

Disaster risk at the urban edge

Australian Institute for
Disaster Resilience



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Local government role
in DRR

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Community involvement
and land-use planning

SUPPORTING A DISASTER RESILIENT AUSTRALIA

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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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Image: S Kunevski



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Foreword



Collene Bremner

Executive Director
Bushfires NT

Disaster risk reduction is critically important in the Northern Territory, with communities regularly exposed to the destructive power of natural hazards.

The Northern Territory is susceptible to the full range of disasters experienced in Australia and destructive bushfires, cyclones, floods and storms occur with regularity. Due to these factors, essential services are regularly affected by single points of failure.

I have been involved in emergency management roles in the Northern Territory for over 15 years. I was chair of the Australia and New Zealand Emergency Management Committee Recovery Subcommittee for several years, which developed the National Impact and Assessment Model and the Monitoring and Evaluation Framework. Both are used today to assess the impacts of disasters.

While working as the Director of Security and Emergency Recovery, I led the development of several key emergency management projects. One project reviewed sheltering options in the event of a cyclone across the Top End. This project identified how many residents could safely shelter in the community during a cyclone event. This progressed to evacuation centre planning for up to 5000 people for an extended period of time. These plans came into their own when the small community of Daly River was flooded and residents evacuated, and when the community of Warrawi was twice evacuated by air due to the threat of tropical cyclones. Warrawi is a small Indigenous island community with a population of 400 located 300 km east of Darwin. The community had been identified as at high risk in a cyclone, mainly due to the lack of safe shelter. Warrawi was also evacuated during Tropical Cyclone Lam, which turned towards land directly over the island community of Galiwinku as a Category 4 cyclone. The communities of Milingimbi, Ramingining and, to a small extent, Maningrida as well as numerous outstations were badly damaged.

The challenges to assist these very remote communities from a recovery perspective were numerous. The first impact assessments identified between 200 and 600 residents in Galiwinku who needed emergency accommodation. The evacuation centre planning undertaken previously was flipped

when community elders requested that no local people could be evacuated and that they should be supported on community. This was at a time when there was a 'boil water' alert, sewage systems were overflowing when power was cut due to damage to the system, asbestos was spread across the communities from destroyed buildings and large mahogany trees had fallen across homes, roads and power lines. The only way to access these communities was by air or sea.

The evacuation centre model set up on Galiwinku used a base camp on loan from NSW Rural Fire Service that was set up on the community oval. Within weeks of residents moving into the camp, Tropical Cyclone Nathan threatened the community of Galiwinku and the camp was demobilised. The cyclone shelters were re-opened and residents again sheltered from the cyclone. The camp was re-established within a week and continued to operate for three months.

Since then, cyclone shelters have been constructed in Ramingining and Warrawi. When a cyclone threatened the communities in 2018, there were enough safe sheltering options for residents to stay in place. New homes and infrastructure are constructed to cyclone building standards in the remote communities to reduce the risk to residents.

The predicted climate outlook is a good indicator that floods, cyclone and extended fire seasons are to be expected. For a small jurisdiction such as the Northern Territory, managing the scale of risk with limited resources will continue to test policy makers and bean counters. Improvements in our disaster risk reduction activities may appear slow due to the scale of work required, but when you look at what has been achieved over the years it is pretty amazing. The Northern Territory has major road and rail linkages and Darwin now has two hospitals. The generation network continues to improve its resilience and local councils have identified trees that are less vulnerable in cyclones. In June 2020, Bushfires NT moved into a new headquarters in the rural area in time for the next fire season.

Publisher's Note: In the Foreword of the April 2020 edition (vol, 35, no 2, p. 4), the author's name was incorrect. This error appears in the printed issues. The author's name was published as Dr Robert Cameron Glasser. The author's name is Dr Robert Glasser.

Overcoming systemic vulnerability through the *National Disaster Risk Reduction Framework*

**Hon David Littleproud
MP**

Minister for Agriculture,
Drought and Emergency
Management

Australia is facing disasters, which are increasing in both their frequency and intensity. Driven by a changing climate, these disasters require a coordinated, collaborative and national response to reduce impact and severity.

The Australian Government, through Emergency Management Australia, is leading the charge through the implementation of the *National Disaster Risk Reduction Framework*. We are encouraging all sectors of society and government to engage in re-evaluating our vulnerabilities and embedding resilience.

Australia's 'Black Summer' of 2019–20 has been a catalyst for reflection and revision. A realisation has occurred in terms of just how fragile lifestyles can be in the face of Mother Nature's wrath.

This summer has also reaffirmed the world-class professionalism of our emergency services and first responders. The best way for governments to honour their work is to reduce the risks they face. This means systematically and proactively reducing disaster risk; integrating resilience and building back better to a stronger and more resilient standard.

We have limited control over when natural hazards happen. We have far more control over how they impact on the nation. The *National Disaster Risk Reduction Framework* provides the foundation for a coordinated national response. Emergency Management Australia leads a comprehensive program to protect communities from the effects of natural hazards in partnership with states and territories and the private sector. However, engagement from all sectors of society is required to deliver systemic and real change. Implementing the framework requires a collaborative effort.

A key aspect of this work is the examination of vulnerability to disasters. It is important to remember that natural hazards only become disasters when our capacity to respond at the local,

state or national level is overwhelmed. Changes in the climate, increasing population and changes in population density are compounding this vulnerability exposing more people to potential disasters. Consequently, buy-in and engagement from all levels of government and all sectors of society is required.

The effects of disasters are complex due to the increasingly interconnected world. The integrated nature of infrastructure and supply chains means that flow-on affects are often felt further from the disaster site. However, while integration creates increased risk, it can also bring opportunities and pathways to mitigate, adapt and embed redundancies to reduce the severity of disaster events.

The financial strains disasters place on the economy are another reason for disaster risk reduction. In 2017, Deloitte Access Economics estimated that disasters cost the Australian economy approximately \$18 billion per year over the last decade. This is predicted to increase to \$39 billion a year by 2050 if current development patterns and population growth remains unchanged.

On top of the immediate consequences of disasters, challenges can be far reaching into the future. Disasters can trigger long-term issues in terms of reduced education and workforce participation, adverse effects on mental health and wellbeing and increased crime rates.

It is tempting to dismiss catastrophic events in risk assessments due to their low likelihood. However, the unprecedented nature of Black Summer illustrates that collaborative effort is needed

to improve resilience and reduce vulnerability through our policies, programs, systems and services to prevent hazards from becoming disasters.

Efforts to reduce disaster risk have gained political momentum since the *National Disaster Risk Reduction Framework* was endorsed by the Council of Australian Governments (COAG) in March 2020. Through Emergency Management Australia, and in collaboration with state and territory governments, local governments and representatives from the private sector, a National Action Plan is being developed to deliver outcomes to communities.

The *National Disaster Risk Reduction Framework* and the National Action Plan reflect the need for action across sectors and acknowledge the importance of national leadership and coordination. Through Emergency Management Australia, the Australian Government recognises the importance of information coordination and is pursuing projects to bolster data and intelligence capabilities across the nation.

Early 2019 saw a pilot project begin; the goal of which was to inform the development of improved information and service capabilities. This will be completed during 2020. The focus of the pilot is on the resilience and vulnerability of the freight and supply chain sector and was undertaken in partnership with other sectors of government. These included the Department of Infrastructure, Transport, Regional Development and Communications; the CSIRO; the Bureau of Meteorology; Geoscience Australia; the Queensland Department of Transport and Main Roads; the Bushfire and Natural Hazards Cooperative Research Centre and the University of Adelaide.

Experience with this pilot will inform further work to improve national natural hazard and disaster risk data, intelligence and the development of new information and services products, including for bushfires. Ultimately, the government is committed to establishing an Australian climate and disaster risk information and services capability that decision-makers across sectors need. Improving availability, access and use of information is a key priority of the framework to provide tools to all sectors for disaster risk reduction decision-making.

The experiences of the Black Summer illustrate the need for government to examine the role it plays in both immediate disaster response and long-term recovery. The Prime Minister has commissioned two major inquiries so that we may learn from these tragedies.

The Royal Commission on National Natural Disaster Arrangements began in February and will report its findings by 31 August 2020. The Commission is examining coordination, preparedness for, response to and recovery from disasters as well as improving resilience and adapting to changing climatic conditions mitigating the effects of natural disasters. The CSIRO Report into Climate and Disaster Resilience with implementable recommendations on building Australia's climate and disaster resilience in the immediate and long-term was delivered in June 2020. Recommendations from these reports will inform future national action plans and form part of the central focus for the resilience agenda.

We continue to see positive trends in the private sector. Credit ratings are starting to factor in climate-related risks, parametric insurance products are increasing, and several banks are running analyses on mortgages based on location and regulatory authorities are encouraging company directors to address climate-related risks alongside all other financial risks.

One of the fundamental objectives of the *National Disaster Risk Reduction Framework* is the least tangible: changing the mind-sets of Australians and their approaches to Natural Disasters. We need to consider how to embed resilience into planning, policies, systems and services. We need to ensure a cultural change when it comes to disaster resilience, resulting in a conscious shift in the private, public and policy focus. This requires a serious reflection on our values. Decision-makers at all levels of government, the public and private sector and non-government organisations must consider how an increase in the frequency and severity of hazards will impact on their organisations. Those recovering from recent disasters must replace what was lost and build back better. Higher and more resilient standards must be achieved. I am confident that people will step up to this challenge, recognise what needs to be done and fulfil the role they must play to reduce disaster risk.

The Black Summer bushfires have reaffirmed that implementing the *National Disaster Risk Reduction Framework* is a palpable priority for Australia. On a massive scale, the fire season revealed the extent of our vulnerability. The task ahead is not an easy one, but it provides an opportunity for widespread resilience building on a whole-of-nation level. We must work to include all sectors of society into this common goal. Our efforts to reverse vulnerability must be united, collaborative and all-encompassing. Throughout the crises of the Black Summer, people displayed incredible courage, generosity and personal strength. This energy is providing focus on reducing vulnerability. In doing so, we can save the households, livelihoods and lives not only in the present, but also for generations into the future.

In short, Australia cannot afford to be reactive to disasters. We must be proactive, considered and direct. Disasters are changing. And so should we.

The 1960 Chilean earthquake and tsunami helped prepare Australia for tsunami

Jane Sexton¹

Gareth Davies¹

Kate White²

¹ Geoscience Australia and Australian Tsunami Advisory Group member.

² Victoria State Emergency Services and Chair of Australian Tsunami Advisory Group

In the early hours of 23 May 1960, an earthquake and tsunami struck Chile. There were no morning television shows and newspapers had already been printed for the day. Tsunami warning systems for Australia did not exist and there were no tools nor knowledge to help Australia prepare. Thankfully, we live in different times.

The 1960 Chilean earthquake remains the largest instrumentally recorded earthquake in the world and the resulting tsunami was observed to travel across multiple oceans. The death toll and damages in Chile are unknown, however, there were many reports of the tsunami impacts on countries across the Pacific Ocean (Figure 1).

Australia was lucky. The tsunami reached the Australian east coast around 14 hours after the earthquake, slightly before it reached Hawaii. By then it was 7:00 pm local time and there were limited activities in the coastal zone. The first

tsunami wave was very small and tidal observations show that wave energy built steadily over the following 8–12 hours. In Australia, New South Wales tide gauges recorded peak-to-trough waves between 0.4 and 1.7 metres and observers reported waves up to 4.3 metres in isolated locations.¹ A series of waves persisted for the next three days in some locations (Figure 2). The reported wave heights vary greatly from site to site but exceeded three metres (peak-to-trough) in some locations.



Figure 1: This graphic recreates the travel of tsunami waves across the Pacific Ocean. International figures taken from the National Ocean and Atmospheric Administration.¹

The significant marine effects² in south-eastern Australia included:

- two vessels sunk; one in Newcastle (a 24-foot fishing boat) and another in Sydney Harbour (a punt loaded with timber)
- two grounded vessels
- dozens of broken moorings (including 30 at The Spit near Mosman in Sydney; the tsunami was reported to produce a large whirlpool)
- erosion of a 90 x 55 metre strip of land at Clontarf in Sydney
- localised run-up in Batemans Bay on the New South Wales south coast
- damages to the oyster industry in the Clyde River at Batemans Bay.

The tsunami was observed within estuaries and harbours in south-eastern Australia. This occurred at areas tens of kilometres inland up streams and rivers due to the narrowing channels of estuaries. There were no casualties, but several injuries and near misses were reported.

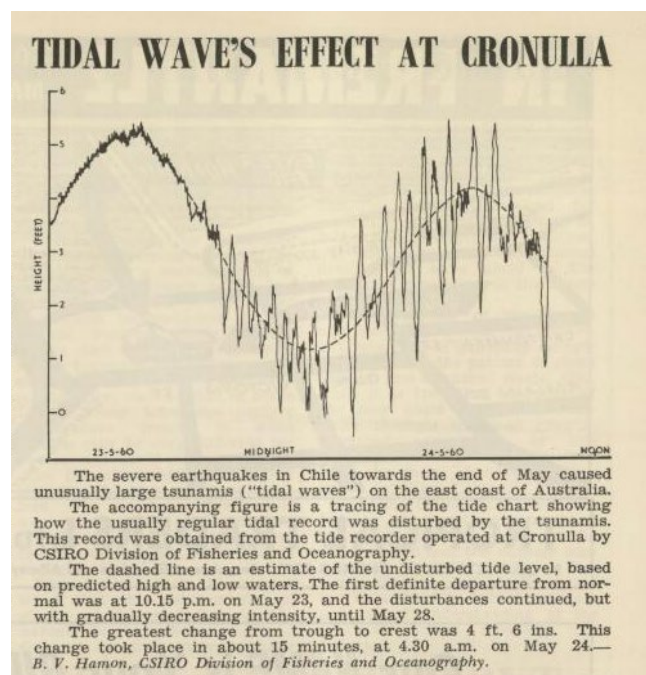


Figure 2: An Australian newspaper clipping from 1960 shows the changes in wave heights recorded at Cronulla, New South Wales. Image source: CSIRO Marine Laboratories – Fisheries Newsletter: Volume 19, July 1960.

Tsunami warnings in 1960

In 1960, receiving regular updates on events that happened elsewhere in the world was not imaginable. There was no social media, no 24-hour news, no images delivered from helicopters as happened during the Tohoku earthquake and tsunami in 2011.

In most cases, people did not receive any warning about the tsunami and instead, responded based on the signs from

nature they experienced. In the days that followed, there were aftershocks from the Chile earthquake and warnings related to these reached the Australian Civil Defence and port authorities. However, the aftershocks did not produce tsunami in Australia.

While most people in Australia would have received updates from ABC News via radio or television, few would have known about the event before the first waves arrived. It wasn't until 25 May, two days after the event, that the *Canberra Times* front page carried the syndicated story 'Destructive Tidal Waves Sweep Over the Pacific' and papers, such as the *Hobart Mercury* and the *Courier Mail*, carried stories describing observations in Australia. There were also some local instances of the story, buried among the ads in *The Biz* on 8 June (Sydney region) and the July issue of the *Fisheries Newsletter*.

Tsunami warnings today

A lot has changed since 1960. We hear about earthquakes and tsunami almost as they happen via social media and online news. We have also learnt from other tsunami events and put measures in place to offer greater protection.

The 2004 Indian Ocean Tsunami hit close to home and resulted in the establishment of the Australian Tsunami Warning System in 2005, which includes the Joint Australian Tsunami Warning Centre (JATWC).

The JATWC is operated by Geoscience Australia and the Bureau of Meteorology and issues tsunami bulletins within 30 minutes of the origin time of the earthquake. This nationally coordinated warning system is led by the Australian Tsunami Advisory Group (ATAG) and includes tsunami hazard information and a suite of tsunami awareness products.

Most communities in Australia will be warned at least 90 minutes before the arrival of a tsunami's first wave given Australia's proximity to major earthquake fault lines. The closest source of earthquake-induced tsunami for the Australian mainland and Tasmania coast is the Puysegur Trench that is south of New Zealand. Some Australian offshore islands and territories are closer to fault lines and may have less than 90 minutes to respond to a JATWC warning. Australia's location and warning systems allows warnings of possible tsunami to be shared with regional neighbours.

Warning systems are important, but not enough

In 1960, news of the Chilean tsunami reached Hawaii before the waves, yet the country suffered devastating effects. As described by Okal (2011³), there was a warning with a call for evacuation at about 8.30 pm local time (3.5 hours before the expected arrival). The first wave arrived in Hilo Harbour just after midnight and was about 1.5 metres. At this point, the alarm was not maintained. Unfortunately, the third wave came ashore just after 1:00 am and was much larger. It ran 12 metres up the coast and penetrated one kilometre inland. It's not clear whether it was well-known at the time that tsunamis are more than a single wave and that the first wave is often not the largest. This is important information

and features prominently in tsunami education materials in Australia.

Australia was fortunate that the 1960 Chile earthquake occurred so far away and so far south on the Chilean coast. If a similar-sized event occurred a few thousand kilometres further north, the impacts on Australia would be very different. Tsunami propagation can be highly directional, as shown in Figure 1. Being far from the source doesn't mean protection. The impacts on Japan and the Philippines demonstrate that far-field tsunamis can be very damaging. This is why national-scale hazard assessments are so important.

How Australia prepares

The Geoscience Australia Probabilistic Tsunami Hazard Assessment (PTHA⁴) estimates the likelihood of tsunami wave heights for the Australian coastline as well as offshore territories. The PTHA uses data from historic events, including the 1960 Chilean earthquake and tsunami, to improve estimates of possible future tsunami.

The 2011 Tohoku earthquake and tsunami was a key event that strengthened the PTHA. Prior to this event, the tsunami science community did not think it was possible that such a large-magnitude earthquake could occur in that location. As a result of the Tohoku earthquake, tsunami scientists have been collaborating to revise the maximum magnitudes expected for the subduction zones globally. This had led to major updates in hazard assessments, including to the PTHA.

The PTHA includes earthquake sources from the Pacific and Indian oceans' basins, with over one million tsunami scenarios. These scenarios are used by government, industry and research sectors to understand the localised effect of tsunamis. Like all hazards, tsunami does not stop at state borders. The PTHA provides a nationally consistent approach to assessing tsunami risk, so businesses and industries with interests across multiple states and territories can understand their overall risk.

The ATAG is an expert advisory group to the Australia-New Zealand Emergency Management Committee. The group provides national leadership in the coordination of programs and projects relating to tsunami capability development, promoting research, information, knowledge management and education in Australia. ATAG members are acutely aware of the challenges in raising awareness of the rarer hazards such as earthquake and tsunami in an environment which frequently experiences bushfires, floods, storms and cyclones.

ATAG uses anniversaries of significant events as a trigger to raise awareness of tsunami and its potential impacts on Australia. For rare hazards such as tsunami, it is perhaps even more critical to use historical events to remind us that Australia is not immune to this hazard.

ATAG and resources, at: <https://knowledge.aidr.org.au/resources/australian-tsunami-advisory-group/>.

Tsunami Emergency Planning in Australia Handbook, at: <https://knowledge.aidr.org.au/resources/tsunami-planning-handbook/>.

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- 1 National Oceanic and Atmospheric Administration, at: <https://www.noaa.gov/>.
- 2 NSW State Emergency Service 2009, *Measurements and Impacts of the Chilean tsunami of May 1960 in New South Wales, Australia. Report by NSW SES, State Headquarters*. At: www.ses.nsw.gov.au/media/2530/effects-of-1960-tsunami.pdf.
- 3 Okal EA 2011, *Tsunamigenic Earthquakes: Past and Present Milestones, Pure and Applied Geophysics*, vol. 168, pp.969–995.
- 4 Probabilistic Tsunami Hazard Assessment, at: www.ga.gov.au/about/projects/safety/ptha.

Did you know

The largest recorded tsunami runup in Australia occurred at Steep Point in Western Australia on 17 July 2006. Steep Point is the most westerly point on mainland Australia.

The tsunami that reached the coast at Steep Point was generated by a magnitude 7.7 earthquake in the Indian Ocean south of Java.

The tsunami caused widespread erosion of roads and sand dunes, extensive vegetation damage and destroyed several campsites that were 200 metres inland. The tsunami also lifted and moved a 4WD vehicle ten metres. Fish, starfish, corals and sea urchins were deposited on roads and sand dunes well above the regular high-tide mark.



A destroyed campsite following the tsunami at Steep Point in Western Australia in July 2006.

Image: Paul Dickson.

Simulated disaster: how games prepare us for emergencies and crises

Heide Lukosch

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Games can help us prepare for emergencies and manage crises as they enable players to experience emergency situations in a safe and interactive way.

Disasters are situations that are threatening, highly dynamic and with uncertain developments. How humans react when hit by a disaster is difficult to predict as this depends on unknown and sometimes irrational factors. Farmers who do not want to leave livestock behind when threatened by a flood, tourists who continue taking videos of a volcanic eruption, or friends holding large gatherings in times of a global pandemic are examples of unpredictable behaviour that is far from what science calls 'rational choice'.

Disasters are challenging for emergency responders. Humanitarian aid workers face the risk of being attacked during aid delivery and medical personnel operating new machines or instruments often need regular training.

Immersive games allow experts to step into simulated yet realistic worlds. Games can represent threatening and new or unusual situations without the serious consequences of an emergency or real disaster. Immersive experiences such as medical simulations are very efficient educational tools. When confronted with a real emergency, medical personnel who have trained in immersive worlds are well prepared and can act accordingly.

Immersive, interactive games that simulate disaster events offer safe and engaging ways to prepare for an emergency as players are exposed to and experience likely situations before they eventuate. Games provide a safe environment to explore actions and procedures. Players can walk through scenarios, take over roles and explore the consequences of certain actions and decisions to change the course of events.

Imagine the management of a medical team confronted with many patients suffering from a fast-spreading virus like Covid-19. Numeric models can forecast how fast the disease spread would increase under certain circumstances. Yet, models

cannot show how patients would react being asked to wait and keep their distance to others while they struggle to breathe. Most probably, most people would not follow those lines of rational choice.

Immersive, game-based experiences allow for new and insightful perspectives on an emergency situation that would otherwise be dangerous and difficult to realize. For example, putting responders and people in danger when 'trying out' different disaster management approaches in a real situation. Immersive games make use of realistic models, which include experiences and knowledge about the real situation. In comparison to mathematical models that are based on numbers and rational choice models, games offer deep, qualitative insights into human behaviour under extraordinary circumstances.

Immersive games go beyond preparation and training. They serve as laboratories, such as the game Foldit that is used to find solutions to the spread of the Covid-19 virus. This approach has already produced thousands of puzzle solutions to the problem. While games may still be seen as something to mainly entertain us and offer a way to flee into a simulated world when the 'real' one becomes too tough¹; in the right context, they might enable people to take that extra step and help save lives in times of crises.

End note

- 1 Lukosch H & Phelps, AM 2020, *Online plagues, protein folding and spotting fake news: what games can teach us during the coronavirus pandemic. The Conversation*, 7 May 2020.

Bushfire lessons from cultural burns

Dr Jessica Weir

Western Sydney University
Bushfire and Natural Hazards
Cooperative Research Centre

Whether cultural burns are the answer or not, depends on the question. During the Australian summer of 2019–20, Aboriginal peoples' landscape fires—often called cultural, traditional or Aboriginal burns—were central in discussions about bushfire responses. Aboriginal peoples have traditionally lit 'cool' fires to reduce the occurrence of hot fires and for other reasons. But what question is really being asked about cultural burning?

If the question is: how does Australia eliminate large bushfires?, then cultural burns are not the answer and neither are any other bushfire risk mitigation activities. There have always been large fires in Australia and always will be.

A more helpful question is: how do we reduce bushfire risk? This approach reflects Australia's reality. However, before discussion narrows to specific burning techniques, there are other questions, for example, what is at risk and why?

Values are fundamental to whether people do something about bushfire risk or not. This is evidenced by the difference between fire risk mitigation in western Arnhem Land (owned and managed by Aboriginal people) and neighbouring World Heritage Kakadu National Park (owned

by Aboriginal people and joint-managed with the Australian Government's Parks Australia in Canberra).

Two decades of scientific research confirms that Aboriginal burning reduced the intensity of bushfires in Arnhem Land. These results arise from Aboriginal people's initiatives to collaborate with researchers and organisations to reduce destructive bushfires and secure international carbon abatement funding. While Kakadu has improved its fire regime marginally, satellite pictures¹ show that it lags behind the success evident in Arnhem Land. The geographic proximity of the two fire regimes raises issues as to why Kakadu has not achieved similar reductions in hot fires. The answer must lie in a consideration of the human context.

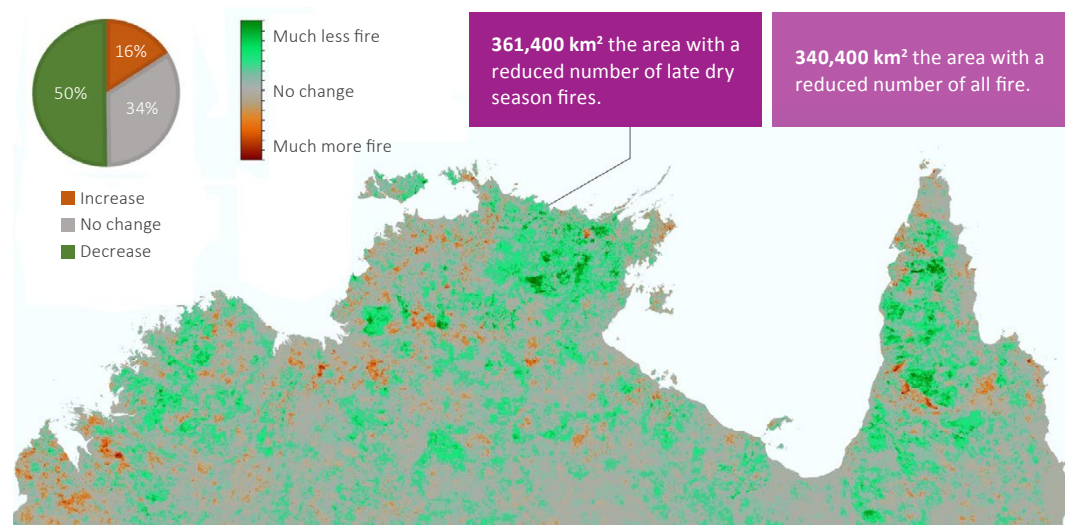


Figure 1: Comparisons of the average fire frequency in North Australia between 2000–2006 and 2013–2019.

Source: North Australia Fire Information website at: www.nafi.org.au

In response to the 2019–20 summer of catastrophic bushfires, Bushfire and Natural Hazards Cooperative Research Centre CEO Richard Thornton wrote:

What is needed is a quantum shift in our thinking. Just doing the same thing or planning to do the same thing, but just more of it, is a simple solution that is neat and plausible. And wrong.

The Australian, 4 January 2020

Governments and inquiry processes looking for a quantum shift in thinking could start with Australia's Indigenous leaders who have inherited unique knowledge that has been formed over millennia with the land. Indeed, Indigenous people repeatedly express that 'the land and the people are one'.

Indigenous fire practitioner Victor Steffensen has said:

We can't continue to sit back and watch hundreds of kilometres of land being annihilated and yet just sit down and just think about ourselves. But, in due respect, we need to be looking after our residents and we need to be looking after our houses, but what's the point in doing that if we're not looking after the land?

SBS Insight, 16 February 2016

Steffensen emphasised that looking after people and property cannot be separated from looking after the land. This does

not downgrade the importance of people and property but understands that looking after the land is also looking after people and property. Indigenous peoples express this land ethic as 'Country'.

As a researcher of meaning and assumption, I've studied how ways of thinking influence the possibilities that people see. I've tracked how explicit and implicit conceptual moves determine what is considered normal and appropriate from different viewpoints to identify where shared values lie. The environment is neither dispensable nor just a nice place to visit. People live within it and it supports everything. When we conceptually separate the land from lives, we do so at our own peril.

Cultural burns in southeast Australia made headlines for saving property at Tathra in NSW in the 2018 fire and in multiple locations during the 2019–20 bushfires. This was good news, but not the core purpose. Cultural burns are embedded in ways of knowing and doing that are attuned to the land and that sustain relationships across generations with practical and purposeful understanding. I believe the question that needs to be asked of cultural burning is: how do we understand Country? Because what is at risk is Country, and Country is everything.

End note

- 1 North Australia Hot Spots 2004 and 2019 comparison. At: <https://youtu.be/3dBDfKr018>.

Readiness for the next major bushfire emergency

Andrew Gissing

Risk Frontiers

Neil Bibby

People and Innovation

Australia needs to be ambitious in its thinking about readiness for major bushfires; in particular, how future bushfires are managed and fought. Bushfires over 2019–2020 caused 35 fatalities, widespread disruption and significant damage with 3093 homes being destroyed and major damage to community infrastructure. We must learn from this experience.

Current management of bushfire risk is largely reliant on long-standing approaches that are resource intensive and that struggle to control fires when conditions are catastrophic. This issue is compounded under a warming climate with fire seasons becoming longer and days of significant fire danger more frequent.

An inherent problem is that bushfire detection is complex. In the time it takes before resources can be targeted and tasked, bushfires may have already spread to the point where suppression is difficult. This problem is exacerbated when bushfire ignition occurs in areas far from emergency response resources. Making the problem worse is a growing bushland-urban interface where buildings and community infrastructure are highly vulnerable and exposure is increasing.

Discovering the next generation of firefighting capability should be a priority.

New thinking is required

There are two stages in considering future capabilities. The first is planning and investment to improve capabilities in the short term particularly before the next bushfire season. The second is research and innovation to inspire the next generation of firefighters.

What is needed is a blueprint of how bushfires will be fought in the future. This blueprint should be a vision whereby bushfires can be rapidly managed and controlled in a coordinated manner that is informed by advanced predictive intelligence and where the built environment is resilient. Research into the development of such a blueprint should include:

- Bushfire detection and suppression:
 - How can bushfires be detected more quickly?
 - How can bushfires be extinguished before they are able to spread?
 - How can the safety of firefighters be improved?
- Coordination:
 - How can communications enable effective coordination?
 - How can resources be tasked and tracked more effectively?
 - How can situational awareness be enhanced to inform decision-making?
- Community resilience:
 - How can new buildings be made more resilient?
 - How can existing building stock be retrofitted for resilience?
 - How can community infrastructure such as energy distribution systems, telecommunications, water supplies and sewerage systems be designed with greater resilience?

Short term

It is widely agreed that there are many technologies and systems already existing that could enhance firefighting and disaster management capabilities. Specific opportunities identified by industry experts:

- Satellites, such as data sourced from the Himawari satellite, should be evaluated for

their ability to enhance fire detection. High Altitude Platform Systems may be another option.

- In the United States, Unmanned Aerial Vehicles (UAV) have been employed to provide enhanced imagery over firegrounds and, if equipped with infrared sensors, these can support monitoring of fire conditions at night. The Victorian Government has established a panel contract with UAV providers to assist with real-time fire detection and monitoring. Further policy regarding airspace management is required to support demand-based deployments of UAVs.
- Airborne sensors can improve data availability regarding bushfire fuels.
- Existing agricultural monitoring technologies could be repurposed to monitor bushfire fuels and soil conditions.
- Balloons equipped with radio communications could provide coverage when traditional communications technologies have been disrupted. Small UAVs could create a mesh network to provide a wireless communications network or equipment fitted to aircraft.
- Advances in using robotics in the mining sector may provide applications to firefighting, for example autonomous trucks.
- Resource tracking technologies could be implemented to improve coordination and firefighter safety.
- Night-time aerial firefighting capabilities could be used.

Operational decisions could be improved by enhanced collation and fusion of data already available. There are many data sources managed by different organisations, not just government agencies. Collating these datasets to provide a common operating picture across organisations would improve situational awareness and data analytics.

The widespread adoption of artificial intelligence and greater digital connectedness across the economy and the emergency management sector will find new ways to make sense of data and improve decisions. In the built environment, improved information to householders about the resilience of their buildings along with programs to implement simple retrofitting measures should be considered. Enhanced data availability and analytics could be used to tailor emergency warnings.

In the aftermath of bushfires, land swaps and buy-outs should be considered to reduce future exposure in high-risk areas. Similarly, communities should be better planned to ensure infrastructure is resistant to failure when most needed.

2030 and beyond

A key area for research and innovation investment over the coming decade should be how to rapidly suppress bushfires. This could see swarms of large-capacity UAVs supported by ground-based drones to target suppression and limit fire spread. Resources could be rapidly dispatched and coordinated autonomously. Pre-staging of resources would be informed by predictive analytics and enabled by unmanned traffic management systems. UAVs and drones have applications beyond fire suppression including for rapid impact assessment, search and rescue, logistics and clearance of supply routes.

The way forward

A research and innovation blueprint is needed that outlines how technologies will be translated to enhance firefighting and resilience in the short term and, beyond this, how the next generation of capability will be designed and built. Its development should involve government, research and industry stakeholders in a collaborative manner. The final blueprint should be integrated with future workforce and asset planning to support change management.

Adopting new technologies will not be easy and existing cultural and investment barriers should be considered. In adopting new technologies, it is important to recognise that innovation is an iterative process of improvement and rarely provides a perfect solution in the first instance.

Public-private partnerships will be key to realising opportunities and governments must engage a broad range of stakeholders. In the aftermath of Hurricane Sandy in 2012, the USA launched a competition called 'Re-build by Design'¹ focused on solutions to minimise risk. Already in Australia, numerous innovation challenges involving businesses and universities assist in inspiring ideas. There is an opportunity to harness and coordinate such challenges on a grand scale to promote new thinking and collaboration linked with responsible agencies.

We need to be bold in our thinking to build resilience!

Acknowledgements

This article was informed by a forum which included representation from IAG, SwissRe, IBM, Defence Science and Technology, IAI, Cicada Innovations, Lend Lease and ARUP.

End note

- 1 Re-build by Design, at www.rebuildbydesign.org.

The new Australian Disaster Resilience Index: a tool for building safer, adaptable communities

Bethany Patch

Bushfire and Natural
Hazards Cooperative
Research Centre

An understanding of disaster resilience will help communities better prepare for, absorb and respond to natural hazards. A newly launched website helps explain and measure resilience so that we can adapt and transform our communities for the better.

People learn to live with a changing, unpredictable and uncertain environment, of which natural hazards are an increasing part. We are all developing ways to cope with, adapt to and recover from changes in our lives. But how does your community adapt and respond to change, and how can this process be improved? What resources does your community have at its disposal when responding to a natural hazard, and how could these be transformed so that your community recovers more easily and quickly, and is able to adapt its resources effectively so that it is better prepared next time?

Suellen Flint, the Deputy State Recovery Coordinator at the Department of Fire and Emergency Services (Western Australia) explains what makes a resilient community.

'At their best, communities are prepared, are able to adapt to changing situations, are connected to each other and are self-reliant,' said Ms Flint.

An understanding of disaster resilience focuses on ways that we can *improve* a community's chance of adapting to future change, rather than focusing on its ability to *react* to hazards that have already occurred. To support resilience across Australia, a new research-based website, the Australian Disaster Resilience Index, has been developed to help industry, business, government and emergency services improve the resilience of their local communities before, during and after natural hazards.

Developed by the Bushfire and Natural Hazards CRC and the University of New England, the Index is free to use and allows anyone with an interest in understanding the resilience of their local community to access this information.

What does the new Australian Disaster Resilience Index do?

The output of six years of CRC research, the Australian Disaster Resilience Index provides a clear but detailed pathway to better understanding and measuring resilience across Australia, so that businesses, governments, not-for-profits and community organisations can improve their decision-making about planning, development, policy, engagement and risk assessment.

'The Index is capturing a national picture of disaster resilience,' said lead researcher of the Index, Dr Melissa Parsons at the University of New England. 'This national picture will help communities, governments and organisations further develop the capacities for adapting to and coping with natural hazards.'

The Index gives you everything you need to start exploring the resilience of your community, including an interactive map that generates data reports for specific areas, and information about the strengths and barriers to disaster resilience for each area. You can examine the resilience of your local community and start to plan for improved resilience.

It measures overall disaster resilience, as well as coping and adaptive capacity, by assessing eight key factors:

Coping capacity:

- social character (the social and demographic characteristics of the community)
- economic capital (the economic characteristics of the community, such as wealth or market health)

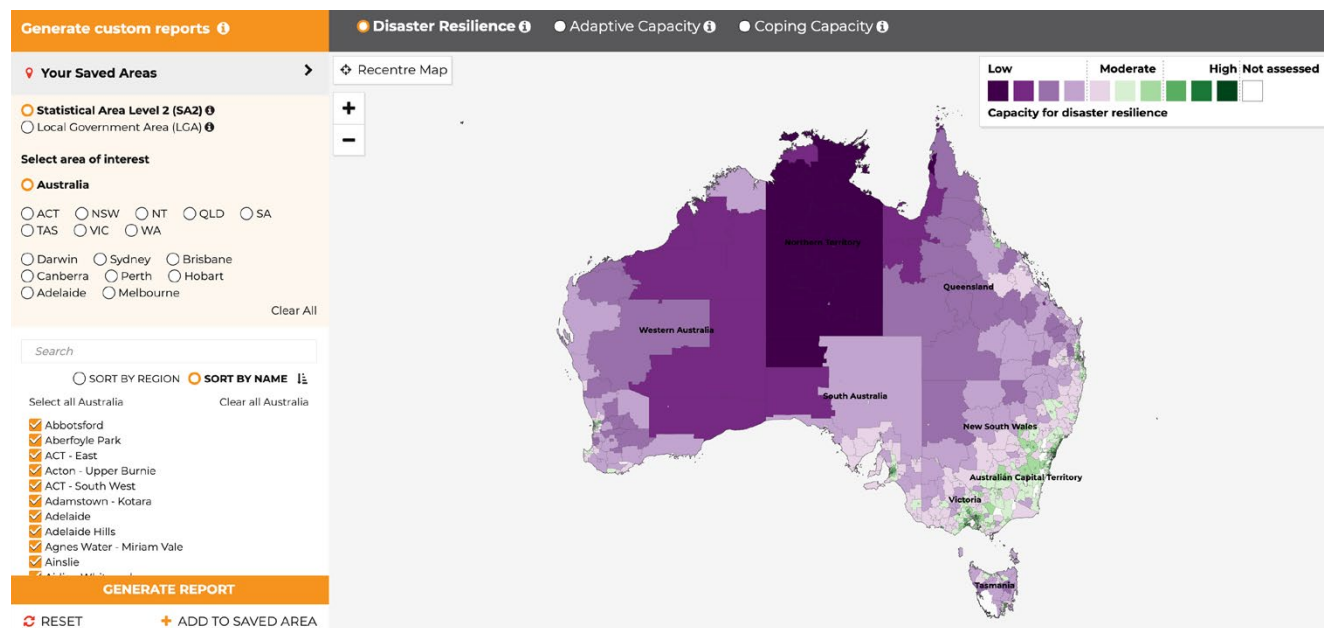


Figure 1: The Australian Disaster Resilience Index provides a national picture of disaster resilience, with an interactive map, detailed reports and information about strengths and barriers to disaster resilience of each community.

Source: Bushfire and Natural Hazards CRC

- emergency services (the presence and resourcing of emergency services)
- planning and the built environment (the presence of legislation, plans, structures or codes to protect the community and its built environment)
- community capital (the cohesion and connectedness of the community)
- information access (the potential for the community to engage with natural hazard information).

Adaptive capacity:

- social and community engagement (the capacity within the community to adaptively learn and transform in the face of complex change)
- governance and leadership (the capacity within organisations to adaptively learn, review and adjust policies and procedures, or to transform organisational practices).

Dr Parsons and her team have assessed these factors in each community and combined them to determine whether each community has high, moderate or low capacity for resilience.

Coping capacity is the means by which people or organisations can use available resources and abilities to face a hazard that could lead to a disaster. For example, if a community has high levels of economic capital, plenty of emergency services to use and good access to information, it has high coping capacity.

Adaptive capacity measures the arrangements and processes that are in place in the community to enable adjustment through learning, adaptation and transformation. For example, if a

community has strong community engagement and governance, it has high adaptive capacity.

Applying an understanding of disaster resilience

Not all communities have the same capacity for resilience given the many social, economic and institutional factors that play a role. In fact, not even all communities within one area have the same level of resilience. This cross-community mosaic of resilience within larger areas can be used to identify strengths, form alliances and develop targeted improvements.

For example, if you use the Index to look at the overall resilience of the greater Perth area, you will see a range of resilience capacities within that area. This means that it's not one-size-fits-all for areas such as Perth. Understanding the differences between communities within your area will help you understand where specifically to invest more resources and resilience-building initiatives.

Five disaster resilience profiles

'What works in one place won't necessarily work somewhere else,' Dr Parsons said, explaining that the improvements to resilience will look very different in different communities.

To explore this, the Index also proposes five disaster resilience profiles in Australia – nationwide collections of communities that all fit a similar profile of resilience strengths and constraints.

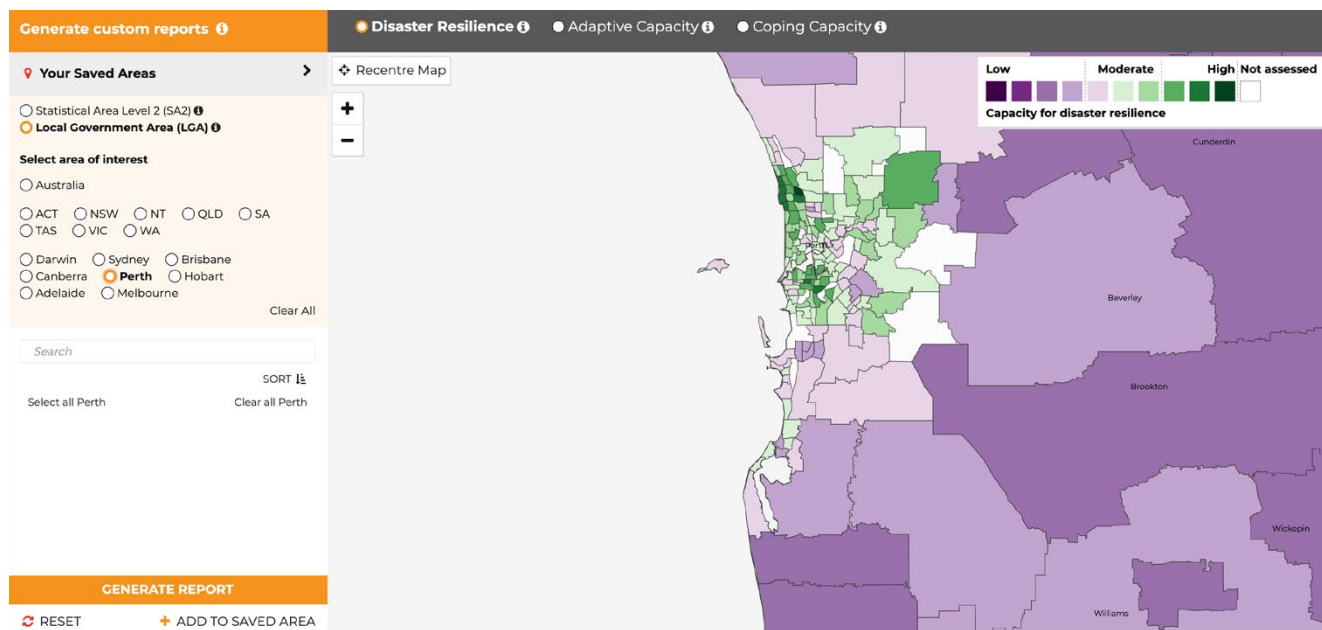


Figure 2: The Australian Disaster Resilience Index provides views of the resilience capacities of large or small areas using local government areas and Statistical Area Level 2.

Source: Bushfire and Natural Hazards CRC

These profiles provide an opportunity to address specific constraints and strengths of an area.

For example, local government areas in west Queensland, north western New South Wales, South Australia, Northern Territory and Western Australia all share a similar resilience profile. Once you can identify areas similar to the one you live in, you can start looking at what those areas have done to improve their resilience, and assessing whether a similar approach will work for your community. This also allows the opportunity for an open dialogue with other resilience partners, and the coordination of resilience-building initiatives and sharing of resources between areas.

'In some places, the capacity for disaster resilience comes from social strengths. These same places can also have constraints on disaster resilience because of lack of access to government services, telecommunications and low economic capital. In another place, the capacity for disaster resilience might come from the provision of emergency services or local and regional planning. But these places also face limitations from lower community connectedness,' Dr Parsons said.

The future of disaster resilience

The Index sets a new benchmark for measuring future changes in resilience to natural hazards and promoting resilience-building initiatives. By informing and supporting leaders in Australian organisations to better understand and measure resilience, those organisations will be able to enhance how they currently support

communities before, during and after a natural hazard, thereby building a more disaster-resilient country.

While the Index can be specifically applied to fire and emergency services, it will also be of great value for business and industry, not-for-profit organisations and local, state and federal governments. It will be used to inform policy, resource planning, community profiling, strategic planning, emergency planning and preparedness, risk assessment and other crucial processes.

Ms Flint emphasises the importance of the Index for the emergency management sector. 'The ability to identify hot-spots of high or low disaster resilience in Australia and identify areas of strength in coping and adaptive capacity...will help to embed disaster resilience not only into policy and legislation, but to lead to an increase in shared responsibility and resilience across Australia,' she said.

The Australian Disaster Resilience Index is at www.adri.bnhcrc.com.au.

Uncovering exposure to natural hazards

Bethany Patch
Bushfire and Natural
Hazards Cooperative
Research Centre

As Australian communities recover from one natural hazard and prepare for the next one, there are important questions to ask about which areas are most exposed to possible loss of life, landscape and property.

We need to understand which of our people, buildings, business, public facilities, infrastructure, agricultural areas and natural landscapes are exposed to *any* natural hazard, as well as human-induced disasters and structural failures. A clearer understanding of this exposure is a highly valuable starting point for any sector that is required to prepare for and respond to hazards, both in the response and warnings phases, but also in mitigation.

The Australian Exposure Information Platform (AEIP) is an online platform that provides an accessible snapshot of all assets within a specified area, in the form of a customised 'exposure report'.

It was designed through a partnership between the Bushfire and Natural Hazards CRC, Geoscience Australia, University of Melbourne, University of Canberra and emergency management organisations.

Chief of Division at Geoscience Australia, Alison Rose, explained the significance of the platform to the Royal Commission into National Natural Disaster Arrangements in early June.

'The AEIP is an all-hazards capability, which provides exposure reports on demand at any scale,' Ms Rose told commissioners.

Lead CRC researcher, Mark Dunford from Geoscience Australia, says that these exposure reports provide a new, quick way of accessing important information that can be used for mitigation and operational decision-making for any hazard at any time within any specified area. This is essential information that helps improve safety, save lives and reduce damage to property and natural landscapes, and can be used not only by emergency management, but also researchers, town planners or anyone else who's interested.

'For the first time, everyone has direct 24/7 access to nationally consistent exposure information anywhere in Australia, through a user-driven, on-demand interface,' Mr Dunford said. 'They can readily utilise exposure information as a key piece of intel for critical pre-planning, or on-the-fly scenario event assessments.'

The reports created by the AEIP draw on a wealth of data sources out of the National Exposure Information System database, including local, state, federal and industry data; ABS demographics; environmental exposure data from the Department of Agriculture, Water and the Environment; and agriculture, business, building and institution data.

The AEIP is already being widely used across Australia, including during our most recent devastating natural hazards.

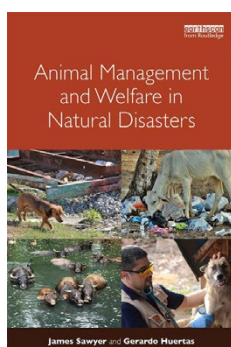
'During the 2019–20 bushfire period, 14,400 reports were generated. On an average monthly basis, we have around 400 reports that are generated, and we currently have 244 users across 58 different entities that use the tool,' Ms Rose told the Royal Commission.

Half of these entities are emergency management agencies, with local government authorities and electricity providers among a group of regular users.

The AEIP has proven to be invaluable in a crisis, when demand for critical information is extremely high. By speeding up the automatic delivery of vital exposure information, its nationally consistent and easily accessible format ensures that information and decision-making can be calculated and coordinated across Australia.

Access the Australian Exposure Information Platform at aeip.ga.gov.au.

Animal Management and Welfare in Natural Disasters



Author

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Reviewed by Steve Glassey

University of Otago, New Zealand.

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For the first time, an authoritative text on the relationship between humanitarian response systems and animal welfare has been published. Traditionally, texts have focused on animal emergency management in the United States and other developed countries.

Sawyer and Huertas share their 55-plus years of collective professional experience with high-profile organisations such as World Animal Protection and the British Animal Rescue and Trauma Association. Their mixed experience covers responding to animals affected by disasters such as Cyclone Haiyan, Cyclone Pam, Haiti Earthquake, Indian/Asia Tsunami, Mongolian Dzud and war zones.

The authors have qualifications in emergency planning, disaster management, biology, human resources, law and geography. However, neither of these experts are veterinarians so they provide a more holistic approach to the topic. This gives the reader a significant body of knowledge filled with anecdotes and published studies that supports an animal-inclusive approach to disaster and humanitarian response. Doing so benefits the animals as well as humans involved.

The book is full of examples and covers:

- why animals are worth protecting in times of disaster
- key concepts of contemporary emergency management
- international response structures and how the animal response can engage in this
- understanding the impacts of disasters on animals
- immediate response priorities
- recovery considerations
- capacity building
- risk reduction approaches
- professionalisation of animal emergency management
- potential future needs.

The book brings together animal welfare philosophy and complex operating models typically adopted in large-scale humanitarian interventions. For those seeking advice, particularly in animal

emergency management in developing countries, this book provides an exceptional depth of knowledge and good, practical advice.

Examples included in the book that were of particular interest include the application of international conventions and agreements to protect animals (such as the United Nations *Sendai Framework for Disaster Risk Reduction 2015–2030*), the issue of aid dependency and ‘do no harm’ in the context of animal-related interventions, the negative consequences of focusing on livestock insurance and re-stocking, the post-flooding impacts on pastures (mineral deficiencies), the importance of engagement and collaboration by governments with non-government organisations in animal disaster response and the gender issues arising from negative impacts on livestock particularly in developing countries.

The book states that New Zealand has a guideline for animals in emergencies, however, this guideline was never published. The book’s section on technical animal rescue is light in content and might not ensure operational safety, though further training options are noted. Inclusion of the International Search and Rescue Advisory Group First Responder training package would have been useful. In addition, a short commentary on the *Code of Conduct for International Red Cross and Red Crescent Movement and NGOs in Disaster Relief* and how it could apply to animal-focused responses would have been worthwhile.

The purists of disaster research may object to the book’s title that refers to ‘natural disasters’. For many the term ‘natural disaster’ has become a misnomer given there is nothing natural with a human system interacting with a natural system. However, it would appear the title was decided upon to better relate to a readership that may not have a background in emergency management.

This book is easy to read and is full of examples that advance the compelling argument that animal welfare is a critical cross-cutting theme in humanitarian development and response. The book’s style and content make it a must read for those who want to help communities to become more resilient anywhere in the world.

Abstract

Local governments are important actors in achieving the targets of the *Sendai Framework for Disaster Risk Reduction 2015–2030* (UNDRR 2015).

While they play a key role, their level of action on disaster risk reduction varies substantially and the evidence base to explain this variation is limited. This paper reviews three strands of research that improve this evidence base and recommends further research. Data on local government action is generally limited or unavailable, although some survey work has generated valuable insights. Promising theoretical models from the public administration literature could be more strongly applied to disaster risk reduction.

Research over the past few decades shows quantitative evidence for a range of factors that influence local government action including disaster events and risk, leadership, political system, advocacy, community characteristics and local government characteristics and resources. Avenues for further data collection, theoretical development and action research are explored.

When do local governments reduce risk? Knowledge gaps and a research agenda

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Introduction

To meet the challenges posed by emergencies and disaster events, governments and the international community have moved focus away from disaster relief towards disaster risk reduction (DRR) and disaster resilience. This is evidenced in the *Sendai Framework for Disaster Risk Reduction 2015–2030* (UNDRR 2015). Alongside this shift from response to resilience is the increasing attention globally of the role of local governments in DRR by international organisations and in the disaster literature (Blackburn & Johnson 2012, Godschalk 2003). Levels of government closest to communities have the best understanding of local hazards, vulnerabilities and risks and the greatest opportunity to implement DRR interventions (Malalgoda, Amaratunga & Haigh 2013). Yet despite increasing attention and these substantial responsibilities, many local governments around the world do little to reduce disaster risks.

If the targets of the *Sendai Framework for Disaster Risk Reduction 2015–2030* and the Sustainable Development Goals (United Nations 2015) are to be achieved, national and international actors need to understand and be able to influence local action. Campaigns such as Making Cities Resilient (Blackburn & Johnson 2012) and 100 Resilient Cities (100 Resilient Cities 2019) aim to achieve such influence. To increase effectiveness, successors to these campaigns need to be based on the best available evidence. Understanding the influences of local government action on DRR is key to this evidence base.

This paper summarises key theoretical and empirical research on local government DRR action and identifies research needs. It examines the limited existing data sources on local government action, explores promising theoretical developments and outlines theoretical work needed. The paper provides a summary of factors that influence local government action on DRR based on the empirical literature.

Data on local government action

To understand the influences of local government DRR action, data on DRR action is required. One of the more notable efforts to collect that data is the Disaster Resilience

Scorecard for Cities¹ as part of the Making Cities Resilient campaign.² However, this is a self-assessment tool and only 169 scorecards were available for analysis in the most recent *Global Assessment Report for Disaster Risk Reduction* (UNDRR 2019).

Surveys of local governments have been undertaken in some countries, such as Sweden (Nohrstedt & Nyberg 2014) and the USA (National Association of Counties 2019, Leep *et al.* 2017). These surveys, as well as other voluntary reporting, are subject to limitations, particularly selection bias that may lead to over-representation of high-performing local governments. If this type of survey were extended across more contexts it would likely produce a richer data source for analysis.

Local government expenditure on DRR may be an appropriate proxy measure for its overall level of action. Spending on disaster mitigation projects has benefit cost ratios of up to 1800:1, although this varies substantially depending on the hazard, context and type of project (Shreve & Kelman 2014). In Australia, there has been substantial discussion on the allocation of funding for disaster mitigation activities versus response and recovery by state, territory and federal governments (de Vet *et al.* 2019). While information on Australian state and territory government expenditure is generally available, there is limited information on mitigation expenditure by local governments (Productivity Commission 2014). Greater levels of reporting by local governments of expenditure on DRR would provide for analysis of the influencing factors. Reporting obligations could be imposed, however, international collaboration on reporting standards may be required for this to provide a useful data source to compare local governments across countries.

Models of government action

While there is extensive literature on developing models of disaster resilience (Cutter 2016) and some literature on organisational resilience (Shaw 2012), few have explicitly considered the role of local government in reducing disaster risk and building resilience in their communities. There is also relatively little agreement on how to operationalise resilience concepts in these models (Beccari 2016). The investigation of governance in the broader urban studies literature is likewise lacking in theoretical models subjected to study involving the comparison of multiple local government organisations (da Cruz, Rode & McQuarrie 2019).

Although models of local government action on DRR have not been developed, there is considerable literature examining individual policies and influencing factors. The grey literature discusses potential drivers and barriers, but these are largely based on case studies and expert opinion (Blackburn & Johnson 2012, Red Cross 2010). Quantitative studies of specific aspects of local government DRR action have been undertaken in fairly narrow contexts using relatively few variables. These studies have investigated:

- the quality of hazard mitigation plans (Olonilua 2016)
- the US Federal Emergency Management Agency's Community Rating System (Li & Landry 2018)
- US homeland security preparedness (Haynes & Giblin 2014)

- wildfire mitigation (Muller & Schulte 2011)
- flood mitigation (Khunwishit, Choosuk & Webb 2018; Nohrstedt & Nyberg 2014)
- implementation of the US National Incident Management System (Jensen & Youngs 2015).

These studies showed limited application of theory to define variables for investigation or to explain their results.

One of the few theories of policy development and change applied to DRR is the multiple-streams framework developed by Kingdon (1984). This has been applied to disaster policy in general by Birkland (1997, 2006) and municipal emergency management policy, in particular by Henstra (2010). In this theory, disasters act as focusing events that create windows of opportunity for policy change. However, this change is made more likely by an active policy community and political leaders willing to adopt policy and learn instrumental and social lessons from a crisis. The multiple-streams framework provides a useful lens for examining DRR policy change. However, it fails to explicitly account for a local government's context nor address whether a policy will be implemented effectively.

The broader literature on public administration and organisational resilience includes work on organisational capacities as determiners of local government performance. Capacities of local governments to implement the functions assigned to them vary significantly and the gap between their responsibility and capacity is large (Wallis & Dollery 2002). Wallis and Dollery (2002) apply a model of state capacity developed by Grindle (1996) to explore local government activity. It contains institutional, technical, administrative and political capacities that are interlinked with each other and with the activities of the central government. These capacities are underpinned by the social capital in the local government's community. Social capital may enhance local governance and economic performance and be built by local government activity. Capacity-based models have been discussed in the disaster literature. Kusumasari, Alam and Siddiqui (2010) proposed that institutional, human resources, policy, financial, technical and leadership capabilities of local governments are key to effective emergency and disaster management.

Other scholars have focused on the relationship between local government management and performance (Walker & Andrews 2015). This literature has been extended to consider the influence of context on the management-performance relationship (O'Toole & Meier 2015). This work identifies political, environmental and internal contexts that influence the overall effectiveness of management in public organisations as well as determining the effectiveness of individual management actions. Bullock, Greer and O'Toole (2018) have extended this theory to consider risk management in public organisations and set out ten hypotheses for further investigation.

1 Disaster Resilient Scorecard for Cities. At: www.unisdr.org/campaign/resilientcities/toolkit/article/disaster-resilience-scorecard-for-cities.

2 Making Cities Resilient. At: www.unisdr.org/campaign/resilientcities/.

Ongoing theoretical work should seek to integrate the strengths of these different streams and produce testable hypotheses to drive empirical research. Models also need to explicitly consider time to examine windows of opportunity and develop hypotheses that require testing through longitudinal study.

Influences to explore

While further theoretical development is highly warranted and may present some utility for those seeking to influence local governments, any model needs thorough empirical testing. A scan of selected literature (Table 1) reveals evidence for a variety of factors that influence local government DRR action.

Much of the existing literature summarised in Table 1 investigates similar concepts, but variables are operationalised differently in different studies and incomplete statistics are included. This

makes the literature highly resistant to quantitative synthesis that would guide theoreticians to develop their models. Investigators should publish complete statistics and, ideally, raw data to enable better comparisons between studies and eventual quantitative synthesis. Limited longitudinal research is available. This is needed to test theory models that explicitly consider variation over time. This will help to rigorously evaluate the effects of international campaigns such as 100 Resilient Cities and Making Cities Resilient.

There is a need for empirical studies in a variety of global contexts, including in the Asia-Pacific region. Much of the literature summarised in Table 1 is from the USA. There are limited examples of research conducted elsewhere, for example, Canada (Mehiriz & Gosselin 2016), China (Kim & Rowe 2013), Germany (Becker, Aerts & Huitema 2014), Sweden (Nohrstedt

Table 1: Summary of evidence for influences on local government DRR action.

Influence	Existing evidence
Disaster events and physical risk	Disaster events and disaster risk are a focus for research and have been frequently cited in the qualitative literature (Red Cross 2010). Quantitative evidence is mixed with studies finding disaster events and disaster risk may (Li & Landry 2018; Shi, Chu & Debats 2015) or may not positively influence government action (Muller & Schulte 2011, Nohrstedt & Nyberg 2014). There is evidence suggesting that risk and disaster events play different roles (Burby 2003).
Local leader commitment	The commitment of local leaders to DRR is highlighted in qualitative literature (Blackburn & Johnson 2012) and has received quantitative focus with some studies examining other leader characteristics (Becker, Aerts & Huitema 2014; May & Birkland 1994; Shi, Chu & Debats 2015).
Political system and organisation	A government's political system and relationships with other governments may influence its effectiveness in reducing disaster risk. Decentralisation (Avery & Zabriskie-Timmerman 2009), local government form (Johnson <i>et al.</i> 2015) and urban coverage (Nohrstedt & Nyberg 2014) have all been examined. A key focus of research from the USA has been the effects of state and federal government mandates on local action (Berke, Lyles & Smith 2014; Muller & Schulte 2011) while grants and other financial support have also been investigated (Lindell & Whitney 1995).
Advocacy for risk reduction	The role for local activism in driving government action has long been acknowledged in the qualitative literature (Alesch & Petak 1986). A variety of forms of local advocacy, public and stakeholder participation and city-to-city advocacy have been addressed in the literature with mixed findings (May & Birkland 1994, Nohrstedt & Nyberg 2014). Cementing the empirical link between advocacy and political decision-making is evidence that the performance of political leaders in disasters influences voter behaviour at subsequent elections (Quiroz Flores & Smith 2013).
Community characteristics	A range of community characteristics have been studied consistent with theoretical models that incorporate community capacities. These are wealth (Li & Landry 2018; Shi, Chu & Debats 2015), education (Muller & Schulte 2011, Paille <i>et al.</i> 2016) and population size and growth (Avery & Zabriskie-Timmerman 2009, May & Birkland 1994, Nohrstedt & Nyberg 2014). These community characteristics have been the focus in the literature while some researchers have used a Social Vulnerability Index to aggregate relevant variables (Rahm & Reddick 2011).
Local government organisation characteristics	While the internal context of a local government organisation may play a critical role in the effectiveness of local government action, this area has received limited attention in the literature. What has been examined is organisation structure (Randol 2012), management culture (Wang & Kuo 2017), organisational risk perception (Johnson <i>et al.</i> 2015) and internal communication (Brody, Kang & Bernhardt 2010).
Local government organisation resources	Limited financial resources for DRR is a commonly cited barrier (UNDRR 2019) and has been a focus in the quantitative literature. The evidence for its role is mixed with studies suggesting financial resources may (Becker, Aerts & Huitema 2014; Shi, Chu & Debats 2015) or may not influence local government action (Muller & Schulte 2011, Nohrstedt & Nyberg 2014, Paille <i>et al.</i> 2016). Beyond financial resources, local government staffing and skills have been examined (Brody, Kang & Bernhardt 2010; Randol 2012). Access to technical resources such as maps (Deyle, Chapin & Baker 2008) and information technology (Johnson <i>et al.</i> 2015) may also play a role.

& Nyberg 2014), Taiwan (Wang & Kuo 2017) and Thailand (Khunwishit, Choosuk & Webb 2018). More international research is critical to ensure that theory models developed can be applied in multiple contexts.

Conclusion

Despite substantial work over many decades there are still many gaps in the understanding of what influences local governments to reduce disaster risk. The literature, as summarised, provides suggestions for further research. This includes greater deployment of local government surveys in international contexts, collection of longitudinal data, improved reporting by local governments on DRR expenditure and greater data sharing by researchers. Collaboration by researchers in fields of disaster, urban studies and public administration presents an opportunity to share data and develop joint data collection programs.

Rigorous and independent evaluation of campaigns to promote local government action will improve knowledge of local government influences beyond campaign effectiveness. Mixed-methods approaches should include a quantitative arm that examines pre- and post-intervention data and comparisons with local governments that were either not program participants or joined later. Action research in collaboration with organisations that seek to influence local governments to increase their DRR efforts, such as the United Nations Office for Disaster Risk Reduction, will help bridge the policy-research nexus, improving the quality of programs and data collection and ensuring that theory has a better grounding in practice.

While there is extensive theory on the performance of local governments, this largely has not been applied to DRR. The multiple-streams framework, capacity model and management-performance theory (including recent developments considering risk management) each have strengths. Integration of these strengths into a single theory with testable hypotheses offers one avenue of research. Application of different frameworks to a single dataset on local government influences and DRR action could identify superior models for further development and application.

Emerging rapid research on the 2019 Novel Coronavirus pandemic is already documenting differing responses by governments and noting potential influencing factors (Hale *et al.* 2020). This presents a unique opportunity to study the differential response of local, national and other subnational government responses and the factors that influence these; informing the evidence base for public health and disaster risk reduction.

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Engaging stakeholders in pre-event recovery planning: using a recovery capitals framework

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Introduction

The Wellington Region Emergency Management Office (WREMO) is the Civil Defence and Emergency Management office serving the Wellington Region. WREMO's role is to lead and coordinate the effective delivery of civil defence and emergency management across the 4R's of comprehensive emergency management (Reduction, Readiness, Response and Recovery).

Following a disaster, communities undergo a stage of immediate response followed by a period of recovery. Recovery can be broken down into phases of short-term (restoring critical services and infrastructure) and long-term (either returning communities to their pre-disaster conditions (Schwab *et al.* 1998) or improving to build back better). Recovery in the short and long term is a complex process and involves a multi-faceted approach to communication and coordination (Becker, Saunders & Kerr 2006). Smith and Wenger (2007, p.237) define disaster recovery as 'the differential process of restoring, rebuilding and reshaping the physical, social, economic and natural environment through pre-event planning and post-event actions'.

In Australia, Beyond Bushfires has conducted significant research addressing the recovery of communities following major disasters (Block *et al.* 2019, Bryant *et al.* 2017, Gibbs *et al.* 2016). Pre-event recovery planning is important because it allows for time to build partnerships, identify opportunities to improve resilience and create shared expectations of post-disaster actions and priorities (Vallance 2011a, 2011b; Ward, Becker & Johnston 2008). WREMO identified a need to improve pre-disaster recovery planning by increasing stakeholder engagement as well as to better understand stakeholders' priorities following a significant event.

1 Iwi are extended kinship groups often a large group of people descended from a common ancestor and associated with a distinct territory in New Zealand.

Abstract

In 2018–2019, the Wellington Region Emergency Management Office in New Zealand, in partnership with Te Hiranga Rū QuakeCoRE, ran a series of workshops on the five recovery environments (built, cultural, economic, natural and social) to develop the region's recovery framework. To get balanced and diverse perspectives, workshop attendees included representatives from central and local governments, iwi¹, community groups, businesses, not-for-profits and academia. This paper uses a case study to highlight the challenges and opportunities of a collective partnership approach to pre-event planning. The workshop outputs are used to develop a regional recovery framework and to improve emergency management engagement before and after an emergency event. This paper demonstrates and evaluates a novel approach for engaging stakeholders about pre-event recovery planning. This can guide similar efforts for Civil Defence and Emergency Management agencies in other locations in New Zealand as well as elsewhere.

Te Hiranga Rū QuakeCoRE encompasses four technology platforms and six flagship programs of multi-disciplinary research undertaken to improve how communities recover from and thrive after major earthquakes. As part of the QuakeCoRE Flagship 5 Programme, Resilience in Practice, it was decided that the Wellington Region could be a case study to understand the perceived roles and responsibilities of agencies and organisations in a recovery context.

To this end, the WREMO and Te Hiranga Rū QuakeCoRE Flagship 5 developed five three-hour workshops on post-disaster recovery across the five recovery environments of built, economic, cultural, natural and social environments. These workshops were held between November 2018 and June 2019 in Wellington, Aotearoa-New Zealand. In total, 208 people attended the workshops from sectors including planning and policy, health and social services, central government, regional and local authorities, utilities and insurance as well as some private organisations. Each workshop averaged 42 participants.

The key objectives of the workshops were to:

- build relationships among future recovery partners
- create a shared understanding of the recovery context
- prioritise potential activities in short-term and intermediate recovery
- identify future partners and capabilities
- explore potential cross-environment partnerships.

Methodology

A ‘capitals framework’ was adopted for the analysis of the workshop feedback. Initial thinking on a capitals framework was developed by Flora and Flora (1993) who explored the concept

of resource mobilisation through different infrastructures such as social and physical. This was adapted in later literature to concentrate on how to mobilise resources throughout the cycle of a disaster. The capitals construct originated from the economics discipline (Miles 2015) and has broadened to include community capitals (Emery & Flora 2006, Aldrich 2012, Cutter *et al.* 2014, Gilbert 2011). While the core idea of recovery capitals is used in some emergency management frameworks in New Zealand, capitals are framed as ‘environments’. This project adopted the resilience capitals definitions developed for the Ministry of Civil Defence and Emergency Management (2019) *National Disaster Resilience Strategy* that uses the five environments as a model for a resilient nation (p.20), see Figure 1.

Activity design

This research investigated stakeholder input in the recovery planning. Data were collected from five workshops and from an online survey of attendees after the workshops. Survey questions explored levels of participation, what attributes of the workshops were useful to participants and what potential actions could be taken by individuals and groups.

This research received approval from Massey University; Ethics Notification Number: 4000020312.

Engagement

Each recovery environment encapsulates specialist knowledge, perspectives and relationships. To generate an effective workshop outcome, a range of participants was required to stimulate discussions and provide adequate context and expectations. To facilitate this, a working group was assembled

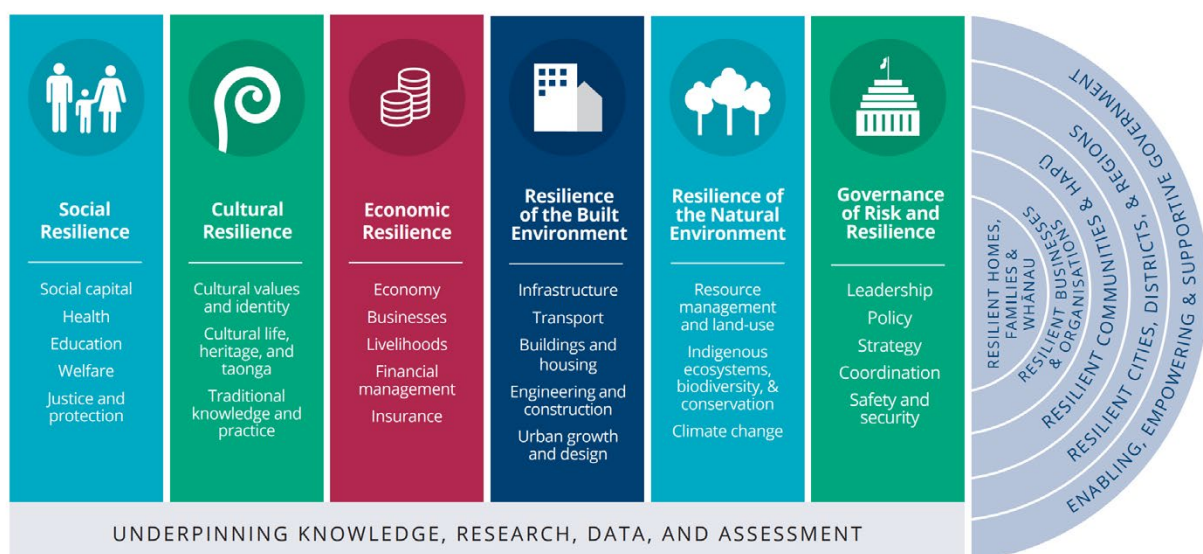


Figure 1: *National Disaster Resilience Strategy* model of a resilient nation.

Source: Ministry of Civil Defence and Emergency Management

before the first workshop (the cultural environment) to identify pre-workshop tasks and to leverage networks and knowledge. Working group members included WREMO, QuakeCoRE researchers and stakeholders from the cultural environment.

To create a breakdown of each recovery environment and the potential stakeholder engagement, each environment was split into possible groupings. For example, the built environment was split into 'transportation, land use and planning, utilities and buildings'. Using this information, a first wave of invitations was sent with subsequent invitations sent as more potential invitees were identified via the working group or by potential participants.

Workshop

Each workshop used the same base scenario to help participants imagine the disruption and damage they might face after a disaster. WREMO opted to use the magnitude 7.5 Wellington fault earthquake scenario outlined in the Wellington Region Earthquake Plan as it is used throughout the region and is consistent with national response planning. WREMO used staff knowledge, previous hazard and risk modelling and examples from other earthquakes to develop conditions for this scenario. Scenarios were projected to 30 days and 9 months after the event to align with the existing short- and intermediate-term recovery planning framework.

At most workshops (except for the natural environment workshop) guest speakers presented on work or topics relevant to that environment. Speakers generally made connections to the workshop and expanded on specific examples of their work or experiences in recovery.

Each workshop included an introduction, guest speaker presentation and an explanation of the scenario for that workshop. Three activities were facilitated with the participants and were in the same format for each of the five environments.

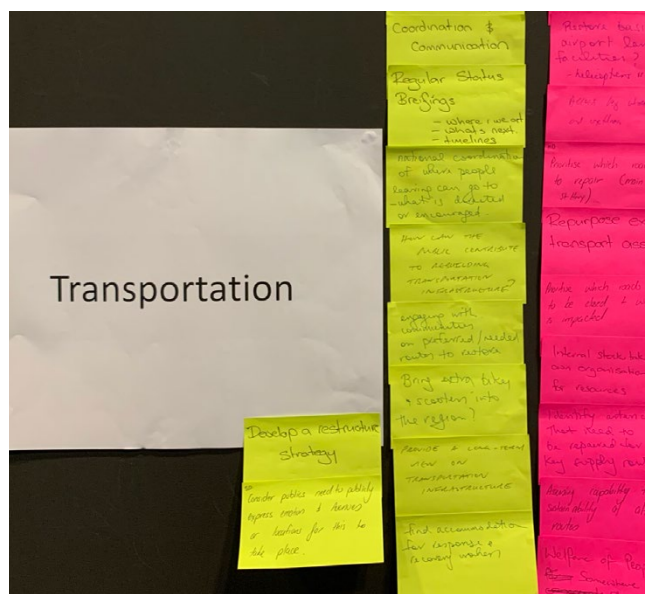
Activity one, identify potential activities, had two goals:

- To facilitate collaboration and networking among table groupings.
- To capture examples of short- and intermediate-term priorities for inform the recovery framework.

The activity was run in two parts. The first was to identify short-term priorities and activities and separate these into 'must do' and 'should do' activities. After discussion, the second half of the activity examined the 'must do' and 'should do' lists for intermediate-term recovery. Each part took approximately 20 minutes and the activity ended with a discussion.

For activity two, recognising future sector partners, participants were given handouts and asked to record the names and contact details of agencies and individuals who would be important to include in recovery planning and initiatives. Participants could also record why they considered these agencies and individuals important and what they might contribute.

For activity three, explore cross-environment collaborations, participants were asked to design collaborative recovery activities that included roles under each of the five environments. The purpose was to widen their thinking beyond their specific role. Participants were asked to present their ideas. These were then voted on by attendees to identify the most successful ideas.



Workshop participants identified short-term priorities and activities and categorised these into 'must do' (pink post-it notes) and 'should do' (yellow post-it notes).

Image: Lucy Kaiser



The Hon. Grant Robertson, Minister of Finance, Arts, Culture and Heritage and Sports and Recreation participated in group activities.

Image: Lucy Kaiser

Workshop analysis

Participants could take notes during activities and used post-it notes and printed forms. These different forms of data were drawn on to describe some of the key themes and concepts that arose.

Limitations

A limitation of the workshops was the different levels of familiarity and existing partnerships between the emergency sector and other environments. As WREMO had existing programs addressing infrastructure resilience and urban planning, staff had particularly good knowledge of the built environment relative to the other four. For environments where WREMO had less familiarity, they used small groups and one-on-one conversations with subject-matter experts. The primary purpose of these groups and conversations was to break down different focus areas within a recovery environment and identify agencies to invite to a workshop. The cultural environment working group was the most formalised, while the other four environment groups were largely conceptualised by WREMO with input from subject-matter experts.

As the cultural environment was one of the least familiar environments to WREMO and as it was the first workshop, it was beneficial to have a formal working group for planning. The other workshops had informal expert input largely through one-on-one conversations, rather than intensive working groups. As such, the understanding of components and potential invitees were not as robust as it was for the cultural environment workshop.

There may have been benefit in including other representatives as part of the data analysis team, such as working group members. While the outputs of the data review process chosen for this project seem adequate, it is acknowledged that other reviewers, particularly those imbedded in their sectors, would have different interpretations.

A final limitation was that only a small number of responses were received to the survey that was circulated to participants at the conclusion of each workshop. Survey responses are included for exploratory reasons and reflection as opposed to providing quantitative rigour to the evaluation process.

Activity results

A total of 208 participants attended the five workshops. The social and built workshops had the highest attendance rates (63 and 58, respectively), while 50 individuals attended the cultural workshop and the economic and natural workshops had the least number of attendees (26 and 31, respectively). The number of attendees is illustrated in Figure 2.

The difference in attendance could be due to multiple factors. Organisers relied on their knowledge of each environment and their relationships with organisations and individuals within these environments to compose the attendee lists. As organisers were most familiar with the cultural, social and built environments, it was easier to compose the attendee lists for these workshops. Additionally, the final workshop (economic) was held close to the

end of the financial year and individuals who may have otherwise participated might have been too busy to attend.

Attendees for each environment

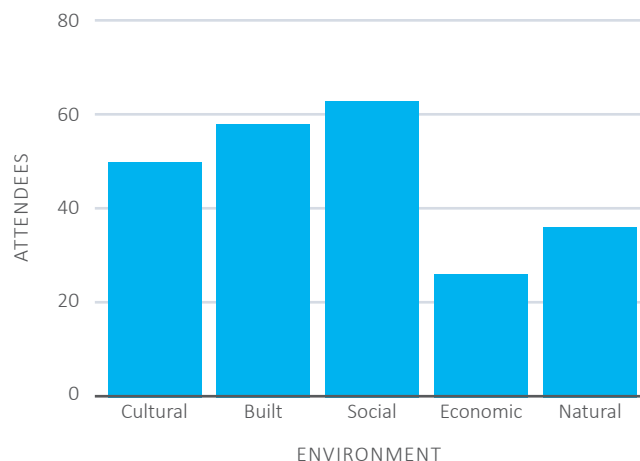


Figure 2: Total attendees across the five environment workshops.

Representatives from a broad range of stakeholder organisations were invited to improve the diversity of perspectives. However, participants tended to associate with individuals from the same agency. Organisers ensured a good range of different agencies made up each thematic table. Ultimately, 129 agencies were represented across the five workshops.

Activity 1: Identify potential activities

Activity one identified the short- and medium-term ‘must do’ and ‘should do’ activities in a disaster-recovery context. A comparative summary of activity one data outputs for each of the environment workshops is illustrated in Figure 3(A).

Participants produced 1272 unique data outputs (in post-it-note form) across the five environment workshops. The social and built environment participants produced the most outputs (379 and 308, respectively) and the economic and natural participants produced the least (139 and 160, respectively). However, the number of outputs per person for each workshop was fairly even with an average of six outputs produced per person across all five environments.

Observations

Participants took two approaches to the activity. They either discussed the prompts as a group and produced collective post-it notes representing these ideas or they took a more conversational approach on the prompts and produced individual thoughts on post-it notes. Both approaches were effective at getting people to think collectively about their sectors.

Several themes of discussion occurred universally across all of the five sectors. These were communications, business continuity planning, collaboration, community wellbeing, governance and legislation as well as planning and welfare. Perspectives on short- and intermediate-term planning were separated into:

- inwardly focused agency and organisational issues for returning to operations
- outwardly (and more holistic) focus around collectively catering to the interests and needs of communities and collaboratively assisting in the recovery of the Wellington Region.

Activity 2: Recognise future sector partners

Activity two identified future sector partners for disaster recovery, particularly those who were not at the workshop. A comparative summary of activity one data outputs for each of the environment workshops is illustrated in Figure 3(B).

A total of 554 organisations and agencies were named by workshop participants (repeats included). Natural and economic environment workshop participants generated particularly high outputs per attendee (approximately four outputs per participant). This may have been a reflection of the fewer attendees at the workshop or, potentially, there was less knowledge of these two environments.

Observations

There was minimal repetition in listing potential partners (e.g. of 116 suggestions from the cultural workshop, 109 were unique agencies and organisations). Suggestions ranged from very specific (a particular person with contact details) to more broad recommendations ('local marae' and 'oil companies'). This was primarily an individual activity and generated little discussion.

Activity 3: Explore cross-environment collaboration

The third activity facilitated collaborative thinking across all five of the environments. Participants compiled a recovery activity idea that included the cultural, built, social, economic and natural environments. A comparative summary of activity one data outputs for each of the environment workshops is illustrated in Figure 3(C).

There were 99 individual activity sheets created across all five workshops, varying in detail. Suggested activities ranged significantly and included community fun events aimed at raising morale to ideas looking at the long-term such as using the regional park network to house displaced people by creating mobile communities.

Observations

Participants seemed responsive to the competitive element of this activity; clapping and cheering loudly for their own ideas. There appeared a strong sense of pride from many participants related to their designed activities and a few participants requested to retain their activities to share with colleagues. It was also a useful mechanism for getting people to continue talking through lunch. Several tables of participants delayed handing in their designs at the conclusion of the activity so they could continue to talk further with others on the ideas. This was encouraging and is an indication that conversations and connections may be maintained.

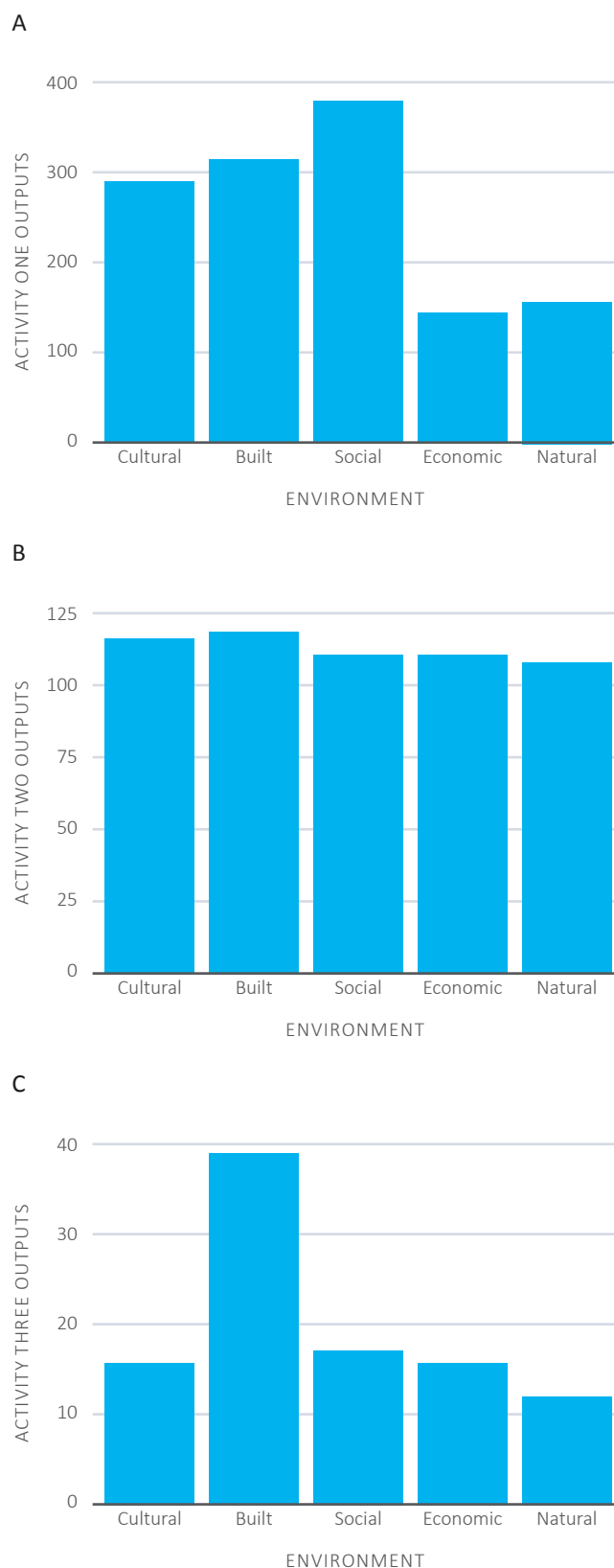


Figure 3: Comparisons of data outputs for activities one (A), two (B) and three (C).

Figures 3(A), 3(B) and 3(C) offer a comparison of activity outputs across each of the five environment workshops.

Evaluation and learnings

After the workshops, a tailored summary of each workshop and survey were sent to all participants. The summary included information on next steps and other opportunities for learning and engagement relevant to each environment (books, workshops and online modules).

In total, 27 survey responses were received across the five environments providing an average response rate of 12 per cent for each workshop. The survey consisted of two closed questions and three open-ended questions. Question one asked what environment sector the respondent represented and question two was a Likert-style question asking respondents 'how useful did you find the workshop?' In answer to question two, 26 respondents (all but one) rated the workshop as either 'very useful' or 'somewhat useful'.

There were three additional open-ended questions in the survey to evaluate the effectiveness of the workshops and to improve the development and facilitation of similar workshops. These questions were:

- Q3 - *What were the most useful parts of the workshop?*
- Q4 - *What parts of the workshop could be improved in the future?*
- Q5 - *What, if any, action do you intend to take as a result of the workshop?*

Several respondents addressed multiple points in a single answer while others responded to one or two of the open-ended questions.

Q3 - What were the most useful parts of the workshop?

There were 20 responses to this question. Eleven responses mentioned that networking, interacting and collaborating with other people in the environment/sector was the most useful part of the workshops. Six responses found the scenario and planning elements the most useful component of the workshops while other responses noted that lessons learnt from the Christchurch earthquakes, hearing from guest speakers and the contextual PowerPoint information was useful.

Q4 - What parts of the workshop could be improved in the future?

There were 19 responses to this question (excluding answers of 'not applicable' or 'nothing comes to mind'). Three respondents highlighted that more people from across the sector could have been present at the workshops. Three suggested that an introduction exercise to discover who was in the room would have been useful earlier in the workshop. There were also responses pertaining to the length and format of the workshop activities with three respondents suggesting more time for discussions and presenters. Two respondents suggested that the activities took too much time and five respondents stated that more clarification was needed on the exercises in the pre-workshop communication and whether experts were there to learn or contribute. The table groupings were an issue for two

respondents who would have preferred bigger groupings as opposed to smaller groups across two tables and that similar organisations needed to be grouped together. Other responses referred to the diversity of communities addressed in the scenarios, relevance of the workshop to particular stakeholders, a need for tailored advice for each sector and suggestions about catering and parking.

Q5 - What, if any, action do you intend to take as a result of this workshop?

There were 22 responses to this question with actions ranging from individual and personal disaster preparedness actions to business continuity and organisation-wide actions. Personal actions included getting water tanks for the home. More broadly, participants mentioned reading more, reconsidering personal emergency plans and being more 'ready' in general. Individuals also discussed actions they could take to increase their organisation's preparedness such as displaying mental health information in their office and sharing PowerPoint presentations from the workshop with their team. Team-based actions included preparing or revisiting business continuity plans (three responses), pursuing collaboration opportunities with other agencies in the sector (three responses) and improving organisational planning in general (two responses). Some miscellaneous actions included reflecting on lessons learnt from the past, understanding the diversity of clientele and a call to action for WREMO to be inclusive of Māori and Pacific Islander identity in their recovery planning.

This feedback was useful to understand participants' thoughts on the core themes. To improve feedback quality, participants could fill in a physical copy of the survey at the conclusion of the workshop and leave with organisers. This has potential to increase the number of responses. In addition, meetings with a selection of stakeholders from each workshop could be conducted.

Conclusion

Practitioner and researcher collaboration is important to deliver projects that are relevant to the often rapidly changing contexts that practitioners work in while maintaining a connection to researcher knowledge drawn from multiple areas. Using a recovery capitals framework brought a practical and academic framing to structure stakeholder engagement. Based on participant feedback and using recovery capitals (recovery environments in the Wellington Region) helped to bring together distinct communities-of-practice under each environment to share ideas, build cohesive networks and collaborate. Ideally, these connections may be maintained to build stronger recovery networks for each environment. The release of the *National Disaster Resilience Strategy* by the Ministry of Civil Defence and Emergency Management in 2019 and the increasing presence of capitals frameworks in policy and legislation both locally and nationally means that this approach is in-line with current policy framing in the sector.

The workshop format allowed participants to understand the roles, responsibilities and potential contributions of other organisations and the relevance of organisational capacities and

capabilities using a disaster-recovery scenario. It also enabled participants to think about the ways everyone can collaborate across the environments to aid in recovery and how they can effectively work together now within current decision-making contexts. The findings from these workshops have informed the development of WREMO's regional recovery framework. There is considerable scope for future initiatives of this kind that raise awareness, broaden perspectives and build networks to support decision-making and recovery planning.

Regular engagement with sector partners is important to build relationships and trust and for people to work together if a major disaster strikes in the region (Doyle *et al.* 2015, Doyle & Paton 2017). This aspect is crucial when establishing recovery work plans and initiatives inclusive of region-wide stakeholders in disaster recovery. It would be useful to develop an overarching strategy that regularly engages workshop participants and other sector stakeholders in activities (e.g. discussion forums, workshops, conferences, training, online initiatives and talks). Some of these activities may already exist (e.g. conferences) and could be identified in future planning as current activities; others may need specific development.

Future activities that enhance the quality of recovery planning in the Wellington Region could be workshops that promote intra- and inter-environment collaborative discussion. Working groups should be identified for the environments consisting of stakeholders from each sector to inform recovery-based activities as part of an enduring relationship-building process. Topics could focus on specific applications of a major earthquake scenario, hazard agnostic discussions of effects or how agencies can be proactive in 'working backwards' from recovery planning to reduce risks and prepare for likely outcomes. WREMO will begin this process using periodic newsletters and providing the regional recovery framework publicly as a resource for agencies other than Civil Defence and Emergency Management to reference as well as host disaster-recovery exercises.

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Abstract

The challenges facing settlements relating to bushfire require integrated approaches that manage risks across a wide range of factors. This paper sets out a framework demonstrating how urban planning, when coupled with appropriate decision support and future scenario testing, can reduce risks relating to bushfire while considering future growth. Examples of how planning can modify aspects of risk in association with scenario testing are included. Five main categories of risk reduction treatments are shown. The paper contributes to risk reduction by providing practical mechanisms for risk avoidance and treatment via urban and land-use planning systems combined with forward scenario testing to guide existing settlements and future growth.

Urban planning capabilities for bushfire: treatment categories and scenario testing

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Introduction

Bushfires pose significant threats to life and property. The frequency and intensity of bushfires is increasing in association with worsening weather conditions that support extreme fires (Dowdy 2018) and ongoing settlement growth (Allen 2018). The intensity, duration and scope of bushfires during the Australian 2019–2020 summer highlighted this, exacerbated by the fact that the highest risks generally occurred when fires impact on human settlements where housing and other structures are in proximity to flammable vegetation. While considerable knowledge already exists in this field, this paper seeks to clarify and strengthen the principles for urban planning as a mechanism for integrated risk reduction.

The challenges facing human settlements relating to bushfire require integrated approaches that manage risks across a wide range of factors. Bushfire frequency, intensity, location and other characteristics influence human activities and the multiple ways the land is occupied. Bushfire risk profiles in a specific location can be understood as a function of the characteristics of the bushfire hazard, exposure to that potential bushfire and the level and type of vulnerability in a given location. These aspects comprise the ‘risk triangle’, shown in Figure 1. On the left are the main elements comprising bushfire risk. On the right, the reduced bushfire risk is shown along with indicative actions that can reduce risks. This paper sets out a framework demonstrating how urban planning, when coupled with appropriate decision support and future scenario testing, can reduce bushfire risks. As a hazard, bushfires progress through landscapes and are influenced by general characteristics of:

- ignition, location and timing
- vegetation fuel loads, arrangement and continuity
- topography
- weather conditions including humidity, temperature, wind speed (Country Fire Authority, 2007).

The risks of negative consequences including deaths, physical and psychological injury, property loss and environmental

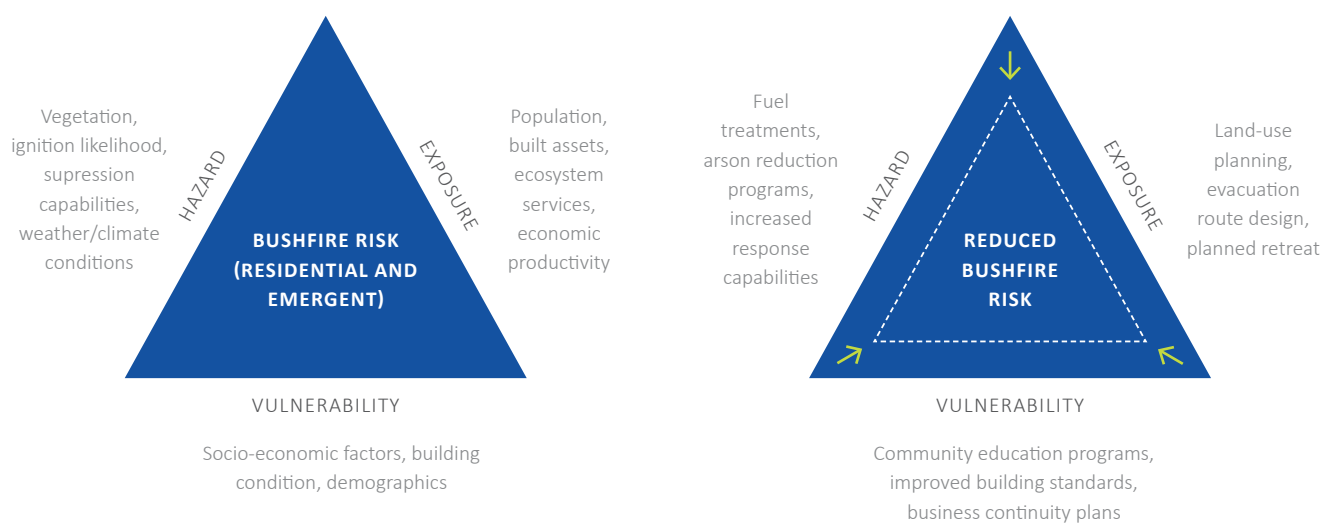


Figure 1: The risk triangle is a combination of exposure, vulnerability and hazard for bushfire risk.

Source: adapted from Crichton 1999

loss, relate to exposure to the bushfire and being vulnerable when exposed. This can be expressed as a function of proximity to the vegetation that is burning (Blanchi *et al.* 2014) and being vulnerable to the effects of the hazard such as a lack of shelter for humans and combustibility of structures (Blanchi *et al.* 2014). Urban planning provides powerful mechanisms to manage and improve many of these bushfire risks.

Urban planning and human settlements

While existing urban structures remain as a legacy of previous decisions, most settlements are also dynamic, changeable and multi-faceted in the ways that growth, change and decline occur temporally and spatially (March 2016). Urban planning generally seeks a middle ground between allowing individual and market-based freedoms alongside providing coordinating parameters and minimum standards. This seeks to ensure that overarching economic, social and ecological functions are not undermined by self-interest. It avoids urban development being excessively risky resulting from uncoordinated individual and private interests that ignore overall risk assessments.

Urban planning is essentially a decision system concerned with identifying appropriate land-use and development futures and seeking to bring that into reality. Thus, Australian urban planning should influence many factors relating to bushfire risks even while a range of complicating factors may erode the ability for planning to be effective. These factors include politics, legacy issues, property interests and ineffective enforcement (e.g. see March & Kornakova 2017). In broad terms, the location and design of buildings and the activities conducted on that land are under the remit of zoning, regulation and related systems, such as the building code. The ways in which roads are designed, materials are used in and around structures, land is cleared,

vegetation is managed and the size and shape of building lots are generally under the control of planning and building systems.

Figure 2 represents a generic layout of a residential development near flammable vegetation. Influencing the structure's exposure to bushfire is a combination of multiple components including the distance to and type of vegetation, the construction of the property to reduce vulnerability to fire and the road network layout suitable for emergency services response and evacuation.



Figure 2: A property's risk from bushfire includes its location relative to vegetation, access routes and building design.

Importantly, as well as risk-related matters, planning is also required to identify multiple and sometimes conflicting goals such as those linked with economic productivity as well as social and environmental sustainability. These can be challenged by many legacy existing settlement patterns. Further, planning is often confounded by excessive complexity, challenging bureaucratic structures, interest groups, policy failures in relation to climate change, heavy population growth (especially in Melbourne and Sydney) and a lack of information to inform

decisions. This paper argues that the potential of urban planning to manage and act on key elements of the built-form relating to bushfire risk can be improved significantly. This can be achieved through consideration of urban planning influence across prevention, preparedness, response and recovery. Using appropriate scenario testing of planning effectiveness under different future conditions highlights urban planning efficacy in bushfire risk reduction.

Urban planning risk treatments for bushfire risk

Avoidance of exposure to hazards

The short-term mechanisms for death and injury resulting from bushfires are heat, flames, suffocation and poisoning. This is followed by secondary causes associated with firefighting or injuries from car crashes or falling trees and debris (Blanchi *et al.* 2014). Structures are damaged and destroyed by bushfires via heat, direct flame contact, ember attack and secondary aspects such as extreme winds, falling trees and flying debris (Blanchi, Leonard & Leicester 2006).

A risk-treatment approach is to minimise exposure to bushfire, mainly by avoiding exposure altogether in the first place, before any need for subsequent remediation (see Figure 3). A key focus of strategic urban planning is to manage overall residential growth patterns particularly in peri-urban areas. It is at this stage of decision-making that exposure can be limited or avoided altogether. Further, the need for urban planning to manage competing demands avoids some of the detailed issues of self-interest, land ownership, local politics and the 'work-arounds' and excessive expenditure resulting from prior decisions.



Figure 3: Through avoiding exposure to the hazard, risks to property are precluded.

In simple terms, if housing, infrastructure and land development and growth are directed away from high-risk areas then risk to property and populations can be avoided altogether. In addition, exposure of emergency responders to further risks is reduced. Locations with high bushfire risk topography, vegetation, weather systems and other risk factors should be identified and assessed early. Urban planning processes and terminologies vary across

Australian jurisdictions, but each state and territory allows for the coordination of urban development via growth corridors and plans, settlement area plans and expansion areas. Similarly, parks and reserves, biodiversity areas, farming and rural zones, vegetation protection areas and limited-growth areas can be identified and managed giving consideration to their value as well as to bushfire risks. It is worth noting that even if some areas have been developed previously, it may be worthwhile restricting or modifying future change to appropriately manage risks.

Reduction of hazard impacts or exposure in situ

Urban planning and hazard treatments can be undertaken at a range of spatial scales. It is sometimes appropriate to employ site-based treatments that manage exposure and impacts on communities at the precinct or site scale. This is usually in areas where overall risk is assessed as low or to remediate existing areas. The clearing of vegetation around new or existing structures or urban-edge areas is a way to reduce heat, flame contact and, to some extent, ember attack on structures (see Figure 4). Fuel-reduction measures, often carried out by property occupiers or land management non-planning agencies, can reduce the intensity and behaviour of fires. It is common that clearing or fuel reduction occurs in parallel with new structures being sited (if lot size allows) away from the likely worst effects of a future fire.

The risk treatments described will have implications for other aspects of land and urban management that should be considered. Fuel reduction via prescribed burning or mechanical means has resource and environmental implications as well as aesthetic and health concerns. Further, the density of buildings, sizes of building lots and amount of vegetation clearing required will have implications for social, economic and environmental outcomes. This will also have implications for the multiple goals sought by planning authorities in a location. For example, large building lot sizes may allow for the retention of significant vegetation but result in low yields in terms of new housing provision. Larger lots may also be difficult to service in terms of infrastructure and basic services.



Figure 4: Property occupiers can reduce the bushfire risk reduction by removing vegetation nearest to the property to reduced bushfire hazards.

Reduce vulnerability or increase resistance in situ

Vulnerability is the status of an individual and the 'extent to which a community, structure, service or geographic area is likely to be damaged or disrupted by the impact of a particular hazard' (Australian Institute for Disaster Resilience 2015, p.118). Reducing vulnerability in situ, while related to exposure (proximity), is distinct and is a function of the characteristics of the particular at-risk element and its ability to withstand the hazard. In terms of bushfire, this aspect includes social and physical elements (see Figure 5).



Figure 5: Property occupiers can reduce the vulnerability by installing on-site water supplies with a water tank and a sprinkler system.

Improving structures to withstand ember attack, heat and flame contact is a key aspect of physical resistance. It is achieved mainly via the application of building code AS-3959-2018 Building in Bushfire Prone Areas, combined with planning regulations related to siting and vegetation management. Social aspects of vulnerability relate to the variable capabilities and vulnerabilities of people when they are exposed to bushfire. For example, the vulnerability caused by locating aged care, medical facilities, childcare centres or schools in bushfire-prone areas. Additionally, social-economic status and disadvantage typically worsen vulnerability in multiple ways. Other factors such as demographic change over time, can modify vulnerability as the characteristics of a population change.

Australian urban planning systems have traditionally managed land use and development using regulations and issuing permits to ensure compliance with the standards. Significant vulnerability and physical resistance can be delivered by these traditional zoning and regulation approaches. This can be done by withholding permission for development that does not manage risk. Significant gains can be made by improving the physical resistance of structures and by limiting people's presence in bushfire-prone areas.

Improving response

Response is action 'taken in anticipation of, during and immediately after, an emergency to ensure that its effects are minimised' (Australian Institute for Disaster Resilience

2015, p.112). In bushfires these actions include warnings and evacuations; active defence by emergency services personnel, trucks and planes fighting the fire; and rescue operations, provision of relief and medical care. Careful coordination and deployment of resources are key to success during response activities. Integrating related assistance from police, local government, earthmoving companies and interactions with news media are all important aspects.

While urban planning does not play a direct role in response, the design and management of urban areas can significantly affect the need for, and effectiveness of, response at a range of spatial scales. Three main areas of response can be positively facilitated via urban planning (see Figure 6):

- provision of water for firefighting
- ensuring movement in and around settlements, access and active defence facilitation around structures
- location of fire stations, refuges and safer places.



Figure 6: Property occupiers can improve their response capacity with road networks that allow improved access for response vehicles and evacuation.

Response is typically seen as an emergency services agency activity. However, the actions of members of the community related to how they prepare themselves and their homes and their willingness and capacity to evacuate promptly are key aspects in reducing risk.

Improving recovery

Recovery is the 'process of supporting affected communities in the reconstruction of the built environment, and restoration of emotional, social, economic, built and natural environment wellbeing' (Australian Institute for Disaster Resilience 2015, p.112). In bushfires, destruction includes deaths; losing houses, businesses and farms; significant changes to the natural environment as well as other far-reaching economic and psychological effects. Recovery can restore as many features of the previous circumstances as possible to assist with a return to normalcy. However, a contemporary view of resilience is that there is a significant opportunity to improve risk profiles during recovery (Meerow, Newell & Stults 2016).

The opportunity to improve risk profiles in recovery is not always taken up. Urban planning in Australia often has limited formal ways to contribute during recovery. An alternative would be to establish mechanisms to identify potential improvements for risk-prone areas before events occur. This could allow considered approaches to be developed. Fundamental improvements to the risk profiles of settlements are possible especially during recovery phases. Realignment of building lots, buy-back schemes and relocations such as the township of Grantham in Queensland after the 2011 floods, improving structures, changes to access and response capabilities and careful location of sensitive land uses are good examples (see Figure 7).



Figure 7: Property owners could reduce risk by making changes to road networks for response access, reducing exposure to hazards by relocating further from a managed vegetation area and improving resistance with provision of on-site water storage.

Decision support systems and scenario testing

Scenario testing of urban planning alternatives allows for policies, plans and infrastructure developments to be tested against future plausible conditions to consider their effectiveness or consequences. In bushfire risk reduction and urban planning, the process of scenario testing can be used, for example, to consider future alternate urban developments against population growth scenarios and their effects on bushfire risks. Scenario testing allows assumptions to be used to assess changes in bushfire risks, how possible growth will emerge into the future and how residual risks vary given factors of population and economic development, climate change on future bushfire intensity and likelihood and influence of urban planning risk reduction measures.

Scenario testing must be transparent, consistent and systematic. Decision support systems allow for the modelling of risk both spatially and temporally and for the implementation of risk reduction options (Newman *et al.* 2017). The Unified Natural Hazard Risk Mitigation Exploratory Decision (UNHaRMED) support system was designed in Australia in collaboration with government agencies to understand risk and inform risk reduction planning (Riddell *et al.* 2016). Results from UNHaRMED

highlight the role of scenario testing for comparison and visualisation of urban planning risk reduction methods and demonstrating how urban planning can reduce future bushfire risk.

In this paper, comparisons are made for different risk treatments applied to reduce risk in 2050 versus the baseline risk shown in Figure 8, which shows components of risk including vegetated areas and exposed residential and agricultural properties (Figure 8, left panel). The right panel shows the bushfire risk based on fire behaviour, asset exposure, building type vulnerability and response effectiveness. The risks shown relate to vegetation being near to a rural settlement.

Scenario testing linked with urban planning processes are shown to assess growth and change in a region. This allows the spatial expression of dynamic bushfire hazard and risk over time. It also shows the interaction between dynamics such as urbanisation reducing vegetated areas, while increasing exposure and the provision of infrastructure supporting urban growth, as well as ignition likelihood, suppression accessibility and evacuation routes. Figure 9 shows the same area as Figure 8 but, in 2050 (a simulated future using UNHaRMED), considers population and economic drivers. The risk shown is significantly increased due to residential sprawl and a large wildland and urban interface.

The following examples set out core areas of bushfire risk assessment and treatment that can be undertaken via urban planning. Illustrative examples based on scenario testing are provided as an explanatory aid and should be understood as components of overarching risk treatments that integrate a suite of approaches, rather than stand-alone 'fixes'.



Development in urban fringe areas highlights the vital role urban planning can play in improving the survival of dwellings in bushfire events.

Image: Bushfire and Natural Hazards CRC

Modelling undertaken for this analysis shows results compared against risks in 2018 and 2050 (Figures 8 and 9, respectively) to examine the effects of the risk treatment. Residential growth can be seen in the left-side panel, which is highlighted by the increased risk from bushfire (due to high exposure values) in comparison to Figure 8.

Scenario modelling testing spatial planning to avoid exposure to hazards is shown in Figure 10. This scenario uses zoning to restrict urban development in the areas adjacent to vegetation and instead infills development within the existing urban areas. Comparing Figure 10 to Figures 9 and 8, there is less urban

development in risk areas and there is significantly different bushfire risk between the two 2050 scenarios. Reduced ‘extreme’ risk can be seen in areas surrounding vegetation as residential development has been restricted from there, although risk remains ‘high’ due to the value of agricultural activity.

Figure 11 shows the effectiveness of hazard reduction. In comparison to Figure 9 of baseline development and risk in 2050, the left-side panel of vegetated area has been reduced adjacent to residential development. The left and centre section of vegetation has been reduced in area and the right section

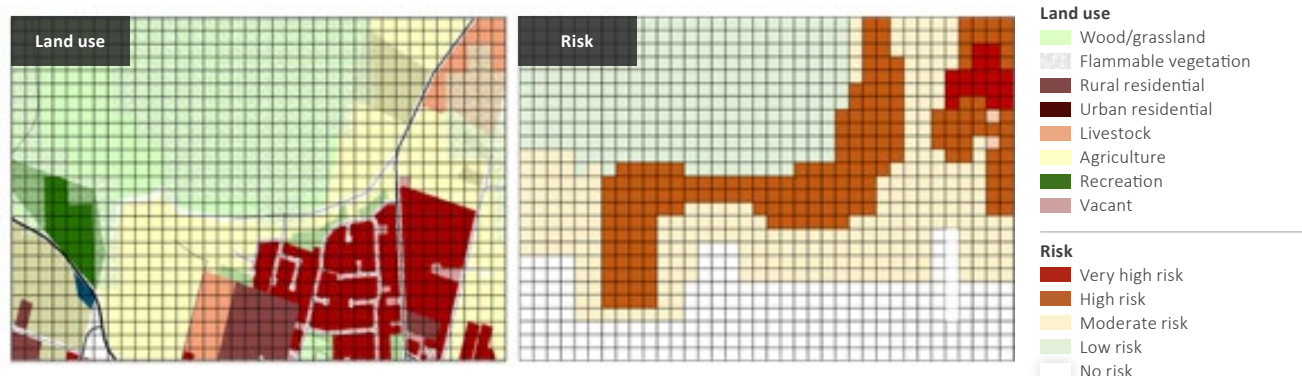


Figure 8: 2018 development layout (left-side panel) and bushfire risk (right-side panel).

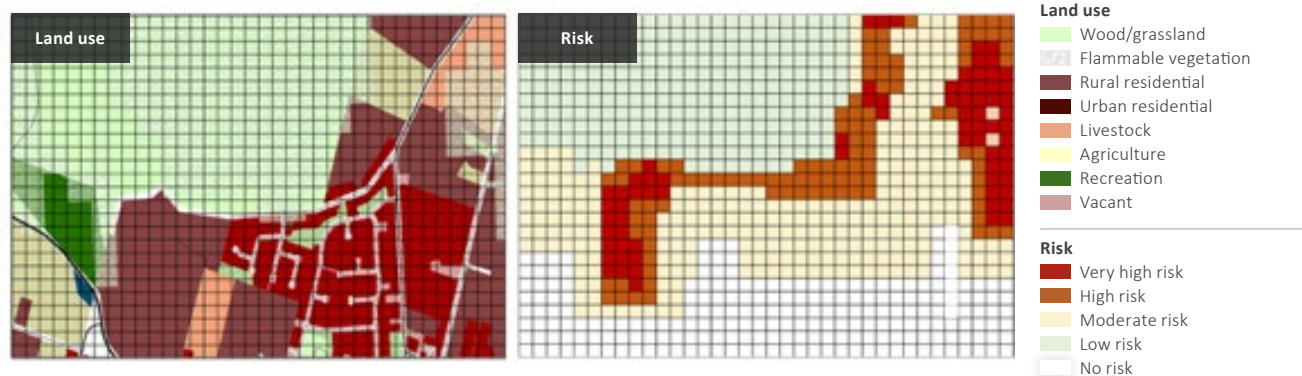


Figure 9: 2050 development layout (left-side panel) and bushfire risk (right-side panel). Higher levels of risk can be seen compared to the 2018 risk (Figure 8) due to the expanded residential development and its greater interaction with vegetated areas.

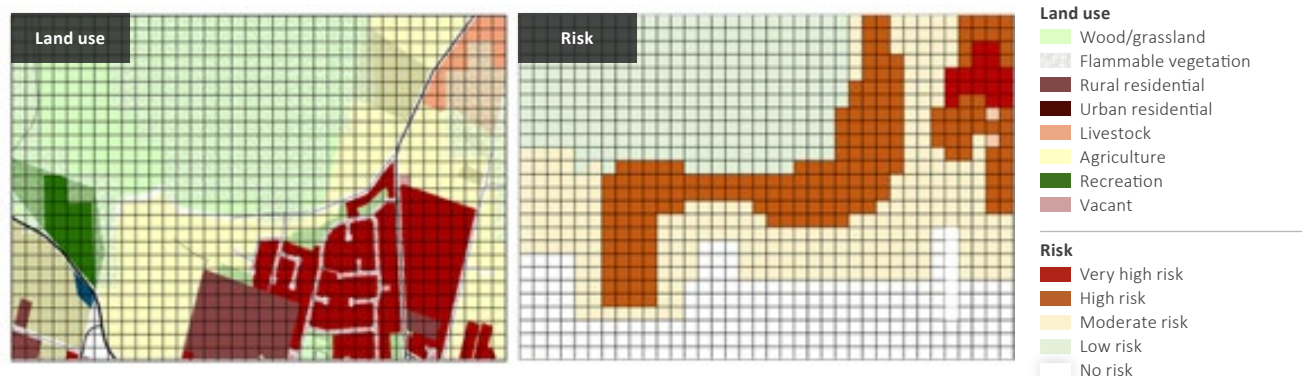


Figure 10: Bushfire risk and development of the rural settlement in 2050 with zoning strategies implemented to restrict development in areas adjacent to vegetation.

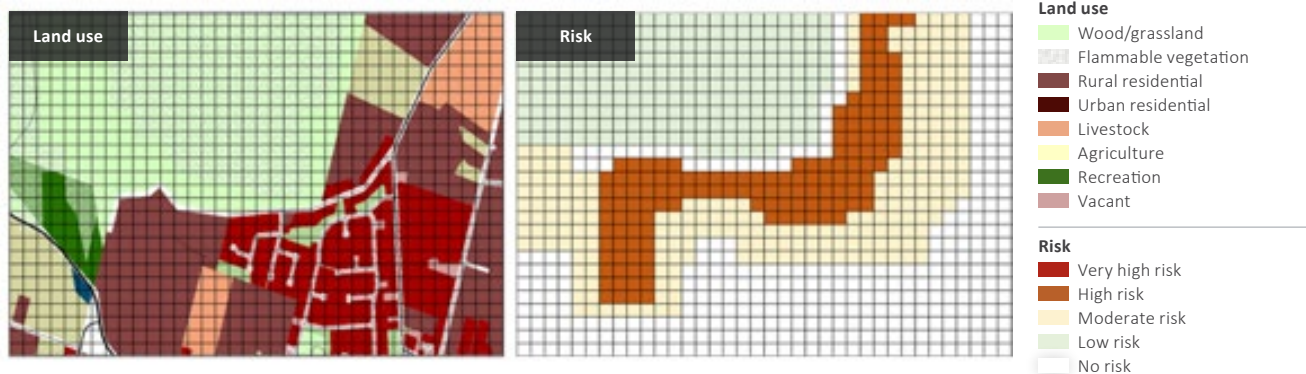


Figure 11: Hazard treatments applied to developments in 2050 shows reduced vegetation in the left-hand-side panel in comparison to Figure 9, showing reduced risk in areas adjacent to the large vegetated area and completely removed in the right-hand section of the risk panel. Although the development is the same as Figure 9, the risk is reduced as the hazard has been.

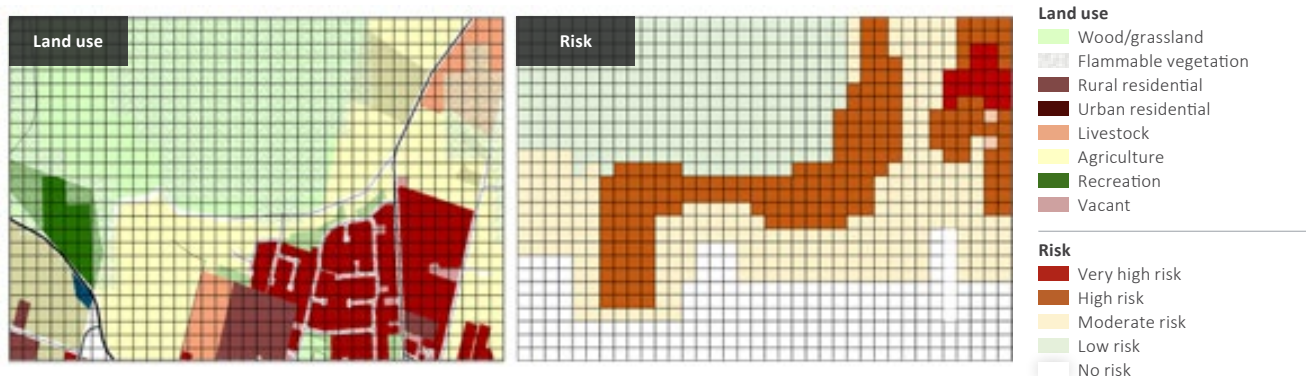


Figure 12: Scenario modelling of bushfire risk in 2050 with reduced vulnerability to bushfires. The left-side panel shows the development equal to the baseline residential growth for 2050 in Figure 9. The right-side panel shows reduced risk from bushfire compared to Figure 9 as due to improved levels of building controls.

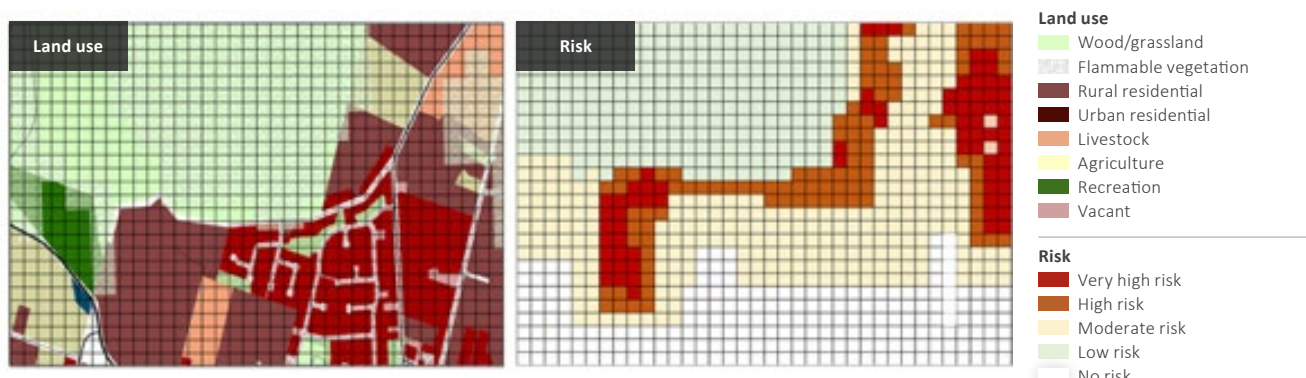


Figure 13: Scenario panel of 2050 with improved response by providing increased connectivity of the road network in the left-side panel compared to the baseline scenario of 2050 in Figure 9. This shows reduced risk in the right-side panel with roads providing fire breaks and access and egress for response and evacuation actions.

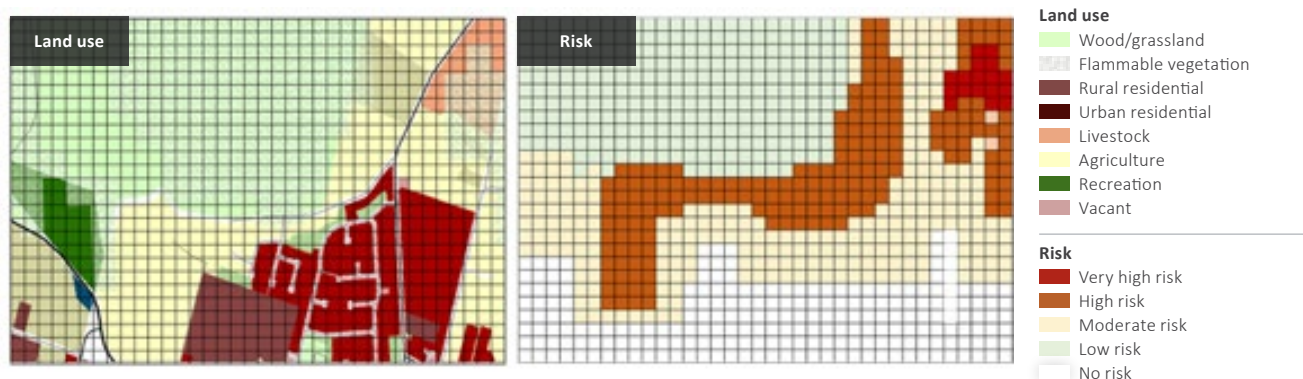


Figure 14: Risk in 2050, when a combination of treatments, is implemented including improved road access, zoning to restrict residential development in areas adjacent to vegetation and improved resistance to bushfires. Compared to Figure 9, changes in development patterns can be seen on the left-side panel and in bushfire risk on the right-side panel.

of vegetation has been removed entirely. This has significantly reduced risk as shown in the right-hand panel.

Figure 12 shows scenario testing demonstrating reduced vulnerability of residential structures to bushfires. The left-side panel has the same hazard (vegetation) and exposure (residential development). However, in the right-side panel in comparison to Figure 9 (with the same hazard and exposure extent), the risk is decreased. This decrease is due to implementing stronger building codes for new developments in years 2018–2050. These new developments have increased resistance to bushfires and a reduced risk is shown in the right-side panel.

Figure 13 highlights the scenario testing showing the influence of urban planning actions to improve response and reduce risk. In the left-side panel (compared to Figure 9) road networks have been improved, including a boundary road between vegetated areas and residential developments. This provides a fire break and improved access and egress for response and evacuation activities. Road networks have been improved and have reduced risks as shown in the right-hand panel (compared to Figure 9).

Scenario testing also provides opportunities to highlight the role of urban planning after events. This is shown in Figure 14 by bringing together many of the other treatment elements shown in previous scenarios for 2050. These include improved road networks for response actions, increased resistance via building and design codes in the built-form and reducing exposure through zoning.

Conclusion

Treating bushfire risks in settlements requires integrated land-use planning and design. This paper showed ways that bushfire risk profiles can be understood in terms of the interactions of bushfire hazards, exposure to actual or potential bushfires and the level and type of vulnerability (or resistance) of housing and communities in any given location. Treatments of bushfire can be categorised into five types of exposure, reduction of hazard or exposure in situ, reducing vulnerability or increasing resistance, improved response and improved recovery. Ideally, a combination of all five treatments is best; using urban and regional planning combined with building and other mechanisms.

A decision support system was used to model various scenarios of combinations of treatments. Modelling allows the management of urban and regional land to help direct growth and change over time. This allows for the most appropriate management of the risks associated with bushfire hazards while achieving many other objectives possible through urban planning mechanisms.

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Stakeholder engagement for disaster management in master-planned communities

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Introduction

Strategies for population and urban growth management in South East Queensland include the development of large, residential master-planned communities (MPCs) within the region's peri-urban (urban fringe) landscapes (Queensland Government 2017a). Some of these are designated by the state government as Priority Development Areas (PDAs) that streamline land-use planning and assessment processes and, in some cases, shift these responsibilities from the local council to the Queensland Government. Some local government disaster managers¹ have formally expressed concerns about their ability to advance strategic disaster planning when large, prioritised residential MPCs (PDA MPCs) are expanding within local jurisdictions.

In Logan City in South East Queensland, two large, state-managed residential PDA MPCs are emerging. Interviews with Logan City Council disaster managers indicated a need for better engagement with the PDA MPC planning and development decision-makers to gain improved knowledge of changing and future landscapes. Better integrating land-use planning and disaster management for building community disaster resilience is widely advocated in policy (Queensland Government 2017b, Queensland Government 2017c, Planning Institute of Australia 2016), but still faces challenges, including optimising engagement (e.g. March & Leon 2013). Such engagement implies working together, collaborative action, shared capacity and strong relationships (Australian Emergency Management Institute 2013). Models of effective engagement (some have been developed in the disaster management space) include identifying and engaging stakeholders and resources, information sharing and ongoing commitment. They offer a conceptual framework for this area of research (e.g. Australian Emergency Management Institute 2013, National Research Council of the National Academies 2011).

¹ Terms of disaster management, managers and planning are often used in Queensland instead of 'emergency' and also in the context of this study.

Abstract

Stakeholder engagement is an important part of planning for emergencies and disasters. This paper describes and discusses the processes of engagement, particularly information sharing, between local government disaster managers, land-use planners and the developer of a large master-planned community in Logan City in South East Queensland. Due to its large scale and importance for the local economy, this development has been designated as a Priority Development Area by the Queensland Government, meaning that approval processes are managed by the state rather than the local government. This study found that local disaster managers are keen to promote strategic disaster planning by improving their engagement with state-level planning, development and assessment processes governing priority development areas. Collaboration with local 'place managers' emerges as a potential way forward. A better understanding of the roles, responsibilities, accessible information and opportunities for collaboration across stakeholders and between disaster management and planning frameworks can facilitate improved outcomes for emergency and disaster management.

Aims

This was an exploratory study using Logan City as a case study. Using a concept of ‘engagement’ as the liaisons and means that immediately support information sharing, the aims of the study were to:

- capture and report expert knowledge and reflections of contemporary engagement from active participants in a development-and-disaster-management context
- understand the perceived gaps in information sharing and engagement that can hamper local, strategic disaster planning
- consider ways to facilitate better engagement based on suggestions and opinions from participants.

Stakeholder representatives who participated in this study comprised local disaster managers, emergency services representatives, land-use planners, development assessors (state and local level) and land developers. The insights offered during this study provide a basis for further research to analyse and critically evaluate specific current practices to identify improvements.

Disaster management and land-use planning frameworks

Queensland local governments assume lead responsibility for local disaster management within a hierarchical policy and management framework (*Disaster Management Act 2003* (Qld), Queensland Government 2018). Land-use planning and development assessment can, however, be managed locally, or in the case of some PDAs, at the state-government level.

In general, Queensland local governments, guided by state planning legislation and subordinate policies are responsible for local land-use planning and development assessment (i.e. the *Planning Act 2016* (Qld) replacing the *Sustainable Planning Act 2009* (Qld), Queensland Government 2017b). Considerations of hazard risks and community resilience are achieved through addressing state interests in the local planning scheme (i.e. Queensland Government 2016).

When the Queensland Government considers developments (including MPCs) to be of economic importance, they can be declared as a PDA and removed from the regular planning and assessment system under the *Queensland Economic Development Act 2012*. Planning and assessment are executed by Economic Development Queensland (EDQ)—the Queensland Government’s specialist, state-level land-use planning and development unit—unless development assessment is delegated to local government. In undertaking these functions, EDQ considers state planning policies and interests (i.e. those developed under the *Planning Act 2016* (Qld)). PDA declaration, however, reflects a clear government intention to expedite development. PDA planning schemes generally take precedence over other schemes and provisions to make appeals are limited.

Although PDA planning and development assessment functions have been turned over to local governments in several cases,

external management by EDQ is common and, therefore, warrants attention related to its engagement with local disaster management. Large MPCs in South East Queensland that are managed by EDQ include Yarrabilba and Greater Flagstone (Logan City), Caloundra South (Sunshine Coast) and Northshore Hamilton (Brisbane). Smaller developments are located near Gladstone (Central Queensland) and Townsville (North Queensland).

Figure 1 is a simplified illustration of the land-use planning, development and disaster-management frameworks. Indications of current ‘institutionalised’ engagement between entities is shown and reflects the present degree of separation between the existing structures.

Research methods

Research consisted of separate, semi-structured, face-to-face group interviews with volunteer stakeholder representatives relevant to disaster management and PDA MPC development in the Logan City area (see Table 1). Figure 2 shows the local government (council) area of Logan City and includes the PDA MPCs of Yarrabilba and Greater Flagstone, both managed by EDQ (Figure 2).

Before the interviews, participants were provided with proposed discussion themes covering a range of locally relevant disaster and risk management topics. These included the nature and efficacy of stakeholder engagement regarding disaster management for PDA MPCs. Local council disaster managers were interviewed first to focus the research around a local disaster management perspective.

After each group interview, the data were interpreted and a synthesised account of discussions was forwarded to the participants for ratification.



Figure 2. The Greater Flagstone and Yarrabilba priority development areas within Logan City local government area.

Source: Queensland Department of Infrastructure, Local Government and Planning (2017a). The information on the maps in this source is not intended for reference to specific parcels of land and should be treated as indicative only.

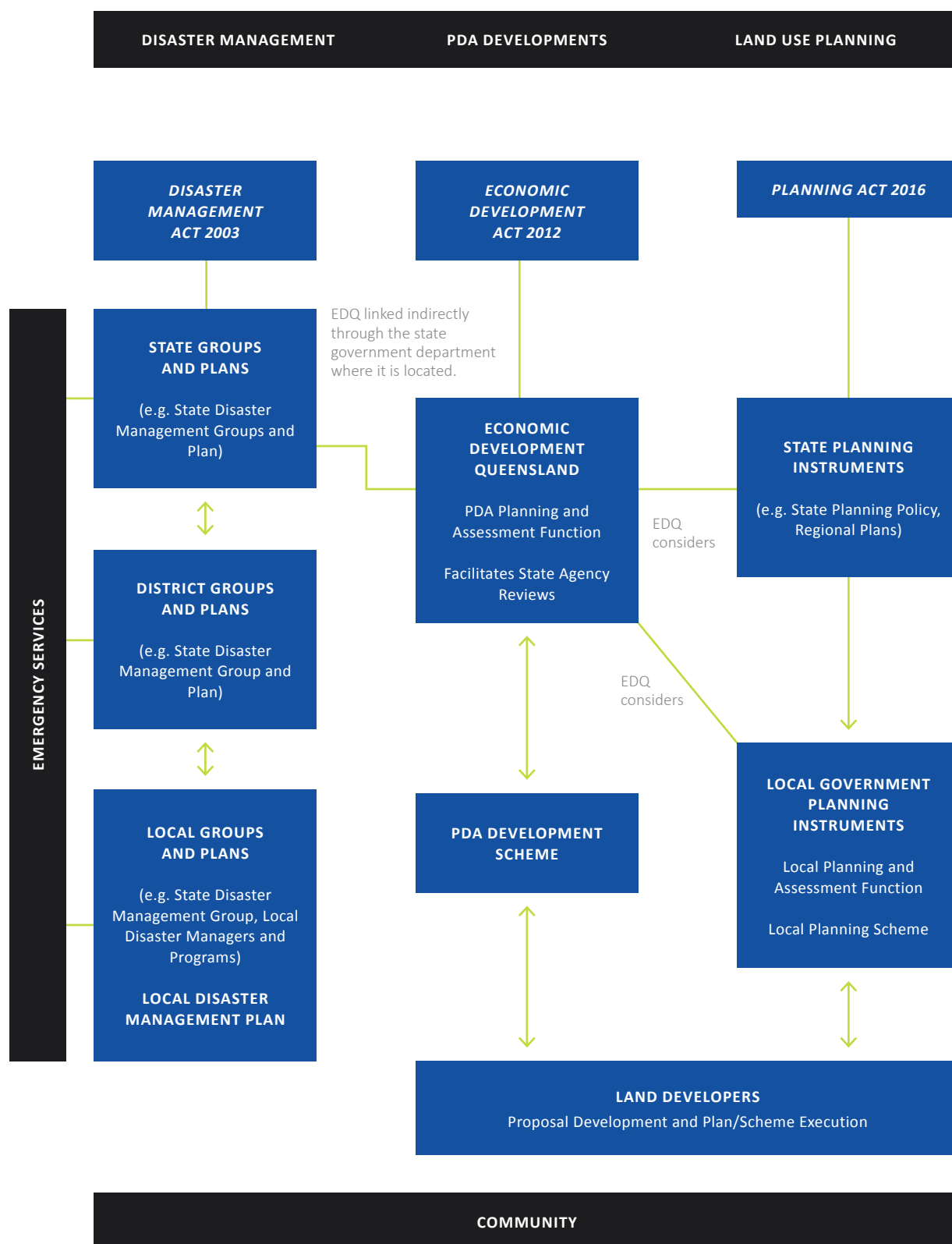


Figure 1: Simplified representation of the contemporary frameworks for disaster management, PDA development and land-use planning in Queensland showing the strong, formalised and institutionalised linkages.

Participants reviewed and returned them to the researchers. These final versions were manually interpreted and analysed qualitatively using a thematic content analysis to resolve narratives that specifically addressed the research aims. Analyses were conducted with reference to PDA MPC land-use planning and development and disaster management frameworks and guided by the study's conceptual model of engagement. Ethics approval was obtained from the Office of Research, Bond University (Bond Ethics Reference Number BB00054).

The reported results and discussion are based on the ratified stakeholder interview data and its subsequent interpretation, synthesis and analysis. As flagged, engagement here particularly refers to the liaisons and means that immediately support information sharing.

Logan City PDA MPCs

Yarrabilba and Greater Flagstone are characterised by their planned size, growth and fragmentation away from existing urban areas. Yarrabilba, located south of Logan Central, is a fast-developing MPC anticipated to house approximately 50,000 people on about 2200 hectares. The site is exposed to bushfire risk and flooding is an issue for some existing residences immediately downstream of the development, making the management of stormwater run-off an important consideration. The area is periodically affected by thunderstorms. Developer Lendlease participated in the research and is progressively developing Yarrabilba, where the population now exceeds 8000.² Greater Flagstone is similarly under development by Peet Limited. It is located to the west of Yarrabilba and has an expected population of 120,000 (Queensland State Development, Manufacturing, Infrastructure and Planning 2019).

Results: stakeholders' knowledge and reflections

Supporting local disaster management

The initial interview with the Logan City Disaster Management Program representatives (local disaster managers) revealed there were opportunities to progress information sharing and engagement between that group and the land-use planners and development assessors responsible for the Yarrabilba and Greater Flagstone PDA MPCs; both being managed by EDQ. Timely exposure to detailed, fit-for-purpose information on evolving or planned changes such as population size, demography, community infrastructure and the design of the built environment would augment the understanding of local council disaster managers of what the growth areas would look like in coming years. This could hence underpin enhanced strategic disaster planning for the area. Improving and formalising mechanisms for information sharing between local disaster managers and PDA planning and development stakeholders, including EDQ, state agencies and developers, was viewed as a way forward.

Community education and engagement related to disasters is another role of the local Disaster Management Program that would benefit from improved information about land developments. Community needs as well as available and required facilities would be identified. Target audiences could be better defined and anticipated in designing information and education programs.

The research refined how the Disaster Management Program and stakeholders managed PDA MPC developments and ways to share information for better outcomes.

² Information from Lendlease. At: <https://communities.lendlease.com/queensland/yarrabilba/living-in-yarrabilba/project-update/>.

Table 1: Details of groups and participants.

Groups	Level	Responsibilities representing	Number of interview participants
Logan City Disaster Management Program	Local government	Local disaster management and planning	2
Logan City Major Developments and Appeals Program and place managers	Local government	Local land-use planning, development assessment and place management	4
Lendlease	Private developer	MPC planning and development	3
Economic Development Queensland	Queensland Government	MPC PDA planning and development assessment	4
Queensland Fire and Emergency Services Emergency Management and Community Capability Unit	Queensland Government	Community resilience and risk mitigation, sustainable development	2

Local government engagement with EDQ

The study indicated there was significant liaison and information sharing between Logan City council land-use planners and development assessors (and development-related council entities) and EDQ regarding developing PDA MPCs. The local council's role was one of consultative and strategic involvement, which supported their later role in assuming community assets and responsibilities when the development project is completed. Local land-use planners and development assessors, however, had limited involvement in producing PDA MPC development schemes, infrastructure master plans and overarching site strategies. This included the application of hazard-related risk management in these plans.

The appointment of local 'place managers' for Yarrabilba and Greater Flagstone at the Logan City Council enhanced engagement between EDQ and Logan City Council. Their role was to provide a contact point liaison between EDQ, local planners and development assessors and other council business units. The place managers were informed by EDQ of progress in PDA planning and development and generally knew the volume, nature and status of development applications and approvals. They are valued as being a focus point to synthesise a consensus local government view from diverse or fragmented information, responsibilities, motivations and interests. The land-use planners and development assessors and developers viewed the establishment of place managers as a significant step to provide a single local contact and conduit for council-related matters. The study interviews indicated that contact between EDQ and the place managers was 'frequent' and included face-to-face meetings, although this was dependant on the issues and needs. There is a distinction between the place management role described in this study and that of 'place making'. Responsibility for place making that typically involves planning, design and social infrastructure development to create community cohesion and a sense of place remained with the developer and is guided by EDQ guidelines.

Engagement between local Disaster Management Program managers, EDQ and the place managers was less structured. Disaster managers understood EDQ's role in administering the Yarrabilba and Greater Flagstone developments but there were no direct means of engagement between the program and EDQ. Engagement with council-based place managers does not occur on a regular and systematic basis.

From an EDQ viewpoint, disaster management was largely a local government responsibility. The compatibility of a PDA with local disaster planning was not purposefully addressed in the understanding that local disaster managers develop their own plans to recognise and manage new PDAs in their local area. PDA development schemes (and related instruments) provided a holistic, 'high order' framework and incorporated information including population projections and densities, development footprints and development types.

Engagement within local government

The establishment of place managers and, hence, the information exchange between land-use planners, development

assessors and EDQ suggested that significant detail on PDA MPC developments was potentially available through mechanisms of information sharing within local government. The study indicated that land-use planners, development assessors and place managers did not participate in the Local Disaster Management Group but could be invited to attend as advisers. This had occurred, but the PDA MPCs had not been extensively discussed in this forum. Data describing planning, development and community profiles were on local databases but participants were uncertain if stakeholders were aware of these sources and their accessibility.

Improved engagement between local land-use planners and disaster managers was generally supported, but differing perceptions of their roles in disaster risk management were obvious in the study. The role of land-use planning was viewed by planners as mitigating hazard risks 'up front' by applying state planning policies and interests through local zoning and development codes to assess development proposals. Disaster managers conceptualised their objectives in terms of strategic, holistic and adaptive landscape management and planning, rather than being focused on operational responses to events, as can be the perception.

Developer, emergency services and local government engagement

The Queensland Fire and Emergency Services (QFES), EDQ and Lendlease had productive, ongoing and frequent interactions regarding PDAs, including Yarrabilba. This was driven by state-level, EDQ-led processes of PDA planning and development approval. In the early stages of planning and development, EDQ facilitated the engagement across state agencies (including with emergency services organisations) and engaged with agencies on specific planning and assessment issues. Outcomes were fed back to the developer. Local councils can be included in discussions if, for example, council reserves are involved. With Yarrabilba, QFES conducted reviews of the interim and final plan schemes and guided operational and strategic considerations, including infrastructure requirements.

QFES engaged directly with developers in conversations when operational conditions were being considered (e.g. development staging). For Yarrabilba, Lendlease initially engaged with emergency services organisations through EDQ but then continued direct liaison for the provision of land for emergency services (required by EDQ) and the establishment of these services in the community. Meeting schedules were not necessarily regular nor formalised (i.e. were based on need) and occurred every few months, with EDQ 'kept in the loop'. EDQ, still the primary planning and assessment entity, was noted to be content with handing over service-provision decisions to the appropriate agencies once land handover had occurred.

In terms of Queensland's disaster management system, local and district QFES (and emergency services organisations generally) are typically represented on local and district disaster management groups. This facilitates their contact with local disaster management programs. QFES advocated a multi-level approach to engagement; dealing locally with the community

but escalating complex legal and planning issues to higher levels within a robust, hierarchical structure. Based on their experiences, QFES considered this approach covered strategic issues, local issues and service and planning requirements as well as opened opportunities for all-hazards-based cooperative planning and management.

Developers were less likely to systematically engage with Queensland's disaster management system through disaster committees and groups membership. However, Lendlease provided information to entities, including to the Logan City Council, as well as via the appropriate place manager. Lendlease also deals directly with specific council business units with the knowledge of the place manager as well as with emergency services organisations. The place manager indicated that Lendlease's protocol of engaging with local disaster management programs was through that role.

Discussion: facilitating better engagement

These results and discussion are based on one case study of Logan City local government area. Application of study results to other areas and contexts is a matter for further research. However, anecdotal evidence suggests broader application in comparable development situations.

Stakeholder accounts and reflections of information sharing and engagement revealed that relationships and networks were underpinned by formal policy and legislative requirements but significantly supported by less formal arrangements and local stakeholder initiatives. Although productive engagement between EDQ, the Logan City Council, the developer and QFES were noted, gaps were identified in the information flow between the local Disaster Management Program and land-use planning and development stakeholders. These gaps resulted from a lack of formal inclusion of local disaster managers in planning and development frameworks and, conversely, lack of involvement of land-use planners, assessors and developers in those of disaster management.

The reflections and comments of the participants prompted discussion of two potential engagement mechanisms to enhance information sharing: use of the Local Disaster Management Group and the engagement of place managers. Study participants offered critical appraisals of these suggestions and made further proposals for arrangements and protocols to improve the situation.

Augmenting local disaster management groups

Disaster management groups offer an existing, institutionalised, vertically integrated pathway for stakeholder engagement that can meet the criteria for good practice (e.g. Australian Emergency Management Institute 2013, National Research Council of the National Academies 2011). Representatives from government, emergency services organisations, critical infrastructure providers and community groups are already part of these groups. However, Queensland disaster management policy and guidelines do not mandate positions for EDQ nor land

developers on the state, district or local disaster management groups and committees. While it may be possible to invite EDQ and land developers as observers or advisers to these groups, it has not occurred regarding the Logan City PDA MPCs.

The proposal to have EDQ and PDA developers represented on local and district disaster management groups was canvassed with study participants. While not dismissive of the proposal, both EDQ and PDA developer participants expressed concerns about the practicality of the approach. EDQ already embraces wide-ranging responsibilities and has no direct role in operational matters in disaster management and advocates agencies should take responsibility for their strategic planning in their areas of business. Greater involvement of land developers on district and local groups risked 'overloading' these groups with additional and diverse membership.

Engaging council place managers

A related proposal involved the expanded use of council-located place managers in a liaison position. As local representatives for EDQ-driven PDA development processes, they can potentially engage closely and systematically with local and district disaster management groups. This could occur even when development assessment responsibilities are delegated to local government. In this case study, place managers as facilitators of engagement and information exchange were favourably supported by participants. Their inclusion in disaster management planning, particularly their involvement with the Local Disaster Management Group, could provide a conduit to PDA information for the Local Disaster Management Program. They also may promote greater knowledge across stakeholders of the needs of local disaster managers to execute their roles.

From a critical viewpoint, however, participants pointed out that place managers were not currently appointed for all major developments in all local governments. They (and their local council) would need to be amenable to expanding their responsibilities. Land developer participants indicated that place management, as described here, might not be always appropriate, including where it fosters excessive competition for resources from within hierarchical administrative structures, or contributes to the fragmentation of responsibilities. The appointment of place managers for some, suitable developments (e.g. prioritised or particularly large developments) may be a better option.

Improving arrangements and protocols

Participants were generally supportive of collaborative approaches but pathways and protocols to this end were not always clear. They were sometimes reliant on relatively informal, though often successful, processes. Participants suggested several tactics that would improve collaboration. These included:

- better defining, publicising and widely disseminating information on roles, responsibilities, chains of command and issue-specific contact points within and across relevant organisations

- improving and publicising data accessibility (e.g. development plans and assessments) so providers better understand and engage with the potential users
- encouraging and supporting wide, systematic and purposeful collaboration between local disaster management and planning and development stakeholders by promoting processes through policies, guidelines and exemplars
- investigating how the Queensland Emergency Risk Management Framework (Queensland Government n.d.) may provide a common basis for engagement and collaborative, risk-based planning.

Barriers and constraints

In this study, all participants expressed considerable desire and 'good will' to pursue better integration of local land-use planning, disaster management and PDA processes. However, participants observed that basic issues such as resources and staffing constraints could directly challenge local capacities to establish and maintain information sharing and engagement. The range of responsibilities often bestowed on local staff, exacerbated by high staff turnover in some areas, were two factors in this context. Also expressed was the need to address a common misconception that the role of disaster management focuses on response.

Conclusion

This research used a case study of Logan City to confirm the need to support information sharing and engagement between local council disaster managers and planners, land developers and development assessors of PDA MPCs. Study participants' perspectives indicate a potential way forward is to establish local council place managers for major PDA MPC developments. Their role would be to liaise with stakeholders and be a single, common contact point for information exchange and referrals. Their formal inclusion in the Local Disaster Management Group would provide a clear conduit within existing frameworks for information exchange and engagement. However, the appropriateness of this approach needs to be considered in individual circumstances and supported by other improvements to information-exchange pathways and protocols.

Resolving participant reflections on engagement and information sharing and clarifying both formal and informal engagement mechanisms provides a basis on which to promote discussion and research. This research would critically evaluate engagement and its wider applicability, including in other development situations.

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Abstract

This paper examines media commentary related to wildfire risk in Aotearoa-New Zealand following two large-scale wildfires that affected urban and rural areas of the country in 2017 and 2019. Surrounding commentary is considered using an established model of disaster risk that highlights the relevance of increased wildfire scale and effects. The model reinforces that increasing numbers of vulnerable dwellings amplify future wildfire threat. The result resembles a ‘multi-headed beast’ of increased risk, one that can be met with a robust set of fire management interventions. Emergency planning frameworks in Aotearoa-New Zealand need to bolster the wildfire risk awareness of landholders as well as local community capacities to manage the potentially elevated levels of overall wildfire risk.

The many-headed beast of wildfire risks in Aotearoa-New Zealand

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Introduction

The South Island of Aotearoa-New Zealand has experienced two recent major wildfire¹ emergencies. The first occurred in February 2017 in the Port Hills area adjacent to the city of Christchurch, in the Canterbury region. The fire burnt an area in excess of 1600 hectares (Langer, McLennan & Johnston 2018) and resulted in the evacuation of 2800 residents. At least 14 homes were severely damaged or destroyed (Christchurch City Council 2018; Langer, McLennan & Johnston 2018). The second fire started in Pigeon Valley in the Nelson/Tasman region in February 2019. It grew to over 2300 hectares and forced the evacuation of around 3000 people and the loss of one home and 1900 hectares of production forest (Nelson Mail 2019).

Pearce (2018) used the Port Hills fire to illustrate how several areas of New Zealand face increased levels of wildfire risk. He proposed that, historically, New Zealand wildfires mostly destroyed fewer residential properties and were limited to much smaller areas. His reasoning was promulgated, to varying degrees, by press media citing a 25 per cent increase in wildfires between 2016 and 2017, with larger wildfires in much closer proximity to metropolitan areas (Wright 2018). Subsequently, Mitchell (2019) cited analysis by Scion (Watt *et al.* 2019) to illustrate how climate change has increased the amount of dry vegetation fuelling these wildfires, referencing the Intergovernmental Panel on Climate Change (2014) report. The analysis by Watt and co-authors (2019) went so far as to project a 71 per cent increase in ‘Very High’ and ‘Extreme’ fire danger level days² from 2019 to 2040.

This paper takes a broader look at Pearce’s (2018) proposal and associated predictions by applying the disaster risk framework set out in the *National Disaster Resilience Strategy* (MCDEM 2019). The framework allows the consideration of several factors that contribute to heightened wildfire risk in the southern-most antipodes. It is hoped this clarification will establish a foundation for further research into, and remedies for, wildfire-related challenges facing Aotearoa-New Zealand.

1 In this paper, the term ‘wildfire’ is interchangeable with bushfire.

2 The New Zealand Fire Danger Rating System is used to monitor fuel dryness and fire behaviour potential with ratings ranging from ‘Low’ to ‘Extreme’ (Anderson 2005).

Defining cumulative disaster risk

The United Nations (2016, p.14) defined cumulative disaster risk as:

The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity.

The hazard component of this definition aligns with the Australian and New Zealand Standard for Risk Management (AS/NZS 2009) that addresses both likelihood and consequence aspects of risk identification and supports planning to control, minimise or avoid identified risks. The New Zealand *National Disaster Resilience Strategy* (MCDEM 2019) defines risk using four principle components also outlined in the United Nations (2016) definition:

- hazard
- exposure
- vulnerability
- capacity.

The *National Disaster Resilience Strategy* calls on emergency management agencies to better identify and manage each component. However, the components are not defined in the strategy document; thus necessitating further definitions from other sources.

For the purpose of this paper, the term 'hazard' is: 'something that may cause, or contribute substantially to the cause of, an emergency' 'which causes or may cause loss of life or injury or illness or distress or in any way endangers the safety of the public or property' (*Civil Defence and Emergency Management Act 2002*, p.9) 'characterized by its location, intensity or magnitude, frequency and probability' (UNISDR 2017, para.75).³

The term, 'exposure' has also been defined using United Nations Office for Disaster Risk Reduction (UNISDR) terminology as:

The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas... can include the number of people or types of assets in an area.

UNISDR 2017, paras 69–70

The term 'vulnerability' is defined as:

The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

UNISDR 2017, para.114

Each of the three components are effectively multiplied by one another to generate an overall level of risk. This overall risk level may be effectively reduced by capacity, which is defined as:

The combination of all the strengths, attributes and resources available within an organization, community or society to manage and reduce disaster risks and strengthen resilience.

UNISDR 2017, para.12

Such strengths, attributes and resources may reduce at least one of the components previously outlined, thus decreasing the overall level of risk. In mathematical terms, this creates an equation where H = hazard, E = exposure, V = vulnerability and C = capacity.

$$\text{Risk} = \frac{H \times E \times V}{C}$$

This equation is often used by emergency management agencies as a conceptual framework that helps identify components driving or mitigating risk in notionally at-risk locations. Although it resembles a strictly mathematical calculation, numbers often cannot be assigned or combined to usefully calculate a numerical value of overall level (Aven 2017). Among other implications, this means that many risk assessments rely on judgements and are, therefore, at least partially qualitative. In a similar vein, this paper takes a largely conceptual approach to defining wildfire risk components, in contrast to more quantitative approaches like those documented by Miller and Ager (2012).

Defining increases to cumulative wildfire risk

The following section uses the conceptualisation of risk to define an increasing level of future wildfire risk likely to effect Aotearoa-New Zealand. This increased level of risk results from the combination of increasing hazard, increasing exposure, increasing vulnerability and compromised capacities.

Increasing hazard

The hazard component of wildfire risk appears to worsen in terms of impacts on communities and affected locations, rather than overall frequency. Wildfires have been a frequent annual occurrence throughout Aotearoa-New Zealand this century (Pearce 2018), although there has been an unusual number of wildfire events since 2017 (Langer, McLennan & Johnston 2018). For example, there was an average of 4100 wildfires burning 4170 hectares per year from 2005 to 2015 (Langer & McGee 2017). Wildfires have been frequent but also generally small and controllable, compared to fires in other countries, such as Australia and the US. Figure 1 shows that the number

³ In this multi-hazard context, intensity refers to the extent of damage, rather than the energy output of fires.

of particularly severe wildfires at the rural-urban interface⁴ that appears to be increasing. Koksai, McLennan and Bearman (2020) state this represents a grave and under-estimated risk to residents who are attracted by natural environments surrounding properties at this interface.

Wildfires may also become more hazardous as time goes on, especially given the prospect of rising temperatures and less frequent rainfall. According to Reisinger and colleagues (2014), these consequences lead to an increase in both the frequency and severity of wildfires in many parts of the world. The effects of climate change on wildfire frequency and severity have also been highlighted (Brunette *et al.* 2020, Sanderson & Fisher 2020, Yu *et al.* 2020, Watt *et al.* 2019). In Aotearoa-New Zealand, effects of climate change are exacerbated by the retirement of rural pasture properties that had led to increased areas of woody scrub vegetation (Langer & Wegner 2018). Research conducted in the USA (Radeloff *et al.* 2018) indicated that the retirement of rural pasture properties is related to increases in ignition-prone human activities at the wildland-urban interface.

Increasing exposure

Changes at the rural-urban interface exacerbates the exposure to wildfire risk of life and assets. The Australasian Fire and Emergency Service Authorities Council (AFAC) (2017) stated that the number of houses badly damaged or destroyed by the Port Hills fires made 2017 the most destructive wildfire season in Aotearoa-New Zealand for almost 100 years. Pearce (2018) and Langer and Wegner (2018) outlined how this was worsened by an increasing number of houses being built in locations exposed to wildfire.

Houses and other structures need not be built right next to vegetation to become exposed to wildfire hazards. The long range of ember attacks, along with other vulnerabilities means houses and structures built anywhere within 700 metres of wildlands may be at increased risk (Chen & McAneney 2004). This range may be even greater when ember attacks originate from the stringy-barked species of eucalyptus, as outlined by Gill and Zylstra (2005).

Increasing vulnerability

Communities are increasingly vulnerable to wildfire hazards. This goes beyond location or direct proximity to rural areas. It includes construction, which has traditionally used highly flammable wooden cladding. A 2010 study concluded that just under half of the dwellings were still clad in wood (Page 2010, Statistics NZ 2013).

Lifestyle property houses and suburban sections at the urban fringe of rural-urban interfaces are more closely grouped than infrastructure built for agricultural purposes. Smaller properties and generally denser development means there is less defensible space with reduced fire danger, or safety zone, around homes (Syphard, Brennan & Keeley 2014, Kornakova & March 2017). This can be worsened by flammable exotic garden plantings, such as Australian and South African shrubs, and more flammable native

⁴ The rural-urban interface, or wildland-urban interface is the area of transition between rural and urban areas where houses and buildings are intermixed with, or sit adjacent to, areas of vegetation (Radeloff *et al.* 2005).

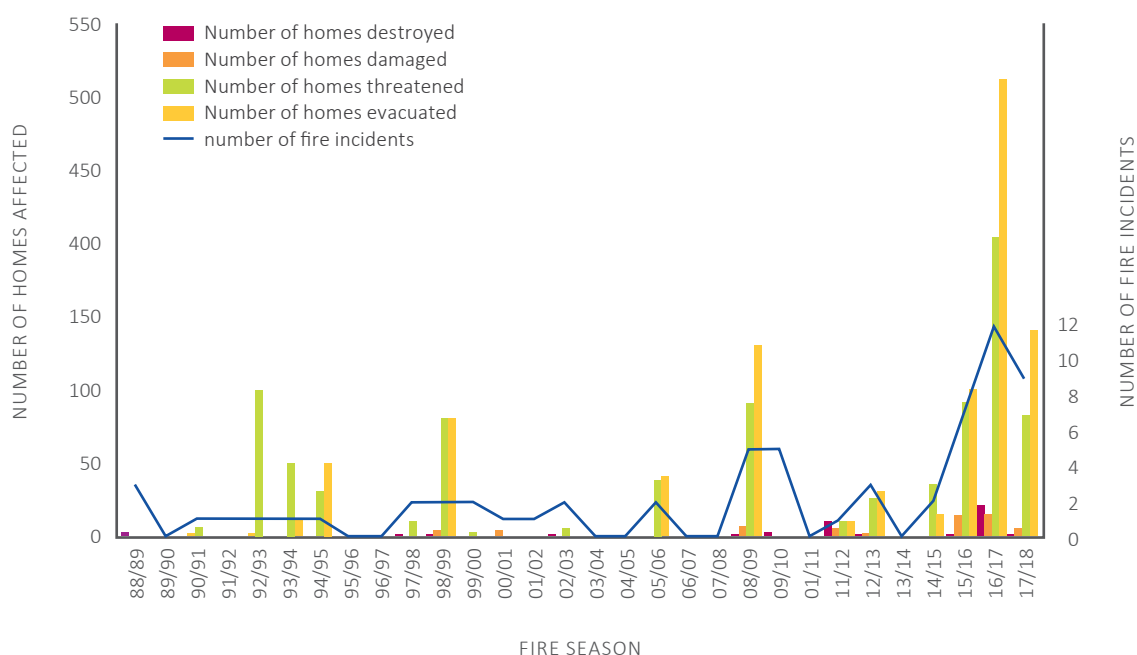


Figure 1: Trends in reported rural-urban interface fire events.

Source: Pearce 2018, reproduced with permission.

flora, such as flaxes and tussock grasses. These types of plants have become a popular part of residential gardens (Stewart *et al.* 2004).

Even in the absence of flammable gardens, the ignition of one house is rarely an isolated event in residential areas. This has often lead to structure-to-structure ignition of adjacent dwellings (Cohen 1995; Chen & McAneney 2004; Hakes, Caton & Gollner 2017). An increase in the density of flammable infrastructure is contributing to greater vulnerability in areas already prone to wildfire hazards. The socio-economic vulnerability of many families further exacerbates these issues. Such issues deserve an expansive discussion and are beyond the scope of this paper.

Compromised capacities

Increased residential migration into the rural-urban interface may compromise fire prevention, preparedness and response capacities. Jakes, Kelly and Langer (2010) outline that many people moving to the urban fringe and the interface may have no experience with preparing, preventing and responding to wildfire events. Longer-term residents may also be unprepared for the new and rapidly increasing levels of wildfire risk. As outlined in Aotearoa-New Zealand-based research by McGee and Langer (2019), exposure to wildfire events is not enough to prompt local preparedness. Communities may still lack awareness of wildfire risks and appropriate preparative actions (Jakes, Kelly & Langer 2010; Hart & Langer 2014) such as minimising flammable material in a cleared or safety zone around houses and avoiding high risk activities like burning rubbish that can start fires under high fire danger conditions.

Drought conditions experienced prior to the 2019 wildfires in Nelson (Science Media Centre 2019) highlight how wildfire events can form part of a compound, or even cascading, disaster event. As outlined by Cutter (2018), these events occur when a sequence or other combination of disasters are effectively triggered by another. The resulting combination of events can develop to a scale and severity that stretch the capacities of emergency response agencies.

Discussion

Increased wildfire risk can be examined using a model of disaster risk defined by the United Nations (2016), which is being implemented through the *National Disaster Resilience Strategy*. Components of the model appear to worsen to some extent, including:

- increasing wildfire severity, scale and probability, being driven by climate change and other issues and evidenced by an increase in fire events and impacts at the rural-urban interface
- increasing exposure to wildfires through the proximity of highly flammable infrastructure being built at the rural-urban interface
- increasing vulnerability due to the clustered patterns of development in these areas.

The worsening combination of these risk components signals that increases in overall wildfire risk may not be linear, but

exponential. The shift in hazard effects and probability documented by Pearce (2018) is of concern. However, by increasing exposure and vulnerability, which means the predicted increase in the frequency of 'Very High' or 'Extreme' fire danger days projected to 2040 (Watt *et al.* 2019), may contribute to a higher level of future wildfire risk. This is because the increasing likelihood of extreme fire events is multiplied by increasing exposure and vulnerability.

Unless counteracted by an equivalent increase in fire management capacities, these compounding aspects of wildfire risk amount to a many-headed beast. Compounding increases to each risk component may prove catastrophic, especially when capacity thresholds, such as local firefighting resources, are overwhelmed. These concepts are not hypothetical especially if Aotearoa-New Zealand follows precedents from Australia to limit increases in firefighting response resources and pursue a policy of shared responsibility. In practice, this means that communities are expected to shoulder more responsibility for responding to the scale of wildfire risks that are being increasingly driven by climate change (Reid, Beilin & McLennan 2020; MCDEM 2019).

New levels of risk may possibly exceed capacities for mitigation, as affected property owners and communities adapt to the new circumstances. Communities with little awareness of emerging wildfire risks are unlikely to be prepared for severe wildfire events. There is an opportunity for rural firefighting capacities to adapt to increased levels of wildfire risk. Some aspects of this are already occurring through improved evacuations for people and animals and added aerial firefighting resources. According to Wright (2018), Fire and Emergency New Zealand (FENZ) have consolidated large-scale response capabilities.

There are opportunities to develop community wildfire prevention and preparedness. These opportunities are being pursued by FENZ, whose activities form part of a long history of proactive fire prevention. FENZ has declared intentions to increase fire risk reduction activities and to improve community resilience (FENZ 2019). These intentions are complemented by a range of associated initiatives, including:

- improving landscape-scale spatial (Kraberger, Swaffield & McWilliam 2018) and land-use planning (Kornakova & Glavovic 2018) using regulatory controls
- improving house construction practices
- using less flammable plant species close to infrastructure
- improving water supplies and firefighting access (Pearce 2018).

These and other proactive approaches are informed by relevant research that supports community disaster resilience across disaster reduction, readiness, response and recovery phases.

Conclusion

This paper reflects on the multi-headed beast of increased risk in Aotearoa-New Zealand; one that requires sound and appropriate emergency planning frameworks. Research-based concepts of compounding and cascading disasters have highlighted how worrisome it can be for government agencies to simply leave communities to their own devices, and to their own potentially

inadequate resources. There is a need to better communicate the increasing wildfire risk faced and to help communities adapt to living with worsening wildfire hazards. Much of this increasing risk is due to trends in urban and rural-urban interface development in close proximity to vegetation types, changes in climate and other aspects of physical geography that increase community vulnerabilities.

Further investigating these and other factors will identify geographic areas and communities that most urgently require attention and support towards specifically promoting community wildfire safety. Relevant research in American and Australian contexts provides a valuable background for research conducted in Aotearoa-New Zealand. Further research initiatives commissioned and managed by FENZ, together with research by the Scion Crown Research Institute and other research institutions, are well positioned to meet current and future wildfire risk challenges.

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Abstract

One of the challenges facing disaster risk reduction is the gap between research and practice. Despite the considerable investment in publicly funded and commissioned disaster risk reduction research, the application of research findings to operational practice often lags, if implemented at all. This paper addresses the need to understand the antecedents of implementation and identifies activities involved in the research utilisation process. This paper reports on findings that led to the development of a research utilisation maturity matrix that encompasses four levels of maturity being: basic, developing, established and leading. This study involved collaboration and discussion with emergency services practitioners and a conceptual model of the elements needed to support implementation of research was identified. This model suggests that the four elements play key roles in effective implementation. The study gathered information from emergency services practitioners and their stakeholders about the meaning of the research findings and what, if anything, needed to change. The study's findings can help emergency services personnel assess organisational practices to improve research utilisation within the emergency sector and contribute to greater disaster risk reduction outcomes.

Implementing research to support disaster risk reduction

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Introduction

Disaster risk reduction is global in scale and includes many communities and societies. Those communities comprise formal and informal groups and organisations, of which emergency services organisations form one part. Nevertheless, their role in supporting disaster risk reduction is important. It is also important to acknowledge that commissioned inquiry using research is one source of information on how best to sustain or improve practice. In the emergency services sector, there has been a sustained and significant investment in research, as evidenced by the 18 years of Australian Government funding of the Bushfire CRC and the Bushfire and Natural Hazards CRC to improve knowledge and improve practice.

Although using research to inform practice sounds straightforward, as Kay and co-authors (2019) point out, negotiating this in the real world is not as simple as it might seem. This is because researchers produce findings in published papers and these are not easily or directly usable by practitioners. Moreover, decision-makers face barriers to integrate research into practice. In some circumstances, research is disconnected from practitioner experience and lacks credibility. In other cases, research findings are contested on ideological grounds because they do not align with the beliefs of a particular group or organisation. Sometimes research findings are just too costly to implement relative to the proposed benefits.

The need to demonstrate value and effect from research has never been greater. Over the past decade there has been increased scrutiny on emergency management organisations to justify actions (see Eburn & Dovers 2015, Boin & t' Hart 2010). There is an urgent need for these organisations to 'learn about learning' (Adams, Colebatch & Walker 2015) to innovate. One-way to do this is to use research outcomes from their partnerships with researchers and their institutions. This paper reports on what emergency services practitioners can do to use commissioned research to inform and improve the way they do business.

Closing the research-practice gap

Part of the problem is that utilisation of research is assumed to be transferred through passive information-giving (Rogers 2003, Cornes *et al.* 2019). Labels like 'research adoption'

and 'research transfer' reinforce this view. The approach, which assumes a linear flow of information, is wanting (Baumbusch *et al.* 2008, Cornes *et al.* 2019, Kay *et al.* 2019, Radin Umar *et al.* 2018). Utilisation from research does not magically flow from research outputs. There is no 'truth' out there. For research to be relevant it needs to connect to real-world problems and add value to practitioner and end-user experiences. When there are good links between research and practice, it enables:

- co-creation of new knowledge (Brown *et al.* 2019)
- increased support of resilience (Doyle *et al.* 2015)
- better understandings of resilience and enhanced capability (Brown *et al.* 2019, Vahanvati 2020)
- improved emergency response and management capability (Brooks *et al.* 2019)
- improved ways to review and evaluate programs (Spiekermann *et al.* 2015; Taylor, Ryan & Johnston 2020).

Utilising research in emergency services organisations is a social process; one that is supported or resisted by collective beliefs that are held by communities, organisations and societies. Utilising research requires understanding of the conclusions, the context, assessing and evaluating meaning and implications and whether or not a change in practice is worthy or desirable. Any change must be connected to organisational business and strategy.

Standing and colleagues (2016) claim that adopting new practices may be enacted by individuals and teams but must be supported by organisational processes. This includes having resources and organisational structures (e.g. governance, policies) that allow changes based on research to be implemented. Standing and colleagues (2016) also suggest that a new research agenda needs to focus on the antecedents of implementation and the different stages involved in the research utilisation process.

This paper addresses the research question: What are the organisational conditions that facilitate successful implementation of research findings commissioned by emergency services organisations and what are the implications for research commissioned to support disaster risk reduction?

Survey

The survey used for this study is part of a longitudinal study conducted by University of Tasmania on behalf of the Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC) and the Australasian Fire and Emergency Services Authorities Council (AFAC) every two years since 2010. The survey is used to consult with the emergency services sector on research utilisation. Results inform future directions in policy for AFAC and the BNHCRC. The survey includes qualitative free-text questions and quantitative items.

Method

This study involved developing a research utilisation maturity matrix based on most recent survey responses. This was followed by consultative work that was conducted over a 12-month

period. This work led to a trial of a self-assessment diagnostic tool used by emergency services practitioners to reflect on how they use research. Drawing on findings from existing research, a conceptual framework is proposed that describes the important processes in utilising research. Case studies were used to explain the model and the role the maturity matrix plays in understanding the different stages in research utilisation maturity. Ethics approval was provided by the University of Tasmania Social Sciences Research Ethics Committee; HHREC H0010741.

Survey questions sought answers on the perceived effectiveness of research adoption within emergency services organisations and assessed and evaluated the effects on agency practice. This included implementing changes, monitoring processes to track changes and communicating outcomes of changes made as a result of research. The survey also compiled participant perceptions of their agency as a 'learning organisation'. A learning organisation is defined as one where personnel were able to learn from the experience of members of the organisation or emergency services community through processes of reflection, sense-making and action. This develops new ways of acting that can lead to an increased capacity to act differently in the environment through changes in practice (adapted from Kolb 2014). In addition, a number of survey questions were adapted from research investigating barriers to research utilisation (Funk 1999). The results of these aspects of the survey are reported elsewhere (Owen 2018; Owen, Bethune & Krusel 2018).

In 2016 and again in the 2018 surveys, a free-text question sought information on whether participants were aware of how their agency kept up to date with research. If the participant answered 'yes' they were asked to provide details. In the 2016 survey, themes from that question were discussed with practitioners involved with the AFAC Knowledge, Innovation and Research Utilisation Network (KIRUN). Based on those discussions, a set of descriptors was used to develop a research utilisation maturity matrix (see Table 1).

For the 2018 survey, and based on collaboration with KIRUN members, these descriptors used in 2016 were included and survey respondents were asked to rate their level of agreement with the statement as something they experienced within their agency (see Table 1). This paper explores those responses.

Procedure

Emergency services organisations across Australian states and territories were identified to take part in the study. An email was sent to heads of each organisation (e.g. commissioner, chief fire officer) inviting their participation and cooperation. The email invitation requested organisations to ensure a survey sample included staff in:

- senior management roles (e.g. communications, training and development, operational community safety, knowledge management, innovation and research)
- middle management roles (e.g. district managers)

Table 1: Research utilisation maturity codes and survey responses examples from surveys in 2016 and 2018.

Level	Description	Examples in data
1 = Basic 2016 n=46 2018 n=29	There are pockets of research utilisation, however, these are not systematically organised. Attempts to keep up to date with research depend on efforts by individuals.	<i>Undefined, not clearly communicated within communications. Nil business unit assigned to research and development.</i> <i>...the onus for keeping up to date is largely upon individuals maintaining an interest or subscribing to emails.</i>
2 = Developing 2016 n=46 2018 n=70	Some systems and processes are documented that enables research to be disseminated. There is little or no evidence of analysis or effects assessment.	<i>We have two people that email CRC updates to staff.</i> <i>Lots of material is distributed via our portal and email to keep staff and volunteers informed.</i>
3 = Established 2016 n=44 2018 n=22	There are systematic processes in place for reviewing research (e.g. dissemination and review either through job responsibilities or an internal research committee).	<i>...developed a research committee.</i> <i>SMEs appointed as capability custodians to ensure up-to-date best practice.</i>
4 = Leading 2016 n=32 2018 n=10	There is evidence of using research proactively. Operational and strategic decisions are informed by research using formal research utilisation processes. The processes and systems are widely understood.	<i>... a process of ensuring results are read by key specialist staff involved in program design and delivery, are interpreted and analysed for their implications and relevance and then used to inform decision-making and strategy through numerous internal fora.</i> <i>Alignment of evidence-based decision-making in the planning phases of annual planning and the development of indicators around causal factors that inform emergent risk.</i>

- operational and frontline service positions (e.g. volunteers, field operations personnel, community education officers and training instructors).

The introductory email included a link to the survey on the Survey Monkey platform. The email explained that the purpose of the sampling method was important to target personnel who:

- had an understanding of the strategic planning of the agency
- had some awareness and involvement in research activities
- had responsibility for implementing any changes based on research evidence.

Heads of agencies were requested to distribute the survey to 5–15 people in the survey target audiences depending on the size of the organisation. For example, 5 people for small-sized organisations (<1000 personnel), 5–10 people for medium-sized organisations (1000–5000 personnel) and 10–15 people for large organisations (>5000 personnel). Mailboxes were set up for 47 responding organisations. Mailboxes were monitored and reminders were sent until the response threshold was reached or three reminders had been sent.

Participants

A total of 190 participants from 29 organisations across all states and territories completed the 2018 survey. Table 2 shows the demographic details of respondents. To compile the demographic data, a free-text question was ‘What is your role?’ Answers from 122 responses were coded. The median number of years’ experience participants had in emergency services was 19 years and the median years of participant experience in an organisation or agency was 12 years.

Table 3 shows the organisational types represented in the survey.

Results

Of the 190 total responses, 142 participants provided comments to a question about strategies their organisation had in place to keep up to date with latest research. Answers were coded to four levels of research utilisation maturity as developed in 2016. What is interesting is that participants who provided comments coded at higher levels of research utilisation maturity also reported higher levels of organisational learning and greater agility in overcoming barriers to implementing changes. This was evident in both the 2016 and the 2018 surveys (see Owen, Bethune & Krusel 2018).

Collaboration with the KIRUN led to developing descriptors of research utilisation maturity. Table 4 is a summary of the descriptors for each of the levels of research utilisation maturity presented in Table 1. Descriptors relate to four elements identified as important to support successful implementation of research where a need for change was indicated. The four areas are:

- people and culture
- communities-of-practice
- support systems of governance
- resourcing.

Analysis of the data from the 2018 survey showed that when maturity to use research is low, based on the coded comments, use of research outputs was limited (e.g. products or outcomes ‘sit on the shelf’). They can also be implemented in a fragmented

Table 2: Characteristics of participants in the survey sample.

Participants by role type	Number	Percentage
Senior management (e.g. directors)	11	6
Middle management (e.g. district managers)	70	37
Frontline responsibilities (e.g. training instructors)	41	22
Answers not codifiable (e.g. 'fire', 'operations')	38	20
Not answered	20	15
Total	190	100

Table 3: Characteristics of organisations represented in the survey sample.

Participants by organisation type	Number	Percentage
Urban fire services	15	8
Rural fire services	46	24
Land management	37	20
State Emergency Services (flood and storm)	23	12
Multiple-hazard agencies (e.g. departments of fire and emergency services)	55	29
Specialist agencies (e.g. water utilities, specialist sciences)	14	7

way if tied to one-off projects. When organisational maturity to use research is high, research outputs were discussed and adapted, used in multiple applications and connected to organisational or operational practice.

A conceptual model to implement research findings

Figure 1 is a model to conceptualise how these elements may work together to support research utilisation that leads to changes in practice to support disaster risk reduction.

Governance structures and resources authorise and support conversations within communities-of-practice so they can adapt and transform findings in ways to fit context. This becomes effective implementation.

Conversations

In the 2018 survey, there were items that highlighted the importance of discussions as enablers of research utilisation. Table 5 shows these items and reports their internal consistency reliability estimates using Cronbach alpha scores (all above the industry standard of 0.7). Table 6 shows the correlation of these items when combined as subscales.

Theoretically, while discussions might be the start of a process, not all discussions will succeed in implementation or utilisation of research, even if the research findings have merit. In conceptualising change in a workplace context, Radin Umar and

colleagues (2018) claimed that successful change is dependent on the kind of discussions that occur. They suggest there are qualitative differences depending on whether discussions rely on Type 1 or Type 2 thinking (Kahneman 2011). Type 1 thinking is speedy and automatic, unquestioned and abstract. Type 2 thinking is slow and effortful. While reference to Kahneman (2011) may seem puzzling, the point is that emergency services practitioners are more likely to engage in quick and reactive thinking and dismiss an idea as irrelevant to them, leaving their assumptions and biases untested. The ways in which reactive thinking impedes learning has been demonstrated (Owen *et al.* 2018). If Type 1 thinking is occurring in discussions, they are likely subject to cognitive bias when individuals select information that reinforces their existing beliefs, leaving their previous assumptions unexamined.

In research examining the challenges of emergency services organisations working with communities, Cornes and colleagues (2019) found that information-giving based on a knowledge-deficit model pervaded the assumptions of practitioners about what is needed for community resilience. This finding is an example of a 'basic' level of maturity (see Table 1) when it comes to applying research.

Cornes and co-authors (2019) proposed that emergency services personnel need to better understand human rationality and why people think the way they do. This would assist in moving to a higher level of research utilisation maturity. In doing so, facilitators of discussions can assist if they create the conditions

Table 4: Indicators of maturity in research utilisation to support evidence-informed practice.

Element	Maturity Level: collective capability in utilising research for implementation			
	1 = Basic	2 = Developing	3 = Established	4 = Leading
People and culture	Individuals bring prior skills and find their own professional development. Small pockets of research utilisation value are contested. Limited sharing of knowledge and assumptions remain untested.	Research utilisation is formally acknowledged but is limited. Limited organisational understanding or support for using research or its implications for practice.	Inquiry related practices embedded in all or many job roles. A learning culture supports testing existing ways of working. Value of research utilisation is widely acknowledged but limited to 'safe' questions.	Open knowledge sharing and evidence used to improve, adopt, anticipate and question existing understanding and practice.
Communities-of-practice (communication and engagement)	Occurs through individuals who use their own resources and networks.	Some end users are engaged but activity is not linked to organisational processes. Communications are one-way.	Active and widespread engagement.	Proactive integration of research insights into multiple aspects of activity.
Support systems (resources)	Limited to individuals and their influence within the organisation.	A research policy or unit exists but is not connected to core business.	Technical systems in place to monitor, review and evaluate.	Support systems are resourced as part of core business.
Governance (policies, procedures, doctrine PPD structures and monitoring)	PPD locally organised. Research utilisation is undertaken by individuals as an add-on. Research utilisation is not part of core job. No systematic quality assurance, monitoring and reporting on research utilisation.	PPD exists but with limited connection to core business. Reactive structures are put in place when a problem emerges. Project-based governance. Some processes exist but are largely spasmodic and unconnected.	PPD codified, clearly visible and accessible. Research utilisation is strategic, planned and systematic. Research utilisation is monitored and reporting is reasonably established within governance structures.	PPD embedded with loops to core business. Structures support risk taking and innovation. Research utilisation is monitored and reporting is well established. Governance allows for 'safe fails' and transformational change.
Implementation of research findings and research output products (e.g. tools, aides-memoire)	Research products sit on the shelf. Some individuals 'know' and use the products but information disappears when people leave.	Products are one-off and tied to a specific project. Experience of use is often short-lived and organisational memory of utilisation is partial. Utilisation is not sustained (i.e. does not get built into business-as-usual).	Products are user-friendly, fit-for-purpose, easily accessible, widely known and actively incorporated into business-as-usual. Products are widely disseminated and resourced and may have a cost-benefit assessment (link to systems). Products are likely used in multiple applications.	There is active testing and prototyping of products emerging from research outputs. Widespread knowledge and use of products. Products may be tested and transformed and there is application beyond the organisation.

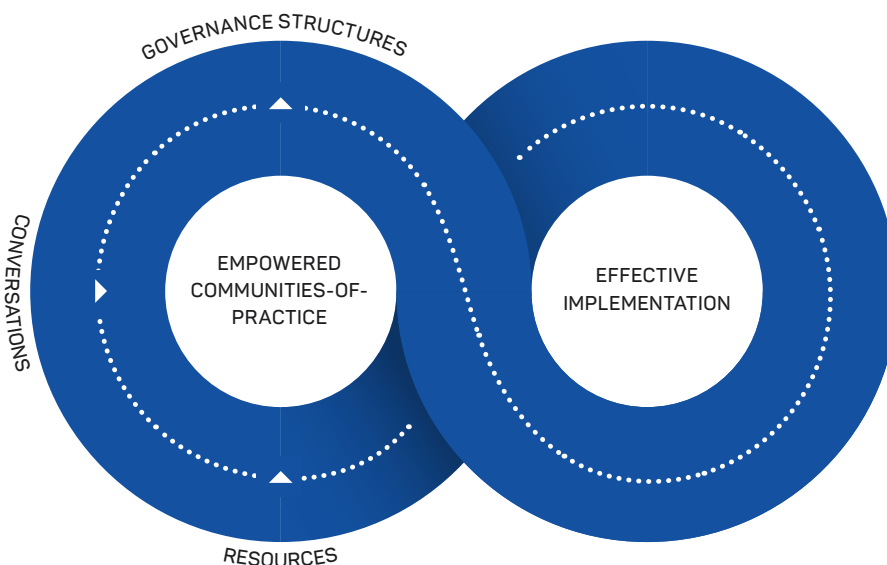


Figure 1: Conceptual model of implementing change from research knowledge.

for Type 2 thinking (Kahneman 2011). This requires a slowing down of default thinking processes to one that is deliberate, effortful, logical and conscious. Radin Umar and colleagues (2018) suggest this may assist practitioner perceptions and attitudes and, ultimately, the acceptance and adoption of new ideas. This can be modified during the sense-making iteration process.

If discussions support slow thinking to cycle through iterations of processing information and meaning-making, practitioners are more likely to arrive at a deliberate conclusion rather than a default, reactive approach, which has been identified as impeding practitioner learning (Owen *et al.* 2018). In addition, face-to-face discussions provide a richer environment where participants can detect body language or other visual cues and use this to process meaning or disagreement. It is also important that facilitators of discussions about research findings be mindful of who is part of the conversation and who is not. Inequality and aspects of power need consideration if discussions are inclusive. These conversations are more likely to empower communities-of-practice through greater awareness of collective efficacy.

Empowered communities-of-practice

Taylor, Ryan and Johnson (2020) examined how community engagement can be evaluated. They noted that ‘conversations with members of the public were valuable tools to determine the overall success of community engagement programs’ (p.49). The authors concluded that a community-of-practice approach enhances community engagement evaluation. This is consistent with findings in this study where a number of items indicated high agreement with indicators of enabled communities-of-practice (Table 5) were associated with higher indicators of research implementation (Table 6).

Drawing on learning theory (Argyris & Schon 1974), communities-of-practice are empowered when they are able to move through three stages of learning to reflect on their practice and how new knowledge may be applicable. Argyris & Schon (1974) identified three levels of learning. Third-order learning occurs when stakeholders critically reflect on their learning and generate new modes of acting.

Governance and resources

The capability to mobilise resources and orchestrate actions is an important determinant of effective implementation (Weiner 2009). Research undertaken to develop the research utilisation assessment tool found associations between how survey respondents reported their agreement with indicators of governance and resourcing (see Tables 5 and 6).

Conceptually, governance and resources are determinants of implementation in that they authorise and make visible the work that is undertaken. When there are governance processes in place, activities associated with research utilisation are codified, linked to the business and monitored. Without these processes, research utilisation relies on passionate individuals whose actions are lost from corporate memory once those individuals leave. Implementation does not rely solely on whether these organisational systems are present. When collective efficacy is weak, then implementation, regardless of governance processes or resources available, is likely to be resisted. If implementation of changes arising from research findings is enacted it is likely to demonstrate compliance rather than commitment. When commitment and collective efficacy is high, resources will be used skilfully and efforts may exceed those listed in job functions.

Table 5: Survey indicators used to develop the conceptual model of research implementation.

Indicators	Items included in the survey
Conversations (n=4, a=0.851)	There are frequent discussions of the implications of research knowledge. Conversations about evidence-based practice informs decision-making. The organisation culture values research and its use. There is active and widespread engagement in utilisation and learning activities.
Communities-of-practice (n=4, a=0.863)	People transform research products to suit multiple applications. Testing research findings includes processes that trial new practices and allows for 'safe fails'. There is active participation in testing and prototyping research products to make them suitable for the context. Research is about solving problems and 'problem seeking' to proactively explore and develop solutions.
Governance (n=3, a=0.809)	Responsibility for using research is formally embedded in job roles. There are structures (e.g. research committees) that review and monitor research utilisation. Reporting processes are well established.
Resources (n=3, a=0.879)	Resources are available to drive change based on research and to make changes part of core business. There are resources available to implement changes needed to use research based on findings. Resources are in place for individuals to participate in professional development events.
Implementation (n=4, a=0.853)	Research products are incorporated into business-as-usual. Research products are embedded into training, guidelines or doctrine. The agency is able to implement changes that may be needed. The agency is able to assess and evaluate the impact on practice of the research.

Table 6: Correlations between items included in Table 5 as subscales.

Pearson correlations	Conversations (n=116)	Communities-of-practice (n=96)	Governance (n=96)	Resources (n=103)	Implementation (n=100)
Conversations	1	0.749**	0.660**	0.786**	0.631**
Communities-of-practice		1	0.632**	0.693**	0.607**
Governance			1	0.590**	0.524**
Resources				1	0.691**
Implementation					1

** Correlation is significant at the 0.01 level (2-tailed).

Conclusions and limitations

This paper discussed previous empirical work as well as co-construction work with the KIRUN to develop a research utilisation maturity matrix. A self-assessment tool, based on the matrix, allows practitioners to diagnose the stage of their organisation in terms of organisational capacity to utilise research. To address research questions, a conceptual model was proposed to illustrate how organisational elements work together to accelerate implementation of research outputs. While there are gaps between research and practice, closing gaps that support disaster risk reduction is more urgent. Figure 1 suggests that a critical and often overlooked component

of research implementation is the collective beliefs of end users. For this study, the focus was on the perceptions of emergency services practitioners and the findings of research relevant to them. Figure 1 suggests that enabling critically reflective discussions that unpack collective beliefs and test assumptions is an important step in implementing research. This may provide insights for changes in emergency services practice.

The findings here provide ways that emergency services personnel can assess their organisation's practices related to research utilisation. They can also use the maturity matrix to identify steps needed to move along the path towards research implementation. This study supports the work of others (e.g.

Radin Umar *et al.* 2018) that conversations are an important starting point. Implementation of research is not content-specific but is context-specific. Similar to others (e.g. Taylor, Ryan & Johnson 2020), a staged approach is needed.

This research area has limitations. At present, this conceptual model has been empirically derived and needs further testing. Associations exist between key indicators but this does not support causation. The assessment tool explained in this paper has been adapted for the needs of disaster risk reduction researchers but the content is preliminary and speculative. More needs to be understood about how stakeholders successfully implement research. This would help to identify the enablers and barriers that exist to ensure effective use of research and to accelerate courses of action.

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Abstract

In 2017, areas of northern New South Wales experienced significant flooding as a result of ex-Tropical Cyclone Debbie. Such events are likely to become more frequent and severe due to climate change. There is a current gap in the literature investigating the effects of indirect disruption caused by flooding (e.g. loss of access to health and social care for people who have not had their property inundated) on mental health. A survey was conducted of flood-affected communities across northern New South Wales six months after the event to investigate relationships between the flood and adverse mental health outcomes. Responses were used to investigate associations between indirect disruptions and psychological morbidity. Respondents who reported indirect disruption were significantly more likely to report experiences consistent with probable post-traumatic stress disorder than those who did not report any disruption. Those who reported a loss of health and social care or a disruption to their utilities were more likely to experience adverse mental health outcomes. This study showed that indirect disruption due to flooding is associated significantly with adverse mental health. Post-disaster recovery managers might consider allocating mental health support for people who have experienced indirect disruptions.

Disruptions and mental-health outcomes following Cyclone Debbie

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Introduction

Recent years have seen a growing literature on the mental health and wellbeing of individuals affected by flooding (Fernandez *et al.* 2015). Much of the focus has been on the relationship between direct disruption due to flooding and poor mental health (Alderman, Turner & Tong 2012; Zhong *et al.* 2018; Waite *et al.* 2017; Jermacane *et al.* 2018; Reacher *et al.* 2004; Paranjothy *et al.* 2011; Fontalba-Navas *et al.* 2017; Milojevic *et al.* 2011). Inundation of property, damage to possessions and forced evacuations due to flooding can all be classified as direct disruptions. A key finding regarding direct disruptions has been their significant association with post-traumatic stress disorder (PTSD) (Waite *et al.* 2017; Munro *et al.* 2017; Jermacane *et al.* 2018; Zhong *et al.* 2018; Alderman, Turner & Tong 2013; Paranjothy *et al.* 2011; Matthews *et al.* 2019).

Conversely, there is a dearth of published research investigating the associations between mental health morbidity and *indirect* disruptions such as losing access to health care, food or place of employment for people who have not had their property inundated with flood water. Two of the only studies of indirect disruptions following flooding events come from England. These studies identified adverse effects on mental health, especially PTSD (Paranjothy *et al.* 2011, Waite *et al.* 2017). To date, there has been no research on the mental health effects of indirect disruptions published in the Australian context.

Objectives

The objectives of this research:

- Examine the associations between an experience of indirect disruption and direct disruption with mental health outcomes after a flood.
- Examine which types of indirect disruption due to flooding are most strongly associated with adverse mental health outcomes.

Study design

From September to November 2017, six months after ex-Tropical Cyclone Debbie caused extensive flooding

in northern New South Wales, a cross-sectional survey was implemented targeting people who had been living in six local government areas of Ballina Shire, Tweed Shire, Richmond Valley, Kyogle, Byron Shire and Lismore City at the time of the flood. These areas had an estimated population of 247,000 (Australian Bureau of Statistics 2017). Community members aged 16 years and older were recruited using a 'snowball' sampling method. This method incorporated social and organisational networks of local government authorities, business groups and community organisations and was supplemented by an extensive local advertising campaign using print, broadcast and social media. This included a leaflet drop in the two largest centres of population flooded; Lismore and Murwillumbah. All residents were encouraged to participate whether or not they felt the flood had affected them. The survey was available in online and paper formats. Potential respondents were advised that completion of the questionnaire would signify consent to participate in the study. A detailed description of the study design was published by Longman and colleagues (2019).

The study was approved by the University of Sydney Human Research Ethics Committee (reference-2017/589) and the Aboriginal Health and Medical Research Council Human Research Ethics Committee (reference-1294/17).

Measures of disruption

The survey contained questions relating to the degree of flooding, disruption, socio-demographic characteristics and the mental health and wellbeing of the respondents. Using the responses to the disruption questions, participants were categorised into three independent groups: directly disrupted, indirectly disrupted and non-disrupted (Waite *et al.* 2017).

Directly disrupted respondents: Those who reported flooding or damage to any area of their home or income-generating property (e.g. business or farm). These respondents had answered yes to at least one of the following questions:

- *Were non-livable areas of your home damaged or flooded (e.g. garage, garden shed)?*
- *Was at least one livable room in your home damaged or flooded (e.g. bedroom, living room, kitchen, bathroom)?*
- *If you own a business, was it damaged or flooded (e.g. if you own a shop, farm, warehouse)?*

Indirectly disrupted respondents: Those who were not flooded (i.e. answered 'No' to all the previous questions) but who answered yes to any of the following:

- *Your access to health and social care was disrupted.*
- *You had difficulty getting the food supplies you needed.*
- *You were temporarily isolated as surrounding roads were cut.*
- *You were unable to travel to your place of education (e.g. school, university, TAFE).*
- *There were interruptions to your household utilities (e.g. electricity, gas, drainage, septic).*
- *Your Wi-Fi/internet stopped working.*
- *You were unable to travel to your place of employment.*

Non-disrupted respondents: Those who reported none of the specified disruptions.

Measures to assess mental health

Previous studies of natural disasters including flooding have indicated that PTSD, depression, anxiety and increased suicide risk are common sequelae (Alderman, Turner & Tong 2013; Paranjothy *et al.* 2011; Waite *et al.* 2017; Zhong *et al.* 2018; Tang *et al.* 2018; Lowe *et al.* 2019). Therefore, in this study, mental health status was assessed using brief versions of validated screening tools of:

- the Patient Health Questionnaire (PHQ-2) for depression (Kroenke, Spitzer & Williams 2003)
- the Generalised Anxiety Disorder scale (GAD-2) (Kroenke *et al.* 2007)
- the Post Traumatic Stress Disorder Checklist (PCL-6) (Lang & Stein 2005, Fernandez *et al.* 2015).

The PHQ-2, GAD-2 and PCL-6 were selected to keep the outcomes of this study in-line with the only other study previously published investigating the comparison between disruption type due to flooding and adverse mental health outcomes (Waite *et al.* 2017).

Cut-points for probable diagnosis were ≥ 3 for the PHQ-2 and GAD-2 and ≥ 14 for the PCL-6 (Lang & Stein 2005; Kroenke, Spitzer & Williams 2003; Kroenke *et al.* 2007). To relate responses to the PCL-6 to the flood, the checklist was introduced as a list of complaints that people express after extreme rain and flooding. Additional mental health measures included an indicator of suicidal ideation from the Screening Tool for Assessing Risk of Suicide (Hawgood & DeLeo 2017) and an indicator of continuing distress six months after the flood (Clemens *et al.* 2013).

Socio-demographic measures

Socio-demographic data included age, gender, Indigenous status, relationship status, education level, employment status and government income support status. Only respondents with complete socio-demographic data were included in the analysis.

Analysis by disruption category

The analysis was conducted in two stages. First, binary logistic regression models were constructed to calculate the odds of experiencing each of the five types of mental health outcomes: continuing distress, suicidal ideation, probable depression, anxiety and PTSD. Respondents who did not complete a particular health outcome measure were excluded from analysis for that outcome. The dependent variables were the category of disruption, with non-disruption as the reference group. The models were adjusted for all measured socio-demographic characteristics. Sensitivity analyses were conducted to assess the level of bias introduced by including these characteristics.

Analysis by type of indirect disruption

In the second stage of the analysis, five multivariate logistic regression models were constructed that considered the

association between each type of indirect disruption with each of the five mental health conditions as an outcome.

It was reasoned that a substantial portion of participants who experienced an indirect disruption was likely to also have experienced direct disruption. Therefore, only analysing the participants who experienced an indirect disruption without direct disruption would have resulted in a markedly reduced sample from which conclusions could be drawn and could introduce risk of bias in the results. For this reason, every participant who reported an indirect disruption was included and participants were not grouped by disruption category. To account for potential confounding caused by experiencing both direct and indirect disruption, the regression models included a binary variable that indicated any experience of direct disruption by the participants. Again, each model was adjusted for socio-demographic characteristics.

The interest was in identifying significant associations and important confounders. As such, purposeful selection was employed to construct the multivariate logistic regression models. Consistent with the purposeful selection method, other indirect disruptors were retained in the model if they demonstrated a p -value of less than 0.15 or if they demonstrated significant confounding effects ($\Delta\beta > 20\%$) (Bursac *et al.* 2008). As there were multiple analyses investigating the mental health outcomes in both sets of analyses, the α for significance testing was set conservatively at 0.01. Every regression model produced in this study was tested for effect modifications ($\alpha=0.01$). Stata 15 (Stata/SE 15.1 for Windows) was used for all statistical analyses.

Results

Respondent characteristics

In total, 2530 people responded to the survey and 350 (14 per cent) of the responses were missing socio-demographic data. Therefore, the analysis conducted using socio-demographic data was performed using a sample of 2180 participants. Negligible dissimilarities in parameter estimates and patterns of results were found between the full dataset and the dataset absent of missing socio-demographic records.

Mental health outcomes by disruption category

Of these 2180 respondents, 105 could not be classified into disruption categories due to incomplete survey responses, 242 respondents were classified as non-disrupted, 605 were classified as indirectly disrupted and 1228 were classified as directly disrupted. In total, 2075 respondents were included in this part of the analysis. Most of the respondents were over 45 years of age, were female, in a relationship and employed (Table 1, Appendix 1).

Among those who were classified as directly disrupted, between 10 per cent and 33 per cent demonstrated evidence of mental health distress in the outcomes measured. By comparison, among those who were classified as non-disrupted, between 2 and 8 per cent reported mental health distress (Table 2).

Accordingly, the differences in proportions demonstrating evidence of mental health distress between the two groups ranged from 7 per cent (suicidal ideation) to 25 per cent (still distressed).

The differences in proportions demonstrating evidence of mental health distress between those classified as indirectly disrupted and non-disrupted was less stark, ranging from 1 per cent (suicidal ideation) to 7 per cent (probable anxiety).

When factoring in potential confounders in the logistic regression model, the greatest effect on the odds of probable PTSD was found in respondents who experienced direct disruption (OR: 14.4; 95 per cent, CI 5.9–35.3) (Table 3). After adjusting for socio-demographic factors, probable PTSD remained strongly associated with direct disruption (OR:13.5; 95 per cent, CI: 5.5–33.4). Indeed, the odds of experiencing every mental health outcome remained significantly elevated in response to direct disruption after adjusting for socio-demographic factors (Table 3).

Respondents categorised as indirectly disrupted were significantly more likely to experience probable PTSD, probable anxiety or still feel distressed than those who were categorised as non-disrupted. After adjusting for socio-demographic factors, only the odds of probable PTSD remained significantly elevated (OR: 3.52, 95 per cent, CI: 1.36–9.15) (Table 3).

Mental health outcome by indirect disruption type

The relationships between each mental health outcome and each of the indirect disruption types were also examined using multivariate logistic regressions ($n=2180$). The other indirect disruptions were added to the models according to the purposeful selection method and were also adjusted for any experience of direct disruption and socio-demographic factors.

Loss of access to social or health care was shown to significantly increase the odds of every outcome except probable depression. No individual disruption type significantly influenced the odds of having probable depression (Table 5). On the outcome of probable anxiety, employment status significantly modified the size of the effect of a loss of access to health and social care. Among those participants who experienced a loss of access to health and social care, unemployed participants demonstrated greater odds of probable anxiety than those who were employed (OR: 2.67; 95 per cent, CI: 1.64, 4.35 vs OR: 1.05; 95 per cent, CI: 0.67, 1.64, respectively). A loss of utilities was strongly associated with every mental health outcome although this effect was only statistically significant for probable PTSD (OR: 1.9, 95 per cent, CI: 1.41–2.56) (Table 5).

Discussion

The strong link between disruption after a flood event and PTSD has been clearly elucidated in recent literature (Fontalba-Navas *et al.* 2017, Zhong *et al.* 2018, Dai *et al.* 2017, Waite *et al.* 2017, Paranjothy *et al.* 2011, Fernandez *et al.* 2015, Matthews *et al.* 2019). Consistent with Waite and co-authors (2017), these results

Table 1: Socio-demographic characteristics of respondents by disruption category.

Demographic		Disruption Category			
		No disruption	Indirectly	Directly	Total
Age (years)	16 to 25	8 (3%)	37 (6%)	65 (5%)	110 (5%)
	24 to 45	51 (21%)	173 (29%)	290 (24%)	514 (25%)
	45 to 65	115 (48%)	296 (49%)	667 (54%)	1078 (52%)
	65 and older	68 (28%)	99 (16%)	206 (17%)	373 (18%)
	Total	242 (100%)	605 (100%)	1228 (100%)	2075 (100%)
Gender	Female	163 (67%)	430 (71%)	834 (68%)	1427 (69%)
	Male	79 (33%)	175 (29%)	394 (32%)	648 (31%)
	Total	242 (100%)	605 (100%)	1228 (100%)	2075 (100%)
Aboriginal or Torres Strait Islander peoples	Yes	9 (4%)	14 (2%)	53 (4%)	76 (4%)
	No	233 (96%)	591 (98%)	1175 (96%)	1999 (96%)
	Total	242 (100%)	605 (100%)	1228 (100%)	2075 (100%)
Relationship status	In a relationship	162 (67%)	414 (68%)	820 (67%)	1396 (67%)
	Single	80 (33%)	191 (32%)	408 (33%)	679 (33%)
	Total	242 (100%)	605 (100%)	1228 (100%)	2075 (100%)
Education attained	University	119 (49%)	304 (50%)	483 (39%)	906 (44%)
	Other	123 (51%)	301 (50%)	745 (61%)	1169 (56%)
	Total	242 (100%)	605 (100%)	1228 (100%)	2075 (100%)
Employment status	Employed	143 (59%)	450 (74%)	835 (68%)	1428 (69%)
	Other	99 (41%)	155 (26%)	393 (32%)	648 (31%)
	Total	242 (100%)	605 (100%)	1228 (100%)	2075 (100%)
Income support	None	165 (68%)	451 (75%)	800 (65%)	1416 (68%)
	Support	77 (32%)	154 (25%)	428 (35%)	659 (32%)
	Total	242 (100%)	605 (100%)	1228 (100%)	2075 (100%)

Table 2: Respondent mental health outcome by disruption category.

Outcome	Overall cohort	Disruption group		
		Non-disrupted	Indirectly	Directly
Still distressed	478/2050 (23%)	20/242 (8%)	58/597 (10%)	400/1211 (33%)
Probable PTSD	327/2044 (16%)	5/232 (2%)	40/599 (7%)	282/1213 (23%)
Depression	326/2026 (16%)	13/235 (6%)	57/590 (10%)	256/1201 (21%)
Probable anxiety	335/2021 (17%)	9/232 (4%)	62/590 (11%)	264/1199 (22%)
Suicidal Ideation	156/2056 (8%)	8/240 (3%)	23/601 (4%)	125/1215 (10%)
Total*	2075	242	605	1228

* Totals differ from the overall sample size due to missing responses for outcome and exposure reporting.

Table 3: Crude and adjusted odds ratios (OR) for mental health problems by disruption category.

Outcome	Disruption group	<i>n</i>	Crude OR	Crude <i>p</i> -value	<i>n</i>	Adjusted OR [#]	Adjusted <i>p</i> -value [#]
Still distressed	Non-disrupted	260	1 [†]	-	242	1 [†]	-
	Indirectly	654	1.21 (0.72–2.05)	<0.001	597	0.95 (0.47–1.89)	0.878
	Directly	1374	5.77 (3.6–9.23)	<0.001	1211	3.31 (1.79–6.12)	<0.001
Probable PTSD	Non-disrupted	246	1 [†]	-	232	1 [†]	-
	Indirectly	646	3.52 (1.38–8.99)	0.008	599	3.52 (1.36–9.15)	0.01
	Directly	1341	14.43 (5.9–35.31)	<0.001	1213	13.48 (5.45–33.35)	<0.001
Probable depression	Non-disrupted	249	1 [†]	-	235	1 [†]	-
	Indirectly	639	1.88 (1.01–3.49)	0.045	590	1.9 (1–3.62)	0.05
	Directly	1331	4.99 (2.81–8.86)	<0.001	1201	4.26 (2.35–7.73)	<0.001
Probable anxiety	Non-disrupted	247	1 [†]	-	232	1 [†]	-
	Indirectly	639	2.56 (1.33–4.92)	0.005	590	1.55 (0.7–3.44)	0.279
	Directly	1325	6.09 (3.28–11.3)	<0.001	1199	3.64 (1.74–7.62)	0.001
Suicidal ideation	Not Disrupted	256	1 [†]	-	240	1 [†]	-
	Indirectly	648	1.24 (0.55–2.8)	0.597	601	1.02 (0.44–2.35)	0.961
	Directly	1340	3.47 (1.68–7.18)	0.001	1215	2.86 (1.36–5.99)	0.005

Adjusted for age, gender, Indigenous status, receiving income support, education and relationship status.

† Reference group.

showed a significant association between direct disruption and probable PTSD. By comparison, significant association has also been demonstrated between indirect disruption and probable PTSD, although the strength of association is comparatively weaker. This apparent dose-response relationship offers evidence for the causative relationship between the level of disruption due to flooding and the outcome of probable PTSD.

Direct disruption also demonstrated significant associations with the other four mental health outcomes when compared with non-disruption, namely: still distressed, probable depression, probable anxiety and suicidal ideation. By contrast, no significant associations were found between indirect disruption and these four mental health outcomes.

This is one of the few studies that has sought to investigate the associations between mental health and indirect disruption due to a flooding event. Consistent with previous research, indirect disruption was found to be significantly associated with an increased risk of probable PTSD in comparison with individuals classified as non-disrupted (Waite *et al.* 2017, Paranjothy *et al.* 2011).

To date, there has been little discussion in the literature about mechanisms that might account for this increased risk of probable PTSD in cases where there has been disruption

experienced, albeit with no direct damage to people's homes or businesses. Some indications of possible mechanisms might be derived from research on the impact of near-miss experiences and PTSD diagnostic criteria.

Recent literature on 'near-miss experiences' following traumatic events suggests that people who have had near-miss events tend to experience more intrusive thoughts about what might have been and are more likely to think about the actual misfortune of others, which may reinforce intrusions and raise the likelihood of post-traumatic stress symptoms (Poulin & Silver 2019). It might be inferred that those who experienced indirect disruption had a 'near-miss experience' and may have been more sensitive to what might have been and therefore more prone to post-traumatic stress than those who were classified as non-disrupted.

Except for probable depression, these results demonstrate a strong association between losing access to health and social care and every mental health outcome investigated. A similar association was reported by Waite and colleagues (2017), although their results were not mutually adjusted for other disruption types. Interruption to household utilities was also shown to significantly increase the odds of having probable PTSD, consistent with similar findings reported related to the loss of electricity after a flooding event in Hat Yai, Thailand (Assanangkornchai, Tangboonngam & Edwards 2004).

Table 4: Multivariate logistic regression models for mental health outcomes and individual indirect disruption types.

Mental health outcome	Contributing variable	Adjusted odds ratio (95% CI)	P-value
Still distressed	Loss of access to social or health care		
	No loss of access	1	-
	Loss of access**	1.86 (1.38–2.49)	<0.001
	Loss of utilities		
	No loss of access	1	-
	Loss of access	1.34 (1.02–1.75)	0.034
	Loss of access to internet		
	No loss of internet	1	-
Probable PTSD	Loss of access to social or health care		
	No loss of Access	1	-
	Loss of access**	1.93 (1.38–2.7)	<0.001
	Loss of utilities		
	No loss of utilities	1	-
	Loss of utilities**	1.9 (1.41–2.56)	<0.001
	Difficulty accessing food		
	No difficulty	1	-
Probable depression	Loss of access to social or health care		
	No loss of access	1	-
	Loss of access	1.51 (1.44–2.82)	0.016
	Loss of utilities		
	No loss of utilities	1	-
	Loss of utilities	1.38 (1.02–1.85)	0.035
Probable anxiety [^]	Loss of access to social or health care		
	Not employed/No loss of access	1	-
	Not employed/Loss of access**	2.67 (1.64–4.35)	<0.001
	Employed/No loss of access	1	-
	Employed/Loss of access	1.05 (0.67–1.64)	0.838
	Loss of utilities		
	No loss of access	1	-
	Loss of access	1.31 (0.98–1.74)	0.07
Suicide ideation	Loss of access to social or health care		
	No loss of access	1	-
	Loss of access*	1.74 (1.14–2.66)	0.01
	Loss of utilities		
	No loss of access	1	-
	Loss of access	1.43 (0.96–2.13)	0.079

Each model is adjusted for age, gender, Indigenous status, receiving income support, education, relationship status and an experience of direct disruption; remaining covariates retained and presented as per the purposeful selection method.

[^]Denotes significant effect modification identified ($\alpha=0.01$)

* Denotes p -value ≤ 0.01 .

** Denotes p -value ≤ 0.001 .

People who lost access to health and social care as well as being unemployed, were more likely to have an outcome of probable anxiety than those who were employed. It may be that people experiencing unemployment are more likely to need access to health and social care than people who are employed. It may also be that unemployment as well as a loss of this access may have a cumulative effect on anxiety.

There were increased odds of reporting probable PTSD for participants who were classified as indirectly disrupted and for those who specifically reported either a disruption of access to social and health care or a disruption to utilities. Therefore, it is possible that the association between an experience of indirect disruption and the outcome of probable PTSD is largely explained by losing access to social or health care and/or a disruption to utilities.

Given the predicted intensification of the effects of climate change (Climate Council 2017), there is likely to be an increasing number of people who are disrupted by flooding events. This study offers evidence that after a flooding event those in need of mental health support will include people who have been directly disrupted and also those who have lost access to social and health care as well as those who have experienced a disruption to utilities provision.

Treatment of mental health problems, including PTSD, following disasters requires specific training for those working in the mental health field (Foa, Gillihan & Bryant 2013). Furthermore, it is recognised that different approaches delivered by professionals may be needed at different stages post disaster (Forbes, O'Donnell & Bryant 2017). Given the findings of this study, it may be prudent to provide the health care workforce with access to appropriate-level training (e.g. mental health first-aid for the general health and community sector, PTSD training for specialists) in preparation for future acute events. Part of this training could involve how to identify people most in need of mental health care, including those who have been indirectly disrupted. Also, given that those who require mental health support after a flood event may need assistance more than six months after a flooding event (Zhong *et al.* 2018), planning is needed to provide support in the longer, not just immediate, term.

Limitations

The self-selection recruitment method means the respondent population is not representative of the population of the flood-affected communities of northern New South Wales. In this study, men, those with less education and those under 25 years of age were under-represented, which is consistent with previous post-disaster postal survey respondent characteristics (Grievink *et al.* 2006). However, this study did not aim to establish prevalence of mental health outcomes after flooding, but rather to examine the relationships between levels and types of disruption and mental health status. Further, to ascertain the relationships of interest, a study's population does not necessarily have to be representative of the general population from which it was derived (Willett *et al.* 2007, Banks *et al.* 2008).

Conclusions

The responses to the community survey conducted in northern New South Wales have contributed to knowledge around mental health effects after a significant flooding event (Matthews *et al.* 2019). The findings are consistent with, and extend, what has been presented in recent literature. It is proposed that people experiencing disruptions to social and health care services or utilities after a flood might be targeted for mental health support.

Further research in this area might investigate causal mechanisms behind indirect disruptions and their associated mental health outcomes. Also, planned follow-up surveys involving respondents who have indicated an interest in future participation may shed light on the longer-term mental health consequences of flooding events.

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Appendix i. Number and proportions of respondents reporting mental health outcomes for each indirect disruption type.

	Loss of access to food		Loss of access to social/health care		Isolated due to flooding		Couldn't get to education		Disrupted utilities		Loss of access to internet		Couldn't get to work	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Still distressed	Yes	132 (30)	354 (21)	135 (41)	351 (19)	328 (27)	100 (15)	94 (30)	334 (22)	244 (34)	188 (32)	240 (19)	191 (24)	237 (22)
	No	302 (70)	1363 (79)	197 (59)	1468 (81)	870 (73)	560 (85)	217 (70)	1213 (78)	476 (66)	954 (84)	1023 (81)	612 (76)	818 (78)
Total	434 (100)	1717 (100)	332 (100)	1819 (100)	1198 (100)	1198 (100)	660 (100)	311 (100)	1547 (100)	720 (100)	1138 (100)	1263 (100)	803 (100)	1055 (100)
Probable PTSD	Yes	107 (25)	225 (13)	115 (35)	217 (12)	231 (19)	62 (9)	70 (22)	223 (14)	189 (26)	104 (9)	163 (13)	128 (16)	165 (16)
	No	324 (75)	1458 (87)	217 (65)	1565 (88)	971 (81)	591 (91)	242 (78)	1320 (86)	536 (74)	1026 (91)	461 (78)	1101 (87)	888 (84)
Total	431 (100)	1683 (100)	332 (100)	1782 (100)	1202 (100)	1202 (100)	653 (100)	312 (100)	1543 (100)	725 (100)	1130 (100)	1264 (100)	802 (100)	1053 (100)
Probable depression	Yes	97 (23)	237 (14)	95 (29)	239 (14)	204 (17)	82 (13)	65 (21)	221 (14)	158 (22)	128 (11)	109 (19)	105 (13)	181 (17)
	No	328 (77)	1435 (86)	233 (71)	1530 (86)	982 (83)	569 (87)	243 (79)	1308 (86)	562 (78)	989 (89)	477 (81)	1074 (86)	866 (83)
Total	425 (100)	1672 (100)	328 (100)	1769 (100)	1186 (100)	1186 (100)	651 (100)	308 (100)	1529 (100)	720 (100)	1117 (100)	586 (100)	1251 (100)	1047 (100)
Probable anxiety	Yes	104 (24)	238 (14)	102 (31)	240 (14)	219 (18)	81 (13)	75 (24)	225 (15)	164 (23)	136 (12)	115 (20)	123 (16)	177 (17)
	No	321 (76)	1432 (86)	225 (69)	1528 (86)	966 (82)	566 (87)	234 (76)	1298 (85)	551 (77)	981 (88)	471 (80)	1061 (85)	862 (83)
Total	425 (100)	1670 (100)	327 (100)	1768 (100)	1185 (100)	1185 (100)	647 (100)	309 (100)	1523 (100)	715 (100)	1117 (100)	586 (100)	1246 (100)	1039 (100)
Suicidal ideation	Yes	52 (12)	106 (6)	50 (15)	108 (6)	105 (9)	32 (5)	37 (12)	100 (6)	79 (11)	58 (5)	50 (8)	61 (8)	76 (7)
	No	377 (88)	1595 (94)	281 (85)	1691 (94)	1092 (91)	635 (95)	276 (88)	1451 (94)	645 (89)	1082 (95)	546 (92)	1181 (93)	982 (93)
Total	429 (100)	1701 (100)	331 (100)	1799 (100)	1197 (100)	1197 (100)	667 (100)	313 (100)	1551 (100)	724 (100)	1140 (100)	596 (100)	1268 (100)	1058 (100)
All	434	1717	332	1819	1210	1210	671	314	1567	730	1151	601	1280	1070

Disaster memorial events for increasing awareness and preparedness: 150 years since the Arica tsunami in Aotearoa-New Zealand

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Introduction

Anniversaries of disaster events are a time when people's memories and personal experiences are powerfully evoked, prompting recollection, reflection and storytelling (Forrest 1993, Echterling 1998). Disaster memorials, including permanent features such as plaques, gardens, art and statues as well as services and events are 'symbolic forms of ritual expression demonstrating the impact of tragedy, particularly sudden and unexpected events, on communities' (Eyre 1999, p.23).

Memorial events held within the weeks, months or years following a disaster may play a crucial role in community recovery and encourage community resilience (Eyre 2007, 1999; Nicholls 2006). Eyre (1999) explained that both informal (impromptu, community-led initiatives such as flower laying) and formal (organised events) anniversary memorials allow collective expression of grief. This is an important process for some people to come to terms with tragedy and seek comfort and is part of the healing process. However, for some people, these memorials may cause trauma and reduce community resilience (Garde-Hansen *et al.* 2017, Fraser 2018, McKinnon 2019). This can occur when memorials place the event in the past and put pressure on people to forget, downplay the effects, are not inclusive of marginalised groups, are not carried out in a culturally appropriate manner or do not appropriately address failed disaster management policies (McKinnon 2019, Fraser 2018).

This paper describes the memorial event held to commemorate a 150th anniversary, which held a different purpose or kaupapa¹. Anniversaries in longer timeframes

1 Kaupapa is a Māori term for topic, policy, matter for discussion, plan, purpose, scheme, proposal, agenda, subject, programme, theme, issue, initiative (Moorfield 2019).

Abstract

On 15 August 1868, a great earthquake struck off the coast of the Chile-Peru border generating a tsunami that travelled across the Pacific Ocean. Wharekauri-Rēkohu-The Chatham Islands, located 800 km east of Christchurch city, was one of the worst affected locations in Aotearoa-New Zealand. Tsunami waves, including three over six metres high, injured and killed people, destroyed buildings and infrastructure and affected the environment, economy and communities. Advancements in disaster risk reduction systems and technology have significantly advanced since then, as has Aotearoa-New Zealand's capacity to be ready for and respond to earthquakes and tsunami. However, collective memory of this event and other tsunami events has diminished. In 2018, a team of scientists, emergency managers and communication specialists collaborated to organise a memorial event on the Chatham Islands and coordinate a multi-agency media campaign to commemorate the 150th anniversary of the 1868 Arica tsunami. This paper describes the purpose and variety of contexts in which anniversary memorial events are held. The 1868 Arica tsunami event and the design and components of the 150th anniversary memorial event are examined to detail the educative function this memorial held and potential improvements for future memorial events. The importance of commemorating centennial disaster anniversaries using memorial events is highlighted as it raises awareness and increases community preparedness for future events: 'lest we forget and let us learn'.

after disaster events, where people have not been directly affected, can have an educative function greater than those held in the immediate aftermath. These memorials raise awareness of past events that may have diminished in a community's collective memory (defined by Roediger & Abel (2015) as recollections of events shared by a group). Memorials also reflect on the lessons learnt and encourage preparedness for future events (Blanchard-Boehm & Cook 2004; Cowan, McClure & Wilson 2002; McGee & Young 2000; Blanchard-Boehm 1996).

Aotearoa-New Zealand's disaster risk reduction agencies, including the National Emergency Management Agency, regional Civil Defence Emergency Management groups and operational monitoring agencies such as the MetService and GeoNet use websites and social media channels to acknowledge and publicise historical disaster anniversaries (Hill 2016). However, memorial events for events of decades or centuries ago are rare. Examples include the 85th anniversary of the Hawkes Bay earthquake in 2016 and the 50th anniversary of the Inangahua earthquake in May 2018 (Laing 2016). Prior to 2018, memorial events were not held to commemorate historical tsunamis.

The 15 August 2018 marked the 150th anniversary of the 1868 Arica earthquake and tsunami. While Aotearoa-New Zealand's tsunami exposure is widely documented, there has been less focus on the Chatham Islands, located 800 km east of Christchurch (Figure 1). The Chatham Islands are exposed to tsunami from all sides and was one of the most affected locations during this event. Since then, no tsunami has been as destructive and tsunamis have not caused damage to the Chatham Islands since 1960. As a result, some members of the community have grown complacent (Thomas 2018).

This study received approval from Massey University, Ethics Notification Number 4000019934.

The 1868 Arica tsunami

On August 14 1868 at 10:15 am (Chatham Islands local date and time), a large-magnitude earthquake struck off the coast of Arica, near the Chile-Peru border. The earthquake generated a large tsunami that was observed throughout the Pacific region (Figure 2). As no tsunami warning system existed for the Pacific at that time, people in areas beyond the earthquake source were generally caught unaware. Almost 15 hours after the earthquake, at 1:00 am on 15 August, an hour before high tide, the largest tsunami waves arrived along the east and north coasts (Downes *et al.* 2017, McSaveney 2006, *North Otago Times* 1868). People woke to a loud roar and water surging through their homes. Ten minutes later, a larger wave hit followed 3–5 minutes later by a third large wave that dragged away everything still standing (Wanganui Herald 1868, Downes *et al.* 2017, *Hawkes Bay Herald* 1868).

...the first great wave rushed in with such force and terrific noise that the very foundation of the deep seemed broken up. In ten minutes more, another wave, more terrible than the former, commenced its work of destruction and after a like interval, the third and last completed the catastrophe.

*Indeed, the full wrath of the ocean seemed to battle with the island in fierce resolve to submerge it... The third wave, which came rolling in with most awful grandeur and thousand-fold power, bearing down outbuildings and stout old akeakes [native tree, *Olearia traversiorum*], which broke and cracked beneath its fury like matchwood, carrying away young cattle, and scattering the debris of the ruins far away...*

Hawkes Bay Herald 1868

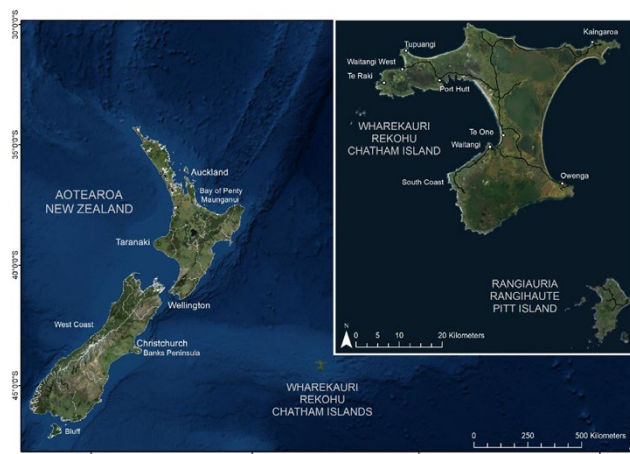


Figure 1: Location of the Chatham Islands off the east coast of Aotearoa-New Zealand.

Map produced using ESRI World Imagery Basemap and Stats New Zealand Regional Council 2018 Boundaries.



House ruins at Tupuangi from the 1868 Arica tsunami.

Image: Kristie-Lee Thomas.

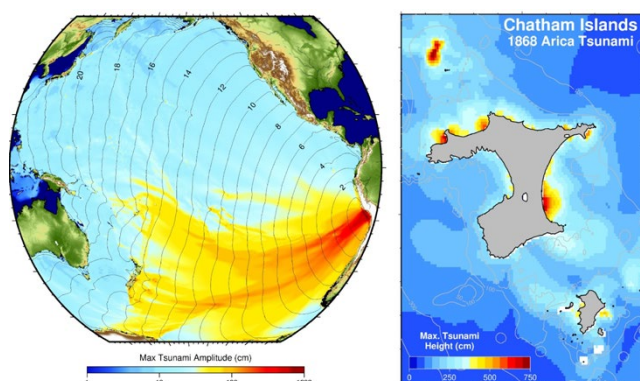


Figure 2: Trans-Pacific propagation pattern of the 1868 Arica tsunami (left) and modelled tsunami height around the Chatham Islands coastline (right).

Image: Jose Borrero

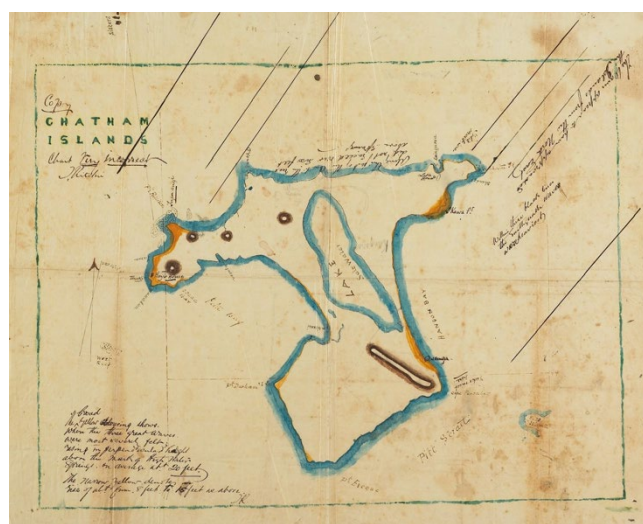


Figure 3: Map of the 1868 tsunami inundation (yellow) produced by local run holder and trader, Mr Thomas Ritchie.

Image courtesy of National Museum of New Zealand Te Papa Tongarewa (1868)

The entire Chatham Islands coastline was affected (Figure 3). The north and east coasts experienced waves up to six metres that flooded up to six kilometers inland. Waitangi, Te One and the South Coast experienced waves of 2.4–4.6 metres (*Hawkes Bay Herald* 1868).

Tupurangi, Te Raki and Waitangi West experienced the greatest effects of the tsunami. The entire kāinga² at Tupurangi, where approximately 70 people lived, was destroyed. Whare³ were smashed, vegetation was destroyed and sand, boulders and seaweed covered the ground (Holmes 1993; Richards, Carter & Amery 2009; *Otago Witness* 1868). Māori oral histories reveal three whānau⁴ were washed away with their whare and drowned (Thomas 2018). People who ran to high ground survived but were left with nothing. The once flourishing settlement was abandoned and many people returned to ancestral lands

in Taranaki (on mainland Aotearoa-New Zealand) soon after (Holmes 1993, Lawrie & Powell 2006, Travers 1871).

The rest of the island fared little better. A man drowned at Waitangi West while trying to save a fishing boat (*Otago Witness* 1868, *Wanganui Herald* 1868). Many houses were destroyed and washed away and the Pā⁵ at Waitangi was damaged (*North Otago Times* 1868, *Otago Witness* 1868, *Hawkes Bay Herald* 1868). Boats and bridges were damaged or washed away, beaches were covered in debris and sand dunes were eroded (*Otago Witness* 1868; Richards, Carter & Amery 2009; *Wanganui Herald* 1868; Travers 1871). Abnormal waves, surges and strong currents continued over the following 24 hours even as people cleaned up the mess left behind the tsunami (Downes *et al.* 2017).

Tsunami waves affected Aotearoa-New Zealand one to two hours after arrival in the Chatham Islands. Several people were nearly swept away, many boats were damaged and some homes, roads and fences were destroyed, particularly around Banks Peninsula near Christchurch (Downes *et al.* 2017; De Lange, Healy & Geophysics 1986; Borrero & Goring 2015). In Lyttleton Harbour, the tsunami had a trough-to-peak height of around 7.6 metres (Gibson 1868). Tsunami waves and surges were observed over the next two days along the east coast from Maunganui in the north to Bluff in the south as well as in places along the West Coast region.

Memorial event and media

Research investigating the 1868 tsunami and its impacts on the Chatham Islands by Thomas (2018) and developing tsunami evacuation zones by the Chatham Islands Council provided a timely opportunity to hold a memorial event to commemorate the 150th anniversary and promote tsunami awareness and readiness. GNS Science, GeoNet and Massey University Joint Centre for Disaster Research evaluated interest from Chatham Islands Emergency Management, both indigenous groups Ngāti Mutunga o Wharekauri Iwi⁶ and Moriori (through their respective Iwi Trust Offices⁷) as well as other interested groups including the Chatham Islands Chatham Islands Emergency Management and Ngāti Mutunga o Wharekauri Iwi Trust Manager. Two primary

2 Māori settlement, village (Moorfield 2019).

3 Traditional Māori dwelling (Moorfield 2019) usually made from ponga (silver tree fern, *Cyathea dealbata*) and, on the Chatham Islands, sometimes with other materials such as driftwood.

4 Whānau is 'extended family, a family group; a familiar term of address to a number of people, the primary economic unit of traditional Māori society' (Moorfield 2019).

5 Fortified village (Moorfield 2019).

6 Iwi are an extended kinship group, tribe, often refers to a large group of people descended from a common ancestor and associated with a distinct territory (Moorfield 2019).

7 Ngāti Mutunga O Wharekauri Iwi Trust and Hokotehi Moriori Trust are Mandated Iwi Organisations established under the *Māori Fisheries Act* 2004 to receive fisheries settlement assets on behalf of and for the benefit of registered members and beneficiaries (who are determined by whakapapa). Mandated Iwi Organisations may also represent the members and beneficiaries on other matters, such as resource management, and wider engagement and consultation on behalf of iwi.

schools on Museum, schools and infrastructure companies. Interest in designing and organising the event was received from the Chatham Island, Kaingaroa School and Te One School, were also interested (Pitt Island School was not contacted and will be for future engagement). Other groups indicated they may attend the memorial or were unable to contribute at the time. Phone calls and emails were exchanged to design the activities and organise the event. Invitations were extended to members of the science community invested in tsunami research on the Chatham Islands.

The agreed purpose of the campaign was to:

- raise awareness of the fatal and destructive 1868 Arica tsunami
- acknowledge and remember people who lost their lives and incurred losses from the tsunami; people on the Chatham Islands and the 25,000 who died in areas of southern Peru
- raise awareness of potential tsunami sources for Aotearoa-New Zealand and the Chatham Islands as well as tsunami processes and warning systems
- raise awareness of the potential impacts that may occur if a tsunami of similar magnitude hit the islands again and what the community can do to reduce the consequences (sharing results from recent research)
- encourage the community to be prepared for and resilient to future tsunamis.

Chatham and Pitt islands have a combined population of approximately 600 people, of which, 59 per cent identify as Māori with the remainder mostly identifying as being European or Pacific Islanders (Statistics New Zealand 2013). People known to have lost their lives in 1868 on the Chatham Islands were of Ngāti Mutunga decent (Thomas 2018). Therefore, it was vital that memorial activities be carried out in a culturally appropriate manner, abiding by Chatham Islands community tikanga⁸ and kawa⁹. This was ensured by co-designing the memorial event with local and iwi representatives.

To prepare for the event, postcard-sized flyers were created with tsunami facts and evacuation messages (Figure 4). These were co-designed with Chatham Islands Emergency Management and GeoNet as take-home resources that could be displayed in homes. The messages were consistent with National Emergency Management Agency messaging and had specific advice for the Chatham Islands community. The messages and layout also followed evacuation boards to be erected on island. The postcard was designed with local context in mind; a light-hearted image of a Weka (native bush hen, *Gallirallus australis*) and her chick evacuating with a kete¹⁰ was used to connect with local people as Weka are well-known on the Chatham Islands and are used as mascots of sports teams.

The anniversary was commemorated by travelling to the worst-affected site of Tupuangi to acknowledge the destruction and to say a karakia¹¹ for the lives lost there. This was followed by kai¹² (sausage sizzle) to abide by tikanga, followed by korero¹³ looking at how the community could be prepared for a future tsunami. Copies of a story written for the Chatham Islander newspaper, the postcards and evacuation zone maps were distributed to attendees. Copies were also left at the hotel for local people and tourists. Kaingaroa School (less than ten pupils) joined in with memorial activities. Te One School (approximately 50 students) preferred to be visited in the afternoon for a korero and other activities.

- 8 Tikanga is 'correct procedure, custom, habit, lore, method, manner, rule, way, code, meaning, plan, practice, convention, protocol - the customary system of values and practices that have developed over time and are deeply embedded in the social context' (Moorfield 2019).
- 9 Kawa are customs, protocols, rules and appropriate karakia (blessings/prayers) for events.
- 10 Kete is a basket traditionally made with woven harakeke, flax (Moorfield 2019).
- 11 Karakia is a blessing (Moorfield 2019) to acknowledge, be present, reflect and prepare.
- 12 Kai is food and sharing a meal, which is significant during cultural procedures (Moorfield 2019).
- 13 Korero is to talk, speech, storytell (Moorfield 2019).

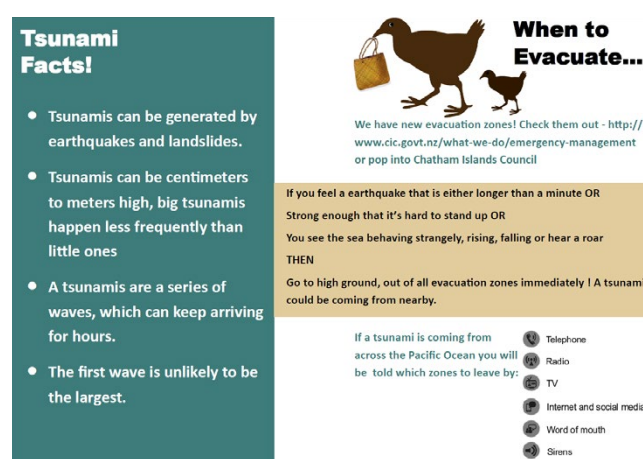
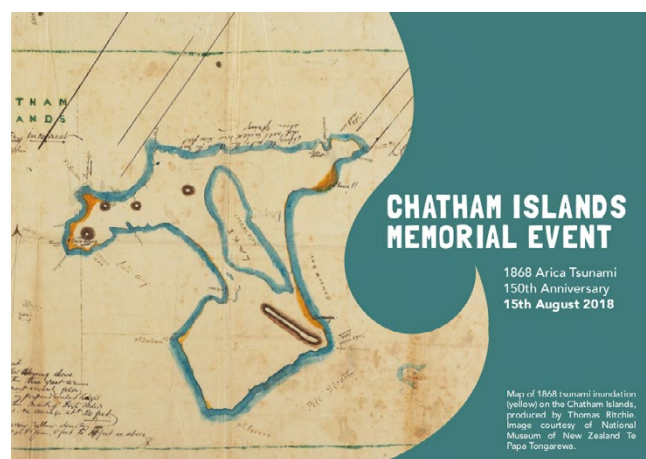


Figure 4: The postcard (front and back) with tsunami facts and evacuation messages.

Image: Emily Campbell



Stories were shared of the 1868 tsunami with Te One School students and teachers.

Image: Lucy Kaiser

Initially the memorial was scheduled for Wednesday 15 August, the day the tsunami struck (1:00 am Chatham Islands time), but it was rescheduled to Tuesday 14 August to accommodate a tangi¹⁴ and a teacher strike scheduled for the Wednesday. This allowed an acknowledgement of the moment the earthquake struck in Arica and to consider how the tsunami travelled across the Pacific Ocean.

Activities of the memorial included:

- gathering at the Emergency Operations Centre at start of the memorial event for a karakia to commence proceedings and introductory speeches
- karakia acknowledging people lost at Tupuangi and korero at Waitangi West Beach about the tsunami and the impacts
- a convoy of vehicles to the site with a stop at the moment the earthquake struck (10:15 am Chatham Islands time) to observe a minute of silence for those who lost their lives in the 1868 Arica earthquake and tsunami
- sharing a meal at the EOC followed by a presentation of recent tsunami research findings, newly developed tsunami evacuation zones and tsunami readiness information
- visiting Te One School for a presentation and tsunami-readiness activities that included playing a game to educate children about earthquakes causing tsunami and identifying their homes, and evacuation routes on the evacuation zone maps. Postcards with key information about tsunamis were distributed for them to take home to their families.

Three media releases were prepared by GNS Science, the National Science Challenge Resilience to Nature's Challenges and eCoast, that described the 1868 tsunami and its impacts on the Chatham Islands and Banks Peninsula (Table 1). eCoast prepared animations of the tsunami propagating across the Pacific Ocean and how the tsunami affected various sites along the Aotearoa-



Members of the Chatham Island community gathered for a karakia and story sharing at Waitangi West.

Image: Lucy Kaiser

New Zealand coast including Lyttelton Harbour and Sumner in Christchurch. A news story about the tsunami, with associated social media promotion, was written by GeoNet. The story described the tsunami and its effects along the New Zealand coastline, incorporating eCoast's animations with a reminder for New Zealanders to know tsunami evacuation zones. A story was prepared for *The Chatham Islander* that detailed the effects of the 1868 tsunami and listed things Chatham Islanders could do to be ready for a future tsunami. Information was posted on the Chatham Islands Council website. Ian Simpson, CEO of GNS Science, sent letters to the New Zealand ambassadors of Chile and Peru sharing the plans for the event and sending condolences for the shared devastation of the 1868 tsunami. The media releases and stories were a collaborative effort to increase awareness of this fatal event and to improve preparedness for future tsunamis.

Discussion

This memorial event served as excellent outreach to promote tsunami awareness and preparedness. The anniversary was widely covered in the media through news articles, social media, magazines and newspapers (Table 1) and many Chatham Islanders attended the memorial event. This showed the appetite of people to commemorate disaster anniversaries and indicates an educative function of memorials to share messages of preparedness. With passing time, people who have not been directly affected by disasters benefit from the educative role of memorial events. Memorials must be co-designed with the community whose ancestors experienced the event and should be carried out in culturally appropriate ways respective of the local context.

¹⁴ Funeral (Moorfield 2019).

Table 1: Press releases, news stories and animations about the anniversary memorial event.

Media Type	Agency	Link
Media Release	GNS Science	www.gns.cri.nz/Home/News-and-Events/Media-Releases/Chathams-tsunami-anniversary
	National Science Challenge Resilience to Nature's Challenges	https://resiliencechallenge.nz/media-release-tsunami-preparedness-in-the-chatham-islands/
	GeoNet	www.geonet.org.nz/news/6QkxQCLs0E4A0QQqgKMqIC
	eCoast	www.ecoast.co.nz/tsunami-of-august-1868/ www.youtube.com/playlist?list=PLiR2pNH9T8nRpbqUnwpYsDUWL_LPXsQ3X
	Chatham Islands Council	www.cic.govt.nz/your-council/news-and-events/2018/150-years-ago-on-the-chatham-islands/
	Chatham Islander Newspaper	https://drive.google.com/file/d/0B1OcsWQ6_z-OWWYweWZ4Yk5ZdHhNGI1dFAzNXl0dTgxcFdn/view
Online News Articles	Māori Television	www.maoritelevision.com/news/regional/150-years-chatham-islands-fatal-tsunami
	Newshub	www.newshub.co.nz/home/new-zealand/2018/08/video-shows-impact-of-new-zealand-s-largest-tsunami-on-150th-anniversary.html
	NZ Herald	www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=12106143
	Scoop Sci-Tech Independent News	www.scoop.co.nz/stories/SC1808/S00020/scientists-go-to-chathams-for-anniversary-of-deadly-tsunami.htm
	Stuff	www.stuff.co.nz/science/106213804/Only-deadly-NZ-tsunami-on-record-hit-the-Chathams-150-years-ago
	GeoNet	www.geonet.org.nz/news/6QkxQCLs0E4A0QQqgKMqIC
Magazines	Insurance Business Magazine	www.insurancebusinessmag.com/nz/news/breaking-news/memorial-set-to-commemorate-nzs-only-deadly-tsunami-108748.aspx
	Natural Hazards Magazine (2017)	https://www.naturalhazards.org.nz/NHRP/Publications/Natural-Hazards-Issues
	NZ Today Magazine	www.stuff.co.nz/science/106213804/Only-deadly-NZ-tsunami-on-record-hit-the-Chathams-150-years-ago

Approximately 30 Chatham Islanders, including Kaingaroa School, joined the commemoration on Tuesday morning. Te One School was included on the Tuesday afternoon. Approximately 100 Chatham Islanders (20 per cent of the resident population) were involved. Attendees sharing information to spouses, parents and siblings may have expanded this reach. The events were planned well and were led by local, well-known and trusted researchers with community connections and who collaborated with an iwi representative and Civil Defence Emergency Management staff. Although identifying direct descendants of the families involved was out of scope for this project, it is recognised that including descendants would be vital to memorial design and organisation processes for future events. Impromptu feedback from memorial participants (either at the end of the day or in

the days following) indicated they learnt a lot and enjoyed the day. The authors perceive that the most important motive for participants attending was to educate the younger generation and perhaps also for cultural reasons to acknowledge and respect the deceased. Future memorial events should collect formal feedback from participants to understand:

- people's motives for attending to help understand why commemoration is important and what form memorial events should take for particular communities or groups
- how participants responded to the memorial activities, the forms of information presented and how these enable resilience



Some of the memorial event team, left to right: Hamish Campbell, Lucy Kaiser, Kristie-Lee Thomas, Emily Campbell, Debbie King, Rana Solomon and David Johnston.

Image: courtesy Kristie-Lee Thomas.

- whether construction of permanent reminders or designated places for people to reflect and remember would assist in education and increased resilience.

Conclusion

The 1868 Arica tsunami caused destruction on the Chatham Islands and across the coastline of Aotearoa-New Zealand. The 150th anniversary was an opportunity to raise awareness and community preparedness for future events. A coordinated memorial event and communication materials achieved outreach across parts of Aotearoa-New Zealand. The anniversary was widely covered in the media and many locals attended the memorial event. The good attendance suggested significant interest in the anniversary and the threats tsunamis pose to communities. A strength of the project was the involvement of a wide cross-section of the community, including school children. This increased the educative value of the commemoration. Anniversaries in the centuries following such significant events provide opportunities to raise awareness of past disasters, to share scientific findings and the lessons learnt during and since that time. The aim is to keep people informed of disaster risk reduction activities and encourage public action to improve preparedness for future events.

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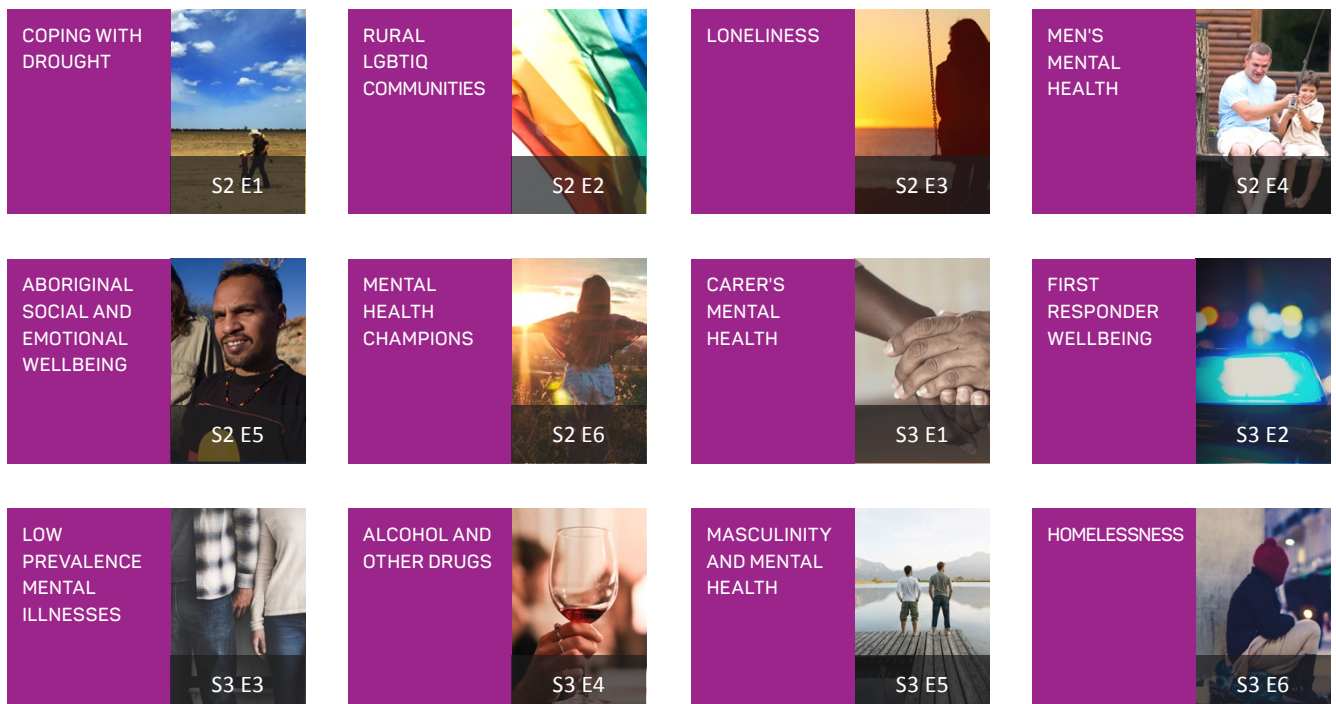
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