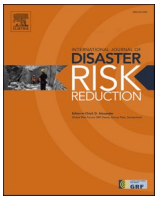
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Strengthening community disaster resilience in uncertain times: a multi-level analysis of an Australian bushfire☆

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A B S T R A C T

This paper examines how community groups develop resilience over time through influencing and interacting with different societal levels throughout the phases of the disaster management cycle: prevention, preparation, response, and recovery. This provides an opportunity for a more insightful and holistic understanding of the factors involved in resilience. The macro/governmental level shapes governance of bushfire management and resources; the micro level reflects the actions of individual and households; while the meso level represents local community groups providing a bridge between the two through trust-based integration and collaboration.

This four-year longitudinal study used a complexity analysis framework to reveal latent tensions, as well as strong social relationships and community connections. These had implications for the emergent, local-specific responses to the bushfires, based on community attributes, needs and characteristics. The work reveals the importance of the meso level as a bridge between the governmental and individual levels, which can support tailoring, reconfiguring, and organising resources to strengthen resilience. These findings also have implications for shared responsibility, as community-based organisations may disagree with objectives at other levels, eroding resilience across the entire system. The analysis in this paper indicates that careful, flexible integration of the locally specific knowledge, meso level coordination, relationship-building, and transparent information-sharing that community-based organisation can provide, can be beneficial in effectively managing the multiple complexities of disasters.

☆ Note that three authors have changed institutions since conducting this research (MD, SM, CE). The lead-author (MD) is now a *Research Principal at the Institute for Sustainable Futures, University of Technology Sydney*.

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1. Introduction

Climate change presents serious risks to communities around the world [1]. Resilience strategies, in natural hazard-prone countries, have evolved to address increasing climate variability, urbanisation, and socio-economic vulnerability. For example, in the Philippines, community-based disaster risk reduction has been institutionalised, empowering local populations through early warning systems, evacuation planning, and participatory mapping [2]. Likewise in Japan, following the 2011 Tōhoku earthquake and tsunami, integrated advanced technological infrastructure has been implemented with grassroots preparedness, including multi-hazard drills, seismic-resistant buildings, and school-based education programs [3]. Similarly, Bangladesh has significantly reduced cyclone-related fatalities through the expansion of cyclone shelters, community awareness campaigns, and the Cyclone Preparedness Programme, a globally recognised model for integrating local and institutional response [4]. In Sub-Saharan Africa, resilience efforts have focused on adaptive livelihoods, such as climate-smart agriculture and drought-resistant cropping systems [5].

Increasingly, resilience is seen as a socio-ecological challenge that requires both technical responses and community-level adaptation [6]. In the USA, the fire-prone states of California, Oregon, and Colorado have focused on a combination of fire-adapted communities, prescribed burns, and interagency coordination to strengthen resilience. Programs encourage communities to reduce wildfire risks through fuel management, defensible space creation, and public education [7]. Investments in early detection technologies, satellite monitoring, and evacuation planning have also strengthened institutional preparedness. However, research highlights a paradigm shift toward living with fire rather than eliminating it entirely [8].

Fires are an increasing global socio-ecological concern, with growing frequency, severity and geographical reach [9–11]. The terms bushfire, forest fire and wildfire are often used interchangeably. However, the literature has identified wildfire as the umbrella term, with forest fires a subtype that occurs in forests and bushfire the Australian variant, often occurring in shrubland and eucalypt-dominated ecosystems [12]. Land use and climate change have dramatically altered fire regimes and weather conditions worldwide, contributing to the considerable increase in annual number of high-fire-danger days, more intense fire behaviour, and more people living in high-risk areas [13,14]. Increasingly, bushfires are challenging the resilience of many communities spatially local to the disaster, with planned relocations occurring globally in response to extreme weather-related hazards [15]. Comprehending how disaster resilience can be strengthened requires an understanding of how local community resources can be tailored, reconfigured, and organised to address the disaster events [16,17].

Researchers have studied community bushfire resilience from a multi-level societal perspective that involves shared responsibilities across the:

- macro, governmental level - providing top-down guidance and support to communities [17–21];
- meso, community-based level – representing the localised groups formed to prepare and address bushfires [22,23]; and
- micro, household/individual level – reflecting the issues and challenges faced by individuals and their families [15,24–26].

Others have examined community bushfire resilience in terms of emergency management [27], risk mitigation [20,28], public health [29,30], planning policies [1,31,32] and impact assessment [33–35]. This body of research has generated informative insights into societal problems and concerns surrounding bushfires, highlighting the complex and dynamic nature of disaster preparedness for policy makers, emergency services, households, and the local communities in which they reside. Less research has been conducted into the social institutional factors that strengthen community resilience and increase the resilience of the encompassing socio-ecological systems [36].

The importance of local communities in disaster resilience is recognised in both academic research and government policies, highlighting the criticality of engaging community groups as active participants in disaster preparedness, planning, and response activities [21,37,38]. Community resilience as an important aspect of disaster planning has received attention globally (e.g. the US [39], Japan [40]), with empowerment of local communities recognised as one of the thirteen guiding principles of the Sendai Framework for disaster risk reduction [41]. The criticality of local community participation is highlighted by Coles and Buckle [41, p. 6] who suggest that resilience is best realized in situations in which the “community participates fully in the recovery process and has the capacity, skills and knowledge to make its participation meaningful”. Research has also shown that local communities provide altruistic and mutual assistance to disaster survivors [42,43]. Through the action of local communities, resources provided by government agencies can be tailored, reconfigured, and organised to address emerging events.

Community disaster resilience can be a useful guiding paradigm for the promotion of disaster risk reduction and the enabling of disaster recovery through attention to, and investment in, local capacities for adaptation to a changing and uncertain environment [37,44]. However, government cannot view community resilience actions as a panacea, as the unique characteristics of every community means these actions have variable levels of effectiveness [20,45]. Top-down approaches by disaster management agencies, which do not engage with local participants, can inhibit development of resilience within communities [46,47]. Bushfire research highlights that the fit between government and community norms can create difficulties as bureaucratic policies tend to be relatively insensitive to unique local conditions and marginalise the people they are designed to assist [20,48]. Therefore researchers have identified a gap to better understand the processes that contribute to resilience at a community level [49,46], with calls for the development of both quantitative and qualitative resilience knowledge that can inform public policy [50,47,51] and allow local resources to be brought together as effective responses to larger threats [52].

The importance of increasing knowledge on local community disaster resilience is highlighted through issues around the equity and effectiveness of resilience approaches that are based on shared responsibilities across multiple levels [25,27,53]. Governmental disaster-resilience policies in Australia have often advocated shared responsibilities without necessarily specifying its meaning, or how

it should be discharged across the different levels. This challenges actors to develop approaches that are interlinked and coherent [21]. Bushfire resilience literature has often examined resilience from a discrete level perspective, whether that be top-down, bottom-up, or otherwise [20,27]. However, comprehending how resilience develops, changes, and is sustained needs an understanding of how disturbances, such as bushfires, can be managed by interlinked 'bottom-up' as well as 'top-down' approaches [16,54]. Recent resilience research recognises the importance of the linkages between different levels, through intermediaries for example, and the way each level operates over discrete ranges of scales in both time and space [15,55].

It is understood that response and recovery to disasters varies across communities [56]. Multiple factors influence the way communities are impacted and recover, and hence the resilience of a community. These factors can include both the features and complexities of the community and the disaster, along with how the underlying and emergent characteristics shape potential responses. The purpose of this paper is to understand how community groups develop resilience over time through influencing and interacting with different societal levels, throughout the phases of the disaster management cycle: prevention, preparation, response, and recovery [16,27,52]. Specifically, this research focuses on multi-level interactions which impact on community resilience throughout the disaster cycle. This provides an opportunity for a more insightful and holistic understanding of the factors involved in resilience. The macro/governmental level shapes governance of bushfire management and resources, the micro level reflects the actions of individual and households, while the meso level represents local community groups providing a bridge between the two through "linking mechanisms and conventions regulating exchange" [55, p. 210]. This paper focuses on understanding:

1. What is the role of the community in the inter-relationships across societal levels (micro, meso, and macro)?
2. How can we understand the multiple factors involved in supporting community resilience?

This four-year longitudinal study (2020–2022, with a follow-up in 2023) took place in the aftermath of the unprecedented 2019/20 Australian 'Black Summer' bushfires. Australian bushfire management involves a complex interplay between federal, state and local government responsibilities, along with input from communities. Each state is responsible for developing and implementing their own bushfire management plans, with the federal government focused on funding, coordination and recovery. This study placed the central focus on the community level, and analysis revealed latent tensions between regulated governmental and emergency service-led systems and structures that were in place to address bushfire risks, and emergent, local-specific responses based on community attributes, needs, and characteristics.

The next section provides information on the research approach and the collection and analysis of data. Through applying a complexity framework, across micro, meso and macro levels of the community, the successful planning and emergent responses, along with tensions that reflect potential misalignment of purpose and resources between different levels, were revealed [57]. This understanding of how complexity influences the development of multi-level community resilience has implications for shared responsibility in disaster planning, as community-based organisations may disagree with objectives at other levels, eroding resilience across the entire system.

2. Research methodology

2.1. Case study background

During the Australian spring and summer of 2019/20, a bushfire crisis unfolded across several states and territories. It was unprecedented in many ways, including the number, size and intensity of the conflagrations [58]. The fires came to be known as the Black Summer Bushfires. The focus of our study is a semi-rural, high bushfire-risk area of New South Wales. The area has a population of around 900 people in 500 private dwellings. It is a popular tourist destination with multiple holiday homes and rentals, and the population increases substantially during the summer months. Bushfire preparations in the area took on a new urgency in late 2019 in response to the extremely dry and hot conditions across south-eastern Australia, where "the occurrence of drought and low values of dead fuel moisture content primed the landscape" for unprecedented fires [57, p. 1040]. A major bushfire – named the Currowan Fire, started in November 2019 approximately 90 km away, reaching the case study region in early January 2020. Residents had significant forewarning of the possibility of impeding fire, unless significant rainfall occurred beforehand. When the fire arrived, the regional weather station recorded air temperatures of 43 °C and wind speeds over 55 km/h (BOM 2020). Approximately 50 homes were destroyed by the Currowan Fire, along with sheds, equipment, and infrastructure on many more properties. While no human lives were lost, many thousands of animals died, including livestock.

2.2. Research design

This paper primarily draws on data from an in-depth investigation of the bushfire preparation, response, and recovery phases at multiple levels ranging from households and local communities to local government and industry. The broad aim of the research was to understand better the complex, multi-level, multi-disciplinary issues that influenced bushfire resilience within the case study community. To understand the multiple dimensions of community resilience – from macro to micro levels - a longitudinal approach was taken with archival data being examined to understand events and processes prior to the bushfire (2018–2019), an intensive period of data collection that included both qualitative interviews, quantitative building assessments, and review of technical records during the post-fire recovery period (2020–2021), along with additional documentary review and interviews to track implementation and community learnings up to late 2023. This built an understanding of the specific household experience, along with that of broader

community before, during and after the bushfire, within the context both meso and macro level policy and organisational actions.

2.3. Data collection

Multiple approaches to data collection were employed, as detailed in Table 1. In total 70 semi-structured interviews were conducted involving 83 interviewees. The interviews typically ranged in length from 30 to 90 min. They were typically conducted individually, except in a small number of cases when multiple members of the same household or organisation wished to be present in an interview. The data collection occurred with the backdrop of the COVID-19 pandemic, meaning the majority of interviews were conducted via telephone and/or video conference calls. Site visits and some interviews were conducted in-person when lock-down restrictions were eased. Semi-structured interview protocols were developed prior to conducting interviews, drawing on best practice guidance and the experience of the research teams. Three separate protocols were developed for interviews. One for households impacted by the disaster directly (examples of interview questions include: *'How prepared were you for the bushfire (mentally and practically)?' [with additional prompts] and 'What strategies have been most helpful so far in your recovery process?')*, another for interviews with community organisation members (e.g. *'What were the major challenges facing the community after the fires?', 'How have the needs of the community changed over time since the fires?)*, and a third for industry and government stakeholders involved in the disaster more generally (e.g. *'How have your regular business practices changed in response the bushfire recovery and reconstruction?' and 'What could be done to improve the recovery process and develop better responses in the future?')*. The household protocols were tested during a small pilot study of 14 households in early 2020, whilst the community and industry stakeholder protocols were jointly developed by research team members with supply chain and bushfire research experience.

In conjunction with interviews, building assessments were conducted a bushfire building resilience researcher on eighteen homes. This assessed vulnerabilities and hazards faced by each home, considering the standard of construction of dwellings, surrounding environment, and the retrofits undertaken by householders to increase the resistance of buildings and property to bushfires. A summary of the assessment including recommendations to improve building resilience was provided to the participants. These assessments provided a different lens to understand the household experience as described in the interviews, and also served as a helpful tool for building rapport with the research team. Results were analysed separately to this paper [59], however informed the understanding of household retrofits and behaviours described below.

Participants were recruited through notifications in the local community newsletter and online community groups, posters on village noticeboards, letterbox drops of flyers, contacts shared by local community organisations, and snowballing from interviews. The research team aimed to provide the opportunity for any household or community member impacted by the bushfire to participate. As participation was voluntary, the representativeness of the sample is difficult to prove. However, the interviewers noted that by the end no new ideas were encountered, indicating saturation had likely been reached. Professionals known to be working in roles relevant to the research, such as local government, and tradespeople working on reconstruction, were also approached to obtain as wide a range of insights as possible.

2.4. Data analysis framework

This study sought to capture the multiple issues at different levels identified during the research. In doing this, a framework was required that could capture and meaningfully represent different facets from the data. Previous resilience analyses have used, for example, ambidexterity [60] to distinguish different actions employed, but this is insufficient for this broader investigation. Other frameworks have analysed the disaster resilience of a place, considering a wide array of social and infrastructure indicators [33], but these can be too broad to facilitate in-depth study of community disaster response dynamics.

This paper utilises the concept of complexity to classify and present the data, as it is an analytical lens that is well-established in operations literature [51–55] and can readily capture the broad areas of interest. The framework used allows subjective understandings of complexity, based on real-life experiences, to be structured and usefully analysed. While the complexity of contemporary disasters is widely acknowledged and researched [56,61], we find value and insights from applying the knowledge from operations scholarship to disaster management and response.

Maylor and Turner [62] categorised three overarching dimensions of complexity: *structural*, *socio-political* and *emergent*. Structural complexities deal with factors such as coordination, scale, technology, and pace; socio-political complexities encompass people, power, politics, and the impact of stakeholders; and emergent complexities are those such as novel situations and the challenge of dealing with the unexpected [63].

Practical responses to manage these complexities are suggested to fall within three themes: an emphasis on planning and control; relationship building; and flexibility (aligned with structural, socio-political and emergent complexities respectively) [63]. Previous use of this framework has established that all nine options (i.e. three forms of complexity and three types of response) are actually utilised. These studies have been done in numerous fields, but each has assumed a monocular perspective in terms of the context levels. These include supply chains [64], social enterprises in isolation to the wider governmental framework in which they operate [65], and team knowledge-sharing segregated from the community in which it is based [66]. Providing clear boundaries aids conceptualisation of the issue under investigation, yet this can limit the applicability of the findings. Researchers are now addressing these theoretical constraints through examining problems across macro-meso-micro levels simultaneously [48,67]. Within our study we also embrace this more inclusive opportunity, using the complexity framework to parse the rich data obtained both across the nine facets of complexity and response, as well as across societal levels. This structuring of the data analysis was used to explore the role of community groups in developing resilience across societal levels throughout disaster cycles. This is a novel use of the complexity

framework, both in its application to resilience, and addressing a multi-level analysis.

2.5. Data analysis

All interviews were recorded and transcribed with data initially analysed across multiple disciplines, including operational management and supply chain, social science, and engineering. Data coding occurred manually due to the various disciplinary perspectives on the interview data. Data analysis for this manuscript occurred across two phases, initially focused on understanding the case study across multiple levels, throughout the disaster cycle, with a second layer of analysis based on the complexity framework as discussed in this manuscript. The data were initially analysed thematically by the interdisciplinary research team, across a framework based on the stages of the disaster cycle (prevention, preparation, response and recovery), and through the lenses of household, community, and government and industry experiences. Emergent themes were identified through multiple readings of the transcripts, by different members of the research team, through a process of progressive meaning making across the interview data [63]. The interdisciplinary research team was co-located during this analysis stage, allowing for frequent and ongoing intercoder consistency checks, when coding and analysis could be challenged and reanalysed if appropriate [64]. The use of intercoder consistency checks strengthened the credibility of the analysis by ensuring that coding decisions were applied consistently across researchers, thereby reducing individual bias and enhancing the trustworthiness of the findings [65]. Whilst manual coding can introduce data management challenges, these were mitigated through ongoing and progressive research documentation and reporting [66]. The multi-disciplinary approach allowed for triangulation of data sources, understanding aspects of preparedness and recovery from perspectives of householders, community organisations, government and emergency services, along with construction industry personnel involved in the rebuild [66]. In addition, a two-stage feedback process was implemented starting with an online seminar for the community (October 2021) to verify findings and invite feedback. This was followed by the development of published research briefs to disseminate the findings to the local community and invite additional comments and insights [66]. The research briefs were shared with all participants, and the participants were all invited to attend the online seminar and provide feedback to research team, with feedback incorporated in final research and analysis. Community members verified that the researchers' interpretations and thematic findings accurately reflect their experiences, perspectives, and language. The online seminar in combination with the release of the research briefs were critical research instruments for strengthening the validity of the investigation. The online seminar also validated data saturation as community members confirmed that the data presented reflects a sufficient range of views and that the analytical process was systematic [67,68].

This manuscript introduced the dimensions of complexity of Maylor and Turner [62], as the overarching guide to second phase data analysis. The authors used the complexity model to categorise and capture data in all nine elements, each at three levels (micro, meso, macro [69]), and across the phases of the disaster management cycle (grouped as prevention/preparation, and response/recovery), resulting in 54 categorisation codes. For example, one code would be a meso level planning response to a structural complexity impacting the planning and preparation phase of the disaster cycle. This data, and the coding structure, are captured in Tables 3 and 4. This served as the guide to the unfolding ‘story’ and enabled us to ensure key aspects were captured and categorised, as well as providing a reliable and replicable analysis framework. Analysis iterated between the data (interview transcripts, building impact assessments, archival data) and the data table, discussing the issues to ensure they were captured accurately. The complexity coding was performed in concert by two researchers, with multiple review and feedback sessions with the extended research team to validate coding interpretations. The analysis necessarily became quite lengthy, and a reduced version of the significant points is presented later in Tables 3 and 4

Table 1
Data collection overview.

Time	Levels	Data Collection	Details
2020–2022	Micro - Households and buildings	• Interviews (30) • Building vulnerability assessments (19 households/ buildings) • Archival data	• 30 interviews with 36 residents and householders living in and around the region
2020–2023	Meso - Community and householders	• Interviews (16) • Archival data	• 6 interviews with 8 community members involved in local bushfire resilience initiatives (e.g. community bushfire committee) • 5 interviews with 6 local business owners (e.g. main street stores) • 5 interviews with 5 volunteers and employees of emergency services and not-for-profit organisations
2020–2023	Macro - Government and industry	• Interviews (24) • Business Network geo-mapping • Archival data	• 4 interviews with 4 employees of local government • 2 interviews with 2 local industry professionals with relevant expertise, e.g. bushfire consultants • 18 interviews with 22 people involved in the post-bushfire reconstruction program, including industry peak bodies, architects, builders, tradespeople, suppliers of building materials, demolition/earthmoving contractors, etc.

Table 2
– Timeline of key bushfire resilience related events and activities covered under the research project.

Phase	Time	Key Activities (key organisation level involvement)
Prevention	September 2018–December 2018	1 Public Meeting (macro-meso-micro) 2 Establishment of Community Bushfire Committee (meso) 3 Establishment of nine Bushfire-Ready Neighbourhoods (meso)
Preparation	October 2019–December 2019	4 Catastrophic Fire Danger Rating Forecast (macro) 5 Currowan Fire ignition 6 Emergency Public meeting in Community Hall (macro-meso-micro)
Response	December 2019–January 2020	7 Drop-in Recovery Centre established (meso) 8 Post-fire information sessions organised (meso-micro
Recovery	February 2020–December 2023 [ongoing]	9 BlazeAid and other not-for-profit recovery activities (macro) 10 Demolition and clearing of destroyed buildings (macro) 11 Covid 19 restrictions 12 First home rebuild approved
Prevention	June 2020–December 2023 [ongoing]	13 Establishment of community resilience not-for-profit organisation (meso) 14 Further development of Neighbourhood Groups Network (meso) 15 Initial bushfire resilience mapping online tool developed (meso)

Table 3
Patterns of complexity management identified in the prevention and preparation phases.

Complexity management	Structural Complexity	Socio-political Complexity	Emergent Complexity
Planning Response	MICRO – Retrofitting by householders to increase resilience of properties.	MICRO - Households supported to discuss their bushfire plans and priorities (e.g. staying/leaving).	MICRO - Waiting during bushfire season but timing and intensity of bushfire are unknown. Intensity of householder retrofit activity increases with proximity of bushfire.
	MESO - Formal community bushfire committee formed. Coordinated neighbourhood groups -specific mapping to highlight local infrastructure and other vulnerabilities.	MESO - Preparation via getting to know your neighbours. Coordinators of the neighbourhood group who share information, collected details of (stay/leave) households.	MESO - Some neighbourhood groups were formed early on; others formed only in the days and weeks before the fire.
	MACRO - Locally focused CBC formed aiming to bridge the gap between external government agency and local bespoke community knowledge.	MACRO - While emergency services promoted early stay/leave decisions and provided extensive preparation resources, residents' responses were more complex. Neighbourhood groups helped bridge this gap by engaging households and translating official advice into practical action.	MACRO - Government-led risk planning and mapping was perceived by the community as lacking local detail (e.g. geographic, community needs, and local infrastructure/ assets).
Relational Response	MICRO - Relationship-building with tradespeople and local suppliers to enable initial retrofitting.	MICRO - Tensions within some households with regards to stay/leave decision-making were reported.	MICRO - Households sharing their plans with others who could then adapt for their own use.
	MESO - Building trust and relationships within the community to drive bushfire awareness and knowledge. Meetings ('Bushfire-Ready Neighbourhood Groups') and supporting social relationships.	MESO - 10 neighbourhood groups established in the 1–2 years prior to the bushfire, others formed immediately prior. Relations managed by neighbourhood groups. CBC providing support for getting prepared. Building of social capital amongst community.	MESO - Neighbourhood groups set up for information-sharing were powerful as a mechanism for support. Community events organised, including RFS community event and neighbourhood groups.
	MACRO - Working relationship between VRFB and CBC. RFS as a source of information and guidance, shared amongst the community.	MACRO - VRFB aimed to visit as many properties as possible to discuss preparations. Continuous dialogue between CBC and VRFB throughout the preparation.	Local shops/business became channels for knowledge transfer, valuable to the community. MACRO - VRFB members participated in last-minute neighbourhood meetings with residents.
Flexibility Response	MICRO - Household keeping open the option to stay/leave.	MICRO - Communication with others deemed valuable, including supporting late stay/ leave decisions.	MICRO – A lot of last-minute DIY retrofits in the weeks before the fire.
	MESO - Setting up of WhatsApp group provided for information transparency. Coordinators of some neighbourhood groups purchased CB/UHF radios.	MESO - Neighbourhood group meetings served to build social capital amongst residents.	MESO - Knowing that the fire front is approaching, physical preparation for defending homes was supported. Community 'get ready' day, and emergency public meeting for residents.
	MACRO - Ongoing dialogue between members of VRFB and CBC. Worked with neighbourhood groups attending last-minute meetings with residents.	MACRO - Community meetings to build relationships between the residents and VRFB to enable more effective and integrated information flow.	MACRO - Last minute updates of householder plans coordinated with CBC.

Source: Authors' own creation

Table 4
Patterns of complexity management identified in the response and recovery phases.

Complexity management	Structural Complexity	Socio-political Complexity	Emergent Complexity
Planning Response	MICRO - Household rebuilding impacted by: shortages of materials post-fire, post-disaster process complexity, insurance issues, shortages of building professionals. Some households investigated prefabricated or mobile homes. MESO - Volunteer drop-in centre set-up to coordinate and provide access to information (within 3 days). Long-term attempt to shift the CBC into a formal structure with own facility. MACRO - Financial support from government and charities helped with immediate financial pressures. Changing in regulation and rules to help with the rebuild (e.g. fast track approval process).	MICRO - Decisions to stay or leave were highly stressful, and recovery was challenging, with ongoing mental health impacts worsened by COVID-19, highlighting the value of pre-planning. MESO - Drop-in centre provided a place to share experiences with other residents and to gain emotional support through community connections. MACRO - Local council and agencies developed a novel Hybrid Building Impact Assessment (BIA) team; coordinated multi-agency process enabled efficient single visit to damaged properties.	MICRO - Delay, increased costs and frustration during the rebuild efforts as COVID-19 and disrupted construction material and labour supply chains increase prices. MESO - Local supply issues; store had limited spare parts for critical items. Drop-in centre coordinated places to stay, contact insurers, and apply for emergency funds. MACRO – Regional timber mills and plantations also burnt in the fires. Roads and bridges were damaged slowing down supply lines. Mobile recovery hubs initially available but ceased operation in April 2020 due to COVID. Longer-term, Council funding resilience and communication upgrades at community halls. Submissions by the CBC to government inquiries.
Relational Response	MESO - Neighbourhood and WhatsApp groups continued after the fires, providing communication channels, emotional and technical support. CBC coordinated neighbourhood groups at a grassroots level. Volunteer groups were valued by residents and helped with fencing, replanting, etc., while developing relationships. MACRO - Government recovery hubs act as one-stop-shop for assistance, but information-sharing was complicated by privacy laws. Government assisted with clearing destroyed buildings; a highly emotional experience, done with compassion via a novel hybrid BIA coordination of multiple bureaucracies to speed up process.	MICRO - Tradies and builders provided social support as well as rebuilding. MESO - Community groups reassured people they were looked after. Role of Neighbourhood group coordinator required better definition of scope, expectation, and skill. Neighbourhood groups are still going and working together, but formal process post-bushfires not focused on trauma recovery. MACRO - Interrelationships developed and strengthened between RFS, CBC and the local government. Strengthened relationships due to strong collaboration during the event.	MICRO - Experiences with insurance companies and service providers were varied, causing stress for householders. Drop-in centre provided place to share experiences and knowledge. MESO - Neighbourhood coordinators provided latest updated information on the most recent stay/leave decisions within their community (information transparency). MACRO - Liaison between the local RFS and the community also strengthened, including a CBC initiative to develop a web-based Bushfire Preparedness geo-spatial map for region.
Flexibility Response	MESO - CBC and neighbourhood groups having representatives from their individual localities, allowing for tailored agility. Drop-in Centre as a problem-solving hub. MACRO - Government assistance to impacted household including easing restrictions on temporary accommodation usage for homes and businesses. Bridge burned down and required replacement. Novel bridge system provided access within two weeks.	MESO - Local stores were a point of contact and social hub for the community after the fire. Later misuse of the neighbourhood groups for non-fire problems. The CBC is still working through policies for users. MACRO - Supportive assistance for local governments in planning approvals came just after the bushfire (additional staff from neighbouring councils) to ease work pressure.	MICRO - Last minute change of stay and defend decisions when faced with the fire (9 % changed their mind late). MESO - Drop-in centre evolved according to the changing necessities of the community. Variable responses from insurers. Some managed the rebuild, some just paid for the work but left it to individuals to organise. MACRO - Limited opportunities for Prefab construction (except bridge system) to rapidly build replacement homes post disaster. Opportunity but limited uptake.

Source: Authors' own creation

3. Findings

In order to use this case study to understand the multiple factors involved in supporting community resilience (RQ2), we first provide an overview of the disaster management activities that occurred within the case study community, focusing on the role of the community the inter-relationships across societal levels (RQ1). These findings are organised by the four phases of the disaster management cycle: prevention, preparation, response and recovery. A timeline of events is provided in Table 2. The description of events within each phase focuses on the level of individuals and households (micro) and neighbourhood and community (meso), along with community perspectives on wider scale (macro) actions amongst the institutional and government actors interacting with the community. The role of emergency service actors that cross-over between the meso and the macro – the NSW Rural Fire Service (RFS) and the State Emergency Services (SES) - is important for understanding community responses to the bushfire. However, direct engagement between the authors and the emergency services on a formal level were outside of the scope of the research. Our knowledge of their operations is therefore based on publicly available information and community perspectives provided to the research team. The stakeholders relevant to this research are summarised in Fig. 1.

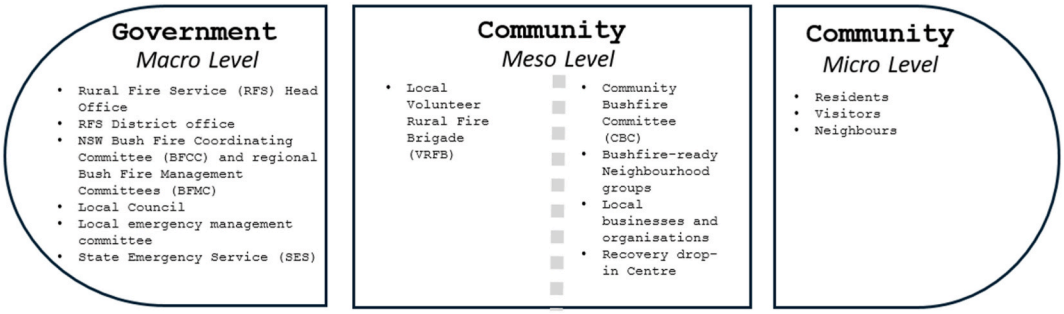


Fig. 1. Overview of relevant stakeholders at the macro, meso and micro levels. Within community, stakeholders are split to indicate where links exist to the other levels.

At a state and regional (macro) level, there are existing structures and processes that carry out ongoing planning for fire prevention. The NSW RFS has overall responsibility for state planning, led by the RFS Commissioner, and the Bushfire Coordinating Committee (BFCC) has a key role in advising the RFS Commissioner. Across the State, there are 45 districts, grouped into seven Area Commands. At the district level, the District Office of the RFS (operating at a regional level) coordinates bushfire planning in the region (this is a paid role), whilst the Bush Fire Management Committee (BFMC) coordinates planning and management. The BFMC is comprised of a range of stakeholders from the area, including emergency services, land management agencies, local government and local Aboriginal land services. This committee produces a Bush Fire Risk Management Plan (BFRMP) for the Local Government Area (LGA) every 5 years, with the version covering the study time period being approved in March 2019. The BFRMP identifies bushfire risks at the regional level, and the types of works scheduled to address this risk.

Local communities in Australia often have a RFS brigade that is run by volunteer members from the community (meso level, with links to macro). This includes the Volunteer Rural Fire Brigade (VRFB) in the case study area. Importantly, the RFS has dual functions in this case, as it also operates the state-wide command and control structure, separate from the VRFB made up of volunteer community members. The following sections describe key aspects of the community response to the bushfire, across the four stages of the disaster management cycle, followed by a complexity analysis of these actions.

3.1. Prevention phase

Prevailing dry weather conditions over a number of years across south-eastern Australia meant there was a general community awareness of heightened bushfire risks in the years leading up to the Currowan Fire. Fifteen months before the eventual arrival of the fire, locally based members of the Police and the RFS convened a 'bushfire awareness and preparation' public meeting in September 2018 in the case study community. This represented an initial collaboration in the case study timeframe between macro, meso and micro level actors, and contributed to a strengthening of the meso level organisation in the community. This meeting was described as a catalyst for the forming of the Community Bushfire Committee (CBC) in the same month. The members came from a variety of backgrounds, motivated by shared concern about the likelihood of bushfires. The CBC expressed concern that the Bush Fire Risk Management Plan for the LGA was too general for the specific geographic and infrastructural features of their community. Hence the CBC developed a discussion paper identifying specific vulnerabilities at the individual, neighbourhood, and geographical level for their community. Other key activities of the committee included liaison with the community members and with an emerging bushfire-ready neighbourhood network. This resulted in a multi-tiered approach to community level organisation. The first Bushfire Ready Neighbourhood Network started in December 2018. Nine neighbourhood areas in total were designated, each with their own coordinator and deputy. Other groups formed over the months, weeks, and days prior to the fire's arrival.

The Neighbourhood Network proposed an 'integrated hierarchy' of bushfire planning that included three locally specific plans (in italics) additional to the existing resources, in a clear effort to increase the influence of the community/meso level organisations.

1. Level 1 - Individual Bushfire Survival Plans
2. *Level 2 - Bushfire Ready Neighbourhood Plans*
3. *Level 3 - Locality Bushfire Plans*
4. *Level 4 - Community Bushfire Plan*
5. Level 5 - Bush Fire Risk Management Plan (BFRMP)
6. Level 6 - NSW State Bushfire Plan

Whilst these organisational structures were forming at the community level, some individual households were taking their own steps to increase the resilience of their properties. Key to this was retrofitting older homes, following a 'research and rehearse' approach to bushfire preparation, whereby homeowners would research the materials, safety equipment (e.g., sprinklers and bunkers), as well as behaviours and decision-points to either stay and defend a property, or evacuate safely. Leading into the preparation phase, as the bushfire threat was increasing, the knowledge and skills of these residents became an asset that would frequently be shared

among friends and neighbours through formal and informal networks.

3.2. Preparation phase

The Currowan Fire first ignited in November 2019 and took over 70 days to travel from the ignition point to the case study area. This meant residents had a relatively long period of time to assess the situation and prepare accordingly. There was significant activity at the community level in the days and weeks leading up to the arrival of the fire. A number of additional Bushfire Ready Neighbourhood Groups formed in this period, and these all served as valuable pathways for sharing information and providing support to residents. Most groups met in the lead up to the fire, covering topics such as household bushfire survival plans, sharing locality-specific advice, along with collecting details of residents' intended actions if the fire arrived – i.e. whether they planned to evacuate, or to stay and defend their property. Confidential lists of those households who were intending to stay and defend were provided to the local Volunteer Rural Fire Brigade (VRFB) so that fire crews and other emergency personnel would be aware of residents' intentions. This is an illustrative example of the meso enhancing information transparency between organisation layers. In the week before the fire arrived, the RFS held a meeting for the local community, providing a frank assessment of the very high level of bushfire-risk the community faced:

> "That meeting, [my partner] and I said it, I don't know how many times, that meeting saved countless lives, in our opinion. [A local RFS member] went through what to expect for the fire, how horrifying the experience would be, how difficult it would be for someone to defend their property unless they were completely fully resourced and had everything in their favour, and even then, they may not be able to." (Resident)

Three stages emerged from the interviews with residents with regards to the timing of planning and preparation:

1. Early - conducted when there was no specific bushfire threat.
2. Preparation in response to a heightened level of danger, such as during a particularly dry summer, or when bushfires are burning in neighbouring regions.
3. 'Last-minute' - in response to an approaching bushfire.

While all households had created some form of bushfire survival plan during stage 1, the majority of the preparation activity occurred during stage 2, during the relatively long period when the bushfire was approaching. This long period of forewarning is unusual. In the weeks when the fire was approaching, many residents became more focused on their readiness and concerned about whether they were adequately prepared. All the participants modified their properties to some degree, with many doing substantial do-it-yourself retrofits, along with clearing of vegetation close to the house, and/or installation of bushfire sprinkler systems. Particularly for those with no previous bushfire experience, this prompted a search for as much information as possible about likely impacts of the fire, and mitigation options. It also included the search for and procurement of necessary equipment, which in some cases included difficulties finding fire pumps, hoses, and protective clothing. Residents drew on a range of external information sources, including internet research, news media reporting, and government advice.

In addition, advice shared via community networks was also seen as highly important, from local emergency services volunteers, along with business owners, friends, and neighbours. There was a significant flow of information between local community groups. This information was often converted into direct action. For example, several participants shared how their bushfire survival plans had previously been somewhat vague, or something they had discussed but never committed to paper. They were prompted to formalise their plans, because, as one resident recalled being told by a local RFS volunteers: "If you don't have a written plan, you don't have a plan." However, local residents also experienced information gaps particular to their region:

> "So, my plan was to get out early and I made sure I knew where refuges [i.e. 'Neighbourhood Safer Places' or evacuation centres] were. And that, I've got to say, isn't the clearest thing. I was told various things. … And I didn't find where you could go, online, to find a definitive answer for that." (Resident)

3.3. Response and recovery phase

When the fire front arrived, a wind change pushed the direction of the fire away from the most densely populated parts of the community. Nevertheless, the impact on the western areas of the Valley was catastrophic. Approximately 10 % of homes in the community were destroyed.

The community response to the arrival of the fire was varied. 33 households were interviewed about their intentions and actions. Prior to the fire, 55 % intended to evacuate early, 39 % to stay and defend their properties, and 6 % were unsure. In the end, 67 % evacuated early, a further 9 % left late, and 24 % stayed to defend their properties. 15 % of the households interviewed had changed their minds in the final few days before the fire from staying to defend to evacuating, judging the fire conditions as abnormally severe.

Immediately following the fire, many residents were dealing with damage to, or destruction of, their properties. This meant navigating multiple complex processes, including locating temporary accommodation, replacing important documents, contacting insurers, and applying for government assistance, while also dealing with the trauma of living through the bushfire. Without electricity, phone or internet on their properties post-fire, these processes were made even more challenging.

The local Council established a Recovery Committee that was operated slightly separately to normal local government process to

coordinate the recovery phase as an emergent response to the scale of the disaster. To assist residents, a Recovery Centre was established in the LGA, which hosted all the relevant government agencies in one building to facilitate access their services. However, this Centre was located a 90-min drive from the case study community, resulting in significant access challenges for impacted residents.

The community responded quickly to fill an evident need, with a local 'Drop In' Centre established by a local community member in an empty shopfront within three days of the fire, with the help of an overwhelming response to an online fundraiser. This was initially intended to raise money to 'buy a beer' to thank RFS volunteers, but so much money was donated that funds were also used to establish the Drop In Centre in the local village. This provided some of the services of the council run recovery centre in a more accessible location (e.g. internet and phone access), as well as more specific emergency and personal needs. Run by local volunteers, it quickly helped residents with damaged homes locate places to stay, contact their insurers and banks, and apply for funds from charities and government sources. It also, importantly, provided a space to share emotional support and experiences with fellow residents. It was organised as an official Incorporated Association and formally registered within six weeks.

A key aspect of the recovery process was the need to deal with damaged and destroyed properties and commence planning for rebuilding. Multiple actors needed to come together to assess and agree on actions for these properties. To streamline this process, the Local Council established hybrid Building Impact Assessment (BIA) teams, a multi-agency process aimed at implementing a single site visit to damaged properties to reach to an official decision. This involved significant coordination between multiple local and state agencies (including Council Environmental Services, NSW Police, RFS, Fire and Rescue NSW). It was described as a first for this type of approach to be implemented in the State, representing an emergent practice.

In addition to the community Bushfire Recovery Association's Drop In Centre, local businesses, such as grocery stores, the post office, hardware supply stores, etc. were often the first places that people went for assistance. Likewise, construction industry workers, builders, tradespeople, delivery drivers, and local council officers were in regular contact with the homeowners most impacted by the disasters. This kind of incidental contact through professionals involved in the reconstruction effort became a valuable way to reach impacted residents who found asking for help difficult, and it became a vital part of the support process.

In the longer term, this involved exploring options for rebuilding, for example, by speaking with insurance companies, builders and trades, and engaging with the local council for planning approvals. At an inter-governmental level, efforts were made to assist bushfire-impacted councils to process the influx of rebuilding approval applications by sharing staff. However, this was reported by some interviewees as being neither well planned nor coordinated, resulting in local councils paradoxically being burdened by managing offers for assistance.

> "We had lots of people from other councils offer to help us. 'We'll send you someone for two weeks.' You wouldn't even understand our systems in two weeks. We need somebody for 12 months, or 18 months. And the State Government did not deliver on that, and I was really, really annoyed with that because [our staff] have gone out, over and above." (Government employee)

Throughout the research it was evident that professionals involved in the clean-up, recovery and reconstruction following the bushfire often played an important but under-recognised role in providing emotional support to those impacted by the disaster.

> "We spend a lot of time on the phone, dealing with what was really grief, with the people. I think for the first three months, I would have somebody crying on my phone every day and it was just trying to get them through that process, to get to the next stage." (Government employee)

3.4. Recovery into prevention

In 2021, the CBC undertook a bushfire preparedness mapping project, which created an electronic map intended as a resource for both community and emergency personnel. The community-led initiative has parallels with bushfire preparedness 'participatory mapping' activities done elsewhere, such as the series of workshops run in Tasmania as described by Haworth et al. [70]. The committee also continued working to capture and formalise the community's experience. In 2022, members of the CBC participated in a process to develop a community-led Adaptation and Resilience Strategy for the wider region in collaboration with a university partner.

The CBC that coordinated the Bushfire Ready Neighbourhood Groups is now incorporated (formalised) as the Community Association for Disaster Resilience. This was launched in November 2023, with the attendance of local RFS volunteers and the District Manager. The purpose is to assist the community to be more aware of, better prepared for, and more resilient to bushfires and other natural hazards and emergencies. In a further step towards formalising the lessons learned from the 2019/20 bushfires, the municipal council has committed to supporting the development plans for a 'Community Centre and Resilience Hub', with the intent that this will also serve as a 'Community Bushfire Refuge'. The initial proposal was created with the support of seven local community organisations. These actions indicate the growing formalisation of lessons learned from the bushfire, as well as a growing acceptance of the role and value of community input and engagement into the disaster planning process.

By the end of 2023, the recovery phase from the Black Summer bushfires was still ongoing in the study area, and community activities continued to be formalised. In total 31 Bushfire Ready Neighbourhood Groups had been established, each comprising around 10 households. The thoughts of the community were also on how to deal with the next incident, and how the lessons from the disaster could be used most effectively.

4. Analysis - patterns of complexity in community responses

In order to increase our understanding of the multiple factors involved in supporting community resilience (RQ2), and how this can contribute to communities develop resilience over time, we analysed how community groups interacted across societal levels throughout the phases of the disaster management cycle. Analysis was carried out based on a longitudinal evaluation of the complexities, and responses, over time (as Boehme et al., [71]), using the Maylor and Turner [62] framework. The analysis of responses to dealing with the complexities of the bushfire are split between the prevention and preparation phases before the arrival of the bushfire in January 2020 (Table 3) and the response and recovery phases (Table 4) during and after the fire. These are classified within the Tables as primarily micro, meso, or macro level complexity management responses.

The description of events within each phase focuses on occurrences at the level of individuals and households (micro) and neighbourhood and community (meso), whilst also detailing community perspectives on key developments at a wider scale (macro) amongst the institutional and government actors interacting with the community and shaping bushfire management on a wider scale. The role of emergency service actors that cross-over between the meso and the macro is important to understanding community responses to the bushfire.

4.1. *Complexity in community bushfire resilience*

The complexity of processes and responses that unfolded within the community context before, during and after the disaster are all factors that influenced the development of community-level resilience. Fig. 2 summarises the multitude of responses, roles and interactions that emerged from our complexity framework analysis, as being of key significance to the resilience of this community and its macro level context.

For the structural complexities, there were multiple technical issues, such as the availability of construction and retrofitting resources and technologies needed to undertake relevant work, and shortages of key materials. The structural category also covers important coordination activities and the formation of entities, such as committees and neighbourhood groups. This latter aspect is necessarily also social, with relationships, trust and a feeling of belonging being central to their effectiveness. The social aspect pervades the activities documented in the study, as revealed in the analysis of socio-political complexities. Many of these are reliant on a level of pre-developed relationships among community members, which is further extended to key focus points within the community, such as local stores and businesses as relational contact points after the fire. Others appear more spontaneous and altruistic, such as when tradespeople provided social support to residents, as they were often one of the initial points of contact for the fire-impacted households.

In the case of emergent complexities, these resulted in the rapid formation of new neighbourhood groups as the fire approached, and the coordination of activities via 'get ready' activities. After the fire had passed, the community Drop In Centre was created as a way of responding to a community need. The identified responses to these complexities highlight that emergency responses should not just be considered in terms of technical or flexible approaches, as they are underpinned by social cohesion at the community level.

Multiple emergent issues were identified, and these were often addressed by knowledgeable and motivated individuals within the community. Examples include households making late decisions not follow their bushfire survival plan - reflecting different degrees of preparation across households, but also the dynamic and stressful reality of a wildfire. Another example was the establishment of the Bushfire Committee or the Drop In Centre. Had such local expertise and initiatives not been available, external support might have been beneficial. However, community resilience is by necessity context specific, and efforts to build it may lose effectiveness if solely imposed by external actors.

The response to the bushfire recovery phase across the construction industry ecosystem was varied. Some impacted households were fully insured and able to navigate bureaucratic pathways quickly to rebuild, while others experienced years of delays. While the construction industry is largely decentralised and resilient in the face of shocks, the market and supply chain for off-site building approaches, such as modular and prefabrication, is not well developed in Australia. However, a number of households were considering off-site or prefabricated construction as a more rapid response to rebuilding. A stronger off-site construction capacity, so that

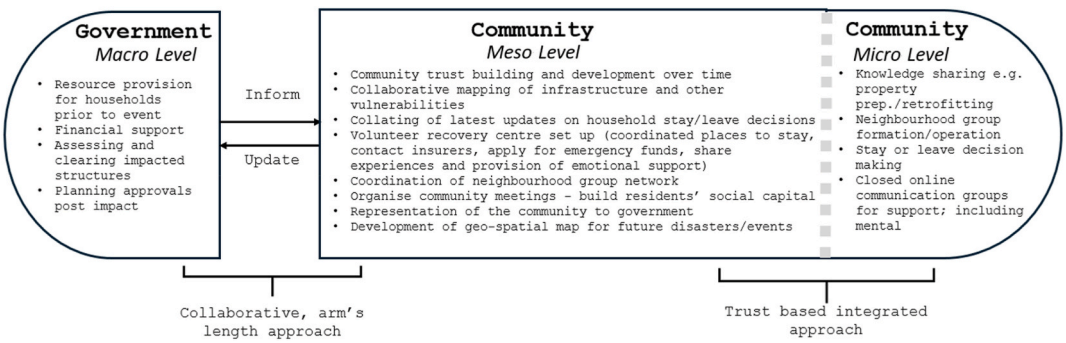


Fig. 2. Meso level community resilience development, and interactions with macro and micro levels, as observed in case study community.

building can take place in regions not impacted by disasters, has been suggested as a means of further improving the resilience of the construction industry [72].

5. Discussion

5.1. Development of multi-level community resilience

The analysis of this case study can inform a growing understanding of multi-level factors and interactions impacting community resilience throughout the disaster cycle. Research highlights that resilience is most effective when it combines top-down macro level support with bottom-up micro level community engagement, tailored to the local hazard profile, governance structures, and cultural context [7,8]. However, one of the strongest themes emerging from this research is the critical role played by the established pre-disaster meso level network in local engagement, communication, and policy translation, particularly in times of crisis. Rather than developing a strategy based on simplistic assumption of what a community entails and offering tokenistic resilience strategies, that fail due to a lack of understanding of the context, policymakers should engage iteratively [16]. State governments operate at the macro level in developing state-wide homogenous policies, along with regional and sub-regional specific plans. These policies generally cannot fully take into consideration the particularities of the local context [45], and if macro level control is too dominant, it can stifle resilience and adaptive learning at the community level [16,20,46,73]. The role of community level structures as intermediaries has been discussed in the context of climate related relocations, or scalar assessment of community resilience [15,34]. This research shows how community resilience can be enhanced by the effective bridging of different organisational levels. Fig. 3 provides a visual contextualisation of the interfaces of the macro, meso and micro levels, and illustrates the key role the community played as a connector between the somewhat disconnected macro level and the households that are an integral part of the community.

Within the case study community, the meso level played a vital bidirectional role, both engaging constructively to seek to modify macro level understanding with locally specific information on risks and capabilities, and in orchestrating and translating macro level policy into micro level actions. The local knowledge provision of the community and neighbourhood groups enhanced and supplemented the existing macro level approaches to bushfire preparedness and response, in a manner that was tailored to both the physical and social characteristics of the area. This both increases the relevance of local disaster preparation, and increases the likelihood that information provided to the community is acted upon [45]. There was a significant degree of coordination and cross-over of personnel between the local volunteer bushfire brigade and the local community, which enhanced the communication and trust in the implementation and translation of bushfire preparation, response and recovery policies to the household (or grassroots) level. This had a dual effect. It created a tightly integrated net of critical actors with different functions that enhanced information transparency, for instance with the active WhatsApp channels coordinated by neighbourhood groups. This intermixing of roles at the meso level also developed relationships, and provided opportunities to strengthen the social capital within the community [37,43]. This improved critical feedback loops, such as by collating and sharing the real-time 'stay and defend or leave early' decisions of local households and being able to update emergency services when last minute changes occurred.

Research by Akter [56] on this same disaster event showed that recovery varied across locations, proceeded at different speeds, in relation to community economic resources. Following the impact of the fire, in this case study community, the meso level emerged to serve a need for support and connection for the local households with the community Drop In Centre. There was nominally a government-led service that served a similar role (the Recovery Hubs), which was an important part of the recovery. However, the emergence of the local Drop In Centre, and the positive impact it provided illustrates the value of community-led initiatives that can understand and address context-specific needs in an adaptive capacity [56]. Locally-led initiatives like this are needed, particularly in the immediate aftermath of major disasters, because government agencies often lack the capacity to act/respond with sufficient speed to all community needs. However, the appropriate level of formalisation of the meso level, as well as the level of integration with other relevant stakeholders during the different phases of disaster management, will vary with context, and likely depend on the existing inherent resilience of a community [33].

A community is a dynamic space, with residents, along with visitors and tourists, continually moving to or from an area. This can pose both general and specific challenges and may require mitigation approaches that are unfamiliar to new residents. The meso level has a key role in connecting and coordinating disaster resilience action in the community, acting as a bridge between individual

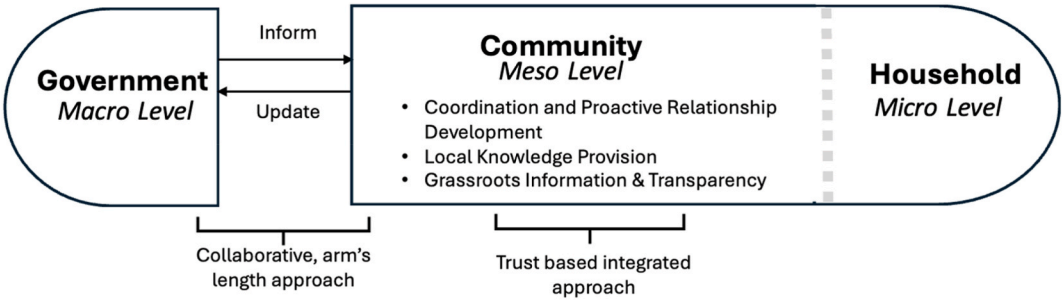


Fig. 3. Effective community resilience development and coordination.

households and disaster planning policies and initiatives. For instance, undertaking translational work through the repetition of information across the community, in the smaller sub-networks (individual streets and neighbourhood groups) as the community evolves. In general, the people of a community are likely to change more quickly than the bushfire preparation and prevention advice changes (and appropriately so). At a slightly longer, but also meaningful scale, the community itself changes as infrastructure evolves, vegetation grows or is removed, and the demographics and dynamics may change. In this case, the community can hold important knowledge to be shared back to the macro level. When there is a strong relational approach the meso level can also provide meaningful feedback to the macro level and therefore provide input to policy improvement. Policymakers and practitioners should consider how to harness the power of the meso level through the development of relational approaches and instruments that can gather and distribute community knowledge (e.g. the nested networks of the community and neighbourhood groups for trusted two-way information translation). Deriving benefits may require changes to managerial/technocratic structures to enable local resources to be brought together as effective responses to larger threats [53].

The findings from the complexity analysis suggest that effective community resilience should have buy-in and proactive support from both micro and macro level actors. It cannot be forgotten that the 'community' is a construct of its constituent parts, and that effective collective action requires support from individuals, and good leadership [36]. Ideally the actors at the community level would have formal or informal engagement with stakeholders at the other organisational levels, and allow for future flexibility in regard to the depth and breadth of services the community is providing in disaster planning, as capacity evolves. In the small case study community, there were actors already engaging across societal levels, and this was supported by the active engagement between the CBC, RFS and local government. This can have wider implications for multi-hazard resilience, as the same relationships and structures that emerged around the actualised bushfire threat have useful applications in maintaining resilience to multiple potential future natural hazards.

While this study makes a strong contribution to revising the literature and highlighting meso level dynamics, future work could deepen the comparative dimension by considering similar governance and coordination challenges in other hazard-prone contexts. For instance, disaster governance in hurricanes in Haiti, earthquakes in Chile, or floods in Pakistan may reveal analogous meso level tensions that test the interplay between macro level policy and community-based action. Enhanced integration of community-level relationships may be able to enhance institutional trust, and improve disaster planning and response capabilities [74]. Extending the analysis in this direction would not only reinforce the generalisability of the findings but also enhance their global resonance.

6. Conclusions

The objective of the research was to provide novel insights into the role of community groups in the preventions, preparation, response, and recovery phases of bushfires, and how these groups interact and link with other levels of society in sharing responsibilities across the phases of disaster management cycle. In presenting our data, we looked at the complexities as experienced by the research participants, categorising the difficulties as structural, socio-political or emergent. This was a novel application of the complexity framework outside the domain of operations, supply chain and project management, as was the successful application of the framework for use in a multi-level (macro, meso, and micro levels) study.

The major research contribution lies in an enhanced understanding of the actions and responses of the case study community, particularly at a meso level, when facing the multiple complexities of bushfire risks [27,42]. By further focusing analysis across the micro, meso and macro scales, the interactions between and across organisational levels were foregrounded as crucial to developing resilience.

Throughout the research and analysis, it became clear that strong community connections and social relationships operated across all four phases of the disaster management cycle. These connections were important in shaping how the community met the challenges of a major bushfire, and they delivered real benefits across all phases of the cycle. Geographically-specific networks helped share resources and advice for home retrofitting and preparedness planning in the lead up to the bushfire, messaging networks maintained (relatively) clear communications between neighbours and with the emergency services throughout the bushfire, and the establishment of a Drop In Centre was a vital community-led initiative for both the mental and physical recovery of the community in the days and weeks immediately following the impact of the bushfire. There were also aspects of the community that were less formalised, yet still vital, such as the role of builders and trades in both preparation and recovery as a source of information, motivation and social support.

However, even in a well-prepared community, there remained points of contention and communication challenges before, during and after the bushfire. The community also faced difficulties as it worked to increase its agency to respond to major disasters, and inherent tensions when trying to balance formal disaster management structures and informal grassroots approaches.

One of the key limitations within this research was the lack of formal engagement with emergency services to gain deeper insights into the macro level perspectives on development of community resilience initiatives, and the tensions that emerge. Another challenge in drawing transferable insights from this research is the case study approach adopted, meaning the findings are necessarily grounded in the unique context (e.g. geographic, demographic, disaster characteristics) of the case study. Future research could further explore the evolving nature of meso–macro interactions in disaster planning, including how different approaches are designed and enacted across contexts. Applying a similar complexity lens and data analysis framework to other disaster responses in diverse locations would provide valuable comparative insights. The relational dynamics between and within societal levels could be examined more deeply using social network analysis. Additionally, future research could propose a comparative framework for meso level institutions across hazards and countries. For instance, studies could investigate whether, and how, trust-based community groups can be formalised without losing flexibility, and how cross-national learning might strengthen the design and function of meso level institutions.

The experience of the case study community highlights the importance of giving communities a strong voice in disaster management planning. Effectively managing the multiple complexities of an emergency benefits from the locally specific knowledge, meso level coordination, relationship-building, and transparent information-sharing that community engagement can provide. However, as seen in this case study, community-level engagement is inherently dependent on the pre-existing capacities and skills of its members, meaning outcomes will inevitably be emergent. These insights are not only relevant for Australian contexts but can also guide practitioners—including community leaders, NGOs, and municipal governments—in other fire- and hazard-prone regions by informing strategies to strengthen local networks, enhance coordination, and adaptively leverage community knowledge in disaster preparedness and response; in particular at the meso level.

CRediT authorship contribution statement

Matthew Daly: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis. **Tillmann Boehme:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization. **Neil Turner:** Writing – review & editing, Writing – original draft, Formal analysis. **James Aitken:** Writing – review & editing, Writing – original draft, Formal analysis. **Alan Green:** Writing – review & editing, Validation, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Scott McKinnon:** Writing – review & editing, Validation, Methodology, Investigation, Formal analysis, Conceptualization. **Christine Eriksen:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Paul Cooper:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Consent to participate

Written consent to participate was obtained from all research participants.

Ethical considerations

This research was undertaken in compliance with approvals received from the University of Wollongong and Illawarra and Shoalhaven Local Health District Social Sciences Human Research Ethics Committee (HREC), approval number HREC2020/342, and appropriate measures were taken to ensure the safety and rights of participants and researchers.

Consent for publication

Not applicable.

Data availability statement

Due to the sensitive nature of this study, participants only agreed for their data to be shared in an analysed format by the authors. No supporting data is therefore available.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

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