. Research design

Wildfires generate plenty of research attention with thousands of peer-reviewed articles. Conducting a qualitative review to unpack various wildfire representations requires boundaries that narrow the thousands of papers down to reasonable numbers. To delimit the number of articles while still including the breadth of scientific disciplines engaging with wildfires, we selected publications related to three particular wildfire events/seasons: (1) the Black Saturday fires in the Australian state of Victoria in 2009; (2) the fire in the Swedish province of Västmanland in 2014; and (3) the combined fires of the 2018 Californian fire season. These three events are among the biggest and, in terms of financial and health-related impacts, the worst experienced by the respective countries. Furthermore, the three events cover different parts of the globe with varying regimes of fire and human-fire relationships. Departing from these three different wildfire events and deliberately leaving the events undefined in terms of time and space allows us to identify how the scientific literature conceptualizes, draws boundaries around, and constitutes these wildfire events as events of particular kinds.

Two online databases were used to identify relevant articles: Scopus and Web of Science. Considering the different socio-ecological contexts of the fires selected, we used additional inclusion requirements for the three events (see Table 1). Initially, Web of Science generated 190 hits for Black Saturday, 57 for Västmanland and 206 for California, while Scopus generated 291 for Black Saturday, 115 for Västmanland and 245 for California. Once the articles were downloaded, we read the abstracts and made a second sorting (see Table 1).

Table 1. Inclusion criteria and search terms for the three chosen events.

	Black Saturday	Västmanland	California 2018
Title	Articles that mention bush fire in relation to an Australian context from 2009 onwards.	Articles that mention forest fire in relation to a Swedish context from 2014 onwards.	Articles that mention wildfire in relation to 2018.
Abstract	Must focus on aspects of the Black Saturday event, be based on empirical study and attempt to contribute to understanding the elements of the fire.	Articles that in some way refer to events from the year 2014 and are based on empirical study.	Articles that focus on aspects of the 2018 California fire season, are based on empirical study and attempt to contribute to understanding the elements of the events.
Full Text	Must contribute to making sense of the event and not use the event in the form of an example to make sense of theory or likewise.	Articles that contribute to making sense of the fire event and not use the event in the form of an example to make sense of theory or likewise.	Must contribute to making sense of the 2018 fire season and not use the event in the form of an example to make sense of theory or likewise.
Search terms	TITLE-ABS-KEY("Black Saturday" OR (Victoria and fire* and 2009)).	TITLE-ABS-KEY("forest* fire*" and Sweden or (Västmanland and fire* and 2014)).	TITLE-ABS-KEY (2018 AND California AND wildfire*).

The remaining papers, a total of 80 (47 Black Saturday, 8 Västmanland, 25 California), were all read twice and analyzed by the first author using the CLA framework. Using CLA to unpack text is challenging because it means "conversing" with it. To establish meaningful ways of "conversing" with the literature, coding questions were adapted from the CLA framework (Table 2). The first author coded in two steps. First, the texts were thematically coded according to the coding questions. The thematic segments of text resulting from the first coding step often included two or more of the coding levels, which allowed the relationships between the layers to be preserved. These thematic segments of texts were then analyzed in-depth and categorized according to the coding questions adapted from the CLA framework to identify different and dominant conceptualizations of the events, different representations of their cause, effect, and responsibilities, and their underpinning assumptions and worldviews. Although, the CLA framework has four levels, our coding questions consist of three levels. This comes down to the overlapping nature of levels three and four through our analytical interpretation of the CLA framework (see Table 2).

3. Results

The results from the literature analysis on the three wildfire events are divided into four sections. Each subsection starts with a brief descriptive overview of the context in

Table 2. Questions used to analyze the literature based on the four CLA levels.

Litany		
What concepts are used to understand why the event happened and unfolded as it did?	What concepts are used to understand/describe the impact during and after the fire?	What concepts are used to understand and discuss how to relate to the fires in the future?
System		
What are the systemic causes attributed to the fire/extent of the fire?	How is the fire described in terms of its impact?	What should have been/ should be done – by whom? – prior to, during or following the fire?
Worldview		
What do the descriptions of cause, impact and possible interventions assume?		Which narratives, ideologies or worldviews are expressed in the paper?

which the wildfire emerged. Following the descriptive overview, we present our analysis according to the analytical levels in Table 2. Finally, the three cases are brought together in the discussion section, illuminating similarities and differences while maintaining the friction, overlap and complementing nature stemming from the interdisciplinary material. Overall, the analysis pays more attention to representations that recur in multiple papers rather than presenting every single representation. Table 3 offers a summary of the three events. While the CLA framework consists of four levels, our translation of the framework to coding questions and our summary of the findings are presented in three levels. This comes down to the overlapping nature of levels three and four through our analytical interpretation of the CLA framework.

3.1. *The Black Saturday, Australia*

The Black Saturday fires took place in 2009 in Victoria, a region located in the southeastern part of Australia. This region is one of the most fire-prone globally, and fire historians refer to it as "the fire flume." Much of the ecosystem depends on frequent fires, and fire-dependent species, such as the Mountain ash, have evolved with intense fires (Griffiths 2009a). The region's fire history stretches into geological times. The anthropogenic character began about 50,000 years ago when Aboriginal peoples settled the continent and altered the fire regime. This regime was changed yet again upon the arrival of European settlers (Attiwill and Adams 2013). Apart from being fire-prone, Victoria is also a prominent agricultural region with an extensive production landscape. About 55 per cent of Victoria's 23 million km^2 of land is used for significant farming systems, including dryland cropping, irrigated agriculture, horticulture, dairy production, and livestock grazing (Sheffield *et al.* 2015). Fires threaten these rural enterprises by potentially altering the available water (Bosomworth, Handmer, and Dovers 2014) or taking the lives of cattle, but are at the same time influenced by agricultural production. Risks to human lives correspond with the sprawl of urban areas into bush landscapes. For example, the sprawl of Melbourne, the capital of Victoria, into bush regions drove the disastrous outcome of the Black Saturday fires, resulting in the highest casualties recorded in Australian bushfires causing further community trauma,

Table 3. Results summary for the three fire events presented in accordance with the CLA framework.

	Black Saturday	Västmanland	California

Key concepts and litany level representations	Drought
	  Temperature
	  Wind
	  Death
	  Displacement
	  Property damage
	  Burned land
		Heat
		  Drought
		  Wind
		  Forestry work
		  Death
		  House damage
		  Timber damage
		  Burned land
			Climate change
			  Drought
			  Wind
			  Death
			  Displacement
			  House damages
			  Costs
			  Burned land

Causes, impacts and systems level representations	The event was a disaster of ignorance at the household level, and the inability of responsible authorities to transfer knowledge and necessary information in all three phases of the fire. The pre-fire phase through precautionary measures, during the fire through updates on the status of the fire, and after the fire through various forms of support.	The event as a failure of crisis response stemming from poor communication and coordination from responsible authorities.	The event as an exploiter and promoter of vulnerability. The event as a failure to direct resources to where they were considered necessary to reduce vulnerability.
Normative underpinnings and worldviews	Risk, vulnerability and adaptation are recurring concepts that come with inherent assumptions. The prevailing normative assumption of the Black Saturday literature is that risk and vulnerability are effectively approached through educating and informing citizens; vulnerability then, it seems, is situated in the know-how of locals.	Risk underpinned the systems level of Västmanland just as it did with Black Saturday. However, the prevailing assumption from Västmanland is that control, achieved through functioning communication and coordination, could manage risk. Control, furthermore, was portrayed as exercised by authorities creating the further assumption that risk is best dealt with in a top-down manner.	Household vulnerability facilitated the lens from where most perspectives at the systems level departed. The assumption underpinning the systems level focused on the social institutions that supported a functioning day-to-day reality for most people. Interventions were, thus, often spoken of in terms of resources, assuming that more resources could adequately mitigate the restructuring of social landscapes brought about by the fires.

Note: Table showing brief descriptions of dominant representations across our analytical levels.

dislocation and anxiety (Butt *et al.* 2009). As the global climate continues to heat, Victoria becomes more vulnerable as the fire season gets extended (Di Virgilio *et al.* 2019). However, fire management is a profoundly divisive question in the southeast territories of Australia, both between and within groups (Attiwill and Adams 2013), making fire management a complex policy issue, not only due to biophysical reasons (Bosomworth, Handmer, and Dovers 2014).

3.1.1. *Conceptualizing the fire (litany)*

The literature from Black Saturday refutes neat packaging. Some authors focus on how policy and governance function in reality by examining the planning phase as well as the fire fighting phase and how various cultural, financial and social dynamics influence the planning and fire fighting (Oloruntoba 2013; Whittaker *et al.*, 2013, 2017; Whittaker, Eriksen, and Haynes 2016; Griffiths 2009a, 2009b; Thornton 2011; Au 2011; O'Neill and Handmer 2012; Handmer and O'Neill 2016; McLennan *et al.* 2011, 2013; McLennan, Elliott, and Omodei 2012; Blanchi *et al.* 2018; Ambrey, Fleming, and Manning 2017; Anderson, Chubb, and Djerf-Pierre 2018). Others focus on the atmospheric conditions that underpin the weather patterns related to the event (Cai, Cowan, and Raupach 2009; Santín *et al.* 2012; Price and Bradstock 2012; Cruz *et al.* 2012; Sullivan and Matthews 2013; Siddaway and Petelina 2011; Engel *et al.* 2013; Jumelet *et al.* 2020; Kala, Evans, and Pitman 2015; Dowdy, Fromm, and McCarthy 2017), or ecological factors and consequences of the fire (Hansen 2018; Banks *et al.* 2011; Lindenmayer *et al.* 2021). Furthermore, the effects on individuals, families, and communities in the aftermath harnessed attention from researchers (Parkinson and Zara 2013; Zara *et al.* 2016; Molyneaux *et al.* 2020; Cowlishaw *et al.* 2021; Forbes *et al.* 2015; Bryant *et al.* 2021; Harms *et al.* 2018, 2021; Hall 2011; Walters and Clulow 2010; Jacobs, Vihma, and Pezza 2015; Pfitzer *et al.* 2016; Cameron *et al.* 2009; Wasiak *et al.* 2013). Despite the complexity inherent in this Black Saturday assemblage, certain representations harness more attention than others.

Generally, the literature conceptualizes the Black Saturday as particularly disastrous compared to other bushfires. Typically, authors describe the extreme weather conditions and how a 12-year long drought, record temperatures in the days leading up to the disastrous event, and strong winds resulted in the death of 173 people. The sense of unparalleled disaster brought by these weather conditions is reinforced by descriptions of injuries, perished livestock, lost wildlife, loss of businesses, economic costs, and astronomical figures of burned land. As a whole, the literature conceptualizes the Black Saturday fires as an unparalleled disaster resulting from extreme atmospheric conditions.

3.1.2. *Causes, impacts and solutions (system level)*

At the systems level of analysis, representations of causes, impacts and responsibilities associated with the fires sprawl into multiple directions. However, certain representations recur more frequently. Particularly prominent is the portrayal of the Black Saturday fires as a disaster brought about by ignorance, both through a lack of know-how at a household level and through a lack of ability among authorities to convey the necessary information and knowledge to households. Knowledge, communication and

education are thus depicted as crucial concepts to make sense of the event's causes, irrespective of academic discipline or phase.

Representations of responsibilities and causes of the fire tie into authorities lacking communication and coordination, as well as various cultural aspects at play in different households (Whittaker *et al.* 2013, 2017; Whittaker, Eriksen, and Haynes 2016; Griffiths 2009a; Thornton 2011; Au 2011; Oloruntoba 2013; O'Neill and Handmer 2012; Handmer and O'Neill 2016; McLennan *et al.* 2011, 2013; McLennan, Elliott, and Omodei 2012; Blanchi *et al.* 2018; Zara *et al.* 2016; Logan 2015). The lack of knowledge was portrayed as manifested through failures on behalf of households to plan, prepare, evacuate and shelter in appropriate ways, eventually resulting in disaster (Whittaker *et al.* 2013, 2017; O'Neill and Handmer 2012; Handmer and O'Neill 2016; Thornton 2011; McLennan *et al.* 2011, 2013; McLennan, Elliott, and Omodei 2012; Blanchi *et al.* 2018). The ignorance, parts of the literature claims, led to a disaster that not only had an immediate impact in terms of human deaths and material destruction. The longer-term impacts come across through descriptions of how the fires altered family and community dynamics, caused mental health problems, and interconnected issues such as an increase in domestic violence, depression, anger and alcohol abuse; effects that continued long after the fire was extinguished (Ambrey, Fleming, and Manning 2017; Cowlishaw *et al.* 2021; Pfitzer *et al.* 2016; Wasiak *et al.* 2013; Molyneaux *et al.* 2020; Bryant *et al.* 2021; Harms *et al.* 2018, 2021; Hall 2011; Parkinson and Zara 2013; Forbes *et al.* 2015). While ignorance was central to explaining why Black Saturday turned into a fully-fledged disaster, multiple factors were considered to influence decisions, ranging from masculine cultures and bush romanticization to an array of personal life factors (McLennan *et al.* 2011, 2013; Handmer and O'Neill 2016; O'Neill and Handmer 2012; Logan 2015; Whittaker *et al.* 2013; Blanchi *et al.* 2018; Knapp *et al.* 2021; Thornton 2011; Hansen 2018; Oloruntoba 2013; Asbi *et al.* 2020).

Lacking knowledge as a theme was present in every discipline included in this review. The literature embracing meteorological explanations tends to point to the need for more institutional knowledge and refers to the importance of understanding large-scale weather patterns to improve models and help foresight (Price and Bradstock 2012; Dowdy, Fromm, and McCarthy 2017). However, the main bulk of the literature takes an interest in the households' ability to plan and prepare for the risk of wildfires and in families' relationship with various authorities by departing from the colloquially known policy "stay or go" (Whittaker *et al.* 2013, 2017; O'Neill and Handmer 2012; Handmer and O'Neill 2016; Thornton 2011; McLennan *et al.* 2013; McLennan, Elliott, and Omodei 2012; Blanchi *et al.* 2018). The policy at the time, "stay or go," encouraged households to either make plans to evacuate early or ensure they had plans to stay and defend their property. The focus on households and their ability to cope with risk thus indicate where research represents the manifestation of risk. However, as the literature suggests, the "stay or go" policy put households at significant risk as they lacked the necessary knowledge and skills for appropriate planning (Whittaker *et al.* 2013, 2017; O'Neill and Handmer 2012; Handmer and O'Neill 2016; Thornton 2011; McLennan *et al.* 2013; McLennan, Elliott, and Omodei 2012; Blanchi *et al.* 2018). The lack of knowledge and awareness further manifested itself in a households' ability to fight the fires or shelter from them (Whittaker *et al.* 2013; O'Neill and Handmer 2012; Handmer and O'Neill 2016; Blanchi *et al.* 2018; Whittaker *et al.* 2017; McLennan, Elliott, and Omodei 2012). In representing the cause

of the disaster as a lack of knowledge and awareness, the literature also suggests that the event could have been handled in other more appropriate ways.

Although risk and vulnerability are primarily portrayed at household and community levels, the responsibility for the failure that led to the impact of Black Saturday was rarely attributed to the households alone. Responsibility was also attributed to the public authorities in charge of planning and preparation, which were occasionally held responsible for failed land management. Nevertheless, the weight of the literature gravitated toward issues of communication and, more specifically, a failure to transfer the necessary information to households regarding planning for fires, fighting flames, evacuating in time or sheltering in appropriate ways (Oloruntoba 2013; O'Neill and Handmer 2012; Handmer and O'Neill 2016; Whittaker *et al.* 2013, 2017; Whittaker, Eriksen, and Haynes 2016; Thornton 2011; McLennan *et al.* 2011, 2013; McLennan, Elliott, and Omodei 2012; Blanchi *et al.* 2018; Au 2011). This focus on a teacher-student relationship between households and public authorities alludes to the literature's understanding of risk as something manifesting at a household level, which explains the focus on empowering families with knowledge and awareness to reduce risk.

The relationship between households and responsible public authorities continues as a theme in the literature more focused on the postfire phase. This literature makes it clear that the impact of the fire goes well beyond death and destruction and also alludes to the role of mental health issues within families and households (Bryant *et al.* 2021; Silveira *et al.* 2021; Hamideh *et al.* 2022; Odimayomi *et al.* 2021; Cowlishaw *et al.* 2021; Pfitzer 2016; Harms *et al.* 2021; Forbes *et al.* 2015; Molyneaux *et al.* 2020). Harms *et al.* (2021; 334) neatly captures the way these impacts manifest in households, and their drivers, in the following quote:

> "[…] we found at 3–4 years after the fires (Wave 1) that major life stressors and subsequent traumatic events (along with the death of someone close and fear for one's life during the fires) were predictive of poor mental health outcomes, including post-traumatic stress disorder (PTSD), depression, and severe psychological distress (Bryant et al. 2014). These prescribed major life stressors included moving to temporary accommodation; financial issues (insurance and employment related); experiencing other disasters, accidents or assault or violence; and changes in health, relationships, accommodation or employment."

The impact on mental health illustrates how vulnerability, risk and adaptation are entangled with families and communities and how fire alters social, financial and political landscapes. Although the papers focus prominently on the contexts where vulnerability unfolds, they rarely neglect the relationship between households and other scales of responsibility.

The attention to the relationship between those at risk and those holding knowledge is also found in the literature focusing on the post-fire phase. Again, education is an essential tool, but the supervisory relationship between authorities and households is not as prominent in the literature during the prefire phase. Rather post-fire literature acknowledges mental health states such as anger and recognition of the needs of vulnerable groups in the aftermath of fire episodes (Bryant *et al.* 2021; O'Neill and Handmer 2012; Harms *et al.* 2018; Hall 2011; Parkinson and Zara 2013; Forbes, Jones, and Reupert 2012; Forbes *et al.* 2015; Cowlishaw *et al.* 2021). The call for acknowledgement of the long term effects of the fires reflects a gap between what responsible authorities plan for and how the effects of the fires unfold in reality. As evidenced by the literature, the impacts can stretch multiple years beyond the extinction of the flames.

3.1.3. *Normative assumptions and worldviews (worldview level)*

Representing the Black Saturday as the outcome of ignorance and a knowledge gap suggests that aspects of the portrayed disaster could have been controlled but, in reality, were not. The basic assumption underpinning much of the literature studying the Black Saturday fire is that more aware and knowledgeable citizens reduce their exposure to risk and vulnerability and strengthen their adaptive capacity. Knowledge and awareness are, thus, seen as approaches that can change families and communities' relationship to the risks posed by extreme weather conditions. However, conveying the necessary knowledge and information demands that planners consider an array of personal life factors that form a complexity difficult to engage with. O'Neill and Handmer (2012, 5), for example, writes:

> "Fire agencies have considerable specialist information and expertise that they should proactively share with households and communities at risk. Agencies do share this information, but in a generalized form emphasizing household choice in dealing with fire risk. But generalized information fails to take into consideration the variable adaptive capacity of different households; for example, for reasons of knowledge, economics, geographical location, health, number of occupants or employment."

The key to understanding underpinning assumptions is what most papers refer to: not an ability to control the fires, but rather an ability to mitigate the risks they pose. Most of the literature considered the management of factors influencing risk as inadequate and where improvements are deemed possible. Since risk is perceived as something expressed at a household level, authority-household relations become essential. The normative underpinning can be found in the imagined configuration of this relationship and the benefits it is expected to deliver. While knowledge and information through education and smart communication may be responses that influence vulnerability and risk, it remains to be reflected upon whether or not an aware population would be enough to mitigate existing risks and whether, and possibly how, education and information can create an aware population. These questions and perspectives were present in the vast Black Saturday literature. However, they were marginal.

3.2. *The Västmanland fire, Sweden*

Västmanland is a county located in mid-Sweden. In late July 2014, the county experienced Sweden's largest wildfire since the 1950s, burning 14,000 ha of forests. The fire generated media attention in Sweden and abroad, not least due to the decision to call for assistance from the European Union Emergency Response Coordination Centre (ERCC) to put out the fire. The Västmanland fire revealed weaknesses in Sweden's civil defence and led to several measures to strengthen the country's emergency preparedness (MSB 2016). The fire burnt in sparsely populated areas shaped by industrial forestry (Sjöström and Granström 2020). Since the mid-1800s, after which modern forestry and aggressive fire suppression started, the forest landscape has witnessed a reduction in burned areas by roughly 1/100th (Sjöström and Granström 2020). Despite wildfires and prescribed fires being deemed necessary for the survival of fire-dependent species, Sweden maintains a vision of strict control when it comes to fires. Overall, Ramberg (2018) estimates that only 0.006% of the Swedish forest burns per year (prescribed 65%, wildfires 35%), with 58% of the prescribed fires occurring on clear-cuts. The approach to fires in Sweden follows the lines of war on fire, where responses to fight and put out the fires

quickly are considered the best way to protect people and resources (Sjöström and Granström 2020). However, climate change may challenge this pursuit of control when the probability of forest fires increases (Krikken *et al.* 2021).

3.2.1. Conceptualizing the fire (litany)

The conceptualisation of the Västmanland fire resembles that of the Black Saturday fire. It is generally pictured as a result of dry, hot and windy conditions where a forest company's subsoiling interventions caused the ignition. The focus on the weather was furthermore linked to descriptions of impacts, including fatality, evacuation, loss of timber and destroyed houses, leading to a conceptualisation of the fire as a disaster (Lidskog 2018; Butler *et al.* 2019; Marklund and Wiklund 2016; Johansson and Lidskog 2020; Lidskog *et al.* 2019; Butler *et al.* 2018; Pimentel and Arheimer 2021; Lidskog and Sjödin 2016). Climate change and forest management generally frame and motivate the scope of the articles, suggesting to their readers that wildfires deserve our attention (Johansson and Lidskog 2020; Lidskog and Sjödin 2016; Lidskog 2018; Lidskog *et al.* 2019).

3.2.2. Causes, impact and solutions (system level)

When moving from questions at the litany level to questions at the system level, the literature turns from describing weather conditions and the disastrous nature of the event to exploring why it became a "crisis" and what we may learn to avoid similar outcomes in the future. This turn is essential, as it puts the crisis response in the spotlight, portraying the disaster as "man-made" resulting from poor communication, a general lack of coordination, and a lack of structures to support effective firefighting (Lidskog and Sjödin 2016; Lidskog 2018; Lidskog *et al.* 2019; Butler *et al.* 2019; Marklund and Wiklund 2016; Johansson and Lidskog 2020; Butler *et al.* 2018; Pimentel and Arheimer 2021). Johansson and Lidskog (2020, 358) concisely capture the representation found in most of the literature;

> "The absence of risk assessment in connection with the deployment of emergency services was considered a key concern [in how the fire was responded to], as well as difficulties in collating and communicating a combined picture of the situation during the initial day of the effort."

Communication, coordination and structures are critical concepts in the literature's representation of the Västmanland fire as a technical failure. This focus on controlling the fire and controlling the crisis from worsening is essential. Much attention is given to how responsible authorities were unable to control the fire in its early stages, a failure resulting from a lack of coordination and collaboration between a large number of organizations and agencies, as well as an inability to involve actors in risk assessment (Lidskog and Sjödin 2016; Lidskog 2018; Lidskog *et al.* 2019; Butler *et al.* 2019; Marklund and Wiklund 2016; Johansson and Lidskog 2020; Pimentel and Arheimer 2021). The focus on control was primarily confined to the status quo, i.e. focusing on effective firefighting, with little attention directed to more significant structural or cultural changes, as discussed in the other two cases.

However, the literature also describes more positive impacts, such as increased social cohesion and, more importantly, a moment for learning and dialogue about regulatory

change that could support growth to mitigate future risks (Lidskog 2018; Johansson and Lidskog 2020; Marklund and Wiklund 2016; Lidskog *et al.* 2019). In terms of impact, the fire is thus represented as a creative destroyer where learning is an outcome that may allow better control of future fire and fire risks. Accordingly, the Västmanland fire represents an opportunity to understand why the fire or "crisis" unfolded and how errors may be corrected to avoid similar situations in the future. Marklund and Wiklund (2016, 4) wrote, "What lessons have in fact been learned remains to be seen at the next major crisis."

3.2.3. *Normative assumptions and worldviews (worldview level)*

The desire for control reflected in the literature on the Västmanland fire leads us to the norms and worldviews underpinning the representation of the fire as a crisis and technical failure. Control and risk are central concepts reflecting the worldviews in the literature. Risk is often conceptualized through extreme weather and climate change descriptions, while control takes a practical form in crisis training, communication, and coordination discussions. While control and risk are critical concepts in the Black Saturday fire literature, they are underpinned by fundamentally different assumptions and worldviews in the Västmanland case. In the Västmanland literature, risk is represented as manageable through control, and risk management is a task for public authorities. In contrast, the literature on the Black Saturday fires represents risk as something that needs to be adapted to in various ways depending on multiple conditions. Furthermore, the Västmanland literature pays little attention to the socio-economic dynamics in which the wildfire is entangled and advocates better control through more efficient coordination and communication. The desire for control differs from the Australian case, where the literature also alludes to a need for cultural changes. The need for adaptive responses in Västmanland is not spoken of because the literature represents fires as uniform, as technical failures rather than as a complex web of interactions between multiple variables and contexts. Despite their ability to increase social cohesion and strengthen biodiversity (Lidskog 2018; Lidskog *et al.* 2019), wildfires are represented as phenomena that should be excluded from the landscape through effective firefighting and crisis management.

3.3. *The Californian fire season*

The 2018 Californian fire season differs from the previous two cases. It is not considered a single fire event but rather a fire season that encompasses a much larger area than the other cases. California as a region has a long history of massive wildfires, and since California is a vast region, fire regimes and the ecologies underpinning them vary greatly (Keeley and Syphard 2019). Since 2000, however, the frequency has increased due to varying ecological and climatological factors (Keeley and Syphard 2019). Climate change has been, and continues to be, a prominent driver of this change, with more frequent warm-season days warmed by approximately 1.4 °C (Williams *et al.* 2019). However, settlement patterns, land use such as forestry, and long-standing successful fire suppression have also changed the fire regime (Keeley and Syphard 2019; Williams *et al.* 2019). Like Västmanland and Victoria, though, wildfires are integral to maintaining Californian shrublands' structure and species composition (Syphard *et al.* 2007). 2018 was California's worst-ever fire season to date in terms of death and destruction, with 8,257 fires making up the season and a burned

area of 1.9 million acres (Wang *et al.* 2021). Calhoun *et al.* (2022) analyzed the role of fire in different types of ecosystems in California. Findings suggested that shrubland represents 38% of the total burned area, conifer forests represent 36%, hardwood 17%, and grasslands (9%). However, the risk to humans and communities, like Australia, corresponds to an increased population in WUI, as these areas are at the highest risk of damage to civil infrastructure (Schulze *et al.* 2020).

3.3.1.   *Conceptualizing the fire (litany)*

Much like Västmanland and Black Saturday, the Californian fires of 2018 are conceptualized in the literature as disastrous. Astronomical figures of burned land mingle with descriptions of death, property destruction and other financial costs (Willson *et al.* 2021; Wang *et al.* 2021; Spialek, Allen, and Craig 2021; Silveira *et al.* 2021; Schulze *et al.* 2020; Comfort *et al.* 2019; Lareau, Nauslar, and Abatzoglou 2018; Rosenthal, Stover, and Haar 2021; Grajdura, Qian, and Niemeier 2021; Qian *et al.* 2021; Mueller *et al.* 2020; Dieckmann *et al.* 2020; Kaltofen, Gundersen, and Gundersen 2021; Hamideh *et al.* 2022; Mass and Ovens 2021; Chase and Hansen 2021; Rooney *et al.* 2020; Odimayomi *et al.* 2021; Knapp *et al.* 2021; Brewer and Clements 2019; Enders *et al.* 2021; Gin *et al.* 2021). Like in Sweden and Australia, the literature from California portrays the event as an expression of extreme weather conditions that enabled the rapid spread of the fire (Wang *et al.* 2021; Comfort *et al.* 2019; Lareau, Nauslar, and Abatzoglou 2018; Grajdura, Qian, and Niemeier 2021; Hamideh *et al.* 2022; Mass and Ovens 2021; Knapp *et al.* 2021). Drought and wind are thus central concepts, often referred to concerning geography and terrain. The Californian case stands out from the other cases as climate change occupies a more prominent role as a driver of winds, low humidity and other weather-related concepts (Wang *et al.* 2021; Silveira *et al.* 2021; Kaltofen, Gundersen, and Gundersen 2021; Spialek, Allen, and Craig 2021; Schulze *et al.* 2020; Rosenthal, Stover, and Haar 2021). From that point of view, the fire events of 2018 are more explicitly related to a changing climate.

3.3.2.   *Causes, impact and solutions (system level)*

Despite commonly conceptualizing fires as resulting from climate change, none of the literature addresses the sources of climate change. Instead, the focus is on how the people in California might cope with the effects of climate change expressed through wildfires. Regarding causes, prevailing representations are connected to land and fuel management, with the expansion of the wildland-urban interface and passive fuel management recurrently mentioned (Knapp *et al.* 2021; Chase and Hansen 2021; Rosenthal, Stover, and Haar 2021; Hamideh *et al.* 2022; Schulze *et al.* 2020). However, most attention is paid to factors that determine people's vulnerability when exposed to shocks like a massive wildfire. In this discussion, the impacts of the 2018 fires become important in guiding climate adaptation strategies.

There are two dominant representations concerning the impacts of the 2018 fires in California. The first impact is air pollution, which the literature points out, goes far beyond the site of the flames. Wang *et al.* (2021) estimates that the smoke from the 2018 fires caused 3,562 deaths, a considerably higher number than the total death toll from the fire of just over 100 people (Grajdura, Qian, and Niemeier 2021). The problem of air pollution stems from fire burning biomass and massive fires burning houses,

cars, and so on, releasing potentially toxic chemicals into the air (Willson *et al.* 2021). The second impact concerns the interaction between physical damage and social dynamics. Destruction of houses, schools, and businesses and the contamination of the groundwater caused by the fire are recurring examples of how social and family dynamics were altered by the physical destruction of the fire, which furthermore contributes to mental health issues and interconnected problems (Silveira *et al.* 2021; Rosenthal, Stover, and Haar 2021; Hamideh *et al.* 2022; Odimayomi *et al.* 2021).

The breadth of social impacts caused by the destruction by the 2018 fires all tie into the concept of vulnerability. The fires are represented as a force that both exploits and promotes vulnerability, moving families and households along a spectrum of vulnerability. The literature describes how vulnerability is manifested through loss of work when certain businesses and hard infrastructure disappear and through the subsequent obliteration of structures causing social fabrics to crumble, leading to dropped performance levels in school, as both teachers and students struggle with mental health problems often stemming from the stresses of daily lives that the fire had created; issues with contaminated drinking water, and lack of access to clean water; loss of community and social support, as friends and families were displaced; loss of housing and changed housing markets in surrounding towns (Rosenthal, Stover, and Haar 2021; Hamideh *et al.* 2022; Odimayomi *et al.* 2021: Schulze *et al.* 2020; Chase and Hansen 2021; Gin *et al.* 2021). Collectively, the literature on the 2018 fires shows how wildfire impacts are entangled in the social dynamics of prefire situations, such as households' financial situation, their insurance and social connections, which influence their vulnerability (Rosenthal, Stover, and Haar 2021; Hamideh *et al.* 2022; Chase and Hansen 2021; Grajdura, Qian, and Niemeier 2021).

The issue of vulnerability is mainly addressed at a household level. Unlike Black Saturday, the Californian fire does not delve deep into how families and households can influence their vulnerability in the prefire phase. Instead, the focus is directed at how people can cope with a social reality radically altered by the fires. To adapt to new realities and manage to thrive in altered social landscapes, the literature draws attention to the importance of having access to basic needs for living, such as a roof over one's head and access to potable water (Wong, Walker, and Shaheen 2021; Chase and Hansen 2021; Gin *et al.* 2021; Odimayomi *et al.* 2021; Hamideh *et al.* 2022; Rosenthal, Stover, and Haar 2021). Beyond basic needs, the literature underlines the importance of schools and hospitals as vital institutions that support recovery as well as financial status, contractual status of households, availability and longevity of the community as well as NGO support, and access to smartphones and information on community evacuation plans (Grajdura, Qian, and Niemeier 2021; Chase and Hansen 2021; Gin *et al.* 2021; Hamideh *et al.* 2022; Rosenthal, Stover, and Haar 2021).

The focus on planning, coordination and communication is, nevertheless, a theme present in the Californian case. The attention is directed toward evacuation planning to reduce the death toll and as a way to adapt to a new reality of more frequent extreme fire events. In the pursuit of improved evacuation, similar themes to Black Saturday and Västmanland can be found. Communication, both in the form of information and in more of a learning sense, is often featured in reference to the Paradise evacuation. An evacuation of the roughly 27,000 residents living in Paradise before the town, including homes, vehicles, and all their contents, were consumed by the Camp Fire (Willson *et al.* 2021). Comfort *et al.* (2019) argued that the successful evacuation of Paradise demonstrated a capacity to self-organize, which is key to community

resilience. Behind this ability for self-organization, Comfort *et al.* (2019) noticed an active planning process, creating an informed understanding of wildfires in the community and ensuring active engagement by local leaders who could take timely and informed action based on direct observation of risk. Despite relative success in anchoring an understanding of wildfires and risk among the community, other factors still impaired the success of the evacuation, not least those related to physical conditions such as infrastructure. Wong, Walker, and Shaheen (2021, 6) write, for example, how insufficient evacuation instructions lead to traffic jams due to "shadow evacuation rates (i.e. not receiving a mandatory evacuation order but still evacuating)."

The difficulties with the evacuation were again attributed to communication issues (Comfort *et al.* 2019; Wong, Walker, and Shaheen 2021; Hamideh *et al.* 2022).

3.2.3.   *Normative assumptions and worldviews (worldview level)*

The literature on the California fires refers to vulnerability mainly as a phenomenon expressed at an individual or family level. The fires function as a shock to the already existing vulnerabilities of complex social landscapes, influenced by various social, political, cultural and financial dynamics. The representation of the Californian fire as an exploiter and promoter of vulnerability reflects the assumption that the problem can be attributed to a lack of resources to replace critical societal functions robbed by the fire. Due to multiple factors influencing vulnerability, the literature portrays the Californian fires as a disaster resulting from a lack of resources or willingness to direct resources to where they are most needed. For example, resources to strengthen schools' capacity to support students, ensure vulnerable groups have access to housing, support families and individuals suffering from mental health issues, and more resources for the pre-fire phase and work on climate mitigation. While more resources may contribute to greater community resilience in the event of massive shocks, vulnerability itself may stem from dependence on existing structures, such as schools and health care that lack capacity. Strengthening such institutions may be effective in managing vulnerability. However, more resources for institutions influence the social ecology underpinning vulnerability. Thus, it is essential to reflect on what futures get afforded and which get locked out.

4.   Discussion

This review has used a CLA framework to unpack dominant representations of wildfires in the academic literature. By departing from three different fire events/seasons, this review article has aimed to make visible how we as researchers co-produce wildfires as particular phenomena and simultaneously co-shape fire policy, management and future wildfires. By addressing this issue, we seek to stimulate cross-contextual reflections and discussions that can generate "alternative" relationships to wildfire to benefit people and ecosystems in a time of changing fire regimes. Questions addressed were: How are wildfires represented and delineated (e.g. conceptually, spatially, temporally)? What implications for actions emerge from these representations? What norms and worldviews underpin them?

Although the fires differed in how they were delineated in time and space, the scientific literature similarly represented the events as disasters. At the litany level, the events are all conceptualized as disasters following extreme weather patterns that resulted in burned land, property loss and lost human lives. However, at the systems

level, there are contextual differences in representation (see Table 3). Representations of Black Saturday have a sprawling nature with attention directed at authority-household relations. The Black Saturday literature further ascribes the family a crucial role in managing risk and vulnerability, whereas, in the Västmanland literature, households have a marginal role. Attention is mainly given to the failure of authorities to control the fire and effectively fight it. The Californian case also pays significant attention to households but, unlike the Australian context, focuses on how vulnerability is expressed at the household level, with limited attention given to their role as active stakeholders in managing and reducing risk. The different conceptualizations of risk furthermore facilitate alternative responses. The prevailing idea of managing risk and reducing vulnerability in the Black Saturday case concerned households developing a sensitivity to risk and an ability to adapt and act upon it to reduce their vulnerability. The Västmanland case represents the opposite. Departing from risk and control, the literature places responsibility on authorities to monitor and act upon risks. The Californian case again departs from vulnerability but focuses on ensuring that necessary social services are maintained. All in all, the three cases overlap and mingle but end up in different representations of these disasters, proving wildfires are not just wildfires.

Analyzing the three wildfires has made visible how the scientific representations are contextual. Although all fires were conceptualized as disasters, the representations of causes, impacts and solutions differed across the three fire events. It is clear from the review that the way causes and impacts are represented create the suggested responses for the future. By drawing different temporal and spatial boundaries around the three wildfire events, different causes, impacts, roles, responsibilities, and different types of interventions emerge. In the Black Saturday case, lack of knowledge was found to compound risk, and thus a promoted response to cope with risk and reduce vulnerability was empowering locals with the knowledge needed to adapt and act in suitable ways. In the Västmanland case, the fire was understood more as a technical failure, and therefore future risk was discussed more in terms of improving coordination and communication for an improved fire fighting response. The Californian case called for more resources to avoid the social repercussions that followed from the fire tearing up essential institutions such as schools and health care.

The differences articulated at the systems level continue through the narratives, normative assumptions and ideologies underpinning them. In all three cases, risk is an essential concept, although representations of risk and vulnerability are different. In the Västmanland literature, risk was represented from a top-down perspective focusing on control, while Black Saturday focused on empowering households with appropriate knowledge. In California, risk was seen as largely embedded in a social landscape, with the fire altering this and thus promoting vulnerability. As a response, maintaining functioning social institutions becomes an essential response to risk. Overall the review has illustrated how wildfires are not merely trees and bushes burning and through flames, heat and winds causing death and destruction. Wildfires are tangled up with risk and thus with social landscapes. Bateson (2017) conceptualizes complexity as something recognizable in situations that have characteristics of multiple variables in ever-shifting contexts of interdependency. The findings in this review fit very well with Bateson's definition of complexity. Examples of multiple variables found in the review include culture, language, age or physical status, while examples of contexts include family, forests, organizational structures and media.

The interdependence between these different variables and concepts would not be identified if we had based the selection of articles on scientific disciplines, policy sectors or land-use types.

If research desires to meet the complexity of wildfire events, then processes of integrating perspectives by looking at the multiple variables, contexts and scales that constitute the events and future risks are necessary. As a minimum, we should be more aware of what perspectives on wildfires we represent and how we challenge and/or reproduce them. We consequently join the many scholars who call for wildfire policy and management to embrace the complexity of these events (Essen *et al.* 2021; Paton *et al.* 2015; Tedim, Leone, and Xanthopoulos 2016; Tedim *et al.* 2020; Chapin *et al.* 2008; Moritz *et al.* 2014; Pyne 2007; Flint and Luloff 2005; Coughlan and Petty 2012; Liu *et al.* 2007; Spies *et al.* 2014; Steelman 2016; Fischer *et al.* 2016; Bacciu, Sirca, and Spano 2022), but stress that this goes for scientific knowledge producers too. As the review has shown, representations matter greatly for what actions emerge, which as Toomey *et al.* (2015) calls for, demands processes devoted to creating reflective spaces. In relation to wildfires, and in the context of research and policy, these reflective spaces may ask; Where do we as a group perceive risk? What representations and connections between different representations of wildfire and wildfire-related risks are present in our team? What representations are we missing, where might we find them, and what implications for action (wildfire policy and management) may our representations result in? In such a reflective space, a CLA process can be a helpful tool to unpack these questions and provide creative openings for alternative metaphors and worldviews leading to potentially different actions.

5. Conclusion

Through this review, we have come to understand wildfire events as "transcontextual" processes in which different notions of risk are crucial ingredients. The term transcontextual aligns with Bateson's (2021) description. Accordingly, wildfire events are situated in the interactions between local ecologies and global environmental change, multiple environmental dynamics, history, politics, social dynamics, culture, economics, media and more. Understanding wildfires as transcontextual processes reminds us that wildfires can be thought of, and dealt with, in different ways in science, policy and management. We, therefore, encourage researchers and practitioners alike to use the review findings as a basis for context-specific conversations on what has been labeled a global wildfire crisis, asking what perspectives, contexts, or representations are present in existing research, policies, and management plans, and which representations are privileged at the cost of others?

In conclusion, the understanding of the entangled nature of wildfire risk that has emerged from this review illustrates a need for transcontextual perspectives that integrate multiple ways of representing fires to maintain the complexity of these events and not promote reductionist interventions based on representations with an insufficient amount of contexts informing them. Analyzing and juxtaposing scientific wildfire representations emerging from different wildfire events is also helpful when trying to understand, imagine and predict what is yet to come in times of extraordinary landscape fires.

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References

Ambrey, C. L., C. M. Fleming, and M. Manning. 2017. "The Social Cost of the Black Saturday Bushfires." *Australian Journal of Social Issues* 52 (4): 298–312. doi:10.1002/ajs4.21

Anderson, D., P. Chubb, and M. Djerf-Pierre. 2018. "Fanning the Blame: Media Accountability, Climate and Crisis on the Australian "Fire Continent." *Environmental Communication* 12 (7): 928–941. doi:10.1080/17524032.2018.1424008

Asbi, A., V. Ramiah, X. Yu, D. Wallace, N. Moosa, and K. Reddy. 2020. "The Determinants of Recovery from the Black Saturday Bushfire: Demographic Factors, Behavioural Characteristics and Financial Literacy." *Accounting & Finance* 60 (1): 15–46. doi:10.1111/acfi.12575

Attiwill, P. M, and M. A. Adams. 2013. "Mega-Fires, Inquiries and Politics in the Eucalypt Forests of Victoria, South-Eastern Australia." *Forest Ecology and Management* 294: 45–53. doi:10.1016/j.foreco.2012.09.015

Au, T. A. 2011. "Analysis of Command and Control Networks on Black Saturday." *Australian Journal of Emergency Management* 26 (3): 20–29.

Bacciu, V., C. Sirca, and D. Spano. 2022. "Towards a Systemic Approach to Fire Risk Management." *Environmental Science & Policy* 129: 37–44. doi:10.1016/j.envsci.2021.12.015

Banks, S. C., E. J. Knight, L. McBurney, D. Blair, and D. B. Lindenmayer. 2011. "The Effects of Wildfire on Mortality and Resources for an Arboreal Marsupial: Resilience to Fire Events but Susceptibility to Fire Regime Change." *PLoS One* 6 (8): e22952. doi:10.1371/journal.pone.0022952

Bateson, N. 2017. "Warm Data: Contextual Research and the Evolution of Science." *Rocznik Naukowy Kujawsko-Pomorskiej Szkoły Wyższej w Bydgoszczy. Transdyscyplinarne Studia o Kulturze (i) Edukacji* 12: 35–40.

Bateson, N. 2021. "The Era of Emergency Relocation: A Transcontextual Perspective." *Journal of Constructivist Psychology* 34 (1): 9–22. doi:10.1080/10720537.2019.1700854

Bishop, B. J, and P. L. Dzidic. 2014. "Dealing with Wicked Problems: Conducting a Causal Layered Analysis of Complex Social Psychological Issues." *American Journal of Community Psychology* 53 (1–2): 13–24.

Blanchi, R., J. Whittaker, K. Haynes, J. Leonard, and K. Opie. 2018. "Surviving Bushfire: The Role of Shelters and Sheltering Practices during the Black Saturday Bushfires." *Environmental Science & Policy* 81: 86–94. doi:10.1016/j.envsci.2017.12.013

Bosomworth, K., J. Handmer, and S. Dovers. 2014. "Learning from Analyses of Policy Frames and Informal Institutions in the Fire Management Sector of Victoria, Australia." In *Adapting to Climate Change*, edited by Bruce C. Glavovic and Gavin P. Smith, 269–289. Dordrecht: Springer.

Brewer, M. J, and C. B. Clements. 2019. "The 2018 Camp Fire: Meteorological Analysis Using in Situ Observations and Numerical Simulations." *Atmosphere* 11 (1): 47. doi:10.3390/atmos11010047

Bryant, R. A., E. Waters, L. Gibbs, H. C. Gallagher, P. Pattison, D. Lusher, C. MacDougall, *et al.* 2014. "Psychological Outcomes Following the Victorian Black Saturday Bushfires." *The Australian and New Zealand Journal of Psychiaty* 48 (7): 634–643.

Bryant, Richard A., Lisa Gibbs, H. Colin Gallagher, Phillipa Pattison, Dean Lusher, Colin MacDougall, Louise Harms., *et al.* 2021. "The Dynamic Course of Psychological Outcomes following the Victorian Black Saturday Bushfires." *The Australian and New Zealand Journal of Psychiatry* 55 (7): 666–677.

Butler, A., I. Knez, A. Åkerskog, I. Sarlöv Herlin, Å. Ode Sang, and E. Ångman. 2019. "Foraging for Identity: The Relationships between Landscape Activities and Landscape Identity after Catastrophic Landscape Change." *Landscape Research* 44 (3): 303–319. doi:10.1080/01426397.2019.1580352

Butler, A., I. Sarlöv-Herlin, I. Knez, E. Ångman, Å. Ode Sang, and A. Åkerskog. 2018. "Landscape Identity, before and after a Forest Fire." *Landscape Research* 43 (6): 878–889.

Butt, A., M. Buxton, R. Haynes, and A. Lechner. 2009. "Peri-Urban Growth, Planning and Bushfire in the Melbourne City-Region." In *State of Australian Cities Conference*, 1–14. Perth, WA: Australian Sustainable Cities and Regions Network (ASCRN).

Cai, W., T. Cowan, and M. Raupach. 2009. "Positive Indian Ocean Dipole Events Precondition Southeast Australia Bushfires." *Geophysical Research Letters* 36 (19): L19710. doi:10.1029/2009GL039902

Calhoun, Kendall L., Melissa Chapman, Carmen Tubbesing, Alex McInturff, Kaitlyn M. Gaynor, Amy Van Scoyoc, Christine E. Wilkinson, Phoebe Parker-Shames, David Kurz, and Justin Brashares. 2022. "Spatial Overlap of Wildfire and Biodiversity in California Highlights Gap in Non-Conifer Fire Research and Management." *Diversity and Distributions* 28 (3): 529–541. doi:10.1111/ddi.13394

Cameron, Peter A., Biswadev Mitra, Mark Fitzgerald, Carlos D. Scheinkestel, Andrew Stripp, Chris Batey, Louise Niggemeyer, *et al.* 2009. "Black Saturday: The Immediate Impact of the February 2009 Bushfires in Victoria." *The Medical Journal of Australia* 191 (1): 11–16.

Carroll, M. S., K. A. Blatner, P. J. Cohn, and T. Morgan. 2007. "Managing Fire Danger in the Forests of the US Inland Northwest: A Classic 'Wicked Problem' in Public Land Policy." *Journal of Forestry* 105 (5): 239–244.

Chapin, F. Stuart, Sarah F. Trainor, Orville Huntington, Amy L. Lovecraft, Erika Zavaleta, David C. Natcher, A. David McGuire., *et al.* 2008. "Increasing Wildfire in Alaska's Boreal Forest: Pathways to Potential Solutions of a Wicked Problem." *BioScience* 58 (6): 531–540. doi:10.1641/B580609

Charnley, S., M. R. Poe, A. A. Ager, T. A. Spies, E. K. Platt, and K. A. Olsen. 2015. "A Burning Problem: Social Dynamics of Disaster Risk Reduction through Wildfire Mitigation." *Human Organization* 74 (4): 329–340. doi:10.17730/0018-7259-74.4.329

Chase, J., and P. Hansen. 2021. "Displacement after the Camp Fire: Where Are the Most Vulnerable?" *Society & Natural Resources* 34 (12): 1566–1583. doi:10.1080/08941920.2021.1977879

Cochrane, M. A., and D. M. Bowman. 2021. "Manage Fire Regimes, Not Fires." *Nature Geoscience* 14 (7): 455–457. doi:10.1038/s41561-021-00791-4

Comfort, L., K. Soga, M. Stacey, M. McElwee, C. Ecosse, J. Dressler, and B. Zhao. 2019. "Collective Action in Communities Exposed to Recurring Hazards: The Camp Fire, Butte County, California, November 8, 2018." Boulder: University of Colorado Natural Hazards Center.

Coughlan, M. R, and A. M. Petty. 2012. "Linking Humans and Fire: A Proposal for a Transdisciplinary Fire Ecology." *International Journal of Wildland Fire* 21 (5): 477–487. doi:10.1071/WF11048

Cowlishaw, Sean, Olivia Metcalf, Tracey Varker, Caleb Stone, Robyn Molyneaux, Lisa Gibbs, Karen Block., *et al.* 2021. "Anger Dimensions and Mental Health following a Disaster:

Distribution and Implications after a Major Bushfire." *Journal of Traumatic Stress* 34 (1): 46–55. doi:10.1002/jts.22616

Cruz, M. G., A. L. Sullivan, J. S. Gould, N. C. Sims, A. J. Bannister, J. J. Hollis, and R. J. Hurley. 2012. "Anatomy of a Catastrophic Wildfire: The Black Saturday Kilmore East Fire in Victoria, Australia." *Forest Ecology and Management* 284: 269–285. doi:10.1016/j. foreco.2012.02.035

Di Virgilio, G., J. P. Evans, S. A. Blake, M. Armstrong, A. J. Dowdy, J. Sharples, and R. McRae. 2019. "Climate Change Increases the Potential for Extreme Wildfires." *Geophysical Research Letters* 46 (14): 8517–8526. doi:10.1029/2019GL083699

Dieckmann, H. G., L. R. Costa, B. Martínez-López, and J. E. Madigan. 2020. "Disaster Medicine: Implementation of an Animal Health Database in Response to the 2018 California Camp Fire." *Journal of the American Veterinary Medical Association* 256 (9): 1005–1010. doi:10.2460/javma.256.9.1005

Dowdy, A. J., M. D. Fromm, and N. McCarthy. 2017. "Pyrocumulonimbus Lightning and Fire Ignition on Black Saturday in Southeast Australia." *Journal of Geophysical Research: Atmospheres* 122 (14): 7342–7354. doi:10.1002/2017JD026577

Enders, J. J., T. W. Rhead, J. A. Phan, and M. C. Zoerb. 2021. "Impacts of 2018 California Wildfires on Organic Aerosol Composition and Air Quality under Low Smoke Conditions." *ACS Earth and Space Chemistry* 5 (2): 163–169. doi:10.1021/acsearthspacechem.0c00202

Engel, C. B., T. P. Lane, M. J. Reeder, and M. Rezny. 2013. "The Meteorology of Black Saturday." *Quarterly Journal of the Royal Meteorological Society* 139 (672): 585–599. doi:10.1002/qj.1986

Essen, M., S. McCaffrey, J. Abrams, and T. Paveglio. 2021. "Improving Wildfire Management Outcomes: Shifting the Paradigm of Wildfire from Simple to Complex Risk." *Journal of Environmental Planning and Management*. Advance online publication. doi:10.1080/09640568.2021.2007861.

Fischer, A. Paige, Thomas A. Spies, Toddi A. Steelman, Cassandra Moseley, Bart R. Johnson, John D. Bailey, Alan A. Ager., *et al.* 2016. "Wildfire Risk as a Socioecological Pathology." *Frontiers in Ecology and the Environment* 14 (5): 276–284. doi:10.1002/fee.1283

Flint, C. G, and A. E. Luloff. 2005. "Natural Resource-Based Communities, Risk, and Disaster: An Intersection of Theories." *Society & Natural Resources* 18 (5): 399–412. doi:10.1080/08941920590924747

Forbes, David, Nathan Alkemade, Elizabeth Waters, Lisa Gibbs, Colin Gallagher, Phillipa Pattison, Dean Lusher., *et al.* 2015. "The Role of Anger and Ongoing Stressors in Mental Health Following a Natural Disaster." *The Australian and New Zealand Journal of Psychiatry* 49 (8): 706–713.

Forbes, R. J., R. Jones, and A. Reupert. 2012. "In the Wake of the 2009 Gippsland Fires: Young Adults' Perceptions of Post-Disaster Social Supports." *The Australian Journal of Rural Health* 20 (3): 119–125.

Gin, J. L., M. D. Balut, C. Der-Martirosian, and A. Dobalian. 2021. "Managing the Unexpected: The Role of Homeless Service Providers during the 2017–2018 California Wildfires." *Journal of Community Psychology* 49 (7): 2532–2547. doi:10.1002/jcop.22653

Grajdura, S., X. Qian, and D. Niemeier. 2021. "Awareness, Departure, and Preparation Time in No-Notice Wildfire Evacuations." *Safety Science* 139: 105258. doi:10.1016/j.ssci.2021.105258

Griffiths, T. 2009a. "An Unnatural Disaster? Remembering and Forgetting Bushfire." *History Australia* 6 (2): 35.1–35.7. doi:10.2104/ha090035

Griffiths, T. 2009b. "We Have Still Not Lived Long Enough." *Park Watch* 237: 12–13.

Hall, C. W. 2011. "After the Firestorm: Supporting Bereaved People following the 2009 Victorian Bushfires." *Bereavement Care* 30 (2): 5–9. doi:10.1080/02682621.2011.577997

Hamideh, S., P. Sen, E. Fischer, and S. Schulze. 2022. "Wildfires' Impacts on Education and Healthcare: Paradise, California after the Camp Fire." *Natural Hazards* 111 (1): 353–387. doi:10.1007/s11069-021-05057-1

Handmer, J., and S. O'Neill. 2016. "Examining Bushfire Policy in Action: Preparedness and Behaviour in the 2009 Black Saturday Fires." *Environmental Science & Policy* 63: 55–62. doi:10.1016/j.envsci.2016.05.011

Hansen, C. 2018. "Deep Time and Disaster: Black Saturday and the Forgotten Past." *Environmental Humanities* 10 (1): 226–240. doi:10.1215/22011919-4385543

Harms, L., R. Abotomey, D. Rose, R. Woodward Kron, B. Bolt, J. Waycott, and M. Alexander. 2018. "Postdisaster Posttraumatic Growth: Positive Transformations Following the Black Saturday Bushfires." *Australian Social Work* 71 (4): 417–429. doi:10.1080/0312407X.2018. 1488980

Harms, Louise, Lisa Gibbs, Greg Ireton, Colin MacDougall, Kate Brady, Lauren Kosta, Karen Block, *et al.* 2021. "Stressors and Supports in Postdisaster Recovery: Experiences after the Black Saturday Bushfires." *Australian Social Work* 74 (3): 332–347. doi:10.1080/0312407X. 2021.1874029

Heinonen, S., M. Minkkinen, J. Karjalainen, and S. Inayatullah. 2017. "Testing Transformative Energy Scenarios through Causal Layered Analysis Gaming." *Technological Forecasting and Social Change* 124: 101–113. doi:10.1016/j.techfore.2016.10.011

Inayatullah, Sohail. 2019. "Causal Layered Analysis A Four-Level Approach to Alternative Futures RELEVANCE AND USE IN FORESIGHT." *Futuribles*. https://www.researchgate. net/publication/332706079_Causal_Layered_Analysis_A_Four-Level_Approach_to_Alternative_ Futures_RELEVANCE_AND_USE_IN_FORESIGHT

Jacobs, S. J., T. Vihma, and A. B. Pezza. 2015. "Heat Stress during the Black Saturday Event in Melbourne, Australia." *International Journal of Biometeorology* 59 (6): 759–770. doi:10. 1007/s00484-014-0889-2

Johansson, J., and R. Lidskog. 2020. "Constructing and Justifying Risk and Accountability after Extreme Events: Public Administration and Stakeholders' Responses to a Wildfire Disaster." *Journal of Environmental Policy & Planning* 22 (3): 353–365. doi:10.1080/1523908X.2020. 1740656

Jumelet, J., A. R. Klekociuk, S. P. Alexander, S. Bekki, A. Hauchecorne, J. P. Vernier, and P. Keckhut. 2020. "Detection of Aerosols in Antarctica from Long-Range Transport of the 2009 Australian Wildfires." *Journal of Geophysical Research: Atmospheres* 125 (23): e2020JD032542.

Kala, J., J. P. Evans, and A. J. Pitman. 2015. "Influence of Antecedent Soil Moisture Conditions on the Synoptic Meteorology of the Black Saturday Bushfire Event in Southeast Australia." *Quarterly Journal of the Royal Meteorological Society* 141 (693): 3118–3129. doi:10.1002/ qj.2596

Kaltofen, M., M. Gundersen, and A. Gundersen. 2021. "Radioactive Microparticles Related to the Woolsey Fire in Simi Valley, CA." *Journal of Environmental Radioactivity* 240: 106755. doi:10.1016/j.jenvrad.2021.106755

Keeley, J. E., and A. D. Syphard. 2019. "Twenty-First Century California, USA, Wildfires: Fuel-Dominated vs. Wind-Dominated Fires." *Fire Ecology* 15 (1): 1–15. doi:10.1186/ s42408-019-0041-0

Kelly, Luke T., Katherine M. Giljohann, Andrea Duane, Núria Aquilué, Sally Archibald, Enric Batllori, Andrew F. Bennett., *et al.* 2020. "Fire and Biodiversity in the Anthropocene." *Science* 370 (6519): eabb0355. doi:10.1126/science.abb0355

Knapp, E. E., Y. S. Valachovic, S. L. Quarles, and N. G. Johnson. 2021. "Housing Arrangement and Vegetation Factors Associated with Single-Family Home Survival in the 2018 Camp Fire, California." *Fire Ecology* 17 (1): 1–19. doi:10.1186/s42408-021-00117-0

Krikken, F., F. Lehner, K. Haustein, I. Drobyshev, and G. J. van Oldenborgh. 2021. "Attribution of the Role of Climate Change in the Forest Fires in Sweden." *Natural Hazards and Earth System Sciences* 21 (7): 2169–2179. doi:10.5194/nhess-21-2169-2021

Lareau, N. P., N. J. Nauslar, and J. T. Abatzoglou. 2018. "The Carr Fire Vortex: A Case of Pyrotornadogenesis?" *Geophysical Research Letters* 45 (23): 13–107. doi:10.1029/2018GL080667

Lidskog, R. 2018. "Invented Communities and Social Vulnerability: The Local Post-Disaster Dynamics of Extreme Environmental Events." *Sustainability* 10 (12): 4457. doi:10.3390/ su10124457

Lidskog, R., J. Johansson, and D. Sjödin. 2019. "Wildfires, Responsibility and Trust: Public Understanding of Sweden's Largest Wildfire." *Scandinavian Journal of Forest Research* 34 (4): 319–328. doi:10.1080/02827581.2019.1598483

Lidskog, R., and D. Sjödin. 2016. "Extreme Events and Climate Change: The Post-Disaster Dynamics of Forest Fires and Forest Storms in Sweden." *Scandinavian Journal of Forest Research* 31 (2): 148–155. doi:10.1080/02827581.2015.1113308

Lindenmayer, D., D. Blair, L. McBurney, S. Banks, and E. Bowd. 2021. "Ten Years On: A Decade of Intensive Biodiversity Research after the 2009 Black Saturday Wildfires in Victoria's Mountain Ash Forest." *Australian Zoologist* 41 (2): 220–230. doi:10.7882/AZ.2020.041

Liu, Jianguo, Thomas Dietz, Stephen R. Carpenter, Marina Alberti, Carl Folke, Emilio Moran, Alice N. Pell., *et al.* 2007. "Complexity of Coupled Human and Natural Systems." *Science (New York, N.Y.)* 317 (5844): 1513–1516. doi:10.1126/science.1144004

Logan, W. 2015. "Bushfire Catastrophe in Victoria, Australia: Public Record, Accountability, Commemoration, Memorialization and Heritage Protection." *National Identities* 17 (2): 155–174. doi:10.1080/14608944.2015.1019207

Marklund, J., and C. H. Wiklund. 2016. "Learning from C2 Situations in the Field: Identifying Lessons from a Major Forest Fire in Sweden." ISCRAM. http://idl.iscram.org/files/jennymarklund/2016/1379_JennyMarklund+CeciliaHullWiklund2016.pdf

Mass, C. F., and D. Ovens. 2021. "The Synoptic and Mesoscale Evolution Accompanying the 2018 Camp Fire of Northern California." *Bulletin of the American Meteorological Society* 102 (1): E168–E192. doi:10.1175/BAMS-D-20-0124.1

McLennan, J., G. Elliott, and M. Omodei. 2012. "Householder Decision-Making under Imminent Wildfire Threat: Stay and Defend or Leave?" *International Journal of Wildland Fire* 21 (7): 915–925. doi:10.1071/WF11061

McLennan, J., G. Elliott, M. Omodei, and J. Whittaker. 2013. "Householders' Safety-Related Decisions, Plans, Actions and Outcomes during the 7 February 2009 Victorian (Australia) Wildfires." *Fire Safety Journal* 61: 175–184. doi:10.1016/j.firesaf.2013.09.003

McLennan, J., M. Omodei, G. Elliott, and A. Holgate. 2011. "'Deep Survival': Experiences of Some Who Lived When They Might Have Died in the 7 February 2009 Bushfires." *Australian Journal of Emergency Management* 26 (2): 41–46.

Molyneaux, Robyn, Lisa Gibbs, Richard A. Bryant, Cathy Humphreys, Kelsey Hegarty, Connie Kellett, H. Colin Gallagher., *et al.* 2020. "Interpersonal Violence and Mental Health Outcomes Following Disaster." *BJPsych Open* 6 (1): 1–7. doi:10.1192/bjo.2019.82

Moritz, Max A., Enric Batllori, Ross A. Bradstock, A Malcolm Gill, John Handmer, Paul F. Hessburg, Justin Leonard., *et al.* 2014. "Learning to Coexist with Wildfire." *Nature* 515 (7525): 58–66.

MSB. 2016. "Ansvar, samverkan, handling Åtgärder för stärkt krisberedskap utifrån erfarenheterna från skogsbranden i Västmanland 2014." Publikationsnummer MSB996 – April 2016 Utgåva 2.0 ISBN 978-91-7383-659-3.

Mueller, S., L. Tarnay, S. O'Neill, and S. Raffuse. 2020. "Apportioning Smoke Impacts of 2018 Wildfires on Eastern Sierra Nevada Sites." *Atmosphere* 11 (9): 970. doi:10.3390/atmos11090970

O'Neill, S. J, and J. Handmer. 2012. "Responding to Bushfire Risk: The Need for Transformative Adaptation." *Environmental Research Letters* 7 (1): 014018. doi:10.1088/1748-9326/7/1/014018

Odimayomi, Tolulope O., Caitlin R. Proctor, Qi Erica Wang, Arman Sabbaghi, Kimberly S. Peterson, David J. Yu, Juneseok Lee., *et al.* 2021. "Water Safety Attitudes, Risk Perception, Experiences, and Education for Households Impacted by the 2018 Camp Fire, California." *Natural Hazards* 108 (1): 947–975. doi:10.1007/s11069-021-04714-9

Oloruntoba, R. 2013. "Plans Never Go According to Plan: An Empirical Analysis of Challenges to Plans during the 2009 Victoria Bushfires." *Technological Forecasting and Social Change* 80 (9): 1674–1702. doi:10.1016/j.techfore.2012.12.002

Parkinson, D, and C. Zara. 2013. "The Hidden Disaster: Domestic Violence in the Aftermath of Natural Disaster." *Australian Journal of Emergency Management* 28 (2): 28–35.

Paton, D., P. T. Buergelt, F. Tedim, and S. McCaffrey. 2015. "Wildfires: International Perspectives on Their Social—Ecological Implications." In *Wildfire Hazards, Risks and Disasters*, edited by John F. Shroder and Douglas Paton, 1–14. Amsterdam: Elsevier.

Pfitzer, Birgit, Lynda Jane Katona, Stuart J. Lee, Meaghan O'Donnell, Heather Cleland, Jason Wasiak, and Steve Ellen. 2016. "Three Years after Black Saturday: Long-Term Psychosocial Adjustment of Burns Patients as a Result of a Major Bushfire." *Journal of Burn Care & Research* 37 (3): e244–e253. doi:10.1097/BCR.0000000000000223

Pimentel, R., and B. Arheimer. 2021. "Hydrological Impacts of a Wildfire in a Boreal Region: The Västmanland Fire 2014 (Sweden)." *Science of the Total Environment* 756: 143519. doi:10.1016/j.scitotenv.2020.143519

Price, O. F., and R. A. Bradstock. 2012. "The Efficacy of Fuel Treatment in Mitigating Property Loss during Wildfires: Insights from Analysis of the Severity of the Catastrophic Fires in 2009 in Victoria, Australia." *Journal of Environmental Management* 113: 146–157.

Pyne, S. J. 2007. "Problems, Paradoxes, Paradigms: Triangulating Fire Research." *International Journal of Wildland Fire* 16 (3): 271–276. doi:10.1071/WF06041

Qian, W., Y. Ai, J. Y. Yu, and J. Du. 2021. "Opposite Anomalous Synoptic Patterns for Potential California Large Wildfire Spread and Extinguishing in 2018 Cases." *Atmospheric Research* 262: 105804. doi:10.1016/j.atmosres.2021.105804

Ramberg, Ellinor. 2018. "Bränder på skogsmark i Sverige – En kartläggning och analys av spontana och kontrollerade bränder 2011-2015."

Rittel, H. W., and M. M. Webber. 1973. "Dilemmas in a General Theory of Planning." *Policy Sciences* 4 (2): 155–169. doi:10.1007/BF01405730

Rooney, B., Y. Wang, J. H. Jiang, B. Zhao, Z. C. Zeng, and J. H. Seinfeld. 2020. "Air Quality Impact of the Northern California Camp Fire of November 2018." *Atmospheric Chemistry and Physics* 20 (23): 14597–14616. doi:10.5194/acp-20-14597-2020

Rosenthal, A., E. Stover, and R. J. Haar. 2021. "Health and Social Impacts of California Wildfires and the Deficiencies in Current Recovery Resources: An Exploratory Qualitative Study of Systems-Level Issues." *PloS One* 16 (3): e0248617. doi:10.1371/journal.pone.0248617

Santín, Cristina, Stefan H. Doerr, Richard A. Shakesby, Rob Bryant, Gary J. Sheridan, Patrick N. J. Lane, Hugh G. Smith, and Tina L. Bell. 2012. "Carbon Loads, Forms and Sequestration Potential within Ash Deposits Produced by Wildfire: New Insights from the 2009 'Black Saturday' Fires." *European Journal of Forest Research* 131 (4): 1245–1253. doi:10.1007/s10342-012-0595-8

Schulze, S. S., E. C. Fischer, S. Hamideh, and H. Mahmoud. 2020. "Wildfire Impacts on Schools and Hospitals Following the 2018 California Camp Fire." *Natural Hazards* 104 (1): 901–925. doi:10.1007/s11069-020-04197-0

Sheffield, K., E. Morse-McNabb, R. Clark, S. Robson, and H. Lewis. 2015. "Mapping Dominant Annual Land Cover from 2009 to 2013 across Victoria, Australia Using Satellite Imagery." *Scientific Data* 2 (1): 1–15. doi:10.1038/sdata.2015.69

Shlisky, A., J. Waugh, P. Gonzalez, M. Gonzalez, M. Manta, H. Santoso, E. Alvarado, *et al*. 2007. "*Fire, Ecosystems and People: Threats and Strategies for Global Biodiversity Conservation*." Arlington: The Nature Conservancy.

Siddaway, J. M, and S. V. Petelina. 2011. "Transport and Evolution of the 2009 Australian Black Saturday Bushfire Smoke in the Lower Stratosphere Observed by OSIRIS on Odin." *Journal of Geophysical Research* 116 (D6) doi:10.1029/2010JD015162

Silveira, S., M. Kornbluh, M. C. Withers, G. Grennan, V. Ramanathan, and J. Mishra. 2021. "Chronic Mental Health Sequelae of Climate Change Extremes: A Case Study of the Deadliest Californian Wildfire." *International Journal of Environmental Research and Public Health* 18 (4): 1487. doi:10.3390/ijerph18041487

Sjöström, J., and A. Granström. 2020. *Skogsbränder och gräsbränder i Sverige: Trender och mönster under senare decennier*. [Temporal, spatial and fire danger distributions of wildfires in Sweden 1996-2018] Report number: MSB1536. Stockholm: Swedish Civil Contingencies Agency.

Smith, Alistair M. S., Crystal A. Kolden, Travis B. Paveglio, Mark A. Cochrane, David Mjs Bowman, Max A. Moritz, Andrew D. Kliskey., *et al*. 2016. "The Science of Firescapes: Achieving Fire-Resilient Communities." *Bioscience* 66 (2): 130–146.

Spialek, M. L., M. W. Allen, and C. A. Craig. 2021. "The Relationship between the Disaster Communication Action Context and Citizen Intent to Shape Climate-Related Disaster Policy across California Wildfire Seasons." *Journal of Applied Communication Research* 49 (3): 325–346. doi:10.1080/00909882.2020.1851041

Spies, Thomas A., Eric M. White, Jeffrey D. Kline, A. Paige Fischer, Alan Ager, John Bailey, John Bolte., *et al*. 2014. "Examining Fire-Prone Forest Landscapes as Coupled Human and Natural Systems." *Ecology and Society* 19 (3): 9. doi:10.5751/ES-06584-190309

Steelman, T. 2016. "US Wildfire Governance as Social-Ecological Problem." *Ecology and Society* 21 (4): 3. doi:10.5751/ES-08681-210403

Sullivan, A. L., and S. Matthews. 2013. "Determining Landscape Fine Fuel Moisture Content of the Kilmore East 'Black Saturday' Wildfire Using Spatially-Extended Point-Based Models." *Environmental Modelling & Software* 40: 98–108. doi:10.1016/j.envsoft.2012.08.008

Syphard, A. D., V. C. Radeloff, J. E. Keeley, T. J. Hawbaker, M. K. Clayton, S. I. Stewart, and R. B. Hammer. 2007. "Human Influence on California Fire Regimes." *Ecological Applications: A Publication of the Ecological Society of America* 17 (5): 1388–1402.

Tedim, F., V. Leone, and G. Xanthopoulos. 2016. "A Wildfire Risk Management Concept Based on a Social-Ecological Approach in the European Union: Fire Smart Territory." *International Journal of Disaster Risk Reduction* 18: 138–153. doi:10.1016/j.ijdrr.2016.06.005

Tedim, F., S. McCaffrey, V. Leone, G. M. Delogu, M. Castelnou, T. K. McGee, and J. ArAnhA. 2020. "What Can we Do Differently about the Extreme Wildfire Problem: An Overview." *Extreme Wildfire Events and Disasters* 233–263. https://www.fs.usda.gov/rm/pubs_journals/2020/rmrs_2020_tedim_f001.pdf

Thornton, R. P. 2011. "Short Communication on Research Response to the Black Saturday (7th February 2009) Victorian Bushfires, Australia." *Fire Technology* 47 (2): 295–301. doi:10.1007/s10694-010-0175-8

Toomey, A. H., N. Markusson, E. Adams, and B. Brockett. 2015. "Inter-and Transdisciplinary Research: A Critical Perspective." Policy Brief, United Nations Sustainable Development. https://sustainabledevelopment.un.org/content/documents/612558-Inter-%20and%20Trans-disciplinary%20Research%20-%20A%20Critical%20Perspective.pdf

United Nations Environment Programme. 2022. "Spreading like Wildfire: The Rising Threat of Extraordinary Landscape Fires." A UNEP Rapid Response. https://www.unep.org/resources/report/spreading-wildfire-rising-threat-extraordinary-landscape-fires

Walters, G., and V. Clulow. 2010. "The Tourism Market's Response to the 2009 Black Saturday Bushfires: The Case of Gippsland." *Journal of Travel & Tourism Marketing* 27 (8): 844–857. doi:10.1080/10548408.2010.527250

Wang, Daoping, Dabo Guan, Shupeng Zhu, Michael Mac Kinnon, Guannan Geng, Qiang Zhang, Heran Zheng., *et al.* 2021. "Economic Footprint of California Wildfires in 2018." *Nature Sustainability* 4 (3): 252–260. doi:10.1038/s41893-020-00646-7

Wasiak, J., P. Mahar, S. Lee, E. Paul, A. Spinks, B. Pfitzer, H. Cleland, and B. Gabbe. 2013. "12-month Generic Health Status and Psychological Distress Outcomes Following an Australian Natural Disaster Experience: 2009 Black Saturday Wildfires." *Injury* 44 (11): 1443–1447. doi:10.1016/j.injury.2012.08.060

Wesselink, A., K. S. Buchanan, Y. Georgiadou, and E. Turnhout. 2013. "Technical Knowledge, Discursive Spaces and Politics at the Science–Policy Interface." *Environmental Science & Policy* 30: 1–9. doi:10.1016/j.envsci.2012.12.008

Whittaker, J., R. Blanchi, K. Haynes, J. Leonard, and K. Opie. 2017. "Experiences of Sheltering during the Black Saturday Bushfires: Implications for Policy and Research." *International Journal of Disaster Risk Reduction* 23: 119–127. doi:10.1016/j.ijdrr.2017.05.002

Whittaker, J., C. Eriksen, and K. Haynes. 2016. "Gendered Responses to the 2009 B Lack S Aturday Bushfires in Victoria, Australia." *Geographical Research* 54 (2): 203–215. doi:10.1111/1745-5871.12162

Whittaker, J., K. Haynes, J. Handmer, and J. McLennan. 2013. "Community Safety during the 2009 Australian 'Black Saturday' Bushfires: An Analysis of Household Preparedness and Response." *International Journal of Wildland Fire* 22 (6): 841–849. doi:10.1071/WF12010

Williams, A. P., J. T. Abatzoglou, A. Gershunov, J. Guzman-Morales, D. A. Bishop, J. K. Balch, and D. P. Lettenmaier. 2019. "Observed Impacts of Anthropogenic Climate Change on Wildfire in California." *Earth's Future* 7 (8): 892–910. doi:10.1029/2019EF001210

Willson, B. E., N. A. Gee, N. H. Willits, L. Li, Q. Zhang, K. E. Pinkerton, and B. L. Lasley. 2021. "Effects of the 2018 Camp Fire on Birth Outcomes in Non-Human Primates: Case-Control Study." *Reproductive Toxicology (Elmsford, N.Y.)* 105: 128–135.

Wong, S. D., J. L. Walker, and S. A. Shaheen. 2021. "Trust and Compassion in Willingness to Share Mobility and Sheltering Resources in Evacuations: A Case Study of the 2017 and 2018 California Wildfires." *International Journal of Disaster Risk Reduction* 52: 101900. doi:10.1016/j.ijdrr.2020.101900

Zara, C., D. Parkinson, A. Duncan, and K. Joyce. 2016. "Men and Disaster: Men's Experiences of the Black Saturday Bushfires and the Aftermath." *Australian Journal of Emergency Management* 31 (3): 40–48.