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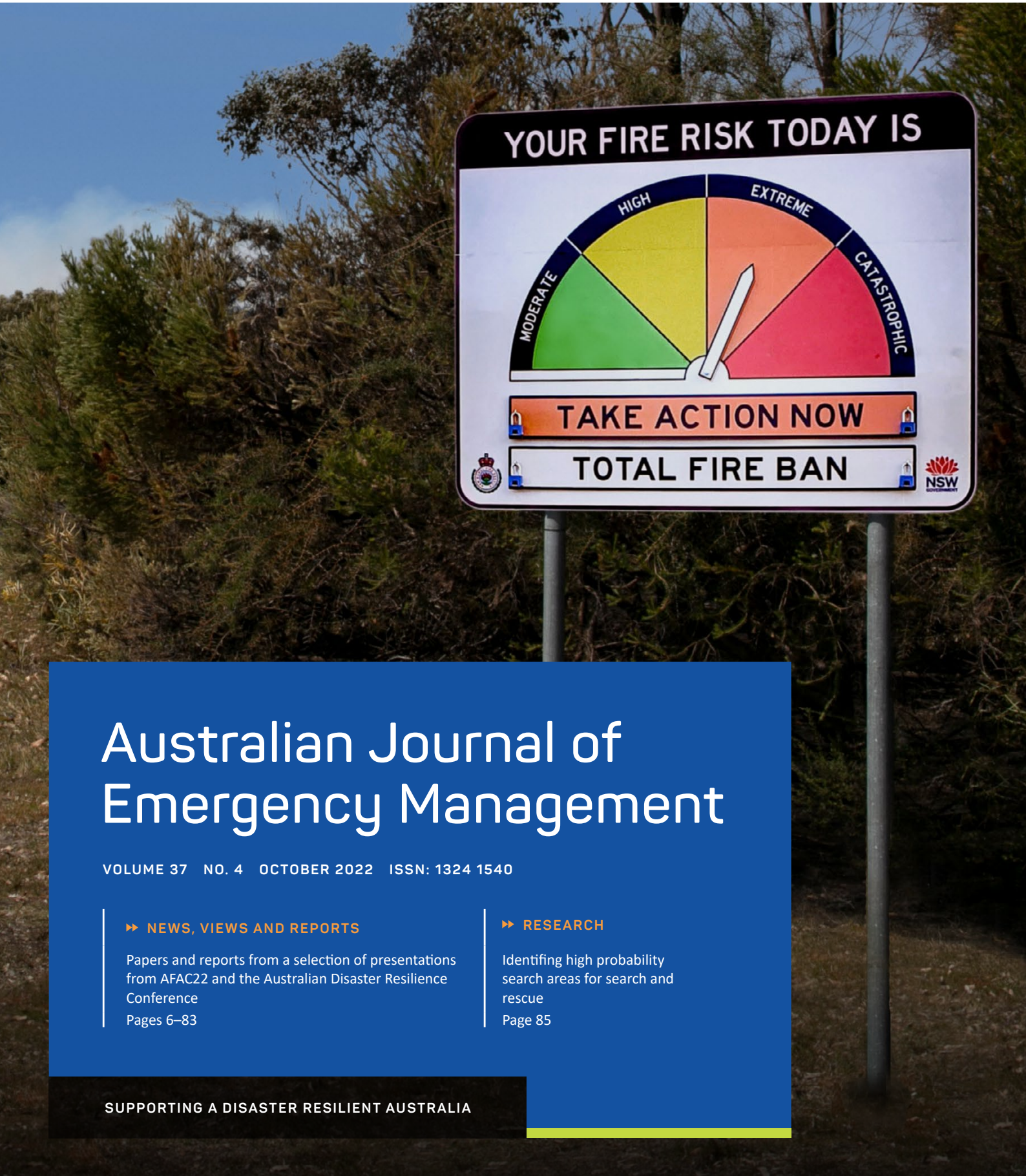

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SUPPORTING A DISASTER RESILIENT AUSTRALIA

About the journal

The *Australian Journal of Emergency Management* is Australia's premier journal in emergency management. Its format and content are developed with reference to peak emergency management organisations and the emergency management sectors—nationally and internationally. The journal focuses on both the academic and practitioner reader. Its aim is to strengthen capabilities in the sector by documenting, growing and disseminating an emergency management body of knowledge. The journal strongly supports the role of the Australian Institute for Disaster Resilience as a national centre of excellence for knowledge and skills development in the emergency management sector. Papers are published in all areas of emergency management. The journal encourages empirical reports but may include specialised theoretical, methodological, case study and review papers and opinion pieces. The views in the journal are not necessarily the views of the Australian Government, Australian Institute for Disaster Resilience or its partners.

Aboriginal and Torres Strait Islander peoples are advised that this publication may contain images of deceased people.

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Contributions in the Research section of the *Australian Journal of Emergency Management* are peer reviewed to appropriate academic standards by independent, qualified reviewers.

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Foreword

Andrew Gissing

Chief Executive Officer,
Natural Hazards Research Australia

As the new CEO of Natural Hazards Research Australia, I am pleased to contribute to the *Australian Journal of Emergency Management*, a publication I view as vital in communicating research to practitioners across the resilience sector and promoting thought leadership to inspire change.

Through my experiences as a practitioner and researcher, I have witnessed end-user-driven research generating positive change to enhance the safety, resilience and sustainability of communities. Such research is vital given the growing complexity of natural hazard risk and the many factors that drive it, such as climate change, environmental degradation, rising inequality, changing demographics, increased development pressures and supply chain interdependencies.

Though we have improved our ability to conceptualise these challenges, recent flood, bushfire, storm and cyclone disasters highlight many opportunities to advance research and disaster risk reduction. More of the same is not the answer. There is a strong role for research and science to inspire and support change. We must look ahead and embrace new approaches, collaborations and technologies. Research can help to assist the development of next generation capabilities across all hazards to confront the growing and evolving challenges of future decades.

Research must embrace the entirety of the resilience sector encompassing government, industry and the community to have maximum affect. It must also adopt a cross-disciplinary approach due to the many facets of risk and its impact on communities. Data provides an enormous opportunity to enhance research through improved approaches to collect, collate, share and analyse it, to answer research problems, inform decision-making and build future capability.

Natural Hazards Research Australia is Australia's national research and implementation capability for natural hazards resilience and disaster risk reduction. Established in July 2021, the centre is supported by the Australian Government and partner organisations across the country. The centre is built on the strong foundations of the previous Bushfire and Natural Hazards Cooperative Research Centre with a much stronger, end-user driven focus. It will deliver research that is useful, useable and used, and adaptable to the changing nature of natural hazards risk.

The Bushfire and Natural Hazards Cooperative Research Centre was highly successful in building research capability through the 250 researchers across 30 universities, plus 150 postgraduates supported by a strong scholarship program. In addition, more than 300 people across 50 partner agencies were engaged with the research. Through similar endeavours, the centre will lead this key role in maintaining and enhancing Australia's natural hazards research workforce.

Vital to the centre's future success will be working collaboratively across different complementary research initiatives and promoting partnerships between end-users and this journal is a significant channel to make this collaboration possible. I encourage your involvement in shaping and using the centre's research to drive change to make us all safe and resilient.

The New South Wales Flood Inquiry 2022: an appraisal

Chas Keys

Former Deputy Director General,
NSW State Emergency Service

As a country frequently and seriously affected by floods, Australia has seen many studies aimed at informing the management of flooding. Land use is perhaps the most critical issue at stake in the management of our floodplains.

Scores of studies have been undertaken over more than a century and a half, mostly in Queensland and New South Wales, which share about 80% of the national flood problem in terms of the dollar damage floods incur. In the Hunter Valley alone, between 1860 and 1914, 10 flood studies were commissioned by colonial and state governments to recommend measures that could reduce the harmful consequences of flooding on community interests.

The recommendations made by these and other studies have not always been taken up. Much advice has been ignored or implemented only at the margins. This outcome may largely be a result of the extreme costliness of mitigating the effects of floods. Flooding is a hazard that defies easy management and governments tend to look favourably on developmental initiatives without noting their downsides until after the severity of the associated costs has become apparent. Government involvement in levee building in NSW, for example, was limited until the 1950s and regulation to restrict housing on floodplains was largely absent before the 1970s.

The report of the NSW Flood Inquiry, the latest substantial flood study to be undertaken in Australia, was released in August 2022. It was commissioned after extreme flooding in NSW in Lismore and other Richmond River Valley communities in the state's north-east, together with repeated severe floods on the Hawkesbury-Nepean river system on Sydney's north-western fringe in 2021 and 2022.

The study, conducted by Mary O'Kane (former NSW Chief Scientist and Engineer) and Mick Fuller (retired Police Commissioner) had a very broad remit. It ranged more widely over the traditional emergency management elements of prevention, preparedness, response and recovery than previous flood studies had done. It investigated agency responses to the floods and made many recommendations about how flood problems should be managed at the agency level in the future. It found deficiencies in the performances of the State Emergency Service (SES) (the flood combat agency) and Resilience NSW, which had been charged with overseeing post-flood recovery. Recommendations were made to restructure the SES and to sharpen its future responses. The lack of planning for floods by the SES was highlighted along with a deficient regional structure. Resilience NSW, it was suggested, should be 'reshaped' into a new agency.

The inquiry's report holds out considerable promise, but it also disappoints in some respects. Pleasingly, the inquiry recognised the necessity of attacking the problems of flooding at their sources, which lie in the ways in which we use floodplains. Recommendations were made about buybacks and land swaps for people whose houses are subject to flooding: these are means of tackling the 'legacy' problems that have mounted over decades. The inquiry also recommended a explicitly risk-based approach to determining how future development on floodplains should proceed: this will reduce the reliance on statistical measures like the 1% Annual Exceedance Probability (AEP) standard that has dominated land-use decision-making in recent times.

It is abundantly clear that there has been (and still is) too much residential development on floodplains in NSW. We have not been sufficiently cognisant of how economically and socially unsustainable much of this development has been. Whole suburbs in Sydney's north-west have been, and still are being, built on land that will be little

affected by 'routine', frequently occurring floods but that will be hit disastrously by infrequent, but nevertheless inevitable, extreme floods. These will inundate the higher parts of the floodplains along the Hawkesbury River and the tributary South and Eastern creeks.

Less central than land use, but significant and also to be welcomed, is the recommendation that informal and 'unofficial' (that is, non-agency) response activity generated from within communities during floods should be facilitated. The recent example of Lismore's 'tinny army' showed what has always been known: people helping each other in dangerous times is necessary and can make a substantial contribution (including by saving lives). The provision of this help must be made as safe as possible, however, and the inquiry recommended training and resourcing to facilitate such assistance and ensure safety in its provision.

The recommendation that disaster (including flood) education be incorporated in school curricula is also welcome. People often fail to recognise that they live on a floodplain and, thus, do not understand the risk they are exposed to.

A number of the disappointing aspects of the report result from the extreme haste with which it was compiled. Little more than 4 months was allocated from the commissioning of the study to its completion, which allowed insufficient time to do the job justice. The result is that much detail remains to be filled in, for example, on how any buybacks and land swaps will be managed. What should be the eligibility criteria? How should risk-based assessments for future residential development be conducted?

There are many thousands of dwellings in NSW whose floor levels are below the levels reached by 1% AEP floods. This is the standard level above which residential floors of dwellings built today must be set (with a small freeboard). But much of our housing stock predates the era in which this standard has applied. In the Hawkesbury-Nepean, there are at least 5,000 dwellings whose floor levels are below assessed 1% AEP levels, and many more whose floors are above these levels but well within reach of extreme floods. The same problem applies on all the state's rivers, but the issue is most pressing in the valleys of the rivers that flow to the Tasman Sea.

Unfortunately, the report was unable to provide an answer to one of the biggest flood management questions currently facing the NSW Government – whether or not a raised Warragamba Dam would be appropriate as a measure to mitigate floods in the valley of the Hawkesbury-Nepean River. This important matter remains unresolved.

The report recommends that NSW Police be given an expanded role in the real-time management of floods. Police are vital in the conduct of many tasks that must be conducted in flood times, but their culture is one of law enforcement rather than the management of civil emergencies. It is doubtful that they can exercise better than the established, experienced combat agencies the leadership needed during emergencies.

Perplexingly, the inquiry struggled to come to grips with climate change in relation to flood frequency and severity. It calls for further research on the relationship; no bad thing in itself, but it seeks a verdict based on the legal principle of 'beyond reasonable doubt' rather than on 'the balance of probabilities'. The fact is that science has largely resolved the issue. It understands well that in a warmer world the atmosphere can hold more moisture to be triggered as rain when the appropriate weather drivers (such as fronts and east-coast low-pressure systems) appear. Thus, a warming atmosphere creates the preconditions for an intensification of existing flood problems. If more rain falls in a given period, the volume of floodwater produced will be increased, flood peaks will be higher and the problems created will be exacerbated. Likewise it is well established that sea levels are rising, with obvious consequences for coastal and estuarine storm surge flooding, erosion and the drainage of rivers.

The politics of floodplain management are difficult and Australia's history of policy diffidence in dealing with the consequences of flooding reflects this fact. The NSW Government has welcomed the recommendations of the inquiry, but we are still some way from knowing how far it will be prepared to go in actioning them. Given the politics involved, we should not be surprised if the response to the inquiry is marked by caution and a reluctance to go as far in accepting its recommendations as might be hoped. Nevertheless, the potential is there for the report to make a real and beneficial difference as far as the management of the flood problems of NSW is concerned.

The problems to be addressed are, of course, huge in terms of financial cost and they cannot be fully overcome. It is impossible to conceive of all residential properties on floodplains being removed and floodplains being sterilised from residential uses up to the level of the Probable Maximum Flood. Long-standing towns and suburbs would have to be abandoned if these outcomes were to be sought. Given this, the real question is how far government can go. Any move towards addressing the worst of the problem of past developmental mistakes on floodplains should be welcomed, as should more stringent restrictions on future floodplain development. But the lessons from the history of government responses to flood studies should caution us as far as expectations are concerned.

Australian conferences bring sectors together

The Australian Disaster Resilience Conference and the AFAC22 conference and exhibition were held in August 2022. This edition of the *Australian Journal of Emergency Management* includes a selection of the thought-leadership presentations.

The conferences included over 120 presentations in themes of 'Resilience in a riskier world, adapting and transforming for the future' and 'Connecting communities. Creating resilience'. Presentations were from a broad range of sectors including emergency services, research and academia, all levels of government and communities.

Notable contributions from the conferences have been selected for inclusion in this journal to provide readers with an overview of the ideas, research and innovation that were shared. The range of papers show the depth and breadth of knowledge in the emergency management sector covering recovery, disaster risk reduction, technology, forecasting, scenario-based training, mental health and collaborative futures.

AFAC CONFERENCE | NEWS AND VIEWS

Community-led disaster recovery – Mallacoota, Victoria

Jenny Lloyd
Carol Hopkins

Mallacoota and District Recovery Association

Like many other communities in 2019–20, the Mallacoota district in East Gippsland, Victoria was ravaged by fire. In our community's living memory, there is no comparable event.

Mallacoota is a small area with a population of around 1,200 that can swell to 8,000 at holiday times. In the summer of 2019–20, bushfires caused significant devastation of wildlife and bushlands with 83% of land area burnt and 123 homes destroyed. Since then, flooding and the COVID-19 pandemic have been cascading events that have disrupted and damaged the community.

This is our story of community-led recovery – what a small community can achieve and the lessons we've learnt along the way.

Establishing a recovery association

The Mallacoota and District Recovery Association Inc (MADRA) was established shortly after the fires. A group of locals – the Thinking Group – proposed a model for community-led recovery based on experiences of the Victorian town, Strathewen, in the aftermath of the 2009 Black Saturday bushfires. This model was endorsed at a community meeting attended by over 500 locals in February 2020.

Mission and Vision

Establishing a mission (why we exist) and a vision (what recovery looks like for the community) were important anchors to ensure recovery efforts were focused and targeted. As we worked through our mission statement, a 16-year-old hit the nail on the head: we are a 'voice' for our community.

Our vision is to be 'an inclusive, vibrant, strong and safe community', which will be achieved when:

- Everyone who needs bushfire assistance has received it.
- We have restored what we loved and fixed what was broken.
- We are prepared for future disasters.
- We have laid the foundations for a more resilient community.

Setting up MADRA

In partnership with Bushfire Recovery Victoria and the East Gippsland Shire Council, the Thinking Group put enormous thought into how MADRA might function and how the community ought to be represented. The Victorian Electoral Commission managed the formal election process, which was a first in the state, and 44 local people stood for 12 committee positions.

The committee comprised 6 men and 6 women ranging in age from 20 to 60-plus with diverse skills and life experience. Our first committee meeting was in June 2020, and we hit the ground running.

The first piece of team building was our nickname – the MADRats[1] – followed by the formation of an organisation structure and protocols, including a Code of Conduct. In the early stages, we decided that MADRA would not take sides on issues that divided the community. We developed 2 mantras: 'Do no harm' and 'Can we live with this decision?'. MADRA is now an incorporated association with charity with deductible gift recipient status.

Recovery framework

Our recovery framework drew from the concept of power: the power of networks, reducing inequalities and empowering people to make a better life for themselves.

Through our formal and informal networks, we identified people in danger of slipping between recovery cracks. We tapped the diverse talents of locals who willingly contributed their expertise, and we built strong relationships with local members of parliament, emergency services agencies, not-for-profit organisations and philanthropists.

A community is as strong as its weakest link. Houses and infrastructure can be rebuilt but shattered lives are harder to put back together. Initiatives addressing mental health support, case management, housing

and social connections were critical to individual and community wellbeing. Understanding the effects of broader political, economic, environmental, social and technological trends is important to empowerment. Our resilience projects included improving volunteer emergency service facilities, enhancing critical economic infrastructure and broadening and diversifying our economy.

What is community-led recovery?

There is no single framework or formula for community-led recovery, but at its heart, it's about communities proposing solutions based on local knowledge, preferences, priorities and (importantly) values. This includes sticking up for people whose circumstances don't fit neatly within established guidelines through advocacy.

Our values

Finding common ground is a challenge! An initial survey identified recovery themes, which informed our values-based approach, including:

- acknowledging the trauma resulting from the loss of homes, amenities, natural environment and infrastructure
- recognising the importance of social connections and community get-togethers to restore a sense of community
- ensuring a balance between maximising biodiversity and enhancing fire safety
- taking a strategic approach to rebuilding and extending community infrastructure
- broadening the diversity of our economy
- prioritising the love of our wilderness environment.

Community consultation

Pandemic restrictions and lockdowns initially slowed the momentum as face-to-face meetings that are crucial to the recovery program were not possible. When restrictions eased, we held sessions on a range of topics and invited relevant emergency services agencies to attend. This provided opportunities for sharing expertise and insights, and for members of the community to convey concerns.

We progressively released chapters of our draft recovery plan for feedback and asked the local community to vote on all suggestions received. Our community-led and endorsed Recovery Plan encapsulates the shared vision and provides context for agencies, philanthropists and grant applications.

An ongoing recovery story

Our first annual general meeting was held in August 2021 and the inaugural MADRA committee stood down and new committee members brought welcome energy and expertise. There is no 'cut off' point for recovery, and MADRats 2.0 faced a different set of challenges including residual 'wicked' problems like housing, adequate support services and fuel management.

Housing

Lobbying for social and affordable housing is our highest priority. Inflexible regulations have meant that available, relocatable housing could not be used. Practical and temporary solutions were also stymied by red tape. Currently, we have a shortage of workers who can help run businesses and the lack of accommodation for builders and tradespeople means the rebuilding of our district is hindered. The Victoria Government has committed to building 10 affordable and social houses. This is a welcome start, but more homes are needed.

Support services

Disaster recovery takes many years. At the 2-and-a-half-year mark, recovery services began to vanish. The abrupt way these services were withdrawn is lamentable. We had hoped for a transition period in which badly affected members of our community could get used to less support, build their own support networks and become familiar with new methods of support. When service contracts expired, staff moved on. Services ceased with little notice and there were no transitional arrangements in place. This caused distress to some people.

Fuel management

Our fuel management group achieved a Herculean task in bringing together all the relevant interest groups to develop a comprehensive plan to this complex issue. Will it be implemented? We need to know that our town will be safe before another such summer comes along.

What we have learnt

We've learned that communication is crucial but not everyone is in 'receive' mode. Hearing the heart of our community's wants and needs, being visible and available outside the Post Office was our best method of communication.

We are not a 'fourth arm of government'. Community-led recovery means we can no longer simply present problems; we've got to come up with solutions and priorities. As volunteers, we have limited capacity, so we learnt that not everything related to recovery is our responsibility.

Politicians and bureaucrats are not our enemies. Building relationships and trust with people in government and emergency services agencies has been crucial to our recovery effort.

Some members of the community are still traumatised and acceptance of what has happened is hard. But our inclusive and transparent approach to establishing our endorsed Recovery Plan has helped in the healing process.

Visit the MADRA website[2] for information and resources including the Recovery Plan, community consultation material and voting report webinars. Contact us directly via madra.3892@gmail.com.

Watch the ABC TV series People's Republic of Mallacoota currently on ABC iview.[3]

Endnotes

1. Mallacoota and District Recovery Association Team = MADRats
2. MADRA website, at https://madrecovery.com/.
3. *People's Republic of Mallacoota*, ABC iview (in Australia only), at https://iview.abc.net.au/show/people-s-republic-of-mallacoota.

AFAC CONFERENCE | NEWS AND VIEWS

Preparing for recovery: building connections through exercising

Mark Drew
Wendy Graham

National Emergency Management Agency

In recent years, people around the world have experienced an increase in the frequency and severity of extreme events; from bushfires to floods and pandemics. In Australia, the Royal Commission into National Natural Disaster Arrangements 2020 determined that Australia increasingly faces cascading, concurrent and compounding natural hazards and that 'stress testing' disaster plans and evaluating outcomes will be crucial for the future.

The royal commission found that the extent and nature of recovery exercising varied across Australia's jurisdictions, with exercising being irregularly or inconsistently undertaken in an integrated fashion or not having the capacity to develop specialised recovery exercising.

The ongoing challenges in recovery from events like the Australia's 2019–20 summer bushfires and 2022 floods highlighted that planning and exercising for recovery is as important as planning and exercising to respond. Integrating recovery exercising into regional and local emergency management programs is critical to build holistic approaches to preparing for, responding to and recovering from extreme events.

While emergency management exercising programs are mature and well-practiced across Australia, historically, exercising has focused on arrangements for the emergency response to, and immediate relief from, an event. The recovery phase has been included as the final element in an exercise scenario, often with limited time for discussion or consideration of the complex issues. While recovery starts at the same time as the response, it is long-lasting and complex and involves a broad range of community and stakeholders.

Regional Recovery Exercising Program

The Regional Recovery Exercising Program has 2 components of:

- a Recovery Exercising Toolkit
- a pilot program of regional recovery exercises.

Recovery Exercising Toolkit

The Recovery Exercising Toolkit (Figure 1) is a national resource that supports recovery planning and capability development through exercising at the regional and local emergency management levels. It also supports emergency management committees, local councils and other groups through evidence-based guidance and a set of specialised resources to enable emergency planners to follow a pathway in a recovery discussion exercise.

A focus of the program is achieving greater engagement, partnership and collaboration between the emergency management sector and local community services organisations and businesses in recovery. The toolkit is a suite of modules on a range of considerations that exercise planners can include in a recovery exercise day. The modules were designed at an 'exposure/introductory level' aimed to increase the understanding of participants of recovery topics and encourage further planning and action. Each module was developed with the contribution of subject-matter experts and based on research and practice and includes recovery resources.

Companion document to the Australian Disaster Resilience Handbook Collection

The National Emergency Management Agency (NEMA) partnered with the Australian Institute of Disaster Resilience (AIDR) to develop the Recovery Exercise Toolkit as a companion document to the Managing Exercises and Community

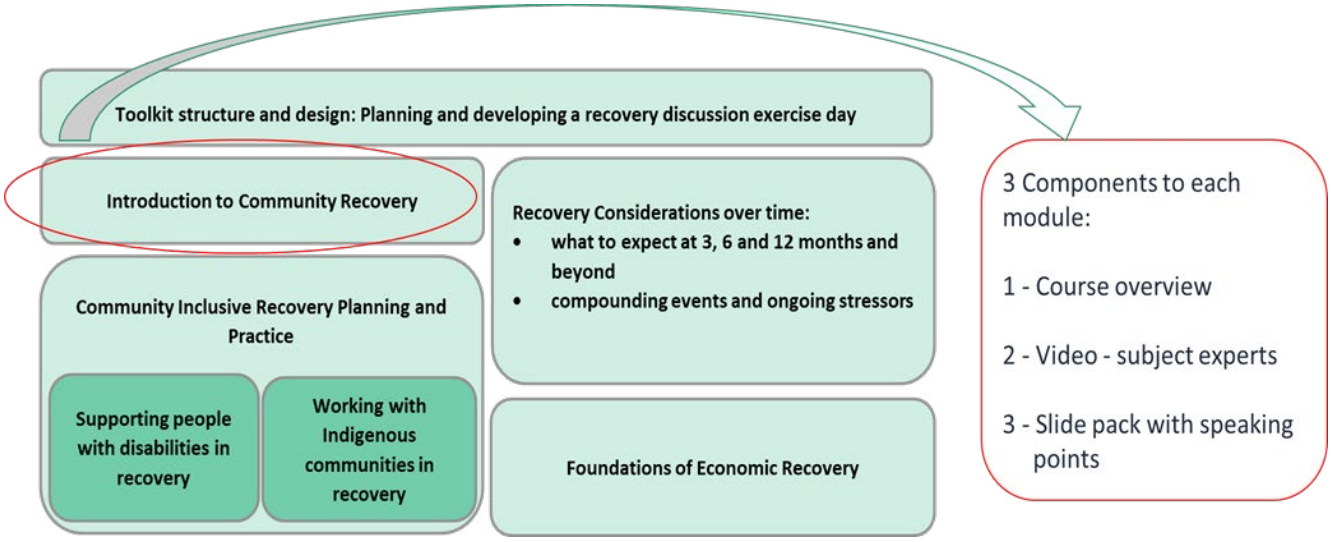


Figure 1: The Recovery Exercising Tools help planners step through a standardised method to develop an exercise.
Image: National Emergency Management Agency

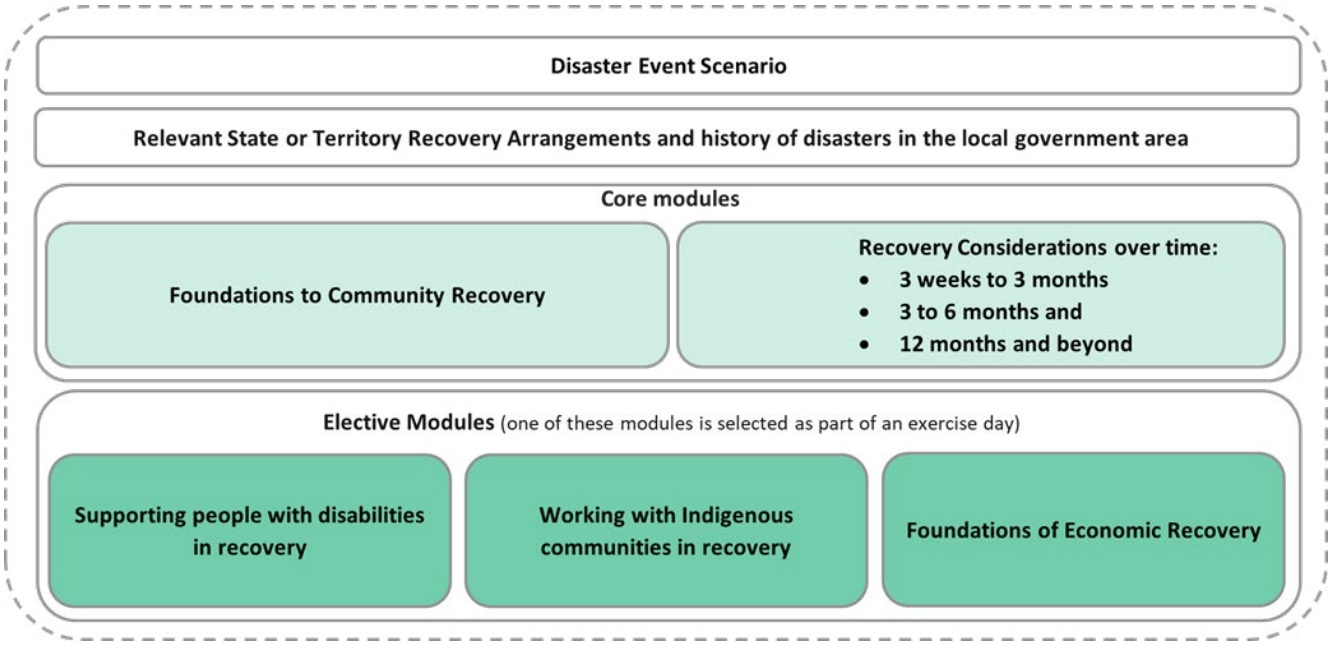


Figure 2: The components of an extreme event recovery planning exercise scenario.
Image: National Emergency Management Agency

Recovery handbooks in the Australian Disaster Resilience Handbook Collection. The collection provides a source of knowledge about disaster resilience principles and practices in Australia. Incorporation of the toolkit into the collection will help consolidate recovery exercising as a standard module in emergency management exercises.

Recovery exercise day components

Recovery exercises are designed as full-day activities. Central to the exercise is a disaster scenario based on local context, risk factors and historical data of the local government area or region. Scenarios are developed in collaboration with local emergency services organisations. The aim of the disaster scenario is to set the context and background for discussions. The exercise recovery considerations commences at the 3-week post-disaster timeframe and extends to 12 months and beyond.

Figure 2 shows the components of a recovery discussion exercise.

Pilot recovery exercises

To develop the program, 3 pilot recovery exercises were facilitated by NEMA in 2021 and 2022 with around 130 participants attending. The exercises were conducted in:

- Livingston Shire, Yeppoon, Queensland
- Barossa Emergency Management Zone, Hewett, South Australia
- Break O'Day Municipal Council, St Helens, Tasmania.

The purpose of the exercises was not to 'stress test' a system or plan but to encourage collaborative and explorative discussions about recovery issues and challenges likely to be encountered in the short-, medium- and long-term phases of recovery. Outcomes from the pilots informed recovery planning processes.

A range of agencies included state and local governments, emergency services organisations, community organisations, volunteer groups, businesses and the private sector. Exercise invitations were targeted to those organisations likely to be members of a recovery committee. There was a strong representation by local government with 14 councils participating in the 3 exercises:

- Queensland: Central Highlands, Livingston, Rockhampton
- South Australia: Light, Town of Gawler, Adelaide Plains, Adelaide Hills
- Tasmania: Break O'Day, Kingsborough, City of Hobart, City of Launceston, Huon Valley, Glamorgan-Spring Bay, Northern Midlands.

Feedback from the pilot exercises

The pilot recovery exercises were facilitated by the NEMA and participant feedback was overwhelmingly positive (see Figure 3). Participants highlighted the value of an emergency management exercise with a recovery focus and the opportunity to discuss recovery considerations and challenges with a network of emergency management practitioners.

Comments from participants included:

...a better understanding of recovery and what happens after the response phase.

...great opportunity to establish network connections and discussion on recovery.

Breadth of representation in the room... acknowledgment of a broad range of perspectives from represented agencies, groups and individuals.

Figure 3: Feedback from the pilot exercises in South Australia, Tasmania and Queensland.

Conclusion

The recovery exercise format provides a strong methodology for sharing and exploring recovery challenges and practice in an identified context, beyond stress testing a system or process. It gives practitioners practical guidance and specialist resources that support the development of recovery-focused scenarios that align with local context and vulnerabilities. Planning for each pilot recovery exercise was a collaborative effort across national, state and territory and local government levels. This partnership approach of the program across all levels of government and with emergency services and recovery planners will help to promote recovery exercising as a priority in emergency management programs.

Endnote

1. Royal Commission into National Natural Disaster Arrangements Report, at https://naturaldisaster.royalcommission.gov.au/system/files/2020-11/Royal%20Commission%20into%20National%20Natural%20Disaster%20Arrangements%20-%20Report%20%20%5Baccessible%5D.pdf, p.28.

AFAC CONFERENCE | REPORT

Demonstrating impact through digital data transformation for the 2019–20 bushfire recovery program

Leanne M. Kelly[1,2]
Lauren Lombardi[1]
Erin Pelly[1]

1. Australian Red Cross
2. Alfred Deakin Institute, Deakin University

Abstract

This paper overviews our transition to digital data collection as an element of a systemic overhaul of Australian Red Cross emergency services monitoring and evaluation. We use the 2019–20 summer bushfires recovery program as a case study to demonstrate how the digital data transformation was implemented. The purpose of this change was to better measure and show outcomes and also to pay close attention to practitioner needs and utilisation of findings for program improvement, accountability to all stakeholders and knowledge generation.

Introduction

Monitoring and evaluation (M&E) in not-for-profit organisations is often hampered by resourcing issues including insufficient time and money, which can affect data accuracy and relevance (Bamberger *et al.* 2012). Limited utilisation of findings is a common result that is well established in the evaluation literature (Alkin & King 2017, Kelly 2021a, Snibbe 2006, Stufflebeam & Coryn, 2014). Despite this, the push for not-for-profit organisations to demonstrate their impact is accelerating (Kelly 2021b).

This paper overviews an aspect of our systemic M&E response in the domestic emergency services team at Australian Red Cross. Through this work, we sought to address calls for demonstrable impact while remaining sensitive to the need for utilisation. This paper outlines the data collection of our monitoring strategy, noting that monitoring is an integral element of effective programming that is regularly sidelined in favour of stronger focus on evaluation (Boardman 2019, Kelly & Reid 2021). Briefly, we define monitoring as:

> *...the tracking and checking of input, output, and outcome data that is continuously and methodically collected while evaluation refers to a judgment of the merit, worth, value and significance of a program or product.* (Kelly, Goodall & Lombardi, p.1).

We have a small M&E function in emergency services at Red Cross based in Naarm/Melbourne on the unceded lands of the Kulin Nation. At the time of this digital data transformation, the M&E team consisted of 2 staff job-sharing one full-time position, situated in a wider team of nearly 250 personnel spread across the nation. We note this to highlight the level of resourcing we had available to develop the M&E system in emergency services. Having this internal function was invaluable at helping drive nationwide teamwork towards streamlined M&E systems and practices, as well as supporting development of evaluation literacy and capacity through consistent presence and stance (Rogers *et al.* 2019, 2021). The internal function enabled an holistic vision for M&E in the team, highlighting the importance of internal evaluation (Kelly & Rogers 2022, Laubli Loud & Mayne 2014, Sonnichsen 2000).

We have spent several years methodically and collaboratively working to connect the dots and create a system built on a foundational theory of change with relevant and meaningful data collected accurately and regularly to feed into evaluation and reporting. Stepping through the phases undertaken, this paper outlines how we transformed from haphazard and inconsistent collection of poorly considered piecemeal data, to a streamlined system of digital data collection where data were collected and utilised purposefully.

Background and building a solid foundation

During the bushfire season of 2019–20, devastating fires swept across eastern and southern Australia with massive and tragic consequences for communities. The extent and severity of the fires was unprecedented in Australian history (Davey & Sarre 2020). The Australian Red Cross plays a key role in emergencies, one of which is supporting communities to recover from disasters. Running across 4 states and 46 local government areas, the 2019–20 bushfire recovery program is the largest in Red Cross history. Due to the scale and urgency of this disaster, we needed real-time information about community needs and the organisation's ability to embed adaptive and timely responses to our recovery program across multiple regions. Working in so many areas and communities, with various local Red Cross teams, we needed to think differently about how we were going to collect this data.

To achieve this, the M&E team developed a framework and theory of change, articulating emergency services goals and outcomes for the program (Markiewicz & Patrick 2016). This was an evidence-informed and collaborative process between the national emergency services team and the state and territory teams, which drew from several pre-existing frameworks (e.g. Argyrous 2018, Commonwealth of Australia 2018, Inter-Agency Standing Committee 2017) as detailed elsewhere (see Kelly *et al.* 2022). Using an Agile management technique to enhance buy-in and relevancy (Beekharry 2017), we worked with personnel to develop measurable indicators for each of the program outcomes.

The next phase was for the recovery teams to develop logframes, based on the framework, for each state and territory. This allowed teams to articulate what they hoped to achieve and align those desires with overall program outcomes. They then mapped their field activities to the outcomes and indicators to ensure the data input was consistent, accurate and measurable.

Moving to digital data collection and analysis

The national emergency services team determined that digital data collection was essential due to the size of the recovery team as well as their wide geographical spread. A transition from collecting data in spreadsheets to live digital data collection would mean that teams could report directly in the field as well as allow the national team to have real-time data oversight and transparency. This was imperative for us to be successful with our recovery work.

To implement this digital transformation, the national team co-designed digital activity reporting forms with locally based personnel on a mobile data collection platform called Fulcrum. This collaboration was vital for supporting relevancy, ensuring ease of use in the field, and moving people away from thinking of reporting as a compliance exercise to a purposeful, useful, and empowering aspect of their work (Patton 2012, Rogers *et al.* 2021, Wadsworth 2011). Guidance documents, support and training for end users was key to our implementation and the success of this transition.

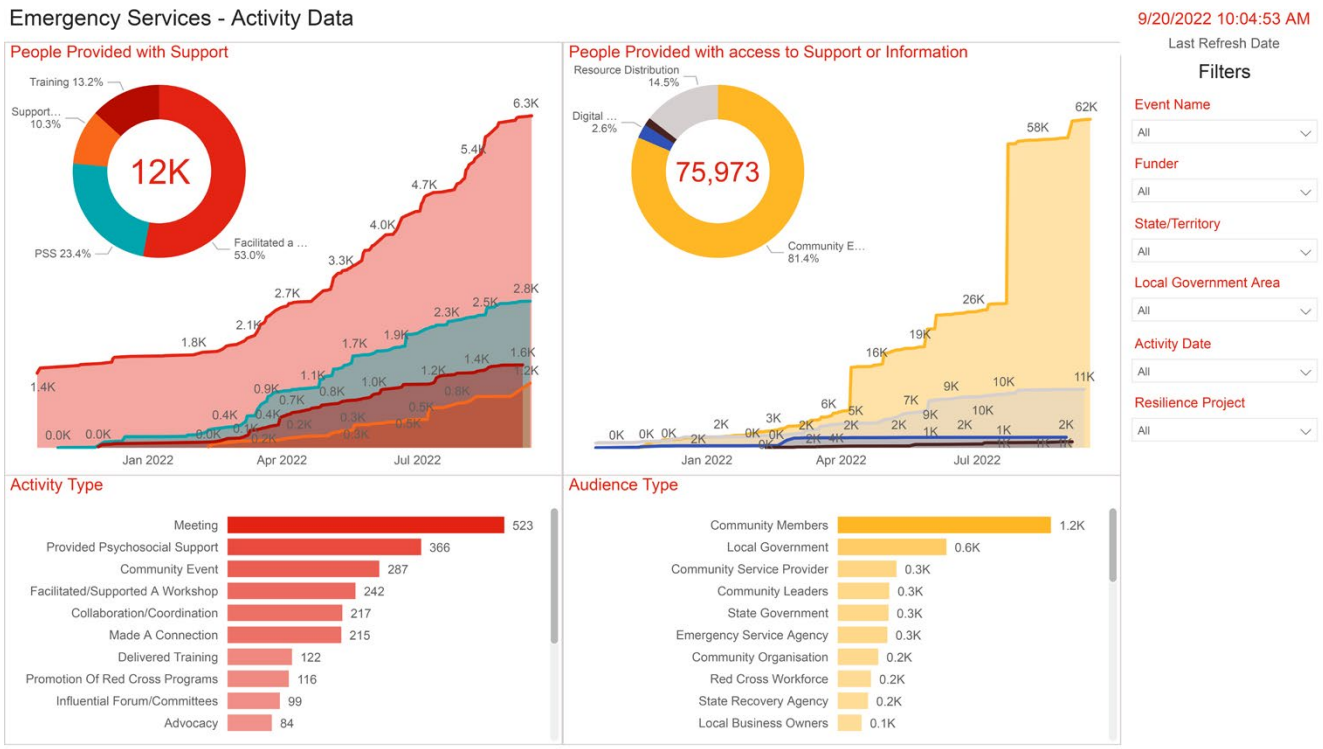
The national team now had recovery teams reporting real-time data from the field, but accessing the data necessitated that it was downloaded into spreadsheets. This was problematic and inefficient and made the streamlined ease of digital data collection redundant. The solution was dashboards, which automatically exported the quantitative data into graphs and tables that allowed us to visualise, in real-time, the data coming from the field. For the first trial of dashboards, we used the software program Tableau. This change in data collection and real-time reporting, through digital tools and visualisation, meant that data were received quickly and accurately, resulting in teams being able to use collated data for program planning and advocacy to address the needs of communities in a timely manner.

In addition to the quantitative data, important qualitative data that captured community voices were being collected via the Fulcrum app. Every day, field teams received feedback and information about the issues facing community members. This included what communities were feeling, their recovery needs, frustrations and stories of success and resilience. While field teams knew intimately the challenges and successes facing community members at a local level, what we heard from our stakeholders was that this information was not reaching decision-makers within and beyond the Red Cross. This highlighted the value of analysing and reporting key and emerging findings on a regular basis to provide stakeholders with evidence and insights for decision-making. Analysis of data is reported in monthly community sentiment reports, which are distributed to people working in recovery within and beyond Red Cross to support planning and coordination conversations and actions.

While these monthly reports are highly valued by stakeholders, compiling the reports was time consuming and resource intensive as the qualitative data submitted was often poorly entered and vast, with hundreds of entries per month. Making sense of the data required analysis skills to theme the data in the most meaningful manner. We used the recovery capitals (ReCap) as a framework for thematically analysing the qualitative data (Quinn *et al.* 2021). ReCap was developed by researchers at the University of Melbourne in collaboration with Red Cross, Bushfire and Natural Hazards Cooperative Research Centre, Massey University and others. The framework sets out 7 key recovery domains: social, built, human, political, natural, financial and cultural. This gave the analysis a logical structure and helped guide stakeholders to the information of greatest relevance to them and their programmatic mandate.

Data utilisation

Stakeholders from all levels of government, community members, service providers and emergency services policy makers highlighted the previous lack of information as a gap and expressed keen interest in the information collected by Red Cross field teams, noting its ability to provide details and evidence from



An example of how we quantify and demonstrate our work through graphs.

Source: Australian Red Cross

the ground to inform recovery policy, planning and activity. Field staff noted that having detailed reports, which highlighted issues facing communities beyond their immediate locale, allowed them to understand concerns that could present at a future time and helped them advocate and put prevention measures in place to address those issues. This qualitative data collection allowed field teams to inform, advocate, and influence external considerations to promote community voice in recovery planning and ensure that community strengths and needs are included. By providing easy-to-understand and relevant evidence from the field in a timely manner, Red Cross field teams were able to support responsive recovery work that was tailored to community needs as they emerged. These reports allowed improved collaboration with local government workers as they were able to anticipate and plan for issues seen in other areas.

The dashboards that present the quantitative data and thematic reports allow teams to regularly monitor their work and assess whether and how things are tracking towards positive outcomes for communities. We use the information to inform internal and external reports and respond quickly to community needs. This method of evidence generation has been effective for executive buy-in and helped us influence the sector at the local, state and national levels.

The use of this information means our work is driven by evidence from the field, which supports learning, generates new knowledge, provides information for advocacy and contributes to overall program development and innovation. Throughout the process of developing a strong M&E system, we have maintained a focus on utilisation, recognising that without utilisation M&E is pointless (Kelly 2019, 2021; Patton 2012). In particular, keeping a focus on downward accountability to communities has been especially useful at helping us stay on track and create a system that contributes to and aligns with Red Cross organisational purpose and humanitarian principles.

Implications and next steps

Using the lessons and techniques learnt throughout the 2019–20 bushfire recovery program, we went through a 6 month review process of our data collection tools and visual applications. This review considered the possibility of extending digital reporting across all emergency services within Red Cross. After a collaborative and informative review, the data collection tool was changed from Fulcrum to Kobo Toolbox and dashboards from Tableau to PowerBi. Both changes have been positive from an end-user perspective and in terms of accessibility across the program. In addition to displaying the quantitative data, through PowerBi we used Kobo Toolbox to collect our qualitative data and display the themes on dashboards. This meant teams have narrative available to them instantly and are not reliant on others to manually analyse the qualitative data before producing reports. We continue to produce the monthly community sentiment reports for personnel and external stakeholders to use for program planning and advocacy, but we have reduced the burden of analysis by 80% by streamlining the way data are collected and visualised.

Since January 2022, we have implemented digital reporting that provides visibility across the activities occurring in real-time. This includes response work for the 2022 floods in New South Wales and Queensland as well as our extensive community disaster resilience work across the country. Having high-quality monitoring data available has positive ramifications for improving our ability to support and advocate for communities. It enables us to share evidence of our contributions and community strengths and needs with our partners including other actors in the emergency management sector and government bodies. Additionally, the wealth of data available means we can evidence our value over time. This frees capacity for us to use evaluation consultants to examine narrow areas of interest rather than producing surface-skimming reports regarding basic program or project-level effectiveness. While we have come a long way, we continue to learn from this work, listen to our teams and community members, improve our systems and use data to track the stories of communities.

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AFAC CONFERENCE | NEWS AND VIEWS

Creating culture change through inclusion

Michael Morgan
Sally Woolford

South Australia Metropolitan Fire Service

What if we changed the way we approached culture, diversity and inclusion in an emergency service? How can we foster a culture of respect and safety; taking a male-dominated organisation to modern-day work practices?

In 2017, the South Australia Metropolitan Fire Service (MFS) underwent an independent review into its organisational culture that was conducted by the South Australia Equal Opportunity Commission. The review found an embedded culture where diversity was frowned upon, inclusion not seen as a necessity and gender inclusion seen as tokenistic.

As one of the oldest fire services in the world, the MFS needed to move forwards, ensuring existing employees are included and that it becomes an attractive employer for future recruits and staff with diverse backgrounds, skills and experiences.

Recognising these issues, a change project was commenced. MFS recognised that it did not have the skills nor expertise to progress change internally and engaged an external consultant to help guide and advise on the changes required.

Unpacking the report by the Equal Opportunity Commission, listening to the journey taken already in terms of recruitment and drawing on experiences of the external consultant from the SA Police cultural reform, a plan was created.

Our approach

Fire services in Australia tend to have a hierarchical, para-military and patriarchal structure. Firefighting operations rely on a command-and-control structure to respond to incidents quickly and efficiently. Employees tend to have long careers, so relationships between them can be very strong and traditions are maintained with pride. This shapes the culture of an organisation and can limit the speed of change.

Any change cannot be successful without engaging the people it affects in real and relevant ways. An announce-and-defend approach creates mistrust and misconceptions of the change. They rarely play out well and the change is often unsuccessful.

People-centric, co-design approaches have been used for all the changes underway for diversity and inclusion within the MFS. Our changes occur *with* people *for* people, not *to* people. This required a mindset shift.

Our actions

Creation of a Diversity and Inclusion Advisory Committee – a group of MFS employees who volunteered to have oversight and provide a lens on the work to be undertaken. This group is an important aspect of all the changes. They provide operational, cultural or demographic insights to the changes, provide input on what and how the change looks like and give feedback on communications for implementation.

One of the first actions undertaken was to understand the current diversity demographics by answering the questions:

- Who are we?
- What does diversity look like in the MFS and what are we looking for?
- Beyond diversity demographics, what other aspects of our identity are important?
- What skills are important and how can they benefit the MFS?

We can now map and monitor the diversity data and embed it into our processes.

A clear vision –we needed a vision which was inclusive and showed every employee that they can feel a part of the organisation and can contribute. The MFS Culture and Diversity Vision is: ‘an

Assistant Chief Fire Officer Peter Button experiencing virtual reality scenarios of 'power' and 'exclusion'.
Image: Sally Woolford, South Australia Metropolitan Fire Service.

organisation that reflects its community where all feel respected, safe, and valued'. Every change we implement aligns with this vision.

Culture and Diversity Plan – beyond diversity and inclusion, we wanted to increase focus on culture. Our culture (or cultures as is sometimes the case) is everything that makes a fire and emergency service either a great employee experience or one that isn't so great. Culture underpins everything that we do, from our relationships, the way we lead and treat each other and how we work together to deliver services.

The key areas of the Culture and Diversity Plan include:

- Culture and Behaviour – developing a more inclusive, values-based culture
- Diversity and Inclusion - a workforce more representative of our community
- Inclusive Leadership – a role model for culture, diversity, and inclusion
- Employee Wellness – a healthy, safe, and sustainable workforce
- Change Management – find innovative and flexible ways to create lasting change.

Continued focus on employee safety and wellbeing – employee safety and wellbeing (particularly mental and physical health) are pivotal parts of culture and are an enabler or detractor from how happy and safe we feel at work. If it isn't fair or we don't feel safe, or our mental health and wellbeing is affected, then we feel unhappy at work. Happy employees means great performance and outcomes.

Focused communications, awareness and training – creating training and awareness approaches aimed at increasing confidence and understanding as well as the role everyone has to each other. These were built to recognise the unique context of MFS while bringing in new thinking and challenging stereotypes.

Our training approaches:

Leading Diversity and Inclusion training – enabling leaders to understand the 'why of D&I' and how they can play their part. For some sessions (pre-pandemic) we used virtual reality technology in this training.

Online learning module – incorporating videos, humour, and key compliance information to take employees on a 30-minute guided journey from the 'why' to the 'what' and 'how'.

On-request presentations – going out to fire stations and offices to support their learning about what is culture, diversity and respect and what does it look like here?

Revising workplace behaviour – inclusive and safe cultures hinge on respectful behaviour. They are an enabler for how an employee experiences the culture of an organisation, what the organisation stands for and how the organisation responds when there are instances of inappropriate behaviour.

MFS policies and practices had gaps and we needed to create a new policy combining conflict, bullying and harassment (including sexual harassment) into one policy and process. This provides employees a one-stop shop irrespective of the type of behaviour. They don't need to identify or categorise the behaviour, rather that it is inappropriate.

We've worked collaboratively with the United Firefighters Union SA and representatives from across the organisation to establish a diverse working group. As a working group, we co-designed the policy and processes and built something unique.

Our approach has some underpinning practices:

Zero tolerance – adopting a zero-tolerance approach to inappropriate workplace behaviour means we are committed to providing safe, healthy and respectful workplaces that are free of bullying, harassment (including sexual harassment), discrimination and victimisation. Zero tolerance isn't an unrealistic expectation that there will be zero instances of inappropriate behaviour. It is merely a standpoint that when it does happen, we are firm in our approach.

Compliance but accessible – we improved compliance with values, community and government expectations, such as a Code of Ethics/Code of Conduct and legislation by adopting the practice approaches outlined by SafeWork Australia and the Australian Human Rights Commission Respect@ Work Report while customising them for the MFS context.

Transparency – we reviewed other policies and practices and found that most had policy position statements but limited process. Transparency is important when encouraging people to comply. When someone submits a complaint, they want to know they've been heard and won't have to tell their story multiple times and that the complaint will be taken seriously.

Consistency – providing a fair and consistent framework and processes where expected behaviours and consequences are clearly defined and communicated builds trust and confidence in the system.

Confidentiality – covers workplace behaviours, how it is maintained and when it may not be able to be maintained.

Early intervention – if you can stop inappropriate behaviour early, you can prevent it from escalating. Catching it early enables learning, increased confidence in the zero-tolerance approach and opportunity for those involved to stop behaviour quickly.

Equally, and just as importantly, we've reviewed our honours and awards policy and have included additional ways to recognise positive behaviour and performance. It's not just about focusing on negative behaviours but encouraging positive ones and for them to be broadly recognised.

Fundamentals to successful culture change

We have learnt a few fundamental aspects:

Commitment – without commitment you cannot change culture. This isn't just commitment from the top but real commitment in every part of the organisation. You need those who are committed to know how they can be a part of the change and support it.

Consistency – continuing to 'drip feed' the vision and its goals into everything, embedding diversity and inclusion into part of the everyday experience. Always looking for opportunities to embed messaging into training and communications.

Challenging – being prepared to challenge the current ways of working and creating momentum to what could be. Work like this is tough and you need to be brave and challenging while having resilience. Not everyone will like every change and not everyone enjoys the journey.

Confidence – taking a leap to trust an external voice that knows how emergency services work but with a culture lens.

Inclusion, equality and belonging and our approach to change is integral to our culture. They are a part of how culture feels to our employees; their lived experience of the MFS: 'Can I bring my true self to work?', 'Am I included and treated as an equal?', 'Do I feel safe here?' 'Can I thrive here?'.

The safety and wellbeing of a workforce is a result of its culture and practices. The expectations of future employees, societal expectations and legal requirements have changed. Every workplace needs to identify and set its bar higher to ensure that everyone is included, can contribute and that they feel they belong and are valued.

We've set our bar higher and are on our way to achieving a better workplace culture.

AFAC CONFERENCE | REPORT

‘I thought you were more of a man than that’: men and disasters

Dr Debra Parkinson

Gender and Disaster Australia, Melbourne, Victoria.

Abstract

The lived experience of men in disasters is unexpected. This paper draws on 10 years of research and publications focusing on interviews with men. Research in 2013 with 32 men and in 2018 with 26 men (aged 18–93 years) exposed the harm of gendered expectations. Men’s narratives were harrowing; not just from a disaster’s physical danger but equally damaging were assessments by society of men and how well they live up to the challenges of disasters. Masculinity was judged and consequences in the workplace and the home followed. Men rated their own perceived ‘failures’ and spoke of the barriers they faced in coming to terms with their experiences. Whether first responders to extreme events or young and old men caught up in disasters, men spoke of expectations from society, people in the workplace and family that they should be strong, stoic, brave and decisive. The literature identifies that gender stereotypes are more stringent when related to disasters. In the aftermath, the pressures only increase and are amplified by the very real barriers men face to access help to cope with their experiences. Disaster risk reduction will be enhanced by policies in the emergency management sector that prioritise wellbeing for its workers.

Introduction

We are all gendered. There’s no escaping that society attempts to shape us from before we’re born. Fifty years ago, the social conditioning started with a blue or pink blanket for newborns in hospital. Now it’s a ‘gender reveal’ party with a fetus. All very necessary when society treats people differently depending on their gender. Cordelia Fine (2010) observed that children quickly learn the ‘codes’ for boy and girl, moving from being gender detectives to gender enforcement agents (Apter 2010). The different status given to people depending on their gender lasts a lifetime. This can be harder to see as men become very old and dependent and somehow lose their status in the eyes of the world. Our society is ageist as well as sexist.

About gender

Ours is a patriarchal society evidenced by the normative, structural and systemic discrimination of men against women, for example, in pregnancy, childcare, the pay gap, objectification of women and violence. This is the dichotomy – or ‘binary’ – of male and female. It is signified by the tick boxes of M or F in data collection. In a recent and small recognition that gender is complex, a third tick box of 'Other' is appearing. Yet the dominant paradigm of male and female persists as the central organising framework of society (Pease 2019) with heterosexual men predominantly in charge. Indeed, the dominant paradigm assumes ‘real’ men are both masculine and heterosexual, and their privileged status is dependent upon both. Disaster researcher, Duke Austin writes:

> *The gender categories of feminine and masculine, emerge from the interaction of a group of people at a particular time and in a particular place within a system of power struggles, differences, and negotiations. Categories of understanding are therefore contextual, yet humans act as if the categories were real, which makes the categories real in their consequences (Thomas 1923).* (Austin 2008, p.2)

The great test of manhood

In disasters, the consequences are very real. This article considers the costs that accompany privilege of men. It draws on 2 research projects, both with ethics approval from Monash University.

In 2013, the late Claire Zara and I interviewed 32 men for the Men and Disaster research (Zara & Parkinson 2013, Parkinson & Zara 2016) and interviews with 26 men followed in 2018 (Parkinson, Duncan & Kaur 2018, see also Zara *et al.* 2016, 2022 and Parkinson *et al.* 2022).

In one interview, Pete[1] told us of the life-threatening experiences he and his young family faced on Black Saturday. He recalled crying at work some weeks after. A colleague said to him: 'I thought you were more of a man that that'. The sentence is dripping with expectation and judgement ; a judgement of failure. Almost 10 years later, Pete has no trouble recalling in detail the words and the tone.

Disaster research tells us men frequently feel they failed the test of their manhood. Just under half of the men interviewed spoke of regret and shame.

> *Absolute hyper vigilance. Very high, high pulse rate all the time, very rapid thinking, a lot of awareness and thinking about what I did wrong. All the things I could have done that could have kept us safer or saved the house, and I guess some guilt or shame.* (Edward)

Objectively, it was impossible to live up to the prescribed role for men to 'protect and provide', but self-blame persists. The stakes are high. Edward continued:

> *We were putting out fires around the place and then the fire came in through the east side… There was one moment where I thought, 'Oh jeez… I have killed my whole family'.* (Edward)

In most research, we learn as little of men's emotional work as of women's physical work (Enarson & Morrow 1998). The 58 men we interviewed **did** that emotional work. They had the courage to reflect on their experiences and the impact on their lives and gave us their insights. Their emotions were in plain sight and we are the beneficiaries. Some had 30 or more years of trying to work out why their disaster experience did not fit the script they had followed since the blue blanket was wrapped around their tiny bodies. Why were they now trapped and accused and haunted?

Catastrophic disasters test our mettle. To pass the test, the men we interviewed said they needed to be brave, heroic, decisive, unemotional and stoic – and right in their decisions. Men, no matter how they expressed their masculinity, were helpless in the path of infernos like Tarrawingee fires in 1943, Ash Wednesday in 1983, Black Saturday in 2009 or devastating floods in Victoria's north-east in 1974, 1993 or 2011.

> *I didn't know I had the emotions that I did. I mustn't be this big strong bloke after all. Just as soft as the rest of them.* (Aaron)

> *I should have just stuck my head up my bum and put a wet towel over my head and not witnesses nothing. But I had a job to do and I just didn't think that it would affect me that much… I wouldn't do it again. I've always been strong-minded and I don't scare easily but that scared the shit out of me.* (Gerald)

There are expectations regarding performance of masculinity and femininity and there are rewards or punishments based on how well individuals conform to stereotypes (Demetriou 2001, Messerschmidt 2009). So-called 'heroes' in disasters and front-line responders are assumed to be both masculine and heterosexual (Leonard *et al.*2018, Parkinson *et al.* 2021). Society monitors it. Family monitors it. Communities and workplaces monitor it. Like Edward, other men were hurt by the thought of what could have happened and how close they and their families had come to dying in the fires.

> *One of my friends really, really struggled … that he fled at the last minute and drove through fiery conditions with his young son and could have been responsible for their deaths … He managed to keep telling himself a story of failure around what he would understand as a traditional male role.* (Paul)

The pressure to 'measure up' to prescribed masculine behaviours was not restricted to self-imposed reflection, but a community and media judgement about what they did on the day. In our interviews with 30 women (Parkinson 2012), some sadly reflected that their male partners seemed to relive the danger they felt in saving, or attempting to save, others, and blamed themselves for not doing enough. The death of neighbours was a source of great pain to men and a constant reminder of their own perceived 'failure'. Regrets haunted men. For some, no matter what they did, it was not enough.

> *[The concept of] 'I am a man, and I can do' has been defeated in so many men. Things they couldn't do and they couldn't be and so much was lost.* (Madeline)

In our research, most of the men spoke of having to shut down emotions in order to stay 'in control'. Very different men felt this pressure. Paul said, 'I think the majority of men suffered in silence'. One man chose to be angry at work in order to prevent colleagues being kind and potentially causing him to cry. Several coped by leaving the room if there was any discussion about the fires. When asked about men's strengths, Steve said:

> *The ability to shrug things off, which isn't a strength at all is it? It's just a denial really isn't it, shrugging something off? … It's not so much admit defeat, but self-preservation … If I don't pull up here, I'm going to drive myself into the ground and be good to nobody.* (Steve)

1. Pseudonyms are used throughout.

We started to see fire trucks... and I just bawled...[But] I switched it off. I thought if I don't, it's going to overcome me. (Walter)

Men intuitively knew penalties would follow their honest expression of human reaction to disaster. As 'heads of the family', they felt they had to deal with their feelings alone.

My second eldest son was with me, and grandson … I was the father figure and they had me to lean on, or felt I was their protector. So they didn't have the fear that I had … I'm at the forefront … I was there as their fatherly figure, and they felt protected. Whereas I didn't have any protection. (Alex)

[T]he little girl … was bloody terrified [I said],' I promise you I'm not going to let you die' and I just kept saying that over and over again. There's nobody around to say it to me is there. (Todd)

Barriers to getting help

For men, the risk of not managing emotions was too big. Many spoke of consequences for not being in control, or struggling with grief and loss in the workplace. The penalties extended to being sidelined, no longer thought of as reliable, and not promoted. If I tell someone in the brigade that I'm feeling a certain way, they might likely take me off the rescue. So that holds me back. (Murray)

Not wanting to risk his rescue role by using an Employment Assistance Program or other workplace supports, Murray tried calling Lifeline. He said his confidentiality was breached when they acted on 'duty of care'. In his small, remote country town, police officers (who he knew) knocked on his door at midnight to check that he was not going to harm himself. Murray said, 'I won't do that again'.

The thing about patriarchy is that ideal men not only don't show emotion or speak about personal issues, but they are also expected not to seek psychological help. It's double jeopardy (Addis & Mahalik 2003, cited in Kahn 2011).

It is impossible for individual men and it is problematic for emergency services through ingrained assumption that those not asking for psychological help are OK.

After Black Saturday, the psycho-social recovery of survivors was well resourced although the approach was weighted to pathologising individuals, with fewer resources to community building.[2] Between 2009 and 2012, 17,772 psychological counselling vouchers were issued. Steve told us, 'You get intercepted in the street and asked if you've been to counselling yet'. About a third of our interviewees found it valuable. However, a third of the men reported that, having overcome stigma and bureaucratic hurdles, they found it unhelpful. Others never shifted from thinking they had only themselves to rely on.

In the aftermath of disasters, the very real barriers men face in accessing help to cope with their experiences is amplified.

Image: Nik Shuliahin, Unsplash

It may not be easy to provide completely confidential support to emergency services personnel, but it is an essential step to expanding the range of accepted behaviours from men—a step towards changing culture.

Failing in the aftermath

The second 'failure' for family men was in not 'providing' after an event. There was monitoring by the community to ensure a continuing 'stronghold of the "male-breadwinner/female carer" model of household and working life' (Pocock, Charlesworth & Chapman 2013). As noted in Hoffman (1998), progress in gender relations takes a 50-year set back in disasters.

The old-fashioned male, female roles and distinctions are a bit more alive and well [in the country]. (Will)

It goes back to the caveman days of, the man's the provider, he's the hunter gatherer, she's just the cook. And I know that's a derogatory term, but that's still the mentality of a modern-day family. (Lou)

Men were pressured to prove they were providing for their families and be quickly recovering from the disaster. Bernard described the intrusive questioning he faced regularly in the aftermath:

2. A significant emphasis and substantial resources were devoted to the psycho-social recovery of Black Saturday survivors. In the 3 years to 2012, 50 information sessions on aspects of recovery were run for communities, 17,772 psychological counselling vouchers and 12,744 wellness vouchers were issued and $1.8million was provided to Australian Red Cross to provide outreach and other support activities (Victorian Government 2012, p.9).

> *Why haven't you got it together? Why haven't you got your garden fixed? Why haven't you got your house done yet? What are you doing with your life? Why haven't you gone back to work? Why haven't you?* (Bernard)

Masculinity is well theorised, most notably by Connell (2005) and by others (Donaldson 1993, Jurik & Siemsen 2009, Messerschmidt 2012, Pease 2010, Wedgwood 2009, West & Zimmerman 1987). Some masculinity theorists conclude that patriarchy ultimately destroys those men and women who conform to its requirements (Kahn 2011).

> *'Doing alright'. That why I keep saying it because if you don't keep saying it to yourself, you'll end up hanging on the end of a rope.* (Eric)

Four men in our research said they had felt suicidal:[3]

> *I'm pretty vulnerable. I've got a history of suicide in my family on both sides… so I've had a determination to fight that. But… I found that when I was really negative, [when] it got that bad… I couldn't find a way of telling anyone.*

> *I haven't even told [my wife] this… Anyway, I came home and I was just sitting in the car out there, nothing was built… and I just felt like hanging myself. So I just sat there… You are the only two I've told. I've told no-one else.*

> *I was lucky enough [to be seen] at the right time otherwise I would have done stupid things to myself or to other people… When you're in a suicidal/homicidal state you really haven't got many tools to keep you on a level field.*

> *There have been very, very many times where I've certainly thought about ending it all and, 'This is just not worth it', or, 'How many people can I kill?'… To get up in the morning and think to yourself, 'Why am I bothering to do this? What's left?' Because there's nothing left.*

Violence against women

The depth of men's suffering post-disaster led to tolerance of their anger. A man's anger was seen as more acceptable than his tears. Even men's violence in the home was excused (Parkinson 2019, Sohrabizadeh & Parkinson 2022). Austin (2008)[4] makes the link between the stereotypical male role and violence:

> *Men … are likely to encounter a feeling of inadequacy following a disaster because they are unable to live up to the expectations of their socially constructed gender roles … Feelings of inadequacy build in men, creating additional stress, more depression and a need to exert control. The presence of these conditions influence higher numbers of men to choose violent, abusive, hyper-masculine masculinities. (pp.7–8)*

We sat with women who were deeply worried about their men, and women who had been hurt by them. These women had their own traumatic experiences and their own reductive feminine stereotypes to follow, for example, female scripts of self-sacrifice, giving up the right to autonomy, to their career and to a life without violence. This was deemed necessary after disaster for the good of the man, the kids, the community. This is the flipside; ideal masculinity comes at a cost, but with great privilege.

What should be done

Constructed ideals of masculinity and the resulting pressures and expectations contribute significantly to community suffering. Acknowledgment of this by the emergency management sector is necessary for improvements in response and recovery. Enarson (2009a) identified key challenges for change: gender is seen as a personal rather than structural issue and is usually read as meaning 'women'. There is limited interest by decision-makers in gendered research, policy and practice, perhaps because there is no reward for men working on gender issues. Report after report[5,6] reveals that rape, sexual assault, harassment and discrimination against women is a part of many (if not all) male-dominated emergency services organisations in Australia. Yet so far, these organisations are yet to demonstrate gender balance and gender equity. Contrition for the discriminatory culture follows each report, but little changes. Knowing these damaging cultures exist and failing to achieve change rubs salt into the wound. It exacerbates harm to women, men and people of diverse gender and sexual identities who try to forge a career without pretending to embody a macho persona.

Australia leads the world in its acknowledgment of the importance of gender in emergency management. Yet, across the nation, the steps are small, fragmented and neither structured nor embedded. The world has moved on and the emergency management sector must catch up. Risks are high for emergency management organisations that choose to wait rather than become safer, more diverse and gender-equal workplaces. Change will need courage as well a multifaceted approach at all levels, and it will be worth it. There are gains to be made in capacity as well as for the wellbeing of individuals who are part of this essential and respected field. There are gains, too, for disaster-affected communities.

In 2012, the first GAD Taskforce aimed to reduce the compounding effects of gender on disaster effects and expand the range of acceptable behaviours for both women and men. Now, 10 years on, significant change is well overdue. There are 3 ways we can progress essential cultural change using the resources of Gender and Disaster Australia:[7]

3. No pseudonyms are given here for increased confidentiality.
4. See also Austin 2016.
5. CFA says sorry after review lays bare ongoing bullying, harassment 2022, The Age 23 June. At: www.theage.com.au/politics/victoria/cfa-review-highlights-ongoing-bullying-harassment-20220623-p5avy1.html.
6. Women face structural barriers at Ambulance Victoria, Human Rights Commission report finds 2022, ABC NEWS 31 March. At: www.abc.net.au/news/2022-03-31/ambulance-victoria-paramedics-human-rights-report/100953792.
7. Gender and Disaster Australia, at www.genderanddisaster.com.au.

Emergency management sector must move beyond the stereotypes and myths of strong, silent men who protect and provide in the face of extreme weather events.

Image: Australian Red Cross

1. Take up Gender and Disaster Australia's Lessons in Disaster training as more than 1,000 people have already done and as the National Red Cross is planning to do. We aim for sustainable change and a key element is the train-the-trainer component. The legacy will be communities and organisations with their own gender and disaster trainers.
2. Make the National Gender and Emergency Management Guidelines and checklists an automatic and valued part of prevention, planning, response and recovery in your organisation or community (Parkinson *et al.* 2018).
3. Advocate for your state or territory to work with Gender and Disaster Australia to establish a GAD Taskforce, headed by your Emergency Management Commissioner (or equivalent). The purpose is to provide statewide strategic direction and leadership to identify and address gendered issues (Parkinson *et al.* 2018).

Conclusion

The likelihood of frequent and catastrophic extreme weather events resulting from climate change dictates that prevention, planning, response and recovery move beyond the stereotypes and myths of strong, silent men who protect and provide. We need to move to a gender-equitable approach for men, women and people of diverse gender and sexual identities. Disaster risk reduction will be enhanced by a contemporary approach to who does what in these events. Policies are needed in the emergency management sector that prioritise the health and wellbeing of its workers. In an increasingly risky world, it is vital that rigid gendered expectations be recognised as outdated and damaging.

Acknowledgment

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AFAC CONFERENCE | REPORT

Aligning disaster risk reduction and climate change adaptation: Pacific perceptions, practice and policy

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Abstract

The climate crisis is compounding disaster risk around the world, heightening the vulnerabilities of communities in disaster-prone regions and increasing the pressure on humanitarian actors to respond effectively to the resulting challenges. The Beyond Barriers research led by Humanitarian Advisory Group in partnership with World Vision Australia, explores ways to strengthen the integration[1] of disaster risk reduction (DRR)[2] and climate change adaptation (CCA)[3] to enhance resilience outcomes for communities in the Pacific region.

Introduction

The Pacific is among the world's vulnerable regions to extreme hazards and the effects of climate change. Of the world's top 10 countries ranked highest for disaster risk, 5 are Pacific nations, with Vanuatu, Solomon Islands and Tonga being at the top.[4] Climate change is heightening these risks with increasing frequency and intensity of weather-related disasters. Rising sea levels lead to coastal erosion and saline intrusion, affecting agriculture, fisheries and ecosystems and compromising the resilience of communities faced with disasters.[5]

Pacific leaders have recognised that there is an urgent need to scale resilience efforts across the region to overcome a legacy of siloes between DRR and CCA. While DRR has long been a policy field within humanitarian and development sectors – codified in global frameworks such as the Hyogo Framework for Action and its successor the Sendai Framework for Disaster Risk Reduction 2015-30 – approaches have focused on mitigation and response to the effects of natural and weather-related hazards, with less attention on the associated risks of long-term climate forecasts and how these affect weather patterns and disaster risk.[6]

Evidence of increasing levels of disaster risk as a result of global warming is becoming more visible. The frequency of climate- and weather-related disasters has increased 5-fold over the past 50 years and 57 million people in Asia and the Pacific were affected by climate change in 2021.[7] The increasingly visible relationship between climate change and amplified disaster risk has accelerated governments and humanitarian actors to integrate DRR and CCA policy and frameworks.

Beyond Barriers research overview

A partnership between the Department of Foreign Affairs and Trade, the Australian Humanitarian Partnership (AHP) Disaster READY Program[8], World Vision Australian and Humanitarian Advisory Group resulted in research to determine persistent barriers to, and realistic opportunities for, better integration of DRR and CCA to build and sustain community resilience.

Research methodology

The project began by publishing a foundational literature review in July 2021, before proceeding to collect data across 5 case study countries to complete Phase 1 of the research. Case study data collection was led by national researchers in each country and supported by a regional research lead based in Suva. It included a desk review, key informant interviews and community focus group discussions. This phase resulted in case study reports for Fiji, Vanuatu, Solomon Islands, Papua New Guinea and Timor-Leste, all the countries where AHP Disaster READY is active. Phase 2 built on the country-level findings from Phase 1 to explore and elevate opportunities for DRR-CCA integration at the regional level. It began with a Reflection and Learning Workshop in December

2021. This brought together more than 60 stakeholders to share learnings from Phase 1 and observe presentations from practitioners and technical experts working towards similar goals. This workshop served to target and validate emerging themes and opportunities identified by this research and to ensure collaboration in other initiatives. Phase 2 also included an additional study in Tonga. The final report leveraged behavioural science principles to unpack the behavioural barriers and opportunities around integration and put forward a framework for action for implementing agencies. The detailed research methodology is illustrated in Figure 1.

Beyond Barriers aimed to elevate a stronger recognition and understanding of community knowledge around resilience in the Pacific and centre community voices and participation in policy and decision-making processes. This research acknowledges that communities are often the first affected by extreme events and recognises that communities often have the closest connection and understanding of their environment. Community knowledge is a central component to the objective of strengthening resilience.

The research recognises that consistent, resourced and sustainable shifts will require change within prevailing norms, structures and frameworks. This includes governments, regional bodies and intergovernmental structures and processes; actors that are traditionally and commonly central in policy and decision-making processes. Such processes often overlook the voices, knowledge and participation of communities.

DRR-CCA integration progress in the Pacific

The Pacific is one of the world's leading regions in progress towards advancing integration between DRR and CCA action, seen with the design of frameworks that codify strategic guidance to better inform climate-sensitive disaster preparedness programming. Most notably, the Framework for Resilient Development in the Pacific (FRDP), endorsed at the Pacific Island Forum in 2016, is the first regional framework designed to mitigate vulnerability to climate and disaster risk and emphasises the importance of community-based approaches to building resilience.[9] Despite this, the FRDP does not emphasise clear guidelines around who is accountable for strengthening community leadership, while its goals are posited as voluntary guiding principles rather than a set of objectives for stakeholders to commit to, raising challenges towards establishing grounded and consistent shared outcomes for the Pacific.

Since the establishment of the FRDP, a range of other initiatives have commenced aimed at advancing implementation, the goals it sets out and its overarching objective to upscale integration of DRR and CCA and strengthen resilience of Pacific island countries. During the 2017 Pacific Islands Forum, the Pacific Resilience Partnership (PRP) was established and endorsed by leaders. The PRP acts as an umbrella mechanism for the implementation of the FRDP and hosts the annual Pacific Resilience Meeting that is a platform for ideas and shared learnings from a wide-

Figure 1: Beyond Barriers research program methodology.

ranging group of regional actors.[10] In 2018, the PRP endorsed the development of the Pacific Resilience Standards (PRS), which were officially established in 2022. The PRS establishes 4 standards and 'good practice essentials' and provides a progress measurement tool promoting self-assessment of progress and planning to support and guide regional stakeholders to advance effective implementation of the FRDP.[11] Figure 2 provides an overview of the relationship between the PRP and the mechanisms, frameworks and standards that support it.

Barriers to effective integration

The initiatives established to strengthen implementation of the FRDP demonstrate progress and momentum towards effective integration in the Pacific. Despite this, the Beyond Barriers research uncovered systemic structural and behavioural barriers that hinder effective policy integration and community-centred resilience objectives.

1. Community-led decision-making is not the social norm

   Social norms have seen agencies lead decision-making processes while community voices have remained largely absent. Decision-making is largely top-down and community needs are generally not prioritised as policies and decision-making tends to align with donor priorities, while traditional knowledge is generally sidelined from resilience-based programming.

2. The status quo does not facilitate integration as the default approach

   Despite the efforts to enhance integration in the Pacific, separate funding and governance structures for DRR and CCA remain the status quo in many Pacific island countries. Embedded systemic structural behaviours have slowed the progress of agencies in shifting their ways of working to prioritise integrated approaches, while government ministries and bodies operate in siloes with limited collective attempts to meaningfully reform the system.

3. Existing structures and approaches are increasingly complex

   While there have been efforts to enhance integration, this has (paradoxically) generated barriers to meaningful change. Multiple frameworks and government structures have resulted in duplicative coordination mechanisms and information-management systems, making the process of streamlining information and information access to communities inherently difficult. Streamlining of frameworks and policy, ensuring the meaningful participation of communities and cultivating and augmenting traditional knowledge into decision-making, can create tangible steps towards a more coherent and effective system.

   Fiji's DRR policy has over 200 strategies […] what's the point of having great strategies if they are just going to sit there and not actually be implemented?' (Regional actor)

4. Without a common authority promoting and guiding process, agencies have no incentive to prioritise community voices or produce consistent reports

Figure 2: Relationship between the PRP and the supporting mechanisms and frameworks.

The lack of a common authority to drive and promote accountability has hindered efforts to meaningfully integrate community voices into resilience programs and decision-making. Top-down power imbalances remain entrenched within structural frameworks, often marginalising communities from decision-making processes and sidelining their participation. Currently, governments, international non-government organisations and donors hold most of the authority that influences decision-making. Community priorities are often considered secondary to donor priorities. Even in contexts where community groups are active and local leadership is supported, entrenched power imbalances continue to hinder meaningful community leadership.

How to overcome the barriers

The areas outlined capture some of the fundamental and overarching issues that the research identified as the greatest obstacles to effective community-focused integration in the Pacific. While the challenges they present for the sector are by no means insignificant, they provide strengthened understandings around why the vision for integration has not yet been achieved and, more importantly, what steps are required to address these challenges, overcome them and advance progress in the region.

Evidence shows that intention and motivation for change is prominent across the region, demonstrated in the significant progress that has been achieved at the policy level in the form of commitments and frameworks, yet more is yet to be achieved for effectively translating this to the operational level. Further work is needed to understand the contextual differences across Pacific countries to inform integration at the country level. There are 4 pathways shown in Figure 3 that describe the central vision for a resilient Pacific in which integrated approaches are the norm and the core behavioural shifts that need to occur.

Centre community members as decision makers

Pacific-based actors should work to ensure that existing local structures and leadership become the default process for programming. This can be supported through elevating local leadership, knowledge and capacities in planning and design phases and through the promotion of inclusive, community-led resilience planning that incorporates traditional knowledge and practice. Identifying shared priorities with communities and elevating these priorities to donors can break the existing siloed funding structures which currently hinder meaningful progress.

Create new resilience defaults

This can be achieved through advocating for and applying new ways of working, both internally within their own organisations, other partners, national governments and donors. For example, seeking opportunities to harmonise internal approaches or models within organisational structures; promoting integrated governance and funding structures for resilience. Creating opportunities to test, learn, adapt and share approaches that demonstrate that change is occurring by sharing success stories to motivate other actors to shift practices.

Make processes simple and consistent

Actors can better support the accessibility of 2-way information flows and ensure all communication mechanisms are accessible to all stakeholders to enable clear and coherent channels of communication. This can be achieved through streamlining information pathways with communities, leveraging traditional knowledge and supplementing with scientific data. Effective and clear 2-way communication can prevent the duplication of activities and messaging, and better articulate consistent information management pathways for stakeholders across the national, provincial and village levels.

Strengthen authority and accountability for resilience outcomes

Stronger resilience outcomes can be achieved through elevating the central authority of the PRP and the FRDP as the regional guiding framework for resilience. This will ensure that programs reflect the FRDP principles and connect them with community-level actions, and leverage the support of trusted organisations and individuals to lead this shift. Use a common framework and measurement tools to design programs and monitor outcomes to provide consistent approaches and measurement of success. By minimising the number of frameworks and tools used, agencies can reduce inconsistencies and increase confidence and accountability in measured outcomes.[12]

Conclusion

Despite leadership in integrated approaches to resilience, agencies often use siloed approaches to align with existing structures and standard practice. Coordination and information-management systems remain complex and inaccessible to communities and, while most stakeholders aim to centralise communities and ensure meaningful participation and decision-making in approaches, these are often deprioritised in favour of donor requirements. This has seen traditional knowledge and practices that can strengthen resilience programming and support a community-centred approach remain absent from decision-making and policy design processes.

The vision and model presented in this report are a pathway for agencies to better support community-led resilience. The integration of DRR and CCA governance, funding, coordination and information management will be critical but there is also room for implementing actors to shift their own organisational norms and practices in the absence of greater systems change towards enhanced resilience. By understanding and using principles of behavioural science, actors can help to build a future where integration is the default and community-led decision-making is the norm. Actors can build on regional momentum to drive this change home in their own organisations, their own communities and on a greater scale.

This work set out to influence implementing agencies to empower and support communities to understand disaster and climate risk and action measures that strengthen their resilience. By using the proposed framework agencies can lead progress towards empowered and resilient communities in the Pacific region.

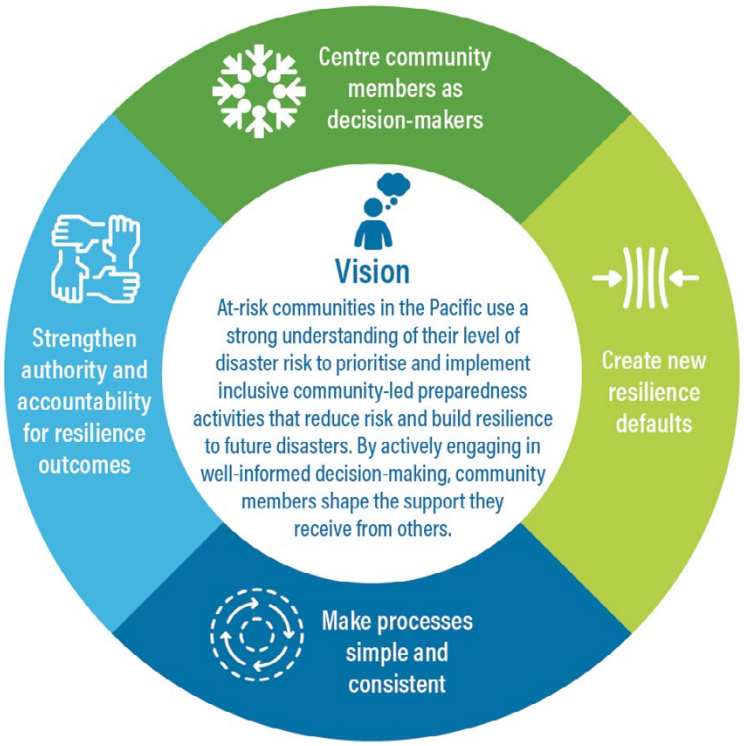

Figure 3: The vision for community-centred integration in the Pacific.

Integration in action: what's next?

A second phase of the Beyond Barriers research will take place under the Disaster READY 2.0 program with leadership from World Vision Australia, implemented by Humanitarian Advisory Group. Phase 2 will build upon the extensive research, engagement and learning from Phase 1 of the research program, while moving from an exploratory research approach to an action research approach.

The objective of Phase 2 of Beyond Barriers is to support the implementation of evidence-based actions that strengthen good practice approaches in enhancing community resilience. We will support key research partners and stakeholders to implement specific components of the framework for driving behavioural shifts at various levels. We will then support ongoing reflection, adaptation and learning on how different approaches can be leveraged and scaled across the region.

Endnotes

1. Integration here refers to the integration of DRR and CCA, meaning the combination of interventions that address CCA and DRR with the intention of improving humanitarian and development outcomes for at-risk and crisis-affected populations. Global Nutrition Cluster (2016), Developing an Integrated Approach to Humanitarian Emergency Preparedness and Response. At: https://fscluster.org/sites/default/files/documents/icnwg_developing_an_integrated_response_approach_gfsc_20191128.pdf.

2. Disaster risk reduction is aimed at preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and to the achievement of sustainable development. IPCC (2019), Glossary. At: www.ipcc.ch/site/assets/uploads/2019/01/SYRAR5-Glossary_en.pdf.

3. Climate change adaptation refers to the process of adjustment to actual or expected climate change and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to the expected climate and its effects. IPCC (2019), Glossary. At: www.ipcc.ch/site/assets/uploads/2019/01/SYRAR5-Glossary_en.pdf.

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8. The Disaster READY initiative is part of the Australian Humanitarian Partnership, a 5-year (2017–22), $50 million partnership between the Department of Foreign Affairs and Trade and Australian non-governmental organisations to improve humanitarian disaster response. Disaster READY was designed to strengthen disaster preparedness and management across the Pacific and Timor-Leste.

9. Framework for Resilient Development in the Pacific 2017. At: http://gsd.spc.int/frdp/#:~:text=in%20the%20Pacific-,Framework%20for%20Resilient%20Development%20in%20the%20Pacific%3A%20An%20Integrated%20Approach,and%20disasters%2C%20in%20ways%20that.

10. Pacific Resilience Partnership 2017, at: https://www.resilientpacific.org/en.

11. Pacific Resilience Standards 2022, at: www.resilientpacific.org/en/media/216#:~:text=The%20FRDP%20is%20a%20regional,Resilience%20Partnership%20in%20September%202017.

12.Humanitarian Advisory Group, World Vision Australia & Australian Humanitarian Partnership 2022, Beyond barriers: behaviours to enable a more resilient Pacific. At: https://humanitarianadvisorygroup.org/insight/beyond-barriers-behaviours-to-enable-a-more-resilient-pacific.

AFAC CONFERENCE | REPORT

Disaster risk reduction and the emergency services: the case for holistic, policy-led integration

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Abstract

Since the 2015 ratification of the *Sendai Framework for Disaster Risk Reduction 2015-2030*, disaster risk reduction (DRR) has been part of Australia's policy environment. However, the extent to which it has affected policy and procedure is questionable. Emergency services organisations, as first responders, should be enthusiastic advocates for DRR, both in terms of their role during the response and recovery phases and as facilitators of risk reduction through mitigation and preparedness activities. DRR dividends include a reduction in the likelihood that extreme events would become disasters, better inclusion of marginalised sections of the community and reduced demand for scarce resources during extreme events. Yet despite the obvious benefits of this paradigm, emergency services organisations in Australia are yet to fully embrace this change. A possible explanation may be found in the policy and procedures that drive the actions of both them and the communities they serve. Recent postgraduate studies have examined the extent of incorporation of DRR principles into recovery planning, planning for animal welfare, disability inclusion during emergency response and others. These studies suggest that DRR is poorly understood, rarely included in policy and procedures and the potential benefits are lost, to the detriment of all. A proposed alignment of disaster-related policy (in the widest sense) with the disaster cycle integrates emergency service know-how into 'normal community development' activities and offers a positive way forward for DRR to become second nature.

Introduction

The world faces accelerated numbers of extreme weather events, each likely to be of increasing severity, primarily because of climate warming. Though the localised consequences over the longer term may not yet be clear it is evident that they will be negative, placing increased demand on the resources required to deal with them. There is growing agreement that increased attention to DRR is necessary to reduce the socio-economic and socio-environmental consequences of extreme events.

In 2015, Australia joined 186 nations in ratifying the *Sendai Framework for Disaster Risk Reduction 2015-2030* (Sendai Framework) (UNISDR 2015). In doing so, it embraced the 4 priority areas and 7 global targets associated with the framework. Although these were expressed in aspirational terms, leaving each nation to contextualise their implementation locally, countries were expected to report periodically on their progress, both in terms of disaster metrics (frequency, impact, investment in initiatives) and strengthened risk governance measures, principal among which would be national and local DRR strategies.

DRR in Australia had changed with the introduction of the *National Strategy for Disaster Resilience* (NSDR) (Commonwealth of Australia 2011) and accelerated after the release of the *National Disaster Risk Reduction Framework* (NDRRF) (Commonwealth of Australia 2018). This has worked its way through to state and territory

legislatures, being reflected in new and revised policies and organisations. In New South Wales, this has resulted in the closure of the Office of Emergency Management and many of its functions transferred into the new agency of Resilience NSW. Parallel changes can be found in other jurisdictions, tailored to local conditions and history.

The global community is conscious that 2023 marks the midpoint of the Sendai Framework. Several students in the Master of Disaster Resilience and Sustainable Development program at the University of Newcastle undertaking their capstone research project investigated the effects that Australia's ratification of the framework has had on practice in disaster and development. These students come from diverse disciplines and professional backgrounds and their interests are equally diverse. Nevertheless, their research has followed similar, rigorous and logical paths, revealing surprisingly similar patterns and outcomes. This paper analyses the policy findings from their research.

Research approach, data collection and analysis

The research has been rationalised in the following way: Australia is a signatory to the Sendai Framework and is therefore morally (if not legally) obligated to make progress on its central tenets. This is detectable in policy, and particularly policy changes, which ought to be congruent with the Sendai Framework, subject to the policies' foci and contexts. Importantly, they should reduce disaster risk by incorporating contextually appropriate best practice. A comprehensive understanding of the relevant literature enables construction of a framework of concepts, together with definitions and characteristics that describe best practice DRR in relation to the focal topic. In turn, this can be used to thematically analyse the related policy(ies) and practice documents to:

- identify the presence or otherwise of each desirable concept
- the extent to which they are addressed, relative to global best practice.

Each research project used some sort of systematic approach to review the literature, including specifying databases to be searched, key search terms (and their justification), date delimitations, and inclusion/exclusion criteria. The papers have been screened for relevance, by title, keywords and review of abstract. The remainder were thematically coded and analysed, with the results being synthesised into main themes (concepts) and detailed subthemes (where appropriate), all being linked to the sources. These were defined by the researchers in their own words, with each main theme being accompanied by synonym words/phrases (since policy makers may use different terms to define similar ideas). This conceptual framework has become the tool used to analyse policy.

During 2019–21, a total of 12 studies were conducted and assessed and 9 were judged to be of publishable quality (Table 1). Six were produced by students who were employed by either emergency service organisations or local governments with the remainder being full-time students of DRR. In some instances, a single relevant policy document was analysed (e.g. the NSW Local Disaster Recovery Plan template) while in others, multiple implementations of a single policy were investigated (e.g. all publicly available Municipal and Local Emergency Management Plans in Australia). In all cases, the investigation was conducted as a policy analysis using qualitative thematic analysis of the content. Together, the 9 studies form the data for this paper, each of which is mapped against a previously developed, generic framework of DRR themes and concepts (Brewer & Conant 2021). Generalisation is confined to this set of studies, though broader implications for policy and practice are later conjectured.

Results

Given that some of the students' studies explicitly looked for evidence of policy alignment to the Sendai Framework while others examined policy for implicit alignment to the principles contained within it, the first step was to look for overt reference to the framework. This was particularly sought in the introduction, or in any overarching enabling policy, since this should be a reliable indicator of subsequent intent. Where none was found, the students' own Sendai Framework-aligned conceptual frameworks were used to gauge congruence with Sendai-inspired principles. Since the policies tended to be diverse in focus and their DRR measures were highly contextualised, the development of synonymous themes became important to identify policy-driven actions that were congruent with DRR principles. Table 1 summarises the results.

Superficially, the results seem self-explanatory. On one level, all policies directing context-relevant arrangements during times of emergency or disaster can be said to be overarched by national legislation, particularly the NSDR (Commonwealth of Australia 2011) and the NDRRF (Commonwealth of Australia 2018). Although there is no guarantee that they will have been revised since these strategies/frameworks were introduced, the NSDR has existed for over a decade and ought to have had some effect. Despite this, none of the policies reviewed made overt reference to the Sendai Framework.

Both hazard identification and disaster risk management were widely found, largely because most of the policies analysed were related to specific hazards (e.g. bushfire) or groups at risk (e.g. disabled persons) and the policies were the mechanism by which these would be managed. Policies relating to vulnerable sections of communities or fixed infrastructure similarly implied a level of vulnerability, though none of the examples in this study contained explicit mechanisms for assessing vulnerability. None of the policies contained capacity assessment requirements, either of facilities/enacting organisations or of communities, though in some cases they referred to other policy and procedures, compliance with which would require capacity assessment.

The governance domain was, unsurprisingly, one of the stronger DRR elements across all 9 studies, mainly because the existence of the policy was an implicit acknowledgment of the management of associated risk, though coordination (with actors) was either explicitly articulated or completely absent. In relation to resourcing, none of the policy documents contained any mechanism detailing budgetary allocations or control. That said, some referred to sources of emergency funding controlled by other actors.

Table 1: Data analysis summary.

		Study								
Theme	Concept	1	2	3	4	5	6	7	8	9
SFDRR	Explicit reference	No	No	No	No	No	No	No	No	No
Knowledge	Hazard identification	Explicit	Explicit	Explicit	Implicit	Explicit	Implicit	Not addressed	Implicit	Not addressed
	Vulnerability assessment	Not addressed	Implicit	Not addressed	Not addressed	Not addressed	Implicit	Not addressed	Not addressed	Not addressed
	Capacity assessment	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed
Governance	Management	Implicit	Implicit	Implicit	Implicit	Implicit	Implicit	Implicit	Implicit	Implicit
	Coordination	Explicit	Explicit	Explicit	Not addressed	Explicit	Not addressed	Not addressed	Not addressed	Not addressed
	Resourcing	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed
Implementation	Monitoring and evaluation	Explicit	Implicit	Implicit	Implicit	Explicit	Implicit	Not addressed	Not addressed	Not addressed
	Communication	Explicit	Explicit	Explicit	Not addressed	Explicit	Explicit	Explicit	Explicit	Explicit
	Training	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed
Participation	Engagement	Explicit	Not addressed	Explicit	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed
Policies	Preparedness	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Implicit	Not addressed	Not addressed	Not addressed
	Mitigation and prevention	Not addressed	Not addressed	Not addressed	Not addressed	Not addressed	Implicit	Not addressed	Not addressed	Not addressed
Policy Target		Local disaster recovery	Disability-inclusive DRR	Animal welfare	Economic recovery	Animal welfare	Bushfire risk management	Municipal emergency management	Local disaster recovery	Municipal emergency management

Direction of implementation was patchier. Communication was the only area of strength although this was usually restricted to defining lines of reporting. Some policies required ongoing monitoring and evaluation, particularly where implementation was expected to stretch over months or years. A few policies implicitly acknowledged that monitoring and evaluation would be required. All of the policies were silent in relation to training.

Engagement with communities was an area of widespread weakness and few policies addressed the issue. Moreover, the few that did include forums for community engagement (e.g. community resilience networks) did not explain how they were to be formed, maintained or scaled up during times of emergency.

Similarly, DRR-specific policy actions in relation to mitigation, preparedness and prevention was essentially absent from all policies analysed.

Discussion and implications

DRR is intended to delay, and even prevent, extreme events overwhelming local capacity to cope. To ensure this happens, the Sendai Framework and the NDRRF stress the need for integration of resources across the whole of the disaster cycle (in New South Wales known as the 'PPRR' or Prevention, Preparation, Response, Recovery Cycle). Table 1 hints at the extent to which this isn't being reflected in the policy domain. When it indicates reasonable levels of inclusion of coordination and communication within policies, this is overwhelmingly restricted to the organising entity affected by the policy or the temporary governance structures set up in times of emergency. No consideration is given to ongoing and systemic inter-organisational collaboration or dialogue. These overwhelmingly response-related policy documents have implications for ongoing 'business as normal' operations. The absence of preparedness, mitigation and prevention actions should be viewed as a missed opportunity.

A clue to this disconnection between DRR intent and disaster policy action might lie in the history and evolution of organisational structures and the policies that regulate them, particularly if the Disaster Recovery Cycle (NSW Government 2018) (Figure 1) is taken into consideration. In essence, while it implicitly covers all 4 stages in the PPRR cycle, it constrains all response agency involvement to the response and recovery stages, implying that prevention, mitigation and preparedness all take place within that time from when recovery is deemed to have been completed, through to the next extreme event. This part of the OEM recovery cycle is euphemistically termed, 'Ongoing Community Development' and includes, among other things, all decisions related to rural and urban land-use, environmental planning, community, health and business development. Given that resilience and DRR are still firmly located within the emergency management domain, it is perhaps hardly surprising that dialogue between emergency services agencies and organisations devoted to ongoing community development is limited.

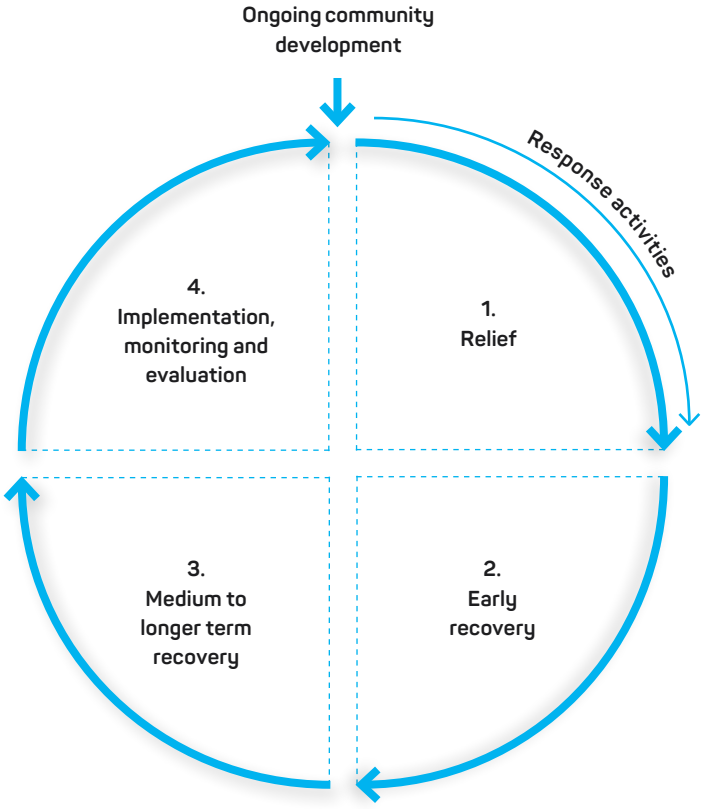

Figure 1: NSW OEM recovery operations model.

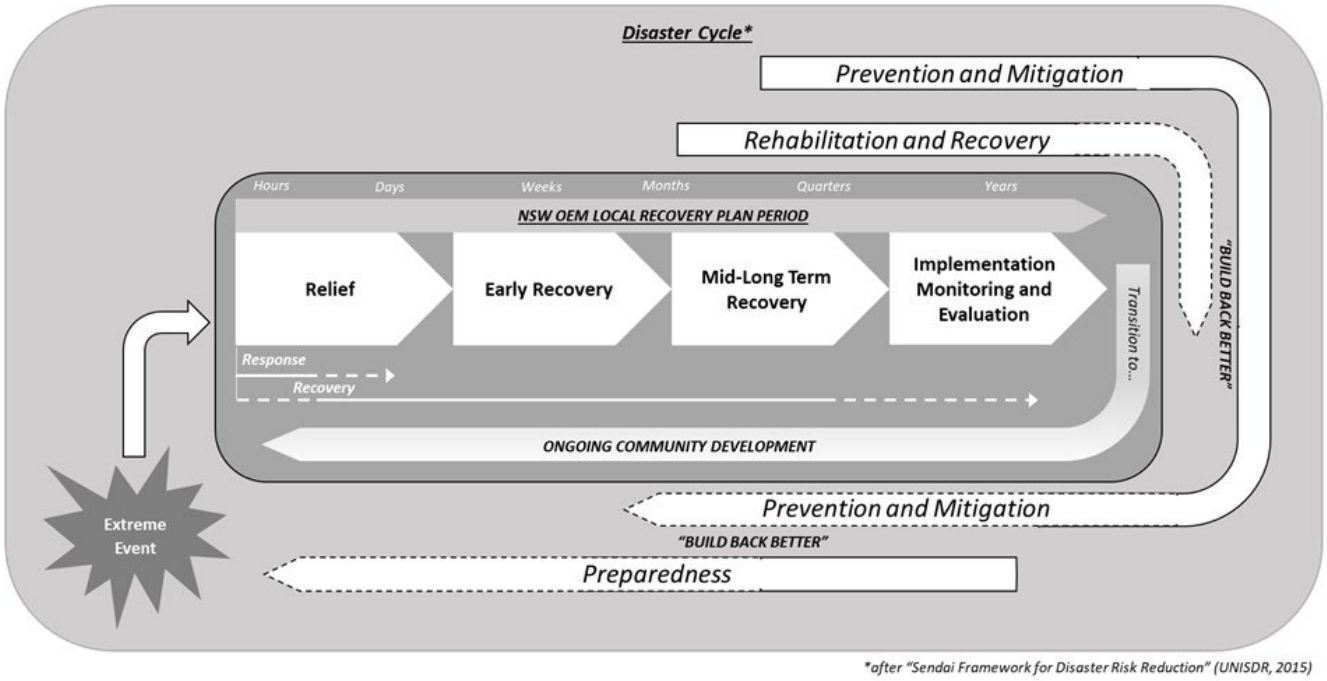

Figure 2: Proposed NSW recovery operations and DRR cycle (Brewer & Conant 2021).

In a world where the frequency and intensity of extreme events is on the rise, the probability that emergency services agencies will become overwhelmed is also increasing. Many of the community development decisions that are made on a regular basis increase disaster risk that goes unnoticed and uncommented. While it is ultimately the public who pay the price for these decisions (socially, environmentally and economically), emergency services agencies also experience increased risk (largely reputational, though also to their members during response activities). It is sobering to reflect that while emergency service agencies often have a legislated duty to review and comment on such decisions and their consequences, they seldom do. Revising the disaster recovery cycle to include all stages in PPRR could give policy makers permission to design integrative activities that are fit-for-purpose for DRR. Figure 2 shows a proposed new model for recovery operations in the DRR cycle. This could extend to risk-informed input into development decisions and planning and exercising for events that overwhelm local coping capacities; the very definition of a disaster.

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NEWS AND VIEWS

Enhancing capability for the increasing complexity of disaster events

Jane Zsombok

Queensland Fire and Emergency Services

Queensland is preparing disaster managers to lead and manage in increasingly volatile, uncertain, complex and ambiguous environments.

Queensland introduced the Operational Leadership and Crisis Management Masterclass in 2018 as a component of the capability development offered through the Queensland Disaster Management Training Framework.[1] Queensland's disaster management education and training programs are designed to provide disaster managers with appropriate capability to effectively perform their roles.

The requirement for capability enhancement in operational leadership and crisis management was identified through research and consultation with disaster management stakeholders. The masterclass sessions were designed to extend learning and build on the core level of training provided through other disaster management courses.

With the increasing frequency, severity and complexity of extreme events, Queensland aims to be adaptive and agile in its education offerings so that disaster managers have contemporary programs that support their capability to lead and to manage.

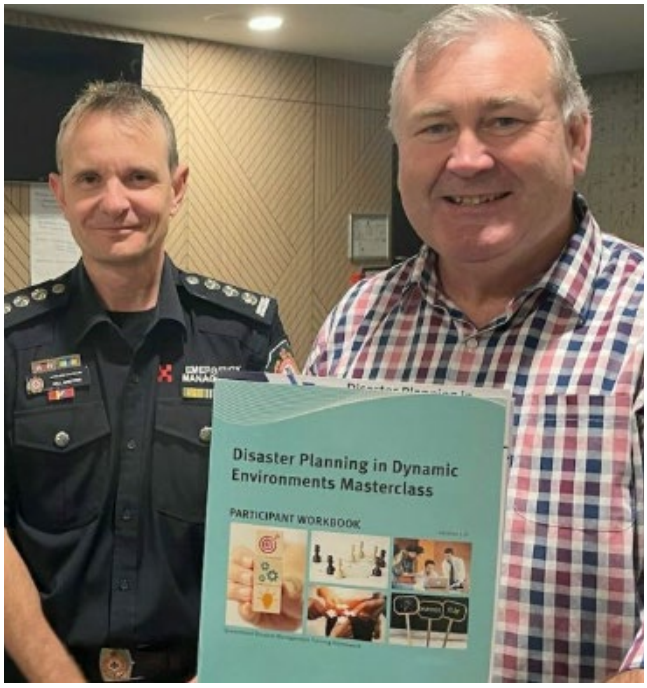
Through a contract with the Australian Institute for Disaster Resilience, a new masterclass, Disaster Planning in Dynamic Environments, was developed and launched in 2022. The masterclass focuses on dynamic planning in an operational disaster management context. It explores the factors that inhibit and enhance good planning, with strategies to monitor and manage events to achieve better outcomes.

The Disaster Planning in Dynamic Environments masterclass was delivered to 197 practitioners in 10 Queensland locations during May and June 2022. Participants were from local government, emergency services, state government and non-government organisations. Reflective of their significant role in the Queensland disaster management arrangements, 41% of participants were from local government including 14 elected officials – mayors and deputy mayors. This included Jack Dempsey, Mayor of Bundaberg Regional Council. Mayor Dempsey is the Chair of the Bundaberg Local Disaster Management Group and had high praise for the masterclass, saying, 'It's important to consider emerging challenges and their implications for planning in dynamic environments'.

The Gympie masterclass was attended by Mayor Glen Hartwig in his capacity as Chair of the Gympie Local Disaster Management Group. Mayor Hartwig is an experienced disaster manager having led and supported his region through 3 major flooding events in the 5 months prior to the masterclass. With the flood waters from the most recent event receding only days before the masterclass session was delivered in Gympie, he shared experiences from these events that enriched the learnings for all participants.

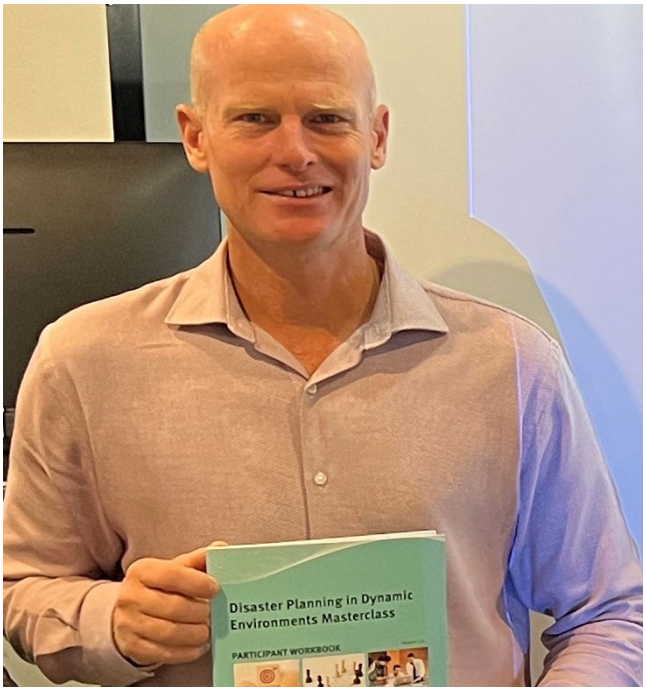
The high level of participation of local officials demonstrates the importance they place on their disaster management role and the value and beneficial outcomes the masterclass sessions offers.

The Disaster Planning in Dynamic Environments masterclass supplements existing topics in the series: Meteorology for Disaster Managers; High Consequence Decision Making; Leadership in Disaster, Crisis and Adversity and Coordinating



Mayor of Bundaberg Regional Council, Jack Dempsey (right) and Emergency Management Coordinator, William Gretton from Queensland Fire and Emergency Services (left), participated in the masterclass at Bundaberg.

Images: Queensland Fire and Emergency Services



Mayor of Gympie Regional Council, Glen Hartwig, completed the masterclass.

Teams Operating in Disaster. There are plans for future topics on recovery leadership and building adaptive capacity and community resilience.

The current and future masterclass topics were identified through evidence-based research and consultation with stakeholders to understand capability requirements. Contemporary research into teaching emergency and disaster management in Australia[2] highlighted the skill areas of leadership, communication and collaboration as fundamental components of a training program for disaster management practitioners.

To enhance the learning experience for managers and to embed these skill areas, the masterclass sessions are designed as full-day, face-to-face sessions with a blend of academic theory and the immediate application of learnings through immersive, interactive team-based scenarios and activities. The benefits of experiential learning in disaster management education are well established and it combined with the opportunity to enhance relationships and practice cross-agency coordination and collaboration has proven to be highly successful.

Queensland aims to keep pace with the changing capability requirements for disaster managers through the evolution of education and training programs. The masterclass series is a critical component of the strategy.

For further information, contact Emergency Management Training: DMTraining.Feedback@qfes.qld.gov.au.

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AFAC CONFERENCE | NEWS AND VIEWS

Taming the beast: why social media should be its own unit under AIIMS

Ilana Pender-Rose

NSW State Emergency Service

Australians are some of the lightest consumers of news in the world.[1] Although the start of the pandemic saw a rapid increase in news consumption as people yearned for information, that has since dropped away.

In 2021, heavy news use dropped from 69% in April 2020 back to a level lower than pre-pandemic years (51% in January 2021).[2] This is proof that, even with the threat of COVID-19 hanging over their heads, many people did not have the enthusiasm to consume news on a regular basis.[3]

Given our tendency to avoid news, it is not surprising that platforms such as Facebook, Twitter and Instagram have become an integral part of how many people communicate life-saving information in an emergency. In stark contrast to these news habits, people in Australia are among the heaviest social media users in the world. According to the Yellow Pages Social Media Report, almost 80% of the population use social media platforms. What's more, they're active from the morning with 58% admitting to checking social media as soon as they wake up.[4]

Social media and its usefulness in emergency management is acknowledged in the structure of the Public Information Section within the *Australasian Inter-service Incident Management System*™ (AIIMS). But just one, stand-alone Social Media Officer sitting in the Information and Warnings Unit is no longer enough. Even with a Social Media Support Officer added to the mix, the current system doesn't reflect how much time, energy and resources it takes to properly manage social media during an emergency. It's time to spin social media out into its own unit, allowing for the creation of roles to manage and moderate online content.

In a Level 3 incident, information and warnings, media and community liaison become too big for a Public Information Officer to handle alone. AIIMS has a built-in redundancy for this, allowing the Public Information Officer to appoint officers to manage each unit.[5] Although it's currently housed underneath the Information and Warnings Unit, social media isn't solely an information and warnings tool. It's not media or community liaison either. It's a unique environment, feeding from and into all 3 Units in the Public Information Section.

Each unit in the Public Information Section of AIIMS reflects the need for specific knowledge and training that one needs to do the job. Social media is a multi-billion dollar industry that requires time and patience to master. It's a skillset that is completely independent of the one needed to work within the Information and Warnings Unit.

It's no secret that large emergencies are rarely managed by one agency. We help each other out; throwing people and resources at a disaster that might not be ours to manage. In such situations, it's essential that we're all speaking the same language, that we have a 'consistent and universally understood and applied system'.[6] This means that we can (and frequently do) take a Public Information Officer from one agency and have them manage communications in a completely different environment to one they are used to. AIIMS takes a large part of the guesswork out of what roles should be filled and when during an emergency. This allows for a consistent approach, better decision-making and less wasted time. It's for this reason that social media needs to be its own unit. The less time we spend guessing what we need to do and when, the more people we can help.

Another reason why social media should be its own unit relates to maintaining a proper span of control, keeping the number of groups or individuals that can be successfully supervised by one person to a ratio between 1:3–1:7. Although it is not part of the formal definition[7], span of control should also apply to the number of tasks or functions that one person can supervise. Adding more staff and resources to manage social media is one thing, however, it's only

by creating its own unit that we can maintain a proper span of control in a large incident. As noted in AFAC (2017):

> *Organising the responders, so everyone understands what their task is, and who they are working with a reporting to, is central to the effective and safe management of an incident.*[8]

Much like the Media Unit, the basic structure of the Social Media

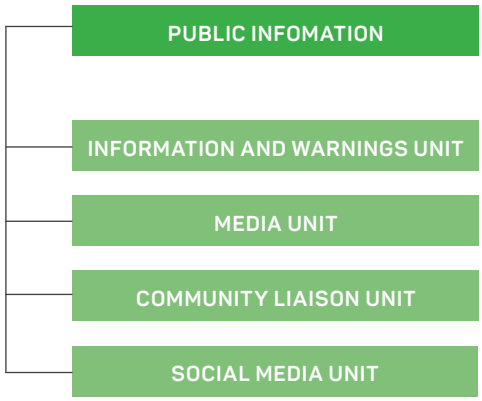

Figure 1: What the structure of the Public Information Section would look like with a Social Media Unit

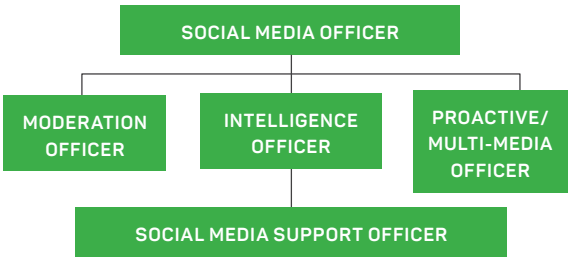

Figure 2: What the structure of the Social Media Unit might look like in a Level 3 IMT.

Unit could include a Social Media Officer and Social Media Support Officer. In a Level 3 IMT, the Social Media Unit could be expanded to include roles such as a Moderation Officer, Social Media Intelligence Officer and Proactive/Multi-Media Officer. The tasks these roles would be responsible for are consistent and need to be filled in most major incidents.

The most important role after a Social Media Officer is the Moderation Officer. The world of social and new media is filled with misinformation and, too often, a harmless-looking comment on a post turns into a rumour that can have the Media Unit trying to clarify a false story. But even if such a comment gains no traction and goes nowhere, it is still dangerous. Following the wrong information in an emergency can lead to injury and death; something we try very hard to prevent. It's very easy for someone to read advice on a post and believe it because there is no one in the Public Information Unit given the sole task of responding to and moderating comments on social media.

The next most valuable role is a Social Media Intelligence Officer. Gathering information and passing it onto the Intelligence Unit is one of the essential functions of the Public Information Section[9], yet it is normally one of the first to fall by the wayside in a crisis when the pressure is on and help is in short supply. Having a Social Media intelligence Officer dedicated to finding and passing on information would be invaluable in large-scale events.

Lastly, appointing a Proactive or Multi-Media Officer to help coordinate what should be published and when would help to keep the flood of content that needs to be published during an emergency to a manageable level. This role could also process or edit video content to help the Media Unit package footage for TV networks and YouTube channels.

Having a good social media presence can make all the difference in a crisis. The first place time-poor and overworked journalists go for updates is a Twitter or Facebook account. Videos posted to social media can gain hundreds or thousands of views within minutes, spreading necessary information far and wide. While radio is still king in areas where a disaster has brought down telecommunications infrastructure, social media helps emergency services organisations reach a larger audience. It can raise awareness and build resilience, making communities aware that they, too, might need to be prepared for a flood or fire one day. The importance of social media in Australia can't be overstated, yet its place is not reflected in the current AIIMS structure. The first step towards taming the beast that is social media is to give it its own unit, allowing for a set structure of roles that all emergency services agencies can understand and use.

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AFAC CONFERENCE | REPORT

Evacuation modelling for bushfire: the WUI-NITY simulation platform

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Abstract

The number of people who live in bushfire-prone areas around the world is growing. In Australia, in the states of Victoria and New South Wales, over 1.5 million people live in areas rated as high to extreme bushfire risk in (SGS Economics and Planning 2019). As effects of climate change increase the size and severity of bushfires, and a greater number of people move into these at-risk areas, there is a growing imperative to understand the likely evacuation outcomes of bushfire-prone communities under various fire scenarios. This paper introduces a freely available simulation platform called WUI-NITY that can be used by evacuation planners and decision-makers to forecast evacuation behaviour within affected areas, and in turn, better prepare for and respond to future bushfire events.

Introduction

Understanding evacuation outcomes is crucial to develop pre-event community and evacuation plans, training programs and educational outreach materials as well as response-based evacuation and warning decisions that are safe and effective. The evacuation outcomes of most interest to planners and decision-makers include evacuation rates (or the percentage of people in an affected area that evacuate), the total clearance or evacuation time for the affected area, the location of congestion points and the numbers of people located in affected areas over time.

Evacuation simulation tools are used to plan for bushfire events. As technology becomes more sophisticated these tools may be viable for use in evacuation response and real-time decision-making. Simulation tools can be used to estimate how a population evacuates an area based on the community's layout and features, varying population types and locations and current and future fire incidents. Simulation tools are the key to testing likely 'what if' fire and evacuation scenarios. This allows planners to test their plans or decisions under challenging conditions, for example delayed evacuation, limited road access or transport options and traffic congestion (Wahlqvist *et al.* 2021).

There are a number of evacuation-related simulation platforms currently available. Ronchi *et al.* (2019) reviewed fire, pedestrian and traffic models that can be used to estimate evacuation outcomes. These models were categorised in several ways, including by modelling approaches. Wolshon and Marchive (2007) describe 3 types of modelling approaches as simplified, refined and hybrid. Relating this to bushfire evacuation, the modelling approaches for bushfire spread (B), pedestrians (P) and traffic (T) within each category are as follows (Ronchi *et al.* 2019):

- in a simplified approach, models are empirical (B), flow-based (P), and macroscopic[1] (T)
- in a refined approach, models are physics-based (B), agent-based (P), and microscopic (T)
- in a hybrid approach, models are a combination of these (e.g. mesoscopic [T]).

An additional way of categorising models is how they incorporate fire, traffic and pedestrian dynamics within the same platform. While some exceptions exist (Singh *et al.* 2021), most models simulate only one of the necessary features (i.e. fire, traffic or pedestrian) (Ronchi *et al.* 2017). Also, only a few of the available simulation platforms consider at least 2 modelling layers, for example (Beloglazov *et al.* 2016, Cova 2005). This paper introduces a freely available platform called WUI-NITY (Ronchi *et al.* 2019, 2020; Wahlqvist *et al.* 2021) that represents all 3 modelling layers of

1. Macroscopic models represent traffic behaviour at the aggregate level to identify broader trends in evacuation behaviour, while microscopic models allow for the simulation of individual vehicles. Mesoscopic models are a combination of these 2 methods, for example, describing vehicles at a higher level and their interactions at a lower level of detail (Intini *et al.* 2019, Kuligowski 2021).

a bushfire evacuation, namely fire, pedestrian and traffic in a coupled manner that, together, forecast evacuation behaviour within an affected area over time.

WUI-NITY model overview

The WUI-NITY platform simulates and visualises human behaviour and bushfire development during evacuation of bushfire-prone communities. It was developed using a popular game engine (Unity 3D) so that fire spread, pedestrian response and movement, and traffic movement can be represented and visualised during bushfire evacuation scenarios (Intini *et al.* 2019). While the output is provided in 2D, the model has the potential to integrate a first-person 3D user-experience that could be used for visualisation purposes as well as future virtual reality interaction with the evacuation scenario space (Wahlqvist *et al.* 2021).

The WU-NITY platform is modular in that it allows for the coupling of different submodels to estimate evacuation performance. While the current submodels for each domain (i.e. fire, pedestrian and traffic) are simplified in their approach, these submodels can be replaced at any time with more sophisticated (e.g. refined approach) models in the future. The current models (i.e. empirical, macroscopic) were selected since they require only limited computational resources that can allow for their use in planning and real-time decision-making applications.

How WUI-NITY works

The functionalities of the WUI-NITY platform are described using a generic timeline for a bushfire event. A simulation begins with the ignition of a fire and its spread throughout a particular region. Before a warning is given, the model simulates 'background traffic' via a vehicle density modifier to account for vehicles initially on the road network (at the start of the fire). Background traffic can include vehicles driving into or through the affected area for trips unrelated to evacuation, as well as some percentage of the affected population who decides to evacuate before any warning[2] is given.

Once a warning is given to particular areas or locations affected by fire, the model simulates a given percentage of people who decide to evacuate. These evacuees may decide to leave their household and enter the road network right away or delay for some period of time before doing so. At the same time, the model accounts for some proportion of the population located outside of the warning areas who also decide to evacuate, referred to as 'shadow evacuees'. WUI-NITY also accounts for the percentage of individuals who decide not to evacuate.

During the evacuation, the model incorporates likely events that can influence evacuee travel times, including routes and destinations being blocked or rendered unavailable due to the fire, shelters reaching capacity or closing, car accidents and road lane reversals. Once the evacuation from the affected area is completed and all evacuees have reached their destinations, the clearance time for the affected area and the evacuation (arrival) time curves at each destination are estimated. Other WUI-NITY outputs include (at each time-step):

- the traffic flow at final destinations (i.e. the number of vehicles arriving at the final destinations over time)
- the number of vehicles in different parts of the road network
- the number of vehicles that have not yet reached a destination
- the number of remaining residents, evacuees and those located in refuge
- the density values (visually) for each road section.

WUI-NITY submodels

A brief discussion is provided on each submodel based on Ronchi *et al.* (2020) and Wahlqvist *et al.* (2021) that provide additional information on the specifics of the fire, pedestrian or traffic models.

The user has 2 choices for simulating the fire scenario(s). Users can import simulation results from the FARSITE model[3], or they can use a custom cellular automata implementation of the BEHAVE fire model[4] that was recently incorporated into WU-NITY (Ronchi *et al.* 2021). The outputs of the fire model serve as important inputs to the other WUI-NITY submodels and include the time of arrival, fireline intensity, flame length, rate of spread and fire spread direction.

The pedestrian submodel distributes the population throughout the affected area and simulates pedestrian/household response and movement into traffic networks. To distribute the population, data from the Gridded Population of the World[5] are imported into WUI-NITY, from which population counts and density are provided with a resolution of 1 km^2 area. WUI-NITY proportionally redistributes the simulated population based on the proximity of the 1 km^2 cells containing the population data to the road network. By doing so, WUI-NITY puts simulated residents in likely residential areas that have access to roads (rather than being placed within national parks, for example). From there, households are generated randomly (assigning 1–5 people per home by default) however, users can override this default. Response delays are assigned to households via a log-normal (or custom) distribution to account for the fact that most people do not evacuate right away. Instead, people are more likely to perform a series of activities before and after they decide whether to evacuate (Kuligowski 2021, Strahan & Gilbert 2021). Evacuation rates, or the probability of evacuation, is assigned throughout the population via response delays.

Within the pedestrian submodel, WUI-NITY simulates the movement of individuals from their household to the nearest traffic node to represent the movement of individuals to their vehicles. Movement speeds are assigned to residents through a default uniform distribution ranging from 0.7 to 1.0 m/s however, a multiplier (greater than 1) can be adopted to represent local movement inefficiencies or people who require adoption of slower speeds. The output from this pedestrian model (the

2. The term 'warning' refers to advice, watch and act or warning messages.
3. Further information on FARSITE is at www.firelab.org/project/farsite/.
4. Further information on Behave is at www.firelab.org/project/behaveplus.
5. Gridded Population of the World v4 at https://sedac.ciesin.columbia.edu/data/collection/gpw-v4.

number of people entering the traffic network over time in a cell or traffic node) becomes the input to the traffic model.

For the traffic submodel, WUI-NITY incorporates data from OpenStreetMap[6] (OSM), a freely available worldwide database to develop the road network.[7] WUI-NITY incorporates satellite images to enhance visualisation. The inputs for this submodel include the percentage of vehicle density (i.e. background traffic) and the arrival of occupied vehicles into the road network (obtained from the pedestrian submodel). Traffic movement is represented at the macroscopic level, considering the conservation law of vehicles (i.e. speed-density relationship). Traffic flows are simulated through a speed-flow-density relationship, where the Lighthill-Whitham-Richards model is applied to calculate the actual impeded speed of each car (Wahlqvist *et al.* 2021). Since the model is macroscopic, overtaking is not explicitly represented and the intersections are assumed to be without signals inhibiting flow.

The evacuation destinations in WUI-NTY are user-defined either via point-click in the GUI or via a list resembling an Origin-Destination matrix. Routing choice, which can be the shortest, fastest or user-defined, is computed via an open-source route planning tool (Itinero). This is used to allow for dynamic changes in the scenario to be captured, for example, loss of routes due to the fire spread.

Additional features of the WUI-NITY platform

The WUI-NITY platform is coupled with a trigger buffer tool called the Population Evacuation Trigger Algorithm (PERIL) (Mitchell & Rein 2020). PERIL allows for the identification of trigger buffers around a community based on bushfire- and population-based inputs from WUI-NITY.

A trigger buffer, while not a new concept (e.g. Cova 2005) is a geographical perimeter around a populated area exposed to a bushfire. These perimeters are useful in evacuation decision-making since they are meant to assist in decisions about when an evacuation warning should be issued for bushfire-affected areas. These buffers represent the boundary whereby, once crossed by a fire, indicate the need to prompt evacuation of that community to ensure sufficient time for the community to leave before the fire spreads to the community's edge.

Figure 1 shows an example diagram of timescales for fire spread and egress in a bushfire-prone area, adapted from Figure 7 in Li, Cova and Dennison (2019) and previously published in Wahlqvist *et al.* (2021). In this figure, the dotted line describes the trigger perimeter designated around the affected community and the orange perimeters (solid lines) indicate the fire front at specific time increments approaching the community. The timescale shown begins with the point of fire detection until the fire intersects the populated area. In this example, the community is successfully evacuated before the wildfire reaches the community (i.e. WASET is greater than WRSET).[8] When the bushfire is confirmed as arriving (i.e. trigger buffer time) the decision to trigger the evacuation is taken and the community begins moving to safety (i.e. the evacuation time starts (WRSET)).

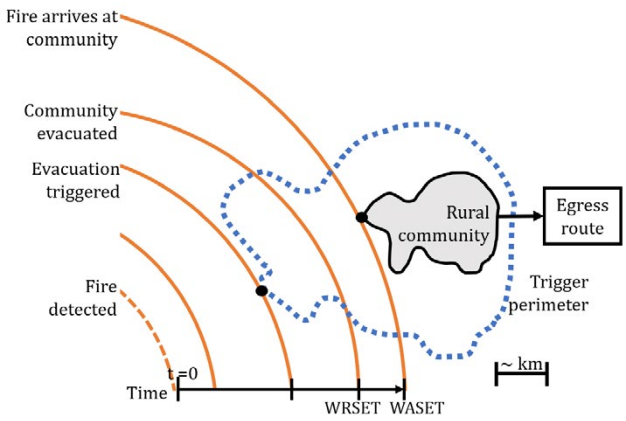

Figure 1: An example diagram of the timescales for fire spread and egress in a bushfire-prone area.

The objective is that the community is evacuated well before the bushfire reaches its edge (i.e. WASET is much greater than WRSET plus a safety factor [SF]). The location of the trigger buffer perimeter is critical since it allows a window of time in excess of what is required (i.e. safety factor is greater than 1).

PERIL has been developed to calculate these geographical perimeters around particular bushfire-prone communities based on the fire spread (via topological configuration of the terrain, type of land, weather and wind) and the clearance time estimates from WUI-NITY. During the planning process, several trigger buffers can be developed for a particular community based on simulation results from a number of likely fire and evacuation scenarios.

Another feature of WUI-NITY is the capability of performing dynamic vulnerability mapping. Outputs from the pedestrian and traffic submodels are used (i.e. the number of people remaining in the affected area over time either at home or on the road). Results can be presented in terms of a ratio or a dose.

These types of vulnerability assessments can identify via a colour-coded map, the capacity of a population to cope with the fire situation and the effectiveness of any evacuation procedure being simulated (Wahlqvist *et al.* 2021).

Discussion and conclusions

The WUI-NITY platform was developed to produce needed insights into evacuation performance, enabling planners and decision-makers to identify vulnerable locations and populations in specific fire and evacuation scenarios. Using a consistent level of granularity, the platform is unique in its coupling of fire,

6. https://www.openstreetmap.org
7. The road network data can be customised by the user by directly modifying the source OSM dataset.
8. WASET refers to the available safe egress time in the wildland-urban interface (or bushfire-prone) area and WRSET refers to the required safe egress time in the wildland-urban interface (or bushfire-prone) area. These concepts were first introduced in (Ronchi *et al.* 2017).

pedestrian and traffic movement to estimate evacuation outputs as well as to generate trigger buffers and vulnerability estimates.

Recent work has validated the model and demonstrates its use and benefits. WUI-NITY was validated using data collected from an evacuation drill in a community in Colorado, US (Ronchi *et al.* 2017) as well as against traffic speed and flow data obtained from the California Department of Transportation Performance Measurement System database during the 2019 Kincade fire in Sonoma County, California.

As with any model, WUI-NITY makes assumptions about features within the scenarios, including the population. These assumptions are that all residents are at home at the time of the fire, the household is together, and they leave together when evacuation begins and only private vehicles are simulated. Additionally, WUI-NITY does not currently account for pedestrian evacuation on foot. In the future, additional features are planned (e.g. evacuation on foot and/or via sea, smoke modelling).

Acknowledgments

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AFAC CONFERENCE | REPORT

Towards an integrated hi-tech solution to detect small fires

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Abstract

The ANU-Optus Bushfire Research Centre of Excellence is developing a novel, integrated, hi-tech solution to detect bushfires early with an approach that combines different remote sensing platforms including satellites, long endurance uncrewed vehicles (drones), cameras on fire towers and ground sensors in the Australian Capital Territory. The different methods and technologies are evaluated using planned, unplanned and experimental ignitions to determine under which scenarios each technology is most effective and the extent to which they outperform or complement current practices.

Introduction

Spotting and attacking fires early is paramount to improving emergency response time and reducing the risk of large-scale bushfires. This is especially true in remote terrain where extensive areas can quickly burn under extreme fire weather and dry fuel conditions. In Australia, when it comes to fire detection, we heavily depend on 000 calls from the public mainly around urban areas, intermittent surveillance efforts from people in towers who can be exposed to health and safety issues, and the deployment of manned, fire-spotting aircraft over lightning-strike areas. These are often delayed because of resourcing issues or restrictions on night flying operations.

Regarding early bushfire detection, there is not a single technique that can do the job of inspecting large areas and detecting small bushfires. Existing satellites can provide surveillance across Australia but may not identify small ignitions given current spatial and temporal resolution and will fail to detect ignitions during cloudy conditions. Long-endurance drones can fly below clouds for up to 10 hours, overcoming satellite limitations. Cameras on towers and on-ground sensors have limited spatial coverage per camera or sensor network but can be located in areas of elevated risk or conservation value. Only a system that combines all the technologies may be able to detect small fires. This work explores some approaches.

Methods

Different methods and technologies for early fire detection are under development, implementation and evaluation within the ACT Rural Fire Service and in collaboration with ACT Parks and Conservation Service as a proof-of-concept. Further deployments of this capability will roll out to other jurisdictions (Figure 1).

Ground sensors

A scalable ground-based Internet of Things fire detection system using low-power wireless sensor devices is under development. The network will also provide situational awareness for reporting and predicting fire risk and fire movement.

Cameras on fire towers

State-of-the art approaches that are publicly available for bushfire detection have been reviewed and compared. A novel learned smoke segmentation method inspired by physics-based image dehazing methods has been developed using a Convolutional Neural Network (Yan, Zhang & Barnes 2020). More specifically, the smoke segmentation approach separates pixels by modelling the contribution to the colour of each pixel from light reflected from smoke, and light from the actual background (e.g. the forest). The approach explicitly estimates the uncertainty of classification using a generative approach (Zhang 2020).

Drones

Long-range drones are being tested for fire spotting. Drones that can fly at night over an area affected by dry lightning strikes and determine how many of those strikes resulted in ignitions and

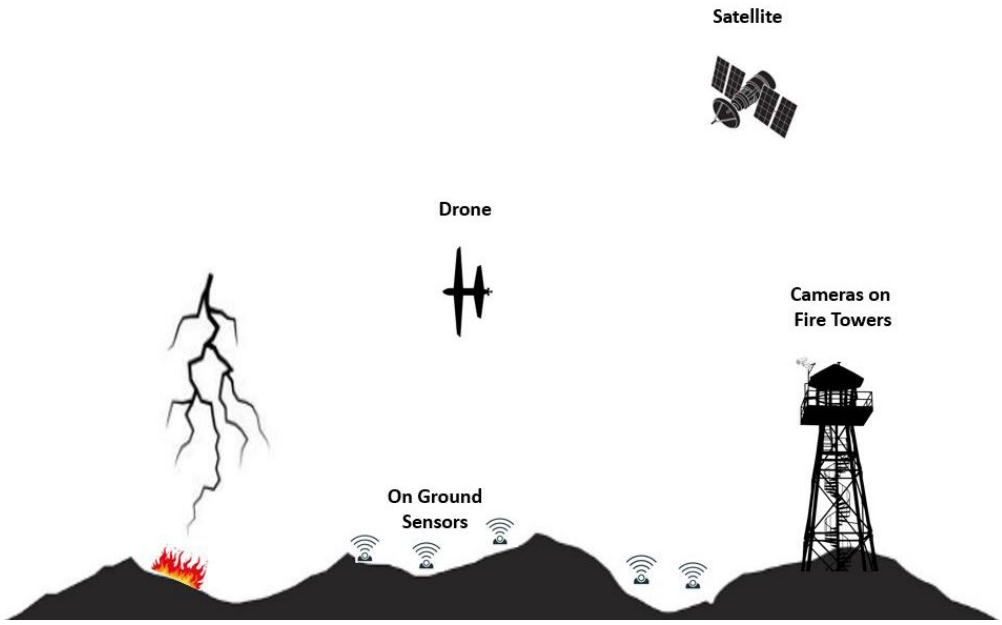

Figure 1: Integrated approach to bushfire detection under implementation and testing in the ACT. The system combines different remote sensing platforms including satellites, long endurance drones, cameras on fire towers and ground sensors.

track the spread of those ignitions. This provides a potentially significant capability enhancement to existing fire management practices. This drone capability has started to be tested in the ACT.

Inspection of lightning events during lightning storms from the 2019–20 bushfire season has been simulated over a 100,000 km^2 region along the east coast of Australia to test the feasibility of a swarm of drone solution to achieve the desired response time.

Satellite

Hotspot detection from existing satellite capability will be integrated into the system. The hotspot alerts will come from Geoscience Australia's Sentinel system that integrates satellite data from several geostationary and polar orbit satellite systems. Italian software developers are working to develop a notification system for fire detections from multiple satellite systems.

Evaluation

The different methods and technologies implemented in the ACT are to be evaluated over the next 4 years using planned, unplanned and experimental ignitions. Ignitions will be stratified across a range of conditions that are expected to influence detection success including landscape position, vegetation structure (grassland/forest), weather conditions and times of the day (day/night). Detection technologies will be progressively incorporated in the evaluation as technologies come on stream and mature. This evaluation will help to determine under which scenarios each technology is most effective and the extent they outperform or complement current practices.

Results

Preliminary results achieved are summarised below for technologies advanced in implementation.

Cameras on towers

The results (Mean Squared Error per pixel averaged across all test images - mMse ranging from 0.12 to 0.14 depending on the datasets used for validation) significantly outperform all state-of-the art smoke segmentation models (mMse ranging from 0.21 to 0.34 depending on the model and dataset) leading to a higher rate of true positives than other approaches (Yan, Zhang & Barnes 2022). The proposed bushfire segmentation approach may also allow better automated estimation of the physical location of the fire including a fine-scale estimation of the edge of the smoke in the transition from thick to translucent smoke. The veracity of this hypothesis will be determined by the results of the evaluation project.

Drones

A suitable platform has been acquired from Carbonix, the Volanti, which provides an initial vehicle on which to undertake the first tranche of experimental tests and verification procedures. The Volanti has a maximum 2-hour flight time. The Volanti will be upgraded to the Domani vehicle in late 2022. The Domani vehicle has a 6–8-hour flight time and a slightly larger payload.

The initial tests of the Volanti have been completed. A thermal camera, a NextVision NightHawk2-UZ, is integrated and the first thermal video has been collected over experimental sources

of heat and smoke (Figure 2). A Silvus mesh radio has been scoped and provided with the Volanti vehicle. This provides the capability for the data feed on the vehicle to be routed through the ACT Emergency Services Agency (ESA) mesh radio network that covers the entire ACT and provides radio communications capability throughout Namadgi National Park. The use of ESA's radio network will both enable Beyond Visual Line of Sight (BVLOS) flight and enable us to stream thermal imagery directly to ACT Rural Fire Service.

Figure 2: Thermal infrared (top) and RGB (bottom) images of 3 different heat sources.

A severe storm from the 2019–20 bushfire season over a 100,000 km^2 region in south-eastern Australia was simulated to verify the feasibility of a swarm of drone solution for bushfire detection. The storm contained approximately 4,000 strikes over 24 hours. Preliminary results indicate lightning inspection times of less than 15 minutes with 100 drones, and 5 minutes with 500 drones when regions of high lightning-strike density are forecasted an hour in advance to allow a pre-emptive increase in drone density over that region (Figure 3). The ignition risk of a lightning-strike ignition depends on many local factors such as the fuel load and associated rain events. Thus, the algorithms can prioritise strikes with high-ignition risk to lower the inspection time of prioritised strikes. Lower inspection times for high-risk strikes are expected by prioritising inspection, and further modelling will be undertaken to further explore this aspect.

Evaluation

A dataset of ignitions in the ACT from 2012–21 has been compiled from Australian Incident Reporting System (AIRS) and Incident Control On Line (ICON) data provided by ACT ESA. The curation of this dataset provided insufficient information to identify trends in the proportion of ignitions detected by different detection sources. However, this process was beneficial in identifying and addressing issues associated with data collection before the commencement of the evaluation. The database of ignitions was also critical to understanding the sources of variation in ignition frequency and location. These data will be used to inform deployment of detection technologies and to specify conditions for experimental burns.

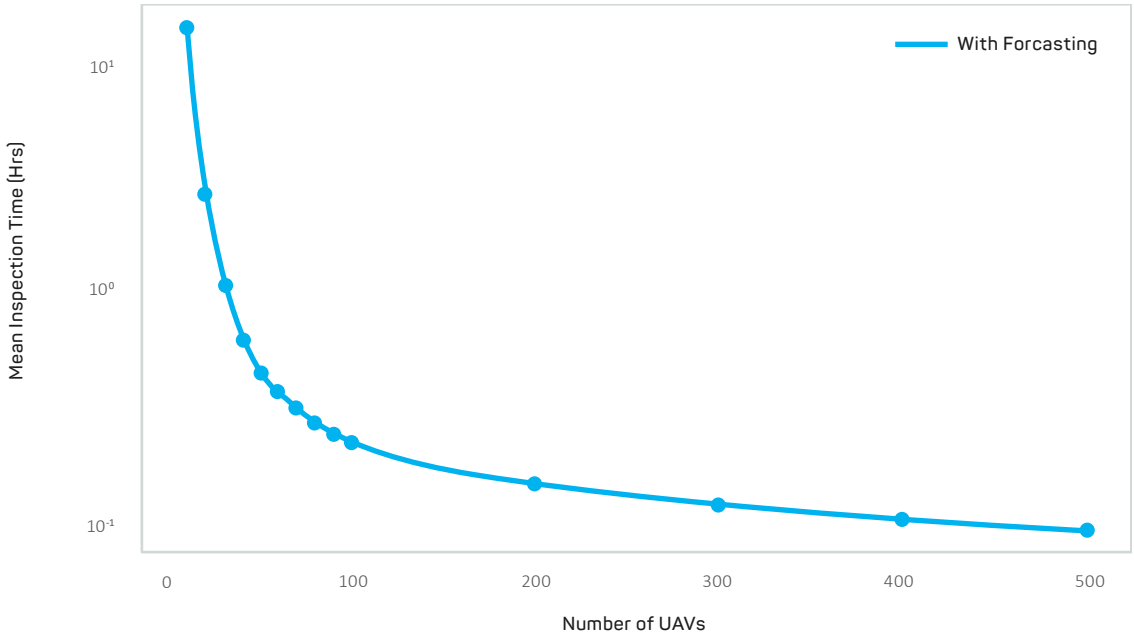

Figure 3: Mean inspection time for different sizes of the UAV swarm used to inspect the lightning strikes.

Figure 4. Small fire lighted by members of the ACT Rivers fire brigade (left). Smoke produced by the smoke machine (right).
Images: Nick Wilson (left) and Robert Mahoney (right)

A safe, cost-effective and realistic way of replicating an unplanned fire ignition has also been identified to enable a more extensive evaluation, especially under fire weather conditions unsuitable for experimental ignitions. So far, we have successfully replicated a small fire using an artificial smoke machine (Figure 4). Smoke from this machine was identified via a fire tower operator, a fire observer monitoring a fire tower camera and imagery captured by the drone.

Conclusions

Most ignitions in Australia, and many other fire-prone regions, are detected by the public or fire tower observers but current approaches are not always effective, especially during extreme weather and in remote, unpopulated locations. We must accelerate the development of modern technologies to meet this challenge, well ahead of future catastrophic bushfire seasons. Novel technologies such as those presented here may offer more efficient detection of ignitions. These technologies have the potential to reduce the resource demands associated with increasing ignition frequency caused by climate change.

Acknowledgment

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AFAC CONFERENCE | REPORT

Leveraging 'Internet of Things' technology for measurement of bushfire suppression

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Abstract

There is currently very little quantitative information on rates of suppression and water usage from bushfire tankers working the edges of bush and grass fires. This information would be of value to improve suppression and longer-term concerns, such as fleet configuration and maintenance. Fire agencies have begun tracking tankers using GPS-enabled radios to provide location intelligence during deployments. However, more information is required to build a dataset that can be used to estimate suppression rates and to investigate the influence that different factors have on these rates. The data includes fine-scale movements and water use, suppression objectives and environmental conditions. In Victoria, the Country Fire Authority (CFA) has installed a high-frequency GPS, water flow meters and video cameras to a tanker capture this information.

Introduction

The effectiveness of bushfire suppression has mostly been evaluated at broad scales using measures associated with the area burnt and the time taken to contain the fire (Plucinski 2019a). Investigations of suppression effectiveness at finer scales are more difficult to conduct, but are required to understand the productivity of suppression resources in different situations, including their safe limits of operations (Plucinski 2019b). Understanding the use and productivity of fire tankers during fires can inform future investment in the firefighting fleet. While the effectiveness of wet firefighting in grassfires is dependent on many factors other than vehicle specification, understanding travel speeds, flow rates and the role of tank capacity are critical for appliance design. Fire agencies have started to track resources using GPS-enabled radios or other real-time automatic vehicle location transceivers for operational purposes.

In the CFA, automatic vehicle location (tracking) is performed by a system known as the Resource Tracking System (RTS). The RTS records location and speed data from a GPS receiver attached to the vehicle's mobile radio. RTS data are available for most CFA vehicles while responding to an incident. Data are recorded by the system:

- every 200 m at slow speeds
- every 2 km at highway speeds
- every 30 minutes when stopped.

In addition to variability of speed, critical flow rates and water-tank capacity are fundamental to tanker design and effectiveness in grassfires. Selected flow rates during operations are influenced by factors such as fire behaviour and firefighter training and experience. Operational data are required to investigate the influence of environmental and fire behaviour factors on water use. These data have great potential for the development of suppression productivity models, which could be used to estimate the likely resource and time requirements for a range of scenarios and applied to planning and operational decisions. This paper, examines a novel way in which CFA, in collaboration with CSIRO and industry, is addressing this data need by comparing existing data (from the RTS system) with an Internet of Things (IoT) prototype system retrofitted to an operational tanker.

Methodology

Twenty-one tankers were fitted with an IoT device to capture continuous GPS tracking data at a nominated, high-frequency time interval. The installed tracking systems captured GPS data from

the tankers when the ignition was turned on. The systems were accessible through a secure website where data (real-time and historical) could be downloaded and settings, such as the logging frequency, could be adjusted with notifications of activity that could be pre-set. The GPS devices provide data on movement during incidents at a fixed 5-second interval, compared to the speed conditional reporting intervals of the RTS system. The value of these data for analysis is limited without additional information from the crews to provide some context of the corresponding conditions and activity.

Of the IoT connected tankers, one was selected to trial additional instrumentation to relate operational activities to movement and flow rates. This tanker, known as the 'smart tanker', was fitted with additional video and water usage monitoring equipment. The smart tanker had 4 cameras placed to provide a visual understanding of the suppression tasks undertaken as well as environmental conditions and fire behaviour (Figure 1a-c).

The cameras were set to begin recording on triggers such as geofences and pump or vehicle ignition activation to avoid unnecessary capture of footage. Examples of the imagery captured by these cameras is shown in Figure 2. The tanker also has 2 flow rate meters (Figure 1d) that were installed to monitor water usage on the deck outlets. These outlets are the primary water source used for suppressing running grassfires. A box containing data loggers and communication devices is mounted to a panel in the firefighting deck (Figure 1e).

Figure 1: The smart tanker that includes water flow meters and video cameras: a) the circles show the locations of the side and forward mounted cameras, b) the forward-facing camera above the windshield, c) a side (left) mounted forward-facing camera, d) one of the 2 flow meters above the fuel tank and e) weatherproof boxes containing data loggers and modems on the deck behind the left side of the cabin.

Images: Garry Drabsch

Figure 2: Example screenshot of the view from the 4 cameras installed on the smart tanker: CAM1 rear, right side facing forward (obscured by spray), CAM2 rear left side facing forward, CAM3 rear elevated facing forward showing crew bay and cabin and CAM4 top of cabin facing forwards.

Results

After the smart tanker system was commissioned, a demonstration of the technology was performed, as shown in Figure 3.

The initial trial day proved the system functionality; however, the following fire seasons (2020–21 and 2021–22) were operationally quiet and the tankers were deployed to a few incidents. The smart tanker was deployed to the Langkoop fire on 1 January 2022, but was largely involved with patrol and edge consolidation tasks. Incidents within the brigade area of the smart tanker were quickly extinguished using hose lines while tankers were parked, so deck outlets were not used. One of the high-frequency GPS tankers was deployed to a fire at Beaufort in 2022.

In autumn 2022, the smart tanker was taken to the new Central Highlands Victorian Emergency Management Training Centre (VEMTC) to benchmark the systems, as well as to capture basic parameters related to branches, flow rates and wind effects. The data from this day included travel to and from the training facility and was compared with the existing RTS system and the specialised IoT system. The results comparing the speeds measured by the systems are shown in Figure 4.

Comparing speeds derived from the generic RTS and specialised IoT system (Figure 4) shows reasonable agreement. An important note on the RTS speeds is the truncation where speeds are less than 10 km/hr. Examining a short window of time from the benchmarking day, Figure 5 shows the data captured from both systems with the IoT system providing a more detailed picture of the tanker's speed during testing.

Figures 4 and 5 show that there are limitations to the application of the RTS system for collecting tanker movement data because of the less frequent and irregular track points that do not capture short stops and small variations in speed and direction.

Several tests were run during the day to examine the interaction of wind with different hose branches commonly found on CFA tankers. The demonstration of the smart tanker combined with remotely piloted aircraft systems (RPAS) during the nozzle comparison highlighted the possibility for leveraging the 2 technologies for work in the future. Figure 6 shows the set-up for capturing the nozzle comparison data using the smart tanker that is shown in Figure 7.

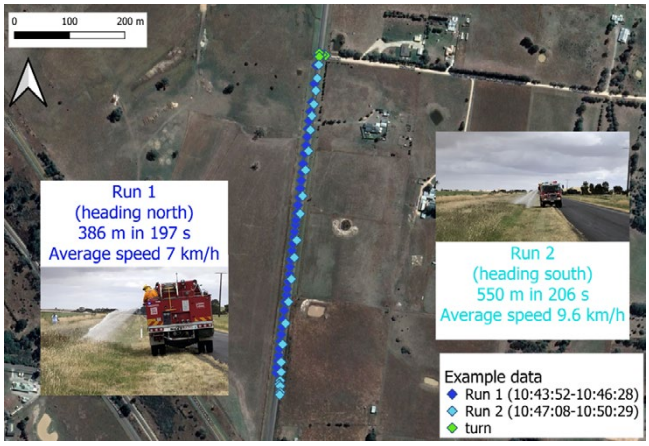

Figure 3: Examples of tracking data collected from the IoT device installed in the smart tanker on the initial trial day (8 December 2020).

Discussion

Despite the technical capability of the IoT tankers, they have yet to be used under operational conditions for running edge attack as was simulated without fire in Figure 3. Capturing sufficient data to accurately represent the bounds of safe and effective suppression will require a diversity of case studies. Despite this, the tankers provided opportunities for validating the performance of the RTS system, which has been used in other case study work by Butler, McCarthy and Deutsch (2022). There is merit to leveraging the RTS data as high-frequency GPS may not be required for capturing some types of operational data, such as edge attacks along flanks that extend for multiple kilometres or for providing information on turnaround times between fires and refill points.

Tracking data from systems such as RTS and the IoT GPS can provide useful information on tanker locations at different times. It is collected passively and does not influence the actions of crews. Complementary data are required to give context to this for meaningful analysis. This includes information on the suppression objectives, methods and outcomes, as well as the environmental conditions and fire behaviour. Some of this information can be determined from videos captured on

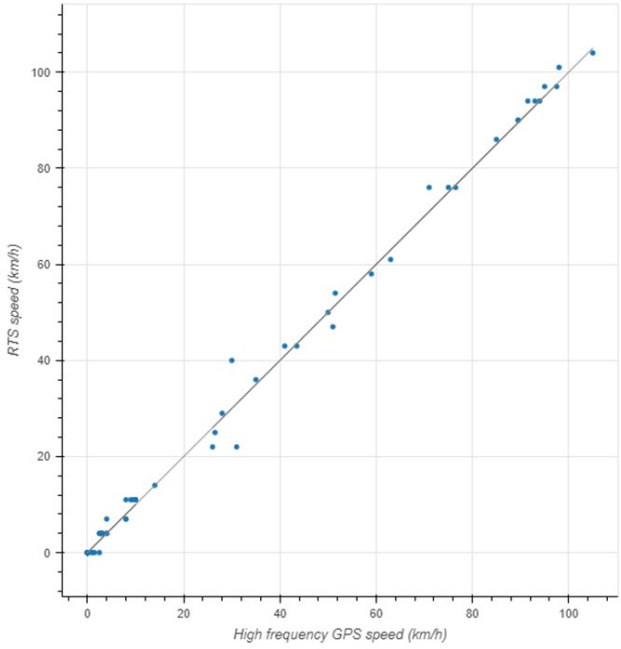

Figure 4: Data from a single day of use of the smart tanker including normal road and highway condition driving, and low speed edge attack simulation. The data compares the RTS GPS-derived speed as is standard on all CFA appliances with the high-frequency system fitted to the instrumented tankers.

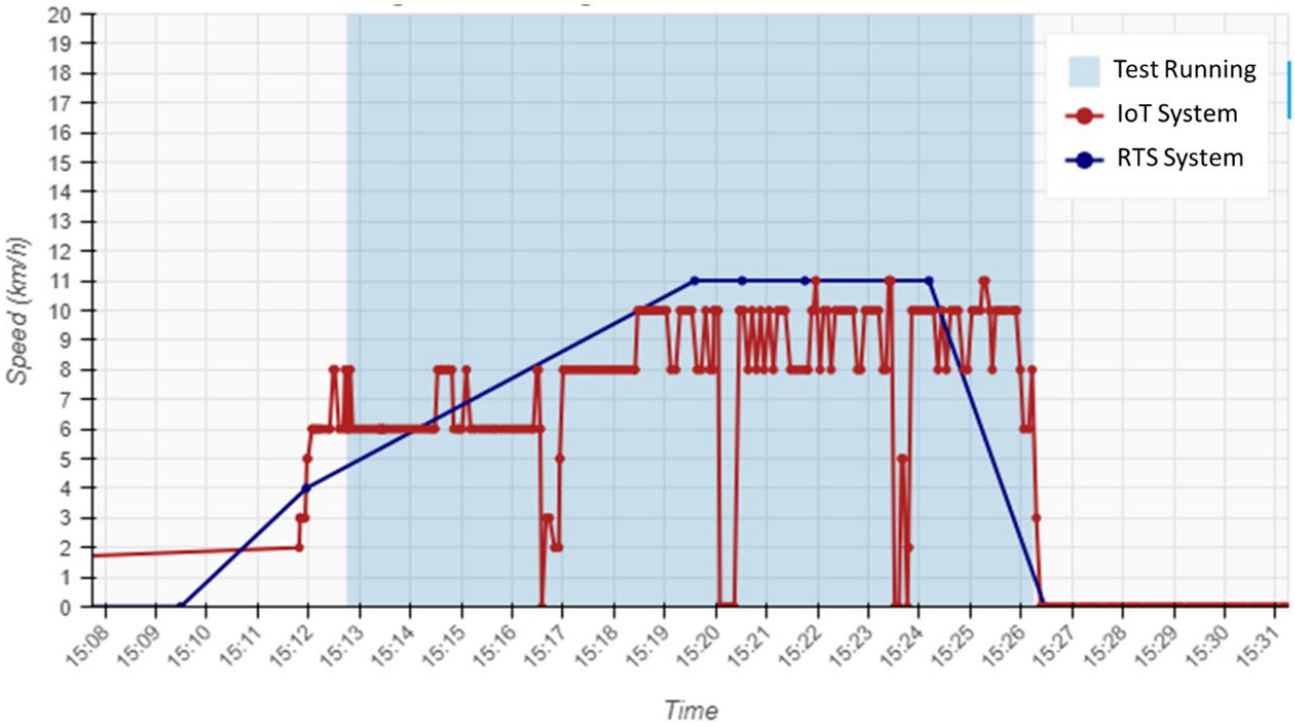

Figure 5: Data from a 15-minute test of the smart tanker in a simulated grass attack comparing the CFA radio-based system (RTS, in blue) and the specialised IoT system (GPS, in red).

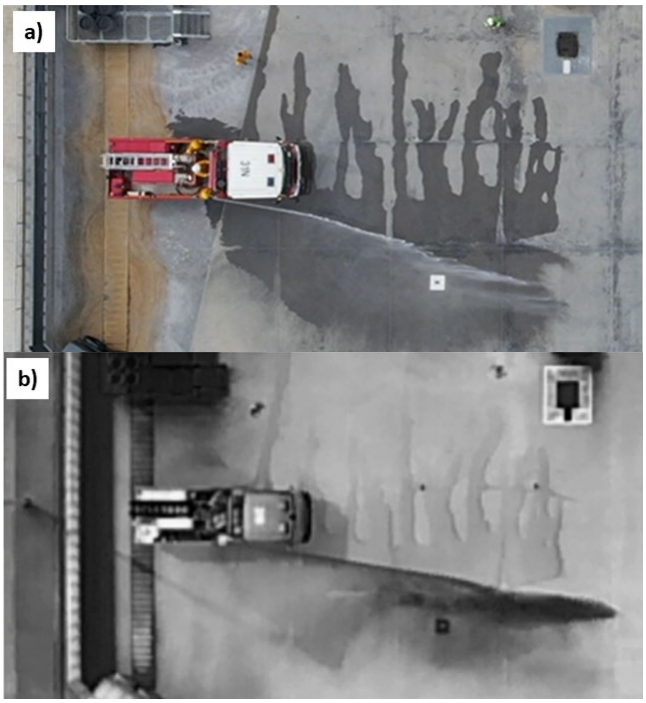

Figure 6: Images from a video from an RPAS in visible colour (a) and thermal infrared (b) showing the nozzle throw distance testing against the wind.

Images: Fire Rescue Victoria RPAS Unit, provided by Dan Green

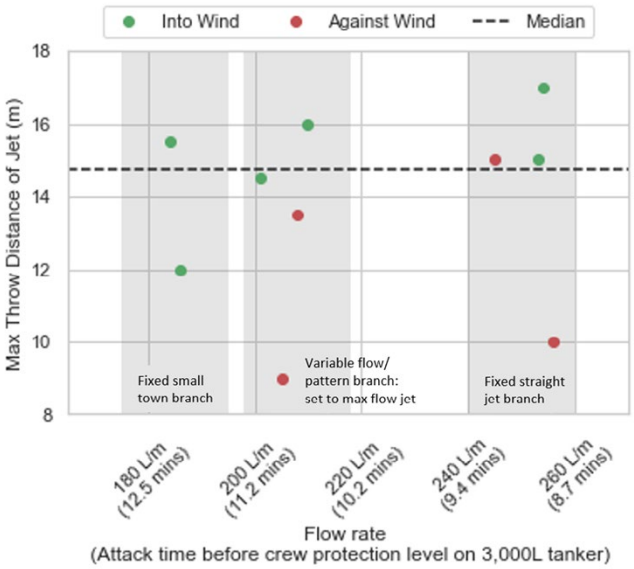

Figure 7: The variation in throw distance from 3 common varieties of hose branches found on CFA tankers, as tested into and with a 22 km/hr wind (as measured at 10 metres).

the smart tanker, but much of this needs to be sourced from interviews or surveys of tanker crews. The onboard digital video recording system has yet to be proven as a cost-effective solution for fire behaviour and situational context. However, review of the multi-angle system during the smart tanker deployment to the Langkoop fire suggests it will capture the required data. The ability to trigger recording using the pump ignition is valuable for conserving hard drive space and avoiding recording superfluous footage.

The smart tanker and its flow rate meters proved very effective for a benchmarking study of branch capability from the top deck outlets. Such data are important for studying the limits of suppression capability in different fire weather conditions, and for informing equipment procurement decisions.

The latest installation on the smart tanker has been the addition of a tank-level sensor to the IoT system. On a unit basis, these are more cost effective than flow rate meters but will require testing for the effects of movement and tilt of the tank. The combination of high-frequency GPS, flow rate meters, a tank-level sensor and a multi-angle video recording system on the smart tanker will provide a capable tool for investigating current and future tanker capabilities and capacities. Data captured from deployments and experiments will provide valuable insights into a range of suppression effectiveness questions such as tanker containment rates and water consumption during different suppression tactics and fire conditions.

Conclusion

The IoT smart tanker represents a novel application of existing technology to acquire data for research and development in bushfires. Acquiring data for developing suppression productivity and water-use models requires a sustained effort in resource-level data collection over many fire seasons. While tankers are an important suppression resource type, over time this should extend to other resource types. The data insights from these instrumentation efforts generate value for existing support and strategic investment within fire agencies.

Acknowledgments

The authors acknowledge the significant contributions of Garry Drabsch, Rachel Bessel, Theo Goslett, Nigel Buchanan and Richard Hurley to design and implement the IoT solution. The teams within CFA Research and Development, CFA Ballarat District Mechanical Officers and CFA Engineering contributed to the success of the trial. The authors also acknowledge Dan Green, Wayne Rigg and the Fire Rescue Victoria RPAS Unit, along with the VEMTC Ballan staff for their help during the benchmarking day. Stephen Deutsch and Evie Eker provided valuable input to the Forest Fire Management Victoria contribution to the suppression effectiveness research and Sarah Harris provided comments on the manuscript. Thanks is also extended to Creswick Brigade and the Birch Group for their help with the trial, and to the crew and crew leaders who assisted with trial days and postfire follow up by the research team.

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AFAC CONFERENCE | NEWS AND VIEWS

The Australian Fire Danger Rating System

Dr Simon Heemstra

AFAC

On 1 September 2022, the Australian Fire Danger Rating System (AFDRS) was launched in Australia. It was the result of national collaboration with all states and territories working to develop a consistent and national fire danger rating system.

Fire danger ratings describe the potential level of danger should a bushfire start. These ratings are important because they provide people with information so they can take action to protect themselves and others from potentially dangerous bushfires.

The AFDRS replaces the current system developed in the 1960s. By using the latest science, data and technology and by having a better understanding of community needs, the AFDRS will improve public safety and reduce the effects of bushfires by:

- improving the scientific accuracy behind fire danger predictions
- improving the ways fire danger is communicated
- providing government and industry with better decision-making tools to support their management of bushfire.

Nationally consistent levels and action-oriented messaging

The new fire danger rating system has 4 levels that have action-oriented messages to encourage people to take action to protect themselves and others during times of heightened bushfire risks. The AFDRS also introduces 'no rating' for days where no proactive action is required by a community. This does not mean that fires cannot happen, but that they are not likely to move or act in a way that threatens the safety of communities.

All Australian jurisdictions will display the fire danger ratings in a consistent way, including using similar colours and roadside signage design. The design was decided following a very large survey of communities and supplemented by extensive focus groups. These studies revealed that most participants did not understand the previous system.

Fewer levels of fire danger rating

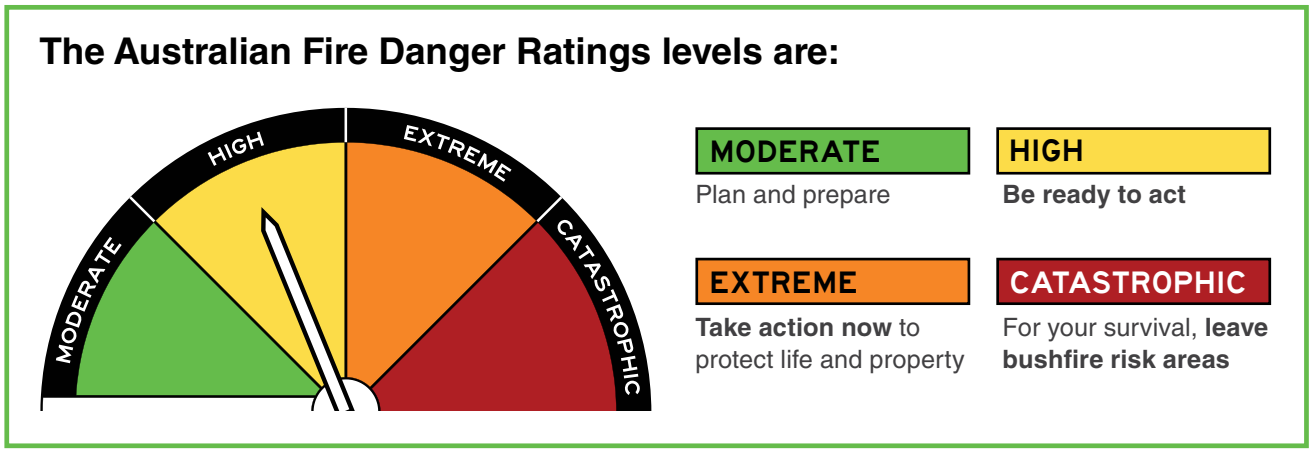
Australia's bushfire agencies, led by the NSW Rural Fire Service, worked to test, improve and retest the evidence that predicts fire danger. The previous system was developed in the 1960s and only considered how a fire might burn in forest or grass areas. The new fire danger ratings consider 8 different fuel vegetation types, including mallee heath, button grass and spinifex, and factors how much fuel is in an area and how long it has been since the last fire.

Through these expansions in what is considered to make a rating, local fire services agencies are able to better predict risk for communities and can help people to prepare. In determining a fire danger rating, fire services agencies will have greater insights as to where the areas of most concern are and can allocate resources to extinguishing fires faster.

Better decision-making tools

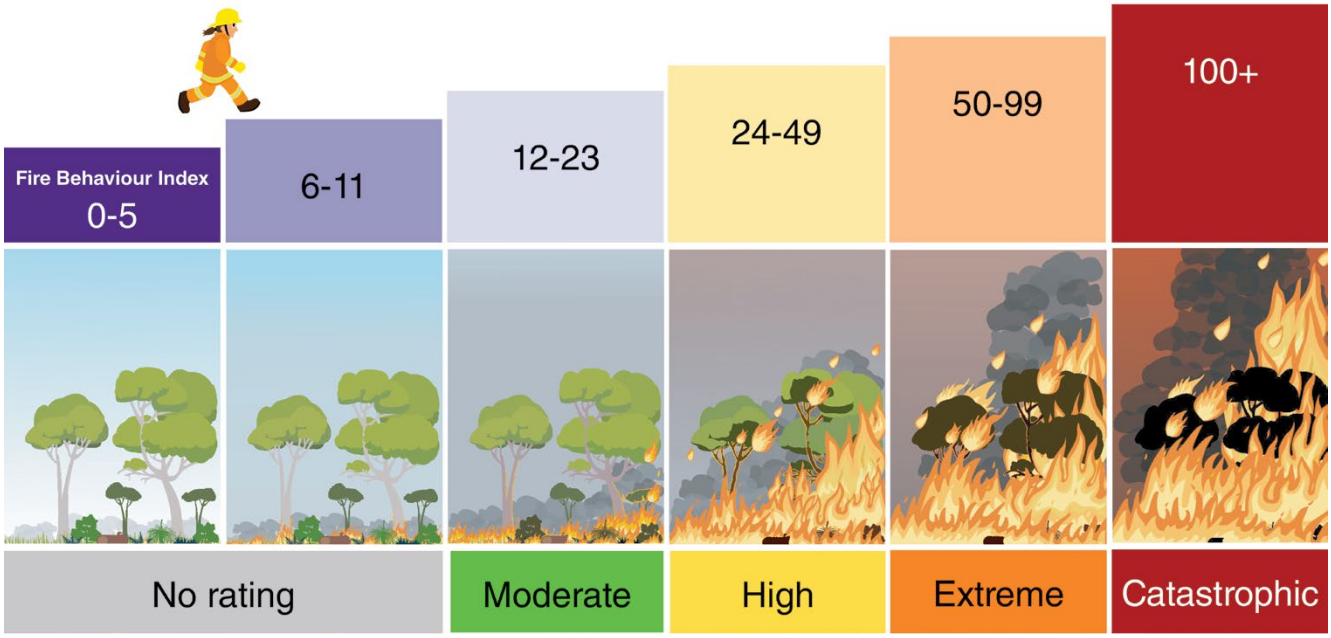
The AFDRS introduces the Fire Behaviour Index as a scale of fire danger that produces fine-scale information across the fuel types, the fuel loads, the time since the last fire as well as weather data to build better predictions. Because the index is provided at such a fine scale and considers so many variables, the AFDRS better supports decision-making for a range of activities such as harvesting regulations, operational activities, prescribed burning plans and suppression tactics. This significantly reduces over-regulation and over-warning and can also avoid the need to shut down activities unnecessarily.

The improved AFDRS reflects our advancements in understanding fire behaviour, delivering a more



The Australian Fire Danger Rating System standardises the determining of the risk and how it is communicated.

Image: AFAC



The Fire Behaviour Index value determines the fire danger rating level.

Image: AFAC

accurate reading of fire danger across all Australian landscapes and vegetation types. To ensure these improvements continue, the AFDRS has been designed to be updatable, allowing the system can take advantage of new science, data and information into the future.

Across the country, fire and emergency services are applying nationally consistent colours, signs and terminology to communicate fire danger risk. This means that wherever you go in Australia, and whatever the season or fuels you're surrounded by, you can understand the level of threat and what you need to do to stay safe. The key benefit is a more prepared and resilient community resulting in a reduction in loss of life, property and human harm.

The AFDRS is a project of national significance that was developed collaboratively by all states and territories and the Australian Government. More information about the AFDRS is available online at www.firedangerratings.com.au.

AFAC CONFERENCE | REPORT

Lessons from NSW RFS trial of the Australian Fire Danger Rating System

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David Field

NSW Rural Fire Service

Abstract

The Fire Danger Rating System is the cornerstone of community warnings, messaging and preparedness, fire agency operational readiness and decision-making. It reflects the legislative controls over activities that could potentially cause the ignition of fires. The system underpins decision-making by private enterprise and other 'non-combat' government agencies and departments. It is critical that fire danger ratings are readily understood, appropriate and accurate. The science that underpins the system hasn't changed in more than 50 years. A new Australian Fire Danger Rating System (AFDRS) provides the framework to significantly improve the way fire danger is calculated and communicated in Australia. During the bushfire season of 2021–22, the NSW Rural Fire Service trialled the AFDRS alongside the existing McArthur-based Fire Danger Rating System. Due to decreased fire activity during the 2021–22 fire season, live trials were supplemented with retrospective analysis. Several insights were gained as well as lessons learnt about how fire danger should be calculated and determined. The NSW Southern Operational Trial highlighted the quality of work and progress made so far in building the AFDRS. Although ongoing adjustments to the systems and the Fire Behaviour Index may be required, the trial found the AFDRS is fit-for-purpose and shows clear advantages over the previous system. This paper outlines operational testing undertaken in NSW.

Introduction

Australia's Fire Danger Rating System used in NSW is largely based on past research and practices. New technology and research have greatly improved our ability to accurately predict fire behaviour and the potential threats to the community. The AFDRS uses current scientific understanding about how fires behave in different types of vegetation to improve the reliability of fire danger forecasts. Instead of the Fire Danger Index, the new system is based on the Fire Behaviour Index. The index is calculated by fire behaviour modelling for 8 fuel types as opposed to 2 as is the current situation. Considering the scale and significance of the proposed changes, all jurisdictions were asked to undertake testing to prepare for implementation of the AFDRS scheduled for September 2022. This involved both live trials and retrospective applications of the AFDRS system over the 2021–2022 fire season.

Key elements of testing included:

- the suitability and error free function of new systems - Fuel State Editor and Fire Danger Viewer
- the appropriateness of the new Fire Behaviour Index for regulatory and operational decision-making.

The AFDRS Fuel State Editor is a national web application that supports the workflow associated with updating of jurisdictional fuel-type mapping, fire-history mapping and grass-fuel state. This data is critical to the AFDRS to generate fire behaviour indices.

The AFDRS Fire Danger Viewer is a web application that enables fire personnel to view and interrogate

forecast weather and fire danger information to support operational decision-making.

The Bureau of Meteorology also established a pilot registered users web page to help users view and interrogate forecast weather and fire danger information to support their decision-making.

Methods

The NSW trial ran between 1 September 2021 and 31 January 2022 and was led by the NSW RFS in collaboration with other NSW combat agencies including Fire and Rescue NSW, National Parks and Wildlife Service and Forestry Corporation of NSW. Tests were performed on the AFDRS web applications of the Fuel State Editor, Fire Danger Viewer and the Bureau of Meteorology registered user's page. The trial also assessed the appropriateness of the AFDRS Fire Behaviour Index for decision-making including operational readiness decisions, the issuing of cease-harvest advice and suspension of fire permits as well as legislative instruments such as a Total Fire Ban (TOBAN).

Operational testing of the Fuel State Editor was performed by the NSW RFS Predictive Services Team, Area Planning and Fire Behaviour officers, district staff and RFS volunteer members. A total of 805 tests were completed.

During the trial, all aspects of the Fuel State Editor were tested including:

- management of reporting locations
- submission of field observations of grass-fuel state (curing and fuel load)
- validation of grass-fuel state field observations
- editing of grass-fuel state data in-line with validated field observations
- Approval of data for upload to the Bureau of Meteorology
- uploading fire-history and fuel-type data.

The Fire Danger Viewer was tested in conjunction with Fire and Rescue NSW, NSW National Parks and Wildlife and Forestry Corporation NSW. These agencies were introduced to AFDRS through a series of 1.5-hour online training seminars. Within the NSW RFS, there were many briefings and discussions that used the viewer during the trial period. Overall, 52 tests were conducted in accordance with the testing plan devised to test the AFDRS.

Results and discussion

Fuel State Editor trials

The Fuel State Editor trial was considered successful with all aspects of the system tested and clear advantages identified:

- Increased ease of use - the Fuel State Editor provides a user-friendly interface that steps observers through the process and the rest of the system is clearly labelled and easily navigated.
- Improved quality of intelligence – the Fuel State Editor allows for the upload of photos of observation sites that vastly increases contextual understanding, especially at a head office level
- Streamlined process – the Fuel State Editor allows for observations, validations, edits and authorisations to all be done on the one platform, whereas the current process requires data to be taken off an observation system, edited on a local computer then uploaded, manually to the Bureau of Meteorology.

The trial found that due to the size of the state and density of the NSW observer network, particularly in Western NSW, continued monitoring and intervention will be required to ensure accurate and consistent fuel-curing maps.

Fire Danger Viewer and Bureau of Meteorology products

NSW agencies participating in the trial were able to undertake testing with limited training and minor adjustment. There were minimal bugs identified with the Fire Danger Viewer. The Fire Danger Viewer pages provides a vast range of practical information and layers. The layout is clean, simple and easy to navigate with minimal experience.

At the time of testing, the Bureau of Meteorology products were in development and required formatting and fixing of bugs before they were ready for implementation. A key improvement identified to the Incident Weather Forecast product was the ability for a requesting officer to choose 'fuel type' for calculation of the FBI.

Appropriateness of the Fire Behaviour Index for decision-making

Due to widespread and consistent rainfall, fire activity across NSW decreased significantly in the 2021–22 fire season. During the trial period, NSW experienced a wetter-than-average spring and its wettest November on record. This weather continued throughout summer, which led to unseasonably high soil moisture during a time when soil and fuel conditions would typically dry out. As a result of decreased fire activities, the AFDRS Project Team supported the NSW RFS to supplement its live testing with retrospective data.

Despite the reduced fire activity, the existing system and live trial the AFDRS reached TOBAN thresholds on a number of days. At times, it was evident that the use of modern fire spread models in AFDRS generally makes that system more sensitive to strong wind speeds and low relative humidity and less sensitive to temperature. This is a significant improvement to address the existing McArthur-based Fire Danger Rating System's sensitivity to high temperatures. Table 1 shows the TOBAN results that occurred in the live trial.

Table 1: Live trial results for TOBAN-threshold decisions.

Date and fire weather area	McArthur-system TOBAN	AFDRS-system TOBAN	RFS-declared TOBAN
02/09/2021 – South Western	No	Yes	No
17/09/2021 – South Western	No	Yes	No
04/10/2021 – South Western	No	Yes	No
18/12/2021 – Northern Riverina	Yes	Yes	Yes
18/12/2021 – Southern Riverina	Yes	Yes	Yes
18/12/2021 – Lower Central Western Plains	No	Discretionary	No
19/12/2021 – Northern Riverina	Yes	Discretionary	Yes
19/12/2021 – Southern Riverina	Yes	Yes	Yes
19/12/2021 – South Western	No	Yes	No
26/12/21 – Southern Riverina	Yes	Yes	Yes
26/12/21 – Northern Riverina	Discretionary	Discretionary	Yes
Total	**5**	**8**	**6**

During the live trial, it was noted that the AFDRS would have triggered the consideration of TOBANs in the South Western Fire Weather Area on 3 occasions in September and October (Figure 1). This was attributed to the AFDRS consideration of spinifex and mallee fire behaviour, compared to the existing system generalising and considering these areas as generic grassland. While the proper consideration of vegetation types is a major improvement on the existing system, the danger depicted for these fuel types was still assessed as being slightly overestimated by the AFDRS. Based on NSW and other feedback from intensity with a wind reduction jurisdictions, adjustments were made to the way the Fire Behaviour Index was calculated for these fuel types.

It was observed that there may be additional scope to improve fire danger calculations for other fuel types by improving the way fire spread models resolve the effects of recent rainfall. Discussions with operational fire managers identified that the AFDRS was overestimating the risk for vegetation types such as grassland, heath, wet forests, softwood pine plantations and arid vegetation types after recent rainfall.

Retrospective analysis (Figure 1) showed an increase of the frequency of reaching TOBAN thresholds for some fire weather areas and reduced in others.

Insights from the state-wide retrospective analysis of total fire ban decision-making thresholds:

- The frequency of TOBANs in the AFDRS was 5–6% higher than the existing system.
- From 2017 to 2020, the AFDRS did not reach TOBAN thresholds in grass-dominated fire weather areas. Consultation with fire managers in those areas confirmed that due to low grass-fuel loads or benign weather during these periods, this was more appropriate than ratings provided by the existing system.

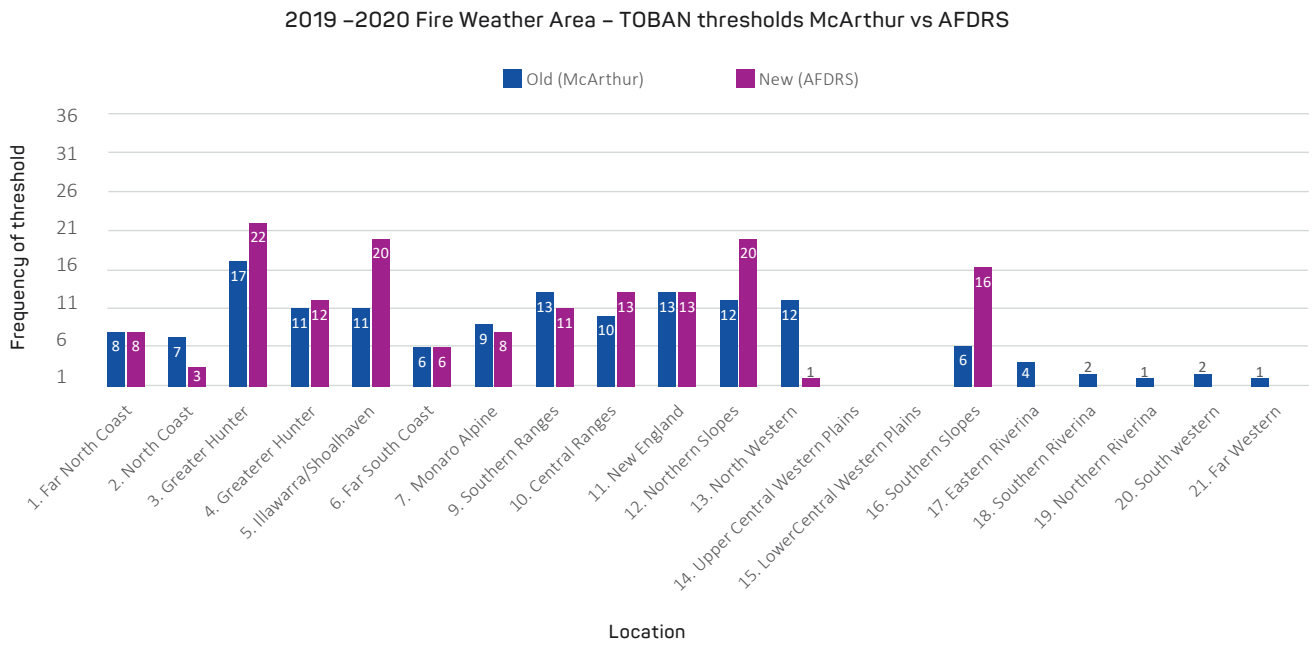

Figure 1: Count of the number of times TOBAN thresholds were retrospectively reached by McArthur and AFDRS systems across during the 2019–2020 fire season.

- The frequency of TOBANs in the current combined fuel (forest/grass) dominated fire weather areas was 14% higher in the AFDRS than the existing system.
- Eight fire weather areas showed an increase in the number TOBAN thresholds reached in AFDRS.
- Eleven fire weather areas showed fewer TOBAN thresholds reached in AFDRS.

Overall, the AFDRS Fire Behaviour Index performed better in comparison to the current system and improved the operational readiness decisions. However, there remains a need for research and adjustment to the way the Fire Behaviour Index is calculated. The AFDRS Fire Behaviour Index is generally more sensitive to wind than temperature compared to the McArthur system, which appears appropriate. The fuel-driven Fire Behaviour Index categories provide the much-needed accuracy with finer details at the local government level that will assist with preparations and warnings.

It should be noted that following the Southern Operational Trial, several adjustments were made to the calculation of the Fire Behaviour Index particularly with respect to fuel moisture in wet sclerophyll and pine forests. These adjustments resulted in the difference between the number of days reaching TOBAN thresholds for the old and new systems.

Summary

- No critical errors or bugs were found in the system to prevent implementation in NSW.
- The new system will change the frequency and occurrence of Fire Danger Thresholds for TOBANs in NSW.
- AFDRS is a significant improvement delivering quality systems and national consistency.
- Nine recommendations are:
  - functionality improvements to the Fuel State Editor and Fire Danger Viewer applications
  - ongoing support for the systems
  - development of the Fire Behaviour Index model performance in grass, wet forest, heath and pine areas
  - adaptation and calibration training for personnel about the changes in the fire rating system and fire danger rating.

AFAC CONFERENCE | REPORT

Progress towards a new National Seasonal Fire Outlook

Naomi Benger[1]
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1. Bureau of Meteorology

Abstract

The new Australian Fire Danger Rating System (AFDRS), is a nationally consistent approach to forecasting fire danger for all major vegetation types found in Australia. AFDRS climate outlooks, out to 6 months ahead, are the first operational products of their kind in Australia and build on years of research and collaboration between the NSW Rural Fire Service, AFAC and the Bureau of Meteorology. The suite of products was designed through a user-centred process with operational applications in mind, using the Bureau's ACCESS-S seasonal model (the model).

Introduction

During the 2021–22 southern Australia fire season, we ran a trial to assess how the products performed to support agencies in their adoption of the new products. Through this trial, we provided interpretive support question-and-answer sessions and solicited feedback from land and fire management operations about how the outlooks reflected their observations (a formal verification process is yet to be established). Based on initial feedback, we made improvements and delved into the interpretive capabilities of the products. This paper outlines a significant technical improvement and one study into the product hindcasts, both of which lead to the effective operational use of the products.

Using curing climatology: technical improvement

Grasslands and savanna fuels cover most of the Australian continent. How dry the fuel is (curing) is an input into grassland and savanna AFDRS calculations (savanna intensity calculation is based on the grassland intensity with a wind reduction factor included). Matthews *et al.* (2019) determined the relative sensitivity of the rate of spread to perturbations in input variables. Rate of spread is used to calculate AFDRS intensity and has the same relative sensitivity. Curing sensitivity is significantly higher than sensitivity to other inputs.[1] Thus, any improvement to the curing input values would lead to a significant improvement in the AFDRS intensity outlook.

Details on the analysis are in Matthews *et al.* (2019). For the purposes of this paper, the following interpretation suffices: a relative sensitivity value of x means that a 10% perturbation in the input curing causes a (10x)% change in the output.

The relative sensitivity values were averaged over ranges of values for ease of interpretation. Most notable is the relative sensitivity of 4.1 when curing is in the 40–60% range, very high sensitivity, which would occur most often in the shoulder seasons. Table 1 shows the grassland rate of spread based on vegetation curing.

Early in the trial, the 'persistence' method was used – where the current observed curing value is used for the outlook period, as is done for short-term forecasts. This is a suitable solution for the short-term as there is usually little change in the curing data in that period. However, the persistence method does not capture any changes to curing over longer periods. This is particularly important leading into the fire season. It was apparent during the 2021–22 southern fire season that this approach was insufficient.

Figure 1 shows national curing values. The blue ellipse highlights the fire weather areas of Upper Great Southern, Beaufort, Roe, Mortlock, Avon[2] in the South West Land Division of Western Australia, which predominantly have grass fuels (on the fringe of forest fuel areas).

In October, the Roe and Beaufort districts had curing in the 40–60% range with relative sensitivity 4.1. The centre plot in Figure 1 shows that the late November curing was around double the 26 October curing. Figure 2 (left) shows the December outlook using the October curing (26 October 2022) shown in Figure 1 (left); Figure 2 (right) uses curing from 29 November 2022 shown in Figure 1 (right).

The forecast issued in late October showed a high chance of lower-than-average AFDRS intensity for December in the circled region. One month later, the outlook showed a chance of higher-than-average AFDRS intensity. The October curing resulted in a significantly lower estimation of the December averaged intensity than expected, given the atmospheric inputs. The devastating Wooroloo fire in southwest Western Australia started around 6 weeks after the October issued forecast.[3] This had significant operational implications of underestimating the fire intensity and a possible lack of preparedness. Finding an appropriate value for curing was identified as an area for significant improvement.

A curing climatology was created from the BARRA dataset[4], using the years of the AFDRS hindcast 2003–17. A daily climatology was created for each day from a 7-day window of values centered on the day.

The right image in Figure 3 shows that the curing climatology for December is much closer to the agency determined December curing values (smaller difference) than the October agency determined values are (left image, larger difference).

Table 1: Grassland rate of spread sensitivity to curing.

Curing level	20–40%	40–60%	60–80%	0–100%
Grassland mean relative sensitivity (st. dev.)	2.9 (0.5)	4.1 (0.12)	2.9 (0.66)	0.85 (0.37)

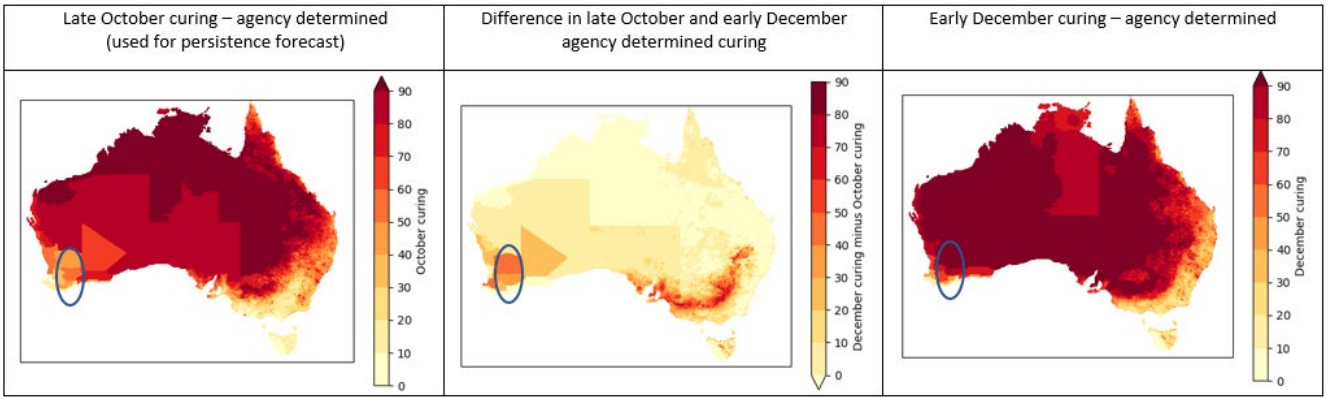

Figure 1: (Left to right) October curing – agency determined (used for persistence forecast), Difference in October and December curing, December curing – agency determined.

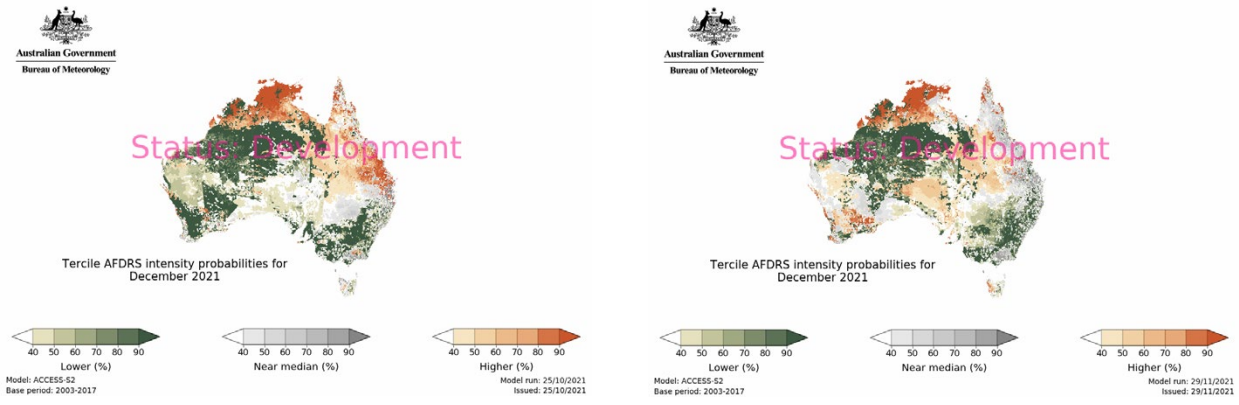

Figure 2: (Left to right) December forecast from 25 October 2021 (October curing), December forecast from 29 November 2021 (late November curing).

1. Aside from relative sensitivity of dead fuel moisture content of -3.8 in the 15–20% range, refer to Matthews (2019) for details.
2. Western Australian Fire Forecast Areas Map at: www.bom.gov.au/wa/forecasts/firemap.shtml.
3. Dupe C & Dugan B 2021, Wooroloo bushfire: Emergency warning issued for fire in Beechina area. The Western Australian, 26 December 2021. At: https://thewest.com.au/news/bushfires/wooroloo-bushfire-emergency-warning-issued-for-fire-in-beechina-area-c-5092109.
4. Atmospheric high-resolution regional reanalysis for Australia, at www.bom.gov.au/research/projects/reanalysis/.

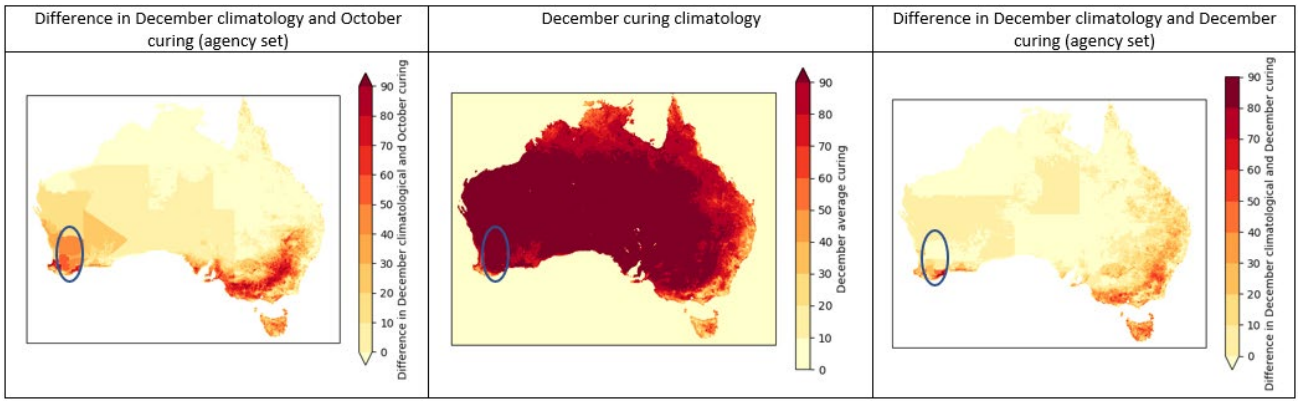

Figure 3: (Left to right) Difference in October curing and December climatology, December curing climatology using BARRA, Difference in December curing and December climatology.

Operational note

AFDRS outlooks are now calculated using the curing climatology. For operational interpretation, it is important to know how the actual curing compares to the climatology and take this into account:

- When curing is more advanced than the climatology, the outlooks will tend to underestimate the AFDRS intensity.
- When curing is behind the climatology, the outlooks will tend to overestimate the AFDRS intensity.

Further work is required to quantify how operational variations influence outlook probabilities. Users should exercise caution when curing differs to the climatology and conservatively interpret the conditions indicated by the outlooks.

Hindcast comparison: practical understanding

The outlook hindcast is generated using the model to produce a representation of the past from which we can calculate the average conditions. The chance of above median outlooks compare the model runs with the median of the hindcast to create a probability of the outlook period having above/below average AFDRS intensity (see Bureau of Meteorology 2022).

Users should examine numerous products for operational preparedness but must understand how the products may vary for the best interpretation. For this purpose, we compared elements of the AFDRS hindcast with the hindcast of other Bureau outlook products. We present the results for maximum temperature, which is one of the atmospheric inputs into AFDRS calculations.

Ideally, a hindcast would be calculated for a window of at least 30 years to capture the climate variability. The AFDRS outlooks are based on a relatively short hindcast period (2003-17) due to the limited availability of fuel information. The Bureau's official outlook products have a hindcast period 1981–2018.

Climate variability in Australia is driven by climate change and large-scale climate drivers with irregular returns. The large 2 drivers are the El Niño - Southern Oscillation (ENSO) and the Indian Ocean Dipole, which have 2 non-neutral states; bringing either generally wetter and cooler conditions or warmer and drier conditions to Australia.

We compared the instances of each of the large-scale drivers captured by the hindcasts (see Table 2). The table shows the counts of El Niño and La Niña events, positive Indian Ocean Dipole and negative Indian Ocean Dipole, events and the count of the top 10 warmest years on record for Australia (nationally averaged).

Both hindcasts have a similar proportion of positive and negative Indian Ocean Dipole phases and El Niño events. The AFDRS hindcast period, however, has around double the proportion of La Niña events and 3 times the proportion of years in the top 10 warmest on record.

Table 2: Climate influences in hindcasts for the years 1981–2018 and 2003–2017.

Climate driver	1981–2018 (38 years)		2003–2017 (15 years)	
El Niño	10	26%	3.5	23%
La Niña	8	13%	4	27%
Negative IOD	8	21%	3	20%
Positive IOD	7	18%	3	20%
Top 10 warmest years	8	13%	6	40%

La Niña events are generally associated with lower-than-average temperatures in the mid-latitudes and above-average rainfall in eastern, central and northern Australia (Bureau of Meteorology, 2022). The observed trends of climate change include increasing temperatures across Australia and decreasing rainfall across southern parts during April to October (Bureau of Meteorology and CSIRO 2020) as can be seen in Figure 4. In broad terms, the influence of a La Niña could be seen to counteract the climate change trends (within a very short timeframe). We investigated if these opposing influences manifest as significant differences in the hindcasts, initially focusing on temperature.

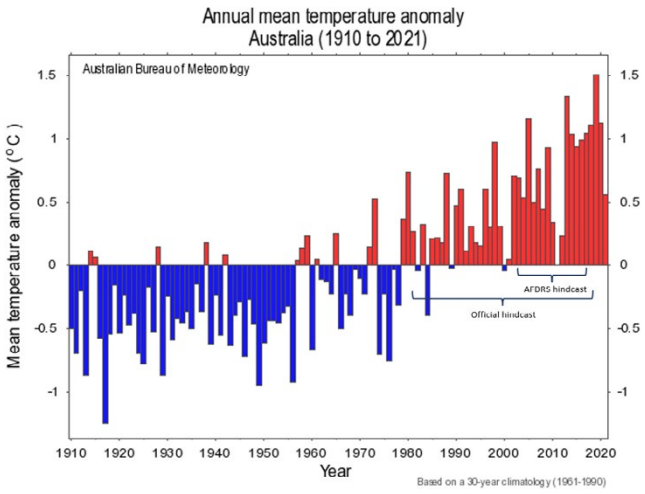

Figure 4: Temperature anomalies with AFDRS and official hindcast windows.[5]

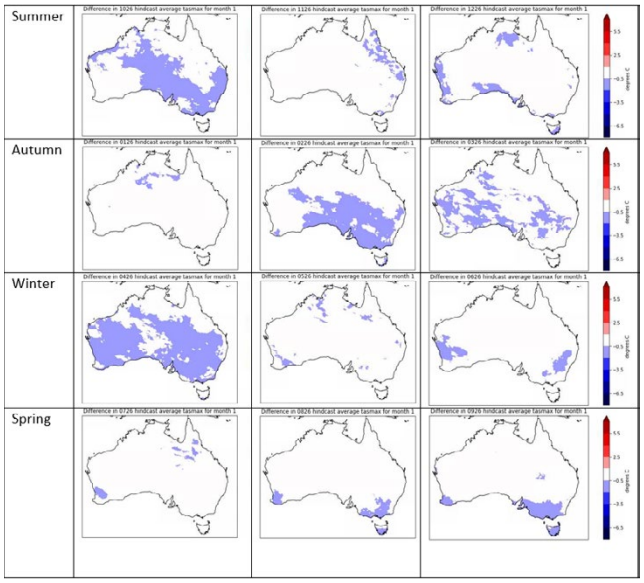

Figure 5: Differences of official hindcast and AFDRS period hindcast for average maximum temperature.

We examined the average for each month with a lead time of one month (i.e. December average is taken from the 26 October hindcast). The differences are presented in Figure 5. There are variations throughout the year, but the average maximum temperature for the AFDRS hindcast window is generally either approximately equal to the longer hindcast average (white areas) or higher (blue areas).

The average conditions of the AFDRS intensity hindcast are warmer than the average conditions, which are used to create the Bureau's maximum temperature outlooks for December, April and June but otherwise comparable. December and April are near the start and end of the mid-latitude fire season, respectively. June is around the start of the northern Australian fire season. When interpreting the various outlooks operationally, it is important to recognise that when the outlook is suggesting a high chance of above-average maximum temperature, the same atmospheric information might not necessarily translate to the expected above-average conditions for AFDRS, which has a higher benchmark for temperature.

This is consistent with the AFDRS hindcast being based on a shorter and more recent window and, thus, more representative of the current climate. The influence of climate change is, however, modulated by the higher proportion of La Niña events captured.

Operational note

Temperature is an input to the fuel moisture component of the AFDRS calculations for all fuels to a varying degree. This hindcast period difference would be particularly relevant during fire season shoulder seasons when temperature outlooks are expected to be slightly above the longer-term average and grass fuels are on track to be drier than the climatology would estimate. In that situation, the AFDRS outlook might not present as high a risk of above-average intensity as may be expected if the user were not aware of the nuances in the hindcasts. This could cause the user to incorrectly assess the risk of elevated intensity. This is an important operational consideration, particularly at the start and end of the fire seasons when conditions can be more changeable.

5. Climate change – trends and extremes.

Summary

Climate outlooks can be very powerful planning tools, particularly leading into fire seasons. To gain the best intelligence from these outlooks, it is important for users to understand how variations in the inputs influence the information presented. This work highlights the importance of comparing the actual curing with the curing climatology for grass and savanna fuels as well as the differences between the hindcasts of the Bureau's temperature and AFDRS outlooks and when that difference may need to be considered.

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AFAC CONFERENCE | NEWS AND VIEWS

Co-designing predictive maps for community use during a bushfire

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Climate change means that planning for and responding to future bushfire events is increasingly challenging for emergency management organisations. Arguably, meeting the challenges caused by climate requires more than an improvement in our knowledge about climate change and its likely effects. Instead, the current challenge lies in the translation of this knowledge into emergency management policy practice.

The Predictions in Public: Using Predictive Fire Spread Products to Support Public Information and Warnings project commenced in February 2022 and was funded by Natural Hazards Research Australia. The project seeks to support the translation of scientific and community knowledge into agency practice. This will be achieved by developing an evidence base for the future use of predictive fire spread maps in public information and warnings products during an emergency.

The project focuses on the use of existing and potential products that are created by trained fire behaviour analysts. These products include fire behaviour intelligence and scenarios before first attack and predictions of fire spread during an extended attack. These products are already used to inform public information and warnings. However, the way that they are used varies by jurisdiction.

The use of fire predictions has received increased attention since the 2019–20 fire season when 'Red Maps' were released to the public in NSW and the ACT. Questions about the value of producing fire-spread predictions during fire seasons have arisen. There is a focus on the need to develop a consistent approach to public information and warnings across jurisdictions as part of the Australian Warning System. This project offers an opportunity to reflect on the purpose of public-facing predictive maps and to collect empirical data to build an evidence base to support and inform agency decisions related to the future use of predictive products for public information and warnings.

Co-design: overview, challenges and opportunities

Co-design is defined as 'The process of designing with people that will use or deliver a product or service'.[1] It is a concept that is gaining popularity in a number of sectors. For example, in academia, the concept of co-design originates from product design and communication studies as a way of improving products and services. However, over the last few decades, academic literature from the climate change and disaster risk reduction discourses increasingly refers to the need for more inclusive research processes that bring a range of disciplines and practitioners together to translate knowledge and solve complex issues. While fundamental research is important, so too is collaboration across disciplines and between researchers and end users to achieve research translation. The Victorian Government defines co-design as a process that 'brings citizens and stakeholders together to design new products, services and policies'.[2] The increased use of the term acknowledges that simply providing products, services and policies, does not necessarily result in meaningful engagement with end users or their acceptance of those outputs.

Therefore, there is a growing acceptance that we need to work better together to improve outputs and solve complex problems. Rationally, co-design makes sense. The idea is if stakeholders are involved throughout the entire process of a project the results will be of higher quality in terms of usability and use than if they were not involved. But how do we achieve these benefits through co-design?

There are many examples of how to engage stakeholders in the academic literature and from

public service practice. However, there is less discussion about what specifically leads to effective co-design and every project, context and stakeholder group is different and different methods are going to be required. We may not have a one-size-fits-all recipe, but we can use broad principles to help steer us in the right direction.

The co-design process requires the active involvement of stakeholders throughout a decision-making process and is built on the principles of collaboration, inclusion and flexibility.[3] Collaboration refers to the opportunities that are provided for different people with different needs to participate in the decision-making process. This could include meetings, workshops, interviews or surveys. Regardless of how we collaborate, it is important that collaboration results in inclusion. Inclusion means that everyone's contribution is reflected in the decisions made throughout the entire process. Finally, flexibility allows for shifts in the process and the direction of the project if needed to meet project objectives. Importantly, for a co-designed project to work, strong project design is required to keep the project on track. A clear understanding of the decisions that need to be made and a plan for when and how opportunities for collaboration and inclusion will take place are important to successful co-design.

The Predictions in Public project and its approach to co-design

The Predictions in Public project is being led by the Victorian Country Fire Authority (CFA) and Emergency Management Victoria (EMV). The research team is made up of 4 Australian universities (RMIT, Queensland University of Technology, Deakin University and Swinburne University of Technology) that represent expertise in cartography, warning communication, evacuation behaviour and organisational learning.

We created a project steering committee, which is made up of representatives from the AFAC Warnings Group and AFAC Predictive Services Group, as well as representation from the Bureau of Meteorology. CFA and EMV play a facilitation role between the research team and the steering committee to ensure that the needs of both groups are reflected and included in decision-making. During facilitated conversations between the research team and the steering committee, we discuss the expected outcomes of the project and decisions related to the empirical research.

There are also multiple opportunities for community feedback. We have planned for surveys, interviews and focus groups to first understand current comprehension and use of existing spatially represented public information and warnings products and, later in the project, to test some map concepts to inform a consistent national approach to public-facing predictive map design, dissemination and education. It is the intention to meaningfully use all expertise and knowledge presented by the steering committee, research team and representatives of the community.

Regarding flexibility, the proposed outcomes of the project are deliberately broad. The project has been broken into 3 phases. Each phase is designed to build upon the last:

- **Phase 1:** Understand the status quo. What do agencies aim to achieve by using the current public information and warnings products? How do members of the public comprehend and intend to use existing products?
- **Phase 2:** Develop and test national predictive map concepts. How should predictive bushfire maps be designed, communicated and disseminated across Australia?
- **Phase 3:** Develop fit-for-purpose outputs. How can the results of the project be directly translated into agency policy and practice?

Challenges

The approach requires attendance at regular meetings. This is difficult for busy researchers and emergency management staff to commit to. Rather than the steering committee communicating an evidence need and then allowing researchers to complete the research separately, this approach requires involvement by the steering committee and researchers in regular discussions about what the research should test and what the results of the research can be used for. This requires strong relationships and trust. It also requires commitment from the steering committee and flexibility and openness from researchers to listen to and adapt research as the steering committee's needs evolve.

Other challenges include research being conducted within emergency management timeframes. Research takes time and often does not work within the short timeframes desired by emergency management organisations. However, the collaborative approach used offers opportunities for emergency management staff to learn with the research team as they go. It is hoped that these lessons can be used to inform organisational decisions and practice in addition to using the results of the project once it is completed.

Opportunities

We are hopeful that this approach will lead to improvements in research utilisation and agency practice by resulting in robust research and outputs that meet agency and community needs.

We also hope that through the development of relationships and shared understandings, researchers and agencies will learn from one another. By providing opportunities for discussion, we are translating science and integrating different ways of knowing and expertise to make sense of and solve complex problems.

Scientific knowledge and evidence do not often translate into organisational contexts without assistance. Issues related to capacity and capability pose barriers to scientific results being understood, translated and implemented within organisational practice. Through the development of strong relationships and a culture of emergency management staff involvement throughout the research process, it is hoped that the legitimacy of science and appetite for its use to inform and support decision making within agencies will be improved.

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AFAC CONFERENCE | REPORT

The role of social connectedness in protecting first responder mental health and wellbeing

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Fortem Australia

Abstract

There is broad evidence that social connectedness is a significant factor contributing to mental health and wellbeing. Research on first responders in Australia has demonstrated that social connectedness moderates various aspects of psychological health. For first responders, social connectedness exerts a protective influence on the harmful effects of trauma exposure, such as psychological distress in the form of anxiety, depression, Post Traumatic Stress Disorder (PTSD), and increased suicide risk. Furthermore, first responders' social support, team cohesion, engagement with workplace support programs and work-life balance are all associated with higher resilience. The research also identified barriers to seeking help among first responders who may be struggling. These included poor mental health literacy, stigma and delayed help-seeking due to a lack of confidence in psychological treatments.[1] These barriers increase the potential for mental health issues to develop into larger and debilitating problems that adversely affect workplace functioning and people's quality of life.

Program description

This paper presents a model of care that places the wellbeing and mental health of first responders and their families at the centre. The model is designed to help protect first responders from the negative effects of their work by improving protective factors and addressing the barriers to help-seeking identified in the research. Fortem's programs are independent and adjunctive to other workplace programs. They are available to employees, volunteers and family members of over 30 emergency services, law enforcement and national security agencies. A core feature of the model of care has been to establish service delivery 'on the ground' in locations where need is greatest. This allows direct, in-person connection within specific first responder communities. This is augmented by virtual activities that extend the reach to members who are deployed overseas and has allowed continuity of service during pandemic lockdowns. Fortem has 4 service offerings suited to first responders: wellbeing programs, clinical services, mental health literacy and transition support. This paper focuses on data from the wellbeing programs and clinical services.

The social connection-focused wellbeing activities enhance resilience for first responders and also for their families. Based on evidence for the modifiable determinants of wellbeing summarised in the Royal Melbourne Hospital's 5 Ways to Wellbeing framework[2], the activities provide opportunities to build connections within families, work teams and between different first responder agencies, allowing the formation of networks of safety and support. Furthermore, through low-threat, low-stigma activities, the program engages first responders who may otherwise be unaware of the need for, or indeed actively avoid, overt attempts to address mental health concerns. These activities pave the way for early detection and early intervention for mental ill health and serve as a 'soft entry' into clinical services.

Fortem's specialist psychology services are first responder-culture-informed, confidential, accessible, independent of injury management systems and inclusive of family. Participants can access psychological support via self-referral or referral from internal agency support or other

health professionals. Evidence-based psychological treatments are provided via face-to-face and telehealth consultations to maximise accessibility, especially for people in regional areas.

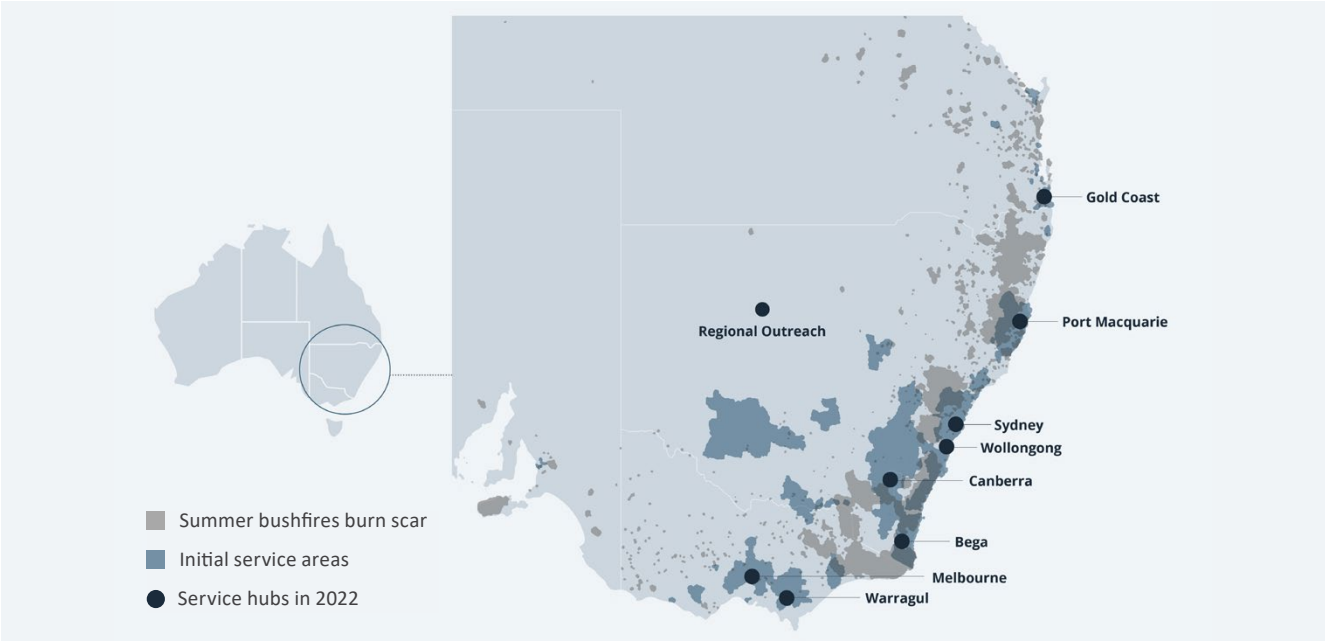
Methods

The preliminary qualitative and quantitative data collected for study was done via routine quality assurance monitoring. Data from the wellbeing programs was derived from a sample of 975 participants in activities held between March 2020 and April 2022. For short (single day) events, post-activity surveys covered areas of engagement, satisfaction, wellbeing and mental health.

Longer programs (4 weeks or more) also included standardised measures for wellbeing (Personal Wellbeing Index) and social support (Brief 2-Way Social Support Scale). The clinical services data was derived from a sample of 46 first responder employees, volunteers and family members who completed a course of treatment between December 2020 and April 2022.

The clinical services were evaluated using standardised psychometric measures administered both pre- and post-treatment. These cover mental health conditions and wellbeing constructs relevant to first responders. In choosing the measures, care was taken to balance the need to collect as much useful data as possible in key areas while also minimising the

The wellbeing model draws on international research about the modifiable determinants of wellbeing summarised in the 5 Ways to Wellbeing framework.



Service locations were established to 'reach in' to communities most effected by the summer bushfires.

burden for participants. Measures were selected to benchmark with those used in population-level research on first responders in Australia. Additional demographic and engagement data were extracted from Fortem's customer relationship management system.

Table 1: Standardised psychometric measures used to evaluate a range of clinical outcomes.

Construct	Measure
Psychological distress	Kessler Psychological Distress Scale (K10)
PTSD	International Trauma Questionnaire (ITQ)
Complex PTSD	International Trauma Questionnaire (ITQ)
Alcohol use	Alcohol Use Disorders Identification Test (AUDIT)
Wellbeing	Personal Wellbeing Index (PWI-A)
Social support	Brief 2-Way Social Support Scale (Brief 2-WaySSS)
Resilience	Connor-Davidson Resilience Scale 2 (CD-RISC-2)

Results

The quantitative and qualitative data from the wellbeing programs demonstrated broad engagement with wellbeing and protective lifestyle practices. Participants were employed first responders (36%), volunteers (13%) and family members (44%).

Participants reported relatively high social connectedness to family members (85% 'well' or 'very well' connected) with lower rates of connectedness to workmates (57% 'well' or 'very well' connected). Of the 5 Ways to Wellbeing, the category 'Connect' emerged as the way to wellbeing enhanced by a wellbeing activity by the greatest number of participants (79%). Similarly, 64% of participants indicated that they felt the activity had strengthened their social network. An overwhelming number of participants (97%) reported that an activity had benefited their health and wellbeing. Program feedback was generally very positive, with various measures of satisfaction and engagement between 89% and 91%.

Regarding attitudes towards help-seeking, a majority of participants (79%) indicated that they were either 'likely' or 'extremely likely' to seek mental health support if needed. There were some rich themes that emerged from the qualitative data that demonstrated increased awareness and engagement in behaviours that increase wellbeing. Participants indicated greater motivation to prioritise social connection and other wellbeing behaviours that were outside of their usual comfort zones.

The clinical services data presented a broad story of preventative and restorative health: participants enter the service showing signs of compromised wellbeing and leave the service with this largely restored. Just over two-thirds (69%) of clinical services recipients were serving first responders, with the remainder (31%) being family members. A significant number (17%) accessed the clinical services following an experience of a wellbeing activity. The primary concerns included PTSD (33%), anxiety (29%) and relationship difficulties (16%). Feedback included:

> *This isn't an activity that I would have usually chosen for myself but by attending with my family… it allowed me to try something very much out of my comfort zone and help build confidence and skills. By meeting up with a colleague too it allowed us to have… time to chat and catch up too.* (Survey participant response)

With regard to clinical outcomes, 80% of participants who demonstrated measurable symptoms of PTSD no longer had active PTSD symptoms after treatment. This is above average for PTSD where remission rates following treatment typically range from 33–66%.[3,4] There is a related diagnosis known as

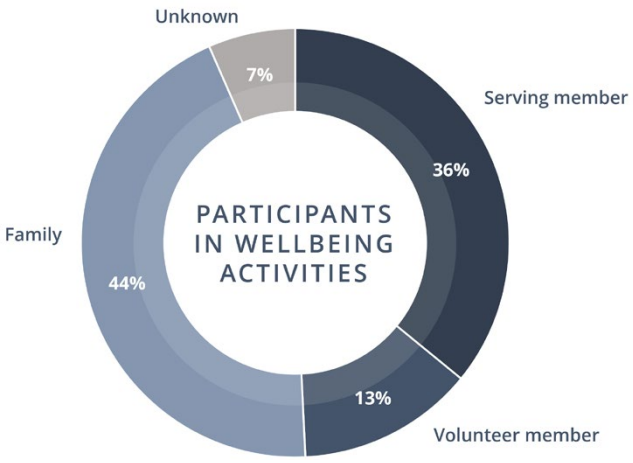


Figure 1: Wellbeing program participants by role status

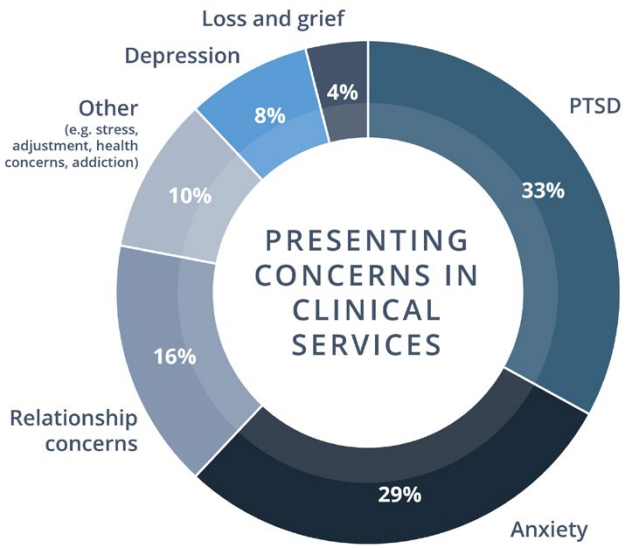


Figure 2: Presenting concerns of participants seeking psychological support

Complex PTSD, which indicates a deeper and more extensive influence from multiple traumatic events and prolonged exposure to traumatic stress. Complex PTSD remains an under-recognised condition among first responders. Sixty-seven per cent demonstrated measurable symptoms of PTSD no longer had active PTSD symptoms after treatment. This is encouraging as Complex PTSD can be harder to treat and generally takes longer to achieve clinically significant improvement. Psychological distress improved from 'very high' at intake to 'moderate' at discharge. This result is encouraging given research that demonstrates that first responders experience 'substantially higher' rates of psychological distress compared to the general population.[1] At intake, the average levels of wellbeing were 'compromised' compared to the general population and largely restored to a 'normal' range by the end of treatment. Despite participants reporting relatively high levels of social support, the data indicated an increase in the sense of receiving emotional and instrumental support. Like wellbeing, the average levels of resilience were slightly compromised at intake and returned to within population norms at discharge.

Discussion

The primary focus of this work was to support the communities affected by the bushfires that occurred in the summer of 2019–20. It is apparent that there will be a long tail to the mental health impact of that event, not in the least exacerbated by the ongoing pandemic and other fire and flood events. For first responders, these extraordinary events add to the burden of an inherently high-stress occupation. Fortem will continue to extend the reach of its services that augment and complement existing supports.

The quantitative data from the wellbeing programs shows good engagement with protective factors and important mechanisms of wellbeing. The qualitative data gives a rich account of participants' experiences and perceptions of outcomes and social connectedness emerged as a dominant theme. However, it is difficult to obtain meaningful quantitative data about sustained effects without longer-term follow up. Our aim is to partner with a first responder agency to pilot a longitudinal study exploring the lasting outcomes of wellbeing activities.

> *I have seen others that I have invited… begin to understand and reach out far more willingly because of the acceptance from others around them at events and the idea that these programs… are all directed at the lifestyle and career workings of [our] unique jobs.*
> (Survey participant response)

Lifestyle programs are often viewed as alternative to other mental health care. Mental fitness and resilience training programs often put the emphasis and onus on the individual, neglecting the important and powerful variable of social connectedness. We argue that facilitated wellbeing and social connection activities can not only be augmentative to traditional mental health interventions, but that social connection in and of itself can function as a primary lever of wellbeing and resilience in the first responder community.

Despite some limitations, the wellbeing program data indicates that facilitated social connection activities may not only strengthen social networks and enhance protective factors, but can also serve as a 'soft entry' into clinical services that allow first responders to benefit from evidence-based treatment for work-related psychological injuries. The clinical services outcomes suggest that, with early intervention (many participants indicated this was their first use of a psychological support service), compromised mental health and wellbeing can largely be restored. These outcomes may help reduce the burden of stress leave on first responder agencies and improve vocational functioning and career longevity for first responders. But more than this, we hope that this truly holistic approach leads to meaningful improvements in the quality of life of first responders and their families.

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AFAC CONFERENCE | REPORT

Transformative scenarios in a climate-challenged world

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1. Australian Institute for Disaster Resilience
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Abstract

AFAC convenes an ongoing national Climate Change Group comprised of individuals from jurisdictional emergency management agencies, the Bureau of Meteorology and leading research centres. The group is tasked with producing a body of work to strategically support effective climate change risk mitigation and planning and adaptation outcomes for AFAC members, their stakeholders and the community. In 2020–21, the group received Tactical Research Funding through the Bush Fire and Natural hazards CRC (BNHCRC) to develop a suite of climate and social change scenario resources. These resources can be used by emergency service agencies across Australia and New Zealand to test their strategic planning, preparedness activities and capabilities in an increasingly volatile, uncertain and climate-challenged world. This paper outlines the process used to develop the scenarios and the resources as well as a case study outlining how the transformative scenario methodology was applied by the Queensland Fire and Emergency Services (QFES) to test Queensland's Strategy 2030.

Developing scenarios

A research team from RMIT University and Reos Partners guided the group through immersive workshops to prduce a set of plausible scenarios about how the future might unfold in a climate-challenged world and what this means for strategic planning and operations in the emergency services sector. The scenario timeframe was set to 2035, which is a period long enough that significant change can take place but close enough to be meaningful and tangible.

Workshop participants were asked to step outside the comfort zone of their organisation and sector to consider other driving forces that shape the world and drill these down to the most significant yet uncertain forces that affect emergency services's ability to operate effectively. A broad range of driving forces (that can also be understood as uncertainties) were identified, including socio-economic factors, domestic and geopolitical dynamics, the state of the environment, advances in technology, approaches to governance and the level of social cohesion in society. Unlike the relative uncertainty of these driving forces, climate change was locked in as a certainty. That is, we know through scientific consensus that no matter what we do now to avert climate changes, we are on a fixed trajectory of changing weather and climate. In the scenario timeframe to 2035 there will be a continuation of existing climate trends alongside increasing volatility, frequency and magnitude of weather extremes.

Two factors were called out as having the most tangible impact on emergency services ability to operate effectively into the future, namely: the degree to which governance regimes are long-term, proactive and strategic versus short-term and responsive; and the level of social cohesion in society, for example, whether social bonds and collective efforts are strong versus an individualistic 'me first' ethos. These factors were mapped against each other on axes to establish the structural framework for 4 distinct and plausible future scenarios. Each scenario, outlined in Figure 1, was developed as a believable narrative to stretch the thinking and mental models of emergency services leaders and to generate new insights and operational improvements. The criteria underpinning each scenario is relevance, plausibility, challenge and clarity.

Each scenario unfolds in a different way and leads to a different future that has distinct and profound implications for emergency services agencies as the they navigate operations in a climate-challenged future.

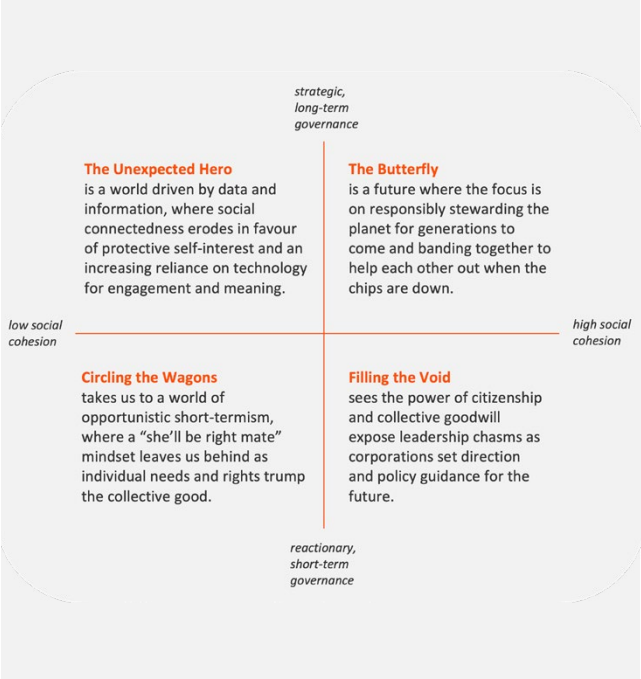


Figure 1: Four possible futures.

Source: Reos Partners

Scenario resources

A set of scenario resources was developed to help emergency services leaders explore and test how well their organisation will be able to deliver services out to 2035 in a climate-challenged world and to stress test their existing adaptation strategies and plans. The resources are presented as 'board game' analogy, where the scenarios become the 'board' and the resources are the 'pieces' organisations can use to test their services and strategies. The resources are presented in 4 stages.

Stage 1: the board

The first 2 resources, an introduction and guide to using the scenarios, explain and compare the scenarios and provide the tools organisations can use to adjust or create scenarios of their own. For example, the guide outlines the 'wind-tunnelling' process, which is a simple and effective way for organisations to test and improve decision-making and planning in an uncertain world where the volatility, frequency and magnitude of climate events will challenge the sector.

A set of case studies demonstrate how the transformative-scenario approach can be used. Worked examples of the wind-tunnelling process are outlined using examples from different emergency agencies, including urban operations, rural operations, land management and State Emergency Services.

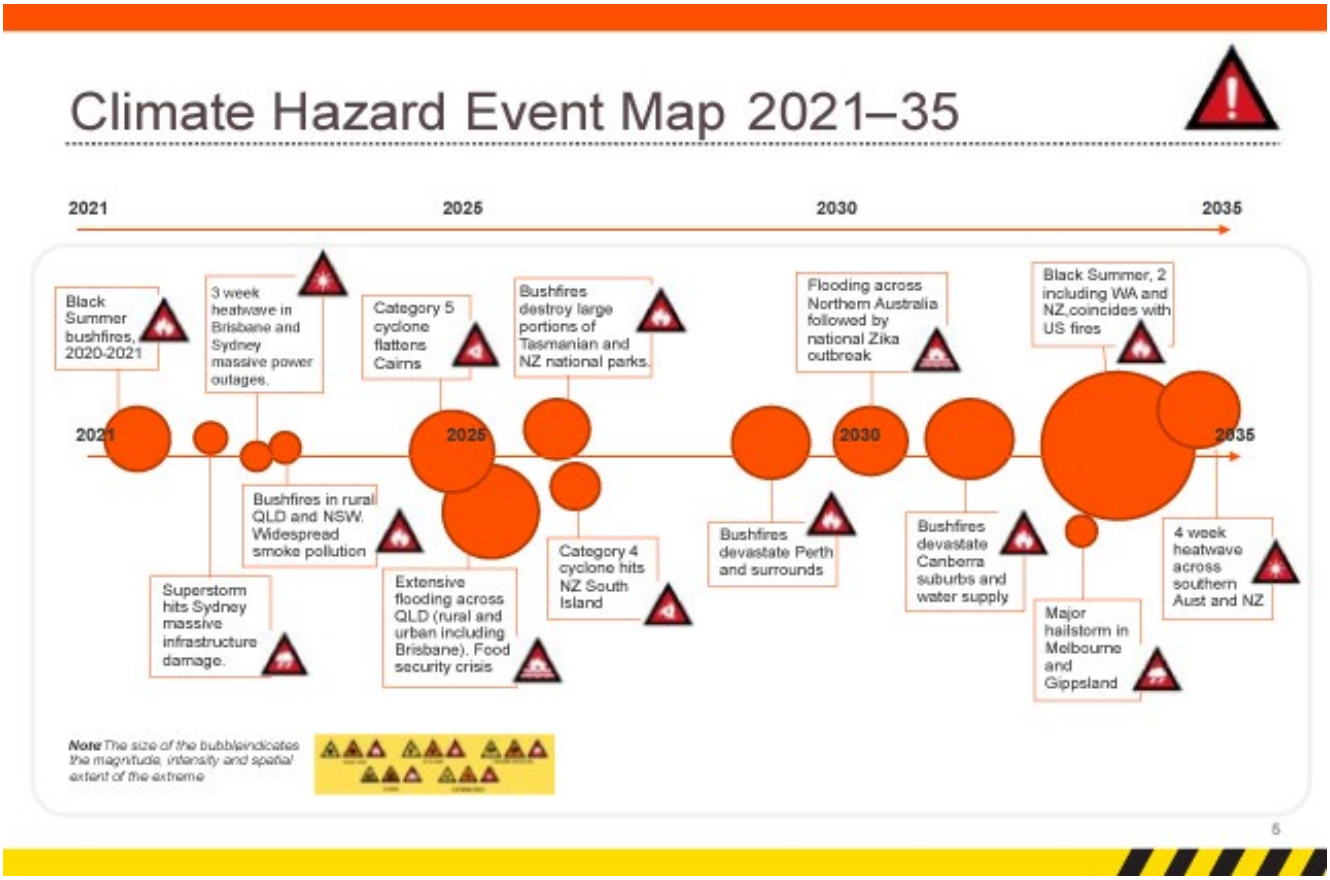


Figure 2: Climate hazard event map 2021–35.

Stage 2: the hazard piece

A climate hazard map is included as a visualisation tool to help emergency leaders appreciate the range of hazard exposures that may affect their organisation's operations and services within each scenario. The worked example in Figure 2 shows a timeline of hazards that may play out in the scenario timeframe to 2035. The hazard map can be used to explore the implications of different hazard types and magnitudes as well as the complexity of navigating consecutive, concurrent and compounding hazard events in each scenario.

A blank hazard event map is included so people can develop and test their hazard profiles (Figure 3).

Stage 3: the climate risk piece

When emergency leaders have a solid understanding of the scenarios and the range of hazards that are likely to exist, a 'climate risk' piece can be applied. A series of climate 'wild cards' present possible climate or weather projections that emergency leaders can use to stress test their organisation's services and capabilities beyond the 4 scenarios and hazards. Organisations can also create their own relevant wild card projections.

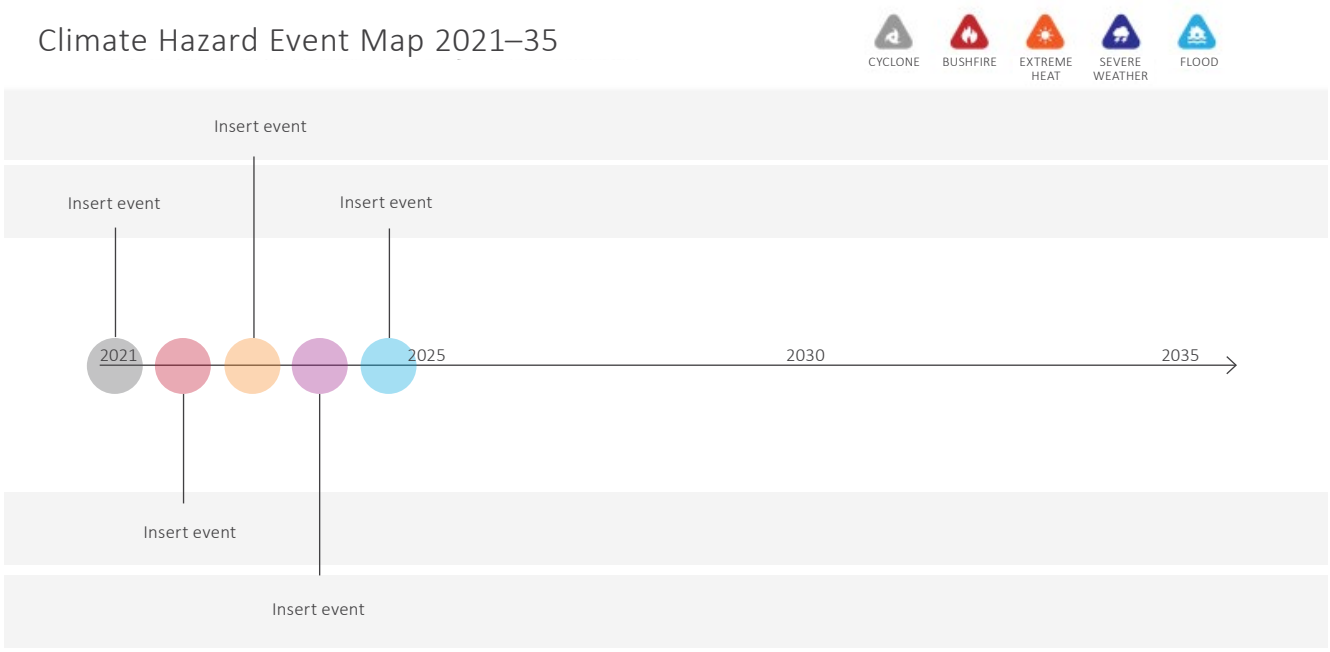
Stage 4: further resources

The final resource is a systematic review of literature, 'Implications of Climate Change for Emergency Services Operations'.[1] The report provides a comprehensive picture of what climate change effects might influence the emergency management sector and what resources agencies might have to manage them. The report presents the increasing frequency and severity of hazard events as one of the most immediate and visceral consequences of climate change. However, the report indicated that addressing the effects of climate change requires effort and transformative thinking and action across climate, social, demographic and economic trends. The report presents systems thinking as an enabler of good climate change adaptation. For the emergency services sector, this means broadening the understanding of the sector, how it interacts with the systems and driving forces around it and the implications of climate change for it. A sample systems map helps emergency leaders visualise the elements and relationships under a changing climate. The report also explores what adaptive capacity could look like for under the 4 future scenarios.

Applying the scenario resources with QFES

The scenario research has progressed to the utilisation phase and was applied by QFES in a workshop in June 2022 to stress test Queensland's *Strategy 2030*.

QFES was an active participant through the development and utilisation of the transformative and climate scenarios resources. With so much upheaval in recent years, including a pandemic, flooding and intense geopolitics with far-ranging implications, QFES decided to test the efficacy of its *Strategy 2030* in a climate-challenged world. *Strategy 2030* is a long-term strategy that defines and unites QFES through a vision for a preferred future and a set of guiding principles.



Note: The size of the bubble indicates the magnitude, intensity and spacial extent of the extreme

Figure 3: Blank climate hazard event map 2021–35.

One way QFES tested the efficacy of *Strategy 2030* was to bring together subject-matter experts who comprise the QFES Climate Change Advisory Group (QCCAG) and apply the transformative scenarios research. The QCCAG is a diverse group of QFES staff with operational and corporate backgrounds. The transformative scenarios material meant the strategy workshop could be completed in approximately 4 hours. That relatively short time was remarkable when considering that this included determining scenarios, understanding what those scenarios meant (so participants could 'inhabit' the scenario) then applying the scenarios using the wind-tunnelling approach to discrete aspects of the strategy in a workshop environment.

The 4 scenarios were applied to test *Strategy 2030*. Because the scenarios were developed through extensive engagement across the emergency services sector in Australia and New Zealand, a high degree of confidence and trust existed that the scenarios were plausible, even if an individual scenario wasn't exactly how participants might imagine the world beyond 2030. Supporting audio-visual content integrated succinct summaries of the scenarios to ground subsequent application of the scenarios throughout the session. The suite of climate scenario resources provided a method for integrating a plausible and modifiable climate scenario. In Queensland, that meant QFES could tailor the climate scenario input to reflect versions of past events and modify them in line with climate projections with subject matter experts prior to the strategy workshops. This meant the workshop team could be imaginative (because as the sector has learned, a 'failure of imagination' can bring things undone).

For QFES, the strategy-testing session was the focus of participants' time and efforts, not the creation of scenarios. This matters because the participants in strategy sessions are typically the leaders of organisations. Another way to speed up the process, while still getting the iterations to test strategy, was to run the scenarios in parallel. This means that rather than have each participant inhabit each scenario, participants self-selected which scenario resonated the most with their view of the future. Remarkably, a relatively even distribution of workshop participants across the 4 scenarios eventuated, which reflects well on the representativeness of the scenarios.

The workshop provided compelling insights about *Strategy 2030* across the scenarios in a fast and engaging way. It is easily adapted to suit the objectives of strategy development and review. This work demonstrates that scenarios provide a powerful tool for engaging and opening the minds of leaders and decision-makers to pay attention to novel, less comfortable and weaker signals of change, and to prepare for discontinuity and surprise in the future.

The scenario resources are available at www.bnhcrc.com.au/climatescenarios.

An animated summary of the scenario resources is available at www.youtube.com/watch?v=mrqCyiUSzyA.

Resources

An introduction to alternative futures in the emergency management sector – introduction to transformative scenarios, the 4 plausible futures for emergency management services and how they were developed. At: www.bnhcrc.com.au/sites/default/files/managed/downloads/an_introduction_to_alternative_futures_in_the_em_sector.pdf.

A guide for using scenarios in the emergency management sector – a guide to apply the scenarios, including interactive elements for teams to use to future-scope and brainstorm. At: www.bnhcrc.com.au/sites/default/files/managed/downloads/a_guide_for_using_scenarios_in_the_emergency_management_sector.pdf.

Emergency management sector case studies as worked examples – case studies showing examples of emergency services that are already using transformative scenarios to guide their strategies. At: www.bnhcrc.com.au/sites/default/files/managed/downloads/emergency_management_sector_case_studies_as_worked_examples.pdf.

Blank Climate Hazard Event Map – www.bnhcrc.com.au/sites/default/files/managed/downloads/blank_climate_hazard_event_map.pptx.

Preparing emergency services for operations in a climate-challenged world – summary report- summarising the research behind the transformative scenarios and their development. At: www.bnhcrc.com.au/sites/default/files/02-1_preparing_emergency_services_for_operations_in_a_climate-challenged_world_-_summary_report_1.pdf.

Implications of climate change for emergency services operations – insights from the literature- a literature review and findings relevant to climate change adaptation. At: www.bnhcrc.com.au/sites/default/files/02-2_implications_of_climate_change_for_emergency_services_operations_-_insights_from_the_literature_1.pdf.

Research methodology for scenario development – the methodology that led to the development of the transformative scenarios. At: www.bnhcrc.com.au/sites/default/files/research_methodology_for_scenario_development_1.pdf.

Endnote

1. Rickards L & Keating A 2021, *Implications of Climate Change for Emergency Services Operations. At: www.bnhcrc.com.au/sites/default/files/managed/downloads/02-2_implications_of_climate_change_for_emergency_services_operations_-_insights_from_the_literature.pdf.*

AFAC CONFERENCE | REPORT

Bushfire evacuation decision support system use in incident management training

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Introduction

In preparation for the 2021–22 summer bushfire season, approximately 60 emergency management specialists from 20 different emergency response and support agencies came together at the Geelong Incident Control Centre in an Incident Management Team (IMT) training exercise. The aim was to plan the response to a mock scenario bushfire threatening coastal townships and summer traffic on the Great Ocean Road within the Surf Coast Shire of Victoria. The scenario was set in real-time, and it tested the IMT's evacuation decision-making under pressure on a severe fire-danger day. When deciding on evacuation, an IMT Incident Controller considers impact and community preparedness and resourcing often within a limited timeframe in a rapid-onset event. The Controller should only recommend evacuation when it is expected to offer better protection for the community than other options and can be achieved without endangering response agency personnel.

During the exercise, CSIRO/RMIT's SEEKER (Simulations of Emergency Evacuations for Knowledge, Education and Response) tool was trialled for IMT decision support. SEEKER provides rapid integrated analysis of bushfire, human behaviour and traffic simulations and testing of alternatives significantly beyond the capacity of traditional information sources and processing. It supports timely decisions by providing information on:

- the extent and severity of fire impact to the community
- the complications associated with large numbers of tourists, major events, and transient populations in the region
- the expected response of community members to the fire situation and official warnings
- the impact of activating traffic management plans given available resources
- the trigger points for decision-making
- road speed and capacity constraints with respect to evacuating and background traffic
- unplanned consequences of traffic accidents or blockages as a result of trees over roads
- evacuation outcomes against a base case of no evacuation or messaging; i.e. no intervention.

SEEKER modelling used on the exercise day simulated outcomes of the number of people in high-risk areas affected by the fire (Figure 1), dependent on different evacuation and traffic management strategies employed. The exercise highlighted for the participants the complexity of evacuation in a congested environment, and to the fact that ordering an evacuation, under short timeframes, may worsen the outcome for some people due to traffic bottlenecks that can form.

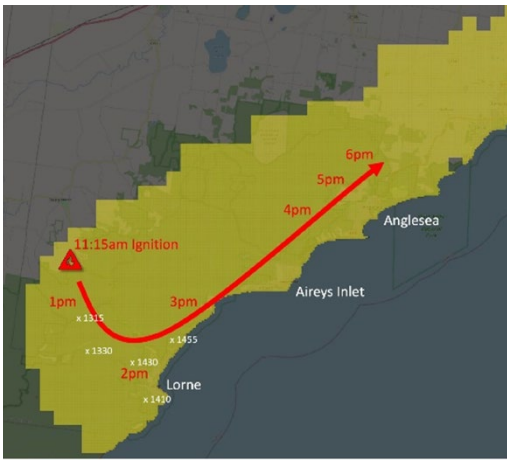

Figure 1: A simulated fire scenario in the Surf Coast Shire used as the basis for the IMT exercise.

Simulations of Emergency Evacuations for Knowledge, Education and Response (SEEKER)

A conceptual model for SEEKER and SAFER is given in Figure 2. These models take as input a baseline representation of the population in the region, its key roads and an estimate of the fire progression, to simulate community response and likely consequences. Underlying SEEKER is a data-driven human behaviour model that captures who is in the region (residents, visitors, etc.) and where (at home/work/shops or travelling to destinations), and how they will respond to the bushfire threat (go home, check on dependents, wait and see, leave) (Singh *et al.* 2021).

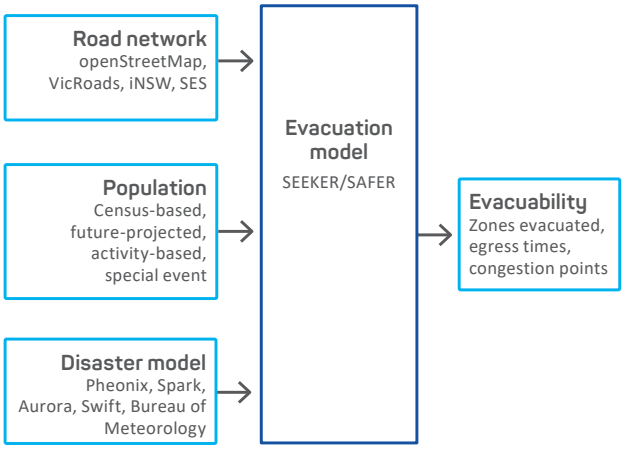

Figure 2: A conceptual model for the CSIRO/RMIT evacuation tools.

To build the synthetic population for a typical midweek summer day in Surf Coast Shire, with associated social and demographic variations, the population was broken into 5 logical groups, being permanent residents, semi-permanent residents, regular visitors (non-holiday visitors from outside the study area), day visitors and overnight visitors. Tabular data were developed for each group including numbers at different start locations, and aggregated spatio-temporal activity (e.g. home, work, shop) distributions for the sample day (Figure 3). These tables were estimated through traffic counts, and local Council studies with the use of census and VISTA transport data. Location data for different activities was developed in QGIS software. Spatial points were derived from several sources, including public address point and point of interest datasets, and supplemented with local knowledge.

Once the base data was created, an automated synthetic population generation script (Robertson *et al.* 2021) produced the population of synthetic individuals with their travel itineraries for the day, that was then used to simulate likely traffic on the day using MATSim (Axhausen, Horni & Nagel 2016). Initial outputs from the traffic simulation were used to undertake a series of adjustments to fine-tune the inputs. Traffic simulation outputs available in visual and tabular form were compared

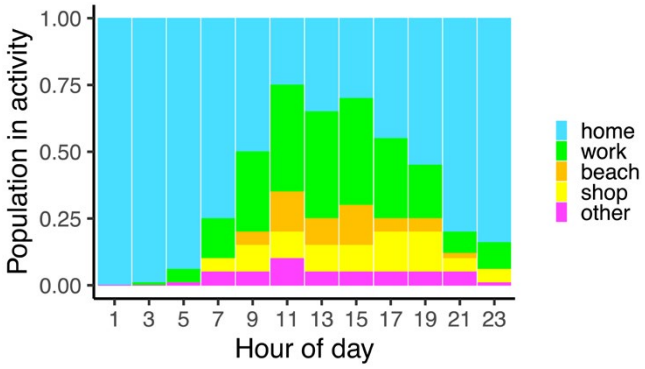

Figure 3: Example expected distribution of daily activities for the resident sub-population used as input for synthetic population generation.

against background data and local knowledge, then input tables for each population group adjusted to better match reality. This largely involved adjusting starting times, destinations and the percentage of users in each sub-category. Capacity and speed attributes on the road network were also adjusted to steer the algorithm to select main thoroughfares for egress routes. Following revisions to inputs, traffic simulations were re-run, and the calibration process repeated, until satisfactory background traffic flows as expected on the sample day were achieved. The final synthetic population (Figure 4) was then used as the input population for all evacuation scenarios modelled in SEEKER.

Evaluating SEEKER for IMT decision support

SEEKER allows 'what-if' scenarios to be simulated, to understand the likely impact of emergency response (sequencing of emergency messages to the community, activation of traffic management points at key intersections to direct traffic), or unforeseen events (impact of road blockages from accidents or fallen trees on egress routes) on evacuation. Table 1 shows evacuation scenarios that were modelled for the exercise.

Figure 4: Zoomed view of the output synthetic population showing the town of Torquay. An example synthetic resident's activities and travel legs are highlighted (orange).

Table 1: Example 'what-if' scenarios simulated in SEEKER for the IMT exercise.

Scenario	Evacuation stages
S1	Roads blocked when overrun by fire, no messaging or traffic management in place.
S2	Evacuate message at 1215 hours to all zones, roads blocked by fire as in S1.
S3	Evacuate message at 1215 hours to all zones, implement Traffic Management Plan at 1315 hours, roads blocked by fire as in S1.
S5	Evacuate message at 1215 hours to high-risk zones, implement Traffic Management Plan at 1315 hours; roads blocked by fire as in S1.
S7	Evacuate message sequence to high-risk areas: Lorne and rural at 1215 hours, Airey's Inlet at 1315 hours, Anglesea at 1415 hours; implement Traffic Management Plan at 1315 hours, roads blocked by fire as in S1.

Modelling showed that in the hypothetical rapid-onset event, there was insufficient time to safely evacuate the coastal townships along the Great Ocean Road (Figure 5). IMT decisions had to therefore incorporate 'too late to leave' situations. Observing the use of SEEKER during the training exercise provided important insights. SEEKER results were used throughout the day to assist the IMT with evacuation decisions and resource management.

When first presented with the modelled scenarios, the IMT consulted SEEKER's outputs to make decisions about evacuating Lorne, the township nearest to fire ignition. A few hours later, the incident controller referred to the outputs again to decide whether to evacuate the townships of Airey's Inlet and Anglesea as the fire rapidly progressed towards them. SEEKER's video-based outputs (Figure 6), showing a bird's eye view of the traffic, were used more frequently during this exercise than the web-based tool (Figure 5) that provided aggregated information on estimated numbers of people in various zones. These preferences highlight areas of interest for future study. SEEKER's video results were also used to prioritise traffic management points given limited resources available on the day with the mobilising agency.

The debrief session following the exercise provided additional opportunity to obtain feedback from participants. Overall, SEEKER was found to be useful in evacuation decision-making. With that said, the model was considered as 'one more tool in the toolbox'. Participants reflected that integration of 'ground truth' data regarding the fire and road conditions into the modelling would be valuable. IMT members expressed interest in the ability to re-run scenarios in real-time after decisions like mobilisation of traffic management points to assess their effects. Also of interest were data on the numbers of people located in specific locations over time, including campsites in the region. While obtaining these data is a challenge, it is a necessity for any evacuation modelling tool used during fire incidents, which is a future goal in the development of SEEKER.

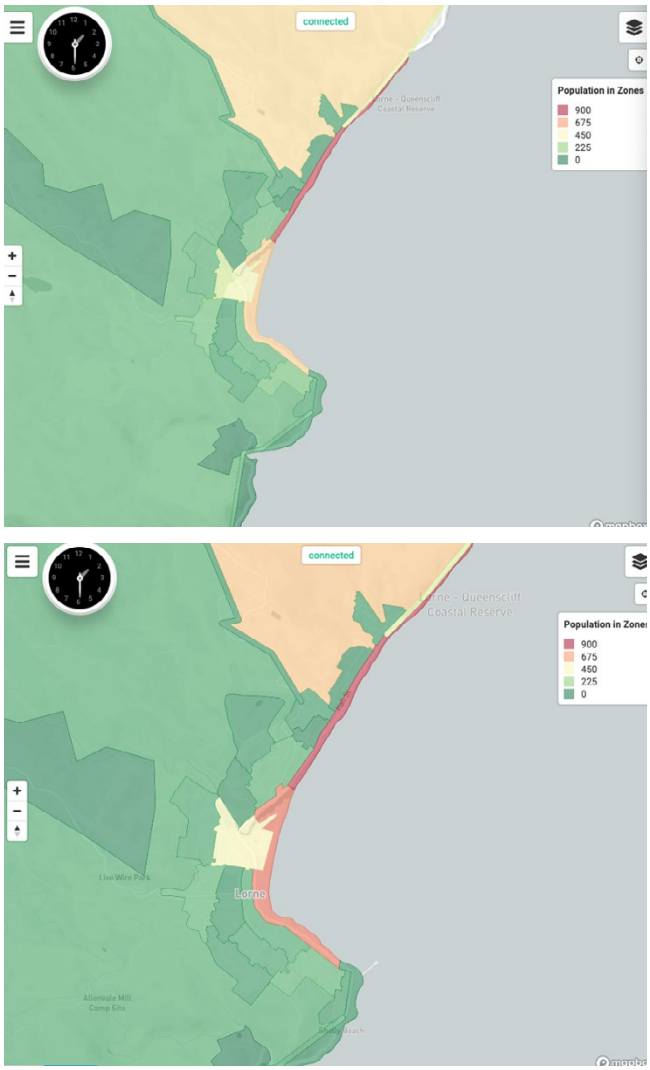

Figure 5: Example SEEKER simulation output showing a significant number of persons around the township of Lorne in scenarios S1 (top) and S3 (bottom) when the fire reached the township.

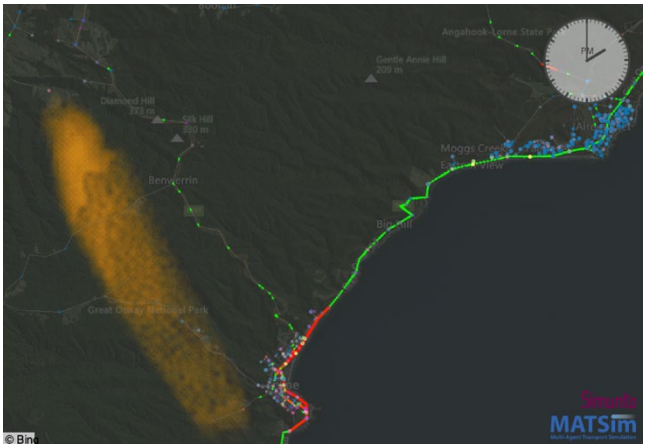

Figure 6: Snapshot of video-based visualisation of SEEKER simulation outputs.

Discussion

The integration of bushfire models and population evacuation has been reviewed for decision support tools. Initini et.al. (2018) examined 22 traffic models and applications (e.g. TransModeler, DynusT, CUBE) in the context of fire evacuation scenarios in the wildland-urban interface (WUI) and evaluated these models against benchmark features specified for WUI fire applications. Benchmarked features include the 4-step transport modelling framework and its 2 main stages of travel demand and traffic assignment, fire-related factors (affected area, vegetation, meteorology, hazard propagation) and factors related to infrastructure, demographics, human behaviour and network characteristics. Bergstedt (2018) analysed 12 existing traffic models (e.g. Paramics, OREMS, Transims), designed for traffic simulation and for evacuation and their capabilities compared to the benchmark characteristics. Both reviews concluded that most current models still have significant gaps in the integration of the 3 modelling domains of traffic modelling, fire and smoke spread and pedestrian movement, needed for a complete WUI evacuation model.

Three models have been noted that attempt the coupling between bushfire and traffic models. The WUIVAC (Wildland Urban Interface Evacuation) model by Dennison, Cova and Mortiz (2007) combines a simplified traffic modelling approach with a bushfire model that uses trigger points around communities and transport links to initiate evacuations. The dynamic-factors framework by Beloglazov *et al.* (2016) combines the open-source traffic model Simulation of Urban Mobility with a fire-spread model to compute projections on the behaviour of people and timing of events, and calculate a new risk metric, called exposure count, that quantifies the threat to a population. Finally, WUI-NITY (Wahlqvist *et al.* 2021), based on the Unity3D game engine, integrates the 3 modelling layers of fire, pedestrian and traffic movement to simulate and visualise human behaviour and bushfire spread. Synergies between WUI-NITY and SEEKER are currently being considered by the researchers involved in these 2 projects.

In addition to SEEKER, as part of the evacuation modelling project[1], CSIRO/RMIT are developing a second evacuation modelling software called SAFER (State-wide Analysis of Fire Evacuation Risk). SAFER allows the end-user to compute the maximum theoretical flow supported by the road network through a simplified analysis carried out at the state level across a large set of simulated fires. In this way, it is possible to rapidly identify which communities and roads have elevated risks with respect to those fires. Once these 'hotspots' have been identified, SEEKER allows detailed scenario-based analysis of consequences for a single fire, using fine-grained agent-based simulations. Different mitigation strategies and evacuation options may therefore be investigated ahead of time. SEEKER has application in planning, exercising, learning and development, community information and engagement and response.

Research and development of SEEKER and SAFER is ongoing. Stakeholders participated in a collaborative prioritisation exercise to inform the development of these tools. This exercise identified needs and assigned implementation priorities to related functionality (must have, desirable, optional). The results of this exercise were incorporated into a road map of future development for the tools.

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1. CSIRO Evacuation Modelling, at: https://research.csiro.au/evacuation/.

AFAC CONFERENCE | NEWS AND VIEWS

International support in disasters

Kelsey Winter

British Columbia Wildfire Service

Tim Hassiotis

Fire and Rescue NSW

The summer of 2021 brought persistent drought and heatwaves across Canada, resulting in significant fire activity. National preparedness reached its highest level and domestic resources were stretched to capacity when dealing with aggressive wildfires that reached new levels of radical fire behaviour.

In July 2021, the Canadian Interagency Forest Fire Centre (CIFFC) made a formal request for assistance to the AFAC National Resource Sharing Centre (NRSC), facilitated by agreements established 7 years earlier. These exchanges have been instrumental over the years, with NRSC previously facilitating the deployment of Australian resources to Canada; 234 in 2017 and 27 in 2018. The 2021 Australian contingent consisted of 55 resources deployed to British Columbia and Ontario as well as CIFFC headquarters in Manitoba.

The request provided an opportunity for Australia to reciprocate after 242 Canadian resources travelled to New South Wales, South Australia and Victoria to assist with the devastating 2019–20 bushfires.

The protocols and processes involved to integrate fire management specialists and crews into their respective host agencies demonstrates insight on how the linkages between the Australasian Inter-Service Incident Management System (AIIMS) and the Canadian ICS (incident command system) foster a common operating picture and nomenclature for deployed staff to increase interoperability. These exchanges provide an opportunity for CIFFC and the NRSC to test, adapt and improve national standards and doctrine fundamental to resource exchange and contemporary response techniques.

The focus of these deployments is aimed at response to complement efforts on the fire ground. An unintended consequence of this is the learnings that each individual involved, both Canadian and Australian, bring back to their own organisation.

As members involved with the deployment, both on the receiving and outgoing ends, we realized that the value of these exchanges goes far beyond the obvious need to have more boots on the ground or to provide needed support and relief. Each agency was able to tap into the other's expertise, compare methodologies and foster ongoing candid relationships that still reap dividends within a global learning culture that is continuing to develop. The inherent strengthening of the partnerships between each country is experienced by the national resource-sharing agencies, each wildfire and bushfire agency and individuals involved.

Deployments like the Australian/Canadian partnership allows for different perspectives and diversity of thought to strengthen practices, efficiencies and safety.

Understanding the human conditions

After being briefed and having arrived in British Columbia (BC), it was apparent that the province was experiencing a unique situation on many levels. In late June, BC experienced a 'heat dome'; extreme, prolonged high temperatures that contributed to over 800 deaths. On 29 June, the Village of Lytton recorded a temperature of 49.5, higher than the Las Vegas record. On 30 June 30 within less than 30 minutes, a fire razed the Village of Lytton, displacing hundreds, including surrounding First Nation communities. Sadly, 2 civilians lost their lives in the fire, this was a first for the BC Wildfire Service and impacted them deeply.

In May 2021, the mass grave of 215 children was discovered in the grounds of the Tk'emlups te Secwepmc Residential School in Kamloops, BC.[1] The entire country was shaken by this discovery, and this served to rapidly increase distrust of the government. On top of this, Indigenous peoples were simultaneously being impacted by sustained fire activity. On arrival at the Kamloops fire centre, Australian personnel were greeted with a blanket of thick smoke, coupled with numerous signs and displays of hundreds of pairs of shoes in honour of the lost children.

The BC Wildfire Service was faced with the mammoth task of protecting communities, managing over 1,600 wildfires and regaining the trust of First Nations communities. A total of 428 Indigenous and local communities were put on evacuation orders, resulting in psychological stress and economic hardship. Over 850,000 hectares were burnt. At the peak, nearly 4,000 personnel were involved in wildfire response efforts, including more than 900 out-of-province personnel and 625 members of the Canadian Armed Forces.

This complex scenario showed just how important it is to understand the human conditions where you are—the cultural and political environment, social expectations, the key partnerships and relationships. Australian personnel were briefed on these factors to understand the human side—what the local crews were going through—were important to making a valuable contribution and having great learning opportunities at the same time.

Collaboration with First Nations communities

The BC Wildfire Service embedded First Nations liaisons into emergency centres and collaborated closely with them. The liaisons provided local knowledge, reviewed operational tactics and led the communication with their respective communities. First Nations people were involved in the training of initial attack crews and firefighters assisting with preparedness and community protection. These approaches were so successful that they are being incorporated into regular business.

Roaming support

Management representatives, trainees and incident management team coaches were deployed to assist with response efforts and to ensure external engagement was sustainable. These 'roaming' resources were available to coach and mentor junior staff who were relatively new, allowing for in-action learning.

There was also a group of physiotherapists, massage therapists and chiropractors traveling around the fire camps to offer physical recovery and relaxation support to staff. Not only did this program reduce stress, it also reduced factors leading to fatigue, leading to fewer preventable injuries.

Both of these approaches have been adopted as normal practice given their success during the 2021 wildfire season.

Community preparedness

British Columbia has heavily invested in FireSmart, a national and provincial program that educates communities about the risk of wildfire. Participation is encouraged at all levels, from individuals to whole communities and local governments, and funding is made available for mitigation actions, such as clearing branches or prescribed burning. The program encourages communities to seek out fire-resistant materials, clear properties of combustible materials and make a fire plan. It gives everyone a defined role in creating a province that is resilient to wildfires.

In summer 2021 Logan Lake, a FireStart community, was challenged by a fast-moving wildfire. Through a combination of years of fuel treatments, FireSmart neighbourhoods and a well-established community structural protection plan, Logan Lake was saved. Travelling through the community in the aftermath felt like a miracle, but it was one that came about through years of prevention activities.

Structural fire protection units

Structural fire protection units (SPUs) are widely used within Canada. SPUs are sprinklers that create a defensible space on homes and other structures. They are set up to keep rooftops and surrounding fuels wet, which extinguishes airborne embers, increases humidity and allows the fire to burn around the protected area.

Prior to impact from a firefront, properties are assessed and placed in one of 3 categories:

- Needs little or no protection, for now.
- Needs protection, but is saveable.
- Cannot be saved, lost or too dangerous.

In summer 2021, properties in the remote community of Brookmere that were most at risk from a significant fire front had SPUs installed. When conditions became high risk we retreated and returned the next morning to find that the SPUs had been successful and no structures were lost.

Fostering a sharing culture

It is important to take the time to share information during deployments and to build relationships after the fact that establish mechanisms for sharing lessons. During summer 2021, recording differences and ideas regularly during deployment with the intent to inform future practice fostered a deep relationship among staff. As a result, staff personnel from Canada and Australia continue to exchange information and work together on issues of mutual concern. Partnerships between Australia and Canada help to boost response efforts to disasters and enable us to be stronger, more efficient and more effective as a global wildfire management system.

Endnote

1. Beginning in the 19th century, until the last school closed in 1996, Indigenous children in Canada were removed from their families and forced to attend residential schools, mostly operated by churches. Thousands of children never returned home and their families were often given little to no explanation of what happened.

AFAC CONFERENCE | REPORT

The tide is high: a new perspective on coastal flood hazards

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Abstract

The Intergovernmental Panel on Climate Change recently described high-tide flooding as 'the most urgent adaptation challenge' (Cooley *et al.* 2022, p.127) facing coastal communities. However, high-tide flooding hardly features in most Australian coastal hazard assessments. This paper outlines the key findings and implications of recent research on high-tide flooding for planners and emergency managers in Australia.

Introduction: What is high-tide flooding?

In most coastal Australian cities and towns, coastal floods can occur due to high water levels in harbours, bays, estuaries, and tidal rivers. Coastal water levels result from a combination of factors including sea level rise, solar-lunar tides and storm surges. Sustained heavy rainfall can lead to even higher water levels in estuaries, as seen in 2022 in coastal towns in Queensland and New South Wales. Coastal floods in Australia have traditionally been associated with inclement weather including heavy rainfall, low atmospheric pressure and strong winds (McInnes *et al.* 2016, Callaghan & Power 2014).

However, increasingly, floods can occur without any associated significant weather simply because global mean sea levels have risen and continue to rise (Ray & Foster 2016). Tides are the key feature in determining the timing of these flooding events, which are referred to as 'high-tide' floods. Tides occur due to the gravitational pull of the Moon and the Sun on the Earth's oceans and interactions with the shape of coastlines and the ocean floor. The heights of high tides vary between locations and depend on the time of year. Tides can be accurately predicted years in advance for most locations because they follow regular cycles. They typically reach their highest levels for a few days either side of full moons and new moons.

Recent Australian high-tide flooding data and research

For the last 4 years, the Bureau of Meteorology, in partnership with Monash University, has been studying high-tide flood events in Australia, building on existing work from the United States (e.g. Sweet & Park 2014, Sweet *et al.* 2018, Thompson *et al.* 2021, Moftakhari *et al.* 2015, 2017). Definitions of coastal flood thresholds (Hague *et al.* 2019), conceptual models for defining high-tide flooding (Hague & Taylor 2021) and a new high-quality tide gauge dataset (Hague *et al.* 2021) have been developed. These have been brought together into the first national assessment of frequencies and trends in coastal flooding in Australia's major coastal cities and towns (Hague *et al.* 2022).

Our approach maximises consistency between existing products and services delivered by the Bureau, with a view to eventually supporting operational services and decision-making. For example, minor coastal flood thresholds were defined such that the impacts associated with water levels reaching these thresholds are consistent with those implied by warnings for minor flooding in rivers and lakes. Our high-quality dataset, the Australian National Collection of Homogenised Observations of Relative Sea Level (ANCHORS) uses equivalent methods to the Bureau's temperature dataset, ACORN-SAT (Trewin *et al.* 2020), with modification to account for the nuances of sea level. These data have been quality-controlled and assessed for artificial factors such as tide gauges being relocated or replaced. The dataset measures changes in relative sea level rather than changes just due to climate and ocean processes ('absolute' sea level). This is because we want to understand how sea levels relate to land heights at different locations to inform the study of coastal flood hazards. Globally, vertical land motion is a key factor that influences coastal flooding frequencies and severities (Karegar *et al.* 2017). For Australia, this consideration of land motion is less important as variability and change in sea level is generally happening at rates much faster than movements of the land in the coastal zone.

High-tide flooding on the Gold Coast, Queensland in January 2022.
Image: James Thompson

A national assessment of past and present high-tide flood hazards

A new coastal flood hazard assessment (Hague *et al.* 2022) provides the missing link between extreme sea levels and the on-the-ground impacts they cause. This was the first time that spatial patterns and temporal changes in frequencies of coastal floods of common results (in this case, minor flooding) could be described in a nationally consistent way. This enabled the first national assessment of how frequent minor coastal floods are across Australia and how the frequencies of these events are changing as sea levels rise.

Previous regional and national Australian coastal hazard studies have assumed that the coastal floods of concern to planners and emergency managers either occur very infrequently (e.g. once per decade or century), at the same frequency at every point around Australia, or both (e.g. Lowe, Cuttler & Hansen 2022; Pattiaratchi, Hetze & Janekovic 2018; McInnes *et al.* 2015; Haigh *et al.* 2014; McInnes, Macadam & Hubbert 2013). Hague *et al.* (2022) shows this assumption may be less than ideal. For example, the Gold Coast area of Queensland experienced an average of 12 days of coastal flooding per year over the baseline period of 1992-2011. By contrast, Newcastle in New South Wales experienced an average of 26 days per year and Fremantle, Western Australia experienced less than 2 days on average. This shows that not only does high-tide flooding occur frequently in some locations, but its exact frequency also varies from place to place.

Consequences of these floods include inundation of roads and car parks (Hague *et al.* 2019, 2022), which are associated with negative economic and social outcomes (Buchanan, Oppenheimer & Parris 2019; Hino *et al.* 2019; Kasmalkar *et al.* 2020; Hauer *et al.* 2021). In some locations, high-tide flooding, which might be considered moderate, is now emerging, or soon will emerge with only modest further rises in sea level. This shows that floods that should be of concern to planners and emergency managers can occur more frequently than once per decade or century.

Hague *et al.* (2022) also showed that while all locations saw increases in coastal flood rates linked to increases in mean sea level, the amount of sea level rise was not a good predictor of how much coastal flood rates increased by. For example, the coastal flood trend on the Gold Coast was 9 days per decade but at Fremantle it was 0.38 days per decade. This difference is despite both locations experiencing the same sea level rise rate of +4 mm per year over the study period.

Towards a national assessment of future high-tide flood hazards

The present best-available coastal sea level guidance for future planning (CSIRO and Bureau of Meteorology 2015) does not capture these extreme spatial variations in how coastal floods rates respond to sea level rise. This is because the coastal risk measure used, sea level allowances, only considers how much higher (i.e. not more frequent) future sea level extremes will be relative to their historical equivalents. Clearly both perspectives are important, but an allowance approach may not be sufficient to capture all dimensions of the current or future flooding risk.

Multiplication factors (Hunter 2012) indicate how much more frequent historical extremes will become in the future. These

have been computed for Australian locations and are available via the CSIRO online tool, Canute 3.0 (https://shiny.csiro.au/Canute3_0/). However, multiplication factors use statistical methods that do not represent tidal processes well (e.g. Stephens, Bell & Lawrence 2018; Ghanbari *et al.* 2019). While this limitation was acknowledged in development (i.e. Hunter 2012), its significance for coastal flood hazard assessments has only been realised in recent years as the effects of high-tide flood events have seen closer scrutiny from scientists worldwide. Various alternative analysis methods that successfully address this shortcoming have been developed and applied in the United States (e.g. Moftakhari *et al.* 2017, Sweet *et al.* 2018, Ghanbari *et al.* 2019, Thompson *et al.* 2019) and New Zealand (Stephens, Bell & Lawrence 2018) but their adoption is lagging in Australia.

Two studies have made incremental steps towards applying these methods in Australia to understand how the frequency and severity of present-day minor floods will change, but only on local or regional scales. Hague *et al.* (2020) showed that minor flooding is expected weekly in Sydney by 2050, regardless of greenhouse gas emission scenario. By 2100, events like the current '1-in-100-year' flood level used for flood risk planning will occur weekly under moderate- and high-emissions scenarios. Even under low-emission scenarios, these events are expected to occur multiple times per year.

Hanslow *et al.* (2018) found that 8,500 properties in New South Wales are currently flooded annually due to tides. Under 50 cm of sea level rise, 23,700 properties are likely to be exposed. This increases to 50,700 properties under 1 metre of sea level rise. Of these 50,700 properties, 14,200 will have more than 90% of their land area flooded during high tide meaning near complete submergence and likely significant loss and damage. Both studies assume an absence of effective future adaptation that reduces or removes flood hazards associated with the present-day minor flood level and no change to the number or placement of existing assets.

These studies show that a national assessment of future changes in the frequency of present-day and historical floods are urgently needed to assess the extent to which high-tide flooding poses a threat. For example, we do not know whether the results from Sydney and NSW are representative of the risks facing Australia as a whole. Given the number of properties that will be regularly flooded under fairly modest sea level rise, there is some urgency to ensure that current and future planning decisions do not add to this burden and, where possible, actively reduce future exposure and vulnerability.

It is quite probable that increasingly frequent high-tide floods, and not increasingly extreme extremes, will be the dominant driver of adaptation in coastal communities (Buchanan, Oppenheimer & Parris 2019). Conventional responses to extreme extremes such as insurance or engineering in the form of tidal barriers, levees or drain sleeves may not be an option for frequent flood risk. Events that happen frequently are likely to contribute to compound events in the future, for example, where riverine and coastal flooding occurs concurrently. By excluding high-tide floods in coastal hazard assessments, we risk omitting the element of the hazard that most affects community-level responses to that hazard.

Conclusion and next steps

Sea level rise will continue after greenhouse gas concentrations stabilise, with rises of many metres possible (Fox-Kemper *et al.* 2021). Therefore, adapting to increasingly frequent and severe coastal floods is largely a case not if but when. This shows the importance of developing new perspectives on coastal hazards that include high-tide flooding and the triggers that elicit adaptive responses from policy makers and communities (Stephens, Bell & Lawrence 2018). These perspectives need to be considered in new research initiatives and when developing local, state and national dynamic adaptive policy pathways (Haasnoot *et al.* 2013). This will require collaborative approaches between scientists, policy makers and emergency planners to ensure Australia is best prepared for future responses, challenges and decisions regarding coastal floods in the decades and centuries to come.

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Bushfire Safety at Renewable Energy Facilities

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Introduction

Renewable energy technologies, including wind energy, large-scale solar and battery storage are being developed and implemented rapidly across the country areas of Victoria. The pace of innovation has resulted in new and complex risks for emergency responders and communities, particularly where electrical, chemical and landscape risk intersect. There is an opportunity during planning stages to identify and mitigate fire risk through facility design to enable safe and effective emergency response through the construction and operational stages of facilities. The Country Fire Authority (CFA), in conjunction with industry and regulatory authorities, has developed the Design Guidelines and Model Requirements for Renewable Energy Facilities to support designers and operators of facilities to consider and mitigate fire risk. The operational knowledge gained from recent fires at large-scale renewable energy facilities and the knowledge gained in assessing hundreds of renewable energy developments across the country area of Victoria form the foundation of a third edition of the guidelines. While these were developed in a Victorian context, CFA expertise and the guidelines have been sought for supporting fire safety at renewable energy facilities across Australia and internationally.

CFA and the Specialist Risk and Fire Safety Unit

CFA is a statutory authority accountable to government for the delivery of emergency services through its paid and volunteer workforce (CFA 2022). In addition to emergency response, CFA has responsibilities under the building, planning, dangerous goods and work, health and safety legislative frameworks to support fire prevention and emergency management, for the ultimate purpose of firefighter and community safety.

The CFA Specialist Risk and Fire Safety Unit (SRFSU) supports CFA in meeting these responsibilities, by working with designers, developers and statutory authorities in the provision of advice on fire risk management and emergency management for facilities that pose specialist hazards and risks for emergency responders. With their increasing prevalence and risk over the last 4 years, the role of the SRFSU has expanded to include advocacy for fire safety and emergency management at renewable energy facilities.

Victoria's bushfire and planning environment

Victoria is susceptible to large, intense bushfires that can spread across landscapes. This is due to Victoria's terrain, naturally flammable vegetation and frequent exposure to hot, dry, windy weather (Safer Together 2022). Victoria's Planning Scheme affords CFA involvement in the statutory approval process for planning permits under clauses that recognise the need for bushfire risk to be considered in relation to the protection of human life, where land is used and developed for various purposes.

Until 2017, CFA involvement in renewable energy was limited and ad hoc; CFA was only notified where identified as relevant by planners in municipalities responsible for assessing planning applications for renewable energy facilities. In September 2019, Victoria's Minister for Planning became the responsible authority for new planning

permit applications for all energy generation facilities such as wind, solar, pumped hydro, gas and waste-to-energy; and those that send, distribute or store electricity if the installed capacity is 1 megawatt or greater, such as power lines and battery storage (DELWP 2022). The change to manage and assess applications centrally through the Department of Environment, Land, Water and Planning (DELWP) provided CFA with the critical opportunity to make and maintain connections with the renewable energy team within the department.

Bushfire safety in planning and design of renewable energy facilities

The move towards large-scale renewable energy over the last 5 years has been rapid. The capacity of wind farms currently operating in Victoria is over 3500MW, with another 2300MW having been approved but not yet operating (DELWP 2022a). Large-scale solar (over 5MW) has accelerated with projects of a combined capacity of over 4000MW having been approved since 2018 and 695MW currently operating (DELWP 2022b). Many of these facilities include supplementary battery energy storage systems, and there is also an increasing number of stand-alone battery energy storage facilities proposed, approved, under construction and operating in the state.

The rapid development of facilities, coupled with the differing and constantly evolving technologies they employ, create challenges for fire authorities on 2 fronts. The immediate operational challenge is understanding and planning for the complexity of safe and effective response by firefighters facing incidents at renewable energy facilities. For CFA, this frontline work is critical and urgent and is being addressed across multiple departments, including operational support, training and resourcing, as well as the SRFSU.

Accompanying the operational challenge is the strategic one, where the aim is to reduce risks to emergency responders through the implementation of minimum standards and regulatory safeguards that embed fire safety into the design and operation of facilities. Using the expertise gained from assessing hundreds of planning applications and from supporting renewable energy incident investigations, CFA works with governments, authorities and other stakeholders to raise awareness of the risks to responders and support the development of mechanisms to this end. However, regulation always falls behind technological innovation and the rate of change of fire safety outcomes is dependent on the strength of the fire services, relationships with other regulatory authorities and government departments.

Bushfire safety at renewable energy facilities relies on an accurate understanding of the landscape risk and appropriate siting of facilities. The DELWP guidance for large-scale solar specifies that facility siting should not lead to increased exposure of the area to fire (DELWP 2019) and that site selection should consider exposure to bushfire. The department stops short of recommending locating facilities away from high-risk areas and encourages proponents to engage with relevant fire management authorities such as CFA to ensure a facility 'avoids unnecessary bushfire risk exposure and has fire management planning in place to avoid fire risks' (DELWP 2019). This engagement with CFA, as early in the process as possible, is critical.

Renewable energy facilities and utility installations are not buildings or works that formally trigger consideration of bushfire risk when sited in areas with bushfire risk. Similarly, the provisions within the planning scheme that govern industry land uses, specifically those that may have off-site affects, do not include renewable energy or battery installations and do not include mandatory referrals to fire authorities.

Design Guidelines and Model Requirements for Renewable Energy Facilities

The increasing involvement by the CFA in renewable energy facility planning during 2017–18 revealed the need for consistency in determining fire risk and its management across developments that varied in size, siting, landscape risk and chemical and technological hazard. While the standard access, defendable space and water supply requirements existing in the planning scheme for facilities with bushfire risk provided a baseline, a comprehensive risk management approach to understand and develop effective mitigations specific to each facility was needed.

The first iteration of CFA's guidelines in 2019 encouraged the incorporation of a risk management approach specific to the technologies being proposed, and minimum recommendations for fire risk controls for solar and wind facilities. This approach was premised on work, health and safety legislation, which places a duty on designers to ensure that buildings and structures are safe and without risks to health; a duty that provides for emergency responders when facilities become their workplace during emergency response activities.

The result was that planning applications would only address the baseline requirements and not provide risk assessments (or supporting information) that would allow planners and CFA to adequately understand the risk from technologies. This became particularly problematic as proposals incorporating battery energy storage systems started to increase. In early 2021, revised guidelines were released; this time embedding the expectation of a risk management approach and expanding the baseline requirements for battery energy storage systems to demonstrate increasing fire risk controls commensurate to the increasing risk. This was marginally successful as risk assessments began appearing with planning applications. However, in almost all cases, the risk assessment only justified, or attempted to roll back, the baseline requirements without adequate supporting evidence.

The fire at the Victorian Big Battery during its commissioning in winter 2021 was a turning point for CFA. The circumstances surrounding the fire and the emergency response was a highly visible demonstration of the potential risks of these types of facilities. Although not the first fire worldwide, the Victorian fire

showed that the collective societal understanding of the safety of the technology was rudimentary. The fire occurred during winter. The most likely root cause was later determined as a leak within the liquid cooling system causing arcing in the power electronics of battery modules (Blum *et al.* 2022). Critically for CFA, it also revealed the requirements and complexities of a safe and effective response. These factors provided the catalyst for developing the third iteration of CFA guidelines.

As technology evolves, the overarching challenge remains access to comprehensive and accurate information. This is true for response (where the information supports operational decision-making to protect firefighters from harm) and for fire risk management in design (where information supports the ability to assess risk and ensure that appropriate fire risk controls are applied) particularly for battery energy storage systems.

Learnings and the future

While the challenges are complex and ongoing, for other jurisdictions facing these or similar challenges, we offer the following advice for consideration based on our experiences.

Adopt a precautionary approach

We have learnt lessons in taking information provided at face value. The current guidelines adopts the precautionary principle towards risk management for battery storage; that is, an evidence-based approach to justify proposed risk controls. CFA recommends permit conditions that will provide the greatest level of safety for emergency responders. The absence of evidence or scientific rigour does not negate requirements for duty holders to effectively control risk, nor does it remove CFA's legislative obligations or social contract to respond to emergencies.

Fire services engagement in planning and design is critical

Whatever the regulatory systems and processes in your jurisdiction, finding a way to be involved in the planning and design of facilities is critical. Incorporating fire risk management controls in facility design is by far the most effective strategy to reduce the potential of fire occurring, reduce the consequences of fires, and protect firefighters and the community. For CFA, the working relationship that has evolved with the state's planning department has ensured that CFA is notified so that it can provide a formal response to the planning permit assessment process. CFA advice and recommendations concern the effective management of fire risk both to and from proposed facilities and their operations. While consideration and integration of CFA advice remains at the discretion of the department and the minister, the opportunity to work through issues and challenges collectively has exponential value.

This is just the beginning.

Whether the current regulatory framework is adequate to manage the risk associated with renewable energy facilities is a topic that must be inclusive of fire services. The current mechanisms in the Victorian planning system treat the potential off-site risks from battery energy storage systems differently than other industry off-site risks. There are ongoing debates as to whether and how battery storage should be regulated under the dangerous goods and electricity safety regulatory frameworks. There are also significant implications for the increasing prevalence of battery storage within buildings. Emergency response is a critical consideration under all of these frameworks.

Access the guidelines at www.cfa.vic.gov.au/plan-prepare/building-planning-regulations/renewable-energy-fire-safety.

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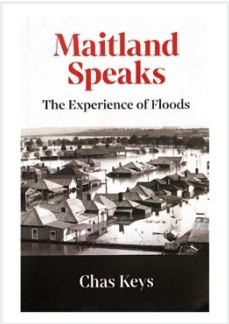
Maitland Speaks: The Experience of Floods



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Our nation's history is entwined with disasters. Many of us have experienced disaster first-hand. In my youth, growing up in the hills of the Murrumbidgee Valley, my grandparents would share their experiences of flooding. Instilling knowledge that would continue in its application for decades. It is the immense value of storytelling that Chas Keys captures in his accounts of those that have experienced flooding in his latest book Maitland Speaks: The Experience of Floods.

Keys, a former Deputy Director General of the NSW State Emergency Service, has been a keen observer of the Australian experience of flooding, with a particular interest in people living in the New South Wales Hunter Valley. The experiences of residents in the valley provides a rich tapestry to understand the effects of flooding and the challenges posed to communities in their adaptation to flood risk.

The book comprises 2 parts. Firstly, Keys explores the stories of 12 long-term Maitland residents stretching back as far as 1930 to illustrate the importance of understanding social perspectives that define the responses of individuals to flooding.

In each story, Keys captures the human emotion and experience as well as the practicalities of flood adaptation through a practitioner's lens. The story of Lillian Adams is one of many interesting examples Keys explores. Following the devastation of the Hunter River flood in 1955, Lillian's mother participated in a scheme arranged by the local Lions Club to relocate her home and many others to higher ground. The home is still occupied today after being dismantled and relocated.

The second part provides a synthesis of the community's adaptation to flood hazard. As Keys describes, flooding has been ingrained in the local culture and the experiences of individuals has shaped the response to floods, although the absence of significant floods in recent decades has led to apathy. Brought about by construction of levees, apathy has disrupted the community's connection with the flood threat as flooding has become less frequent. As Keys says:

Floods are not simply reacted to logically but produce understandings that are subjective and may in some cases be in error or otherwise not necessarily to people's advantage: there is much community psychology to be uncovered in this.

Keys rightly challenges authorities not to be lured by a false sense of security created by flood mitigation but to maintain a close connection with the flood threat and its prudent management.

I particularly enjoyed the book's collation and description of local flood-themed literature and arts that succinctly captures the community's experience. A verse from the poem, 'The Hunter and His Prey', by Archer Crawford illustrates many of Keys's arguments for the community to respect the inevitability of flooding.

> *Go bury your dead and weep for the bold*
> *Who gifted the life that they'd sell not for gold.*
> *Ask not for mercy, you damned Maitland men*
> *Prepare for tomorrow, I'll flood you again.*

Overall, the book is an important contribution to disaster literature through exploration and illustration of historical adaptation in a local community setting. The lessons described are relevant to all flood-prone communities and are useful to inform responses to modern-day disaster management challenges. All disaster managers keen to ensure lessons of the past are not forgotten will enjoy this book.

Copies of this book can be obtained from the author at chas.keys119@gmail.com.

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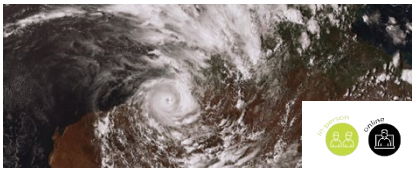

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Abstract

Thousands of people become lost in the wilderness each year and search and rescue personnel are called in to search for and to locate people who are lost. Time is critical as the lost person's chance of survival decreases over time. One method of improving search outcomes is efficient and accurate planning of search areas. Search and rescue planning techniques have been developed over time through extensive training, experience and knowledge. To expedite the search area planning process, an agent-based model (ABM) was used to highlight probabilistic and evidence-based areas typically considered by search area planners. This model takes spatial data calculated to a time-cost raster and incorporates lost person characteristics to determine location-specific probability data that can be used in decision-making.

Using an agent-based model to identify high probability search areas for search and rescue

Peer reviewed

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Introduction

Hiking in the wilderness is a popular pastime with benefits for personal fitness and wellbeing as well as creating positive relationships with the physical environment (Taczanowska *et al.* 2014). In Australia, hiking was the sixth most popular physical activity in 2019–20, with approximately 1.5 million adults participating (Sport Australia 2021). With hiking being so popular, it is unsurprising that thousands of people get lost every year (Alanis *et al.* 2019, Department for Transport 2022, Australian National Search and Rescue Council 2019). In 2019, search and rescue (SAR) organisations in Australia conducted 1,820 land operations to locate lost people (Australian National Search and Rescue Council 2019). With the probability of a lost person's survival decreasing over time, proper planning to make the search more efficient is essential (Syrotuck 1976). Practical tactics can be employed to reduce this time such as reducing the size of the search area using better geographic assessments of where the lost person is likely to be and to find the missing person in the shortest possible timeframe (Doherty *et al.* 2014, Ferguson 2008).

Spatial modelling has been incorporated in SAR using mobility models that estimate the distance a lost person may have travelled (Doherty *et al.* 2014, Alanis *et al.* 2019, Yoo & Lee 2019). When a person is lost in the Australian wilderness, SAR personnel use a spatial model referred to as the 'ring model' to assist searchers to locate the lost person (Australian National Search and Rescue Council 2020) (Figure 1). The ring model indicates to search planners how far a lost person may be located away from their last known position (LKP) based on statistics from previous search incidents. The ring model is a common way to assign probabilities to search regions. It is based on quartile distance statistics and uses buffer rings from the LKP as probability circles by subject categories (Sava *et al.* 2016).

Spatial modelling has been developed to assist in narrowing the possible location of a lost person. Probability mapping conducted by Jacobs (2015) used the percentage of lost people found in locations with specific terrain characteristics to determine the probability of a likely location based on those characteristics. Drexel, Zimmermann-Janschitz and

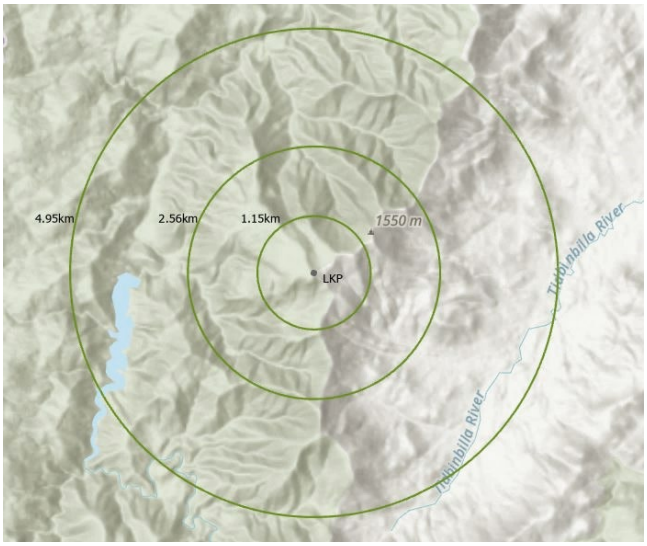

Figure 1: The ring model with Euclidean distances from the LKP for the hiker category

Source: Koester 2008

Koester (2018) used network analysis of linear features as well as elevation and statistical data to determine areas of probability for lost person locations. The watershed model was used in Yosemite National Park by Doke (2012) to determine the number of watersheds crossed by a lost person in order to create a probability map of watersheds most likely to contain the lost person. Lin and Goodrich (2010) used a Bayesian approach to generate a probability map for SAR. This method drops thousands of simulated subjects around the LKP and a Markov Chain Monte Carlo[1] simulation is run where the probability of moving from one cell to a neighbouring one is dependent on the environment in both those cells (Sava *et al.* 2016). In a similar approach, Alanis *et al.* (2019) developed a mechanistic model using a Markov Decision Process, specifically a Decision Tree Algorithm that incorporates a heuristic pathfinding algorithm to predict the movements of a person lost in the wilderness. There is currently no evidence to suggest that any of the spatial models described, beyond the ring model, have been used in real-time SAR incidents.

When SAR commanders are planning search areas, they look for features in the area that, through their training and experience, stand out to them as areas a person might likely be, such as tracks, ridgelines, fences and rivers. Conversely, they also identify areas a lost person is unlikely to have travelled to due to terrain difficulty or behavioural reasons. These subjective assessments could be incorporated into spatial models, providing more consistent approaches and opening them to rigorous scrutiny.

ABMs are potent tools that can help to understand the behaviour in complex spatial systems (Ye & Mansury 2016). They have shown promise in SAR application, as they incorporate movement across landscapes. ABMs consist of 3 elements: an agent, the environment and interactions between 'agents' (autonomous decision-making entities) and the environment (Macal & North 2010). The environment is where phenomena occur, and agents inhabit that environment (Gammack 2015). Some studies have successfully used ABMs as a probabilistic approach to SAR (Hashimoto & Abaid 2019, Mohibullah & Julier 2013, Mohibullah 2017). However, these studies are based on developing total search areas for searching by unmanned aerial vehicles not by a ground search by search teams. Hashimoto *et al.* (2022) created an ABM using a combination of real-world terrain data and lost person incident behaviour data. Rather than determining search areas, they used the model output to determine behavioural profiles of hikers (Hashimoto *et al.* 2022).

This paper describes the application of an ABM developed to model the movement and probable location of people lost in the wilderness in Australia. The model is outlined and the output assessed to highlight areas that may be considered in search area planning.

Methodology

Study area

Tidbinbilla is a nature reserve in the Australian Capital Territory and was selected as the region for study and application of the model. The study area selected within Tidbinbilla Nature Reserve is formed by a rectangle of 19 km by 11 km (centred on -35.44959 148.86686) with an area of 209 km^2 and elevation ranging between 594 metres and 1,649 metres (Figure 2). This study area was chosen because it contains varied terrain and attracts many visitors due to the popularity of walking tracks. Tidbinbilla is an area where SAR assistance has been needed due to lost person incidents (P. Ibbott, personal communication, 11 December 2020).

Data

There is spatial data that influences how people traverse wilderness regions. The first is a terrain ruggedness index (TRI) layer, which captures the elevation difference across the terrain (Bosworth-Ahmet 2020). The second is a vegetation density layer. To create these layers for the study area, LiDAR[2] data were obtained from the ACT Government. These data were resampled to create a 40-metre Digital Elevation Model (DEM). From the TRI and vegetation density rasters, a cost raster was created reflecting the amount of time it would take to traverse each 40-metre cell horizontally or vertically using an average human walking speed (Peper, de Dreu & Roerdink. 2015). The use of Naismith's law, as used by SAR personnel was considered. However, the technique used in the model measures the cost of crossing a cell without considering the slope or direction of travel. Travel time increased from 0.49 minutes to traverse a cell with low vegetation density and less rugged terrain to 1.30 minutes (165% increase) for cells with dense vegetation and rugged terrain. The walking tracks within the study area were created as a vector layer using a combination of the ACT Road Centrelines dataset (ACT Government 2021) and manual digitisation of a Strava heatmap of the area (Strava 2021).

1. A statistical method of Bayesian inference where random observations are indirectly simulated from complex probability distributions (Everitt 2002).
2. A mapping technology using lasers to make digital 3-D representations of areas on the Earth's surface and ocean bottom.

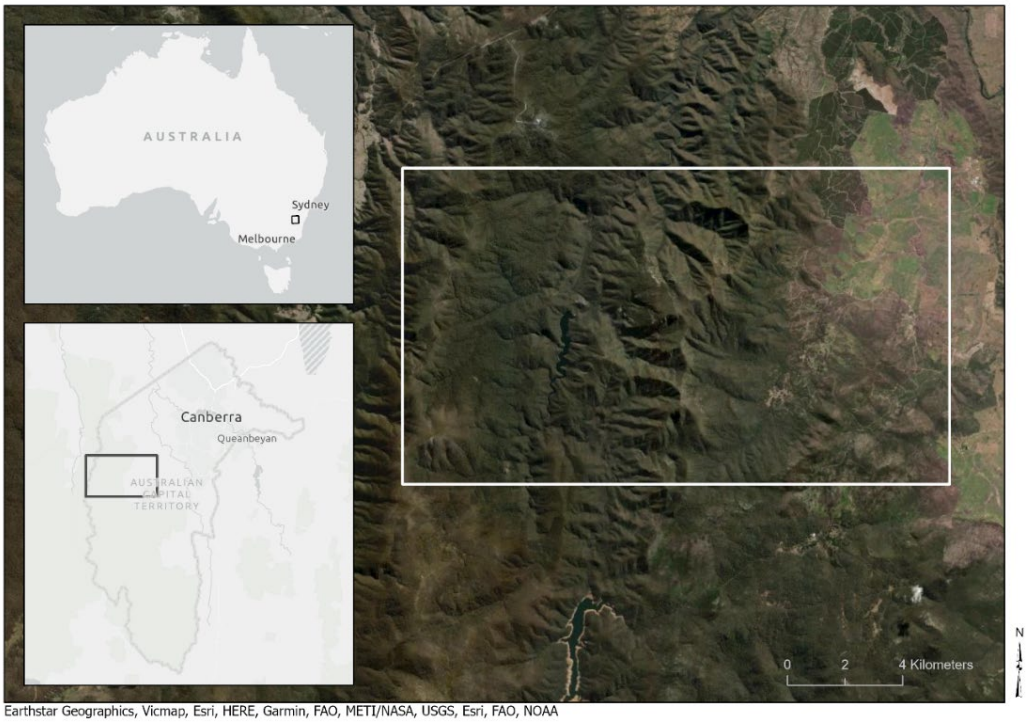

Figure 2: The study area for the model was Tidbinbilla Nature Reserve in the Australian Capital Territory.

ABM specification

The ABM was developed using Netlogo software (Wilensky 1999). This software was chosen as it is open source, there is extensive support documentation online, and it has a Geographic Information System (GIS) extension that allows raster and vector data to be incorporated into the model.

An ABM requires an environment and agents who interact with the environment. Agents are placed within the model and provided with simple rules to govern their behaviour. At each time-step, an agent autonomously decides whether to move and, if so, in which direction. The decisions made by agents are determined using rules incorporating behavioural characteristics and the underlying environment as well as the inclusion of randomness. Decisions about whether an agent moves depend on the current cell, characteristics of surrounding cells and the characteristics of the agent itself. Even though an agent can only move one cell, they can take a much larger neighbourhood into account for decision-making.

In the model for this study, the agents represent multiple instances of a single lost person, initially placed randomly within a user-specified radius of the last known point of the lost person to account for uncertainty in location, the time lost and movement prior to the search commencing. The time elapsed is set as the total time lost and agents individually record the time taken to traverse a cell or the time spent resting. As the agent moves, it maintains an attribute list including the current goal (which determines the direction the agent will face), the time elapsed, distance covered and fatigue level.

The model parameters include the likelihood a person would stay on a track, the possibility of stopping on a track and the physical condition of the lost person. The physical condition is represented as the time before fatigue sets in and incorporates the amount of rest required before continuing. Stochasticity (randomness) was integrated into the model through the random starting point of each agent and the direction they are facing, the agent's autonomous choice of goals, randomness of the fatigue elements as well as the required rest time. It is important to incorporate a level of randomness into the model due to the complexity and high degree of variability in human behaviour and decision-making.

Running the model

While it is possible to run the model with numerous variations of parameters, 3 theoretical case studies were developed to demonstrate how different parameters based on lost person behaviour can affect the model's outcome. The case studies were determined using results from the study by Darcy (2021) into lost person behaviour in the Australian wilderness. The first 3 case studies use profile characteristics outlined in Table 1. All 3 case studies assumed the same LKP and time lost. The model was run for the same length of time (4 hours). These case study profiles translate to the parameter settings in Table 1.

Each of the lost person scenarios was run in the model and the output was exported to a GIS. Kernel density analysis was conducted to determine the probability quartiles and a 95% probability area.

Table 1: Parameter settings for case studies.

Profile Characteristics	Case Study 1	Case Study 2	Case Study 3
Gender	Female	Male	Male
Age	35	60	19
Physical condition	Poor to Moderate	Moderate	Good
Wilderness experience	Low	High	Low
Parameters			
Probability of travelling off-track	Low (20)	Moderate to High (60)	High (80)
Probability of stopping once on a track	Moderate to High (60)	Moderate (40)	Low (20)
Time before fatigue	Low (15)	Moderate (25)	High (40)

Results

Case study 1

Case study 1 modelled a 35-year-old female hiker with poor-to-moderate physical condition and little experience in the wilderness (Table 1). The resulting probability map (Figure 3) is consistent with the profile female staying on track and being more likely to stop once on a track, hence the high density on the tracks closest to the LKP.

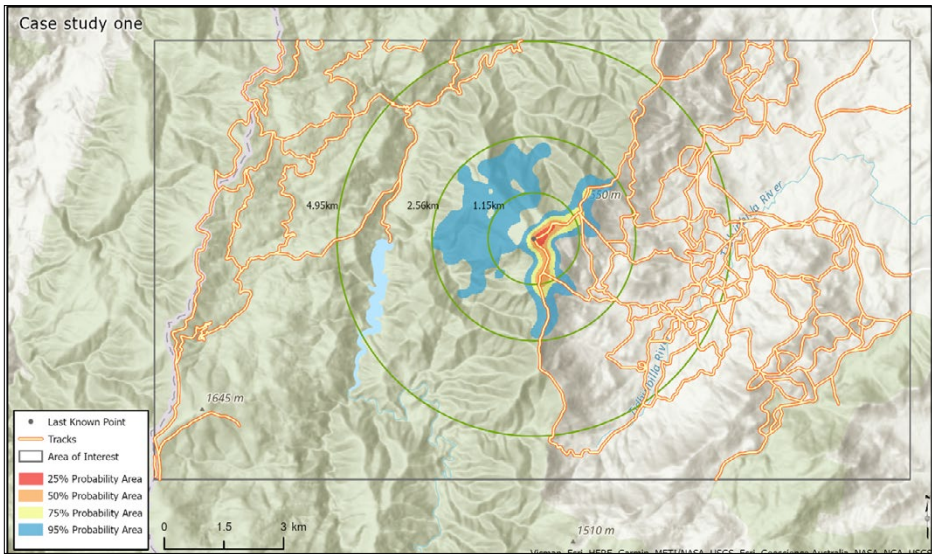

Figure 3: Kernel density analysis results from case study 1 overlayed with the ring model.

Case study 2

Case study 2 was of a hiker with the profile of a 60-year-old male with moderate physical condition and high experience in the wilderness (Table 1). The model predicted a larger search area than in case study 1, with the highest probability areas located around a nearby track (Figure 4). This is consistent with a person who does not move a significant distance and tends to stay near tracks.

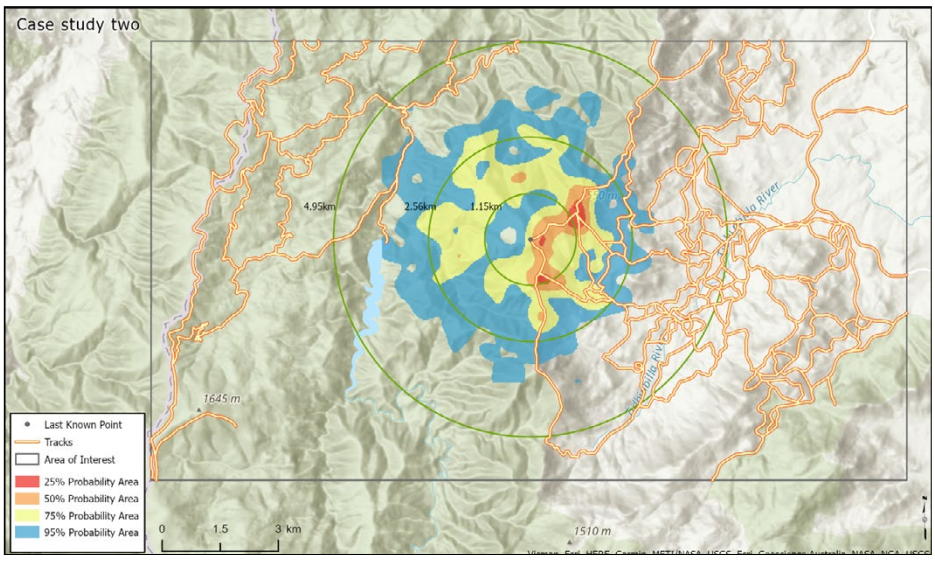

Figure 4: Kernel density analysis results from case study 2 overlayed with the ring model.

Case study 3

Case study 3 modelled a 19-year-old male hiker with good physical condition but little experience in the wilderness (Table 1). The results showed the high mobility of the lost person and a high probability of moving off tracks (Figure 5), which is consistent with the profile. The high probability areas away from the tracks include ridgelines and some valley areas.

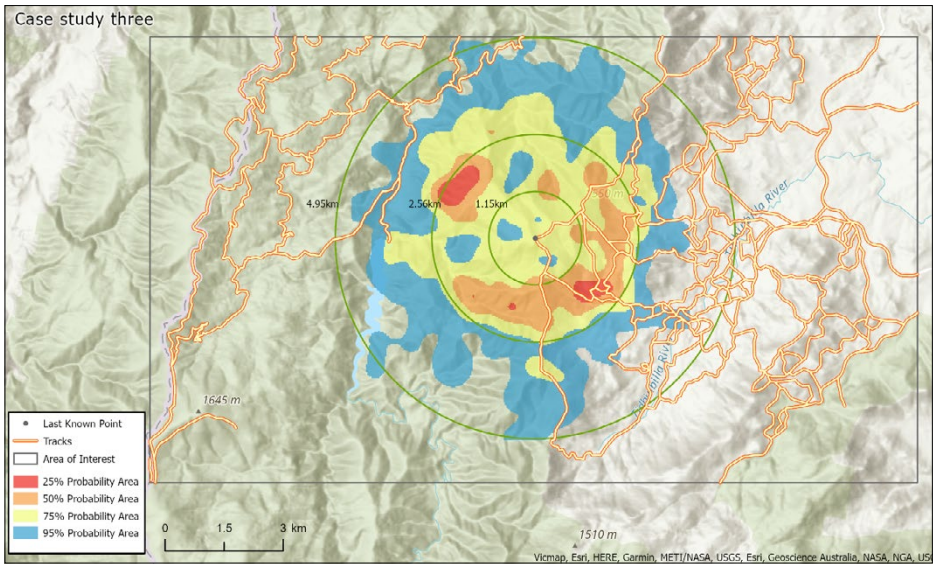

Figure 5: Kernel density analysis results from case study 3 overlayed with the ring model.

Discussion

Time is a critical factor in the survivability of a lost person (Sava *et al.* 2016). This study demonstrated how an ABM can incorporate spatial and lost person behaviour to highlight areas of probable value to a search area planner to expedite the planning process. The results from the case studies show that the characteristics of a person and the terrain they are trying to traverse can significantly affect their likely location.

While SAR personnel are aware of the relationship between lost person behaviour and terrain, the model can emphasise areas using data to provide likely search locations for consideration in search area planning. This is visualised in the first case study, where the lost person is more likely to stay near a track and not travel far due to lower physical condition. Case study 2 showed a dispersed probability area, although the highest probability was to remain near a track. When people are more mobile and tend to travel further, as demonstrated in the case study 3, the higher probability areas derived from the model tend to be clustered about areas containing paths. However, the search area itself can be much larger. When off-track, areas of less challenging terrain are more probable locations, indicating that the agents in the model consider the cost of traversing a cell prior to moving and choosing the path of least resistance. Case study 3 showed higher probability areas circular from the starting point that demonstrated that the agent ignored the paths. This creates a ring indicating where agents reached after 4 hours, with a high probability of travelling further and being less likely to stop on paths.

The model considers that a person will likely move to a path if a path is visible, choosing the least challenging terrain to get there and changing direction depending on the difficulty of the terrain and what they can see. Using an ABM, search area planners can consider the results of the model when making decisions on where to start searches and where to focus effort and human resources.

Factors such as fatigue as well as the difficulty of the terrain a lost person may be traversing are generally taken into account by search planners. The Australian State Police Search and Rescue Coordinator's Course Training Booklet (Whitehead 2018) encourages SAR personnel to apply the subjective method to search area planning. This method uses maps and professional knowledge to assess the terrain, boundaries and potential barriers to identify search areas. This ABM builds on that knowledge and provides additional evidence-based advice for decision-making in search area planning.

Model limitations and potential improvements

Parameterisation of ABMs can be subjective and difficult to validate. However, the goal of the model is to highlight areas that may be considered for a search rather than attempting to predict the exact location of the lost person. By using the ABM and understanding how lost people behave and react within the environment, informed recommendations can be made of which areas are the highest priority in search area planning.

While the model is stochastic, some static numbers informed by research into human movement (Gast, Kram & Riemer 2019; Peper, de Dreu & Roerdink 2015) are still used that limit the randomness of the model. It is possible to change these numbers within the code to reflect a real-life situation better when the incident warrants it. Further development and refinement of the model is required for operational use, including incorporating additional lost person behaviour, decision-making and how lost people choose their goals. However, comparing the model outcomes with points of interest in search planning shows that these assumptions and parameters are plausible and realistic.

Currently, within the model, the main goal for the lost person is to find a track and either continue to travel on it or to find another track. The incorporation of additional goals for agents might prove beneficial to increase the model's accuracy.

SAR personnel use decision points to pinpoint locations where a lost person may have veered off course or lost the track, such as at track junctions, water crossings, sharp bends, or elevation changes (Australian National Search and Rescue Council 2020). Koester (2008) recommended that the next step for computer-based planning tools would be to locate these decision points for use in algorithms that take advantage of that information. Further development of the model presented in the study could assist to determine such features through studying agent movement. The model could be expanded to determine the least-cost path for navigation and to highlight accessibility and predict human movement in the wilderness for emergency planning and protected area management.

Implications of applying the model to SAR

One complicating factor in all human movement modelling is that the behaviour of people can be difficult to predict when combining unknown goals, motivations and decision-making processes. This is especially the case with lost people, who can act irrationally and out of character due to emotions such as fear Dacey (2021). There is further uncertainty when a person is lost as to whether they are genuinely lost or if they are simply overdue, or if they are trapped or injured (Koester 2008). The model described in this paper can be developed to be an accurate predictor of human movement in the wilderness. With the inclusion of additional data such as updated agent goals, behavioural and movement information and appropriate validation data, the model could be used as a location predictor rather than an indicator of areas of interest.

The ABM described in this study has parameter settings that can be altered based on lost person characteristics. The spatial data requirements are terrain ruggedness, vegetation density and track data. With these datasets preloaded, there is no requirement for connectivity to the Internet and it is possible to run the model in the field during a SAR incident. However, current data availability and processing speeds means it is not feasible to develop and run models in real-time to be used in the field. The results of the model can be displayed on a map that can be considered in search planning.

Conclusion

The ABM used in this study showed that this type of model can be an additional tool for search area planning by highlighting areas of interest for search area planners. While no model produces exact results, ABMs are powerful spatial models that can produce complex patterns based on simple movement rules. However, they are under-used in SAR and similar applications. The model requires limited publicly available spatial data and can be adapted to most wilderness areas. Having an automated process for developing the underlying environment raster and creating a user-friendly application to run the model may encourage its use in SAR incidents. While there is a great deal of uncertainty in lost person behaviour, this model uses randomness combined with accurate spatial data and statistically significant lost person behaviour to highlight probable areas a lost person may have travelled. The results of this model are aimed at search planners to provide additional information to refine search areas by producing evidence-based information for planning. With development and validation, the model has strong prospects as a search area planning tool to provide individualised results based on the lost person situation.

Data availability statement

The data that support the findings of this study are openly available in Figshare at https://doi.org/10.6084/m9.figshare.16823617.

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Dr Prue Gonzalez is a senior lecturer at Charles Sturt University. Her work explores how we navigate the complex and diverse interactions between people, space and place. Her research includes the protection of cultural heritage assets during bushfire and the need for reflective and ethical environmental practices.

Insider community participation in recovery from natural disaster, 2009 to 2021: scoping the evidence

Abstract

Much of the policy and literature in disaster studies extoll the virtues of communities participating in self recovery. The empirical evidence, however, is often thin and self-referential. In an Australian context, there exists a need to ascertain 'what is known' about how affected community members can best participate after disasters and what, if anything, can be applied to communities and for policy makers. To address this, a scoping review was conducted of 34 papers published between 2009 and 2021 that detailed studies into how different affected or 'insider' communities responded to 'natural' disasters using geographic, governmental and disaster contexts. While there is a dearth of empirical research on insider community participation (particularly in Australia) and significant problems with current hierarchies of participation, there is evidence that, when harnessed appropriately, insider participation has significant potential to improve recovery outcomes.

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Introduction

The United Nations Development Programme (UNDP 2020) and, closer to home, Emergency Management Victoria's (EMV) Resilient recovery strategy (EMV 2019) stress the importance of community participation in the relief and recovery phases of disasters. Indeed, the latter emphasises the need for government agencies to 'bring communities into the planning process before, during and after an emergency and enable community involvement, so recovery activities better reflect community strengths, needs and values' (EMV 2019, p.10). Within Australia, the virtues of community recovery have been extolled for decades, with one study following the Ash Wednesday bushfires noting that 'communities recover best when they manage their own recovery' (Hill, Hill & Gray 1987, p.11).

Much of the literature also supports the push for greater community participation in recovery, whether due to a neoliberal, democratising ideology (Pyles 2011), the catharsis and empowerment that it may provide (Chamlee-Wright & Storr 2011, Meheux *et al.* 2010), notions of cost-effectiveness and 'sustainability' (Lawther 2009) or the virtues of 'local knowledge' (Allen 2006). The empirical evidence however, is often thin and 'self-referential' (Mulligan 2013, p.281), with notions of 'community' and 'participation' often vague or ambiguous (Davidson *et al.* 2017). As Vallance (2015, p.1289) notes, 'there are relatively few examples of empirical research evaluating different types of public participation in decision-making during disaster recovery'. Therefore, while support for community participation remains strong among literature and policy circles, its empirical foundation is shaky. Moreover, recent Australian evaluations have pointed to a tendency for government agencies responding to disasters to adopt a 'one-size-fits-all' approach to working with communities (Taylor & Goodman 2015). The unique characteristics and contexts of local communities can be overlooked, leading to feelings of being 'managed' rather than being supported (Young, Jones & Cormick 2021). Clearly, there is a need to understand what is meant by 'community participation'.

This scoping review aims to address this by mapping the current 'state of the field' to:

- summarise existing empirical knowledge within current studies of disaster-impacted community participation in their own post-disaster recovery
- identify gaps in current research.

The impetus for this review was a 10-week university placement. During the project, a need to ascertain what information existed regarding community participation in post-disaster contexts emerged in order to determine 'best practice' guidelines for government agencies. The explicit purpose was to see what EMV could take away from the evidence for community-led recovery by those directly affected by disaster; the 'insiders', living and working within disaster-affected communities to maximise recovery outcomes. It is acknowledged that there is extensive literature in the areas of preparation, risk, assessment, inclusion and volunteering after disasters (see McLennan *et al.* 2021), however, this literature was outside of the scope of this study.

Method

A scoping-review method (Peters *et al.* 2015) was used to identify evidence and knowledge gaps in the published literature between 2009 and 2021. This timeframe was selected due to the increase in research in Australian following the 2009 Victorian Black Saturday bushfires. This timeframe also reflects the Australian policy contexts of disaster recovery and resilience at the national, state and territory levels. Similarly, while the terminology of 'natural' disasters is increasingly contentious in the era of anthropogenic climate change, it is useful as a practical distinction to identify relevant inclusion criteria for the review. The Centre for Research on the Epidemiology of Disasters (Below *et al.* 2009) typology of 'natural disasters' is used as they encompass geophysical, meteorological, hydrological and climatological events. A conscious choice was made to exclude 'biological' disasters from inclusion due to the desire to avoid making claims about 'best practice' health guidelines developed in a pre-pandemic world and its intuitive and cultural separation from 'natural disasters' in Australian policy where the language of 'natural disasters' is still useful in distinguishing these events (EMV 2019).

A scoping review method involves 5 stages:

- identifying the research question
- identifying relevant studies
- study selection
- charting the data
- collating, summarising and reporting results (Arksey & O'Malley 2005).

This review method enabled responses to the research questions:

- What is the nature and extent of current empirical studies (2009-21) of insider community participation in recovery from 'natural' disaster?
- What recommendations can be made for future research and/or policy based on the current state of the field?

Search strategy

Searches were conducted using the Web of Science, ProQuest and Taylor & Francis databases for literature published between January 2009 and June 2021 to identify relevant studies of community participation in recovery.

Inclusion criteria for the search were:

- key words:
  - 'community' and/or 'citizen'
  - 'participation' or 'involvement' or 'collaboration'
  - community-led'
  - 'natural disaster' or 'disaster'
- describes a study using any methods or methodology
- was published between 1 January 2009 and 30 June 2021.

Exclusion criteria were:

- non-'natural' disaster (COVID, war, terrorism, internally displaced people)
- scoping or other systematic review
- included government participation
- included non-local/'outsider' participation
- a think piece/opinion/'notes from the field'.

Given the focus on community participation in disaster-affected communities, studies that investigated communities that were not directly affected by the event were excluded. For this reason, groups such as 'outsider' volunteers (McLennan *et al.* 2021) were excluded. The objective was to map existing empirical evidence to inform future policy within agencies looking to understand best practice. Thus, from a research perspective, this meant that existing policy documents and other grey literature were excluded.

Articles were imported into the Covidence software package and underwent screening for title and abstract. From this sample, 46 articles progressed to a full-text screening, 28 of which were deemed relevant for this review (Figure 1).Three additional articles were identified from reference list scans and another 8 from searches conducted with new keywords emerging from the full-text screening. Of those additional papers, 6 were assessed as relevant, yielding a total of 34 articles for the scoping review (asterisked in the references section).

Findings

Features of the studies

The papers were geographically widely distributed (Table 1) with a cluster in New Zealand (n=10) and the United States of America (n=10). The New Zealand publications occurred following the Christchurch and Canterbury earthquakes of 2010 and 2011. In the USA, publications in New Orleans and the Gulf Coast after Hurricane Katrina (n=4), New York after Hurricane Sandy (n=3), Texas following Hurricane Harvey (n=2) and Texas following

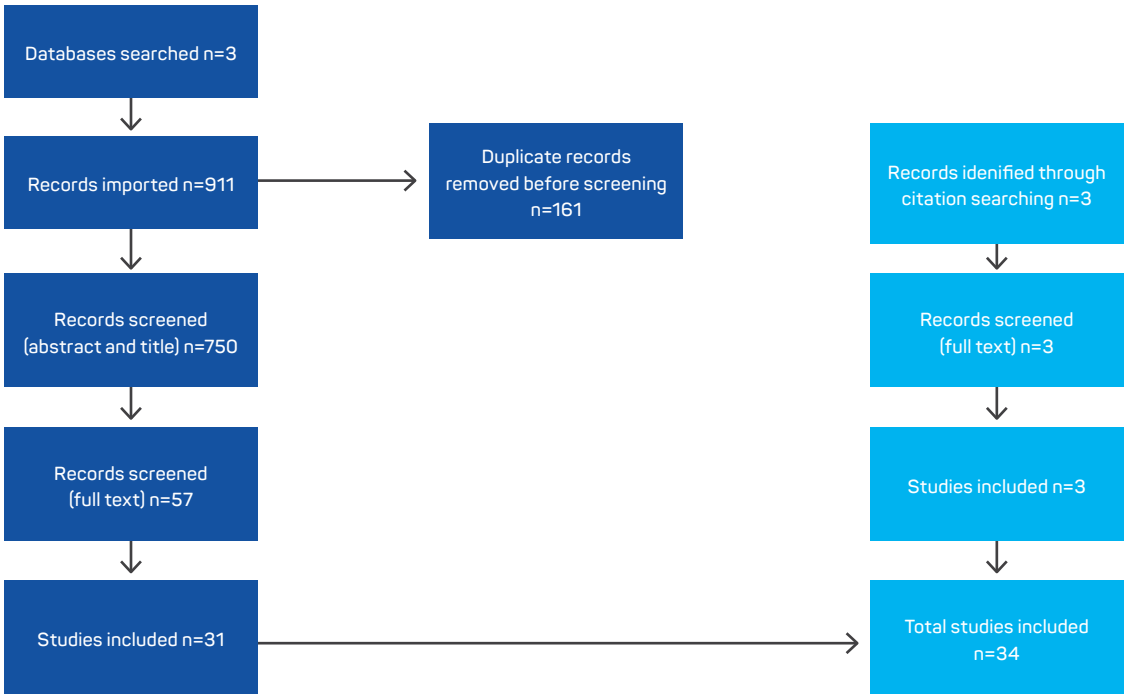

Figure 1: The search approach.

Hurricane Ike (n=1). The Australian studies (n=2) examined community participation following Tropical Cyclone Yasi and the Black Saturday bushfires. Overall, 23 of the studies (68%) were within urban settings while the Australian studies occurred in a more regional context.

Table 1: Studies by country.

Country	Number of studies
USA	10
New Zealand	10
Australia	2
Fiji	2
Philippines	2
Haiti	1
Maldives	1
Bangladesh	1
Nepal	1
Sri Lanka	1
China	1
India	1
South Korea	1
Pakistan	1
Italy	1
Turkey	1

The studies selected presented diverse types of disaster events with 2 significant clusters (Table 2). The high number of studies about community responses to earthquake and hurricane reflect the New Zealand studies (n=10) and, likewise, the US studies (n=10) related to hurricanes.

Table 2: Studies by disaster type event.

Type of disaster	Number of studies
Earthquake	16
Hurricane	10
Tropical Cyclone	4
Tsunami	3
Landslide	1
Bushfire	1
Flood	1
Typhoon	1

While there was an even distribution of disaster events across the last 20 years (Figure 2), studies of community participation following Hurricane Katrina and the Canterbury earthquakes featured 14 times.

Methodologically, qualitative methods dominated the published studies (Figure 3), with interviews used by more than half of the sample (n=26).

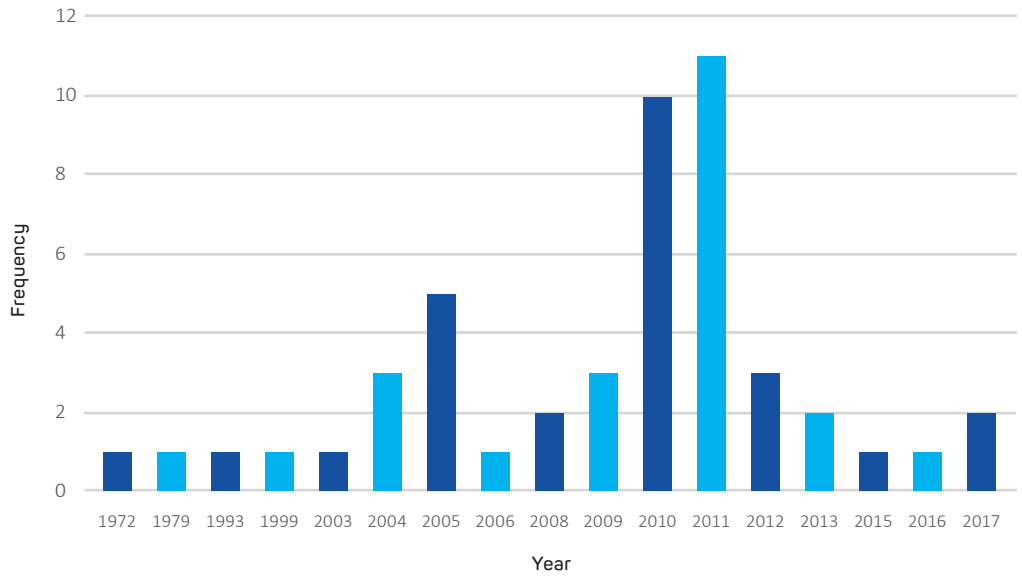

Figure 2: Years of disaster events in studies, by frequency.

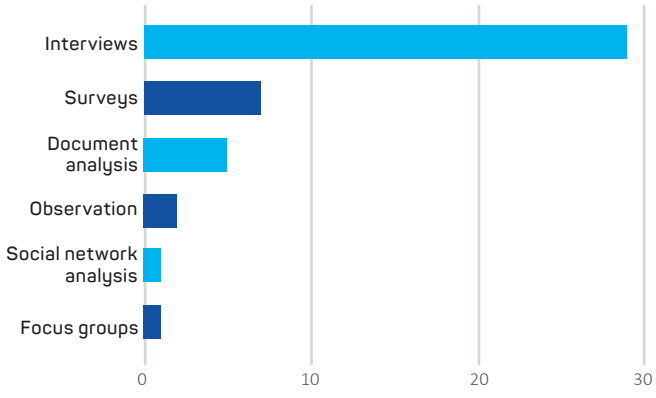

Figure 3: Methods employed by the studies, by frequency.

Thematic findings

Seventeen of the articles (50%) did not report findings regarding the effect of community participation on recovery outcomes. Their analysis focused on reporting 'what happened' or 'how it happened'. Nonetheless, our analysis highlights that, together with the remaining papers, these studies portrayed distinctive understandings of what is meant by (1) community and (2) participation.

On 'community'

The studies differed in their definitions of 'community' (a common issue within the literature (Fois & Forino 2014)), though some distinctions between the type of communities identified can be drawn (Figure 4). In almost half the sample (n=15), the 'community' in question was simply the residents of an affected town or city. Specific town and neighbourhood organisations were the focus of 5 articles. In this respect, geographic understandings of community were by far the most prevalent. Smaller or more specific communities, such as school communities (n=3), families or individuals experiencing homelessness (n=3), digital communities (n=3), religious communities (n=3), First Nations communities (n=2), CALD communities (n=1), gendered communities (n=1) and artistic communities (n=1) completed the sample (noting some studies identified more than one community).

To examine the types of communities identified, the Disaster Research Council's fourfold typology of groups involved in disaster response was used (Dynes 1970). Two types of groups were present in the studies:

- emergent groups - established ad hoc after disaster, responding to specific tasks and issues
- extending groups - pre-existing groups such as neighbourhood or school organisations whose mandates changed in response to disaster.

Emergent groups were identified in 9 of the studies and extending groups in 16 studies. In 12 studies, groups were not specified or not present. In 2 studies, both emergent and extending groups were identified.

The studies drew out several characteristics that enabled extending groups to participate effectively during post-disaster recovery when compared to emergent groups:

- pre-existing governance structures
- pre-existing authority and social trust
- known places and persons of contact
- access to bridging and linking capital
- potential for ongoing financial support.

In 4 studies (Kenney *et al.* 2015a, Kenney *et al.* 2015b, Love & Vallance 2013, Leadbeater 2013), emergent groups established themselves as deliberative, long-term bodies. While further study is required to understand why these examples differed from

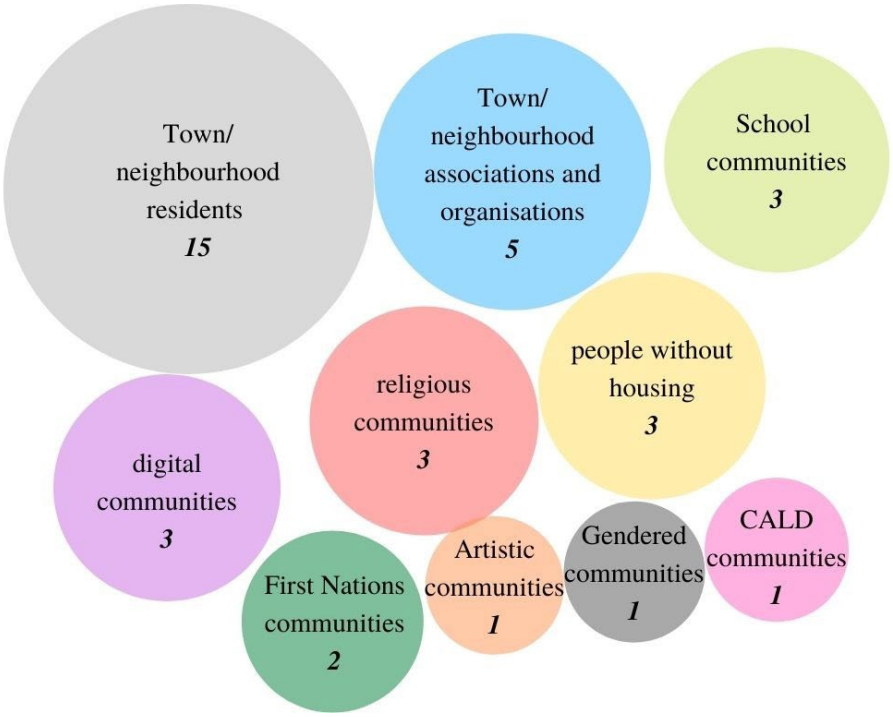

Figure 4: Groupings of communities.

emergent communities (which disband shortly after completing their tasks), each included at least 2 of these characteristics of effective extending groups where other emergent groups did not.

Three studies focused on the use of social media following a disaster. In examining the effect of different social media platforms in studies from Texas (n=2) and South Korea (n=1), increased social media use had a measurable and positive effect for physical recovery outcomes, information-sharing between communities and government and emotional and psychological wellbeing (Page-Tan 2021, Chu & Yang 2017, Song *et al.* 2015). Interestingly, the social media platforms reflect the dichotomy between emergent and extending groups. In each of the studies, communities were drawn to pre-existing WeChat, Neighborhood, Facebook and Twitter groups/pages to share resources and stories after the event, rather than creating new, disaster-specific groups. This phenomenon of extending digital groups reflects the experience following severe storms and floods in June 2021. Victorian State Control Centre personnel noted that community members used pre-existing, local Facebook Buy/Swap/Sell pages to locate and share equipment during an extended period of blackout.

The capacity for communities to possess 'local knowledge' is unclear. Leadbeater (2013) noted that 'While local knowledge is vital in recovery, comprehensive local knowledge does not exist for an event that is outside the community's history or lived experience' (p.45). Although the community in question had general experience of bushfires, the sheer magnitude of Black Saturday left them feeling that their knowledge was irrelevant. Conversely, a study of a similar organisation in Canterbury, New Zealand found that the group was able to effectively participate alongside government agencies after the 2011 earthquakes due to their recent experience during the 2010 earthquakes (Cretney 2016).

On 'participation'

'Participation' was not well defined within the studies. However, by using a typology of participation offered by Vallance (2015), the examples of participation presented in the studies were categorised as either 'active' (the 'sweat work' of physical recovery efforts, n=16), 'procedural' (deliberative/organisational efforts, n=9) or both (n=8). In one study, the type of participation was not specified.

The majority of papers referred to Arnstein's (1969) 'ladder of citizen participation', or a derivative thereof, as a tool for categorising or comparing qualities of participation. The ladder features a hierarchy of participation prioritising community 'control' over more tokenistic involvement. But despite widespread use, many studies showed that greater community 'control' over recovery did not correlate with improved outcomes or higher community satisfaction. Instead, greater control was associated with perceived or actual lack of governmental support. In a study of an isolated community in the Philippines responding to a landslide, Loebach and Stewart (2015) found that a local Catholic high school became the central point of emergency accommodation, distribution of material aid and psychospiritual support following the complete collapse of local government and the inability of other government entities to access remote communities. As an extending religious group, the school community leveraged existing authority and linking capital to take control of recovery efforts. Schmeltz *et al.* (2013)

and Rivera and Nickels (2014) similarly found that local extending groups (a neighbourhood association in New York and a church in New Orleans) took control after hurricanes due to an absence of government involvement. While these studies do not detail the effect of such control on overall recovery outcomes compared to those where government support is forthcoming, each noted the negative consequences for trust in government.

Love and Vallance (2013) and Vallance (2015) highlighted the discomfort felt by one neighbourhood organisation when faced with taking control of recovery activities following the Canterbury earthquakes: '[They] wanted to have the ability to influence planning processes, and its outcomes, but did not want decision-making authority' (Love & Vallance 2013, p.7).

Two studies (Storr & Haeffele-Balch 2012, Fois & Forino 2014) detailed separate community-controlled recovery initiatives operating in direct opposition to government plans. Following Hurricane Katrina in New Orleans and the L'Aquila earthquake in Italy, government plans for recovery were seen by local communities as inadequate and this resulted in neighbourhood associations creating and implementing their own, ultimately successful, counterplans.

In these studies, community control because of government absence, government delegation (i.e. 'buck-passing') and perceived government inadequacy fostered distrust in government authority. While falling trust in government warrants more study, it represents an area of concern for future resilience efforts. Opdyke *et al.* (2019) found that for a government-run housing reconstruction project following a typhoon in the Philippines, consumer control over house design was not an important correlate of satisfaction. In keeping with Love and Vallance's (2013) findings, influence during the planning stage of the project was a far more important variable. While control over the physical rebuilding of houses did correlate with high satisfaction, it was marked by a high opportunity cost for those involved, as found by Vallance (2015). These findings promote collaboration as a higher priority than control when working with communities.

Discussion

These findings have implications for future research and policy. Although many of the published papers did not define 'community' or 'participation', several themes were drawn from them for application within disaster-affected communities. The Disaster Research Council typology identified 2 main types of groups engaged in insider community participation (emergent and extending). While several key attributes of extending groups that enhanced community participatory capacity could be drawn from the sample, there was no empirical evidence within the papers to suggest that they have an inherent advantage over emergent groups. The literature's focus on insider communities that emerge or extend in response to an extreme event may also explain the absence of other communities that have unique experiences of disaster. While Australian literature has investigated, for example, LGBTQI+ communities experiences (Dominey-Howes *et al.* 2018), the studies reviewed in this sample did not explore the experiences of specific communities that were not emergent or extending, that is, those that did not pivot their raison d'etre in the face of disaster. It is beyond the scope of this paper to analyse the reasons for this gap, though similar gaps have been shown to exist in a Victorian recovery program that showed a lack of awareness of diverse community cohorts (Young, Jones & Cormick 2021). There is a need to ascertain why research on 'community' participation chooses to explore the experiences of certain typologies of community over others.

What was clear is that while much of the literature makes use of Arnstein's ladder (1969) in its characterisations of community participation, this construction is, at best an unnuanced way to understand the hierarchy of participatory processes and, at worst, a tool that promotes a style of participation that can negatively affect community outcomes.

Although the number of studies of community social media use as a form of participation was small, we nonetheless conclude that the evidence for its efficacy is strong. The limited contexts of those studies shows a pressing need for similar analyses of social media's potential as a participatory mechanism, particularly in Australia.

Limitations

This review identified 34 studies across diverse geography and disaster events. Its findings are limited by the clustering of those studies around earthquakes in New Zealand and hurricanes in the USA. Although the 2009–21 inclusion criteria for this study is justified on the grounds of its Australian perspective, it is possible that studies of older disaster events may counterbalance this clustering. Similarly, while biological events were excluded from understandings of 'natural' disaster, insights into how communities effectively participate in disasters more broadly may well be drawn from COVID-19 pandemic responses. While we attempted a broad sweep to collect relevant studies of 'community' participation, the lack of clarity of the term within the literature meant relevant studies may have been missed if they used alternative labels for 'community'.

Future research

From an Australian perspective, the most pressing implication for future research relates to the severe lack of applicability of existing empirical evidence in the area of 'insider' community participation. Only 2 of the 34 papers reviewed examined Australian communities. While many others took place in the comparable policy area of New Zealand, their focus on earthquake events limits their applicability to an Australian context. The urban setting of more than two-thirds of the sample reduced the applicability of their findings to communities in regional or remote Australia. There is a strong case to be made, therefore, for research examining how rural and remote communities affected by extreme events participate in their own recovery efforts.

Despite the relatively small number of studies examining social media, their 'harder', measurable findings make them impossible to overlook. Their limited settings, however, mean

that while social media has the capacity to drastically improve a community's capacity to participate in recovery as well as its outcomes, its potential in broader contexts such as Australia remains unclear. Future research could examine how Australian communities use social media and how, in the context of connection 'blackout' zones, existing digital infrastructure affects community participation and recovery.

While there is a clear dichotomy between the types of emergent and extending groups engaged in community participation efforts, this phenomenon remains under-researched. While the studies suggest that extending groups have inherent advantages that allow them to prepare and respond better, as well as work alongside government and non-government agencies, further research is required to unpack this. We found no studies of extending groups engaged in community participation within Australia. However, given the plethora of research on similar groups in New Zealand, it can be assumed that extending groups such as schools, churches, CALD organisations, First Nations groups and neighbourhood associations are already actively involved in recovery. The gap between studies of insider community participation and knowledge on the experience of broader communities such as the LGBTQI+ community also deserves attention, with a need for bridging these fields of knowledge.

The findings regarding the notion of community or citizen 'control' over recovery activities also carry significant implications for future research. While Arnstein's (1969) ladder remains influential in the literature, this review shows that the hierarchy that prioritises control requires updating. Across different countries, disasters and communities, 'control' over recovery planning was shown to be damaging to local trust in government; a result of government absence or perceived inadequacy and not desired by communities. Instead, as highlighted by Opdyke *et al.* (2019), Vallance (2015) and Vallance and Love (2013), a more nuanced hierarchy of community participation favours collaboration over control. In this model, a co-creation of planning projects and knowledge, where community groups maintain the capacity to influence and inform government action, may serve as a better guide to characterise 'ideal' community participation. Two studies, Cretney (2018) and McDonnell *et al.* (2019), highlighted the success that comes from such a model when implemented by governments in New Zealand and the USA.

Future policy

These findings highlight that policy may be better placed to emphasise collaboration instead of control when working with disaster-affected communities. While community-led recovery remains a strong guiding light within policy and literature, this review highlighted its problems when considered synonymous with community control over recovery. Instead, the notion of community-influenced recovery may better reflect the desires and capabilities of communities in the aftermath of disasters. This echoes Ireton, Ahmed and Charlesworth (2014) regarding the role of government in 'holding the space'; supporting communities to consider their priorities and potential beyond the immediate pressures of rebuilding. The Victorian resilient recovery strategy is well-placed to deliver this while living up to its mandate of '[bringing] communities into the planning process before, during and after an emergency and [enabling] community involvement' (EMV 2019, p.10).

This study provides insight for guiding future policy and mapping community resilience and capacity to participate effectively in recovery. In highlighting the dichotomy between emergent and extending groups, this review suggests that extending groups carry existing strengths for responding to events. Government may be better suited to identifying and strengthening these localised groups during disaster planning and preparedness. By identifying a diverse range of extending groups from neighbourhood associations to school groups and religious institutions and locating and supporting these groups governments and emergency management planners could improve community resilience.

Conclusion

While much of the policy and literature idealises the notion of community participation in recovery, the exact nature of community and participation is frequently vague. The empirical evidence to support such idealisation is often thin or self-referential. This scoping review has sought to chart the existing knowledge of how communities directly affected by disasters have participated in their own recovery through examining 34 studies published between 2009 and 2021. As the findings highlighted, there is a clear need for further research, particularly of Australian communities and remote and regional communities more broadly. There is also significant work required to create a nuanced understanding of 'ideal' community participation that stresses the value of collaboration and co-creation over the widely prized standard of community control. The studies demonstrate, however, that when communities are able to contribute to their recovery in a way that is meaningful to them, there is significant potential for improved outcomes.

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Abstract

Modern society is becoming increasingly dependent on social media for communication and information access and its role in disaster management cannot be overlooked. #RecoverSouthCoast is a research project that analysed data from Twitter and conducted interviews to understand the ways in which social media supported (or hindered) recovery following the summer bushfires on the south coast of New South Wales in 2019–20. This paper examines #RecoverSouthCoast findings from a Twitter content analysis. The results revealed that Twitter use can support bushfire recovery in diverse ways, including post-disaster reconstruction and infrastructure services, donations and financial support, mental health and emotional support, environmental health, business and economic activities, animal welfare, information support, solidarity and social cohesion and insurance claims. These findings are important because they strengthen evidence to support policy and investment in tools and social media capabilities within organisations involved in disaster response and recovery. Interestingly, some challenges to the effective use of Twitter during the recovery process were also identified. The paper provides recommendations for emergency management practice in Australia.

#RecoverSouthCoast: how Twitter can support and hinder recovery

Peer reviewed

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Introduction

Social media platforms such as Twitter and Facebook have long shown potential for supporting emergency management activities in Australia (Dufty 2012). However, as Anikeeva, Steenkamp and Arbon (2015) note, there remains significant levels of reluctance or scepticism around social media which research can help to shift. There has been some progress in documenting the role of social media in supporting emergency management in Australia, including in relation to the 2009 Gippsland bushfires (Willems, Forbes & Simmons 2021) the 2010–11 floods in Queensland and Victoria (Bird, Ling & Haynes 2012) and the summer bushfires in NSW in 2019–20 (Atkinson *et al.* 2021). The general consensus is that social media is not a replacement for other formal sources of emergency information, but rather it complements them by extending and amplifying the reach of official messages (Bird, Ling & Haynes 2012; Taylor *et al.* 2012).

Social media plays a role in facilitating the dissemination of emergency information relating to evacuation centres, road closures, warnings, monitoring of people's safety, identifying hazard risk, situational awareness, coordinating community response, fundraising, volunteering, allocating resources during recovery and providing support to people during and after a disaster (Bird, Ling & Haynes 2012; Dufty 2012). For an in-depth appreciation of work in this field, see Wiegmann *et al.* (2021), Reuter & Kaufhold (2018) and Simon, Goldberg and Adini (2015) who provide a thorough review of research relating to the use of social media during emergencies. Despite the burgeoning body of research, a comprehensive review of the literature found that research has so far focused on social media use in disaster response while recovery remains relatively under-explored (Ogie *et al.* 2022).

The aim of this study was to use data from publicly available Twitter messaging during and after the NSW bushfires to investigate the diverse ways in which Twitter supported (or hindered) recovery. In Australia, Facebook is used extensively in disasters Dufty (2016), however, this study focused on Twitter because Twitter has some features that make it practical for use in disaster management and research. As summarised by (Dufty 2016), these features include:

- a less restrictive third-party API (Application Programming Interface) for ease of data access

- non-reciprocal instant connection to users and their postings through 'following'
- real-time monitoring of topics by using hashtag '#'
- speed of disseminating information
- content is publicly available

Method

This study used 12,230 publicly accessible unique tweets about the 2019–20 bushfires on the south coast of NSW. The study area (Figure 1) included 3 local government areas of Shoalhaven, Bega Valley and Eurobodalla on the south coast of NSW. The tweets collected for the research included recovery-related content posted between 1 October 2019 and 31 August 2020.

A total of 200,017 tweets was initially retrieved that used the words 'fire' in combination with one or more bushfire-affected NSW south coast locations such as #Cobargo, #Shoalhaven, #Bega, #Eurobodalla, #Eden or #Southcoast. Tweets that the public did not adequately engage with or contain trivial and/or irrelevant content were eliminated resulting in a net total of 12,230 tweets. This total also included tweets containing the word 'fire' in combination with NSW (e.g. #NSWfires) if they generally conveyed useful information about the NSW bushfires and were not related to locations outside the study area. Tweets were considered relevant if they related to one or more aspects of disaster recovery, as identified by Ogie *et al.* (2022).

The content analysis involved a coding process in which tweets were assigned to one specific category of disaster recovery, based on the core focus or relevance of the message (Kim *et al.* 2018). Based on the description associated with the user account of the sender, each tweet was also assigned to one of several user categories, namely: 'citizen', 'scientist & expert', 'business', 'celebrity', 'community organisation', 'emergency agency', 'news media', 'politician & political organisation', 'NGO/humanitarian' and 'other government agency'. These categories are mostly self-explanatory, however, some require defining:

- 'NGO/humanitarian' includes non-profit organisations that aid vulnerable people and provide humanitarian assistance in times of crises.
- 'Community organisation' includes community-based organisations established to provide services that build capacity, strengthen social connections and improve the overall functioning of communities.
- 'Business' relates to entities involved in trading or other commercial activities, including small private businesses and large corporations.
- 'Other government agency' is government-owned organisations that provide public services that are not related to emergency management.
- 'Scientist & expert' encompasses individuals with extensive training, expert knowledge, and insights to support decision-making relating to the bushfires (examples include professors and distinguished academics, economists, medical experts, clinical psychologists, agricultural scientists, environmental consultants, structural engineers, meteorologists).

Each stage of the categorisation process was scrutinised by 2 or more researchers so that discrepancies could be highlighted, discussed and a consensus reached on the appropriate categorisation for each tweet. Content analysis was performed on tweets to understand the diverse ways in which Twitter was used for bushfire recovery.

This research received ethics approval from the University of Wollongong Human Research Ethics Committee id: 2021/226.

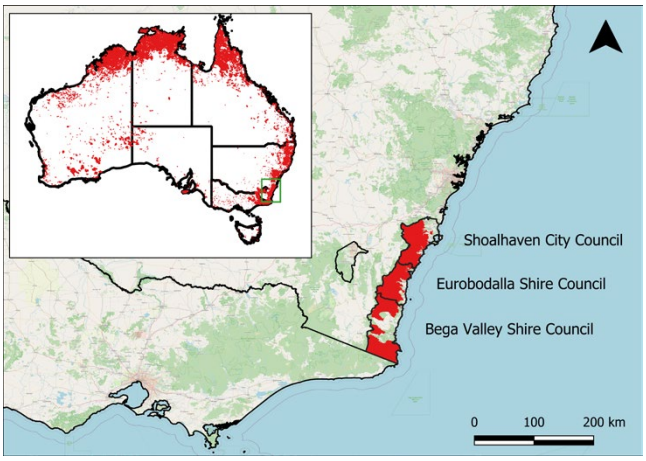

Figure 1: The study area was the south coast region from Shoalhaven to the Victorian border in NSW.

Data source: National Indicative Aggregated Fire Extent Datasets from the Department of Agriculture, Water and the Environment.

Results and discussion

Results are presented in relation to various aspects of recovery (shown in Figure 2). In absolute numbers, the recovery type category of 'Information support' was the most popular aspect of bushfire recovery discussed on Twitter and the tweets mainly originated from news media, citizens, and emergency agencies. The next most popular recovery type category was 'Solidarity and social cohesion'. The recovery type category of 'Insurance claims' was the least represented aspect of the tweets collected. Figure 2 shows the recovery type topics cross-matched with the user groups (in no particular order). The figure indicates the ranging areas and levels of interest (recovery type category) of the user groups. This information can assist in the management of recovery activities.

Reconstruction and infrastructure services

The tweets used in this study showed that the use of Twitter played a role in the reconstruction of buildings and the restoration of infrastructure services in bushfire-affected communities. People used Twitter to publish updates about bushfire damage to roads, powerlines, water supplies, rail networks, telecommunications infrastructure, homes and community assets. Additionally, Twitter was used to provide the updates of subsequent restoration of infrastructure services, including information about the clearing of fallen trees and powerlines to allow road access.

Figure 2: Contributions of user groups to the recovery type categories.

Twitter was also used to coordinate logistics required to access infrastructure services, for example, drawing attention to neighbouring towns where people could get batteries recharged, fuel tanks refilled and connect to telecommunications. Individuals such as engineers and IT business owners used Twitter to offer support to restore infrastructure services. A review of the Twitter engagement (replies) associated with the tweets suggests that bushfire-affected communities in the south coast of NSW found the messages helpful during their recovery with information about boiling drinking water and disconnecting water tanks in case of contamination from ash and particulate matter.

Donations and financial support

Use of Twitter was beneficial in garnering donations and financial support for bushfire-affected communities. Tweets featured information about fundraising events, including sports events, art sales and concerts to raise funds for those affected by the bushfires (Figure 3). Consequently, donations poured in from sport clubs, large corporations, private individuals, celebrities, small businesses and community groups as Twitter was used to mobilise donors. For example, an Australian performer used social media platforms to raise over $50 million through an international fundraiser established for the NSW Rural Fire Service. Many donations for bushfire relief efforts were directed to organisations such as the NSW Rural Fire Service, Red Cross Australia, Wildlife Rescue (WIRES) and the Port Macquarie Koala Hospital, as well as other fundraising campaigns soliciting direct donations to local communities. Several users replied to bushfire donation appeals on Twitter with positive sentiments, commenting that they had donated and encouraging others to do the same. This is a demonstration of ease of use of Twitter to influence behaviours and mobilise donations.

The content analysis for this study showed that Twitter was useful to manage donations. It was used to call for volunteers to help sort donated goods and link people who needed donated items to people willing to donate those items. Some messages provided directions to where people could find financial help, including how to apply for bushfire grants. Twitter was used to send updates on recovery money raised, how donated goods had been distributed and to thank people for donations. In addition, there were tweets about scammers who had tried to financially exploit donors.

Figure 3: Example tweets promoting fund-raisers for bushfire services or affected communities.

Mental wellbeing and emotional support

The research revealed that mental health was an issue for some people and one that is likely to linger for years. Terms such as 'stress',' trauma', 'anxiety', 'depression' and 'grief' were used to describe how people were feeling. Some messages linked high levels of mental distress and psychiatric admissions to bushfire-induced poverty and homelessness. Trauma and anger were evident in messages from people in small communities where lives had been lost. One user used 'climate anxiety' as a general way to describe a normal part of daily life. Other people used Twitter for their emotional support and counselling because they were experiencing fear and anxiety over returning home after the bushfires. Some people used Twitter to express concerns over post-traumatic stress disorder and the potential for a mental health epidemic, including concerns about the wellbeing of first responders, firefighters and farmers. Twitter was used to encourage mental health support-seeking and to circulate free evidence-informed mental health support resources, including links to service providers such as Primary Health Networks, Beyond Blue, Red Cross Australia, Phoenix Australia, Lifeline and other support groups.

Environmental health

Messages contained information about the condition of the environment such as damage to bushland and air quality. The bulk of the messages focused on hazardous air quality, haze blanketing cities and towns, visibility problems and fire alarms going off due to smoke. Some Twitter users expressed concerns related to breathing and chest pain. People with respiratory issues and other conditions were advised to take extra care and to shelter indoors, use face masks, keep medications close by and seek medical attention if needed. There were tweets from some users and news media about people having fatal asthma attacks. Twitter was also used, mainly by individuals, to mobilise support for clean-ups of the environment. Tree planting was a common aspect of environmental recovery that was discussed and coordinated using Twitter.

Business and economic activities

Twitter allowed people to share information and influence positive behaviours relating to tourism, farming and business activities that supported the local economy. Twitter was initially used to advise potential tourists against visiting the south coast of NSW due to the heightened bushfire risk. Later, the platform was used to encourage tourists back to the south coast after the fires. There were several tweets advising that large parts of the NSW south coast were reopened for business. Agencies such as NSW Rural Fire Service posted messages encouraging tourists to visit Bega and Eurobodalla to support regional businesses recovery from the bushfires. These messages received positive replies from holiday-makers and bushfire-affected communities. After the fires, #buyfromthebush trended on Twitter with the hashtag used to showcase products from local businesses to encourage support for communities.

Information sharing

Information sharing is a crucial part to disaster recovery. This research showed that Twitter played a role in helping people (users of Twitter) to understand the bushfire situation and to make decisions about their safety and wellbeing, particularly if the originating tweet was from a credible source like an emergency services organisation. Place-specific information was available on Twitter letting people know when it was safe to return. Twitter was also used to share information about access to recovery support, including help with legal problems associated with the bushfire, insurance claims and tenancy problems. Other topics related to the cause of the fires and evidence from the Bushfire Royal Commission.

Animal welfare

Content analysis revealed that Twitter was used by the NSW Department of Primary Industries, NSW Local Land Services and the Royal Society for the Prevention of Cruelty to Animals to share information to help people manage their pets and domestic animals. This included available accommodation for pets, correctly tagging animals for ease of reuniting with owners and information to get animals to safety. WIRES used Twitter to provide information about helping bushfire-affected wildlife including contacting local wildlife rescue groups or vets when injured animals are found, leaving bowls of water outside, providing shaded areas for animals to cool off, driving cautiously to avoid animals on the road and not to pour water directly into animals' mouths or give wildlife inappropriate food.

Twitter was used to convey information about where help was needed related to animal care, constructing cattle yards, providing supplies for livestock and wildlife, sewing animal pouches and bat wraps, making nesting boxes and crocheting bird nests. Tips from ecologists were also shared on Twitter to help rural property owners manage their land in ways that assists wildlife to recover. Tweets exposed a despair and sadness over the consequences of the bushfires on wildlife. A notable contrast, observed from the tweets, was the focus on wildlife as creatures experiencing the fires or as members of species 'threatened' by the fires, whereas the death of farm animals was mostly, though not always, treated as loss of stock and livelihoods for farmers. The tweets included messages of hope and healing (e.g. Figure 4) when burnt bushland started regreening and healthy wildlife were sighted again.

Figure 4: A tweeted message of hope for animal welfare.

Solidarity and social cohesion

In times of crisis, people can feel a sense of belonging in a socially cohesive and resilient community where there is unity, mutual support and a strong resolve to build back stronger and better. The results of the content analysis in this study revealed that Twitter could connect people needing support and people who provided support. There was a proportion of tweets expressing support and gratitude to firefighters and volunteers, including the volunteer firefighters killed during the bushfires and the 3 American air crew killed in an air tanker crash. There were messages thanking people for working tirelessly to help, including those who donated money and resources or offered their homes to bushfire evacuees. Some users published video links on Twitter to share their personal journeys with recovery, rebuilding and healing processes.

Social cohesion appeared undermined by contentious and socially divisive topics, particularly the politicisation of climate change and its link to the bushfires. Twitter posts were used, in overt and implicit ways, to hold governments accountable for perceived failures to act in relation to climate change and to show leadership (see Bednarek *et al.* (2022)). Other Twitter users (a minority) rejected the link between the fires and climate change and both perspectives of this political argument often used humour and satire (Figure 5). The timing of financial support for recovery was a source of worry expressed in the tweets as some users expressed concerns that the 'notional' $2 billion bushfire recovery fund announced at the time by the Australian Government was not spent and payments were delayed.

Figure 5: Examples of tweets that link bushfires with other political concerns.

Insurance claims

There were some tweets that did not quite fit into the identified recovery type categories but could be categorised into the 'Insurance claims' category. Although, some of these tweets originated from insurance companies offering to support clients who were affected by the bushfires, there were tweets expressing concerns about other insurance matters, including the lack of compensation or insurance cover for volunteer firefighters, frustration over the slow pace of processing insurance claims, concerns about the high number of uninsured property owners in regional communities and worry that insurance premiums might rise after the fires. An interesting finding was that while insurance was a not a prominent topic in the Twitter sample, sentiment analysis revealed that tweets around insurance and insurance claims were largely negative. This suggests that insurance issues are a problematic aspect of recovery.

Issues related to the use of Twitter

Veracity of information

While Twitter can be a valuable source of information, all social media platforms suffer from the confidence people have in the reliability of information shared. Misinformation, conflicting information and the trustworthiness of sources was identified and questioned in several tweets (e.g. Figure 6). This lack of confidence in the credibility of the information on Twitter can have detrimental implications as misinformation or lack of trust can undermine the decisions made by individuals during the recovery process (Anikeeva *et al.* 2015).

Figure 6: Misinformation on social media was a concern expressed on Twitter.

Access to Twitter and information

Content analysis of the tweets revealed that bushfire-affected communities had the greatest need for bushfire recovery messages yet could not gain access due to disruptions to communications and access to the Internet. It is important to recognise that the use of social media to disseminate recovery information does not equally serve everyone's needs when those needing the information do not have access. This also applied to people who do not use Twitter or other online platforms. The use of other, more traditional, methods of emergency communication remain important in the information-sharing mix.

Problematic or disturbing messages

Another issue observed from analysing the Twitter content was that users found some tweets to be distressing, anxiety-inducing, controversial and socially divisive. Twitter users expressed concerns over the antagonistic use of Twitter, particularly for political point-scoring. The 'unvetted' nature of messages can be detrimental to recovery as users in this study expressed a desire for more positive and uplifting content to support recovery.

Social media capability gaps

This research revealed that the readiness of the authorities who took responsibility for producing a lot of social media messaging during and after the fires varied considerably in relation to resourcing and strategy. Most authorities (e.g. Bega Valley Shire and Shoalhaven City Council) disseminated information about the bushfires through multiple social media platforms such as Facebook and Twitter. However, Eurobodalla Shire Council showed less evidence of use of Twitter (Figure 9).

Timing issues

Analysis revealed that issues related to timing can complicate on-the-ground logistics associated with managing and coordinating material donations and relief efforts. When an event changes on the ground, it can be difficult to update or stop the spread of a previous contradictory message once it has been shared/retweeted by users (e.g. Figure 7). This research showed that responding authorities faced logistics challenges in managing excess donated goods following posts on Twitter about the need for support (e.g. Figure 10). There were tweets saying that material donations were no longer needed and that money was preferred. However, a previous post continued to circulate on Twitter related to the need for donations and the donation of goods continued resulting in a logistics challenge.

Recommendations and conclusions

The #RecoverSouthCoast project analysed Twitter data from the summer bushfires in 2019–20 to consider ways to extend knowledge about the role of Twitter during recovery. This may be the first empirical research that provides an account of the diverse ways in which Twitter was used to support different aspects of recovery within communities in Australia, including in relation to post-bushfire reconstruction, donations and financial support, mental health, environmental health, business activities, information sharing, animal welfare, social cohesion and insurance. Recovery activities mostly posted to Twitter related to

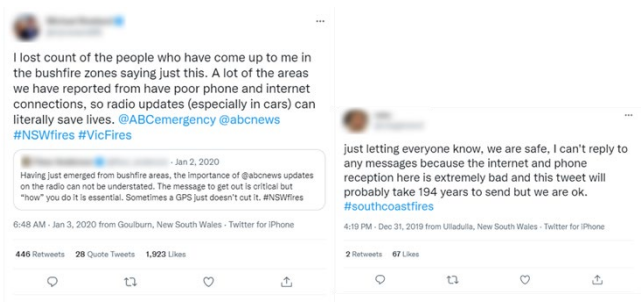

Figure 7. Internet disruption affected the access to information on Twitter.

Figure 8: There was content on Twitter that was problematic for other users.

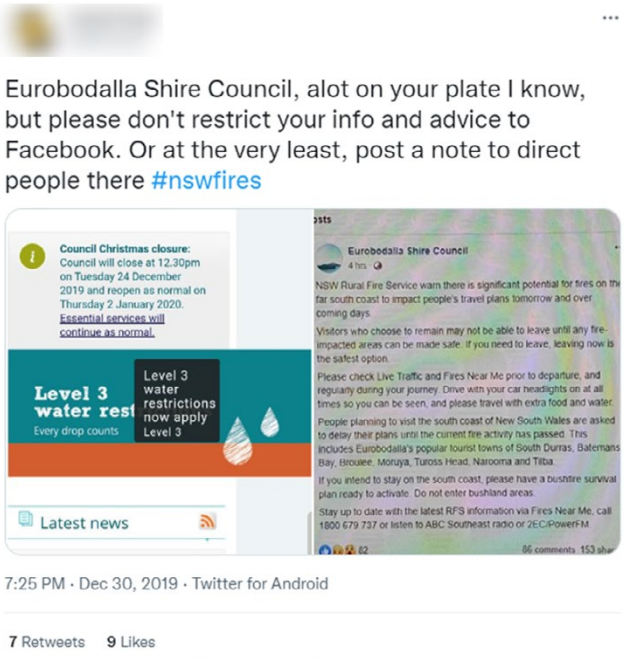

Figure 9: Eurobodalla Shire Council used Facebook rather than Twitter during the bushfires.

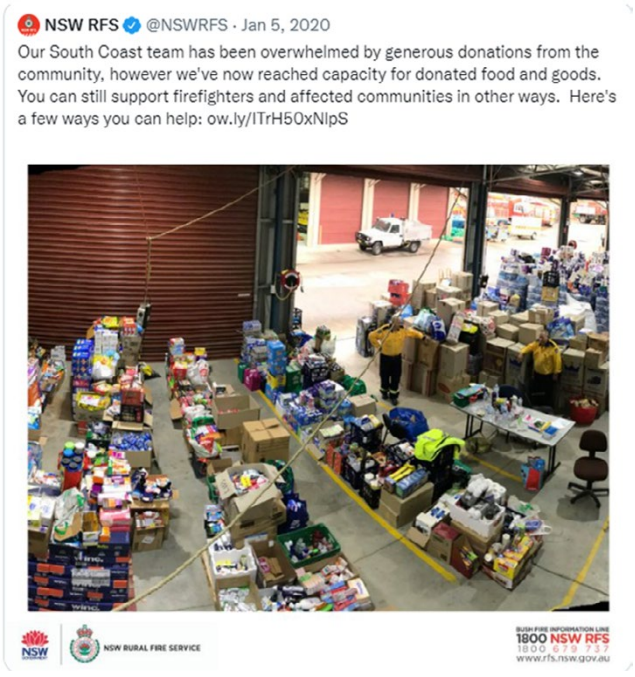

Figure 10: Organisations became overwhelmed by donated goods after an initial appeal on social media continued to circulate.

categories of 'Information support' followed by 'Solidarity and social cohesion' and the content was mostly generated by 'news media', 'citizens' and 'emergency agencies'.

This research suggests that use of Twitter can support recovery in a number of ways and has the potential to be leveraged during future events. Organisations and policy makers involved in disaster response and recovery should maintain and could extend their investment in tools to harness real-time Twitter data to gain situational awareness about the different aspects of recovery, including monitoring topics of interest or concerns, community sentiment towards support or perceived failings and to develop strategies to use Twitter for influencing behaviours of people. Staff training and increased resourcing are always recommended to improve social media capability within organisations and agencies as well as within local governments. Future research could consider issues around Twitter use, as identified in this study, that hinders recovery.

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