External drivers of changes in wildland firefighter safety policies and practices

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ABSTRACT

Background. Firefighter safety is a top priority in wildland fire response and management. Existing explanations emphasise how land management agency initiatives to change organisational culture, usually inspired by fatality incidents, contribute to changes both in formal safety policies and informal safety practices. **Aims.** This paper identifies external factors that lead to changes in wildland firefighter safety policies and practices. **Methods.** This paper uses qualitative data from a long-term ethnographic research project. Data include detailed fieldnotes, semi-structured interviews, and agency documents, which were systematically coded and thematically analysed. **Key results.** In addition to the triggering effects of fatality incidents and agency initiatives to change organisational culture, external factors also directly impact the development of firefighter safety policies and practices. These include socio-demographic, material, political, and social-environmental factors. **Conclusions.** Identifying and under-standing the influence of multi-scalar external factors on firefighter safety is essential to improving safety outcomes and reducing firefighters' exposure to hazards. **Implications.** Attention to and recognition of external factors is valuable for fire managers and practitioners, whose work is influenced and constrained by meso- and macro-level factors. The framework presented in this paper would be useful in understanding other important aspects of wildland fire management.

Keywords: agency policy, environmental sociology, firefighter safety, organisational sociology, risk management, safety culture, sociodemographic changes, tragedy and fatality incidents, technology.

Introduction

Clear consensus exists that risk management is an essential component of wildland fire and forest management, and that social science approaches are needed to understand all aspects of wildfire management (McCaffrey *et al.* 2013; Calkin *et al.* 2014; Dunn *et al.* 2017; Ingalsbee 2017; Thompson *et al.* 2018). Firefighter safety is routinely identified as a top priority in wildland fire response (NWCG 2022a), and improving firefighter safety is of the highest importance for wildland fire practitioners and researchers (Brown 2019; Page *et al.* 2019; Pupulidy 2020; Flores and Haire 2021). To improve safety outcomes for wildland firefighters, it is essential to understand official safety initiatives aimed at changing firefighter behaviours, responses and culture to mitigate risks.

This paper argues that external factors impact the development and evolution of wildland firefighter safety policies and practices, which include checklists and standard operating procedures intended to direct and constrain firefighter behaviour, and agency initiatives intended to change organisational culture. I use 'safety policies' as a shorthand for a range of policy requirements, trainings, procedures, guidelines, and checklists intended to manage risks and make wildland firefighting safer. In the context of wildland fire, *risk* refers to the relevant *probability* (or likelihood) and *hazards* (or severity) involved in uncertain future consequences (US Department of Agriculture and US Forest Service 2020, pp. 2–3). Since wildland firefighting inherently 'involves some form of risk', risk management is the process of taking deliberate action to reduce risks to 'acceptable' levels, often by reducing *exposures* or the amount of time spent

proximate to a hazard (US Department of Agriculture and US Forest Service 2020, pp. 2–3). While recent scholarship has discussed the origins of specific policies and the development of a 'safety culture' or 'learning culture' within the US Forest Service (USFS) (e.g. Ziegler 2007; Brown 2019; Pupulidy 2020; Flores and Haire 2021), existing explanations for changes in safety policies generally limit their focus to proximate causes and official agency activities, ignoring the influence of external factors at multiple scales. This paper draws on multiple years of ethnographic observations and dozens of qualitative interviews to ask: what leads to changes in wildland firefighter safety policies and practices?

Background

Wildland firefighting today confronts 'positive feedback loops' between aggressive suppression strategies and future wildfire risks to firefighters, communities, and natural resources, creating what scholars have described as the 'wildfire paradox' or 'firefighting trap' (Silva *et al.* 2010; Collins *et al.* 2013; Calkin *et al.* 2014, 2015; Ingalsbee 2017). Firefighter safety is a top priority for wildland fire management, yet wildland firefighting is one of the most dangerous professions (Page *et al.* 2019), with a historic fatality rate in the United States trailing only that of fishers, hunters, and roofers (Belval *et al.* 2024; Durbin *et al.* 2024). While annual firefighter fatalities have declined over time, there is no clear trend in annual number of entrapment incidents (Page *et al.* 2019). Working as a wildland firefighter is also connected to higher rates of cardiovascular and musculoskeletal health issues (Semmens *et al.* 2016), multiple types of cancer (International Agency for Research on Cancer 2023), and declines in lung function, hypertension, and mental health outcomes (Groot *et al.* 2019), though more occupational health research is needed (Held *et al.* 2024).

Land management agencies including the USFS have long focused on reducing risks to firefighters, and occupational fatalities are widely seen as unacceptable (Durbin *et al.* 2024). Agency efforts to develop and change firefighter safety policies generally are attributed to two factors as depicted in Fig. 1a (Traditional explanations): *reactions to tragedy fires*, and *official initiatives designed to alter agency culture*.

Fatality incidents, particularly entrapments that kill multiple firefighters, have directly motivated the development and refinement of safety protocols and guidelines, particularly before the mid-1990s (Withen 2003; Page *et al.* 2019; Flores and Haire 2021; Harris 2022). As examples, the 10 Standard Firefighting Orders developed from a fatality meta-analyses following the 1956 Inaja Fire; the Downhill Fireline Construction Checklist was developed from

an analysis of the 1966 Loop Fire; and hotshot superintendent-turned-fire scientist Paul Gleason developed LCES (Lookouts, Communication, Escape Routes, and Safety Zones) as 'an outgrowth of [his] analysis of fatalities and near-misses for over 20 years', including his personal experience with the 1990 Dude Fire (Gleason 1991a; Gleason 1991b, p. 199; Ziegler 2007; Page *et al.* 2019; Flores and Haire 2021; Flores and Haire 2021). As smokejumper superintendent and sociologist Withen (2003) writes, 'it appears as if the rules of firefighting are written in blood. While each new set of rules made needed changes in firefighting operations, their formulation was reactionary…' (p. 2). During this era, accountability was generally constructed as 'answerability,' and investigations focused on how individual firefighters had broken safety policies, making some reluctant to participate in accident investigations (Desmond 2007; Ziegler 2007; Pupulidy 2020).

Although some earlier post-incident reports pointed to human factors and agency inaction (e.g. National Wildfire Coordinating Group 1980), efforts to understand and change agency culture 'did not begin in earnest' until after the 1994 fire season (Flores and Haire 2021, p. 510). That year, much of the US experienced extreme fire conditions and associated resource shortages, and 34 wildland firefighters died (Putnam 1995a), including the 'particularly deafening wake-up call' of 14 fatalities on the South Canyon Fire (Flores and Haire 2021, p. 510).[1] The original South Canyon accident investigation concluded that firefighters' 'can-do attitude… compromised the 10 Standard Firefighting Orders and the 18 Watch Out Situations' (US Department of Agriculture *et al.* 1994, p. 28). According to retired USFS leadership director Ivan Pupulidy, this conclusion was such a problematic 'oversimplification' that the 'human factors specialist assigned to the investigation refused to sign the final report' and instead organised the 1995 workshop on Wildland Firefighters Human Factors (Pupulidy 2020, p. 27; see also Putnam 1995a, 1995b). This workshop led to the multi-faceted Wildland Firefighter Safety Awareness Study, more commonly called the 'TriData' report after the consulting group that conducted the research (TriData Corporation 1998). Additionally, a team of agency fire experts wrote a separate report emphasising fire behaviour rather than individual or crew actions (Butler *et al.* 1998).

Post-South Canyon, the USFS safety focus became grounded in a better understanding of 'human behaviours and social interactions' (Flores and Haire 2021, p. 506), which crystalised into support for a 'safety culture' or a 'learning culture' within the agency. While these terms defy universal definition, key elements include shared systems of meaning that produce certain safety-oriented perspectives and behaviours, are reinforced by policies and organisational structures, and can be measured in employee

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[1] Putnam (1995a) and the Wildland Fire Lessons Learned Center (2024) identify 34 wildland firefighter deaths in 1994. Another report on 1994 firefighter fatalities identifies 38 wildland firefighter deaths (TriData Corporation 1995).
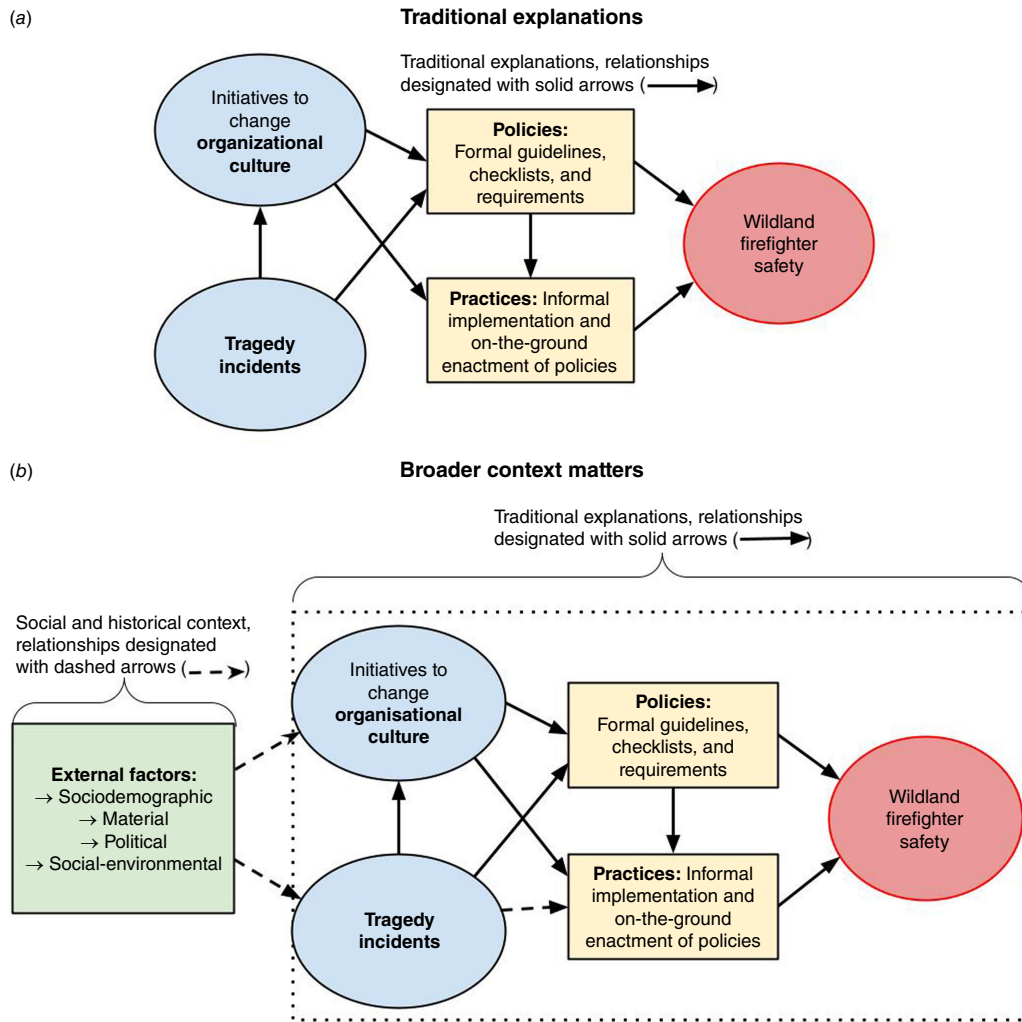
(a)   **Traditional explanations**

Traditional explanations, relationships
designed with solid arrows (———►)

Initiatives to change **organizational culture**

Policies: Formal guidelines, checklists, and requirements

Tragedy incidents

Practices: Informal implementation and on-the-ground enactment of policies

Wildland firefighter safety

(b)   **Broader context matters**

Traditional explanations, relationships
designed with solid arrows (———►)

Social and historical context, relationships designated with dashed arrows (– – ►)

External factors:
→ Sociodemographic
→ Material
→ Political
→ Social-environmental

Initiatives to change **organisational culture**

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Fig. 1. Factors influencing wildland firefighter safety.

attitudes and outcomes (Bisbey *et al.* 2021). The consequences of the USFS's safety culture shift were far reaching, including the formalisation of leadership training as part of firefighter training and promotion, high-level directives promoting critical thinking and speaking up, embrace of management and social science research on 'high-reliability organisations,' and the establishment of the USFS's Innovation and Organisational Learning unit to both conduct research and develop practical interventions (Weick and Sutcliffe 2008; Black and McBride 2013; Pupulidy 2020; Flores and Haire 2021; Harris 2022).

The USFS also shifted its post-incident investigation process to focus more on contextual, environmental, and human factors, rather than blaming individuals and second-guessing decisions (Pupulidy 2020; Harris 2022). The Facilitated Learning Analysis (FLA) and Coordinated Response Protocol processes include interviews, review of physical and document evidence, and a focus on contextualised understanding (US Forest Service 2020, 2024). Unlike

older review processes whose focus on 'accountability' tended to blame individuals by listing how safety guidelines had been 'broken' or 'violated', these learning-focused processes contextualise individuals' actions and decisions, iteratively share findings, and are not intended to be punitive (Pupulidy 2020; Harris 2022; US Forest Service 2024). More attention is also paid to near-misses and learning from complexity, apparent in the work of the Wildland Fire Lessons Learned Center (WFLLC) which was 'born of the Human Factors Workshop and TriData Study' (Wildland Fire Lessons Learned Center 2024). The WFLLC publishes incident reviews, multi-media products, annual summaries, and the 'Two More Chains' newsletter, all of which involve close attention to firefighters' lived experiences with risk and safety. The agency's most recent systematic analysis of wildfire accidents and incidents, the 'Wildland Fire Metareview' (USFS 2022*a*), was initiated following the Learning Review of the Twisp River fatalities (US Forest Service 2016). This Metareview displays the USFS's current

attention to contextualised and qualitative interpretation of tragedy incidents and a focus on the agency's learning culture, while still showing how tragedy incidents directly inspire agency safety initiatives.

The agency's safety culture process was directed through a series of top-down initiatives, including the Fire Suppression Foundational Doctrine (2006), three Safety Journeys (2011–2015), Life First (2016), and Life Work (2017) that variously included listening sessions, focus groups, group dialogues, trainings, and/or surveys (Pupulidy 2020; Flores and Haire 2021; Harris 2022). Agency surveys and reflections identified mixed reception to these top-down safety initiatives (e.g. Lane *et al.* 2014). Safety outcomes are better seen as co-produced between leadership and employees (Flores and Haire 2021), involving both formal policies and informal practices.

Throughout this period of cultural management and reorganisation, fatality incidents remained influential. Though not discussed in USFS employee histories of safety programing (e.g. Brown 2019; Pupulidy 2020; Flores and Haire 2021), the 2008 tree felling death of firefighter Andy Palmer led to the creation of the Dutch Creek Protocols, including medivac requirements on large incidents and the Medical Incident Report in every firefighters' Incident Response Pocket Guide (IRPG) (Gabbert 2011; National Multi-Agency Coordinating Group 2016; National Wildfire Coordinating Group 2018*a*, 2023). As another example, following the deaths of 19 hotshots on the Yarnell Hill Fire in 2013, a 'grassroots movement' of wildland fire managers, practitioners, and researchers came together 'to engage in a sense-making journey, trying to understand the conditions, cultural practices, mental models, and examining our own vulnerabilities' (Smith 2016; National Wildfire Coordinating Group 2023, p. 1). Conversations in this group led to leadership expert Mark Smith publishing 'The Big Lie' on the *Wildland Fire Leadership* blog in 2016 (Smith 2016). Smith argued that acknowledging the inherent dangers in wildland firefighting is necessary to achieve meaningful organisational learning and change. Smith's article was widely read among wildland firefighters and inspired extensive discussion around ideas of 'acceptable' risk (e.g. DeGrosky 2016; Wildland Fire Lessons Learned Center 2016*a*; Durbin *et al.* 2024).

To summarise, official descriptions of the USFS's approach to developing firefighter safety policies, protocols and guidelines focus on two issues: the triggering effects of tragedy incidents, and agency efforts to institute an organisational safety culture (Fig. 1*a*). These existing explanations pay inadequate attention to how macro-level external factors both change the hazards and exposures experienced by wildland firefighters, and influence agency policies designed to change organisational culture and improve firefighter safety. With the exception of Flores and Haire's (2021) historical sociological account, official explanations largely ignore the broader social and historical context, what

sociologists call the *sociological imagination* (Mills 1959; Norgaard 2018). Furthermore, while the importance of 'human factors' that influence wildfire outcomes is widely recognised, these are often reduced to individual-level perceptions and decision-making (TriData Corporation 1998; Thompson 2014). For example, the 'social-political pressures' section of the recent USFS Metareview emphasises individual-, group-, or organisation-level perceptions and communication challenges, rather than external factors such as political polarisation or shifts in wildland–urban interface (WUI) populations (US Forest Service 2022*a*, pp. 34–36). More research is needed on how the broader social context impacts safety policies and practices (Flores and Haire 2021, p. 516).

Using theoretical contributions from organisational and environmental sociology, I argue that understanding changes in firefighter safety policies and practices requires consideration of broader sociodemographic, material, political, and social-environmental factors. This approach is consistent with how frameworks such as 'coupled natural and human systems' (Fischer *et al.* 2016), 'social-ecological systems' (Hamilton *et al.* 2019), and 'socio-ecological problems' (Steelman 2016) have been applied to wildfire and land management issues more generally, highlighting how policy issues must be interrogated at multiple spatial and temporal scales. These approaches generally rely on easily measurable metrics of human settlement or public attitudes, while an explicitly sociological account emphasises how multiple social and cultural elements interact with environmental forces in complex ways and across multiple spatial and temporal scales.

Organisational sociology has long focused on how organisations interact with the external world, with an attention to how organisational culture is constructed and interactive (Strauss 1978; Vaughan 1996; Lizardo and Jilbert 2023; De'Arman *et al.* 2024). Organisational sociology also pays attention to *micro-* (individual or small group), *meso-* (organisational or community), and *macro-* (broad society) level interactions, experiences, and meanings (Haveman and Wetts 2019). Relevant to this analysis, organisational sociology emphasises that formal rules and policies are social, contested, and connected to conflicts over power and resources (Fligstein 2021), and that 'informal social relations, practices, and norms often deviate from formal organisational charts, job descriptions, rules and procedures' (Haveman and Wetts 2019, p. 2). For example, work on 'street-level bureaucrats' including wildland firefighters shows that front-line workers have significant discretion in implementing formal policies and procedures (Lipsky 1980; Cordner 2021).

Environmental sociology argues that society and the biophysical environment are interconnected (Dunlap and Catton 1979; Gould and Lewis 2020). Rather than reifying a socially-constructed binary between society and a separate 'natural' environment, environmental sociology argues that

people impact all aspects of the biophysical environment, and that simultaneously the biophysical environment impacts people in multi-scalar and dynamic ways, ranging from the individual meanings that people ascribe to non-human species, to the types and locations of human settlement (Pellow 2017; Stuart 2021). Thus, an environmental sociological approach identifies how seemingly social outcomes, such as organisational cultures or work practices, are broadly impacted by the biophysical environment, social institutions, and interactions between them.

Methods

To understand changes in wildland firefighter safety policies and practices, I analysed qualitative data from multiple seasons of ethnographic fieldwork. A comprehensive understanding of wildfire management requires attention to firefighters' embodied experiences (Thomas 2022) alongside the discourses surrounding official policies and documents (Ziegler 2007). While the USFS's current FLA processes use qualitative interviewing and pay close attention to firefighters' own experiences (US Forest Service 2024), peer reviewed publications on safety policies rarely draw from qualitative data (see Flores and Haire 2022 for an exception), and agency products such as Learning Reviews or the USFS's Metareview are not published in peer-reviewed journals. Compared to quantitative or historical research, qualitative research is better suited to identifying general patterns and nuances across cases, and gives voice to people's lived experiences (Ragin and Amoroso 2018). Ethnography, or long-term and immersive participant observation, is particularly valuable for research on 'the discipline and practice of occupational health and safety,' though this method has been underutilised in wildland fire science (Durbin *et al.* 2024, p. 2). My research followed an iterative research approach typical of qualitative research that combines deductive attention to prior scholarship and theories with close inductive analysis of data (Ragin and Amoroso 2018).

This paper is part of a larger project on the social aspects of wildland fire risk management (Cordner 2021; De'Arman *et al.* 2024). I conducted three fire seasons of ethnographic research starting in 2015, followed by engagement through 2024, with fire fighters and fire managers, most of whom worked at the 'Mountain View' district (a pseudonym) of a fire management organisation in Oregon. While the location was not chosen to be representative of all wildland firefighting organisations, it was appropriate as a case study of wildland fire management for several reasons, including a history of socially- and ecologically-impactful fires, a range of fuel types, a large and interagency fire organisation, and communities reflecting multiple WUI community archetypes

(Paveglio *et al.* 2015). The project received Institutional Review Board (IRB) approval from Whitman College. I went through the required initial training and subsequent annual physical fitness tests and fire refresher trainings to be Red Carded as a Firefighter Type 2 (FFT2), the lowest level of wildland firefighter certified through the National Wildfire Coordinating Group (NWCG). In my ethnographic research, I filled in as an FFT2 on engines and hand crews on the Mountain View fire district; accompanied a Type 2 Incident Management Team (IMT) on large incidents;[2] shadowed other professionals including prevention and fuels technicians; and attended wildfire-related trainings, meetings, and community events. In addition to countless informal conversations, I conducted 22 semi-structured interviews with firefighters, fire managers, and other fire experts. Seeking informational saturation in deductive or iterative ethnographic research is not always realistic or desirable (O'Reilly and Parker 2013), since 'there are always new theoretic insights to be made as long as data continues to be collected and analyzed' (Low 2019, p. 131). However, the depth of my data collection allowed me to move beyond mere description to uncover conceptual explanations (Katz 2001), what Low (2019) describes as a form of 'pragmatic saturation'. I remain Red Carded as a volunteer wildland firefighter with my local county fire department; while those experiences have undoubtedly informed my scholarly understandings, my volunteer work contributes no data to this analysis.

In the field, I took detailed 'jottings' (Emerson *et al.* 2011) in a small notebook, including direct quotes when possible. I transcribed and expanded these fieldnotes on the computer after each day's fieldwork, typically that same evening. I recorded interviews digitally with the permission of interviewees; if they declined recording, I took extensive notes. I transcribed interviews and coded them in NVivo, a software program for analysing qualitative data.

I used a two-stage *flexible coding* strategy (Deterding and Waters 2021) that involved first identifying overarching *index codes* (e.g. 'firefighter safety and culture') and then more focused *analytic codes* on particular topics (e.g. '10 and 18', 'change', 'formal procedures', etc.). After coding, I analysed the compiled text segments for patterns and themes, returning to the original fieldnotes or transcripts for context and elaboration. This close analysis of my qualitative data, combined with my existing theoretical background in environmental and organisational sociology and close reading of agency documents and academic publications, led me identify and categorise the external factors I describe below.

To protect confidentiality, I do not identify participants, locations, or agency offices by name. When presenting data from my fieldnotes or interviews, passages in 'single quotes' are taken directly from typed fieldnotes, and passages in

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[2]Starting in 2024, Type 1 and 2 IMTs were replaced with a single 'Complex Incident Management Team' (CIMT) structure (National Multi-Agency Coordinating Group 2023; National Interagency Fire Center 2024).

'double quotes' are from verbatim quotations from field jottings or interview transcripts.

Findings

Existing explanations for changes in firefighter safety emphasise how initiatives to change organisational culture, often inspired by tragedy incidents, contribute to changes both in formal policies and informal practices, the combination of which leads to changes in wildland firefighter safety. I argue that external social and environmental factors across multiple spatial and temporal scales also matter greatly. External factors can influence wildland firefighting safety *directly* by contributing to the development and implementation of safety policies and practices, or *indirectly* by changing the constraints under which firefighters work, the hazards of the job, or their exposures to those hazards. The framework in Fig. 1*b* (Broader context matters) combines traditional explanations of tragedy fires and organisational initiatives with a sociological understanding of these meso- and macro-level factors. Using observational and interview data, I show that firefighters themselves are aware of how external factors alter formal policies as well as the hazards and exposures of their work.

Sociodemographic factors include the social and demographic characteristics of groups of people. *Material* factors include resources such as funding or technology. *Political* factors include political initiatives and legislation, stakeholder relationships, and perceived or actual public pressures. Finally, *social-environmental* conditions include features of the biophysical and built environments (and their intersections) that impact fire-related hazards and policies. These factors function beyond the individual or micro scale, including meso-level scales such as the organisational or local community, or macro-level scales such as the nation or the world.

Sociodemographic factors

Wildland firefighting safety can be influenced by the social and demographic characteristics of firefighters themselves, as well as by sociodemographic shifts in the broader society. The firefighters with whom I worked emphasised significant cultural differences from earlier generations of agency firefighters. For example, a fuels technician, who had over 30 years of experience in fire, dramatically described his first year on as a hotshot: as I wrote in my fieldnotes, his captain 'just got in their faces and screamed at them. On the first day, there were 45 of them but only 32 spots, but… it wasn't a problem whittling them down in the first week – people kept quitting.' When I commented that "it seemed like a very different culture today", the fuels technician "laughed and agreed." This change in culture, particularly around

training, authority, leadership, and speaking up has been a major focus of agency 'safety culture' initiatives (Pupulidy 2020; Flores and Haire 2021; Harris 2022). Rather than only being "hired from the neck down," new firefighters are trained from day one to speak up and ask questions.

External sociodemographic shifts in generational attitudes and behaviours may also contribute to these cultural changes. When asked if there was a cultural difference in fire today, one assistant fire management officer (AFMO) said, there are "a lot of changes culturally *outside of fire* that affect fire." Multiple mid- and late-career firefighters described a generational shift in younger wildland firefighters. An assistant engine captain said, 'kids are softer today', while a dozer operator with over 20 years on the fire district called newer firefighters "screen kids." An engine captain described a perceived decline in new hires' work ethic over his career, which he attributed not just to individual shifts but to his belief that 'American culture overall doesn't value hard work.'[3] Another AFMO told me that "GenZ kids need to be convinced in a different way," and this changes how he conveys information: 'I start by assuming [that] I need to convince them… I approach these briefings knowing that the people I'm briefing are "skeptical by design."' Thus, the perception of generational differences in younger firefighters impacts how this AFMO conducts safety-related trainings and briefings.

Finally, macro-level changes in gender norms impact safety policies and practices. Approximately 20% of the firefighters in the Mountain View district were women, slightly higher than the national average (US Government Accountability Office 2022; Westphal *et al.* 2022). My research was not focused on gender norms or gender-related experiences, though several women firefighters described experiences of harassment or bias in their careers. For example, a smokejumper told me that, working as one of the first women on her crew, 'there was a lot of hazing' and 'there were lots of guys that never gave me any respect.' When the #MeToo movement gained global prominence in 2017, it supported people, especially women, speaking up about sexual assault and harassment, and led to dramatic changes in the mainstream media, entertainment, academia, and politics (Rhode 2019). #MeToo impacted the USFS directly; in 2018, USFS Chief Tony Tooke resigned following an investigation into sexual harassment (Boudreau 2018). That year, instead of a planned safety-focused extension of the Life Work initiative, all USFS employees participated in a required 'Stand Up for Each Other' antiharassment training (Flores and Haire 2021), though this #MeToo connection was not discussed in other descriptions of that program (Christiansen 2018; Brown 2019).

Material factors

Material factors include funding and technological trends that directly influence safety policies or firefighting

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[3]This engine captain also discussed challenges in the USFS's centralised hiring process, a topic beyond the scope of this paper.

practices. Agency wildfire management policies are closely linked to funding. For example, the Mountain View district sometimes received 'severity money' because of conditions that impacted fire danger, such as low snowpack and drought concerns. According to a local fire manager, this allowed for increased early season staffing and more units working 12-h shifts instead of the standard eight: 'we had lots of patrols, so lots more fires were found' quickly and kept small. As another example, the Oregon Department of Forestry (ODF) provides wildfire response for private land-owners who pay a Forest Patrol Assessment fee, and ODF describes its firefighting policy as "straightforward: put out fires quickly at the smallest possible size" to protect timber resources "that produce revenue and support jobs" (Oregon Department of Forestry 2024). Multiple firefighters told me that ODF's policy of aggressive suppression increased fire-fighters' exposures to hazards, such as fire-weakened snags or entrapment. As one former ODF employee said regarding aggressive initial attack (IA), 'they [ODF] are really aggres-sive at IA. We did a lot of dangerous work like getting out in front of the fire… "I did a lot of stupid shit working for ODF. I'm lucky I'm still alive."' Similarly, a USFS fire manager said when ODF firefighters turned down a felling assignment in a snag patch, it was 'super telling for me' about how hazardous the assignment was, because ODF's 'approach is "you go get it at all costs"… that's how they operate'. These examples show different ways that funding sources impact suppression-related policies, changing firefighters' practices and therefore their exposure to hazards.

Money is also hugely influential in individual firefighters' experiences. Almost all federal fire resources are paid an hourly bonus called 'Hazard pay' ('H-pay') when working on uncontrolled fires (National Wildfire Coordinating Group 2018b).[4] This pay structure incentivises firefighters to 'max-imize their time on fire assignments,' despite the risks asso-ciate with longer shifts and assignments, including fatigue, exposure to fireline hazards and smoke, decreased cognitive function, and injuries (Belval *et al.* 2024, p. 2). As one former hotshot superintendent told me, "people are paid poorly enough that they have to scrap for hours every year to be able to not eat cat food in the winter," and this means they work as many hours as possible, increasing fatigue and their exposure to hazards. I observed this fre-quently during my fieldwork. At morning briefings or during daily physical training (PT), firefighters would recount who got H-pay yesterday and which "lucky" crews would get H-pay that day for checking on still-uncontrolled incidents. Firefighters described off-district assignments as "good" and "bad" not only in terms of fire or crew experiences, but in terms of whether they worked 16-h H-pay shifts. As one fire manager explained, 'our system on the wildland

side actively rewards you for taking risks, through the H-pay system'.

In addition to the financial motivations of the H-pay policy, macro-level economic conditions have raised the cost of living, particularly for housing, which has negatively impacted wildland firefighter recruitment and retention and inspired new agency policies. Mountain View district is located in a community with significant recent in-migration and real estate investment, such that median home values increased nearly 100% from 2016 to 2024 (Zillow.com). During my 2024 fieldwork, housing costs were a frequent topic of downtime conversations. Those who were homeowners mentioned feeling "lucky" or "thankful" to have bought when they did, often a decade or more earlier. I met early career firefighters who were living in their vehicles, living rent-free in a friend's closet or garage, or living rent-free with relatives, in addition to more typical living situations such as sharing a house with multi-ple roommates. The turnover associated with housing pre-carity, described by one AFMO as "a revolving door of new people," increases pressure on mid- and late-career firefighters, who are constantly training and supervising inexperienced crew members, and increases potential hazards related to firefighter inexperience.

Macro-level technological developments or trends also impact firefighter safety policies and practices in ways that change firefighters' daily work and activities, thus altering their exposures to hazards. Recent technological advances in unmanned aircraft systems (UASs, commonly called drones) has led to their increasingly widespread adoption in fire operations (National Wildfire Coordinating Group 2024a). Using UASs can reduce exposures for firefighters in multiple ways. As an assistant handcrew captain explained, drones are "a game-changer" with aerial ignitions, keeping people out of a fire's interior or areas of rough terrain. He described a prescribed fire in the spring of 2024 where, rather than using a crew to grid a smoky area of the burn, they used a UAS's infrared camera to find even low-intensity areas of heat. In this instance, using a UAS reduced firefighters' exposures to smoke as well as tripping and other gridding-related hazards. Multiple safety-related UAS policies and training programs have been developed, including a UAS section of the *Interagency Standards for Fire and Fire Aviation Operations* (the 'Red Book'), multiple UAS position qualifications, and two 6 Minutes for Safety topics (National Interagency Fire Center 2016; National Wildfire Coordinating Group 2024b).

As another example, many firefighters described how smart phones have changed the firefighter experience and culture. On one hand, one engine captain perceived that 'having phones all the time' led to increased discomfort

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[4]Smokejumpers do not earn H-pay because they have higher base-rates of pay. Most prescribed fire work currently does not earn H-pay, though changes have been proposed in the 2024 cooperative agreement between the USFS and the National Federation of Federal Employees (US Department of Agriculture *et al.* 2024).

with uncertainty and decreased crew cohesion, particularly on off-district assignments. On the other hand, I observed how cell service allowed crew members to maintain communication with loved ones, texting when they were dispatched to an incident or taking a phone call during downtime. When I filled in on Mountain View crews, downtime was often spent playing mobile games or streaming movies, and crews sometimes chose where to stage in the afternoon based on cell service quality. Relatedly, a fuels manager explained that, despite the value in having firefighters and equipment prepositioned at Guard Stations around the forest, Mountain View's last active Guard Station, a roughly 75-min drive from the in-town fire compound, had been closed 'because they can't find people who want to live out in the woods.' Thus, changing attitudes and desires, linked to changing technology and associated cultural expectations, contributed to staffing and resource changes with implications for fire safety, including longer response times and more hours spent driving.

Another major technological shift involves the widespread electronic availability of maps, briefing materials, and training documents. New firefighters are trained to use electronic maps and emergency dispatch programs on their smartphones, and dispatch centres and IMTs post resource availability summaries, Incident Action Plans (IAPs), and other information online. I observed this firsthand during my most recent fieldwork in 2024: within an hour of arriving at the Mountain View fire compound, one of the AFMOs AirDropped me electronic maps of the fire district, instructed me to load them into Avenza and enable location access, and showed me how to enable certain PulsePoint notifications relevant for possible mutual aid responses. The widespread availability of electronic resources has dramatically shifted firefighters' access to information about hazards, exposures, and operational objectives and plans. An assistant engine captain described how, 'with phones, it's easy for everyone on the crew to get a copy of the IAP at a large incident. This means everyone has better SA [Situational Awareness].' Rather than a single printed copy of the IAP given to a crew's captain at an incident's morning briefing, wide availability of an electronic IAP through a QR-code or the NIFC FTP Server gives more people access to information.

As another example, location-enabled smartphone apps such as Avenza entered widespread usage among federal wildland firefighters in the mid- to late-2010s. In my early years of fieldwork, most firefighters relied on large paper maps of their patrol areas when responding to incidents, but these have been almost completely replaced by apps with GPS to identify users' real-time locations. As a dozer operator explained, 'today, people are glued to the 'blue dot' that shows them where they are on an Avenza map,' though this can put people in hazardous situations: he described following firefighters 'who were lining him out to dig the dozer line, but they took him up the wrong ridge – it was where the blue dot was but not where his line was supposed to be. They had to walk an extra 4–5 h over really rocky terrain.' In this case, over-reliance on a smartphone map increased exposures to on-the-ground hazards.

Political factors

Political and social pressures impact firefighting policies and operational decision-making in ways that alter firefighters' potential exposure to hazards. Sometimes this takes the form of perceived or experienced pressures from communities. For example, a retired Type I Incident Commander (IC) described how local suppression strategies were often impacted by the "political risk from the community." These social pressures matter in day-to-day operations. Fire managers often talked about the importance of "political smokes," areas of active incidents that mattered for their public visibility (see also Canton-Thompson *et al.* 2008; Steelman and McCaffrey 2011). For example, on a Type 2 incident, a Division Supervisor described the day's priority for his part of the fire as cleaning up 'lots of little roadside smokes, "political smokes."' In the operations meeting the following day, the Operations Section Chief praised this work: "Good work… yesterday with political smokes… [You were] making lots of friends out there." In this example, operational decisions, and therefore firefighters' exposure to hazards during their workday, were directed by a desire to influence local public perception.

These social pressures were particularly evident regarding aviation resources. A rappeller supervisor talked about "heli-mopping", or a perceived overuse of helicopter water drops, as putting pilots at unnecessary risk 'so the community can see the Type 1 helicopter out there'. Similarly, a handcrew assistant captain critiqued what he perceived to be an overuse of aviation resources: "I feel like sometimes they're just dumping retardant to dump retardant." Another firefighter called highly visible use of aviation suppression a "CNN drop", a reference to the flashiness of cable news (see also Wilkinson 2020). Overuse of aviation in suppression increases potential risks for pilots and other aviation resources by increasing their exposures through longer flight times, and for on-the-ground firefighters, who can be hit by water or retardant drops or by falling trees or debris. It also changes public expectations. For example, several fire managers and firefighters discussed an aviation-heavy fire on their district the year before: the local media's narrative was that 'aviation saved the day', but an engine captain working that fire said, 'we on the ground took a lot of risk… from all of the aviation resources. There were risks of dropping water or retardant on people, or knocking down trees from the wind'. These examples show how external public pressures and operational decisions interact to change firefighters' exposures to hazards.

Non-fire politics matters as well. For example, in 2015, the Bureau of Land Management (BLM) issued guidance

regarding sage-grouse land use plans (Bureau of Land Management 2017), an issue of particular importance due to broader legal implications and debates over habitat protection for the greater sage-grouse (Peterson 2015; Wollstein and Davis 2020). The following year, policy regarding sage-grouse habitat was included in annual fire refresher materials and in the 'Red Book', which stated, 'The BLM's goal is to limit acres burned and damaged within and adjacent to sage-grouse habitat' (National Interagency Fire Center 2016, p. 65). Additional crews were funded in areas of sage-grouse habitat, and firefighters responding there were instructed to pursue aggressive suppression. As a BLM supervisor said at an early season training for local Type 4 and 5 ICs, 'if it's a sage-grouse habitat fire, "we're putting it out."' He also linked the issue directly to politics: 'with the new [Trump presidential] administration, "I'm amazed we're still talking about sage-grouse." I'll be *really* amazed if we're still talking about it a year from now.' This example shows how broad political factors can create new policies for wildland firefighters, impacting their exposures through changes in resource allocation and operational tactics.

Social-environmental factors

Social-environmental factors are elements of the biophysical environment that cannot be understood separately from their intersections with human society and the built environment (Gould and Lewis 2020). The build-up of fuels in fire-prone regions, increased human development in the wildland–urban interface (WUI), and climate change are all examples of this interconnectivity. Development in the WUI has necessitated additional training and preparedness around topics such as structure protection, triage, and defensible space. The NWCG course 'Fire Operations in the Wildland Urban Interface' is required for prospective Strike Team and Task Force leaders, and includes training on structure triage and WUI-specific pre-planning, situational awareness, strategies, and tactics (NWCG 2022b). When I participated in this 3-day class, the instructor said that the challenges of the WUI were increasing: "The WUI's not going away, it's getting worse." He detailed how WUI operations increase risks to firefighters, from interactions with the public to risks of entrapment during structure protection, and he connected WUI challenges to sociodemographic trends. As more people move from cities to rural or semi-rural areas, their familiarity with and support for traditional forest management practices decreases: 'we're getting more and more people moving into the WUI that don't support logging or thinning,' which changes the social pressures that fire managers face.

Several notable fatality entrapments have taken place in the WUI, including the Yarnell Hill and Twisp River incidents. During my ethnographic research, the WUI risks related to these particular fatalities came up in multiple trainings, including 6 Minutes for Safety briefings (National Wildfire Coordinating Group 2024b) and a video about the Twisp River entrapments played during a fire refresher training (Wildland Fire Lessons Learned Center 2016b). After that video played, the facilitator described the setting and associated risks as a typical WUI environment:

> One way in, one way out, and up on a hill. It's not a good spot to be in with a fire below you and a predicted wind shift… At Yarnell, they were hiking to a cabin. The Twisp guys were in a subdivision. [In nearby WUI communities], it's not a question of *if*, it's a question of *when* a fire will threaten those structures. There are more people than ever moving to the WUI.

WUI developments also impact resource availability and distribution, especially during peak fire season. As a forest supervisor described, fire severity combined with increasing demands from the WUI to severely constrain resources: 'We had a fire last summer that was 50,000 acres with only one hotshot crew, and I couldn't get any aviation. Most resources are dealing with structure protection now on these big fires, because of the number of homes in the forest.' The desire to protect values at risk, including homes and infrastructure in the WUI, influences resource allocation, with consequences for WUI and non-WUI incidents alike.

As another social-environmental example, the climate crisis has resulted from interactions between human actions, social structures, and the biophysical environment (eds. Dunlap and Brulle 2015; Norgaard 2018). While a few firefighters I worked with or interviewed denied the scientific consensus on climate change (an interesting topic beyond the scope of this paper), most took climate change seriously. Discussions often blended climatic changes with suppression-induced fuels buildup, a social-environmental combination that demonstrably increases fire severity. For example, a fire manager with over 25 years of experience talked about the changes he had seen over his career. As I wrote in my fieldnotes,

> Fires today aren't like fires twenty years ago. He alluded to climate change: "whatever you believe in and whatever you want to call it," climate change or warming, "I don't need to take a stand there, I just know it's happening." The conditions are different, the fire season is longer, it's hotter and drier, there are more fuels on the landscape.

Firefighters talked about the "new normal" of extreme fire conditions and highly complex incidents, in which unprecedented conditions become typical (see also Costa 2020). Others identified how climate change forced adjustments in their overall workflow: one hotshot squad boss told me that his crew 'used to have rookie [hotshot crew] training in June but they had to move it back to May because of global warming.'

Discussion

Multi-scalar external factors influence wildland firefighting directly, by inspiring the creation of new policies or changing safety-related practices, or indirectly, by altering the hazards firefighters face or their exposures to those hazards. Firefighters identified sociodemographic pressures including generational shifts in work-related practices, use of technology, and information needs. Though impossible to quantify, there may also be demographic shifts among wildland firefighters themselves, who historically were predominantly young men with rural and/or working-class backgrounds (Desmond 2007). Quantitative data on wildland firefighters' social class and upbringings are unavailable, though in my fieldwork I met firefighters from less traditional backgrounds, including growing up in large cities or with college degrees in non-natural resource fields. Additionally, though some avoided discussing observed trends in newer firefighters' attitudes or skills (including an AFMO who described it as a "can of worms"), others described cultural, attitudinal, or demographic differences. There is extensive academic and popular-culture attention to macro-scale generational differences, including measurable changes in expectations about work-life balance and declining work engagement among younger generations (Twenge *et al.* 2010; Kultalahti and Liisa Viitala 2014). Consistent with the views of engine captain who identified a macro-level cultural decline in valuing hard work, these empirical shifts likely reflect both changes in work attitudes across the life-course and a general 'trend of declining work motivation' in American society (Schröder 2023, p. 8). Changes in the demographics, skills, and experiences of new firefighters can impact firefighter safety – in manifold, not always negative ways – by changing internal crew dynamics, shifting training needs, and impacting employee morale and retention, suggesting that land management agencies must pay attention to sociodemographic shifts in widely held societal values or in who they recruit and employ.

Material factors such as external funding and technology clearly impact firefighting policies and practices, from the historical influence of World War II technologies (Flores and Haire 2021), to macro-scale economic conditions. As a handcrew assistant captain said when we talked about challenges with firefighter recruitment, 'wait until we get another recession. Government jobs look really good when the job market is really bad.' External economic factors, such as the cost of housing, contribute to challenges in recruiting and retaining experienced wildland firefighters and to current debates over federal firefighter pay (US Government Accountability Office 2022; Hall-Rivera 2023; Belval *et al.* 2024). Increases in cost of living and housing

can impact firefighters in multiple ways: housing costs are a major driver of houselessness, including encampments or nonrecreational campers in the WUI and on federal land (Cerveny and Baur 2020; Derrien *et al.* 2023), and an inability to buy a house may decrease retention of experienced firefighters, particularly in high cost-of-living areas (Gabbert 2022). Nationwide, the USFS has recently implemented new policies intended to increase firefighter recruitment and retention, including signing bonuses requiring a multi-year commitment (US Forest Service 2023) and partial refunds for those living in government-owned housing (Moore 2024). Forces internal to land management agencies but not specific to wildfire also matter: in their study of the USFS' Life First initiative, Flores and Haire (2022) described how agency-level material constraints and staffing deficits contribute to unnecessary exposures to hazardous working conditions.

Advances in UAS and smartphone technology have changed how firefighters are trained, how hazard and exposure information is communicated by fire managers, and how firefighters mitigate risks on the job. Fire managers experience other political and social challenges in UAS operations during suppression operations, including policy limitations, inconsistencies, or confusions, as well as constraints posed by exclusive use contracts (Kang *et al.* 2024). Firefighters' current ubiquitous reliance on smartphones and GPS technologies requires back-ups to be functional, in place, and a topic of regular training, since those technologies can stop working for reasons ranging from dead batteries on individual devices to system-wide outages.

External political and social pressures impact firefighter safety through daily operations, incident-specific decision-making, and agency-wide policies. Alongside internal agency policies and cultures, external political and community pressures such as 'political smokes' impact fire management strategies and decision-making (Canton-Thompson *et al.* 2008; Steelman and McCaffrey 2011; Flores and Haire 2022). In a recent example, USFS Chief Randy Moore halted all prescribed fire operations and ordered a nationwide review after a prescribed fire and a smouldering pile burning operation in New Mexico escaped containment during a wind event, ultimately becoming the state's largest wildfire and destroying over a thousand structures (U.S. Government Accountability Office 2024). Chief Moore's public statement about this pause identified 'current extreme wildfire risk conditions in the field' rather than naming these declared wildfires directly (US Forest Service 2022*b*).[5]

Finally, social-environmental entanglements such as expanding human developments in the WUI or the climate crisis alter the hazards firefighters experience and the frequency of their exposures. These social-environmental

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[5]Chief Moore's official order only alluded to escaped prescribed fires, saying they occurred 'in rare circumstances' (US Forest Service 2022*b*). The prescribed fire pause was lifted later that year with the publication of a 'National Prescribed Fire Program Review' (US Forest Service 2022*c*).

factors influence suppression strategies (Daniels *et al.* 2024), prescribed fire and managed fire practices (Fillmore *et al.* 2021), wildfire governance (Steelman 2016), and risk mitigation activities (Hamilton *et al.* 2019), while continued reliance on full suppression perpetuates the 'wildfire paradox' (Silva *et al.* 2010; Calkin *et al.* 2014, 2015; Ingalsbee 2017). The WUI is a major site of landscape change, new home construction, population growth and change, and wildfire-related economic losses (Calkin *et al.* 2015; Radeloff *et al.* 2018; Bento-Gonçalves and Vieira 2020; Burke *et al.* 2021; Schug *et al.* 2023), and aggressive suppression activities to protect WUI communities increase exposures for firefighters (Calkin *et al.* 2014). Climate change impacts wildland fire-related hazards, exposures, and health risks in many ways, including increasing the frequency and intensity of weather events, lower fuel moisture, decreased snowpack, and longer fire seasons (Barbero *et al.* 2015; Navarro *et al.* 2019; Halofsky *et al.* 2020; Parks and Abatzoglou 2020; Liu *et al.* 2021). Nearly 10 years ago, Withen (2015) stated unequivocally, 'Climate change is increasing the risk of wildland fire' to firefighters by increasing the likelihood of 'burnovers, heat exhaustion, tree hazards, and many other common fire hazards' (577). Climate change also makes it harder, or even impossible, for experienced firefighters, fire behaviour analysts, and weather specialists to predict wildfire growth and behaviour (Withen 2015), a situation described as an 'era of a nonanalogous past' (Steelman 2016, p. 9; see also Petryna 2018). With 2023 recorded as the hottest year on record (National Oceanic and Atmospheric Administration 2024) and increasing levels of rural gentrification throughout the West (Pilgeram 2021), social-environmental pressures on fire managers are only increasing.

Though I have discussed these four categories of external factors separately, the boundaries between them easily blur. For example, on the Meadow View district, an increasing number of unhoused people live semi-permanently on federal WUI land. While nonrecreational campers or 'residers' had long been present in the area, the number and the durability of their encampments increased following the COVID-19 pandemic due to a combination of factors including local housing costs, substance abuse difficulties, and legal uncertainty related to camping on public lands (see Cerveny and Baur 2020 for a general discussion). In the words of one fire manager, the USFS is 'stuck in a bind, where… it's virtually impossible to evict people' who are camping in the forest. Firefighters described encountering significant non-fire hazards in these areas, including aggressive dogs, drug paraphernalia, and threats with firearms, as well as exposure to toxic smoke when encampments or other WUI structures burned. Concerns about exposure to non-vegetation ('non-veg') smoke from WUI hazards are justified: smoke exposures to WUI fires may be especially toxic (Hwang *et al.* 2023), and the 'Red Book' states that 'wildland firefighters will not take direct suppression action' on non-

wildland fires (Department of the Interior and, Department of Agriculture 2024, p. 158).

In response to increasing concerns about these hazards in the WUI, the Mountain View district recently revised their IA size-up process to include a 'Non-Veg Threat Assessment.' Under this new policy, any fire near a known encampment area or involving non-veg hazards, such as weapons, vehicle fires, or threatening people or animals, initiates the dispatching of additional law enforcement and overhead resources. Mountain View firefighters appreciated what they perceived as an added layer of protection from these non-wildland hazards, while noting that the need for such a policy comes from factors external to fire. As an assistant handcrew captain explained, 'the issue is that there are lots of people in the forest, and that's not going to change. The Red Book says we don't do non-veg fire engagement at all – that's not our job. "But 40 years ago, [local encampment area] didn't have hundreds of people living out there."' Furthermore, as an engine captain noted, 'even if you don't engage the non-veg fire, it's hard to stay out of the smoke,' so the Non-Veg policy mitigates but does not eliminate risks to wildland firefighters. Firefighters recognised how external factors impact the hazards of contemporary wildland firefighting in ways not fully addressed in nationwide policy, necessitating the development of new district-level policies. Those external factors include socio-demographic trends such as housing costs and increasing rates of substance abuse disorder, material factors such as the high of cost of housing, political factors such as high-level judiciary decisions, and social-environmental pressures such as people in the WUI.

Limitations

Most of the data used to develop the framework of external factors proposed in this paper come from one large fire management area, while fire cultures and practices can vary greatly across agencies, geographic locations, or even individual crews. This limitation is somewhat tempered by the presence of many detailers and transfers among my participants, and the fact that even firefighters who had spent most or all of their career at Mountain View had also worked on incidents in innumerable other locations. However, the relative salience of these and other external factors may differ by location and agency. Additionally, this analysis has focused on the role of external factors in firefighter safety policies and practices, but more attention is needed to assess how internal but non-fire agency initiatives and policies also impact firefighter safety and risk management practices.

Another limitation is that individuals' understandings of the policies and practices of their own or others' agencies can be incomplete or inaccurate, particularly given the importance of hierarchy and chain of command in wildland fire organisations. However, understanding firefighters' own

interpretations of safety policies and practices is important on its own, regardless of how fully those interpretations align with agencies' or other individuals' understandings (Scott 2023).

Conclusion

This paper has argued that, in addition to tragedy incidents and agency initiatives, wildland firefighter safety policies and practices are influenced by multiple external factors. Organisational sociology shows that organisations are impacted by external factors at multiple scales, while environmental sociology highlights the inextricable interconnections between society and the biophysical environment.

Attention to external factors is valuable and necessary for fire managers and practitioners. The contexts in which they work, the policies they inherit, and the decisions they make cannot be fully reduced to micro-level experiences, local factors, or official agency mission. Agencies could better acknowledge the external pressures under which they operate. When external pressures obviously matter, claims by leadership that decisions are motivated only by straightforward land management goals or incident objectives may be viewed as empty or unsatisfying explanations, perhaps contributing to a disconnect between leadership and employees. More transparent acknowledgement of external meso- and macro-level factors could allow for productive assessment of constraints and opportunities for improved fire management.

With its focus on how individual-level experiences and organisational outcomes are impacted by meso- and macro-scale social and historical factors and context, sociology is well suited to contribute to studies of wildfire risk management. The framework presented in this paper would be useful in understanding other important aspects of wildland fire management, such as changes in discourse and practice around fires 'managed with a strategy other than full suppression' (Fillmore *et al.* 2024), implementation of and conflicts over prescribed fire, and public and property risks in the WUI. For example, WUI issues involve not just defensible space policies, fire close-calls, and the growing nonrecreational camper population, but also population growth and changes (sociodemographic), housing aesthetic trends and cost pressures (material), building codes and media attention (political), and re-development patterns in fire scars (social-environmental). Wildfire risk is not only paradoxical, it is exceedingly complex, and wildland fire researchers must acknowledge and incorporate this complexity to develop useful knowledge and recommendations.

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