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Fire beyond engineering

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1. Introduction

The field of fire science has deepened our understanding of fire, yet it is hampered by narrow views of fire and its effects. Its failure to integrate with Disaster Risk Reduction (DRR) is notable. In 2019, more people died from built environment fires than from "natural" disasters. Despite this, fire is largely overlooked in prominent DRR literature and reports [1] [2] [3] [4].

Therefore, effectively tackling the issue of fire requires a critical examination of the current approach to fire as a socio-technical-environmental problem, and exploring ways to address the unique challenges it presents. Acknowledging fire as a multifaceted phenomenon allows for comprehensive approaches that encompass its various contexts: as a natural hazard, a societal concern, and a technical challenge simultaneously. In the narrative of this paper, we embrace personal reflection as a tool through which to consider the complexities of the broader social and scientific landscape of fire and the implications for DRR. In this article we summarise our main ideas expressed in the original publication in a simplified way. We encourage readers to engage with the original publication for more nuanced exploration of the topic.

2. A critical approach to fire

In our article we advocate for a critical understanding of fire, encompassing its technical, natural, cultural, mystical, social, political, and environmental aspects. This perspective highlights fire's uniqueness and the need to break free from narrow technical views. We propose an interdisciplinary exploration of fire and its cultural significance, starting with a theoretical framework aligned with DRR Assemblage Theory (AT). This theory examines how various factors converge to shape disaster management [5]. Our aim is to broaden fire studies beyond technical solutions, emphasizing holistic, community-centered approaches that consider social and ethical dimensions of disaster risk.

2.1 Fire is a broad subject

Seeing fire studies outside of their usual engineering context necessitates a broad perspective. While fire is scientifically understood as a hazard, its interaction with the human environment implies risk. Neale, Zahara, and Smith [6] also emphasize the political nature of fire, suggesting possibilities for alternative approaches. Integrating technical, social, political, and environmental viewpoints of fire and engaging in interdisciplinary inquiries challenges siloed thinking and aids in navigating complexities related to risk and safety.

Inspired by McGowran and Donovan's [5] use of Assemblage Theory, in our article we recognize the importance of examining not only power structures in disaster risk management but also the phenomena they attempt to control, in this case fire. In addition, to address the lack of focus on fire in DRR, we explore various themes within DRR Assemblage, showcasing its potential to enrich discussions and broaden understandings of fire. Our goal is to encourage diverse interpretations of the fire assemblage, welcoming contributions from different disciplines and levels of expertise. Through being able to open up to such contributions, fire should not only show its value in DRR and alongside critical disaster studies, but also help and foster critical thinking in DRR itself.

2.2 There is an illusion of control over fire

The exclusion of fire from DRR policies is rooted in the perception of fire as controllable, unlike hazards such as hurricanes or earthquakes. This perception of controllability often results in the complexity of fire being overlooked or completely ignored. This is evident, for example, in national disaster publications that always vary in categorizing wildfires and fires, sometimes considering them chemical phenomena or major incidents [7] [8]. However, since both chemical hazards and incidents are seen as controllable, primarily through technological solutions, such reliance on technology

overlooks human factors like error and capacity (be it organizational, physical, social, economic and mental) for preparation and recovery.

In contrast, communication about hydrometeorological and geological hazards emphasizes human behavior and contextual factors due to their variability across locations. This is because these hazards are often affected by factors such as geography, topography, and weather patterns, which can vary significantly from one location to another, as well as contextual information such as local history and cultural practices.

Thus, in relation to other hazards, it is possible that fire presents a unique challenge in finding its place in DRR, as it can both occur as a hazard alone or accompany other hazards, complicating a reductionist approach. This multifaceted nature of fire challenges its treatment as solely a technical matter requiring scientific expertise [9] [10] [11].

2.3 Fire is surrounded by exclusionary and incurious approaches

The limited integration of fire within DRR may also stem from its technical complexity compared to other hazards. Fire sciences prioritize precision and specificity, influenced by cultural and engineering traditions [12] [13]. The solution-focused approach in fire studies emphasizes mitigation practices based on physics, but at the same time they neglect socio-technical and cultural interactions. We argue that the tradition of science deems such interactions as lesser, which results in a narrow focus. This is a problem to the extent to which this view also shapes the perceptions of policy makers, first responders, engineers, and academics, leading to unrealistic expectations of risk reduction [11]. It also sidelines the human dimension of fire, overlooking disciplines like psychology and anthropology, which offer insights into human behavior and risk perception. However, even when such disciplines find a way into fire engineering, various discussions and media coverage of fire events lack context and often fail to address the social, physical, and mental health impacts of fire on communities. This disciplinary rigidity dismisses the relevance of the human experience in understanding fire as a scientific phenomenon.

2.4 Fire is captivating

Fire's captivating nature is often overlooked in current discourse across the disciplines. One consequence of its exclusion from DRR is restricted access to knowledge about fire, its risks, and prevention strategies, particularly for those most affected. Exploring fire through diverse disciplines, such as folklore, reveals its spiritual and cultural significance, impacting societal beliefs and technological solutions [12] [14]. Understanding these cultural contexts is crucial for designing

effective fire safety interventions rooted in community relationships. For example, in Myanmar, an assessment of one community's fire safety strategies revealed the belief that following a neighbor escaping from a house fire would bring bad spirits to their own home [19]. In this instance, it is important to ensure any solutions involving evacuation from fire in the community are designed with the community and are rooted in their relationship to fire. Another example from South Africa highlights the disconnects that can exist between the technical 'solution' and the experience of daily life. Recovery solutions presented to the Imizamo Yethu community after a large fire included strategies to 'reblock' the community's living space: these were opposed by the community members as having a direct impact on their way of life [20].

As inclusion and exclusion of certain identities contribute to power dynamics and shape how fire is perceived and engaged with, women's voices are still notably absent in both professional and household fire-related contexts, reflecting broader gender disparities in STEM fields [15]. This element of patriarchal influence extends to fire response practices [16]. Recognizing fire as a socio-technical phenomenon is essential for democratizing knowledge and fostering inclusive interventions [17] [18].

3 Re-imagining of fire

We argue that, at its roots, rather than classifying hazards as strictly natural or unnatural, fire should always be viewed within the broader context of risk, which encompasses social, economic, technological, and political factors involving various actors such as governments, NGOs, private companies, and local communities. This holistic approach demands a nuanced understanding of the complex interactions among these actors, technologies, and policies [5].

Thus, as the holistic approach is not the reality currently, or most of the time, the simultaneous involvement of multiple actors in fire management keeps posing challenges. To overcome it, examining governance and governmentality in disasters should be examined, expert advice, power and uncertainty, values, ideologies and social empowerment, vulnerability and imbalances of wealth, resources and scale, disasters and geopolitical risk, and hazard and risk assessment under uncertainty should be considered [5]. This is one of the ways we can gain a more nuanced understanding of how fire risk materializes and can be managed, refuting the reductionist perspectives, where only technical solutions dominate and social aspects are relegated to social scientists.

To summarise our learnings from the reflections in this article, we suggest some practices that can be helpful in opening up fire science to all of the diverse perspectives discussed in our article (quoted from the original paper):

1. *“Moving beyond categorizations that reward studying (and publishing about) hazards in an isolated manner, and instead embracing an interdisciplinary approach that integrates technical and social knowledge.”*
2. *“Emphasizing the importance of understanding the everyday lives of people and the social and cultural factors that shape their relationship with fire.”*
3. *“Acknowledging the complexity of fire as an environmental-socio-technical hazard and recognizing the need for solutions that address all elements and their connections.”*
4. *“Ensuring the inclusion of a diverse range of actors, including women, minorities, and marginalized groups, in decision-making processes related to fire safety and disaster management.”*

4 Conclusions

This article highlights the dangers of adopting a reductionist stance towards fire, emphasizing the potential neglect of crucial social and cultural influences on fire occurrence and impact. It prompts questions about the validity of critical disaster studies that overlook these limitations within hazard studies. Hence, we advocate for a more comprehensive and integrated approach that acknowledges the intricate and evolving nature of fire hazards, considering both social and technical dimensions. Such an approach facilitates a deeper understanding of fire hazard root causes and enables the development of more effective prevention, mitigation, response, and recovery strategies.

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