



# Australian Journal of Emergency Management

VOLUME 37 NO. 3 JULY 2022 ISSN: 1324 1540

## ▶ NEWS AND VIEWS

Resilient Australia Awards

Page 5

## ▶ REPORTS

Emergency sanitation  
planning

Tornadoes in Australia  
Pages 25 – 40

## ▶ RESEARCH

Land use policy and  
planning in New Zealand

Page 45

## About the journal

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

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

## Publisher

The *Australian Journal of Emergency Management* is published by the Australian Institute for Disaster Resilience with financial assistance from the Australian Government. The journal is published online at [www.knowledge.aidr.org.au](http://www.knowledge.aidr.org.au).

## Editorial Advisory Board

Details of members of the advisory board are provided on the website at [www.knowledge.aidr.org.au/collections/australian-journal-of-emergency-management](http://www.knowledge.aidr.org.au/collections/australian-journal-of-emergency-management).

## Editor-in-Chief

Associate Professor Melissa Parsons, University of New England

## Editorial Committee

Katelyn Samson, Australian Institute for Disaster Resilience  
Zoe Mounsey, Fire and Emergency New Zealand  
Zoe Kenyon, AFAC  
Christine Belcher, Managing Editor

## Production

Design, typesetting and production: Emily Fraser  
Print and distribution: Valiant Press

**Cover image:** Winner of the Resilient Australia National Photography Award: Still Standing – We and the Trees.  
Image: Virginia Eastman

## Peer reviewers

The AJEM Editorial Committee recognises the efforts of researchers and practitioners who serve as peer reviewers of articles submitted to the journal. Peer reviewers play an essential role in ensuring the quality of research published. Their contribution is critical to the success of the journal and, more importantly, to the field of emergency management and disaster resilience.

## Circulation

Approximate circulation (print and electronic): 5500.

## Copyright

Articles in the *Australian Journal of Emergency Management* are provided under a Creative Commons Attribution Non Commercial (CC BY-NC 4.0) licence that allows reuse subject only to the use being non-commercial and to the article being fully attributed ([creativecommons.org/licenses/by-nc/4.0](http://creativecommons.org/licenses/by-nc/4.0)).

© Australian Institute for Disaster Resilience 2022.



Permissions information for use of AJEM content can be found at <http://knowledge.aidr.org.au/ajem>

## Submissions

The *Australian Journal of Emergency Management* welcomes submissions for News and Views and Research articles. The Contributors' Guidelines are available at [knowledge.aidr.org.au/ajem](http://knowledge.aidr.org.au/ajem). The guidelines provide word limits for articles. Submissions exceeding those limits will be returned to authors. Articles are to be submitted as a Word file. High resolution photographs, graphs and tables should be submitted in their original software applications as separate files.

Research articles must contain an abstract, university ethics statement as appropriate and a short biographical paragraph about each author. A Copyright Release form and the Editorial Policy are available on the website. Authors should familiarise themselves with the journal before making a submission. Contributions should be forwarded electronically to [ajem\\_editor@aidr.org.au](mailto:ajem_editor@aidr.org.au). All research articles are peer reviewed. The *Australian Journal of Emergency Management* is indexed by several indexing organisations.

## Subscriptions

Online access to all content is available free. Subscribe to the journal at [knowledge.aidr.org.au/ajem](http://knowledge.aidr.org.au/ajem).

Print copies can be ordered online at [aidr.valiantpress.com.au](http://aidr.valiantpress.com.au) for \$30.00\* per edition (includes postage within Australia) or get all 4 editions printed and posted for \$100.00\* per annum.

\*Prices are in AUD and exclude GST.

## Contact us

Mail: Australian Journal of Emergency Management  
Australian Institute for Disaster Resilience  
Level 1, 340 Albert Street  
East Melbourne Victoria 3002  
Email: [enquiries@aidr.org.au](mailto:enquiries@aidr.org.au)  
Phone: +61 3 9419 2388

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

# Contents

## News and views

Foreword <i>Senator the Hon. Murray Watt</i>	4
Resilient Australia Awards: local initiatives celebrated on the national stage <i>Alana Beitz</i>	5
2022 Lessons Management Forum: when observations become lessons learnt <i>Molly Price</i>	11
Are we succeeding at making Australian communities safer in the face of growing disaster risk? <i>Alexandra Nichols, Tricia Addie, Ceri Teather, Lisa Mollard</i>	13
Developing the Second National Action Plan <i>Jacqui Cristiano, Monica Buchtmann</i>	15
Asia-Pacific Ministerial Conference on Disaster Risk Reduction <i>Alexandra Nichols, Tricia Addie, Ceri Teather, Lisa Mollard</i>	17
Mapping communities at risk <i>Lucy Saaroni</i>	19
Fire-atmosphere modelling provides insights for bushfire behaviour <i>Nathan Maddock</i>	20
Taking protective action during floods and storms <i>Radhiya Fanham</i>	22
Book review: Designing the Compassionate City <i>Reviewed by Victoria Cornell</i>	24

## Reports

Tornadoes in Australia: are we prepared? <i>Victoria MacLean, Dr Yetta Gurtner</i>	25
Living behind the Launceston levee: insights from a community survey <i>Neil Dufty, Rhiannon Garrett, Filippo Dall'Osso, Kelsey Sanborn</i>	29
Creating a post-earthquake emergency sanitation plan for the Wellington region, Aotearoa New Zealand <i>Richard Mowll, Carol Stewart, Daniel P Neely, Matthew Brenin, Mike Fisher, Nickola Loodin, Steve Hutchison</i>	35
Community bushfire safety awareness: a community-led initiative progress report <i>Max Garner, Jim McLennan</i>	40

## Research

Improving resilience: a longitudinal analysis of land-use policy and planning for earthquakes in Aotearoa New Zealand, 2000–16 <i>Dr Bridgette Sullivan-Taylor, Sarah Gunnell, Associate Professor Julia Becker, Professor David Johnston</i>	45
Instruments for disaster preparedness evaluation: a scoping review <i>Dr Nina Lorenzoni, Dr Stephanie Kainrath, Dr Maria Unterholzner, Professor Harald Stummer</i>	56
PPRR and AIIMS: a whole-of-government strategy in NSW <i>Alan Holley, Dr Tony McArthur</i>	65

# Foreword



**Senator the Hon. Murray Watt**

Minister for Agriculture, Fisheries and Forestry and Minister for Emergency Management



© 2022 by the authors. License Australian Institute for Disaster Resilience, Melbourne, Australia. This is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

I am pleased to have the opportunity to contribute to the *Australian Journal of Emergency Management*; an important publication contributing to building Australia’s disaster resilience.

As Minister for Emergency Management, I recognise the significant challenges that Australia faces. It is broadly recognised that the scale and cost of disasters is growing, they are occurring more frequently and are having long-term and complex impacts on the economy, environment and of course, communities. For Australia to effectively prevent, manage and rebuild after disasters, an ambitious and holistic approach to reducing systemic disaster risk is required.

Following on from the First National Action Plan to implement the *National Disaster Risk Reduction Framework* that was released in December 2020, the Second National Action Plan is currently being developed. The plan will take a strategic, inclusive and forward-looking approach, and will be informed by comprehensive consultation. This includes discussions from last month’s From Risk to Resilience Summit on disaster risk reduction, which was a rewarding experience for me to hear the insights from leaders in this field.

Australia will need to continuously look for opportunities on how we can work most effectively across the different levels of government and with communities, businesses and other stakeholders to improve how disaster risks are reduced and resilience is built. I am particularly keen to elevate regional involvement in disaster risk reduction and to establish closer partnerships with local government authorities and communities. Genuine community engagement is needed, so I am endeavouring to go to Australia’s regions that have been most affected by disasters and learn more from local leaders.

To support local communities, a new Disaster Ready Fund will provide up to \$200 million per year for infrastructure and programs that improve disaster preparedness and reduce risk. This may include flood levees, drainage improvements and evacuation centres or other, equally important initiatives focused on governance and risk accountability. Disaster recovery funding arrangements will also be streamlined to make sure they are consistent and equitable.

In building capability, it is important that we connect with international counterparts and experts. While this has been challenging over the last few years with the pandemic, it is pleasing that Brisbane will host the Asia-Pacific Ministerial Conference on Disaster Risk Reduction, which is the first regional meeting since the onset of the pandemic. This is a significant event that brings together senior representatives from the world’s disaster-prone regions to review risk reduction efforts and share information on emerging and innovative approaches.

It is timely that the *Sendai Framework for Disaster Risk Reduction 2015-2030* is rapidly approaching its mid-point. The conference provides a platform for the region to reflect on progress and, importantly, for us to make commitments to achieve the 2030 vision set by the framework.

I encourage emergency management practitioners to continue working with the government on disaster risk reduction.

# Resilient Australia Awards: local initiatives celebrated on the national stage

**Alana Beitz**

Australian Institute for  
Disaster Resilience



© 2022 by the authors.  
License Australian Institute  
for Disaster Resilience,  
Melbourne, Australia. This  
is an open access article  
distributed under the terms  
and conditions of the Creative  
Commons Attribution  
(CC BY) license ([https://  
creativecommons.org/  
licenses/by/4.0/](https://creativecommons.org/licenses/by/4.0/)).

Following a year of continued disruption from disaster events that were exacerbated by the COVID-19 pandemic, the 22nd Resilient Australia Awards celebrated local commitment to building resilience.

A record number of projects were submitted to the 2021 Resilient Australia Awards program, with 48 national finalists selected from 182 submissions across 7 categories: business, community, government, local government, schools, photography and mental health and wellbeing.

In her address to the National Awards Ceremony on 8 December 2021, Former Australian Institute for Disaster Resilience Executive Director, Amanda Leck, said the volume and breadth of the submissions captured the spirit of shared responsibility and collaborating for whole-of-community solutions.

'This year's record number of submissions is a reflection of our creative and adaptive response to a period that has tested our resilience in more ways than one.

'Building authentic, lasting resilience in our communities has never been more important. To achieve this, we need a whole-of-community approach and to work together. These awards celebrate steps towards this goal and acknowledge the work of the finalists, who are all helping to support a disaster resilient Australia', she said.

Former Minister for Emergency Management and National Recovery and Resilience, Senator the Hon Bridget McKenzie, attended the event and presented the awards. Senator McKenzie commended the efforts of the national award finalists who have 'taken us on great strides to build more resilience'.

Senator McKenzie said, 'Nobody likes to think that disasters will befall them, their community or their family, but unfortunately we know that we can expect more extreme weather events, and we're seeing compounding disaster events.

'We all share a vision of an Australia where communities not only recover more swiftly from

disasters but are much better prepared before these events even occur. We all have a responsibility in this space. We can't just leave it to others... we're all in this together', she said.

## National Award: educational, economic and community-led resilience building

Prevention through fire-safety education is the first line of defence against misuse of fire, and fire-related injuries and fatalities. While fire-safety education is implemented by fire services organisations around the world to prevent, respond to and recover from fire, there are no overarching evidence-based guidelines for the development or evaluation of programs.

To address this, Fire and Rescue NSW (FRNSW) conducted a comprehensive study. The results informed the revision of their approach to fire-safety education. The project was the winner of the Resilient Australia National Award.

Acting Inspector and Command Liaison Officer of FRNSW Community Engagement Unit, Anthony Picone, said, 'We believe that to build resilience in the next generation, we must enhance their education and preparedness in this generation.

'By giving our current school children the knowledge, the skills and the resilience to move forward and know what to do in an emergency and to educate their families in the same, will build resilience in the future', he said.

Through the delivery of evidence-based fire-safety education programs and the sharing of knowledge, FRNSW has provided effective and usable information for children and their families.



Anthony Picone, Michael Jay and Trent Curtain, Fire and Rescue NSW, accept the Resilient Australia National Award from Senator McKenzie.

Image: Australian Institute for Disaster Resilience

Many businesses in regional and rural Australia were affected by the 2019–20 bushfires and the COVID-19 pandemic. In January 2020, the Spend With Us marketplace was created to assist bushfire-affected small businesses without technical knowledge to continue to trade and get their products freely online. Founded by Sarah Britz, Lauren Hateley and Jenn Donovan, Spend With Us opened a new channel for these businesses, becoming Australia's first and largest online marketplace dedicated to rural and regional small and microbusinesses.

The Spend With Us marketplace was a highly commended project in the Resilient Australia National Award category. There are now over 1,000 registered Spend With Us sellers on the website, with more than 7,000 products listed and 320,000 members in the Buy From a Bush Business Facebook group community.

The platform provides a central place for consumers to find and buy unique products from people in rural and regional Australia and allows communities to diversify their income.

When the community of Happy Valley on K'gari (Fraser Island, Queensland) was assessed as 'undefendable' in 2018, residents were triggered to act. The Happy Valley Community Bushfire Risk Management project was a community-driven planning and development process to ensure the community, with input from local and Queensland Government agencies, was in the best possible position to defend itself. The project built on community knowledge, skills and networks to deliver the Operational Incident Action Plan and the Hazard Reduction and Fire Management Plan. Hazard mitigation and reduction planning and delivery, supported by community engagement and education, were critical components of the project.

The success of the project was evident when, on 7 December 2020, the K'gari bushfire threatened the Happy Valley township reserve. There was no loss of life or property due to the prior preparation and planning of locals.

## Suncorp Resilient Australia National Community Award: youth agency and legal aid in recovery, diversity in disaster resilience

Suncorp sponsored the Resilient Australia National Community Award and Executive General Manager, Corporate and Regulatory Affairs, Karyn Munsie, said she was inspired by the innovation and ingenuity of the submissions.

'As a leading insurer, we do see the impacts, year after year, of natural disasters and all of our research tells us that even small-scale events can have a very large consequences; financially, emotionally and physically', she said.



Suncorp Executive General Manager, Corporate and Regulatory Affairs Karyn Munsie awards Jacqueline Emery, Sarah Eagland and Chris Anderson of Royal Far West with \$5,000 for winning the Suncorp Resilient Australia National Community Award.

Image: Australian Institute for Disaster Resilience

Royal Far West won the Suncorp Resilient Australia National Community Award for their Bushfire Recovery Program, built on the belief that children should have their voices heard and be supported in the recovery process. Following consultation with affected communities and experts in recovery, Royal Far West designed a program to support the wellbeing and resilience of children to reduce the likelihood of long-term adverse effects. The Bushfire Recovery Program, delivered by multi-disciplinary health clinicians, was rolled out in over 30 communities, supporting more than 3,000 children through group programs, individual therapy and capacity building. Recognising the value of helping those around the child, the program also supported more than 1,700 parents, educators and local professionals.

Royal Far West Occupational Therapist Tayla Iellamo said, 'Following the bushfires, we wanted to help give children a voice because they also have a story to tell following disasters and they need to be included and supported in the recovery process'.

Youth resilience building was also the focus of the highly commended Journey of Hope project by Save the Children that

supports children to build resilience and develop ways to cope with worry and anxiety. The evidence-based program helps children and caregivers cope with trauma, identify triggers and stressors, develop their natural resilience and coping strategies and strengthen their support networks through group sessions. Trained facilitators delivered the program through schools and early education centres in regional Victoria and New South Wales in areas affected by the 2019–20 bushfires. Journey of Hope was also delivered in Melbourne to support children struggling with the pandemic; reaching 5,043 children in 80 schools.

Community Legal Centres South Australia's Bushfire Community Legal project in Kangaroo Island was also highly commended in the Suncorp National Community Award category for rethinking and recalibrating how the community legal sector delivers holistic legal outreach in rural areas. The project delivers community-led regular, free, accessible and trauma-informed face-to-face legal help to people in remote areas of South Australia. It contributes to community resilience by providing legal advice to identify, de-escalate and resolve legal issues arising from or exacerbated by disaster. The project worked with the Kangaroo Island community to address general and disaster-specific information gaps through community legal education; giving the community confidence and tools to take responsibility for their wellbeing.

A third of Australia's population is born overseas and one in five people speak a language other than English at home.<sup>1</sup> Multiculturalism is part of the Australian identity, but culturally and linguistically diverse (CALD) communities face challenges and barriers that increase their vulnerability. On the other hand, these communities also possess a wealth of experiences and abilities with a strong potential to enrich emergency management knowledge and practices.

Australian Red Cross was highly commended for their project, Disaster Resilience in CALD Communities. The 2-year project focused on volunteer mobilisation, community engagement, capacity building, development of multilingual preparedness resources, advocacy and research, with the aim of supporting CALD communities to enhance their disaster resilience.

## National School Award: a lesson in student wellbeing

In 2020, Pimlico State High School adopted remote learning due to pandemic restrictions. The school used the opportunity for innovation in teaching and learning and explored opportunities to maintain student connection through extracurricular opportunities.

The school's Beyond COVID-19 project was the winner of the Resilient Australia National School Award. Pimlico State High School Executive Principal, Joel Buchholz said the school used learnings from the 2019 Townsville floods to foreground its response to the pandemic.

'We had some really clear lessons from the previous year when Townsville experienced a major flood event and we saw from that the importance of wellbeing. We took some lessons from that



Pimlico State High School won the Resilient Australia National School Award for their Beyond COVID-19 program to enhance student wellbeing during remote learning.

Image: Polygraph Productions

time into the way we structured the work we did around student wellbeing and support in the pandemic', he said.

The school partnered with charities to distribute computers to students to ensure disadvantaged families had access to online learning. Wellbeing programs were revised for online learning and wellbeing was at the forefront of the response.

Student wellbeing was also central to the highly commended Central West Health and Wellbeing Day project from Longreach State High School. This project aimed to strengthen the bonds between communities and break the stigma associated with mental health. High school students from the surrounding towns were invited to the event, with over 220 students and teachers attending. The Health and Wellbeing Day promoted uncommon conversations leading to personal insights and change and provided students with a platform to learn, grow and discover themselves while experiencing different wellbeing exercises.

Another highly commended National School Award was the Resilience Project from St John's School that promoted gratitude, empathy, mindfulness and emotional literacy for their students. The initiative has evolved and, in 2021, the focus was mental health, starting with the theme 'it's okay to have a blue day' then shifting to resilience and having ways to bounce back. Activities targeted mental health, physical health, connection and kindness, because their research found that these elements can improve mental health and resilience in times of adversity.

## National Local Government Award: working together to prepare and recover, taking a person-centred approach

A state-wide effort to enhance emergency management planning across all 68 South Australian councils was awarded the Resilient Australian National Local Government Award.

The Local Government Association of South Australia developed the Council Ready program to support councils to produce tailored emergency management plans to reduce the effects of high-risk hazards in their communities. This program provided



The Local Government Association of South Australia was the winner of the Resilient Australia National Local Government Award for the project, Council Ready.

Image: Local Government Association of South Australia

guidance on local government emergency management planning and implemented this through a capacity-building approach. The program design was informed by extensive early engagement with councils and emergency sector stakeholders, which created a foundation and buy-in. A team of project facilitators was critical to the success of Council Ready. They ‘walked beside’ councils to support the capacity building and cultural change required to embed emergency management in practices.

Australian Red Cross National Manager of Emergency Services, Andrew Coghlan, congratulated the project team for ‘yet another fantastic example of what local governments are doing, considering their local community’s individual needs and the unique environments in which they reside.’

The Bega Valley Shire was found to be the most disaster-affected local government area during 2020<sup>2</sup> due to the NSW bushfires, subsequent flooding and the pandemic that created broad-reaching challenges for the region.

The Bega Valley Shire Council was highly commended for their efforts to face these immense challenges. The council partnered with the NSW Government to pilot a regional recovery plan, to set up the Bega Valley Local Bushfire Recovery Committee and establish the Recovery Resilience and Rebuilding program to deliver bushfire recovery programs. Throughout the chaos and recovery, Bega Valley Shire Council stayed true to values that people matter, and that recovery is a journey of walking with the community.

Another highly commended project was Person-Centred Emergency Preparedness (P-CEP) to improve the safety and wellbeing of people with disability in the Mackay region. Led by Mackay Regional Council, the project took a capacity-development approach to connect emergency managers with people with disability and their carers, the community, health and aged care providers and disability service providers to learn about and use a P-CEP toolkit. Participants used the P-CEP to develop emergency plans tailored to their individual support needs.

## National Mental Health and Wellbeing Award: 2 winners in inaugural award

In 2021, the Mental Health and Wellbeing Award was added as a new category to the Resilient Australia Awards program.

Former Minister for Emergency Management and National Recovery and Resilience Senator McKenzie said, ‘It’s heartening to see for the first time in 22 years of the history of these awards that the importance of mental health and wellbeing is being recognised.

‘I do think that the compounding impact and effect of flood season, bushfires, cyclonic events overlayed by Covid, means that mental health and wellbeing of our volunteers, our workforce and our communities is very much at the forefront so it’s great to see this recognised in the awards today’, she said.

A collaborative effort between University of Melbourne, Massey University, Australian Red Cross and the Bushfire and Natural Hazards CRC produced the Recovery Capitals (ReCap) resources that was a winner of this category. The ReCap project supports mental health and wellbeing after disasters by providing resources for those undertaking recovery activities. Research from past disasters can guide good decision-making and recovery actions, but findings are often not readily accessible to people supporting recovery.<sup>3</sup>

University of Melbourne’s Prof Lisa Gibbs said, ‘The point of ReCap is to bring evidence forward so people can make decisions about disaster recovery with confidence about what’s known and about what makes a difference’.

ReCap supports inclusive, holistic, strengths-based approaches and takes a broad view of the influences on mental health and wellbeing after disasters. It emphasises the interconnectedness between natural, social, financial, cultural, political, built and human capital.



Lisa Gibbs, Phoebe Quinn, Bronwyn Sparkes and John Richardson are presented with the Resilient Australia National Mental Health and Wellbeing Award by Senator McKenzie.

Image: Australian Institute for Disaster Resilience



Beyond Blue Chief Community Officer Patrice O'Brien accepts a Resilient Australia National Mental Health and Wellbeing Award from Senator McKenzie.

Image: Australian Institute for Disaster Resilience

Another winner of the National Mental Health and Wellbeing Award was Beyond Blue for the Be You Bushfire Response program that provided mental health support to early learning services and schools affected by the 2019–20 bushfires. The program recognised the role that learning communities can play in promoting positive mental health and strengthening resilience. Led by Beyond Blue with delivery partners Early Childhood Australia, headspace and Emerging Minds, the program assisted over 430 learning communities.

Beyond Blue Chief Community Officer, Patrice O'Brien, said, 'We quickly realised that schools and early learning services were going to play this really important role. And it wasn't only with the children and young people, but it was actually the role of schools and early learning services ended up playing as becoming a community hub in recovery from a disaster'.

Taking a place-based approach, the Be You program offered specialist trauma support and guidance, recovery planning and service mapping to address the mental health issues raised by the bushfires, the COVID-19 pandemic, floods and drought.

Across Australia, thousands of young adults volunteer their time as firefighters and emergency services personnel to help communities. Inherent in this role, however, is repeated exposure to potentially traumatic events. A study by the University of Adelaide resulted in the development of a Wellbeing Framework and Resource Guide for mental health in young adult fire and emergency volunteers. It was highly commended at the National Award Ceremony. The study was on addressing and preventing mental health symptoms and disorders among young adult fire and emergency services volunteers aged 16–25. The resources developed were co-designed with fire and emergency personnel and young volunteers, ensuring they are relevant to those who will be using them.

## National Photography Award: capturing volunteer and community spirit

Over 50 photographs were submitted to the 2021 Resilient Australia Awards. Finalists were selected via a people's-choice vote conducted through the Australian Institute for Disaster Resilience Facebook page, which returned more than 3,700 votes. The winning image features on the cover of this edition of the *Australian Journal of Emergency Management*.

The image was captured during the 2019–20 bushfire season along the Oaks fire trail in the Blue Mountains region of NSW. Virginia Eastman's photograph, 'Still Standing – We and the Trees', depicts a lone firefighter against a charred landscape. Virginia joined the Blaxland Fire Brigade in 2013 and her first major event as a volunteer was the 2019–20 bushfires. She described her subject, donned in personal protective equipment, as 'glowing like a golden yellow beacon of hope in defiant contrast to the black and grey expanse of desolation'.

Virginia said, 'When the comfort and "colour" of normality feels like it has burnt to black in the wake of destructive forces, resilience is finding a bright flash of something "golden" within yourself, others or your environment, to be a powerful contrast to the darkness that can come with challenging times'.



Blaxland Rural Fire Service volunteer, Virginia Eastman accepts the Resilient Australia National Photography Award from Senator McKenzie.

Image: Australian Institute for Disaster Resilience

Adam Meyer was highly commended for his portrait, 'The Resilience of Soxy', and shared his subject's story of personal experience that has influenced and contributed to the resilience of his Yorke Peninsula community.

'The bushfires came to Soxy's community in 2019, destroying houses, burning crops, killing stock and threatening whole towns.



Winner of the Resilient Australian National Photography Award:  
Still Standing – We and the Trees.

Image: Virginia Eastman



Highly commended in the Resilient Australian National Photography Award:  
Just another Monday Night

Image: Jacqueline Quaine

The first shearing shed Soxy worked in was reduced to ash while Soxy was fighting the fire.

‘Soxy, being a resilient man, helped set up the local Blazaid, was a founding member of the local recovery committee and gave physical and verbal support to the affected farmers and residents. He was the fixer. So many would say he was the difference between recovery and despair’, he said.

Jacqueline Quaine was highly commended for her photograph of Victorian State Emergency Services volunteers training in the rain at night. One volunteer with 20 years’ experience shared his knowledge with a fellow volunteer with 6 years’ experience.

Jacqueline said, ‘The resilience of the unit depends on a diversity of skills and experience, on new members joining and more experienced members staying on and sharing their skills. In developing their individual resilience and demonstrating the resilience of the unit, they contribute to the resilience of the community they serve, and the service they represent’.



Highly commended in the Resilient Australian National Photography Award:  
The Resilience of Soxy

Image: Adam Meyer

Details of the 2021 Resilient Australia Awards finalists are at [www.aidr.org.au/resources/2021-resilient-australia-national-awards](http://www.aidr.org.au/resources/2021-resilient-australia-national-awards).

## Endnotes

1. Australian Bureau of Statistics. At: [www.abs.gov.au/ausstats/abs@.nsf/lookup/media%20release3#:~:text=Sydney%20had%20the%20largest%20overseas,other%20than%20English%20at%20home](http://www.abs.gov.au/ausstats/abs@.nsf/lookup/media%20release3#:~:text=Sydney%20had%20the%20largest%20overseas,other%20than%20English%20at%20home).
2. The Guardian. At: [www.theguardian.com/news/datablog/2020/dec/22/interactive-map-which-areas-of-australia-were-hit-by-multiple-disasters-in-2020](http://www.theguardian.com/news/datablog/2020/dec/22/interactive-map-which-areas-of-australia-were-hit-by-multiple-disasters-in-2020).
3. ReCap project information is at <https://recoverycapitals.org.au/>

# 2022 Lessons Management Forum: when observations become lessons learnt

**Molly Price**

Australian Institute for  
Disaster Resilience



© 2022 by the authors.  
License Australian Institute  
for Disaster Resilience,  
Melbourne, Australia. This  
is an open access article  
distributed under the terms  
and conditions of the Creative  
Commons Attribution  
(CC BY) license ([https://  
creativecommons.org/  
licenses/by/4.0/](https://creativecommons.org/licenses/by/4.0/)).

The 2022 Lessons Management Forum brought people together in-person for the first time since 2019 by the Australian Institute for Disaster Resilience and AFAC and explored the theme ‘What does success look like?’

In March 2022, delegates gathered in Brisbane and online to hear leading lessons management practitioners unpack the latest research and case studies. Attendees sought to answer the question of how best to ensure that the observations gained in reviews, inquiries and royal commissions are transformed into lessons learnt. During the 2 days of the forum, it emerged that a key element of successful lessons management is creating a learning culture.

In his opening address, Queensland Fire and Emergency Services Deputy Commissioner, Mike Wassing, remarked on the importance of taking advantage of the opportunity to learn and grow from the challenges we face.

‘Taking challenges and opportunities and turning them into lessons is one way we can share and support each other. We can create growth within ourselves, our respective organisations and with our communities’, he said.

Deputy Commissioner Wassing also highlighted the complexities of managing lessons.

‘It’s one thing to identify lessons from a past event or program, but taking these lessons and putting them into action to address identified issues as well as creating an improved outcome in the form of public value, community resilience or reduction in risk, requires a lot more consideration’, he said.

This sentiment was echoed by Queensland Inspector-General Emergency Management, Alistair Dawson, who spoke about moving on from identifying lessons to learning lessons.

‘The information is all there. There is nothing new. However, it is taking the action and sustaining it

through to completion where the complexity may lie’, he said.

Mark Jones, former South Australia Country Fire Service Chief Officer advocated for embracing frank and fearless lessons in his reflections on releasing the Kangaroo Island bushfire review led by C3 Resilience.

***‘The information is all there. There is nothing new. However, it is taking the action and sustaining it through to completion where the complexity may lie’***

‘There’s no point commissioning reviews, audits, staff surveys, cultural surveys, unless you know what you’ll do with them, whatever they find. And what would it say of me—who’s hoping to preside over a learning organisation—if I in any way try to alter the findings or hide the conclusions. What sort of learning organisation would we be then?’, he said.

The importance of true community engagement was another topic raised by presenters. Kylie Mercer from the Queensland Office of the Inspector-General of Emergency Management reflected on engaging with Traditional Owners during the K’gari (Fraser Island) Bushfire Review. She explained the need to take a community-centred approach to incident reviews.



QFES Deputy Commissioner, Mike Wassing made the forum opening address.

Image: AFAC

‘Learning with the Butchella people helped us better understand First Nations people’s knowledge about fire management and protection of cultural assets. It also helped us to understand that early engagement planning provides better results for First Nations communities if it is co-designed and co-delivered’, she said.

Dan Meijer and Josh Atkins from NSW Rural Fire Service spoke of the need to engage with your own workforce to create a learning culture.

‘When implementing our new lessons management system, the key point with convincing volunteers to get on board was to have face time with them. You can’t send a memo out from head office... you must have the workforce engagement’, he said.

Trust is a key part of this, Josh Atkins said, ‘...people needed to trust me that I trusted in them that it wasn’t personal. It was about all the things around them that supported them to make either a decision or not make a decision, to help them get better or help improve those systems so next time the person who is in that same position can make a better decision, or not’.

## AFAC Lessons Management Award

The 2022 AFAC Lessons Management Award that acknowledges excellence in lessons management practice was sponsored and presented by C3 Resilience.



Carla Bailey, C3 Resilience, presented Geoff Cooper, Army Knowledge Centre, with the 2022 AFAC Lessons Management Award.

Image: AFAC

Disaster Relief Australia (DRA) was highly commended for the development and delivery of their post-activity reviews. DRA conducts these reviews after each operation to check they are providing meaningful outcomes for its stakeholders, including community, council, donors, volunteers and affiliated non-government organisations. The review process provides a critical analysis of the operation and captures metrics, operational appraisal, stakeholder feedback and improvement actions.

The winner of the 2022 AFAC Lessons Management Award was the Department of Defence for the COVID-19 Taskforce. This taskforce was established to coordinate the department’s support to whole-of-government efforts, including government agencies and international partners. To provide effective lessons management, a Defence COVID-19 Lessons Framework (DCLF) was established for the operation. One month after the DCLF was created, the number of observations submitted went from 3 to 125 and culminated in over 1,000 observations by the end of 2020. The DCLF worked on a principle of centralised coordination and de-centralised lessons collection and analysis performed by subject-matter experts. The DCLF was an innovative approach to facilitate lessons management throughout Defence.

AFAC and the Australian Institute for Disaster Resilience thanked the sponsors for their generosity and support: Queensland Fire and Emergency Services, Inspector-General of Emergency Management, Queensland, Phoenix Resilience and C3 Resilience.

# Are we succeeding at making Australian communities safer in the face of growing disaster risk?

**Alexandra Nichols  
Tricia Addie**

National Recovery and  
Resilience Agency

**Ceri Teather  
Lisa Mollard**

Department of Foreign  
Affairs and Trade

In 2023, we mark the halfway point in the 15-year *Sendai Framework for Disaster Risk Reduction 2015-2030*. Marking this halfway point, United Nations Member States have been asked to take stock of progress against the Sendai Framework and to look forward, by setting ambitions to meet the goal and targets by 2030.

As the national and strategic coordinator to reduce disaster risk, enhance resilience and provide relief and recovery, the National Recovery and Resilience Agency (NRRA) is leading the consultative process to develop Australia's national Mid-Term Review for the Sendai Framework. The review's report is on track to be provided to the United Nations Office for Disaster Risk Reduction by 30 September 2022. Australia's input will contribute to the global Mid-Term Review that will be delivered by UNDRR to the UN General Assembly by May 2023.

## Context of the review

Both the *Sendai Framework for Disaster Risk Reduction 2015-2030* and Australia's national translation of the Sendai Framework, the *National Disaster Risk Reduction Framework* (NDRRF), emphasise that reducing disaster risk is a shared responsibility. In particular, governments and industry must take action to reduce the disaster risks within their control. This requires coordinated effort across and within many areas including land-use planning, infrastructure, emergency management, social policy, health, energy and the environment.

The national Mid-Term Review will take into account disaster risk reduction activities across all sectors and highlight leadership through case studies. As we know, disasters are not natural. They are a product of the combination of naturally occurring events such as bushfires, floods and cyclones combined with human decision and

actions or inactions. The decisions we make about where to build, work and live can create or reduce risks and result in ever-changing and increasingly complex risk environments. Other factors such as climate change, increasing populations and expanding urbanisation exacerbate disaster risk.

The national Mid-Term Review is as much about looking forward as it is about looking back. It will retrospectively analyse national implementation of the Sendai Framework from 2015 to 2022 and prospectively review and identify challenges, context shifts and adaptive, transformative actions to be taken to the end of the Sendai Framework in 2030. The review will report on progress in integrating disaster risk reduction into policies, programs and investments at all levels of government and across all sectors, identify good practice, gaps and challenges as well as the actions needed to accelerate implementation in Australia. Given Australia's progress and achievements in reducing disaster risks, we recognise the importance of taking stock of the work that has been done and highlighting best practice where it takes place.

## Links with the National Action Plan

The NRRA is concurrently leading the development of the Second National Action Plan under the NDRRF and is consolidating consultations where possible. Given the whole-of-society approach to the Sendai Framework, the consultations take into account local, state and territory, industry,



© 2022 by the authors.  
License Australian Institute  
for Disaster Resilience,  
Melbourne, Australia. This  
is an open access article  
distributed under the terms  
and conditions of the Creative  
Commons Attribution  
(CC BY) license ([https://  
creativecommons.org/  
licenses/by/4.0/](https://creativecommons.org/licenses/by/4.0/)).



Global Platform for Disaster Risk Reduction, May 2022, Bali, Indonesia.  
Image: Antoine Tardy for United Nations Office for Disaster Risk Reduction

community and other sector perspectives to build a national picture of the disaster risk reduction effort. The national Mid-Term Review will highlight case studies on disaster risk management reforms within states and territories.

To deliver key priorities, the NRRRA is involving governments, the private sector and communities in developing a comprehensive and shared domestic vision for disaster risk reduction. This is being done through targeted interviews, subject deep dives, face-to-face workshops, dedicated workshops with local government and the 2-day From Risk to Resilience Summit held in Sydney in June 2022.

Consultations to inform the review have been designed around 3 key pillars:

- understanding the dynamic and systemic nature of disaster risks to address root causes rather than symptoms
- novel approaches to collaboration and robust governance across all sectors of society
- investment in resilience.

So far, stakeholder consultations have raised priority actions including the need for open and inclusive multi-level governance mechanisms, developing a greater understanding of the shared responsibility of the domestic disaster risk reduction system, better integration across systems and the removal of implementation barriers. Other actions include incorporating disaster risk into investment and financial decision-making, increasing investment in disaster risk reduction and resilience and translating the Sendai Framework into local contexts.

## Showcasing Australia’s expertise on the global stage

In May 2022, an Australian delegation from the NRRRA and the Department of Foreign Affairs and Trade attended the Global Platform for Disaster Risk Reduction in Bali. The objectives for the Australian delegation were to:

- exemplify Australia’s commitment to multilateral mechanisms to address disaster risk reduction
- share Australia’s national disaster and resilience capability including experiences in managing bushfires, the pandemic and extreme weather events
- strengthen partnerships within the region to enhance climate and disaster resilience, particularly with a focus on the ‘lived experience’ of people in the Pacific
- learn from practice globally to broaden our disaster risk reduction knowledge and capability
- increase our advocacy for inclusion and reinforce Australia’s international focus and reputation as a leader on disability inclusion, gender equality and use of Indigenous knowledge.

Collaboration included briefings on Australia’s national Mid-Term Review as well as meetings with stakeholders including the Special Representative of the Secretary-General for Disaster Risk Reduction in the United Nations Office for Disaster Risk Reduction, Ms Mami Mizutori.

The time is ripe for transformative, accelerated action to reduce systemic disaster risk and the NRRRA is leading the charge.

# Developing the Second National Action Plan

Jacqui Cristiano  
Monica Buchtman

National Recovery and  
Resilience Agency



© 2022 by the authors.  
License Australian Institute  
for Disaster Resilience,  
Melbourne, Australia. This  
is an open access article  
distributed under the terms  
and conditions of the Creative  
Commons Attribution  
(CC BY) license ([https://  
creativecommons.org/  
licenses/by/4.0/](https://creativecommons.org/licenses/by/4.0/)).

People in Australia are facing intense and frequent natural hazards. Bushfire, drought, flood, storms and tropical cyclones can have significant impacts on exposed communities, the economy, infrastructure and the environment.

With drivers such as changing climate, population growth, rapid urbanisation and infrastructure growth, new risks to people and the things they value are being generated and accumulated faster than risks are being reduced.

Disasters arise when hazards intersect with what we value and when the consequences exceed capacities to cope. Communities are more exposed and more vulnerable to disaster as social, technological and infrastructure systems become more connected. When one fails, ripple effects happen. Now, more than ever before, we need to take action to reduce disaster risks.

**...now is the time to transform systems to build resilience, and to reduce the underlying drivers of disaster.**

The National Recovery and Resilience Agency is improving its knowledge of coordinating national efforts to understand and address systemic disaster risk. Significant efforts continue towards building Australia's resilience to the effects of natural hazards through reducing disaster risk.

## The challenge

A whole-of-society approach is required to reduce disaster risk and everyone has a role to play. Despite commitments to build and improve resilience, human actions and choices are creating risks. Doing more of the same is not enough and now is the time to transform systems to build resilience, and to reduce the underlying drivers of

disaster. Collectively, governments, organisations, the private sector, communities and people's actions can reverse trends. The *National Disaster Risk Reduction Framework* which was released in April 2019 and endorsed by the then Council of Australian Governments in 2020, sets the agenda for all sectors to work together reduce disaster risk.

## National Disaster Risk Reduction Framework

The *National Disaster Risk Reduction Framework* represents a shift in thinking about disaster risk. The framework outlines a national and comprehensive approach to reduce risks and prevent the creation of new risks and provide the information to do so. It establishes a foundation for reform and takes a whole-of-society, systems and values-based approach. The framework is an anchor for the development of new disaster risk and resilience actions, policy goals, capabilities and competencies across all sectors.

The framework reflects the domestic implementation of the international *Sendai Framework for Disaster Risk Reduction 2015-2030* and is broadly aligned with the United Nations Sustainable Development Goals and the United Nations Framework Convention on Climate Change Paris Agreement.

The 4 priority areas of the framework are:

- Priority 1: Understand disaster risk
- Priority 2: Accountable decisions
- Priority 3: Enhanced investment
- Priority 4: Governance, ownership and responsibility.

Sustainable development and climate change adaptation can result in outcomes that reduce

systemic disaster risk and build resilience. The success of one framework is dependent on the success of another. Progressing the implementation of the framework is, in part, driven through national action plans.

## National Action Plans

The First National Action Plan, released in December 2020, was a starting point. It outlined initiatives aligned to the framework that were already underway and consolidated those efforts by the Australian, state and territory governments and the private sector into one document. Feedback on the first plan indicated that a Second National Action Plan needed to be highly strategic, inclusive and forward-looking to drive cultural, behavioural and procedural change. The Second National Action Plan will span 2 financial years.

## Developing the Second National Action Plan

The Second National Action Plan is being developed in partnership with the Australian Institute for Disaster Resilience and through comprehensive consultation across all sectors, including land-use planning, infrastructure, emergency management, social policy, agriculture, education, community development, energy and the environment. The Second National Action Plan identifies the transformational, system-wide actions necessary to accelerate the reduction of disaster risk.

The National Recovery and Resilience Agency (NRRRA) is uniquely placed to lead this work given its role.<sup>1</sup> The NRRRA is providing national leadership and convening authority to bring people together to focus effort to reduce disaster risk for the long term and improve Australia's preparedness for future events.

To date, events have occurred with a broad range of sector representatives and community groups. These include:

- preliminary discovery discussions, held online in March 2022
- webinar: Developing Australia's Second National Action Plan, held online in April 2022

- Catalysing Change workshop, held in Sydney in April 2022
- cross-sector panels held during 2022
- a discussion paper that was open for consultation during May and June 2022
- an online survey was conducted during May and June 2022
- subject deep dives, held online in June 2022
- the From Risk to Resilience Summit, held in Sydney in June 2022.

These opportunities were designed to enable collaboration and connection across sectors and government levels and to provide practical advice on how to work together with clarity and accountability.

## Next steps

The Second National Action Plan will detail the collective actions and partnerships needed to enable nationally significant initiatives to be delivered. The plan will identify the investment needed to build place-based resilience and reduce risk for the long term. It will be the roadmap for how Australia is going to get there.

More information about the development of the Second National Action Plan is available at [www.knowledge.aidr.org.au/resources/second-national-action-plan-for-disaster-risk-reduction](http://www.knowledge.aidr.org.au/resources/second-national-action-plan-for-disaster-risk-reduction).

## Endnote

1. The NRRRA was established in response to a key recommendation of the Royal Commission into National Natural Disaster Arrangements. The NRRRA provides national leadership and strategic coordination for disaster resilience, risk reduction and preparedness for future disasters across all levels of government in Australia.

# Asia-Pacific Ministerial Conference on Disaster Risk Reduction

**Alexandra Nichols**  
**Tricia Addie**

National Recovery and Resilience Agency

**Ceri Teather**  
**Lisa Mollard**

Department of Foreign Affairs and Trade



© 2022 by the authors.  
License Australian Institute for Disaster Resilience, Melbourne, Australia. This is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

2022 is a big year on the disaster risk reduction calendar, with one of the most important regional gatherings taking place in Brisbane in September—the Asia-Pacific Ministerial Conference on Disaster Risk Reduction.

It has been 4 years since the regional gathering last discussed how, in the most disaster-prone region of the world, an inclusive disaster and climate resilient future can be realised that is aligned with the global blueprint of the *Sendai Framework for Disaster Risk Reduction 2015-2030*. As the international community continues to face the challenges of the pandemic and effects of climate change, it is more important than ever that regional opportunities are seized to reduce disaster risk. To build resilience, it will be critical to listen to all voices and leave no one behind.

In May this year, at the Global Platform for Disaster Risk Reduction held in Bali, attendees highlighted that the time for accelerated action is now. This action must include traditional and Indigenous knowledge and diverse voices.

The Australian Government, in partnership with the United Nations Office for Disaster Risk Reduction, will host the Asia-Pacific Ministerial Conference on Disaster Risk Reduction from 19 to 22 September 2022 in Brisbane. The conference theme is ‘From Crisis to Resilience: Transforming the Asia-Pacific Region’s future through disaster risk reduction’. Australia will showcase work already done including the Second National Action Plan to implement the *National Disaster Risk Reduction Framework* and Australia’s national Mid-Term Review of the Sendai Framework. It is an opportunity to bring the region together, particularly our Pacific neighbours, in the lead-up to COP27 in November 2022. This is critical timing as the global Mid-Term Review of the Sendai Framework concludes in May 2023 and we work to transform our region to achieve sustainable development goals by 2030.

The conference includes the themes of the Global Platform and adapts these to our region:

1. **Sharing our region’s progress** towards the Mid-Term Review by discussing challenges and solutions identified through national reviews to chart a path for full implementation by 2030.
2. **Promoting inclusive and locally led disaster risk reduction efforts** that take into consideration the capacities and the needs of communities including women, people living with disability, youth, older people, Indigenous peoples and other marginalised and vulnerable groups. Women and people in marginalised groups are disproportionately negatively affected during crises and yet are often agents of change, leaders in risk reduction and frequently the first responders.
3. **Shining a spotlight on the needs of least developed countries and small island developing states** by focusing on their ‘lived experience’ and inviting Pacific voices to be active and participate.
4. **Accelerating investment** in disaster risk reduction through collective action to increase the proportion of government and private-sector financial investment in understanding and reducing systemic risk and its cascading effects.

## Bringing expertise together

Conference organisers, the Department of Foreign Affairs and Trade, the National Recovery and Resilience Agency (NRRRA) and the Queensland Government as well as other partners are working to deliver an inclusive and innovative agenda. The

conference has 3 theme pillars designed by international and domestic partners:

1. **Investing in resilience and preparedness**, with an emphasis on understanding existing and innovative financial modalities that enhance disaster resilience, preparedness and recovery.
2. **Shock-proofed infrastructure and systems**, focusing on the nexus between hard, soft and ecological infrastructure; and exploring how they interact to foster more resilient communities and societies supported by smarter infrastructure systems.
3. **Resilient communities**, focusing on the specific contexts in which disasters occur, recognising that disasters affect people differently and exacerbate pre-existing inequalities.

## A national narrative

The NRRRA's convening role allows us to champion systemic disaster risk reduction and provide leadership and strategic coordination in developing the national disaster risk reduction narrative. This narrative will be showcased at the Australia host stand at the conference central marketplace where we will

highlight domestic best practice. The host stand will be a place where delegates can meet, connect and collaborate with new and existing partners to share and learn from experiences in implementing the Sendai Framework.

The stand will be set among 60 other exhibitors and will be part of a hive of activity. It provides a prominent platform involving representatives from a range of sectors to show how inclusive disaster risk reduction and climate action is being led in Australia.

## Conference registrations call

Reducing disaster and climate risk is a shared responsibility and the NRRRA invites people in Australia with an interest in disaster risk reduction and resilience to attend or follow the conference. The outcome should be how to reach the goals of the Sendai Framework and the Paris Agreement and Agenda 2030.

Delegate registrations are available at [apmcdrr.undrr.org](http://apmcdrr.undrr.org) and will close on 31 August 2022.



ASIA-PACIFIC MINISTERIAL  
CONFERENCE ON

## Disaster Risk Reduction 2022

*Brisbane, Queensland, Australia*  
**19–22 September**

### The Asia-Pacific is the most disaster-prone region in the world.

The Asia-Pacific Ministerial Conference on Disaster Risk Reduction provides an important opportunity to review risk reduction efforts, and to share and learn about innovative and practical solutions, within the Sendai Framework for Disaster Risk Reduction 2015-2030.

Join up to 3,000 delegates in Brisbane this 19-22 September to engage with disaster risk reduction leaders and experts from across the Asia-Pacific region.

Registrations close on 31 August 2022.



[apmcdrr.undrr.org](http://apmcdrr.undrr.org)

# Mapping communities at risk

Lucy Saaroni

Country Fire Authority



© 2022 by the authors.  
License Australian Institute  
for Disaster Resilience,  
Melbourne, Australia. This  
is an open access article  
distributed under the terms  
and conditions of the Creative  
Commons Attribution  
(CC BY) license ([https://  
creativecommons.org/  
licenses/by/4.0/](https://creativecommons.org/licenses/by/4.0/)).

Putting the community first when designing and delivering fire prevention and preparedness services requires us to have a deep understanding of the composition of our communities. We need to know their strengths, their needs, who is more at risk of fire, where and why. This knowledge should be grounded in evidence and local, lived experience.

The Country Fire Authority (CFA) undertook a literature review in 2021 to develop a body of demonstrable evidence around the social factors that put communities in country areas of Victoria more at risk from bushfire and residential fire. The literature review was designed to complement local knowledge of emergency services volunteers in developing ‘community profiles’ that support service delivery planning to increase community resilience and reduce fire risk.

The literature review collated research on the hazard, risk, social vulnerability and proactive actions associated with bushfire and residential fire risk. The review included a selection of the extensive literature on hazard, exposure, vulnerability and risk in the contexts of bushfire and residential fire. Insights from other disaster contexts were included in instances where there were transferrable insights.

Findings from the literature review indicated that household decisions around mitigation are influenced most powerfully by social vulnerability, place-dependency and a host of complexly interacting contextual factors. Uniquely complex considerations are present in conceptualising bushfire risk in the Australian context. The key outcomes of this project were the improved integration of research and evidence on social vulnerability and application of this evidence within local contexts.

In practice, the findings of the literature review are being used to inform the development of community profiles. The profiles are brigade-specific, showing the brigade response area as a map, which indicates areas of highest concentration of fire hazard, exposure and social vulnerability within the communities that live in,

work and visit the area. The profiling visually shows CFA members where the most ‘at risk’ community members are located. The profiles also include information on the attributes in those specific communities that increase their risk of bushfire or residential fire fatality and injury. This risk intelligence allows brigade members to match CFA services and resources to community members at greater risk, so it delivers the right services to the right people in the right place at the right time.

Due to data accessibility limitations, some metrics were unable to be captured in the first iteration of the profiles. However, as more data becomes available on the listed social factors, they will be incorporated.

CFA’s approach to mapping communities most at risk could be replicated and tailored by organisations delivering resilience services to communities, as the factors identified in this literature review that make a person more at risk of residential fire or bushfire are likely to be common to other natural hazards and disasters.

The concept of developing an evidence base that can be used to tailor community engagement plans, products and programs, supports person-centred fire risk management in a way that is most meaningful to people at greatest risk of fire fatality and harm.

The full report on *Developing Community Profiles for Community Engagement A Review of Existing Evidence* (Country Fire Authority 2022) is available on the Australian Institute for Disaster Resilience Knowledge Hub.

# Fire-atmosphere modelling provides insights for bushfire behaviour

**Nathan Maddock**

Natural Hazards Research  
Australia



© 2022 by the authors.  
License Australian Institute  
for Disaster Resilience,  
Melbourne, Australia. This  
is an open access article  
distributed under the terms  
and conditions of the Creative  
Commons Attribution  
(CC BY) license ([https://  
creativecommons.org/  
licenses/by/4.0/](https://creativecommons.org/licenses/by/4.0/)).

New research offers insights into the destructive bushfires of 2019–20 in Australia, which were driven by complex interactions between the fire and the atmosphere that produced extreme local fire behaviour.

Cutting-edge research uses advanced computer simulations that combine bushfire behaviour and meteorology to investigate why the bushfires were so extraordinary and challenging for firefighters. The research, led by Dr Mika Peace from the Bushfire and Natural Hazards CRC and the Bureau of Meteorology, examined the fires at Badja Forest (New South Wales), Green Valley Talmalmo/Corryong (NSW and Victoria), Kangaroo Island (South Australia), Stanthorpe (Queensland) and Yancheep (Western Australia).

Dr Peace said, ‘The research uses 2 linked models to help us understand the processes driving these challenging and destructive fires; one which simulates the fire and one which simulates the weather. So, by combining them, we can see how both the fire and weather change in response to each other.

‘It’s only possible to research the fire behaviour resulting from these, such as extreme, local winds and rotating fire plumes, through work like this.

‘As we learn and share these findings, we can apply our knowledge to future bushfires. Right now, we can use the findings to help fire behaviour analysts and fire meteorologists recognise the conditions that lead to extremely dangerous localised bushfire behaviour,’ she said.

Research shows that the long drought and heatwave conditions experienced in the lead-up to and during all 5 fires were a significant factor in priming the landscape for extreme fire behaviour. But local weather conditions were important when combined with the very dry vegetation.

***As we learn and share these findings, we can apply our knowledge to future bushfires.***

Unusual fire activity occurred in the overnight period, when fire intensity and rate of spread is typically expected to decrease. Interactions between strong winds above the ground, topography and the fire plume circulation accelerated surface fire spread at night.

‘The conventional understanding of bushfire behaviour tells you that fire activity will decrease overnight as the temperature drops, humidity rises and winds become lighter.

‘Modelling shows that very strong low-level winds descending to the ground behind the fire plume were a critical reason why the Badja Forest and Corryong bushfires burnt so fast overnight,’ she explained.

Pyrocumulonimbus (pyroCb) clouds, sometimes called fire-generated thunderstorms, featured in the 2019–20 fire season. The number of pyroCb clouds recorded was the highest in Australia in any one season. However, the 5 fires examined were not all associated with pyroCb clouds. This showed that it is not the only weather phenomenon that was associated with the extreme fire behaviour that season.



Fires in the Badja Forest of New South Wales created pyroCb clouds that can cause erratic winds and dry lightning.

Image: NSW Rural Fire Service Facebook

The simulations showed that the fire-affected wind near a fire plume can be much stronger than the background winds and that destructive winds can occur, including extreme fire-front winds and fire-generated vortices.

‘For the bushfires that occurred close to the coast, for example Yanchep in Western Australia and on Kangaroo Island, the combination of heatwave conditions, the temperature difference between the hot land and the cooler water and local topography led to complex winds that changed the bushfire behaviour,’ Dr Peace explained.

Sea breezes, the local environment and the fire caused erratic, variable winds along active fire lines, which stretched for several kilometres.

The bushfire simulations undertaken through this research use the Australian Community Climate and Earth System Simulator Fire (ACCESS-Fire) model and are run on the National Computing Infrastructure supercomputer in Canberra. The results show the benefits of enhanced simulation capability and supercomputer power. Due to the level of detail, data and the computer power required, it is not possible to model bushfire behaviour like this when bushfires are burning.

This research was conducted in collaboration with Australian fire and land management agencies. The project highlights the complexity of the fire environment and fire management and shows how a coordinated and multi-disciplinary approach can make fire behaviour predictions.

This research is funded by the Australian Government and the Bushfire and Natural Hazards CRC to investigate issues arising from the 2019–20 bushfire season. The team comprised Dr Mika Peace, Barry Hanstrum, Dr Jesse Greenslade, Dr Dragana Zovko-Rajak, Dr Abhik Santra, Dr Jeffrey Kepert, Dr Paul Fox-Hughes, Dr Harvey Ye, Tasfia Shermin and Jeffrey Jones from the Bureau of Meteorology.

The research report, *Coupled fire-atmosphere simulations of five Black Summer fires using the ACCESS-Fire model*, is available at [www.bnhcrc.com.au/publications/black-summer-fire-modelling](http://www.bnhcrc.com.au/publications/black-summer-fire-modelling).

# Taking protective action during floods and storms

**Radhiya Fanham**

Natural Hazards Research  
Australia



© 2022 by the authors.  
License Australian Institute  
for Disaster Resilience,  
Melbourne, Australia. This  
is an open access article  
distributed under the terms  
and conditions of the Creative  
Commons Attribution  
(CC BY) license ([https://  
creativecommons.org/  
licenses/by/4.0/](https://creativecommons.org/licenses/by/4.0/)).

Public safety messages for floods and storms will be broadcast on ABC Radio in an initiative backed by Bushfire and Natural Hazards CRC research.

New community service announcements are the first-ever nationally agreed public flood and storm risk messages in Australia. Comprising of 26 different public messages, they are the result of findings from the Bushfire and Natural Hazards CRC project in flood-risk communication. This research was conducted by Associate Professor Melanie Taylor from Macquarie University and was endorsed by AFAC, the national council for fire and emergency services in Australia and New Zealand.<sup>1</sup>

The set of community service announcements are designed to give communities information and advice about protective actions they can take when threatened or effected by floods and severe storms. The project was assisted by the creation of a National Flood CSA Working Group that comprised of representatives from the Bureau of Meteorology and State Emergency Services from all states and territories with responsibility for response in floods. The project was facilitated and supported by AFAC through the AFAC SES Community Safety Group.

Former AFAC Director Risk and Resilience, Amanda Leck, said, 'Developing nationally consistent flood messaging is a significant achievement for the emergency services sector. These messages will minimise harm and save lives by ensuring that the ABC is able to communicate key messages to communities during floods.'

'The fact that these messages are based on research and evidence has meant that emergency services agencies across Australia have been willing and able to collaborate to achieve these nationally consistent messages,' she said.

Community service announcements for flooding are used by the ABC before, during and after floods and severe storms and radio broadcasts are typically around 30 seconds in duration. They contain high-level, general advice and support to listeners and contribute to public safety in floods

and storms. They can also be linked to form longer public information segments to provide breaks in rolling emergency broadcasting.

Although the ABC had an existing set of announcement for floods and storms, these could only be used in particular combinations and there was the potential for confusion. An important requirement of this project was to produce a comprehensive and harmonised set of announcements that the ABC could use nationally.

Patrick Hession, Emergency Broadcast Lead at the ABC, said, 'The best way to reach audiences is by giving simple, consistent messages and delivering them regularly.'

'For example, warning people about the dangers of driving through flood water is a goal that all agencies are working towards. It makes sense to simplify the message so that a person receives the same message no matter which side of a state border they are on,' he said.

The development of the community service announcement comprised 3 stages:

1. Scoping - consensus decision-making was used to identify and prioritise message topics and content areas. The goal of this stage was to reach consensus on the content areas and message elements.
2. Co-development and iterative review - messages were co-created and iterative reviews were conducted to produce a provisional set of messages to test. The draft messages went through 3 rounds of review with CSA Working Group members and ABC representatives until a set of agreed messages was finalised.
3. Testing and finalising - messages were tested through focus groups with members of the public and a review with the CSA Working Group to refine the messages based on feedback to produce the final set of announcements.



Floodwaters cover Rosalie Village, Brisbane, Queensland.

Image: Angus Veitch (CC BY-NC 2.0)

Mr Hession said, 'this process has given me a much greater understanding of the thought processes that people might go through when they are making potentially risky decisions. This led to the development of messages that can be broadcast at times where people will be making these decisions. Messages were informed by research to better argue against the temptation or motivation that people might have to make risky choices. It's been a great experience'.

At the end of the project, a set of 26 flood community service announcements was approved, including messages that can be used in all phases of floods and storms in the context of escalating and rolling emergency broadcasts on ABC local radio.

Associate Professor Melanie Taylor said, 'This project enabled me to use our research findings and combine them with the expertise of a great team of emergency communicators to produce messages that resonate with the public. This will hopefully lead to greater public safety in floods and storms.

'As a researcher, it has been a great experience to work with such an engaged set of stakeholders and end-users to translate research findings into outputs that will help protect communities. It was really exciting to hear our messages produced professionally and slotted into the ABC Emergency intro - and outro - wording; ready for use,' she said.

Six community service announcements relate to risks and contexts associated with driving through flood water and 4 relate to playing in floodwater. These are the behaviours most associated with flood fatalities. A further 4 relate to animal ownership and 4 provide information about the meanings or nature of warnings and alerts. The remainder cover topics

around home preparation, safety considerations when cleaning up after flooding, information about what to do if you are trapped by rising floodwater or are considering staying when advised to leave, and messages about flash flooding and the implications of flooding upstream.

The suite of messages has been recorded by the ABC and distributed to ABC Radio teams around Australia. They are being used by the ABC's local on-air teams when appropriate.

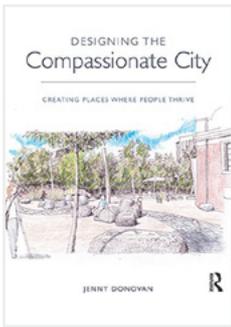
Information about the development of the community service announcements is in the Development of a national set of Community Service Announcements for Flood Risk<sup>2</sup> and the final report.<sup>3</sup>

The Bushfire and Natural Hazards CRC Research into practice brief series provides concise summaries of the research findings.<sup>4</sup>

## Endnotes

1. AFAC National community safety announcements for flood risk communication. At: [www.afac.com.au/insight/doctrine/article/current/afac-national-community-safety-announcements-for-flood-risk-communication](http://www.afac.com.au/insight/doctrine/article/current/afac-national-community-safety-announcements-for-flood-risk-communication).
2. Development of a national set of Community Service Announcements for flood risk. At: [www.bnhcrc.com.au/resources/guide-fact-sheet/8267](http://www.bnhcrc.com.au/resources/guide-fact-sheet/8267).
3. Development of a national set of Community Service Announcements for flood risk Final Report. At: [www.bnhcrc.com.au/publications/biblio/bnh-8283](http://www.bnhcrc.com.au/publications/biblio/bnh-8283).
4. Research into practice brief series. At: [www.bnhcrc.com.au/resources/practicebriefs](http://www.bnhcrc.com.au/resources/practicebriefs).

# Designing the Compassionate City



## Author

Jenny Donovan

## Reviewed by Victoria Cornell

Adelaide University

## PUBLISHED BY

Routledge

ISBN: 9781138183872



© 2022 by the authors.  
License Australian Institute  
for Disaster Resilience,  
Melbourne, Australia. This  
is an open access article  
distributed under the terms  
and conditions of the Creative  
Commons Attribution  
(CC BY) license ([https://  
creativecommons.org/  
licenses/by/4.0/](https://creativecommons.org/licenses/by/4.0/)).

*Designing the Compassionate City* by Jenny Donovan, advocates a way of undertaking urban design and redevelopment that recognises the significance of a social, holistic and collaborative approach, with the user of public space placed at the centre. In the words of the author, the book ‘considers differences urban design can make to people’s lives and seeks to identify the types of interventions that best facilitate people to meet their needs’.

The book is well referenced and, in the holistic and collaborative tone taken, the subject matters referenced are broad ranging including design, health, psychology, philosophy and law.

The book is divided into 3 main sections:

- What is the relationship between people and place and what does it mean to live in either a nurturing or neglectful environment?
- Nine international case study projects that have been undertaken to enhance the relationship between people and place that highlight the successes and challenges for the projects. For example:
  - Play Streets in London where streets are closed to traffic at certain times of the day to allow outdoor play
  - Christie Walk in Adelaide, which is a multi-generational community-led urban infill residential development
  - UN Habitat place-making projects in West Bank villages in Palestine, which allow residents to assert their identity by turning unused places into meaningful spaces.

- Reflections of the case study projects, lessons learnt, barriers and potential solutions

The author takes a life-course approach in considering the needs of young children, families and older people. The overt and visible elements of cities, for example the design and construction of infrastructure and accessibility, are explored. But so are the less tangible and visible, emotional and emotive elements, such as experience, trust and historical and societal influences that shape communities.

The author writes as much from a philosophical standpoint as a practical one where hope, happiness, connections and choice are equally as important as design, planning and building regulations. However, the tone is in no way naïve. Barriers to inclusive and compassionate design are clearly outlined, such as resource constraints, competing interests, perception and an emphasis on risk and regulation.

In closing, the author provides a series of design principles and processes that may overcome these issues. Ultimately, an optimistic view is presented of what can be achieved and a firm grounding is provided of why it should be aimed for. The book concludes with the characteristics of a compassionate city.

While written through the lens of ‘what this means for urban designers’, this book is an enjoyable, informative and valuable read for anyone interested in people and places.

# Tornadoes in Australia: are we prepared?

Victoria MacLean<sup>1</sup>  
Dr Yetta Gurtner<sup>1</sup>

1. James Cook University,  
Townsville, Queensland.



© 2022 by the authors.  
License Australian Institute  
for Disaster Resilience,  
Melbourne, Australia. This  
is an open access article  
distributed under the terms  
and conditions of the Creative  
Commons Attribution  
(CC BY) license ([https://  
creativecommons.org/  
licenses/by/4.0/](https://creativecommons.org/licenses/by/4.0/)).

## Abstract

Australian summers are periods of extensive and severe weather events. This often includes rapid-onset events of intense rainfall, flooding, hail, damaging winds and, in some instances, reported tornadoes. Associated with severe thunderstorms, a tornado is a small-scale vortex or column of destructive rotating winds appearing as a funnel-shaped cloud touching the ground. Meteorological research by Allen and co-authors (2021) indicates that Australia experiences an estimated 60 tornadoes a year, all with significant potential for damage, injuries and fatalities in populated areas. Despite the apparent risk, a review of relevant literature and recent social media posts suggests there is limited community awareness and understanding of tornadoes in Australia. A research project was developed to gauge levels of existing knowledge and capacity from a disaster management perspective. The first phase was an online survey to assess community experience, awareness and preparedness related to tornadoes in Australia. Results from this survey highlighted issues of inconsistent terminology, variable understanding and limited preparedness. Importantly, almost 5% of survey respondents believed tornadoes did not occur in Australia. Subsequent surveys will investigate the perspectives of current weather forecasters and emergency service personnel towards developing improved integrated risk management approaches for such events.

## Introduction

While people in Australia are familiar with the threat of tornadoes usually from movies, the news or other media footage, much of this has been based on events and experiences in the USA. Many people have the prevailing myth that tornadoes do not occur in Australia. While there are eyewitness accounts of tornadic activity dating back to 1795 (Bureau of Meteorology 2019), the documented evidence of tornadoes in Australia has been sporadic and inconsistent. Research by Allen and co-authors (2021) suggests that Australia experiences up to 60 tornadoes per year, but they are predominantly in sparsely populated locations. As human settlement expands into new areas and technology provides greater capacity to record and share events, there has been a growing public awareness of the risk. Although fatalities and injuries remain minimal, the numerous tornadoes reported during the 2021–22 summer period in Australia reveal the damaging potential of these events, particularly in built-up urban environments. While the science to detect, monitor and appraise such rapid-onset weather hazards continues to evolve, community-based disaster risk reduction calls for a broader understanding of tornado risk.



Damage caused by the tornado in Axe Creek, Victoria (12 km southeast Bendigo), 29 June 2019.

Image: Dean Scarbosa

Given that tornadic events in Australia are still considered relatively uncommon, research on this topic remains emergent (Allen 2012; Allen & Allen 2016; Allen *et al.* 2021; Kounkou, Mills & Timbal 2009; Henderson *et al.* 2012). A review of the academic literature indicates an emphasis on climatological and meteorological content rather than the actual risk to people and communities. In contrast, local media reports and associated commentary has been dominated by images and statistics regarding the social and economic costs of such events. With the increasing levels of human exposure and destructive effects of recent tornadoes in the USA, researchers there have begun to explore broader issues of individual and community vulnerability, communication, warning advice and behavioural responses (Demuth *et al.* 2007, Schumacher *et al.* 2010, Ashley & Strader 2016, Demuth 2018, Broomell *et al.* 2020). Effective risk reduction and disaster management for tornadoes in Australia requires a greater emphasis on the social aspects of the hazard risk.

## Gauging understanding and awareness of tornadoes

As current levels of knowledge of tornadoes in Australia appears low, a research project ‘Tornadoes in Australia: Increasing the awareness and addressing the gaps in disaster risk management’ is underway at the Centre for Disaster Studies at James Cook University. A literature review was conducted for the study that showed there was no systematic baseline data regarding community awareness and understanding of tornadoes in Australia. Additionally, there was inconsistent information regarding appropriate weather warnings for tornadoes and related emergency response advice. The research methodology for this project was developed to explore the risk perspectives of the 3 key stakeholder groups – the general public, contemporary weather forecasters and emergency management professionals.

The first phase of this project was to understand general levels of tornado experience, knowledge and disaster preparedness



Destruction caused by a tornado in Townsville, Queensland, 20 March 2012.

Image: Yetta Gurtner

throughout Australia. A survey was developed using the Survey Monkey software platform and made available online in December 2020. The survey was disseminated using invitations and links to the survey to identified, relevant Australian weather and hazard-based groups and individuals via social media, email and LinkedIn. Respondents had to be residents of Australia and aged 18 years or older to participate. The survey comprised 33 questions divided into 4 categories of demographic information, tornado experience and knowledge, weather warnings and household preparedness and response. The online survey took approximately 7 minutes to answer. The survey was open for 16 weeks and, at its close, had a 92% completion rate (n=255).

Ethics approval was received for this research (James Cook University Human Ethics Approval Number H8275).

## Results

Over the 16 collective weeks of the survey, there were 224 respondents with a nominated gender (75% female) and age bias (75% were aged 30–59). While each state and territory was represented in the results, the majority of participants came from New South Wales (37%) and Queensland (21.5%). Almost 40% were employed in either a professional or a government position and greater than 95% of respondents had achieved a senior high school or trade certificate level education or above. One-quarter of survey respondents indicated they had personally experienced a tornado in Australia or overseas (based on the answers in the tornado knowledge and awareness section).

A significant finding was a lack of consistent terminology usage (see figures 1 and 2). Common alternative words used to describe tornadoes included twister, willy-willy, dust devil, mini tornado and waterspout. Less common terms included gustnado, cock eyed bob and whirlwinds. Disturbingly, almost 50% of respondents indicated they had also heard tornadoes referred to as cyclones (n=111) or hurricanes. This misconception was mirrored in the open-end responses:



Figure 1: Word-cloud generated from tornado nomenclature provided by survey respondents.

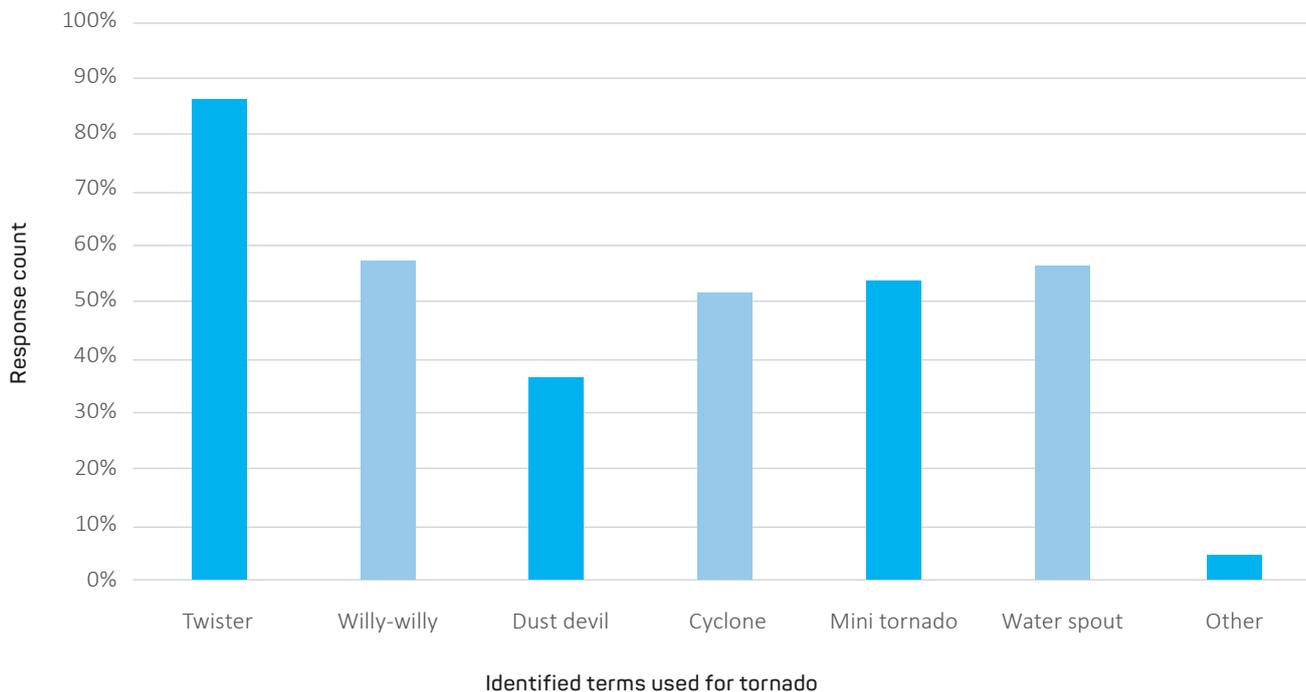


Figure 2: Alternate terms survey respondents associated with tornadoes.

*My understanding is that a tornado is the same as a Cyclone.*

Respondent #22

*I hope this is actually referring to an actual tornado (American in my belief), as I have not answered correctly IF this term is being used to replace my understanding of the word 'cyclone'; as everyone knows this is our common term for such weather events in Australia.*

Respondent #50

In terms of understanding the hazard characteristics and risk potential of tornadoes, general knowledge was good, although 75% of respondents significantly under-estimated the frequency as less than 20 events per year and 9 people indicated that tornadoes did not occur in Australia at all.

For questions related to daily weather conditions and forecasts, most respondents indicated that they liked to keep up-to-date. Only 11 respondents indicated that they had limited or no interest in forecasts. Information on weather conditions and forecasts was primarily sourced via apps on smart phones and via the internet. Although respondents viewed the accuracy of official weather warnings with a degree of uncertainty, the Bureau of Meteorology was identified as the main source of this information. When it came to understanding the official terminology used by meteorologists, 55% of respondents rated themselves as 'somewhat confident', with 20% unsure of the difference between a weather 'watch' and a 'warning'. One-third of respondents (n=75) indicated they had heard or seen a warning for a potential tornado in Australia.

Although tornadoes are not the only weather-based hazard experienced in Australia, 17% of respondents did not know where to source relevant information on local weather hazards or how to prepare for an event. Over half (58%) indicated they did know where to find information or advice on preparing for a tornado. In contrast, if a local tornado event occurred without notice or warning, only one-third (35%) were confident they had the knowledge to protect themselves. For household disaster preparedness, 25% were unsure or did not believe they could be self-sufficient for 3 days (in terms of provisions and supplies). Open-ended responses indicated that better information, education and specific tornado warnings are needed.

*Australians tend to think tornadoes don't occur here. More information needs to be made available to educate people of how to react in the event of a tornado. Better warnings need to be provided like we get for severe winds, rain and fires, SMS is extremely effective.*

Respondent #88

*One of the main issues I see is a lack of education about severe weather. Most people have very little understanding about tornado events in Australia and are even dismissive of it. When events do occur, they are often not reported seriously and terms like 'mini tornado' or 'mini cyclone' are broadcast. This downplays the serious threat that tornadoes pose and leads to common beliefs that only mini-sized ones happen here.*

Respondent #222

## Discussion

Based on the survey data, it is evident that while most respondents were familiar with tornadoes, there is significant variability, and even confusion, in the terminology used in Australia. Lack of clear, consistent messages undermines effective communication of the hazard and risk. Frequently used alternative terms such as willy-willy, dust devil and mini tornado can distort community perceptions regarding the size and destructive capacity of an event. Misconceptions that tornadoes are the same as cyclones and hurricanes may lead to a belief that there is additional time to prepare. It is important that government, meteorologists, emergency planners and the media use the term ‘tornado’ consistently when discussing weather systems and events that fit those hazard parameters.

Beyond a consensus on the use of the term ‘tornado’, the survey highlighted a need for better community weather and hazard education. Although relatively uncommon, tornadoes are a genuine threat and people should be adequately prepared for all relevant disaster risks. Based on this study so far, the subsequent phases of this research project will involve weather forecasters and emergency management personnel to help assess current knowledge, practice and capacity to enhance community-focused risk reduction approaches.

## Conclusion

While this research has limited scope and representativeness, the information provides a good baseline to gauge community risk perceptions and preparedness. Effective risk reduction necessitates an awareness and understanding of the hazard risks and the appropriate response behaviours. As evidenced during the summer of 2021–22, tornadoes have significant destructive potential. With population increases and urban expansion, levels of tornado-hazard exposure and risk are likely to escalate. Disaster risk management in Australia is considered a shared responsibility. Consequently, this research and its subsequent phases will assess and identify the gaps in knowledge and preparedness for tornadoes.

### Acknowledgments

Appreciation is extended to the survey participants and those who openly shared and commented. We also acknowledge Associate Professor David King for his support and guidance in these studies.

## References

- Allen JT 2012, *Supercell storms: Melbourne’s white Christmas 2011. Bulletin of the Australian Meteorological and Oceanographic Society*, vol. 25, pp.47–51.
- Allen JT & Allen ER 2016, *A review of severe thunderstorms in Australia. Atmospheric Research*, vol. 178, pp.347–366.

Allen JT, Allen ER, Richter H. & Lepore C 2021, *Australian Tornadoes in 2013: Implications for Climatology and Forecasting. Monthly Weather Review*, vol. 149, no. 5, pp.1211–32.

Ashley WS & Strader SM 2016, *Recipe for disaster: How the dynamic ingredients of risk and exposure are changing the tornado disaster landscape. Bulletin of the American Meteorological Society*, vol. 97, no. 5, pp.767–786.

Bureau of Meteorology 2019, *Severe thunderstorm archive. At: www.bom.gov.au/australia/stormarchive/ (31 May 2019).*

Broomell SB, Wong-Parodi G, Morss RE & Demuth JL 2020, *Do we know our own tornado season? A psychological investigation of perceived tornado likelihood in the southeast united states. Weather, Climate, and Society*, vol. 12, no. 4, pp.771–788.

Demuth JL 2018, *Explicating experience: Development of a valid scale of past hazard experience for tornadoes. Risk Analysis*, vol. 38, no. 9, pp.1921–43.

Demuth JL, Grunfest E, Morss RE, Drobot S & Lazo JK 2007, *WAS\* IS: Building a community for integrating meteorology and social science. Bulletin of the American Meteorological Society*, vol. 88, no. 11, pp.1729–38.

Henderson DJ, Ginger JD, Kim P & Sumant B 2012, *Investigation of Townsville Tornado, 20 March 2012. Cyclone Testing Station, James Cook University.*

Koukou R, Mills G & Timbal B 2009, *A reanalysis climatology of cool-season tornado environments over southern Australia. International Journal of Climatology: A Journal of the Royal Meteorological Society*, vol. 29, no. 4, pp.2079–90.

Schumacher RS, Lindsey DT, Schumacher AB, Braun J, Miller SD & Demuth JL 2010, *Multidisciplinary analysis of an unusual tornado: Meteorology, climatology, and the communication and interpretation of warnings. Weather and Forecasting*, vol. 25, no. 5, pp.1412–29.

### About the authors

**Victoria MacLean** manages a remote meteorological office with the Bureau of Meteorology. She is a doctoral candidate with the Centre for Disaster Studies at James Cook University. Her research helps to educate people about resilience during severe and repeated weather events.

**Dr Yetta Gurtner** is a lecturer and researcher with the College of Science and Engineering at James Cook University, Townsville. She is the coordinator of the Centre for Disaster Studies and facilitates sustainable community-based disaster management through the delivery and translation of research outputs into practical outcomes.

# Living behind the Launceston levee: insights from a community survey

Neil Dufty<sup>1</sup>  
Rhiannon Garrett<sup>1</sup>  
Filippo Dall'Osso<sup>1</sup>  
Kelsey Sanborn<sup>1</sup>

1. Molino Stewart Pty Ltd,  
Sydney, New South Wales.



© 2022 by the authors.  
License Australian Institute  
for Disaster Resilience,  
Melbourne, Australia. This  
is an open access article  
distributed under the terms  
and conditions of the Creative  
Commons Attribution  
(CC BY) license ([https://  
creativecommons.org/  
licenses/by/4.0/](https://creativecommons.org/licenses/by/4.0/)).

## Abstract

Levees are used in Australia and across the world as a structural means to reduce flood risks. However, people protected by levees can develop a false sense of security believing that the levee is fail-proof or might only fail in extreme flood events. This optimism can lower flood preparedness levels and lead to increased urban development in flood-prone areas. This can magnify flood risk behind the levee—a phenomenon known as the ‘levee paradox’ or ‘levee effect’. This article analyses the results of a community survey conducted with residents and businesses located behind the levees in Launceston, Tasmania. The survey revealed a widespread low level of flood-risk awareness and elevated optimism about the protection afforded by the levee system. However, there were no significant and direct relationships between the possible levee paradox causal factors and the low levels of preparedness identified. This does not rule out the levee paradox, as more complex psychological interrelationships could be involved. Emergency management planning should consider the high proportion of people (over one-third) who stated they would require assistance during a flood in the Launceston levee-protected areas.

## Introduction

The NSW State Emergency Service (2022) defines a levee as ‘...a man-made structure built to contain, control or divert the flow of water in order to provide protection to towns and/or agricultural land from flooding’. A levee is a structural flood mitigation option used to reduce the exposure of the community to flood hazard. It is one of a suite of flood-risk management options used across Australia (Australian Institute for Disaster Resilience [AIDR] 2017) and elsewhere in the world.

According to *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* handbook (AIDR 2017), levees have a ‘high’ ability to address flood risks in existing and new development areas. The guide states:

*For events up to their design flood, levees can provide significant reductions in damage and allow communities to function during long-duration floods, provided the structural integrity of the levee is not compromised.* (AIDR 2017)

However, the handbook acknowledges that:

*...measures such as house raising and levees reduce risk to property but are known to have an adverse impact on perceived risk to life because people incorrectly assume that property protection measures have eliminated flood risk.* (AIDR 2017, p.46).

This can lead to the ‘levee paradox’ or ‘levee effect’ where community preparedness declines and urban development increases (Smith 2003) due to optimistic risk perception related to the levee protection. As a result, levee construction may, paradoxically, result in increased consequences if an extreme flood event occurs.

The existence of the levee paradox has critical implications for emergency management and land-use planning. Emergency managers need to work with communities that may have an optimism bias related to flood risk provided by the levee and who will most likely display low levels of preparedness

and an unwillingness to respond to flood warnings (e.g. to evacuate). Land-use planning should rely on a well-documented risk assessment exercise, rather than on the way the community perceives such risk because of the levee's protection.

There has been considerable research into the levee paradox and associated psychologies as scoped by Di Baldassarre and co-authors (2018). For example, De Marchi and Scolobig (2011) conducted social research with reference to 4 communities in north-eastern Italy. They found a widespread false sense of security induced by the presence of (often significant) flood-risk reduction works. Similarly, research by Ludy and Kondolf (2012) in the Sacramento Valley (USA), found that people protected by levees were not motivated to undertake private precautionary measures and, as such, were more vulnerable.

Multiple factors drive risk perception and the adoption of protection measures. According to Di Baldassarre and co-authors (2018), 'This leads to dissimilar outcomes in different contexts'. For example, Botzen, Aerts and van den Bergh (2009) found that people in The Netherlands were mostly unaware of the protection level of their levees, even though such a protection level is extremely high. Direct flood experience has also been identified as a significant determinant of increased community risk perception (Wachinger *et al.* 2013).

Levees are widely used in Australia and there are 116 levees in NSW alone (NSW State Emergency Service 2022). However, there has been little social research conducted to examine the psychological effect of levees and if the levee paradox exists. One study was conducted by Gissing and co-authors (2018) in Lismore, NSW. For this research, a telephone survey of business owners in the Lismore central business district was conducted resulting in 50 responses from a total of approximately 400 businesses. Evidence of the levee paradox was found:

*The construction of the levee in 2005 has had some impact on the perception of flood risk. This is evidenced by the number of respondents who believed the levee provides more protection than is allowed for in its design. In addition, respondents believed it is now less important to be prepared for floods than prior to the construction of the levee. (Gissing et al. 2018)*

In 2021, a survey was undertaken in Launceston as part of a risk-based study to determine appropriate flood development controls and strategic land-use planning. This article analyses the results of that survey conducted with residents and businesses behind the levees in the city. While the survey was primarily designed to collect input data for a flood-risk assessment and mapping exercise, its results provide a unique dataset to gain insight into the psychological effects of the levees and if a levee paradox exists, at least from a social perspective.

## Launceston levees

Launceston is Tasmania's most populous municipality and has been recognised as a flood-prone area since a major inundation in 1828. It has experienced 36 significant floods since records began, with the 1929 flood considered to be the worst (Fullard 2013).

This flood risk is primarily due to the location and topography of Launceston's lower suburbs, Inveresk and Invermay, which are located at the confluence of the North Esk, South Esk and Tamar rivers (Atkins & Vince 2009).

Ways to protect Launceston from flooding were considered following the 1929 flood. In 1955, the Launceston Flood Protection Authority was established to progress this work. Construction commenced on a levee system in the mid-1960s with the project funded by the City of Launceston Council and the Tasmanian Government. A new Launceston Flood Authority was established in 2008 to design, construct and maintain existing and new flood levees.

Currently, there are approximately 3,000 residential and commercial properties protected by the levee system (Figure 1).

Modelling shows that the levee system would be overtopped in a 0.5% Annual Exceedance Probability (AEP) or 1-in-200-year flood (BMT 2019). However, due to climate change, by 2050 it would be overtopped in a 1% AEP or 1-in-100-year flood (BMT 2019).

## Methodology

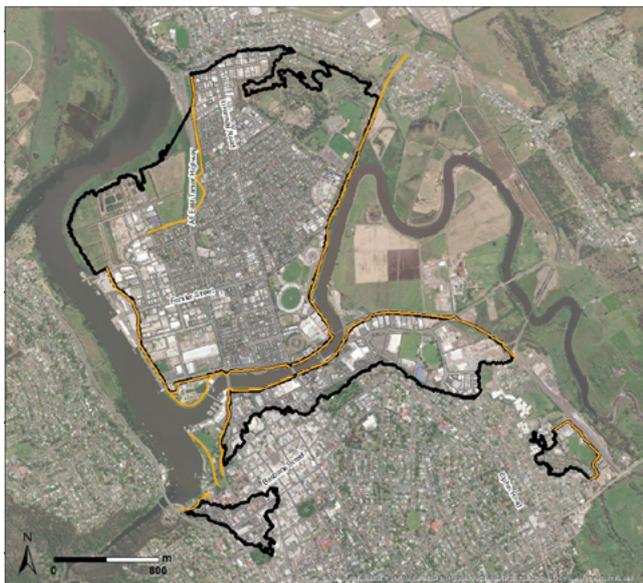
A community survey was designed to assess levels of community resilience to floods in Launceston's levee-protected areas. Questions were prepared to investigate 4 indicators:

- **Risk awareness and perception:** These questions assessed if people had a correct understanding of their flood risk. Therefore, they focused on respondent perceptions of whether their home or business could flood and the extent of protection provided by the levee system.
- **Capability to absorb the impacts of flooding (i.e. tolerability):** These questions involved a self-assessment by respondents to assess the extent to which they thought they could handle a flood on their property without long-term, intolerable consequences.



Floodwaters from the South Esk River enter the kanamluka / River Tamar estuary on 8 June 2016.

Image: City of Launceston Council



**Study Area**

- Study Area
- Levees
- Cadastre

Figure 1: Levees in Launceston currently protect 3,000 residential and commercial properties.

- **Preparedness:** These questions assessed the preparedness of businesses and households for flooding to identify ways in which residual flood risks are managed at the property level. The questions focused on whether there was a flood insurance policy for the property and if a flood emergency plan existed.
- **Emergency management and social capital:** These questions required respondents to self-assess their capability to effectively respond to a flood emergency. Questions assessed if the respondent would require assistance, whether they had somewhere to evacuate to, how well they could keep themselves safe and whether they would help others during a flood.

The survey was mailed to all residential and commercial addresses in the levee-protected areas of Launceston. Respondents could submit their completed survey by return post, email or online.

The research was conducted in line with the principles in the National Statement on Ethical Conduct in Human Research (National Health and Medical Research Council 2015).

**Results**

A total of 540 responses were received, a response rate of approximately 19%. Figure 2 provides a summary of the property occupation background (residential vs business, owner vs renter) of the respondents.

**Risk awareness and perception**

The survey indicated that 57% of respondents from the levee-protected areas were aware that riverine flood waters could enter their yard or driveway, while 39% believed that they could

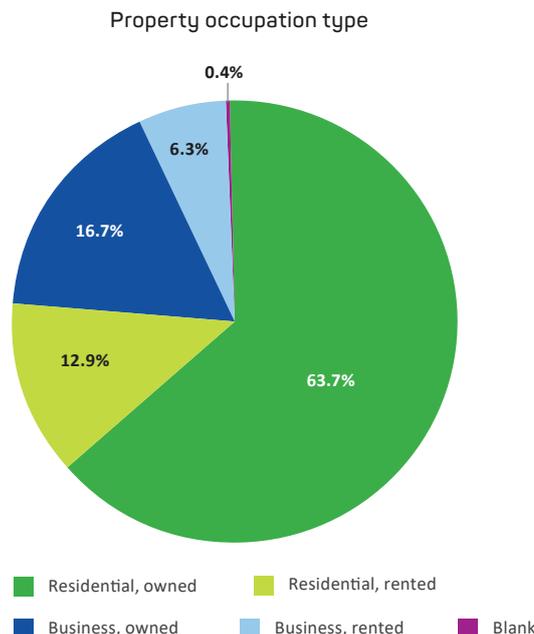


Figure 2: Property occupation type of survey respondents.

not. Similarly, 53% of respondents were aware that the flood waters could enter their home or business, while 42% believed they could not (approximately 4% were unsure).

Interestingly, businesses were more aware of the risk of flooding than occupants of residential properties. Only 48% of respondents for residential properties thought that their home could be at risk of flooding, whereas 70% of respondents for businesses were aware that their business could flood. A chi-square test was performed to test the relationship between property type and occupant awareness of the flood risk to the building. The test of independence showed that there was a significant relationship between the 2 variables,  $\chi^2 (2, N=474) = 15.8, p < .001$ .

The survey revealed a widespread ‘optimism bias’ in the perceptions of respondents regarding the extent of flood protection afforded by the levees. Respondents underestimated the residual flood risk by overestimating the protection provided by the levees. Only 15% of respondents identified the correct level of levee protection, while 63% thought the levees provided protection in floods above the level that they would be overtopped (8% thought that the levee provided protection in all floods).

Respondents who knew that their yard could flood were twice as likely to correctly identify the protection of the levees as respondents who thought their yard could not flood or were unsure. A chi-square test was performed to test the relationship between whether a respondent was aware that floodwaters could enter their yard or driveway and whether they correctly identified the extent of levee protection. The relationship was found to be significant,  $\chi^2 (1, N=468) = 9.29, p = .002$ . However, even among those who knew the flood risk to their yard, awareness of the protection provided by the levees was low, with only 19% correctly identifying the extent. Similarly, respondents who knew

the flood risk to their home or business, were twice as likely to correctly identify the levees' flood protection, although among this group, only 20% correctly identified the extent of levee protection.

Residents who rented their homes were particularly unaware of their property's flood risk, with only 10% correctly identifying the flood risk and 44% indicating that they were unsure of the extent of flood protection afforded by the levee system.



The Invermay Levee in Launceston.

Image: City of Launceston Council

### Flood tolerability

Figure 3 shows that respondents generally had a low tolerance for floodwaters entering their property. Sixty-eight per cent of respondents indicated that they would not tolerate floodwaters entering their home or business (i.e. above-floor flooding), while 12% indicated they would cautiously tolerate such an event and only 4% believed they could tolerate it.

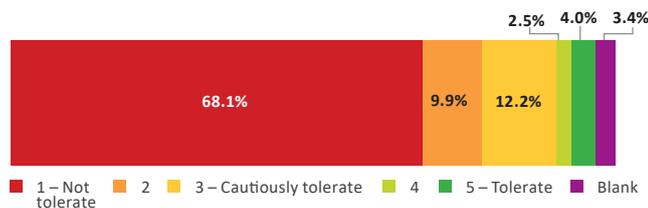


Figure 3: The tolerability to property flooding by respondents.

A chi-square test was performed that showed the respondents who believe that floodwater could enter their home or business are less likely to think they can tolerate the floodwaters than those who believe their building cannot flood,  $\chi^2 (4, N=439)=31.9, p<.001$ .

### Community preparedness

Two aspects of flood preparedness were measured in the survey being:

- uptake of flood insurance

- preparation of a written flood emergency plan (with related knowledge of evacuation routes and preparation of emergency kits) as encouraged by the State Emergency Service (State Emergency Service Tasmania 2022).

Flood insurance is an accepted preparedness indicator, offering the transfer of a risk from one party to another for the payment of a premium (Surminski & Thieken 2017). Its adoption in Australia is contingent on factors including affordability, risk perception and perceived social expectations (Lo 2013).

The survey showed that the uptake of flood insurance was generally low in the levee-protected areas of Launceston, with 41% of respondents indicating they had an insurance policy for their property, 29% indicating that they did not and 27% were unsure. This level of uptake of flood insurance in the Launceston levee-protected areas is far lower than Australia's national average, which is 93% (Insurance Council of Australia 2016). However, most respondents (80%) were aware of flood insurance.

Even fewer respondents (11%) indicated that they had a written flood emergency plan for their property. While only 8% of residential properties surveyed had a written flood emergency plan, 21% of businesses had a plan. Awareness of flooding, risk perception and length of occupancy do not appear to be by themselves causes of this low level of preparedness.

Chi-square tests conducted to test potential relationships between awareness of whether the house or building could flood and flood insurance uptake, and with written plan preparation indicate that the relationships are not statistically significant at  $p<.05$  ( $\chi^2 (2, N=451)=1.18, p=.55$  and  $\chi^2 (2, N=451)=5.34, p=.069$ , respectively).

Similarly, chi-square tests of the relationship between perceptions of the extent of flood protection from the levee and flood preparedness suggest that the data do not provide strong evidence for a significant relationship. There was also no strong statistical relationship between property occupation length (and indirectly flood experience) and the preparedness behaviours.

### Emergency management and social capital

Approximately 35% of respondents indicated that they would require assistance from others during a flood. Many stated that they require assistance due to limited mobility related to age, ill health or disability, while others lived alone and do not drive or do not have access to transport. Ironically, when asked to rate their ability to keep themselves safe, only 6% of respondents rated their ability as 'not good' and 3% as 'poor'.

The most pressing concern among these respondents was that they would require assistance for evacuation, but many were also worried they would need help evacuating their pets. Several other forms of assistance were identified including assistance in securing property (by sandbagging, removing items or raising items), the provision of accommodation and food, assistance in clean-up following the flood and emotional support.

Many respondents indicated that they would rely on assistance from the community, including friends, family and neighbours. Several, particularly those who stated they had no family or

friends nearby, expected that they would require assistance from the State Emergency Service, the local council or other emergency services and some indicated they would need assistance from the National Disability Insurance Scheme or insurance companies in flood recovery.

A smaller proportion of business respondents (27%) indicated they would require assistance during a flood. The most common form of assistance was moving inventory and equipment, followed by assistance with sandbagging and with clean-up post-flood. Business respondents indicated they would rely on local authorities for assistance, such as the State Emergency Service, the City of Launceston Council and other emergency services. Some business respondents indicated that they would need help from staff. The reliance on family and friends was far less pronounced than among residential respondents.

Respondents were more likely to rate their ability to cope with a flood as 'excellent' if they believed that the levees would protect them in all floods. A chi-square test found a significant relationship at  $p < .05$  between a respondent's self-rating and whether they believed there was a residual flood risk despite the levees,  $\chi^2(5, N=371)=14.5, p=.013$ . Respondents who thought that the levees afforded protection from all flood events were more likely to rate their ability to keep themselves safe as either 'excellent' (45%) or 'poor' (8%) than respondents who thought there was a residual flood risk ('excellent', 27%; 'poor', 2%).

This research suggests that social capital levels are high in the levee-protected areas of Launceston, with 83% of respondents indicating that they would help others in a flood. Of concern, this includes 33% of respondents who indicated that they would require assistance during a flood. It is likely that the responses to the question about helping others reflects more of a willingness to do so and not necessarily a capability to do so.

Many respondents indicated they would act as first responders to help neighbours, particularly to help elderly people or other neighbours with low mobility. Respondents also indicated they would help their friends, family, tenants, children, people in distress, people with no transport, local residents, local businesses and strangers. Numerous respondents said they would help anyone who needed it. The main activities that respondents indicated they would assist others with were evacuation, including providing transport and assisting in the evacuation of pets, and with moving items, furniture and business inventory or equipment. Several respondents stated they would arrange, pay or provide accommodation for others or they would provide food and would help with clean-up after the flood.

## Discussion

Although there was a widespread low level of flood-risk awareness and elevated optimism towards the protection afforded by the levee system, there were no significant direct relationships between these potential levee paradox causal factors and the low levels of preparedness that were tested. Although previous flood experience was not directly tested as a causal factor, length of occupancy was tested and found to not be a contributing factor to the low preparedness levels.

This analysis does not rule out potentially detrimental effects of psychological perspectives towards the levee system. The hallmarks of the levee paradox are in place with low preparedness levels and an overriding high-coping appraisal and perceived self-efficacy, even though many people are highly vulnerable (e.g. older adults, people with disability) and would require some type of assistance including from emergency services.

Research shows that there is a complex interrelationship or nesting of determinants of flood preparedness (Grothmann & Reusswig 2006; Lindell & Perry 2004; McIvor, Paton & Johnston 2009). From the survey, there was a strong relationship between awareness of flood risk and correct perception of the levee protection. There could be a cumulative effect of these and other factors influencing the low preparedness levels including the demographics of the study area (e.g. older age population).

The survey was designed to provide input to risk assessment mapping and only 2 preparedness indicators were tested, which limits the ability to determine a local levee paradox. Further research is required to examine other indicators (for example, knowledge of evacuation routes, preparation of emergency kits, willingness to raise items before a flood) to ascertain if preparedness is low.

The levels of flood land-use planning controls can also influence preparedness levels. Planning controls communicate flood risk to landholders (Grech 2011) and, possibly, the current land-use planning regime contributes to the low preparedness levels. The communication of flood risk through land-use planning should be improved as a result of the risk-based approach used in the study.

Local emergency management organisations can help raise preparedness levels through ongoing community flood education programs (Dufty 2020). The importance of flood insurance and having a written flood preparedness plan should be stressed as well as other aspects of preparedness such as evacuation planning and having a property emergency kit. For businesses, continuity planning that includes flood emergency planning should be promoted.

Emergency management planning should consider the high proportion of people (over one-third) that require assistance in the Launceston levee-protected areas. Many of these people say they will depend on emergency services for this assistance. Most people will not tolerate flooding and could be highly anxious if the levee system was compromised. The high number of community members who say they will assist others, including vulnerable people, should be harnessed in emergency management planning.

## Conclusion

This research gives insight into the psychological interrelationships related to living behind the levees in Launceston. Although a strong and direct relationship was not identified between some of the potential determinants of the levee paradox, the low levels of preparedness identified should

be addressed. Emergency management planning should also consider the high levels of vulnerable people in the area.

The research was designed to provide input to a flood-risk assessment to determine appropriate future land-use development controls and was limited in testing a range of preparedness indicators and, thus, the possibility of a levee paradox. However, it does give insight into risk perceptions, tolerability and proposed response behaviours of those living and working behind the Launceston levee system and will be useful to emergency managers.

The possible adverse psychological effects of levees should be researched in Launceston as well as other highly flood-prone areas in Australia. With several hundred levees across the nation, there seems little understanding of how and why people prepare and respond to flooding if the local levee overtops or fails. Levee compromise is a form of dam break and can cause slow onset riverine flooding that converts to flash flooding as water rushes through adjacent settlements. The little warning time and consequences for people who are poorly prepared can lead to perilous situations.

### Acknowledgment

The authors wish to thank the City of Launceston Council for the opportunity to conduct this research.

## References

Atkins B & Vince J 2009, *The Launceston flood policies: levees and beyond*, *Australian Journal of Emergency Management*, vol. 24, no. 3, p.32–37.

Australian Institute for Disaster Resilience 2017, *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*. At: <https://knowledge.aidr.org.au/resources/handbook-managing-the-floodplain/>.

BMT 2019, *North and South Esk Rivers Flood Modelling and Mapping Update Volume 1: Technical Report, report prepared for the City of Launceston*. At: [www.launceston.tas.gov.au/files/assets/public/r.m20921.002.01.final\\_lowres.pdf](http://www.launceston.tas.gov.au/files/assets/public/r.m20921.002.01.final_lowres.pdf).

Botzen WJW, Aerts JCJH & van den Bergh CJJM 2009, *Dependence of flood risk perceptions on socioeconomic and objective risk factors*, *Water Resources Research*, vol. 45, no.10.

De Marchi B & Scolobig A 2011, *The views of experts and residents on social vulnerability to flash floods in an Alpine region of Italy*, *Disasters*, vol. 36, no. 2, pp.316–317.

Di Baldassarre G, Kreibich H, Vorogushyn S, Aerts J, Arnbjerg-Nielsen K, Barendrecht M, Bates P, Borga M, Botzen W, Bubeck P, De Marchi B, Llasat C, Mazzoleni M, Molinari D, Mondino E, Mård J, Petrucci O, Scolobig A, Viglione A & Ward PJ 2018, *Hess opinions: an interdisciplinary research agenda to explore the unintended consequences of structural flood protection*, *Hydrology and Earth System Sciences*, vol. 22, pp.5629–37.

Dufty N 2020, *Disaster Education, Communication and Engagement*, Wiley, Hoboken, USA.

Fullard A 2013, *Launceston - a city on a floodplain protecting Launceston from a 1 in 200 ARI flood*, *Floodplain Management Association National Conference*.

Gissing A, Van Leeuwen J, Tofa M & Haynes K 2018, *Flood levee influences on community preparedness: A paradox?*, *Australian Journal of Emergency Management*, vol. 33, no. 3, pp.38–43.

Grech P 2011, *Report to Queensland Floods Commission of Inquiry Addressing Town Planning Issues*, Grech Planners.

Grothmann T & Reusswig F 2006, *People at risk of flooding: Why some residents take precautionary action while others do not*, *Natural Hazards*, vol. 38, pp.101–120.

Insurance Council of Australia 2016, *Local Government and Insurance – Flood Insurance Pricing*. At: [www.floods.org.au/client\\_images/1787680.pdf](http://www.floods.org.au/client_images/1787680.pdf).

Lindell MK & Perry RW 2004, *Communicating environmental risk in multiethnic communities*, Sage, Thousand Oaks.

Lo AY 2013, *The likelihood of having flood insurance increases with social expectations*, *Area*, vol. 45, no. 1, pp.70–76.

Ludy J & Kondolf GM 2012, *Flood risk perception in lands “protected” by 100-year levees*, *Natural Hazards*, vol. 61, pp.829–842.

Mclvor D, Paton D & Johnston D 2009, *Modelling Community Preparation for Natural Hazards: Understanding Hazard Cognitions*, *Journal of Pacific Rim Psychology*, vol. 3, no. 2, pp.39–46.

National Health and Medical Research Council 2015, *National Statement on Ethical Conduct in Human Research*, Commonwealth of Australia.

NSW State Emergency Service 2022, *Do You Live Behind a Levee?* At: [www.ses.nsw.gov.au/floodsafe/learn-more-about-floods/do-you-live-behind-a-levee/](http://www.ses.nsw.gov.au/floodsafe/learn-more-about-floods/do-you-live-behind-a-levee/).

Smith D 2003, *Climate extremes in Australia: the role of risk management*, *Geography Bulletin*, vol. 35, no. 2, pp.54–61.

State Emergency Service Tasmania 2022, *Flood Preparation*. At: [www.ses.tas.gov.au/plan-prepare/flood/](http://www.ses.tas.gov.au/plan-prepare/flood/).

Surminski S & Thieken AH 2017, *Promoting flood risk reduction: the role of insurance in Germany and England*, *Earth's Future*, vol. 5, no. 10, pp.979–1001.

Wachinger G, Renn O, Begg C & Kuhlicke C 2013, *The risk perception paradox—implications for governance and communication of natural hazards*, *Risk Analysis*, vol. 33, pp.1049–65.

### About the authors

The authors are employed at Molino Stewart Pty Ltd, a natural hazards and environment consultancy based in Parramatta, NSW.

# Creating a post-earthquake emergency sanitation plan for the Wellington region, Aotearoa New Zealand

Richard Mowl<sup>1,2</sup>  
 Carol Stewart<sup>2</sup>  
 Daniel P Neely<sup>1</sup>  
 Matthew Brenin<sup>2,3</sup>  
 Mike Fisher<sup>4</sup>  
 Nickola Loodin<sup>1</sup>  
 Steve Hutchison<sup>5</sup>

1. Wellington Region Emergency Management Office, Wellington, New Zealand.
2. Massey University, Wellington, New Zealand.
3. Green Earth Development Ltd, Otaki, New Zealand.
4. Regional Public Health, Wellington, New Zealand.
5. Wellington Water, Wellington, New Zealand.



© 2022 by the authors.  
 License Australian Institute for Disaster Resilience, Melbourne, Australia. This is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## Abstract

The Wellington region in Aotearoa New Zealand experiences regular earthquakes and is vulnerable to potentially lengthy outages of wastewater and road networks. Recognising this, a collaborative project was conducted between scientists and Wellington's water network management company, emergency management body and regional public health authority to create a coherent emergency sanitation plan for a major wastewater system failure. This work built on a foundation of research and a pilot study previously carried out in the region on emergency sanitation. Workshops with project participants created a plan to provide communities and responders with clearly defined roles and responsibilities. The result is a plan that acknowledges constraints of provision but enables stakeholders and communities to take preparatory steps for, and respond to, sanitation outage events. The plan includes an important infographic about emergency sanitation options as well as what utility and healthcare organisations will do in the event of the plan's activation.

## Introduction and context

The Wellington region in New Zealand is crossed by many active faults, making it highly vulnerable to earthquakes (Wellington Region Emergency Management Office 2019). In the case of a

rupture of the Wellington Fault, there would be considerable damage to the wastewater system in the region. Outages to the wastewater collection system could last 3 months and may exceed 2 years (Wellington Lifelines Group 2019) in the Wellington metropolitan area. This would cover the cities of Porirua, Upper Hutt, Lower Hutt and Wellington (see Figure 1), which, in 2022, have a combined population of approximately 440,000.

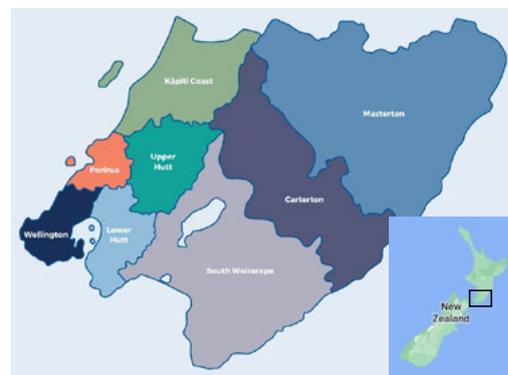


Figure 1: The Wellington region, New Zealand.

Source: Wellington Region Emergency Management Office

The Wellington region has a variety of topographies including flat valley floors and hilly suburbs. The steeper topography, in close proximity to some major transport routes, means that road access around the region could be affected for days to months (Wellington Lifelines Group 2019). This would reduce the ability of emergency services organisations to respond to the earthquake and would also disrupt services such as refuse collection. While the valley floors are largely away from steeper ground that is exposed to landslides, they are highly vulnerable to liquefaction (Dellow, Perrin & Ries 2018). These factors influence the alternatives for emergency toilets as well as the ability to create a system in which waste (such as from chemical toilets and portable toilets) is collected from dwellings.

The region is host to a variety of living arrangements from timber-framed, stand-alone houses on private land, to multi-storey apartment blocks, particularly in central Wellington City. Further, as for any population, there is a range of ages, capabilities, capacities and ethnicities in the community. This results in differing abilities to cope with and respond to an emergency event, including approaches to sanitation. It also affects people’s access to resources, both prior to and during, an emergency event.

## Stakeholder and organisational responsibilities

Local councils of the region carry out the local government functions for the cities. Council-controlled organisations include Wellington Water (for the operation and maintenance of the water, wastewater and stormwater networks for council areas) and the Wellington Region Emergency Management Office (WREMO), which coordinates the Civil Defence and Emergency Management (CDEM) services on behalf of the 9 councils in the region. The councils are responsible for waste management in their areas, although solid waste operations are largely carried out by contractors. Regional Public Health is the public health unit for the greater Wellington region. The work of Regional Public Health includes public health information, working with CDEM and investigating disease outbreaks. Massey University has a campus in Wellington City with staff and students who study post-earthquake environmental health challenges and solutions.

## Creating an emergency sanitation plan

### Research and investigations

Recognising the potential for lengthy outages of wastewater and following experiences in the 2011 Christchurch earthquake response, Massey University and WREMO collaborated on a pilot of a ‘composting toilet’ to capture excreta. This approach uses the concept of separating the urine and faeces at the source using 2 buckets (now referred to as the ‘two-bucket’ system). This approach means that odours are minimised from the waste, the faeces decompose relatively quickly and the bacterial count drops rapidly within 2 months (Brenin *et al.* 2021a).

### Stakeholder collaboration and engagement

Massey University led a collaboration with Wellington Water, Regional Public Health, WREMO and the councils to understand the process of capture, containment, emptying and transport, treatment and disposal or re-use of excreta, if using the two-bucket system. This led to the councils, WREMO, Wellington Water and Regional Public Health to conduct a project including a wider range of stakeholders to plan for emergency sanitation. Stakeholders were from the local Māori iwi (tribe) (Ngāti Toa) and managers and contractors of solid waste.

### Goal of the plan and levels of service

The councils, Wellington Water and WREMO created a high-level goal and target levels of service for an emergency sanitation response:

**Goal:** Minimising gastro outbreaks in the community following an emergency event.

#### Target levels of service:

- First 7 days - self-sufficiency by the community for sanitation needs. Until the wastewater networks are repaired - residents to dispose of wee and poo on their property.
- From day 8 - if the roads are available and all other systems operational (e.g. fuel supply), options 3 and 4 (as shown in Figure 3) will also be viable.

The target levels of service were created to support the outcomes of the plan and to highlight that emergency solutions are not solely for a single organisation to perform. Members of the community will need to be self-sufficient for the first 7 days following an event and adapt their sanitation practices in the weeks and months following until wastewater networks are repaired.

## Workshops

Three workshops were conducted for this project. Details of the first workshop held in November 2019 are outlined by Brenin and colleagues (2021b) and covered understanding the process of production, capture, collection and transport, treatment or disposal or re-use of wee and poo using a sanitation chain framework (Wirmer 2014). Figure 2 illustrates the sanitation chain. At this workshop there was also discussion about appropriate terminology and an agreement to avoid euphemisms in public messaging (and for the project). For this project, we decided to use the terms ‘wee’ and ‘poo’.



Figure 2: The sanitation chain.

Source: Wirmer (2014)

The second workshop was in December 2020 and options for emergency sanitation were examined. At this workshop, the options identified at the first workshop were prioritised and a matrix was created (see Table 1). This matrix established the preferred emergency sanitation options that were taken forward and, importantly, excluded some options from further consideration. For example, chemical toilets and community portable toilets were excluded due to the difficulty of collecting and treating the waste after a major earthquake. The elements of the matrix, and each option overall, were graded:

- green – for options considered acceptable by most stakeholders and technically feasible
- amber - considered acceptable by some stakeholders and/or technical difficulties
- red - for options that were technically unfeasible or were considered not acceptable to some stakeholder.

Table 1: Emergency sanitation options. The emergency sanitation workshops assessed emergency sanitation options as follows:

Option	Production and capture	Capture/containment	Collection and transport	Treatment	Disposal or re-use	Overall viability
<b>Long-drop toilet</b>	For those where land is suitable and can dig suitable holes (i.e. not on slopes, in liquefaction areas, near drinking water sources or where there is high ground water.	Acceptable, but messaging on the covering of waste required, to minimise odour and to control vectors (flies).	None	None	None, but messaging/guidance on how to close-out holes would be required (i.e. fill the hole).	Culturally, this is the only acceptable option to Mana Whenua [Māori].  This option is viable, where land is available and where the land conditions allow.
<b>Two-bucket toilet</b>	Messaging and socialisation of this concept is required. Otherwise, viable.	Organic additives (sawdust, mulch etc.) will lessen odour and improve the break-down of the solids.	Disposal to green-area land (liquids) and disposal to wheelie-bins/waste bags OR a long-drop (solids).  Assume wheelie-bins are collected in the normal waste-disposal cycle, subject to road access.	Landfill or on-site.	Landfill or on-site.	Viable, where households have buckets and organic material. Collection by refuse collectors only viable when road access is open.
<b>Bag in a toilet</b>	Requires suitable bags. (Suitable for mobility impaired and apartments. ONLY short-term.)	Suitable, if ONLY poo is in the bag (see emptying and transport).	Transport of poo bags largely viable. Wee bags not viable.	Landfill or on-site.	Disposal of poo (in bags) at landfills largely acceptable.	Viable only where wee and poo are separated (i.e. only the bagged poo can be collected in suitable bags).
<b>Bag in a toilet for people with disability/ aged care</b>	All dynamics are the same, as for 'bag in a toilet'. However, this is considered the only one considered acceptable by the disability sector.	Helper and transfer required in some cases.	At a workshop held on 30th April 2021, it was agreed with the solid waste contractor in attendance that bagged wee, and poo (in one bag) is acceptable in general refuse IF the wee is soaked up with suitable materials such as fine sawdust or gelling agent (Super-Absorbent Material).			Due to access issues this is the ONLY viable option for some people.
<b>Chemical toilet</b>	Requires procurement and delivery, at scale. Ergonomics are not ideal for some users. One per household is desirable, as each house would then take care of/maintain one toilet.	There would be difficulties for some in carrying used (heavy) toilets out to tanks on road. There is a potential for sloppage/spillage. Assistance may be required for some community members.	Challenges of road access for emptying. A fleet of trucks would be required for this operation, at scale. It could suit an outage involving a few suburbs (i.e. not a region-wide outage).	Concentrated effluent would have to be stored for drip-feeding into treatment plants. (This would not be an issue where treatment ponds are used for treatment (i.e. Wairarapa). depends on chemical used.)		This option is only viable if: the procurement of the units is viable, transport access between home and treatment plant is possible, the treatment plant is functioning at high capacity and the chemicals used are acceptable.
<b>Community port-a-loo (as a long-term solution)</b>	Unit is outside of house (poor safety). Multiple houses would use one unit, which often leads to units being poorly maintained. There is potential for vandalism. Windy Wellington – ohh!		Challenges of road access for emptying. Fleet of trucks required.	Concentrated effluent would have to be stored for drip-feeding into treatment plant. (Green, where there are ponds).		This option is viable for small-scale (suburb or part of a suburb) short-term outages, so is therefore not considered further in this planning (which is focused on longer-term outages).

The third workshop was held in April 2021 and identified the emergency sanitation options that would be taken forward for public information. Early drafts of this information were discussed and the final version became the 'Don't Flush' infographic (Figure 3). The workshop focused on 2 objectives:

- The end-to-end process from capture to disposal was discussed with managers and solid waste contractors. Options that required the collection and disposal of waste could only be activated if options were operationally feasible. For example, whether it would be acceptable to place bagged human waste into refuse bins and, if so, how this should be done.
- The practical and cultural implications for end-users. For example, the option of digging a long-drop toilet (up to 1m deep) in the land at a house appeared, at first consideration, to be a relatively simple task. However, it requires suitable land, digging implements and a suitable seating or crouching arrangement.

This workshop highlighted the need to consider these aspects and the actions to be taken forward in following work. Māori representatives guided the cultural aspects of the plan.

The workshop also highlighted that some people would likely be unable to use a two-bucket solution (e.g. people with weight or mobility issues). Input from disability sector representatives was that people with limited mobility would need to use their

regular toilet facilities that include handrails. Their preferred option would be to use a conventional pedestal toilet, placing a bag within the toilet bowl along with drying material such as sawdust or the super-absorbent material used in nappies. This option would be discouraged for the general population because of anticipated difficulties with sourcing of the bags and drying material, disposal of the resulting waste and potential for spillage and mess.

## 'Don't Flush'

The options for emergency sanitation, as agreed at the third workshop, were translated into an infographic (Figure 3) showing the emergency sanitation options. The infographic is a key output of this project as it informs the waste-disposal operators and people in communities about what an emergency sanitation activation entails. It was created to direct people to use options 1 and 2 (disposal on-site) wherever possible and minimise use of options 3 and 4, which require disposal off-site.

## Next steps

### Public education

The third workshop identified that further public information and education must include:

- why the options were taken and why some options were not taken
- the items that can be purchased pre-event to enable good sanitation practices in an emergency
- suggestions on how to build a functional long-drop toilet.

This work will be led by WREMO and will provide reasons why some options were not taken to help address expectations by members of the public that portable toilets and chemical toilets (as provided in Christchurch following the 2011 earthquake) will be provided in Wellington.

### Procurement and marketing - a public-private partnership

In 2012, WREMO established a public-private partnership to enable people to purchase 200-litre emergency water tanks at an affordable price for \$100 (a saving of \$165). This has generated sales of more than 24,000 water tanks so far (2021) and resulted in nearly 5 million litres of water stored at homes around the region at minimal cost to the ratepayer or taxpayer.

WREMO and Wellington Water worked on a similar approach to improve people's capacity to manage sanitation after an earthquake by promoting the two-bucket approach for toilets. With administrative support from the Greater Wellington Regional Council, a supplier of a two-bucket kit will be supplied as a package comprising a pair of 20-litre buckets with lids, a small seat and 'starter' items including 2 toilet rolls and disinfectant wipes. WREMO will make this the focus of an annual campaign from 2023 to help people understand how to manage waste through a range of options from digging a long-drop toilet, to using 2 buckets to modifying their toilet if they have physical challenges.

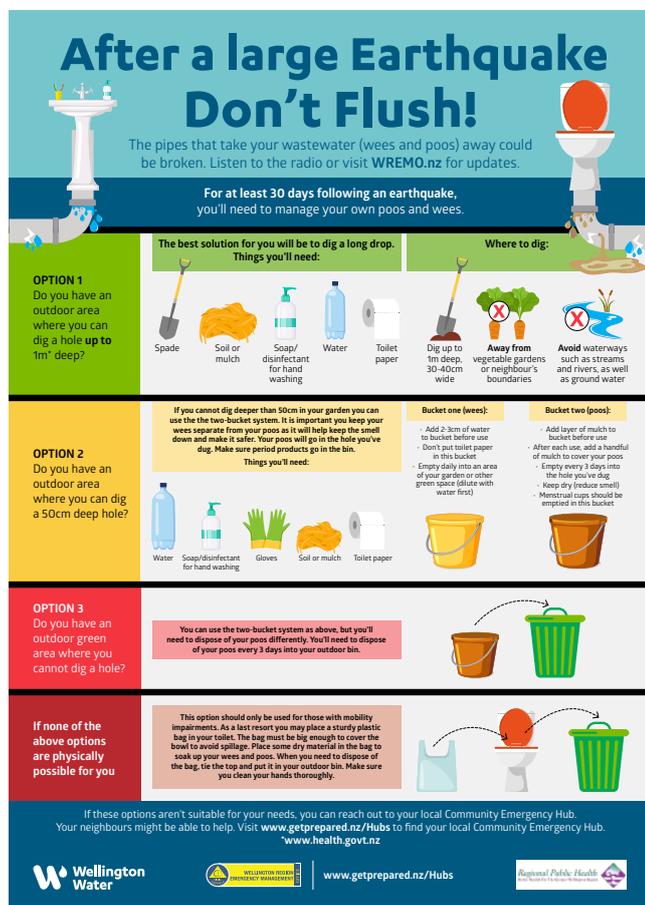


Figure 3: 'Don't Flush' infographic.

## Ongoing engagement

Effective stakeholder engagement was integral to the creating of an emergency sanitation plan for the Wellington region. This engagement will have to continue to progress the public information and education work and to ensure that all parties are prepared to respond in the event of a major failure in the region's water and sanitation systems.

## Conclusion

The Wellington region prepares for a major earthquake on the Wellington Fault because of the high-risk of prolonged damage to the region's wastewater collection system. Target levels of service show that households will need to manage their own toilet waste on-site for at least a week. Beyond that time, viable emergency sanitation solutions have been developed that would be viable for households, giving special consideration to people within communities with extra physical or cultural needs. The emergency sanitation plan allows for physical features of the region (ground conditions, topography, likely availability [or not] of roads following a major earthquake) and cultural and social aspects (living arrangements such as house-dwellers and apartment dwellers) and the needs of those who may not be able to use long-drop toilets or the 2-bucket kits.

The emergency sanitation solutions allow end-users to choose their preferred option, allowing for a range of behaviours, cultures and capacities. This work gives confidence that the options explored were appropriate and achievable for end-users and that a sound process was taken to consider the capture, containment and disposal options for waste.

This progress has identified sanitation options during an emergency for the Wellington region. The next steps will involve informing the region's communities about their options and making 2-bucket kits easily available through a public-private partnership.

### Acknowledgments

The authors acknowledge QuakeCoRE for their funding for the 2-buckets research and appreciate the contribution from the participants in the workshops and throughout the project process.

## References

- Brenin M, Horswell J, Stewart C, & Gutierrez-Gines MJ, Bohm K & Johnston D 2021a, *How effective is a composting toilet system for protecting human health in an emergency context? Proceedings of the New Zealand Society for Earthquake Engineering 2021 Annual Conference, Paper 125*, <https://repo.nzsee.org.nz/handle/nzsee/2357>.
- Brenin M, Stewart C, Johnston D, Mowll R, Horswell J & Wotherspoon L 2021b, *Emergency sanitation challenges and opportunities following a large Wellington Fault earthquake scenario: November 2019 workshop. Australasian Journal of Disaster and Trauma Studies* 25:2. [https://trauma.massey.ac.nz/issues/2021-2/AJDTs\\_25\\_2\\_Brenin.pdf](https://trauma.massey.ac.nz/issues/2021-2/AJDTs_25_2_Brenin.pdf).
- Dellow GD, Perrin ND & Ries WF 2018, *Liquefaction hazard in the Wellington region. GNS Science report 2014/16*. doi:10.21420/G28S8J
- Wellington Lifelines Group 2019, *Wellington lifelines project: Protecting Wellington's economy through accelerated infrastructure investment: Programme Business Case. Wellington, New Zealand: Wellington Lifelines Group*. At: <https://wremo.nz/assets/Uploads/Wellington-Lifelines-PBC-MAIN-Combined-20191009.pdf>.
- Wellington Region Emergency Management Office 2019, *Group Plan 2019-2024. Wellington, New Zealand: Wellington Region Emergency Management Office*. At: <https://wremo.nz/assets/Publications/Group-Plan-2019-2024.pdf>.
- Wirmer BR 2014, *A functional approach to guide sustainable innovations in the sanitation chain. (Master of Science in Innovation Sciences), Eindhoven University of Technology*. At: <https://pure.tue.nl/ws/portalfiles/portal/46969277/778536-1.pdf>.

### About the authors

The authors work in 6 organisations in the Wellington region, New Zealand. All have had input to the emergency sanitation plan for the region. They come from the water, health, academic and emergency management sectors.

# Community bushfire safety awareness: a community-led initiative progress report

Max Garner<sup>1</sup>  
Jim McLennan<sup>2</sup>

1. Bushfire Resilience Inc.
2. School of Psychology and Public Health, La Trobe University



© 2022 by the authors.  
License Australian Institute for Disaster Resilience, Melbourne, Australia. This is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## Introduction

Over the last 30 years, approaches to community-based disaster risk management (CBDRM) in Australia have moved from the margins towards the mainstream of policy and practice. CBDRM is now understood to be an important pillar for building resilience to increasing risks. Compared with previous top-down, command-and-control approaches, CBDRM orients disaster management around principles of community participation, ownership and capacity-building.<sup>1</sup> This paper describes a locally led initiative in an outer-eastern Melbourne community that is helping residents recognise their bushfire risks and how to take action to mitigate them.

As bushfires raged in Australia during the summer of 2019–20, a resident in North Warrandyte (a suburb in Melbourne within the Nillumbik Shire) with a long interest in bushfire safety, was surprised to learn that 30% of people affected by bushfire have no relevant insurance and 30% are under insured. North Warrandyte has experienced serious bushfires in the past and community bushfire safety seemed likely to be increasingly important in the face of climate change. Teaming up with a friend who was a local Country Fire Authority (CFA) volunteer, the initial idea was to hold a community meeting to raise awareness of insurance and bushfire risk. However, the spread of COVID-19 made any public meetings impossible in the immediate future. The number of those interested in a local initiative to promote bushfire safety grew, including a local CFA Brigade Captain and an active Fireguard member. All the members of the group had experienced bushfire threats in the past. It became clear that funding

for any meaningful initiative would be needed. The Chairman of Valley Community Services Limited—the community-based company which operates 5 Bendigo Bank Community Bank branches in Nillumbik Shire—was approached for advice and he became an enthusiastic supporter and a key participant.

A not-for-profit incorporated association was established—Bushfire Resilience Incorporated (BRI)—complying with the requirements of Consumer Affairs Victoria. The purpose of the association was to ‘facilitate the provision of information about bushfires to the community’ thus raising residents’ awareness of bushfire risks and how to mitigate these. This was to be achieved by creating 5 free webinars for delivery during October and November of 2020 to address residents’ knowledge gaps. The ongoing financial support of Valley Community Financial Services Limited was integral. A local resident, also a volunteer in a CFA brigade and an employee of CFA District 14 in a community engagement role, provided his expertise and advice through the planning and delivery stages using CFA’s Zoom platform to present and record the 5 webinar sessions.

## The 2020 webinar program

The team created webinars based on best-practice bushfire safety principles for household safety as described in fire service websites (e.g. Country Fire Authority<sup>2</sup>). The webinars were designed to present information that was relevant to the needs of residents, to raise awareness about risks and to be practical enough to motivate people to take action. The topics were chosen based on identified information that emergency services agencies did not cover sufficiently. For each topic, subject-matter experts presented the webinar and they worked with the BRI team to create the format. The features of the 2020 webinar program are summarised in Table 1.

Table 1: The 2020 webinar program details.

Date	Topic	Presenter	Number of views	Viewer satisfaction levels*
27 October	How houses are destroyed by bushfire	Dr Justin Leonard, CSIRO	141	Overall session: <ul style="list-style-type: none"> <li>· Excellent - 85%</li> <li>· Very good - 11%</li> </ul> Information relevance: <ul style="list-style-type: none"> <li>· Excellent - 71%,</li> <li>· Very good - 21%</li> </ul>
5 November	How to harden an existing house	Dr Justin Leonard, CSIRO	123	Overall session: <ul style="list-style-type: none"> <li>· Excellent - 79%</li> <li>· Very good - 18%</li> </ul> Information relevance: <ul style="list-style-type: none"> <li>· Excellent - 80%,</li> <li>· Very good - 18%</li> </ul>
10 November	Getting your insurance right	Denis Nelthorpe, Consumer Lawyer Clare Cordingley, Insurance Council Helda Sidaoui, Suncorp Georgina Dirks, IAG	84	Overall session: <ul style="list-style-type: none"> <li>· Excellent - 68%</li> <li>· Very good - 28%</li> </ul> Information relevance: <ul style="list-style-type: none"> <li>· Excellent - 70%</li> <li>· Very good - 26%</li> </ul>
19 November	Understanding rebuilding	Rosa Zouzoulas and Renae Ahern, Nillumbik Shire Council Julie Bowyer, Cardinia Shire Council John Ginivan, Strategic Planner Mark Holland, Country Fire Authority Kevin Hazell, Bushfire Planning Peter Collina, Victorian Building Authority	93	Overall session: <ul style="list-style-type: none"> <li>· Excellent - 50%</li> <li>· Very good - 31%</li> </ul> Information relevance: <ul style="list-style-type: none"> <li>· Excellent - 59%</li> <li>· Very good - 33%</li> </ul>
26 November	Make better decisions about bushfire risk in our changing climate	Kevin Tolhurst AM, University of Melbourne Michael Vermeulen, Country Fire Authority	80	Overall session: <ul style="list-style-type: none"> <li>· Excellent - 82%</li> <li>· Very good - 17%</li> </ul> Information relevance: <ul style="list-style-type: none"> <li>· Excellent - 82%</li> <li>· Very good - 13%</li> </ul>

\*Satisfaction level results were obtained via an online survey of viewers after each webinar and totals were collated at the end of the webinar series.

As a result of COVID-19 pandemic restrictions, there was a very short lead time and close spacing of the webinars. This also affected the time available to publicise the program and generate community interest. Understanding this, the CFA contacted local Fireguard groups, Facebook posts were sent to local community groups and special interest groups, posters were displayed in post offices and stores and emails were sent to interested residents via the networks of the organising team. People interested registered to attend the webinars via the BRI website. While this restriction may have limited access, available resources did not allow additional alternative ways to register.

Audience engagement was an aim of the webinar format. Registrants were sent an online, pre-webinar survey to assess their current knowledge of bushfire danger and safety, and what, if any, plans and preparations they had made or intended to make. They could also submit questions before the webinar. A post-webinar survey was sent to collect qualitative information about the topic and viewer's changes in knowledge and motivations to take action. In addition, viewer polls were conducted during each webinar. The evening webinars ran for 90 minutes and comprised either 2 presentations of around 20 minutes or a combination of presentation and/or panel discussions with 30–40 minutes of question-and-answer time.

The average viewing audience across the 5 webinars was 104. Survey response rates from viewers were encouraging:

- 39% responded to the pre-webinar survey
- 55% responded to the post-webinar feedback survey and 48% described what, for them, were the most useful parts of the webinars.

Feedback about the program was very encouraging:

- 89% rated the question-and-answer sessions as ‘Excellent’ or ‘Very good’
- 95% rated the overall sessions as ‘Excellent’ or ‘Very good’
- 96% reported that the information provided was relevant
- 97% indicated that they were ‘Very likely’ or ‘Likely’ to participate in future events.

The second webinar was about ‘hardening’ an existing house against bushfire attack. Viewers were asked whether they would take actions to reduce their risk. Of significance, 92% of viewers responded to the post-webinar survey that they would take action (but were not asked to describe the detail of those intended actions). A total of 156 written suggestions for future webinar topics were provided.

## The 2021 webinar program

A comprehensive review of the 2020 webinar series identified issues and improvements. In response, the website and the webinar registration process were revamped, including:

- uploading webinar recordings within 10 days following the webinar
- establishing a Vimeo account to enable recordings to be viewed from the website without being interrupted by advertisements
- providing a survey platform that enabled a greater variety in the format of questions and a easier and quicker way to analyse results.

A wide-reaching community engagement process was needed. The webinar format was reviewed and the use of panel discussions was preferred. The administration of the webinars was simplified and improved. A BRI logo was created for quick recognition. More sponsors were enlisted to provide funding for the enhanced program. The 5 webinars would be presented fortnightly rather than weekly to allow for greater viewer reflection time and, ideally, family discussion of each topic, and for the BRI team to take action and prepare.

The program was scheduled from July to mid-September to allow viewers to take any mitigation actions before the start of the 2021–22 bushfire season.

The topics of the webinars were influenced by viewer suggestions from the 2020 series and by the experience of BRI team members. Topics were reviewed and discussed with subject-matter experts. Topics identified as important but not covered in fire agency material were given additional consideration. A promotion campaign was assisted by BRI's Nillumbik Community Directory that listed 300 community groups. Facebook and email were used extensively. Each organising team member used their personal

email list and contacts were made with people representing local community groups. Personalised emails were sent to all councils in Victoria likely to face future bushfire threats, and to all elected members in Victoria of the Australian and Victorian parliaments. Face-to-face meetings were held with local government councillors and some local members of the state government. Posters were printed, however, wide distribution was affected by pandemic restrictions. The use of a pre-webinar survey (with a stronger emphasis on viewers to submit questions) to stimulate audience participation as well as the use of subject matter experts as presenters were retained. Table 2 provides a summary of the major features of the 2021 webinar program.

For the 2021 webinar program, registrations tripled to 1,300 and viewing audience numbers doubled to an average of 206 viewers per session. As at mid-June 2022, there have been 2,600 views of the webinar recordings on either the BRI Vimeo platform or YouTube.

Responses in the post-webinar surveys were very encouraging. More people responded to the pre-webinar survey than participated in the webinar (106%, up from 39% in 2020):

- 60% responded to the post-webinar survey (up from 55% in 2020)
- 72% responded with details of their most informative parts of the webinars (up from 48% in 2020)
- 78% responded by providing details of the actions they intended to take (not measured in 2020).

Respondents liked what was delivered:

- 91% rated the overall sessions as Excellent or Very good (94% in 2020)
- 90% rated the relevance of the overall sessions as Excellent or Very good (94% in 2020)
- 99% said they were Very likely or Likely to participate in future events (97% in 2020)
- 99% said they were Very likely or Likely to recommend the webinars to others (not measured in 2020)
- 269 comments were received on the webinar topics and suggestions for future webinar topics
- 95% who indicated in their 2020 post-program survey that they were spurred to take action, reported that they had taken action.

The age profile of survey respondents was:

- 8% were aged 20–49
- 17% were aged 50–59
- 29% were aged 60–69
- 24% were aged 70–79
- 3% were aged over 80.

The relatively small percentage of viewers aged under 50 years was noted. Anecdotal indications are that people within this demographic can be time poor. To increase the appeal to people in this age demographic, future program promotion will emphasise viewing the webinar recordings and associated videos at times of choice.

Table 2: The 2021 webinar program details.

Date	Topic – All format is webinar	Presenters	Number of viewers	Viewer satisfaction levels
21 July	Reduce your house and property risk	Dr Justin Leonard, CSIRO	277	Overall session: <ul style="list-style-type: none"> <li>· Excellent 43%</li> <li>· Very good 50%</li> </ul> Information relevance: <ul style="list-style-type: none"> <li>· Excellent 66%</li> <li>· Very good 24%</li> </ul>
4 August	Get water ready: tanks, pumps and sprinklers	Dr Justin Leonard, CSIRO	216	Overall session: <ul style="list-style-type: none"> <li>· Excellent 57%,</li> <li>· Very good 37%</li> </ul> Information relevance: <ul style="list-style-type: none"> <li>· Excellent 66%</li> <li>· Very good 22%</li> </ul>
19 August	Your physical and emotional preparation	Dr Danielle Clode, Flinders University Dr Rob Gordon OAM, Clinical Psychologist Dr Jim McLennan, La Trobe University	184	Overall session: <ul style="list-style-type: none"> <li>· Excellent 61%</li> <li>· Very good 30%</li> </ul> Information relevance: <ul style="list-style-type: none"> <li>· Excellent 64%</li> <li>· Very good 25%</li> </ul>
1 September	Triggers to take action	Dr Kevin Tolhurst AM, University of Melbourne Dr Katharine Haynes, University of Wollongong Dr Danille Clode, resident Smiths Gully Black Saturday 2009 and Adelaide Hills 2021 Dr Raphaelae Blanchi, CSIRO	181	Overall session: <ul style="list-style-type: none"> <li>· Excellent 44%</li> <li>· Very good 48%</li> </ul> Information relevance: <ul style="list-style-type: none"> <li>· Excellent 59%</li> <li>· Very good 32%</li> </ul>
15 September	Your sheltering options	Dr Raphaelae Blanchi, CSIRO Dr Katharine Haynes, University of Wollongong Dr Chloe Begg, Country Fire Authority	172	Overall session: <ul style="list-style-type: none"> <li>· Excellent 23%</li> <li>· Very good 62%</li> </ul> Information relevance: <ul style="list-style-type: none"> <li>· Excellent 47%</li> <li>· Very good 44%</li> </ul>

## Reflections for the 2022 webinar program

Five free webinars will be offered in 2022. The topics include how to assess risk, involving children in preparing family bushfire plans, vegetation, caring for horses and last-resort options. Short video clips of interviews with residents who have personal experiences caring for horses during a bushfire will be included.

The webinars presented have encouraged people to take responsibility for preparing their properties using best available scientific knowledge about managing bushfire risk. Webinars also emphasise that working with neighbours and joining neighbourhood or local bushfire safety interest groups builds

confidence and capacity to reduce bushfire risk to residents. The webinars encourage people to know the broad risks associated with living in a bushfire-risk locality, which, in Victoria, is a Bushfire Management Overlay or Bushfire Prone Area. This information helps people understand their immediate vulnerabilities and the risks posed by their home’s location, design and state of maintenance.

Information presented by eminent researchers in the sector emphasises the gravity of decisions that must be made prior to a bushfire threat and the risks associated with the absence of a household bushfire survival plan. The presentations by experts provided essential information and the question-and-answer sessions explored many of the topics people are interested in.



Dr Danielle Clode practising starting her fire pump at her property.  
Image: supplied by Dr Danielle Clode

Feedback from viewers indicates that the webinars are a valuable tool for addressing bushfire preparedness. Recordings of previous webinars and other website content provide a valuable online resource into the future. Additional website content sourced from previous webinars is called ‘Bitesize BRI’ and features:

- a searchable database for users to locate their topic of interest
- 26 topic-specific videos with accompanying transcript files available for downloading
- the presentation and/or panel discussions for each webinar available as a video and accompanying transcript files as well as the question-and-answer session transcript
- the feedback provided by viewers for each webinar about the most informative parts and the proposed actions they will take as examples of how comments by a household can assist other households.

It is expected that locally relevant information, presented in an accessible form and easily found from a topic search, will provide benefit for all householders living with bushfire risk. The webinar recordings and additional website content can be used as a resource by fire agencies and community groups.

This is timely, given that the increasing intensification of fire conditions is set to collide with an expanding urban fringe population exposed to bushfire risk, as evidenced by the fact that ‘...the number of people residing in bushfire prone areas increasing by 111,000 in Victoria alone in the decade leading up to 2018’.<sup>3,4</sup>



The webinars and further resources are housed on the BRI website.  
Image: Bushfire Resilience Inc.

More information about BRI and its webinar program and resources is available at [www.bushfireresilience.org.au](http://www.bushfireresilience.org.au).

### Acknowledgments

BRI is very grateful for the wonderful support of presenters and viewers, particularly those who provided feedback. The webinars would not be possible without the support of sponsors and the dedicated BRI team members.

### Endnotes

1. McLennan BJ 2020, *Conditions for effective coproduction in community-led disaster risk management*. *VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations*, vol. 31, no. 2, pp.316–332. <https://doi.org/10.1007/s11266-018-9957-2>.
2. Country Fire Authority Prepare & Plan. At: [www.cfa.vic.gov.au/plan-prepare](http://www.cfa.vic.gov.au/plan-prepare).
3. Gross S & Cadman E 2020, *Bushfire-Ravaged Australians Face Choice in Era of Climate Change: Rebuild or Leave?*, *Insurance Journal* 23 Jan 2020. At: [www.insurancejournal.com/news/international/2020/01/23/556124.htm](http://www.insurancejournal.com/news/international/2020/01/23/556124.htm).
4. Australian Government Centre for Population 2021, *Migration between cities and regions: A quick guide to COVID-19 impacts*. At: <https://population.gov.au/sites/population.gov.au/files/2021-09/the-impacts-of-covid-on-migration-between-cities-and-regions.pdf>.

# Improving resilience: a longitudinal analysis of land-use policy and planning for earthquakes in Aotearoa New Zealand, 2000–16

Peer reviewed

**Dr Bridgette Sullivan-Taylor<sup>1</sup>**

**Sarah Gunnell<sup>2</sup>**

**Associate Professor**

**Julia Becker<sup>3</sup>**

**Professor David**

**Johnston<sup>3</sup>**

1. Formerly The University of Auckland, New Zealand.
2. Urban Edge Planning, Lower Hutt, New Zealand.
3. Massey University, Wellington, New Zealand.

**SUBMITTED**

11 January 2022

**ACCEPTED**

11 March 2022

**DOI**

[www.doi.org/10.47389.37.3.45](https://www.doi.org/10.47389.37.3.45)



© 2022 by the authors.  
License Australian Institute for Disaster Resilience, Melbourne, Australia. This is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## Introduction

### New Zealand’s tectonic setting

New Zealand is a long and narrow island nation that lies on the Pacific Ring of Fire, which makes it particularly susceptible to earthquakes. Approximately 90% of the world’s earthquakes and 81% of the largest earthquakes occur in this tectonic zone (Jang *et al.* 2016). Over 15,000 earthquakes are recorded across New Zealand every year, although, on average, only 100–150 are strong enough to be felt (GNS Science n.d). Figure 1 shows the geographic variation of earthquake hazard across New Zealand as represented in the 2010 National Seismic Hazard Model.

The Hikurangi Subduction Zone lies offshore to the east of the North Island and has the potential to generate magnitude 9 earthquakes and tsunami similar to the Great East Japan earthquake in 2011 (Power 2013). An Alpine Fault earthquake is also regarded as a future event of significance (Orchiston *et al.* 2018) and a large number of other known and unknown faults present threats (Stirling *et al.* 2012). Recent large earthquakes in New Zealand include the February 2011 earthquake in Christchurch that claimed 185 lives (Potter *et al.* 2015), the 2013 Cook Strait/Seddon earthquakes (Doyle *et al.* 2018) and the 2016 Kaikōura earthquake that struck the upper South Island and lower North Island (Stevenson *et al.* 2017). It is vital that New Zealand be as prepared as possible for future earthquake events. It is not a question of if another will occur, but when.

### The vital role of land-use planning

Reducing risks from earthquakes can occur via land-use planning, engineering of buildings and other infrastructure and preparedness initiatives. The vital role of land-use planning in avoiding and mitigating natural hazards such as

## Abstract

Given New Zealand’s susceptibility to a range of natural hazards, reducing exposure is an important step towards strengthening community resilience and reducing potential social, environmental and economic consequences. Land-use planning has long been recognised as a contributor to achieving this goal. Focusing on earthquake hazards, this paper examines the evolution of risk reduction measures in local government land-use planning documents for 3 earthquake-prone regions of New Zealand in 2000 and again in 2016. While some progress has been made in planning for earthquake hazards, overall the planning documents in these regions remain inadequate. As such, resilience from a land-use planning perspective has not significantly improved. This is surprising in the context of major seismic events in New Zealand over the last decade that have caused considerable damage and loss of life. Future anticipated changes to the planning systems in the country provide opportunities for improvements to be included in documentation.

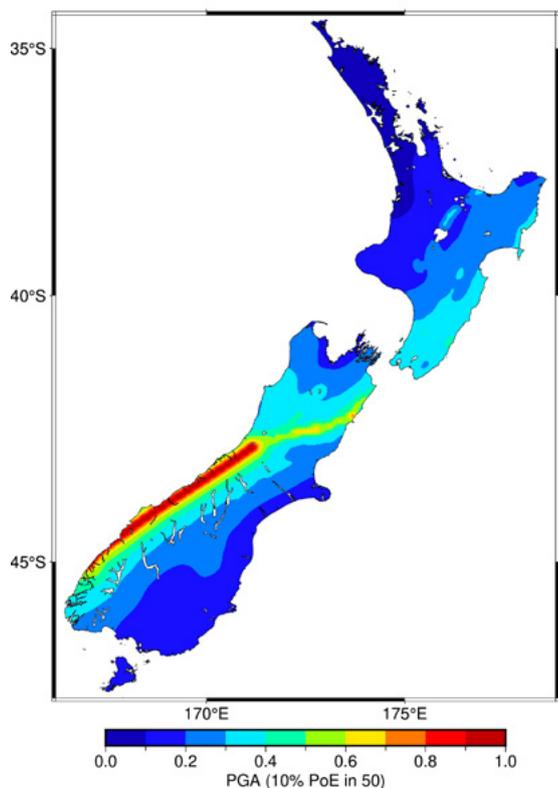


Figure 1: New Zealand’s earthquake hazard based on the 2010 National Seismic Hazard Model showing Peak Ground Acceleration for 10% probability of exceedance in 50 years.

Source: GNS Science

earthquakes is well recognised, as it allows a mechanism by which to control the use and development of land areas identified as susceptible to the effects of earthquakes (Burby 1998, Berke & Smith 2009, Glavovic, Saunders & Becker 2010, Saunders & Becker 2015). The *Sendai Framework for Disaster Risk Reduction 2015-2030* (UNISDR 2015) of which New Zealand is a signatory, highlights governance and risk reduction as priorities to improve resilience (Priority 2 and 3). Land-use planning is a key component of this.

As noted in Brody (2003), a high-quality land-use plan consists of 3 equal components:

- a strong factual basis
- clearly identified goals
- appropriate supporting policies.

A land-use plan that successfully integrates these factors is important to avoid or mitigate the effects of natural hazards (Brody 2003).

Land-use plans evolve over time in response to changing community needs, advances in scientific knowledge and learnings from experience of events (Brody 2003). While a number of studies have evaluated the quality of land-use plans for managing natural hazards within discrete timeframes (Berke *et al.* 1999, Berke & Godschalk 2009, Lyles, Berke & Smith 2014), longitudinal analyses of planning for natural hazard mitigation are scarce in the literature. This study examined patterns of change in 24

land-use planning documents gathered from 3 earthquake-prone regions in 2000 and in 2016. The aim was to examine the evolving nature of disaster risk reduction approaches in local government land-use plans over time, with a focus on earthquake hazards (e.g. fault rupture, ground shaking, liquefaction). Of interest was whether the 2016 analysis would reflect heightened awareness prompted by the 2010–2012 Canterbury Earthquake Sequence that included the devastating 2011 Christchurch earthquake. This highlighted planning issues for hazards such as fault rupture and liquefaction (Saunders & Becker 2015).

## Overview of legislation to manage natural hazards

### *Resource Management Act 1991*

While natural hazards are managed in New Zealand under a number of pieces of legislation (see Glavovic, Saunders & Becker 2010, Saunders *et al.* 2020) the *Resource Management Act 1991* (RMA) is New Zealand’s principal environmental planning statute and provides the framework for land-use planning decision-making. The purpose of the RMA is to ‘promote the sustainable management of natural and physical resources’ by ‘managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety’ (*Resource Management Act 1991*). With respect to hazards, the overall focus of the RMA is an ‘all hazards’ approach rather than being earthquake-specific; similar to other legislation (e.g. the *Civil Defence Emergency Management Act 2002*).

Governance is divided between central and local governments. Local government is further separated into 2 tiers, comprised of 11 regional councils and 61 city or district councils with city and district councils collectively referred to as ‘territorial authorities’. In addition, there are 6 unitary authorities that are territorial authorities with regional council responsibilities. Regional council boundaries generally follow water catchment boundaries, while territorial boundaries are defined by identifying communities of interest. This has meant that, in some cases, territorial authority districts lie across more than one region.

The RMA makes regional councils responsible for controlling the use of land to avoid or mitigate natural hazards. Regional Policy Statements are key documents in meeting this requirement as they identify the significant resource management issues for the region and the objectives, policies and methods (but not rules) to address them. The 67 territorial and unitary authorities (referred to collectively as ‘local authorities’) are responsible for the avoidance or mitigation of natural hazards by controlling the effects of the use of land. This is achieved by District Plans that identify local issues (including natural hazards) and set out the objectives, policies, methods and (unlike Regional Policy Statements) rules to address them, all of which are generally supported by assessment criteria. Regional Plans and District Plans must give effect to the relevant Regional Policy Statements and District Plans must be consistent with Regional Plans (plural since some local authorities straddle more than

one region). Under this structure, District Plans play a vital role in avoiding or mitigating the adverse effects of natural hazards at a local community level by controlling the subdivision, use and development of land. Planning provisions in Regional Policy Statements, Regional Plans and District Plans (collectively referred to as 'land-use plans') are required under the RMA to be reviewed every 10 years.

The RMA does not prescribe how to manage natural hazards. This is in keeping with the principles of devolved power and effects-based management that is largely devolved and left to the discretion of the territorial authority affected. This is providing that the overarching purpose of the RMA is met, namely, the sustainable management of natural and physical resources (Berke *et al.* 1999, Glavovic, Saunders & Becker 2010, Saunders & Glassey 2007). Thus, local authorities and communities have to understand, identify and manage their own risks. This means that a community's exposure and vulnerability to natural hazard risk could reduce or increase over time in response to its interpretation of the RMA. Equally, adjacent communities (that face similar levels of exposure) could have vastly different levels of resilience and vulnerability depending on their approach to managing natural hazards.

Local resilience measures of authorities influence the resilience and sustainability of adjoining districts and regions as the effects of natural hazard events have no regard for boundaries. This influence works through authorities' input into 'broad resource networks through connections with suppliers and other key stakeholders of [their] environment' which organisations access (Branicki, Steyer & Sullivan-Taylor 2016, p.1267). Such organisations include those in neighbouring communities as well as national organisations. This can be a blessing or a curse, depending on whether local authorities do a good job or a poor one. In reality, as Glavovic, Saunders and Becker (2010, p.682) note:

*...in the absence of a recent threat or event, more immediate concerns tend to dominate the public agenda. Taking proactive measures to reduce hazard risks is thus accorded a low priority, and it seems as if communities simply hope that "it won't happen to them".*

Thus, not only are hazards a threat, but vulnerability (and also exposure by location of people, systems and assets) is at risk of being worsened by reactive planning or wishful non-planning and the devolution to local authorities can exacerbate risks.

### Changes to the *Resource Management Act 1991*

A number of changes have occurred to the RMA that relate to hazard planning. Amendments in 2017 elevated the management of significant risks from natural hazards to the national level. Concern over the overall effectiveness of the RMA has led to a resource management review (Resource Management Review Panel 2020) that recommended the development of 3 pieces of new legislation:

- a Natural and Built Environments Act (NBA)
- a Strategic Planning Act
- a Climate Change Adaptation Act.

An Exposure Draft of the NBA bill was released in mid-2021 for consultation (Natural and Built Environments Bill 2021). The NBA Exposure Draft includes environmental outcomes that require targeted risk reduction for natural hazards and climate change, and improvements in resilience and their effects (Part 2, Section 8(p)). A national planning framework is required to set provisions for natural hazards and climate change (Part 3, Section 13(1)i), and these should be implemented in regional plans and spatial strategies (Part 3, Section 15(1)).

Another change under the NBA is mandatory plans for each region, which would reduce the large number of policy statements and plans that currently exist to just 14. These changes are not reflected in this study as data was collected before the changes to the RMA and the release of the Exposure Draft, but are considerations for the future of hazards planning.

### Other relevant legislation and guidance

The *Building Act 2004* also plays a role in managing natural hazard risk at a local-government level and is legislation that includes earthquake-specific provisions. The Act requires that territorial authorities "must refuse to grant a building consent for the construction of a building or major alterations...if the building work is likely to accelerate, worsen, or result in a natural hazard on that land or any other property". (*Building Act 2004*). This does not apply, however, if they consider adequate mitigation measures taken. To comply with the Building Code regulations under the Act, residential buildings must be constructed to withstand a future earthquake with a one in 500-year return period of shaking, while critical facilities such as hospitals must be designed to withstand a one in 2,500-year event. An amendment to the Act in 2016 introduced specific measures that require the strengthening of buildings identified as earthquake-prone in response to the 2010–2012 Canterbury earthquakes (Filippova & Noy 2020).

Also important is the role of the *Civil Defence Emergency Management Act 2002* in avoiding or mitigating the adverse effects of natural hazards. Plans prepared under this Act are designed to inform and integrate with RMA plans (Saunders *et al.* 2007) and provide a stronger directive towards achieving the resilience goals of the *Sendai Framework for Disaster Risk Reduction 2015-2030*. In addition, the *National Disaster Resilience Strategy* that came into effect in 2019 provides guidance on the vision and goals for resilience in New Zealand (Ministry of Civil Defence and Emergency Management 2019).

Several guidance documents assist with land-use planning for earthquakes including 'Planning for the Development of Land on or Close to Active Faults guidelines' (Active Fault Guidelines) (Kerr *et al.* 2003), 'Planning and engineering guidance for potentially liquefaction-prone land' (Ministry of Business, Innovation and Employment 2017) and general natural hazards planning guidance on the Quality Planning website (Quality Planning 2017). While not mandatory, these guidelines help land-use planners when making decisions. No single national policy statement on natural hazards has been issued in New Zealand via the RMA that compulsorily directs local government on how to plan for natural hazards.

## Method

To examine the changing nature of local government policies and plans for the reduction of earthquake hazard risk, an earlier study of policies and plans conducted by Becker and Johnston (2000) was replicated. The original study was a document analysis of 24 planning documents (3 Regional Policy Statements and 21 District Plans or City Plans) from Hawke’s Bay, Bay of Plenty and Waikato regions in New Zealand (Figure 2). The analysis was conducted to understand how land-use planning documents covered earthquake hazards.

For context, Hawke’s Bay Region is highly exposed to the effects of subduction earthquakes from the Hikurangi Subduction Zone approximately 150 kilometres east offshore, as well as other local faults. The Bay of Plenty Region encompasses the Taupō Volcanic Zone and is an area of high earthquake hazard due to numerous faults caused by active crustal extension and volcanism (Stirling *et al.* 2000, 2012). The southern and eastern districts of the Waikato Region lie within the Taupō Volcanic Zone, however, the remainder of the region is considered less prone to earthquake hazard (Becker & Johnston 2002).

Table 1 lists the districts and regions whose policy statements or plans were examined in 2000 and again in 2016. As some district boundaries straddle more than one regional boundary (e.g. Taupō and Rotorua), the 2000 authors allocated these districts to a single region.

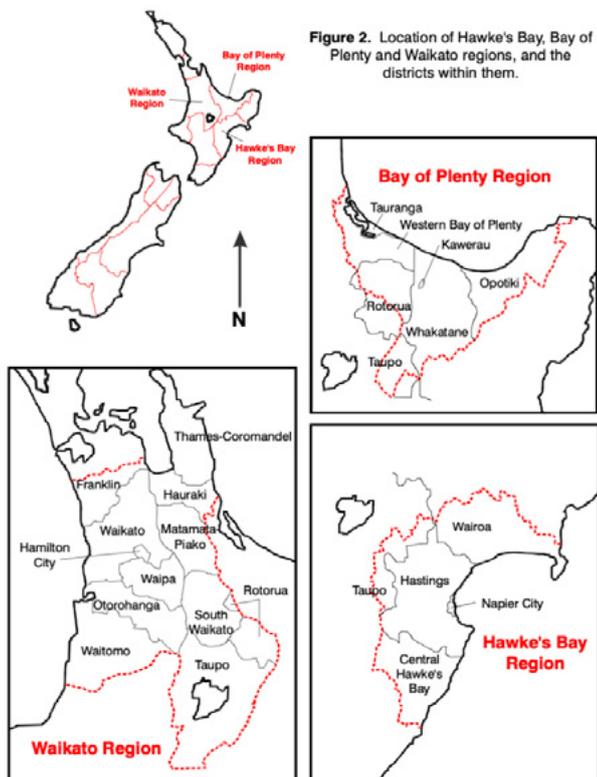


Figure 2. Location of Hawke's Bay, Bay of Plenty and Waikato regions, and the districts within them.

Figure 2: Location of Hawke’s Bay, Bay of Plenty and Waikato regions and districts.

Source: Becker & Johnston 2000

Table 1: List of regions and districts examined in 2000 and again in 2016.

Region	District
Hawke’s Bay Region	Napier City
	Hastings District
	Wairoa District
	Central Hawke’s Bay District
Bay of Plenty Region	Ōpōtiki District
	Tauranga District
	Western Bay of Plenty District
	Kawerau District
	Whakatāne District
	Rotorua District
Waikato Region	Ōtorohonga District
	South Waikato District
	Waikato District
	Franklin District*
	Waitomo District
	Hamilton City
	Thames-Coromandel District
	Hauraki District
	Waipa District
	Matamata-Piako District
Taupō District	

\* In 2010, the Franklin District was abolished and divided between the Auckland, Waikato and Hauraki councils. The Franklin District Plan continues to be administered by the Hauraki District Council. Including that plan there were 24 documents examined in 2016.

Due to the requirements of the RMA for land-use plans to be reviewed and updated at least every 10 years, all the District Plans and Regional Policy Statements examined in Becker and Johnston (2000) had been reviewed by the time the study was undertaken in 2016. The same set of 34 questions used to examine the original dataset in 2000 was applied to the revised planning documents in 2016 (Table 2). These questions were developed to reflect what was considered best-practice planning in the literature (see Becker & Johnston 2000, 2002). Questions sought to identify whether the planning documents included:

- hazard- and earthquake-focused definitions
- objectives
- policies
- methods (including rules)
- assessment criteria and performance standards
- reference to relevant building legislation
- limitations and use of emergent information
- earthquake-related environmental outcomes
- earthquakes on planning maps.

The 24 documents were reviewed and, for each question, were coded ‘yes’ or ‘no’ as an answer.

The 2016 data was triangulated with a secondary data source collected after the 2010–2012 Canterbury Earthquake Sequence by Saunders and Ruske (2014). This study involved an exhaustive examination of 99 regional policy statements, territorial authority plans and Civil Defence Emergency Management Group plans. Where the district and regional planning documents still represented the latest documents created by the authorities, their data were re-interrogated for the 2016 study using the same 34 questions.

The collection of the 2016 data, in combination with the data from Saunders and Ruske (2014), allowed a longitudinal comparison with the original 2000 study to determine whether earthquake hazard and risk reduction measures had been better integrated into land-use planning documents over time.

## Limitations

Limitations of the research include that the data collected were primarily quantitative and that nuances in what is written in plans are not reported here. Data related to the implementation of the *Sendai Framework for Disaster Risk Reduction 2015-2030* or the *National Disaster Resilience Strategy* were not collected as these documents had only just been finalised or not developed at the time of data collection.

## Results

Table 3 provides the quantitative results of the longitudinal comparative analysis. This has been arranged to reflect the original lines of questioning and to allow for comparisons between the original data and updated data.

Table 2: Questions used to analyse earthquake inclusion in local authority policy statements and plans in 2000 and 2016.

Part of the plan or policy statement	Document review questions
Inclusion of a natural hazards chapter/section	Does the plan/policy statement: <ul style="list-style-type: none"> <li>include a chapter/section about natural hazards?</li> </ul>
Hazard and earthquake definitions	Does the plan/policy statement: <ul style="list-style-type: none"> <li>have the definition of a hazard?</li> <li>list earthquakes as hazards?</li> <li>mention earthquakes as a hazard that could affect the district or region?</li> <li>locate the fault lines in the district or region?</li> <li>describe the earthquake hazard and its effects?</li> </ul>
Objectives	Does the plan/policy statement have: <ul style="list-style-type: none"> <li>objectives that are ‘all hazards’ based?</li> <li>specific objectives for earthquakes?</li> <li>specific objectives for other hazards?</li> </ul>
Policies	Does the plan/policy statement have: <ul style="list-style-type: none"> <li>policies that are ‘all hazard’?</li> <li>a specific policy or policies on earthquakes?</li> <li>specific policies for hazards other than earthquakes?</li> </ul>
Methods	Does the plan or policy statement have: <ul style="list-style-type: none"> <li>methods that are ‘all hazard’?</li> <li>methods that mention earthquakes specifically?</li> <li>methods that mention specific hazards but not earthquakes?</li> <li>‘all hazard’ rules?</li> <li>rules for earthquakes/fault lines?</li> <li>specific hazard rules but not for earthquakes/fault lines?</li> <li>monitoring that is ‘all hazard’?</li> <li>monitoring specifically for earthquakes?</li> <li>monitoring of specific hazards but not earthquakes?</li> <li>monitoring only covered elsewhere in plan and does not mention natural hazards?</li> </ul>
Assessment criteria	Does the plan/policy statement have: <ul style="list-style-type: none"> <li>general hazard assessment criteria?</li> <li>specific assessment criteria with regards to earthquakes?</li> </ul>

Performance standards for earthquakes	Are there any performance standards for earthquakes?
The <i>Building Act 1991</i> *	<ul style="list-style-type: none"> <li>Does the plan or policy statement refer to:</li> <li>The Building Act regarding earthquakes?</li> <li>The Building Act regarding hazards in general?</li> </ul>
Practicalities of planning for earthquakes	Does the plan or policy statement: <ul style="list-style-type: none"> <li>note the limitations/practicalities of planning for earthquakes?</li> <li>suggest that due to the nature of earthquakes, control is not possible through District Plan or Regional Policy Statement?</li> </ul>
Earthquake hazard information	Does the plan or policy statement: <ul style="list-style-type: none"> <li>recognise there is a need for the council to update the local seismic hazard information, or acknowledge there is a lack of information available to the district or region?</li> <li>account for new hazard information come to light?</li> </ul>
Environmental outcomes	Does the plan/policy statement have: <ul style="list-style-type: none"> <li>'all hazards' based environmental outcomes and results?</li> <li>hazard-specific environmental outcomes and results?</li> </ul>
Hazards on planning maps	Are local hazards included on planning maps?

\* When the Becker and Johnston (2000, 2002) study was conducted, the statute in force was the *Building Act 1991*, while the *Building Act 2004* was in place for the 2016 data collection. The *Building Act 1991* limits the construction of, or alterations to, buildings that might worsen certain natural hazards, similar to the 2004 Act version.

Table 3: Comparison of results from the original study (Becker & Johnston 2000) and new data collected in 2016.

Theme from content analysis	Results from Becker and Johnston (2000, pp.9–14)	Results from 2016 data collection plus Saunders and Ruske (2014)	Change in percentages of total*
Structure of the plan or policy statement	'Most (92%) have a "hazards section".'	83% have a section on natural hazards.	9% decrease
The prevalence and nature of hazard definitions	'Only 33% of plans and policy statements include a definition of the term "hazard".'	54% of plans and policy statements include a definition of a hazard.	21% increase
	'75% of councils note...that earthquakes are a hazard that could affect the district or region.'	88% of these documents listed earthquakes as a hazard.	13% increase
	'One quarter briefly identify the location of major earthquake hazards, while three-quarters of councils make no mention of the location of earthquake hazards in their region or district.'	A quarter identified the location of fault lines in the district or region.	0% change
	'29% also make some attempt to describe the nature of earthquakes and document their potential physical and/or social affects. 71% of councils do not.'	29% of plans and policy documents describe earthquake hazards and their effects.	0% change
Objectives	'83% of councils' plans or policy statements follow this [recommended 'all hazards'] approach.'	96% of plans and policy documents are 'all hazards' based.	13% increase
	'Only one council has an objective specifically tailored for earthquakes in its plan.'	Again, only one council had specific objectives for earthquakes.	0% change
Policies	'83% of policies in plans and policy statements can be described as 'all hazard'.'	96% of policies can be described as 'all hazard'.	13% increase
	'Earthquakes are mentioned specifically in three councils' policies [13%].'	Four policy documents (17%) have specific policies about earthquakes.	4% increase
Methods	'Methods in plans or policy statements are generally 'all hazards' based although some particular methods (for example, rules) mention earthquakes.'	Two-thirds of methods are 'all hazards' based.	33% decrease

Rules**	'Of the 21 district councils***, half have some rules in their plans that cover hazard issues in general.'	100% of District Plans have 'all hazards' rules.	50% increase
	'95% of those plans have some rules relating to specific hazards.'	100% have specific hazard rules, but not necessarily relating to earthquakes.	5% increase
	'Of the 95% that have rules for specific hazards, two councils [10%]...have some specific rules regarding earthquakes.'	29% have specific rules for earthquakes or fault lines.	19% increase
Monitoring	'Fourteen councils [58%] take an "all hazards" approach [to the use of monitoring as a method to mitigate against hazards].'	42% commit to monitoring that is 'all hazard'.	16% decrease
	'Earthquakes are specifically mentioned once regarding monitoring' [4%].	13% of monitoring statements mention earthquakes.	9% increase
Assessment criteria	'17% of councils have some assessment criteria for natural hazards. Four councils take an 'all hazards' approach to the assessment criteria in their plans.'	All 24 plans and policy statements (100%) include general hazard assessment criteria.	83% increase
	'Only one council (Taupō District Council) has any specific criteria regarding earthquakes.'	Three councils (13%) have specific assessment criteria regarding earthquakes.	9% increase
Performance standards	'With regards to earthquakes, two district councils mention performance standards.'	Three documents (13%) include performance standards for earthquakes.	4% increase
Legislation	'Three-quarters of regional and district councils make reference to the Building Act [1991] with regard to hazards in general.'	71% of plans and policy statements refer to the Building Act [2004] regarding general hazards.	4% decrease
	'One-third...also makes a direct connection between the Building Act [1991] and planning for earthquakes.'	17% specifically reference the Building Act [2004] in relation to earthquakes.	16% decrease
Limitations and use of emergent information	'29% of councils note...that because of the nature of earthquakes, limitations of planning for earthquakes exist.'	29% of the sample noted the limitations and practicalities of planning for earthquakes.	0% change
	'One council [4%] states...that, due to the nature of earthquakes ...avoidance or control is not realistically possible through the District Plan.'	Five councils (21%) stated that planning for earthquakes is not possible through District Plans or Regional Policy Statements.	17% increase
Earthquake hazard information	'46% of district and regional councils acknowledge that there is a gap in the seismic information held by council and/or scientists and make provision in their plans or policy statements to attempt to gain further data.'	50% of plans and policy statements recognise that there is a need for the council to update the local seismic hazard information, and acknowledge that there is a lack of local information available.	4% increase
	'75% of council plans and policy statements have methods to account for and incorporate any new information that arises.'	33% of the documents account for new hazard information coming to light.	42% decrease
Environmental outcomes	'75% [of] plans and policy statements have ['all hazards'] environmental outcomes.'	88% of the sample includes 'all hazards' based environmental outcomes.	13% increase
	'25% mention environmental outcomes related to specific hazards.'	50% have hazard-specific environmental outcomes.	25% increase
Planning maps	'A third of councils [33%] analysed included natural hazards on their planning maps.'	75% of the documents included local hazards on their planning maps.	42% increase

\* Rounded. Changes are in percentages of all documents. Generally, one council = one document out of 24 = 4.2%. Franklin District Council had been disestablished but its document bundle still existed, administered by Hauraki District Council.

\*\* Rules are only included in District Plans. Therefore percentages are based on 21 plans, not 24.

\*\*\* The term 'district council' in this table includes city councils.

While some improvements were seen, other aspects showed negative changes, or no change at all. Results of note include:

- the percentage of planning documents that identified areas subject to natural hazards on planning maps had risen by 42%; from roughly 33% to 75%
- the percentage of documents that recognise that earthquakes are a hazard that could affect the region or district had risen by 13%
- no change in the percentage of plans that identify the location of fault lines in the district or region; at 25%
- the percentage prevalence of ‘all hazard’ objectives, policies and (applicable for district/city councils only) rules, where ‘all hazard’ means there is no differentiation for earthquakes, had risen respectively by 13%, 13% and 50%
- no change in use of specific objectives for earthquakes (remaining at just one plan)
- the percentage use of earthquake-specific rules had risen by 19%
- the percentage of councils stating that planning for earthquakes is not possible through District Plans or Regional Policy Statements had risen by 17%
- the percentage of plans that specifically reference the Building Act in relation to managing earthquake risk had fallen by 16%
- the percentage of documents that have methods to account for and incorporate new hazard information had fallen by 42%.

## Discussion

From the results of the original study, Becker and Johnston (2002, p.7) concluded that:

*...while more hazard information and policies are incorporated into plans and policy statements than they were pre-Resource Management Act 1991, it appears that there is still not enough being done, with many councils undertaking the bare minimum to meet legislative requirements.*

Lyles, Berke and Smith (2014) similarly concluded in their analysis of 175 local mitigation plans in the United States that the reflexive framework of the *Disaster Mitigation Act 2000* (like the RMA) had meant that while local governments had met the requirement to adopt a plan, there was little evidence of going beyond the minimum national requirements in relation to the mitigation of natural hazards. Unfortunately, the results of this study reinforce these conclusions, showing only slight improvement over a long period beyond Becker and Johnston’s (2000) findings.

It was found that natural hazards, in general, are being better recognised and provided for in the 3 regions considered, with the percentage of plans that identified local hazards on planning maps rising by 42% and an increase was seen across ‘all hazards’ objectives, policies and rules. This approach helps to ensure that the actions taken (policies) to achieve the desired outcomes

(objectives) are consistent regardless of what natural hazard is being considered (Saunders, Beban & Coomer 2014). The largest increase was in ‘all hazards’ rules with a maximum-possible rise of 50 to 100%. This is significant because while objectives and policies describe the desired outcomes of a plan and how this outcome is to be achieved, without supporting rules to control development in hazard-prone areas councils have little or no power to ensure the outcomes occur (Saunders, Beban & Coomer 2014).

Saunders, Beban and Coomer (2014) highlight some of the potential limitations of an ‘all hazards’ approach, including that a council may have insufficient information on the risk a particular hazard presents (e.g. earthquake or tsunami) to fulfil the stated objective. The council may be less driven to seek information and, if the objective is poorly constructed and open to interpretation, it may prevent the council from implementing effective risk reduction measures for all relevant natural hazards. Saunders, Beban and Coomer (2014) also identify the advantage of hazard-specific objectives that are supported by hazard-specific policies and provide a strong policy direction for the consideration of the effects of that hazard. When supported by hazard-specific rules and assessment criteria, land-use planners have a strong foundation for decision-making, which will result in improved community resilience over time.

While the number of earthquake-specific objectives remained static, it was encouraging to see a rise of 4% of plans with earthquake-specific policies and a rise of 19% use of earthquake-specific rules, to a total of 29%. This result is broadly consistent with the finding of Saunders, Beban and Coomer (2014) that 38% of all District Plans across New Zealand had specific rules pertaining to active faults. While enforcement of these rules leads to increased resilience of communities, Saunders *et al.* (2014, p.28) observed that ‘given the tectonic environment of New Zealand, this suggests that there is a large under-representation of active fault rules within the District Plans’. Indeed, while there was a rise of 13% of plans that recognised earthquakes as a hazard, the number of councils identifying the location of fault lines remained static at 25%. This suggests that the issue is a lack of information held by councils of the location of active faults rather than a lack of faults present in a region. Indeed, 50% of plans and policies in 2016 recognised the need to include more information. This is despite the presence of an easily accessible national Active Faults Database (Langridge *et al.* 2016).

Surprisingly, the percentage of councils that specified procedures for the inclusion of new information into land-use plans had dropped by 42% to less than half of its former number. As suggested by Saunders and co-authors (2015), it may be that the broader procedure for updating plans and policy statements is provided in the RMA and does not need to be repeated in local land-use plans and councils are, for some reason, relying on this. However, the risk of not detailing a specific process (e.g. that new information will be made available on the council website and planning maps before council undertakes a plan change in accordance with the RMA) is that councils are not compelled to incorporate new hazard information outside of

the 10-yearly review. Thus, development in hazard-prone areas will continue (Saunders, Beban & Coomer 2014) and this will be difficult to undo later. As Glavovic, Saunders and Becker (2010, p.654) noted, there are a number of 'burning issues' which have needed addressing in land-use planning in New Zealand and the first of these was to 'improve understanding about the nature of hazards', a theme that is mirrored in *Sendai Framework for Disaster Risk Reduction 2015-2030*, Priority 1 (UNISDR 2015). However, while recent earthquake events have contributed to scientific understanding of earthquake hazards in New Zealand, Kilvington and Saunders (2016) found that availability of hazard information within local government is not sufficient alone to ensure its incorporation into council decision-making processes. Councils might hold new or updated information, but may wait to incorporate it into the next plan review cycle. In this context, the results are not so surprising.

As identified by Glavovic, Saunders and Becker (2010), another need is to prioritise risk avoidance (reduction) measures. Land-use planning is a key tool to reduce exposure and vulnerability to earthquakes by establishing fault avoidance zones, limiting critical infrastructure and facilities in locations adjacent to faults and ensuring other earthquake hazards such as liquefaction, tsunami and landslides are considered. However, there was a rise of 17% of land-use plans that stated that the avoidance or mitigation of earthquake hazards was not possible via District Plans or Regional Policy Statement provisions. This is despite the availability of earthquake-related guidance such as the Active Fault Guidelines that detail processes for doing so. This suggests that councils are doing the bare minimum to manage earthquake hazards. While it is difficult to know from this study why the bare minimum is being done, Saunders and Becker (2015) suggest it might be due to the general challenges faced by planners including access to reliable information, lack of resources, precedents of development in hazardous areas, pressure to prioritise development and difficulties in understanding how to address the risk.

Interestingly, the increase in plans stating that avoidance or mitigation of earthquake hazards was not possible, was not mirrored by a rise in the number of plans that referenced the role of the *Building Act 2004* in managing the effects of earthquake hazard, with this decreasing by 16%. Land-use plans prepared under the RMA sometimes take the approach of deferring management of earthquake hazards to the Building Act. Yet, as noted by Becker and Johnston (2002), relying solely on the Building Act and Building Code to avoid or mitigate earthquake hazards is inadvisable.

Given the number of large magnitude earthquakes that have occurred across New Zealand, it is surprising that land-use planning has not seen vast improvements. This is despite the response to the Canterbury earthquakes, where amendments to the RMA in 2017 elevated the management of significant risks from natural hazards to a matter of national importance. This means that when local government decision-makers are assessing whether the risk from natural hazards to a proposed development is significant or not, they are required to consider

not only the likelihood of a hazard event, but also the potential consequences.

Despite better legislative direction regarding the consideration of natural hazard risk, the cost of scientific investigations often limits local identification of faults and other earthquake hazards, meaning that information is not sufficient to determine that a significant risk is present. Consequently, there may be no basis under the RMA on which to decline local development proposals located on or near earthquake hazards. It is worth considering how to support scientific investigations of earthquake hazard and risk in regions and districts, so that the impetus is not always upon local authorities to fund these activities.

This research suggests that, under the RMA, land-use planning for earthquakes in New Zealand has not improved enough to ensure the resilience of communities to the risks posed by this hazard. Given the proposed NBA, opportunities exist for land-use planning for earthquakes. The Exposure Draft for the NBA bill seeks to retain a national focus on reducing significant risks from natural hazards and climate change, and has included provisions to ensure that such risks are addressed in national level planning frameworks, regional plans and spatial strategies. Greater national direction via the NBA could be beneficial to raising the profile of earthquake risk and providing impetus for implementing land-use planning provisions and improving resilience. Indeed, stronger and clearer national direction is required to prioritise the management of natural hazard risk generally. At a regional level, the proposed reduction in the number of plans to 14 could be helpful in providing consistency for land-use planning for earthquakes across regions.

An ultimate challenge remains in the application of the NBA. Results from this study highlight gaps in applying the current RMA mandate at regional and local levels in ways that reduce earthquake risk. For over 20 years, evidence shows that implementation of earthquake land-use planning initiatives via local planning documents has been patchy. It is evident that while voluntary guidance for planning for earthquakes is considered useful (e.g. faults, liquefaction), application of such guidance is also limited. Even with strong national direction, effort will be required to implement the NBA effectively within local government policy and planning documents to reduce earthquake risk. It is only through both national direction and local implementation that better land-use planning and improved community resilience can be achieved.

### Acknowledgments

This project was supported by QuakeCoRE, a New Zealand Tertiary Education Commission-funded Centre. This is QuakeCoRE publication number 0726.

## References

- Becker J & Johnston D 2000, *Planning and policy for earthquake hazards in New Zealand*. Institute of Geological and Nuclear Sciences Limited. *Science Report 2000/28*, pp.34.
- Becker J & Johnston D 2002, *Planning for earthquake hazards in New Zealand: a study of four regions*. *Australian Journal of Emergency Management*, vol. 17, no. 1, pp.2–8. At: <https://ajem.infoservices.com.au/items/AJEM-17-01-02>.
- Berke P & Godschalk D 2009, *Searching for the Good Plan: A Meta-Analysis of Plan Quality Studies*. *Journal of Planning Literature*, vol. 23, no. 3, pp.227–240. doi:10.1177/0885412208327014
- Berke P & Smith G 2009, *Hazard Mitigation, Planning and Disaster Resiliency: Challenges and Strategic Choices for the 21st Century*. In Urbano Fra (ed.) *Sustainable Development and Disaster Resiliency*. IOS Press, Amsterdam, pp.1–23.
- Berke P, Crawford J, Dixon J & Ericksen N 1999, *Do cooperative environmental planning mandates produce good plans? Empirical results from the New Zealand experience*. *Environment and Planning B: Planning and Design*, vol. 26, pp.643–664. doi:10.1068/b260643
- Branicki L, Steyer V & Sullivan-Taylor B 2016, *Why resilience managers aren't resilient, and what human resource management can do about it*. *International Journal of Human Resource Management*, vol. 30, no. 8, pp.1261–86. doi:10.1080/09585192.2016.1244104
- Brody S 2003, *Are We Learning to Make Better Plans?: A Longitudinal Analysis Of Plan Quality Associated with Natural Hazards*. *Journal of Planning Education and Research*, vol. 23, pp.191–201. doi:10.1177/0739456X03258635
- Burby RJ 1998, *Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities*. Joseph Henry Press: Washington, DC.
- Building Act 2004. At: [www.legislation.govt.nz/act/public/2004/0072/latest/DLM306036.html](http://www.legislation.govt.nz/act/public/2004/0072/latest/DLM306036.html) [12 April 2020].
- Civil Defence Emergency Management Act 2004. At: [www.legislation.govt.nz/act/public/2002/0033/51.0/DLM149789.html](http://www.legislation.govt.nz/act/public/2002/0033/51.0/DLM149789.html).
- Doyle EE, McClure J, Potter SH, Becker JS, Johnston DM, Lindell MK, Johal S, Fraser SA & Coomer MA 2018, *Motivations to prepare after the 2013 Cook Strait Earthquake, N.Z.* *International Journal Of Disaster Risk Reduction*, vol. 31, pp.637–649.
- Filippova O & Noy I 2020, *Earthquake strengthening policy for commercial buildings in small-town New Zealand*. *Disasters*, vol. 44, no. 1, pp.179–204. doi:10.1111/disa.12360
- Glavovic BC, Saunders WSA & Becker JS 2010, *Land-use planning for natural hazards in New Zealand: the setting, barriers, 'burning issues' and priority actions*. *Natural Hazards*, vol. 54, no. 3, pp.679–706.
- GNS Science (n.d.) *New Zealand earthquakes*. At: [www.gns.cri.nz/Home/Learning/Science-Topics/Earthquakes/New-Zealand-Earthquakes](http://www.gns.cri.nz/Home/Learning/Science-Topics/Earthquakes/New-Zealand-Earthquakes) [12 April 2020].
- Jang L-J, Wang J-J, Paton D & Tsai N-Y 2016, *Cross-cultural comparisons between the earthquake preparedness models of Taiwan and New Zealand*. *Disasters*, vol. 40, no. 2, pp.327–345. doi:10.1111/disa.12144
- Kerr J, Nathan S, Van Dissen RJ, Webb P, Brunson D & King A 2003, *Planning for development of land on or close to active faults: A guideline to assist resource management planners in New Zealand*. Ministry for the Environment, Wellington, New Zealand. At: <https://environment.govt.nz/publications/planning-for-development-of-land-on-or-close-to-active-faults-a-guideline-to-assist-resource-management-planners-in-new-zealand/>.
- Kilvington M & Saunders WSA 2016, *The role of science in land use planning: exploring the challenges and opportunities to improve practice*. *GNS Science Report*. 2016/057, p.53. At: [https://isref.co.nz/Docs/GNS\\_SR\\_2016\\_057\\_Role\\_of\\_science%20in\\_landuse\\_planning.pdf](https://isref.co.nz/Docs/GNS_SR_2016_057_Role_of_science%20in_landuse_planning.pdf).
- Langridge RM, Ries WF, Litchfield NJ, Villamor P, Van Dissen RJ, Barrell DJA, Rattenbury MS, Heron DW, Haubrock S, Townsend DB, Lee JM, Berryman KR, Nicol A, Cox SC & Stirling MW 2016, *The New Zealand active faults database*. *New Zealand Journal of Geology and Geophysics*, vol. 59, no. 1, pp.86–96. doi:10.1080/00288306.2015.1112818
- Lyles W, Berke P & Smith G 2014, *A comparison of local hazard mitigation plan quality in six states, USA*. *Landscape and Urban Planning*, vol. 122, pp.89–99. doi:10.1016/j.landurbplan.2013.11.010
- Ministry of Business, Innovation and Employment 2017, *Planning and engineering guidance for potentially liquefaction-prone land*. At: [www.building.govt.nz/building-code-compliance/b-stability/b1-structure/planning-engineering-liquefaction-land](http://www.building.govt.nz/building-code-compliance/b-stability/b1-structure/planning-engineering-liquefaction-land) [22 December 2021].
- Ministry of Civil Defence and Emergency Management 2019, *National Disaster Resilience Strategy Rautaki ā-Motu Manawaroa Aituā*. At: [www.civildefence.govt.nz/assets/Uploads/publications/National-Disaster-Resilience-Strategy/National-Disaster-Resilience-Strategy-10-April-2019.pdf](http://www.civildefence.govt.nz/assets/Uploads/publications/National-Disaster-Resilience-Strategy/National-Disaster-Resilience-Strategy-10-April-2019.pdf).
- Natural and Built Environments Bill 2021, (*Exposure Draft*). At: <https://environment.govt.nz/assets/publications/Natural-and-Built-Environments-Bill-Exposure-Draft.pdf> [22 December 2021].
- Orchiston C, Mitchell J, Wilson T, Langridge R, Davies T, Bradley B, Johnston D, Davies A, Becker J & McKay A 2018, *Project AF8: developing a coordinated, multi-agency response plan for a future great Alpine Fault earthquake*. *New Zealand Journal of Geology and Geophysics*, vol. 1, no. 3, pp.389–402. doi:10.1080/00288306.2018.1455716
- Power WL (compiler) 2013, *Review of Tsunami Hazard in New Zealand (2013 Update)*. *GNS Science Consultancy Report*. 2013/131, p.222. At: [www.wremo.nz/assets/Publications/Review-NZ-Tsunami-Hazard-2013.pdf](http://www.wremo.nz/assets/Publications/Review-NZ-Tsunami-Hazard-2013.pdf).
- Potter SH, Becker JS, Johnston DM & Rossiter KP 2015, *An overview of the impacts of the 2010–2011 Canterbury earthquakes*. *International Journal of Disaster Risk Reduction*, vol. 14, pp.6–14. doi:10.1016/j.ijdr.2015.01.014

Quality Planning 2017, *Natural Hazards*. At: [www.qualityplanning.org.nz/node/807](http://www.qualityplanning.org.nz/node/807) [22 December 2021].

Resource Management Act 1991. At: [www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html](http://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html) [12 April 2020].

Resource Management Review Panel 2020, *New Directions for Resource Management in New Zealand. Report of the Resource Management Review Panel, June 2020*. At: <https://environment.govt.nz/assets/Publications/Files/rm-panel-review-report-web.pdf> [22 December 2021].

Saunders WSA, Beban JG & Coomer MA 2014, *Analysis of natural hazards provisions in regional policy statements, territorial authority plans, and CDEM Group Plans*. *GNS Science Report*. 2014/28, p.72.

Saunders W & Becker JS 2015, *A discussion of resilience and sustainability: Land use planning recovery from the Canterbury earthquake sequence, New Zealand*. *International Journal of Disaster Risk Reduction*, vol. 14, no. 1, pp.73–81. doi:10.1016/j.ijdrr.2015.01.013

Saunders W & Glassey P (compilers) 2007, *Guidelines for assessing planning, policy and consent requirements for landslide prone land*. *GNS Science Miscellaneous Series*, vol. 7, p.71.

Saunders W, Forsyth J, Johnston D & Becker J 2007, *Strengthening linkages between land-use planning and emergency management in New Zealand*. *Australian Journal of Emergency Management*, vol. 22, no. 1, pp.36–43. At: <https://ajem.infoservices.com.au/items/AJEM-22-01-06>.

Saunders W, Grace E, Beban J & Johnston D 2015, *Evaluating Land Use and Emergency Management Plans for Natural Hazards as a Function of Good Governance: A case study from New Zealand*. *International Journal of Disaster Risk Science*, vol. 6, no. 1, pp.62–74.

Saunders WSA, Kelly S, Paisley S & Clarke L 2020, *Progress toward implementing the Sendai Framework, the Paris Agreement, and the Sustainable Development Goals: Policy from Aotearoa New Zealand*. *International Journal of Disaster Risk Science*, vol. 11, pp.190–205.

Saunders WSA & Ruske M 2014, *Tabulated results from review of natural hazards provisions in regional policy statements, territorial plans, and CDEM group plans*. *GNS Science Report*, 2014/04, p.92.

Stevenson JR, Becker J, Cradock-Henry N, Johal S, Johnston D, Orchiston C & Seville E 2017, *Economic and social reconnaissance*. *Bulletin of the New Zealand Society for Earthquake Engineering*, vol. 50, no. 2, pp.343–351.

Stirling M, McVerry G, Berryman K, McGinty P, Villamor P, Van Dissen R, Dowrick D, Cousins J & Sutherland R 2000, *Probabilistic Seismic Hazard Assessment of New Zealand: New active fault data, seismicity data, attenuation relationships and methods*. Prepared for the Earthquake Commission. Lower Hutt (NZ): Institute of Geological and Nuclear Sciences, Client Report 2000/53.

Stirling M, McVerry G, Gerstenberger M, Litchfield N, Van Dissen R, Berryman K, Barnes P, Wallace L, Villamor P, Langridge R & Lamarche G 2012, *National seismic hazard model for New Zealand: 2010 Update*. *Bulletin of the Seismological Society of America*, vol. 102, no. 4, pp.1514–1542. doi:10.1785/0120110170

UNISDR (United Nations Office for Disaster Risk Reduction) 2015, *Sendai Framework for Disaster Risk Reduction 2015-2030*. At: [www.unisdr.org/files/43291\\_sendaiframeworkfordrren.pdf](http://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf) [12 April 2020].

### About the authors

**Dr Bridgette Sullivan-Taylor** worked at The University of Auckland while undertaking this research and has expertise in managing uncertainty and developing organisational resilience.

**Sarah Gunnell** is a planner at Urban Edge Planning with experience in environmental and hazard planning.

**Julia Becker** is an associate professor at the Joint Centre for Disaster Research at Massey University. Her research is in areas of societal aspects of disasters including community resilience, preparedness, warnings and land-use planning.

**Professor David Johnston** is Director of the Joint Centre for Disaster Management at Massey University and has a long research career in readiness, response to and recovery from the societal effects of disasters.

## Abstract

Measuring disaster preparedness has been a challenge as there is no consensus on a standardised approach to evaluation. This lack of clear definitions and performance metrics makes it difficult to determine whether past investments in preparedness have made sense or to see what is missing. This scoping review presents publications addressing the evaluation of disaster preparedness at the governmental level. A literature search was performed to identify relevant journal articles from 5 major scientific databases (Scopus, MEDLINE, PsycInfo, Business Source Premier and SocINDEX). Studies meeting the inclusion criteria were analysed. The review considered the multi-disciplinarity of disaster management and offers a broad overview of the concepts for preparedness evaluation offered in the literature. The results reveal a focus on all-hazards approach as well as local authority level in preparedness evaluation. Variation in the types of instruments used to measure preparedness and the diversity of questions and topics covered in the publications suggest little consensus on what constitutes preparedness and how it should be measured. Many assessment instruments seem to lack use in the field, which limits feedback on them from experts and practitioners. In addition, tools that are easy to use and ready for use by practitioners seem scarce.

# Instruments for disaster preparedness evaluation: a scoping review

Peer reviewed

**Dr Nina Lorenzoni, MA<sup>1</sup>**  
**Dr Stephanie Kainrath<sup>1</sup>**  
**Dr Maria Unterholzner<sup>2</sup>**  
**Professor Harald Stummer<sup>1</sup>**

1. UMIT TIROL, Tirol, Austria.
2. District Hospital Reutte, Reutte, Austria

**SUBMITTED**  
30 November 2021

**ACCEPTED**  
16 April 2022

**DOI**  
[www.doi.org/10.47389/37.3.56](https://www.doi.org/10.47389/37.3.56)



© 2022 by the authors.  
 License Australian Institute for Disaster Resilience, Melbourne, Australia. This is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## Introduction

In March 2015, 187 United Nations member states ratified the *Sendai Framework for Disaster Risk Reduction 2018-2030* (UNISDR 2015) that formulated future needs and priorities for disaster risk management around the world. Priority 4, ‘Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction’ states the importance of the ‘[...] further development and dissemination of instruments, such as standards, codes, operational guides and other guidance instruments, to support coordinated action in disaster preparedness [...]’ (UNISDR 2015, p.22).

Although preparedness is considered to be of high priority and importance, there is no universal guide or definition on disaster preparedness (e.g. what it comprises or how to achieve preparedness) (McEntire & Myers 2004, McConnell & Drennan 2006, Staupe-Delgado & Kruke 2017). A commonly used definition by the United Nations explains preparedness as:

*The knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters.* (UNISDR 2016, p.21).

However, standards for disaster preparedness are scarce and this lack of guidance makes collecting data about and assessing preparedness difficult. This is shown in the UNISDR definition that there are different units of analysis for preparedness.

Despite attempts to develop preparedness measures, there remains a lack of consensus and, consequently, a research gap about how preparedness evaluation should be done (Savoia *et al.* 2017, Khan *et al.* 2019, Belfroid *et al.* 2020, Haeberer *et al.* 2020). In 2005, Asch and co-authors (2005) concluded that existing tools lacked objectivity and scientific evidence, an issue that persists. Objective evaluation would allow for intersubjective comparability of preparedness. Savoia and co-authors (2017) analysed data on research in public health emergency preparedness in the USA between 2009 and 2015. Although there was a development of research towards empirical studies during that period, some research gaps remained, such as development of criteria and metrics

to measure preparedness. Qari and co-authors (2019) reviewed studies conducted by the Preparedness and Emergency Response Research Centers in the USA between 2008 and 2015 that addressed criteria for measuring preparedness. They concluded that a clear standard was still lacking and guidance for the research community in developing measures would be needed. Haeberer and co-authors (2020) evaluated the characteristics and utility of existing preparedness assessment instruments. They found 12 tools, 7 of them developed by international authorities or organisations and a further 5 developed by countries (1 x England, 1 x New Zealand and 3 x USA). In their study, Haeberer and co-authors (2010) identified a lack of validity and user-friendliness. Thus, the literature shows that it remains critical to establish commonly agreed and validated methods of evaluation that help to define preparedness, identify potential for improvement and set benchmarks for comparing future efforts (Henstra 2010, Nelson, Lurie & Wasserman 2010, Davis *et al.* 2013, Wong *et al.* 2017).

Due to the relative rarity of disasters, it is unclear whether emergency plans and procedures are appropriate, whether equipment is functional and whether emergency personnel are adequately trained and able to undertake their duties (Shelton *et al.* 2013, Abir *et al.* 2017, Obaid *et al.* 2017, Qari *et al.* 2019). At the same time, a false sense of security due to unevaluated disaster preparedness strategies could lead to greater consequences from disasters (Gebbie *et al.* 2006). Ignorance about the status and quality of disaster preparedness impedes necessary precautionary measures and can cost lives. Moreover, the lack of proper evaluation poses a risk that mistakes of the past are not analysed, adaptations in procedures are not made and mistakes might be repeated (Abir *et al.* 2017). As Wong and co-authors (2017) stressed there is 'a moral imperative' to improve methods of assessing preparedness and raise levels of preparedness to diminish preventable.

The *Sendai Framework for Disaster Risk Reduction 2015-2030* underlines the social responsibility of academia and research entities to develop tools for practical application to help lessen the consequences of disasters (UNISDR 2015; Reifels *et al.* 2018). In addition, the Sendai Framework highlighted the important role of local governments in disaster risk reduction. Their understanding of local circumstances and the affected communities gives them valuable insights and the best chance of implementing measures (Beccari 2020). This scoping study offers emergency and disaster planners as well as researchers an overview of existing concepts and tools in the literature for preparedness evaluation at the government level. For planners, thorough evaluation of preparedness contributes to improved outcomes for people and reduced deaths, reduces costs for response and recovery and helps with future investment decisions (FEMA 2013). Evaluation can serve as performance records as well as provide an argumentation basis in negotiations for further (financial) resources. For researchers, this scoping review helps to compile evaluation concepts and identify conceptual gaps.

## Method

This study used a scoping-review approach as this method allowed an examination of a wide range of literature to identify

key concepts and recognise gaps in the current knowledge (Arksey & O'Malley 2005). Scoping reviews generally aim to map existing literature regardless of the study design reported and without any critical appraisal of the quality of the studies (Peters *et al.* 2015).

For the review process, a 5-stage framework was followed to conducting scoping reviews as presented by Arksey and O'Malley (2005). The research was guided by a broad question: 'What is known in scientific literature about the evaluation of disaster preparedness on the governmental level?' Other questions were: 'Which tools or concepts are available for evaluating disaster preparedness?' and 'Have these tools been tested in the field or used in disaster management?' A scoping review method, which does not exclude any particular methods or assess study quality, was chosen because it provides as broad an overview of the existing tools and concepts as possible. The term 'concept' here means theoretical work that describes what preparedness evaluation should look like and what it encompasses, whereas 'tools' refers to actual ready-to-use instruments.

The search was conducted in 5 academic databases (Scopus, MEDLINE, APA PsycInfo, Business Source Premier and SocINDEX) covering public health, disaster management and social sciences. Searches were conducted in December 2018 with an update conducted in May 2021. The databases were selected as they are multi-disciplinary and encompass a wide range of research fields. In an initial step to gain an understanding of the material and terminology, various quick-scan searches were conducted in the databases as well as academic journals addressing disaster management and public health preparedness. This was followed by searches within the fields of 'Title', 'Abstract' and 'Keywords' as adapted to the specific requirements of each database using the following search terms: 'disaster preparedness' OR 'emergency preparedness' OR 'crisis preparedness' AND 'assess\*' OR 'evaluat\*' OR 'measur\*' OR 'indicat\*' AND NOT 'hospital'.

The terms 'disaster', 'crisis' and 'emergency' are often used synonymously in the literature (Gillespie & Streeter 1987, Sutton & Tierney 2006, Hemond & Benoit 2012, Staupe-Delgado & Kruke 2018, Monte *et al.* 2020), thus these terms were used in all the searches. Additionally, a search of Google Scholar including the first 100 records was conducted. The reference lists of the examined full papers were searched manually to identify additional, relevant published works not retrieved via the databases search. The literature sample was restricted to articles published between 1999 and 2021 in either English or German languages. Some relevant articles may have been excluded from this review due to these selection factors. All citations were imported into Endnote and duplicates were removed.

At the first stage of screening, the title and abstract of each published work were reviewed against eligibility criteria. Reasons for exclusion were:

- The study did not address disaster preparedness on the governmental level but lower levels like hospital or individual and household preparedness.
- The study only discussed disaster preparedness in general, not the assessment, measurement or evaluation of preparedness.

- The study addressed only exercise or emergency drill evaluation.
- The study addressed only communicable disease outbreaks (e.g. influenza pandemics, Ebola or H1N1).
- The study addressed corporate or economic crises.
- The study was not a full text but only an editorial or conference abstract.

Only papers that were clearly irrelevant for the study’s purpose were removed at the stage of screening titles and abstracts. The papers determined eligible for full-text review were checked by 2 researchers independently. The research team met throughout the screening process to discuss uncertainties regarding the inclusion and exclusion of works from the sample.

## Results

The database search returned 4,924 references. Removal of duplicates lead to a total of 3,955. Of these, 29 were added from the Google Scholar search and from a snowballing analysis of the reference lists of the included works. Screening abstracts led to the exclusion of 3,724 records. Of the remaining 271 full-text works that were assessed for eligibility, 29 met all inclusion criteria for analysis, although 8 works were not available in full text. The search methodology is illustrated in Figure 1 and the analysis of the 29 integrated studies is detailed in Table 1.

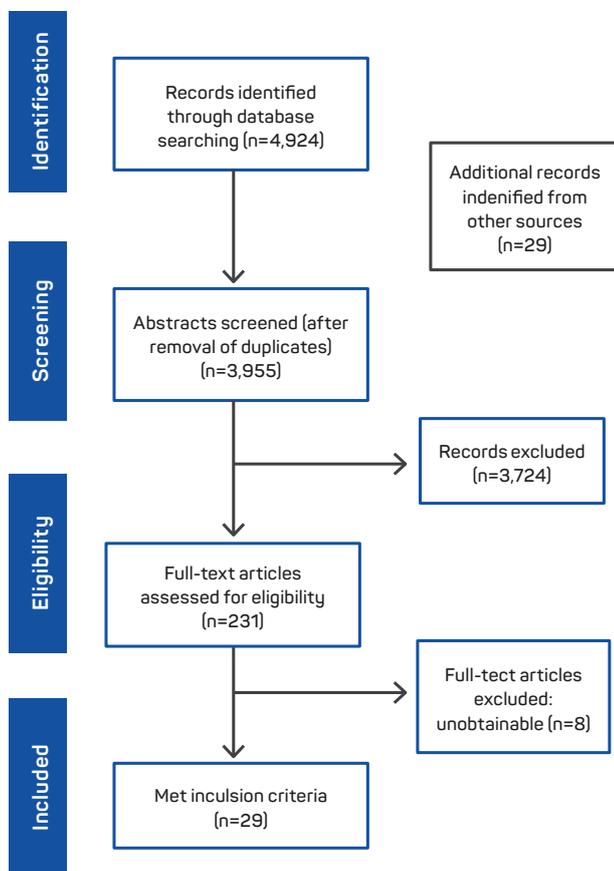


Figure 1: The research methodology taken for this study.

## Geographic distribution

The geographic distribution of the sample shows that the majority (n=15) of articles focused on preparedness evaluation in the USA. Two studies were from the Philippines and one each dealt with preparedness evaluation in European countries, Mexico, Canada, Indonesia, China, Saudi Arabia and Brazil. Two studies conducted case studies in Italy and France as well as Chile and Ecuador. Three conceptual works that addressed theoretical frameworks instead of instruments (Henstra 2010, Diirr & Borges 2013, Alexander 2015) did not specify a country in their descriptions.

Figure 2 graphs the number of papers in the sample by year of publication.

## Hazard type

The majority (n=14) of the studies took an all-hazards approach and 2 studies chose natural hazards as the research scope. One study for each hazard type was selected for radiation, bioterrorism, meteorological disasters and flood. One study addressed flood, typhoon and earthquake. Eight studies did not specify a hazard type.

## Level of analysis

Fourteen studies chose the local authority level for evaluation. Seven studies were at a state level and 2 were at the regional level. Three studies covered more than one level. Three studies did not specify a level of analysis.

## Study design

In 23 works, the studies followed a quantitative approach and 12 included case studies based on the use of their assessment tools. Five studies are conceptual and offered theoretical frameworks, which could be used as a basis for setting up evaluation of disaster preparedness. One study used a qualitative approach by applying document review in combination with in-depth interviews.

## Categories of evaluation

An analysis of the topics in the studies revealed a wide variety of categories and categorisation schemes. For the following description, terms that were most commonly used within the studies as keywords were chosen. For reasons of clarity and comparability, only the main categories of the instruments were analysed and subcategories were not part of the review.

Some categories emerged in the sample only once or twice, either because the instruments were designed to analyse a particular topic or because the analyses were so superficial and generic that the categories were mentioned only once. Categories that occurred less than 3 times in the studies are not listed. Agboola and co-authors (2015) use 160 general tasks in their measurement tool, however, a description of topics covered was not stated.

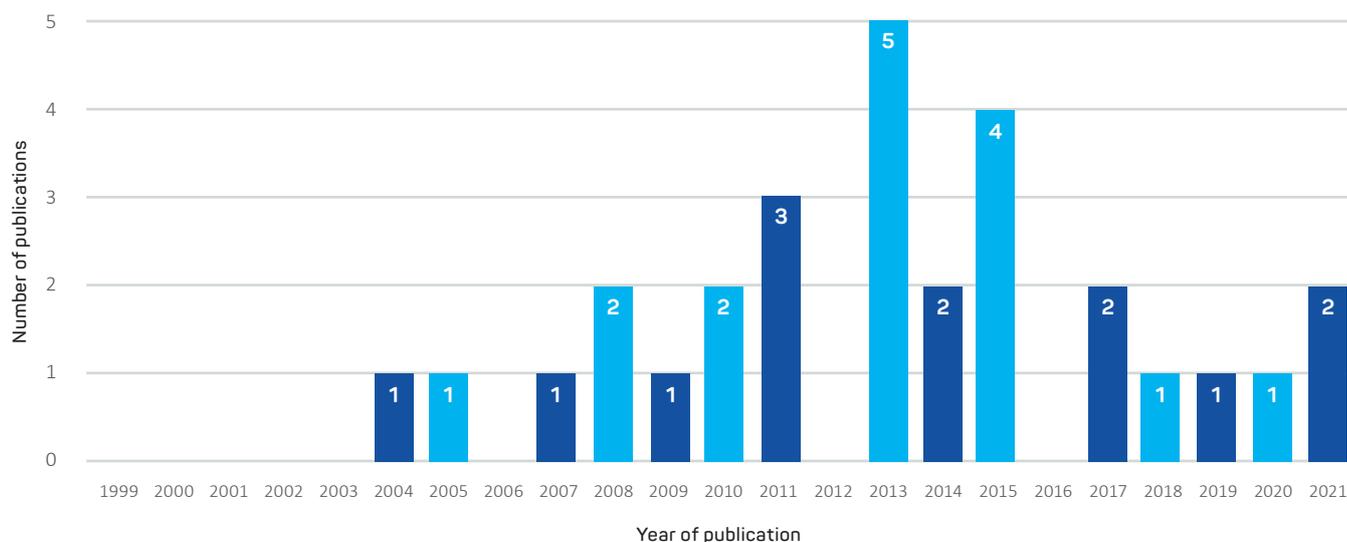


Figure 2: Publications by year of publication.

Table 1: Main categories of evaluation.

Category	n	Authors
Communication and information dissemination	14	(Somers 2007; Jones <i>et al.</i> 2008; Shoemaker <i>et al.</i> 2011; Shelton <i>et al.</i> 2013; Davis <i>et al.</i> 2013; Dalnoki-Veress, McKallagat & Klebesadal 2014; Djalali <i>et al.</i> 2014; Alexander 2015; Schoch-Spana, Selck & Goldberg 2015; Connelly, Lambert & Thekdi 2016; Murthy <i>et al.</i> 2017; Juanzon & Oreta 2018; Amin <i>et al.</i> 2019; Khan <i>et al.</i> 2019)
Plans and protocols (some including testing and adaptation of plans**)	14	(Mann, MacKenzie & Anderson 2004; Alexander 2005, 2015; Somers 2007; Simpson 2008; Henstra 2010; Watkins <i>et al.</i> 2011; Davis <i>et al.</i> 2013; Dalnoki-Veress, McKallagat & Klebesadal 2014; Connelly, Lambert & Thekdi 2016; Juanzon & Oreta 2018; Khan <i>et al.</i> 2019; Dariagan, Atando & Asis 2021; Greiving <i>et al.</i> 2021)
Staff/personnel/workforce (including volunteers*)	11	(Somers 2007; Jones <i>et al.</i> 2008; Porse 2009; Henstra 2010; Watkins <i>et al.</i> 2011; Davis <i>et al.</i> 2013; Dalnoki-Veress, McKallagat & Klebesadal 2014; Schoch-Spana, Selck & Goldberg 2015; Juanzon & Oreta 2018; Amin <i>et al.</i> 2019; Khan <i>et al.</i> 2019)
Training and exercises	9	(Mann, MacKenzie & Anderson 2004; Henstra 2010; Davis <i>et al.</i> 2013; Dalnoki-Veress, McKallagat & Klebesadal 2014; Djalali <i>et al.</i> 2014; Alexander 2015; Juanzon & Oreta 2018; Amin <i>et al.</i> 2019; Khan <i>et al.</i> 2019)
Legal and policy determinants	9	(Alexander 2005; Henstra 2010; Shoemaker <i>et al.</i> 2011; Davis <i>et al.</i> 2013; Potter <i>et al.</i> 2013; Djalali <i>et al.</i> 2014; Khan <i>et al.</i> 2019; Handayani <i>et al.</i> 2020; Dariagan, Atando & Asis 2021)
Cooperation and mutual aid agreements	8	(Henstra 2010; Watkins <i>et al.</i> 2011; Dalnoki-Veress, McKallagat & Klebesadal 2014; Schoch-Spana, Selck & Goldberg 2015; Connelly, Lambert & Thekdi 2016; Amin <i>et al.</i> 2019; Khan <i>et al.</i> 2019; Handayani <i>et al.</i> 2020)
Supplies and equipment	8	(Alexander 2005, 2015; Jones <i>et al.</i> 2008; Dalnoki-Veress <i>et al.</i> 2014; Djalali <i>et al.</i> 2014; Juanzon & Oreta 2018; Khan <i>et al.</i> 2019; Dariagan, Atando & Asis 2021)
Risk assessment	7	(Alexander 2005; Henstra 2010; Dalnoki-Veress <i>et al.</i> 2014; Murthy <i>et al.</i> 2017; Amin <i>et al.</i> 2019; Khan <i>et al.</i> 2019; Handayani <i>et al.</i> 2020)
Financial resources	6	(Potter <i>et al.</i> 2013; Dalnoki-Veress, McKallagat & Klebesadal 2014; Connelly, Lambert & Thekdi 2016; Juanzon & Oreta 2018; Khan <i>et al.</i> 2019; Handayani <i>et al.</i> 2020)
Evacuation and shelter	6	(Jones <i>et al.</i> 2008; Simpson 2008; Alexander 2015; Connelly, Lambert & Thekdi 2016; Greiving <i>et al.</i> 2021)
Early warning	6	(Simpson 2008; Djalali <i>et al.</i> 2014; Alexander 2015; Juanzon & Oreta 2018; Khan <i>et al.</i> 2019; Greiving <i>et al.</i> 2021)
Post-disaster recovery	5	(Alexander 2005, 2015; Somers 2007; Cao, Xiao & Zhao 2011; Handayani <i>et al.</i> 2020)
Community engagement	4	(Simpson 2008; Murthy <i>et al.</i> 2017; Juanzon & Oreta 2018; Khan <i>et al.</i> 2019)

\* (Davis *et al.* 2013, Schoch-Spana, Selck & Goldberg 2015)

\*\* (Alexander 2005, Henstra 2010, Connelly, Lambert & Thekdi 2016)

## Instruments

The majority of studies (n=16) developed a questionnaire or checklist to evaluate preparedness. Some instruments also included weighting of different indicators as well as offered a total preparedness score. The scope and number of items in the questionnaires and checklists varied widely.

Four studies provided theoretical concepts about how to measure preparedness. Alexander (2005) set up 18 criteria to formulate a standard for assessing preparedness. He suggested using them to evaluate existing plans or as guidelines when developing new ones. Diirr & Borges (2013) offered a concept for workshops in which emergency plans are evaluated. Potter and co-authors (2013) presented a framework of the needs and challenges of a preparedness evaluation tool. Khan and co-authors (2019) set up 67 evaluation indicators for local public health agencies, based on an extensive literature review and a 3-round Delphi-Process in which 33 experts participated.

Six instruments using metrics appeared in works in the sample. Cao, Xiao & Zhao (2011) used entropy-weighting to improve the TOPSIS method. A measurement tool based on the Analytical Hierarchy Process Technique was developed in each of 3 studies by Manca & Brambilla (2011), Dalnoki-Veress, McKallagat & Klebesadal (2014) and Handayani and co-authors (2020). Connelly, Lambert & Thekdi (2016) used multiple criteria and scenario analysis in their study. Porse (2009) used statistical analysis to identify significant correlations among the preparedness indicators in health districts and their demography, geography and critical infrastructure.

Three studies used other approaches. Nachtmann & Pohl (2013) developed a scorecard-based evaluation supported by a software-application. Amin and co-authors (2019) developed a fuzzy-expert-system-based framework with a corresponding software tool. Greiving and co-authors (2021) developed a guiding framework for performing preparedness evaluation through a qualitative approach using policy documents and in-depth expert interviews.

## Basis of the instrument

For 5 studies, literature reviews were conducted to form a knowledge base to develop the instrument. In 6 other works, expert opinions and the experiential knowledge of the authors were stated as a basis for the instruments developed. Eleven instruments were based on existing models and techniques. A literature review in combination with expert consultation was used for 7 studies.

## Field testing

Twenty-two studies included some sort of testing of the developed instruments.

Eleven studies included case studies. Alexander (2015) evaluated a civil protection program in a Mexican town. Nachtmann & Pohl (2013) evaluated 3 country-level emergency operations plans using their method. Cao, Xiao & Zhao (2011) calculated the level of meteorological emergency management capability of 31

provinces in China. Manca and Brambilla (2011) conducted a case study of an international road tunnel accident. Connelly, Lambert and Thekdi (2016) applied their method for the city of Rio de Janeiro in Brazil and possible threats around FIFA World Cup and Olympic Games held there. Juanzon and Oreta (2018) used their tool to assess the preparedness of the City of Santa Rosa. Simpson (2008) applied his methodology in 2 communities. Porse (2009) performed a statistical analysis of data collected in 35 health districts in Virginia, USA, to identify significant correlations among preparedness factor categories. Amin and co-authors (2019) analysed the flood management in Saudi Arabia. Dariagan, Atando and Asis (2021) assessed the preparedness for natural hazards of 92 profiled municipalities in central Philippines. Greiving and co-authors (2021) conducted case studies by analysing policy documents and conducting in-depth interviews with experts to evaluate the preparedness of Chile and Ecuador.

Eleven studies developed questionnaires, which were sent to (public) health agencies and departments. The sample size of respondents in the studies varied widely. The remaining 7 studies did not provide information about whether the instruments were tested.

## Expert and stakeholder feedback

Nine studies reported obtaining some kind of feedback from experts or stakeholders. The various feedback methods described were expert interviews conducted (Agboola *et al.* 2015), expert interviews plus a questionnaire (Amin *et al.* 2019), informal discussions (Jones *et al.* 2008, Davis *et al.* 2013, Diirr & Borges 2013, Shelton *et al.* 2013), consultation with professionals who were likely to use the tool at key milestones (Khan *et al.* 2019), pilot testing and incorporating feedback into final version (Watkins *et al.* 2011) and meetings and validation sessions (Manca & Brambilla 2011). Twenty studies did not state whether feedback from experts or stakeholders was obtained.

## Discussion

This review identified that a wide variety of tools for government disaster preparedness evaluation is evident in the literature. However, there is no clear or standardised approach and no consensus about what preparedness encompasses and what elements need to be present in a preparedness evaluation tool. The research is far from the goal of a simple and valid tool that is ready for use for emergency and disaster managers. The lack of dissemination in practice of most of the tools identified in the review suggests that there has been little to no involvement of disaster managers in the development process.

This study revealed an array of concepts and tools to measure and evaluate disaster preparedness at the government level. The wide range of assessment categories and topics covered demonstrates a lack of consistent terminology used in the methods sections, as noted by Wong and co-authors (2017). Many of the works in the sample focused on narrow contexts or special subject areas (e.g. legal aspects, logistics or emergency plans). Concepts for evaluating preparedness and all its components remain scarce, probably due to the

great complexity and consequent scope that such tools would require. Whether it is possible to develop a single one-size-fits-all tool is questionable. Cox & Hamlen (2015) argue for several individual indices as this might give meaningful insights than one aggregated index, while also offering flexibility. A major challenge in developing a comprehensive instrument is balancing between generalisability and flexibility. According to Alexander (2015), local circumstances including 'different legal frameworks, administrative cultures, wealth levels, local hazards, risk contexts and other variations' have to be considered when establishing evaluation criteria (Alexander 2015, p.266, Das 2018). Therefore, developing a modular system consisting of fixed, must-have criteria as well as optional criteria is recommended. That approach would provide minimum standards and comparability as well as support individualisation by adding variables depending on the circumstances of the system to be evaluated. At the same time, a degree of simplicity is necessary in order to ensure an instrument's widespread use.

Most of the included studies were conducted in the USA and the issue of generalisability comes into play. As disaster preparedness is a topic of relevance to any community or state, an overview of existing concepts and tools, regardless of their geographic background, is valuable. By adapting concepts of socio-cultural and legal circumstances, a preparedness evaluation concept from other countries can help improve the preparedness of another system.

Many concepts offer numerical scores for sub-areas as well as overall scores to support comparability of instruments, reveal potential for improvement and help users to assess disaster preparedness. However, the question arises whether one or a few numbers can represent the whole construct of preparedness. It is important to consider whether all factors should be considered equally or whether a weighting of components in the evaluation is necessary (Davis *et al.* 2013).

Another potential problem in evaluating preparedness with numeric scores is the risk of simplification. Having only a few scores and values may be helpful to form an overview of the status quo and they can be a useful instrument in discussions with policy makers or for acquiring financial resources. However, can the whole complex construct of preparedness be measured properly with only one or a few numbers? Important details could be neglected (Porse 2009, Davis *et al.* 2013, Khan *et al.* 2019). Using a mix of qualitative and quantitative measures addresses aspects of cultural factors, resource constraints, institutional structures or priorities of local stakeholders (Nelson, Lurie & Wasserman 2007; Cox & Hamlen 2015).

A considerable proportion of the studies described only partial or limited involvement of experts from within the field. Some studies used the knowledge and assessments of experts as a starting point for their concepts and some tested the instruments and asked disaster managers for their feedback. However, continuous cooperation and exchange appeared to be an exception, a problem unfortunately quite common in disaster risk reduction (Owen, Krusel & Bethune 2020). This is in line with the results by Davis and co-authors (2013) and Qari and

co-authors (2019) who observed a lack of awareness and, as a result, the limited dissemination of instruments for measuring. However, all of those efforts of researchers are worth nothing if not put into practice. As Hilliard, Scott-Halsell & Palakurthi (2011) stated, 'It is not enough to talk about preparedness and keeping people, property and organisations safe. There has to be a bridge between the concepts and the real world' (p.642).

## Limitations

While effort was undertaken to achieve a comprehensive overview of the scientific knowledge base about disaster preparedness evaluation, this scoping review might not have captured all existing concepts. The search algorithm was tested but other keywords might have returned additional or different results. Due to the lack of keywording, some relevant book chapters might not have been identified. Moreover, the selection of languages (English and German) as well as the chosen timeframe of publication (1999–2021) might have reduced the number of relevant results. Results from grey literature may have been missed as only the first 100 results from the web search were used. The classification of the results of the scoping review was carried out by 2 researchers independently, however, errors may have occurred during the selection process due to the subjective evaluation of eligibility. As the focus of the review was the scientific knowledge base, concepts of practice-oriented, humanitarian institutions and organisations were not included in this review. Studies dealing with infectious disease outbreaks or epidemics were not included as their course, duration and spread are very different from disasters triggered by natural hazards or human-made disasters like terror attacks.

## Conclusion

Although disaster preparedness evaluation has importance for practice and preparedness improvement, this study's results indicate a lack of instruments that are ready to use. There is a broad variety of concepts and tools on offer, however, there is no standard or uniform approach. Research on evaluating preparedness has been conducted and the list of these works provides an overview of concepts. However, the goal of developing a valid as well as easy-to-use tool for measuring preparedness at the government level seems far from achieved. Many assessment tools lack dissemination and use in practice, which limits feedback from experts and practitioners. The variation in types of instruments used to measure preparedness and the diversity of questions and topics covered within the studied publications demonstrate a lack of consensus on what constitutes preparedness and how it should be measured. Any tool for evaluating preparedness needs to strike a balance between simplicity and flexibility in order to account for the different circumstances of communities as well as hazard-types. Therefore, a modular evaluation system including must-have criteria as well as optional criteria is required.

## References

Abir M, Bell SA, Puppala N, Awad O & Moore M 2017, *Setting foundations for developing disaster response metrics*, *Disaster Medicine and Public Health Preparedness*, vol. 11, no. 4, pp.505–509. doi:10.1017/dmp.2016.173

Agboola F, Bernard D, Savoia E & Biddinger PD 2015, *Development of an online toolkit for measuring performance in health emergency response exercises*, *Prehospital and Disaster Medicine*, vol. 30, no. 5, pp.503–508. doi:10.1017/S1049023X15005117

Alexander D 2005, *Towards the development of a standard in emergency planning*, *Disaster Prevention and Management: An International Journal*, vol. 14, no. 2, pp.158–175. doi:10.1108/09653560510595164

Alexander DE 2015, *Evaluation of civil protection programmes, with a case study from Mexico*, *Disaster Prevention and Management*, vol. 24, no. 2, pp.263–283. doi:10.1108/DPM-12-2014-0268

Amin S, Hijji M, Iqbal R, Harrop W & Chang V 2019, *Fuzzy expert system-based framework for flood management in Saudi Arabia*, *Cluster Computing*, vol. 22, pp.11723–740. doi:10.1007/s10586-017-1465-64

Arksey H & O'Malley L 2005, *Scoping studies: towards a methodological framework*, *International Journal of Social Research Methodology*, vol. 8, no. 1, pp.19–32. doi:10.1080/1364557032000119616

Asch SM, Stoto M, Mendes M, Valdez RB, Gallagher ME, Halverson P & Lurie N 2005, *A review of instruments assessing public health preparedness*, *Public Health Reports*, vol. 120, no. 5, pp.532–542.

Beccari B 2020, *When do local governments reduce risk?: Knowledge gaps and a research agenda*, *Australian Journal of Emergency Management*, vol. 35, no.3, pp.20–24.

Belfroid E, Roßkamp D, Fraser G, Swaan C & Timen A 2020, *Towards defining core principles of public health emergency preparedness: Scoping review and Delphi consultation among European Union country experts*, *BMC Public Health*, vol. 20, no. 1. doi:10.1186/s12889-020-09307-y

Cao W, Xiao H & Zhao Q 2011, *The comprehensive evaluation system for meteorological disasters emergency management capability based on the entropy-weighting TOPSIS method*. In 'Proceedings of International Conference on Information Systems for Crisis Response and Management', pp.434–439. doi:10.1109/ISCRAM.2011.6184146

Connelly EB, Lambert JH & Thekdi SA 2016, *Robust Investments in Humanitarian Logistics and Supply Chains for Disaster Resilience and Sustainable Communities*, *Natural Hazards Review*, vol. 17, no. 1. doi:10.1061/(ASCE)NH.1527-6996.0000187

Cox RS & Hamlen M 2015, *Community Disaster Resilience and the Rural Resilience Index*, *American Behavioral Scientist*, vol. 59, no. 2, pp.220–237. doi:10.1177/0002764214550297

Dalnoki-Veress F, McKallagat C & Klebesadal A 2014, *Local health department planning for a radiological emergency: An application of the AHP2 tool to emergency preparedness prioritization*, *Public Health Reports*, vol. 129, pp.136–144. doi:10.1177/003335491412965418

Dariagan JD, Atando RB & Asis JLB 2021, *Disaster preparedness of local governments in Panay Island, Philippines*, *Natural Hazards*, vol. 105, no. 2, pp.1923–1944. doi:10.1007/s11069-020-04383-0

Das R 2018, *Disaster preparedness for better response: Logistics perspectives*, *International Journal of Disaster Risk Reduction*, vol. 31, pp.153–159. doi:10.1016/j.ijdr.2018.05.005

Davis MV, Mays GP, Bellamy J, Bevc CA & Marti C 2013, *Improving public health preparedness capacity measurement: Development of the local health department preparedness capacities assessment survey*, *Disaster Medicine and Public Health Preparedness*, vol. 7, no. 6, pp.578–584. doi:10.1017/dmp.2013.108

Diirr B & Borges MRS 2013, *Applying software engineering testing techniques to evaluate emergency plans*, in. *Graduate Program in Informatics*, pp.758–763.

Djalali A, Della Corte F, Foletti M, Ragazzoni L, Ripoll Gallardo A, Lupescu O, Arculeo C, von Armin G, Friedl T, Ashkenazi M, Fischer P, Hreckovski B, Khorram-Manesh A, Komadina R, Lechner K, Patru C, Burkle FM Jr & Ingrassia PL 2014, *Art of Disaster Preparedness in European Union: a Survey on the Health Systems*, *PLoS Currents*, pp.1–17. doi:10.1371/currents.dis.56cf1c5c1b0deae1595a48e294685d2f

FEMA (Federal Emergency Management Agency) 2013, *National Strategy Recommendations: Future Disaster Preparedness*. At: [www.preventionweb.net/publication/national-strategy-recommendations-future-disaster-preparedness](http://www.preventionweb.net/publication/national-strategy-recommendations-future-disaster-preparedness).

Gebbie KM, Valas J, Merrill J & Morse S 2006, *Role of exercises and drills in the evaluation of public health in emergency response*, *Prehospital and Disaster Medicine*, vol. 21 no. 3, pp.173–182. doi:10.1017/S1049023X00003642

Gillespie D & Streeter C 1987, *Conceptualizing and measuring disaster preparedness*, *International Journal of Mass Emergencies and Disasters*, vol. 5, no. 2, pp.155–176.

Greiving S, Schödl L, Gaudry K-H, Miralles IKQ, Larraín BP, Fleischhauer M, Guerra MMJ & Tobar J 2021, *Multi-risk assessment and management—a comparative study of the current state of affairs in Chile and Ecuador*, *Sustainability (Switzerland)*, vol. 13 no. 3, pp.1–23. doi:10.3390/su13031366

Haeberer M, Tsolova S, Riley P, Cano-Portero R, Rexroth U, Ciotti M & Fraser G 2020, *Tools for Assessment of Country Preparedness for Public Health Emergencies: A Critical Review*, *Disaster Medicine and Public Health Preparedness*. doi:10.1017/dmp.2020.13

- Handayani NU, Sari DP, Ulkhaq MM, Nugroho AS & Hanifah A 2020, *Identifying factors for assessing regional readiness level to manage natural disaster in emergency response periods. In AIP Conference Proceedings, vol. 2217, no. 1, pp.030037. doi:10.1063/5.0000904*
- Henstra D 2010, *Evaluating Local Government Emergency Management Programs: What Framework Should Public Managers Adopt?*, *Public Administration Review, vol. 70, no. 2, pp.236–246.*
- Hilliard TW, Scott-Halsell S & Palakurthi R 2011, *Core crisis preparedness measures implemented by meeting planners*, *Journal of Hospitality Marketing and Management, vol. 20 no. 6, pp.638–660. doi:10.1080/19368623.2011.536077*
- Jones M, O’Carroll P, Thompson J & D’Ambrosio L 2008, *Assessing regional public health preparedness: A new tool for considering cross-border issues*, *Journal of Public Health Management and Practice, vol. 14, no. 5, pp.E15–E22. doi:10.1097/01.PHH.0000333891.06259.44*
- Juanzon JBP & Oreta AWC 2018, *An assessment on the effective preparedness and disaster response: The case of Santa Rosa City, Laguna. Procedia Engineering, vol. 212, pp.929-936. doi:10.1016/j.proeng.2018.01.120*
- Khan Y, Brown AD, Gagliardi AR, O’Sullivan T, Lacarte S, Henry B & Schwartz B 2019, *Are we prepared? The development of performance indicators for public health emergency preparedness using a modified Delphi approach*, *PLoS ONE, vol. 14, no. 12, pp.1–19. doi:10.1371/journal.pone.0226489*
- Manca D & Brambilla S 2011, *A methodology based on the Analytic Hierarchy Process for the quantitative assessment of emergency preparedness and response in road tunnels*, *Transport Policy, vol. 18, no. 5, pp.657–664. doi:10.1016/j.tranpol.2010.12.003*
- Mann NC, MacKenzie E & Anderson C 2004, *Public health preparedness for mass-casualty events: A 2002 state-by-state assessment*, *Prehospital and Disaster Medicine, vol. 19, no. 3, pp.245–255. doi:10.1017/S1049023X00001849*
- McConnell A & Drennan L 2006, *Mission Impossible? Planning and Preparing for Crisis*, *Journal of Contingencies and Crisis Management, vol. 14, no. 2, pp.59–70. doi:10.1111/j.1468-5973.2006.00482.x*
- McEntire D & Myers A 2004, *Preparing communities for disasters: issues and processes for government readiness*, *Disaster Prevention and Management, vol. 13, no. 2, pp.140–152. doi:10.1108/09653560410534289*
- Monte BEO, Goldenfrum JA, Michel GP & de Albuquerque Cavalcanti JR 2020, *Terminology of natural hazards and disasters: A review and the case of Brazil*, *International Journal of Disaster Risk Reduction, p.101970. doi:10.1016/j.ijdrr.2020.101970*
- Murthy BP, Molinari NAM, LeBlanc TT, Vagi SJ & Avchen RN 2017, *Progress in Public Health Emergency Preparedness-United States, 2001-2016*, *American Journal of Public Health, vol. 107, no. S2, pp.S180–S185. doi:10.2105/AJPH.2017.304038*
- Nachtmann H & Pohl EA 2013, *Transportation readiness assessment and valuation for emergency logistics*, *International Journal of Emergency Management, vol. 9, no. 1, pp.18–36. doi:10.1504/IJEM.2013.054099*
- Nelson C, Lurie N & Wasserman J 2007, *Assessing public health emergency preparedness: Concepts, tools, and challenges*, *Annual Review of Public Health, pp.1–18. doi:10.1146/annurev.publhealth.28.021406.144054*
- Nelson C, Chan E, Chandra A, Sorensen P, Willis HH, Dulin S & Leuschner K 2010, *Developing national standards for public health emergency preparedness with a limited evidence base*, *Disaster Medicine and Public Health Preparedness, vol. 4, no. 4, pp.285–290. doi:10.1001/dmp.2010.39*
- Obaid JM, Bailey G, Wheeler H, Meyers L, Medcalf SJ, Hansen KF, Sanger KK & Lowe JJ 2017, *Utilization of Functional Exercises to Build Regional Emergency Preparedness among Rural Health Organizations in the US*, *Prehospital and Disaster Medicine, vol. 32, no. 2, pp.224–230. doi:10.1017/S1049023X16001527*
- Owen C, Krusel N & Bethune L 2020, *Implementing research to support disaster risk reduction*. *Australian Journal of Emergency Management, vol. 35, no. 3, pp.54–61.*
- Peters MDJ, Godfrey CM, McInerney P, Soares CB, Khalil H & Parker D 2015, *Methodology for JBI Scoping Reviews*, *Joanna Briggs Institute, vol. 53, no. 9, pp.0–24. doi:10.1017/CBO9781107415324.004*
- Porse CC 2009, *Biodefense and public health preparedness in Virginia*, *Biosecurity and Bioterrorism, vol. 7, no. 1, pp.73–84. doi:10.1089/bsp.2008.0041*
- Potter MA, Houck OC, Miner K & Shoaf K 2013, *Data for preparedness metrics: Legal, economic, and operational*, *Journal of Public Health Management and Practice, vol. 19, no. 5, pp.S22– S27. doi:10.1097/PHH.0b013e318295e8ef*
- Qari SH, Yusuf HR, Groseclose SL, Leinhos MR & Carbone EG 2019, *Public Health Emergency Preparedness System Evaluation Criteria and Performance Metrics: A Review of Contributions of the CDC-Funded Preparedness and Emergency Response Research Centers*, *Disaster Medicine and Public Health Preparedness, vol. 13, no. 3, pp.626–638. doi:10.1017/dmp.2018.110*
- Reifels L, Arbon P, Capon A, Handmer J, Humphrey A, Murray V & Spencer C 2018, *Health and disaster risk reduction regarding the Sendai Framework*. *Australian Journal of Emergency Management, vol. 33, no. 1, pp.23–24.*
- Savoia E, Lin L, Bernard D, Klein N, James L P & Guicciardi S 2017, *Public Health System Research in Public Health Emergency Preparedness in the United States (2009–2015): Actionable Knowledge Base*, *American Journal of Public Health, vol. 107, no. S2, pp.e1–e6. doi:10.2105/AJPH.2017.304051*
- Schoch-Spana M, Selck FW & Goldberg LA 2015, *A national survey on health department capacity for community engagement in emergency preparedness*, *Journal of Public Health Management and Practice, vol. 21, no. 2, pp.196–207. doi:10.1097/PHH.0000000000000110*

Shelton SR, Nelson CD, McLees AW, Mumford K & Thomas C 2013, *Building performance-based accountability with limited empirical evidence: performance measurement for public health preparedness*, *Disaster Medicine and Public Health Preparedness*, vol. 7 no. 4, pp.373–379. doi:10.1017/dmp.2013.20

Shoemaker Z, Eaton L, Petit F, Fisher R & Collins M 2011, *Assessing community and region emergency-services capabilities*. *WIT Transactions on The Built Environment*, vol. 119, pp.99–110. doi:10.2495/DMAN110101

Simpson D 2008, *Disaster preparedness measures: a test case development and application*, *Disaster Prevention and Management*, vol. 17, no. 5, pp.645–661. doi:10.1108/0965356081091865

Staupe-Delgado R & Kruke B 2017, *Developing a typology of crisis preparedness*, *Safety and Reliability – Theory and Applications*, (November), pp.366–366. doi:10.1201/9781315210469-322

Staupe-Delgado R & Kruke BI 2018, *Preparedness: Unpacking and clarifying the concept*, *Journal of Contingencies and Crisis Management*, vol. 26, no. 2, pp.212–224. doi:10.1111/1468-5973.12175

Somers S 2007, *Survey and Assessment of Planning for Operational Continuity in Public Works*, *Public Works Management and Policy*, vol. 12, no. 2, pp.451–465. doi:10.1177/1087724X07308772

Sutton J & Tierney K 2006, *Disaster preparedness: concepts, guidance, and research, report*, *Fritz Institute Assessing Disaster Preparedness Conference, Sebastopol, CA, November*, pp.3–4.

UNISDR 2015, *Sendai Framework for Disaster Risk Reduction 2015-2030*. Geneva. At: [www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030](http://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030).

UNISDR 2016, *Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction*. Geneva. At: [www.preventionweb.net/publication/report-open-ended-intergovernmental-expert-working-group-indicators-and-terminology](http://www.preventionweb.net/publication/report-open-ended-intergovernmental-expert-working-group-indicators-and-terminology).

Watkins SM, Perrotta DM, Stanbury M, Heumann M, Anderson H, Simms E & Huang M 2011, *State-level emergency preparedness and response capabilities*, *Disaster Medicine and Public Health Preparedness*, vol. 5, Suppl. 1, pp.S134–S142. doi:10.1001/dmp.2011.26

Wong DF, Spencer C, Boyd L, Burkle FM & Archer F 2017, *Disaster metrics: a comprehensive framework for disaster evaluation typologies*. *Prehospital and Disaster Medicine*, vol. 32, no. 5, pp. 501–514. doi:10.1017/S1049023X17006471

### About the authors

**Dr Nina Lorenzoni** works as senior scientist at UMIT TIROL. Her main research areas are in organisational and individual learning and disaster management. She focuses on science communication and its impact on making policy.

**Dr Stephanie Kainrath** is an associate researcher at UMIT TIROL. Her research is on high-fidelity simulations.

**Dr Maria Unterholzner** is a medical resident at the district hospital in Reutte, Austria.

**Professor Harald Stummer** is Professor for Management in Healthcare at UMIT TIROL. His research focuses on behaviour in the healthcare sector and health behaviour of communities and groups.

# PPRR and AIIMS: a whole-of-government strategy in NSW

Peer reviewed

Alan Holley<sup>1</sup>

Dr Tony McArthur<sup>2</sup>

1. Winmalee Rural Fire Brigade, RFS NSW.
2. Winmalee Rural Fire Brigade, RFS NSW and Gungahlin Rural Fire Brigade, RFS ACT.

**SUBMITTED**

26 November 2021

**ACCEPTED**

6 March 2022

**DOI**

[www.doi.org/10.47389/37.3.65](https://www.doi.org/10.47389/37.3.65)



© 2022 by the authors.  
License Australian Institute for Disaster Resilience, Melbourne, Australia. This is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## Introduction

The use of *Australasian Inter-service Incident Management System* (AIIMS) is ubiquitous in Australia and New Zealand at every level of incident because of its scalability, comprehensiveness and its interoperability across agencies. Prevent/Mitigate, Prepare, Respond, Recover (PPRR) provides a simple conceptual framework for understanding the way political entities and their agencies prepare for emergencies, respond and recover. Within that framework, while AIIMS is used in the response and recovery phases, AIIMS also offers a tried and tested framework to coordinate better prevention and preparation across agencies prior to incidents.

## Why now?

Such a strategy would support Australia's partial response to the *Sendai Framework for Disaster Risk Reduction 2015-2030* (UNDRR 2015) upon which the *National Disaster Risk Reduction Framework* (Australian Government Department of Home Affairs 2018) relies. Fire combat agencies in NSW are aware of the increasing severity of bushfires and their negative consequences for communities. Climate change is resulting in large, more frequent and harder to control events, particularly bushfires (Mullins 2021, Clode 2018, Adams & Attiwill 2011). Australia has seen the most destructive bushfires as well as cyclones and, most recently, floods. While these events may be predictable in the long term, they present an increasingly uncertain world (Atkinson *et al.* 2021, p.7; Murphy 2021; Quarantelli, Lagadec & Boin 2007, p.25; Rickards & Keating 2021, p.52). Apart from experience, the number of major wildfires in the US, Canada and Europe in 2021 and floods in Germany are reminders that business-as-usual approaches to emergency management are unlikely to be effective in the future. The severity of such impacts on Australian communities will increase as incidents become larger and more frequent. Australia has no choice but to adapt to a changing climate (Howes *et al.* 2013). Apart from loss of life, communities that lose houses and businesses suffer over a long term and cost the broader community financially (Tierney 2007, p.275, Ulubasoglu 2018, p.9).

## AIIMS

AIIMS is a means of managing incidents when they occur. The mode of operation is designed to be used within 'a broader

## Abstract

This paper explores the relationship between the common Prevent/Mitigate, Prepare, Respond, Recover (PPRR) framework and the *Australasian Inter-service Incident Management System* (AIIMS) in NSW. The bushfire experience in Australia during 2019–20 revealed the limitations of existing approaches to 3 of the 4 PPRR phases: prevention/mitigation, preparation and recovery. A lack of coordination across agencies, as identified in the Final Report of the NSW Bushfire Inquiry (Owen & O'Kane 2020), reduced the value of much good work. A whole-of-government strategy using AIIMS structures is recommended to promote effective coordination across agencies rather than relying on current collaborative committees that are constrained by agency priorities. AIIMS provides a means of coordinating the work of agencies in prevention/mitigation, preparedness and recovery by working across agencies to enhance the safety of communities.

framework of emergency management arrangements developed at jurisdictional and national levels' (AFAC 2017, p.2). AIIMS evolved from the US *National Interagency Incident Management System* (NIIMS) that dates from 1981 (NIIMS National Interagency Incident Management System 2004, AFAC 2013, p.ii, Rubin 2012, ps.167, 176). NIIMS and its associated Incident Control System (ICS) arose from *Fire Fighting Resources of Southern California Organized for Potential Emergencies*, which introduced ICS into emergency management in the US (Rubin 2012, p.167). NIIMS became the US National Incident Management System in 2004 (Rubin 2012, p.179f).

The fundamental principles of AIIMS (flexibility management by objectives, functional management structures, unity of command and span of control) have developed from NIIMS but have evolved based on Australasian experience. The command system and functional areas resemble those used in the Australian Defence Force, reflecting NATO practice, common in many countries (Wendling 2010). While AIIMS is accepted across Australasia, it is implemented differently within jurisdictions and agencies (Conway 2012).

**Extract from the Australasian Inter-service Incident Management System (AFAC 2017, p.12)**

The scalable structure of the AIIMS addresses functional areas within an Incident Management Team (IMT) (AFAC 2017). The functions are:

**Control** – The management of all activities necessary for the resolution of an incident

**Planning** – The development of objectives, strategies and plans for the resolution of an incident based on the outcomes of collection and analysis of information.

**Intelligence** – information or data, which is recorded and disseminated as intelligence to support decision-making and planning.

**Public Information** – Provision of warnings, information, and advice to the public, and liaison with the media and affected communities.

**Operations** – The tasking and application of resources to achieve the resolution of an incident.

**Investigation** – The task of conducting investigations to determine the cause of an incident and/or to determine factors that contributed to the impact of the incident or specific events

**Logistics** – The acquisition and provision of human and physical resources, facilities, services and materials to support achievement of incident objectives.

**Finance** – The task of managing:

- accounts for purchases of supplies and hire of equipment;
- insurance and compensation for personnel, property and vehicles; and
- the collection of cost data and provision of cost-effective analyses and providing cost estimates for the incident.

In AIIMS, every incident has these functions. In a very small fire (e.g. a park bin set alight) all the functions would be performed by the crew commander of a single fire appliance who would be the incident controller and the entire IMT. At a state-level, the IMT would scale up so that each of the functions would be headed by a senior officer supported by a staff (see Figure 1).

AIIMS is a robust system for incident management. IMTs exist until the incident that caused it to be stood up is resolved. In services with large numbers of volunteers (e.g. the NSW Rural Fire Service (NSWRFS) or the NSW State Emergency Service) the volunteer crews are stood down as soon as possible so that volunteers may resume their normal lives. The salaried work forces of these agencies are quite small and exist to support the volunteer workforce. Among the NSW combat agencies, it is the NSW Police Force that have an entirely full-time, salaried workforce; even Fire and Rescue NSW (FRNSW) has some part-time salaried firefighters.

**PPRR**

The PPRR cycle is commonly used in emergency management. Often, 'mitigation' is substituted for 'prevention' (Petak 1985, p.3; Simonović 2011, p.31). The model has its origins in the USA from 1978 (Cronstedt 2002, p.10, Rogers 2011, p.55). The model is used in the *NSW State Emergency and Rescue Management Act 1989* to describe the 'stages of an emergency' (*State Emergency and Recovery Management Act 1989* (NSW), s. 5). Figure 2 shows the 4 interconnected phases of the PPRR model.

Simonović (2011), advocating an integrated approach to emergency management, presented PPRR in a Venn diagram (Figure 3). The overlapping sectors suggests there is a central coordination function. Coppola (2015) provided a more complex construct to show the inter-relationships between stages of an emergency. In Figure 4, the emphasis is that disasters tend to exist in a continuum, with the recovery from one often leading straight into another. And while response is often pictured as beginning immediately after an event, it is not uncommon for the actual response to begin before the event actually happens (Coppola 2015). In this model, all phases can coexist within a dominant phase.

Figure 5 shows a detailed version of the PPRR model from the *Systemic Disaster Risk Handbook* (AIDR 2021) in its description of its 'landscape'. The value of the model lies in its detailed allocation of emergency management activities and documentation for each phase. The lack of activities in recovery is notable, reflecting the relative lack of attention paid to recovery.

There are variations on the 2-dimensional cyclic representations of PPRR. Kelly (1999) noted Neal's (1997) criticism of the essentially linear sequence in the conventional PPRR model where different sections of a population can experience different parts of the cycle simultaneously. This can be represented by Coppola's (2015) Venn diagram model. Figure 6 shows a Mobius strip model, proposed by Anderson (1985), Cuny (1985) and (Kelly 1999, p.25). While it may be debatable whether this model amounts to a substantial change, Kelly (1999) offers a different visualisation of what occurs before, during and after an incident.

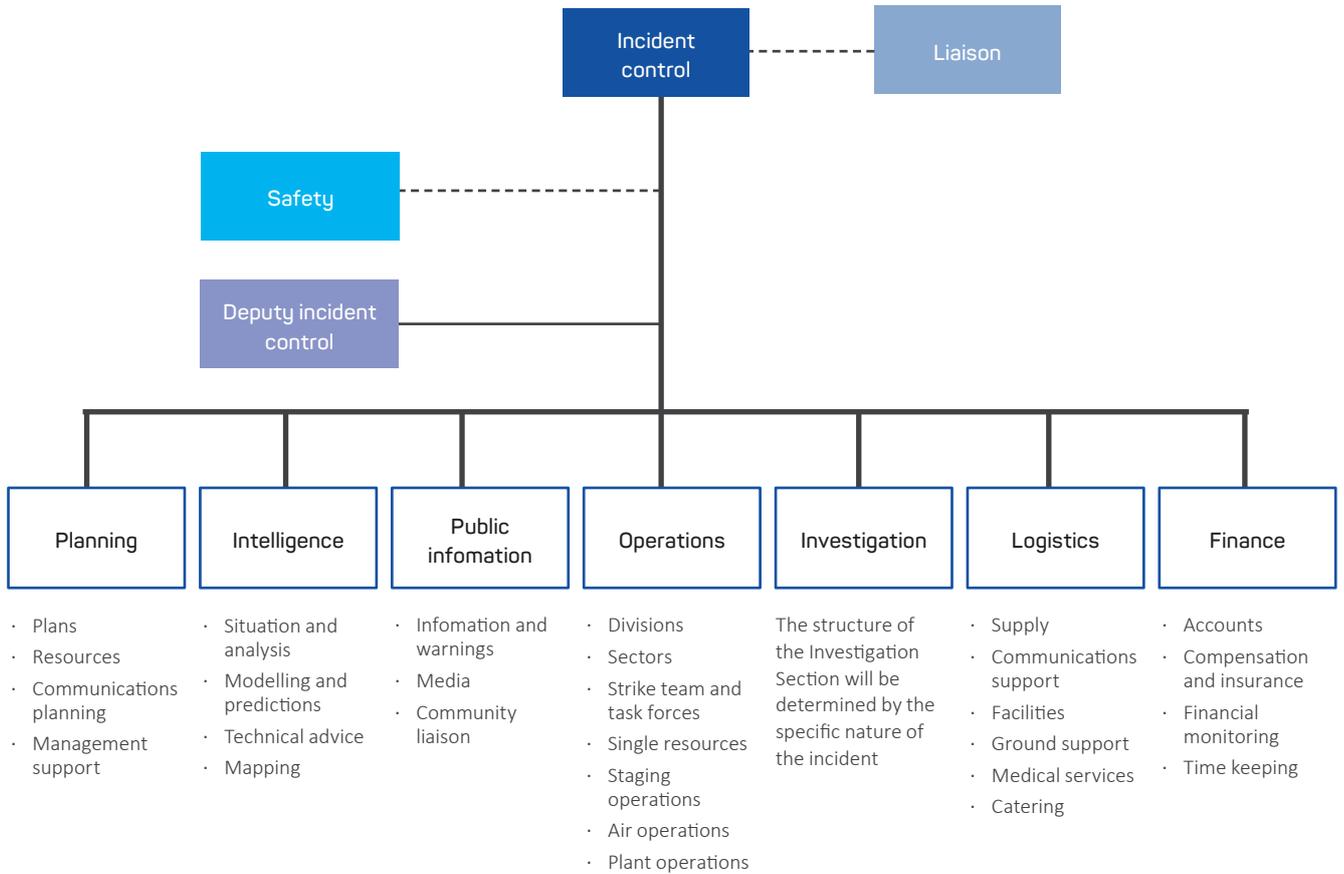


Figure 1: A fully expanded incident management structure showing functional areas.

Source: AFAC (2017), p.46.

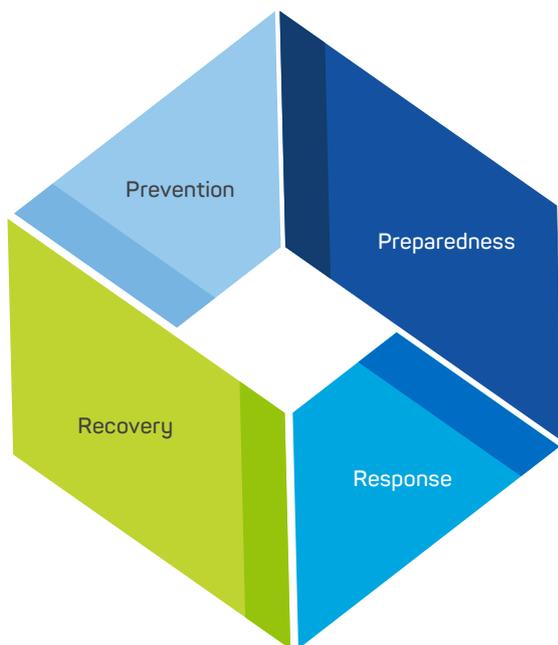


Figure 2: The emergency management cycle.

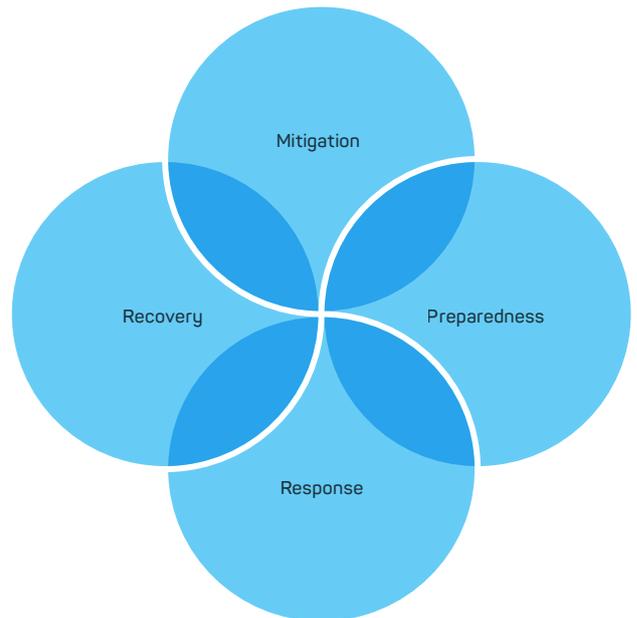


Figure 3: The emergency management cycles as a Venn diagram of interrelated phases.

Source: Simonović (2011), p.31.

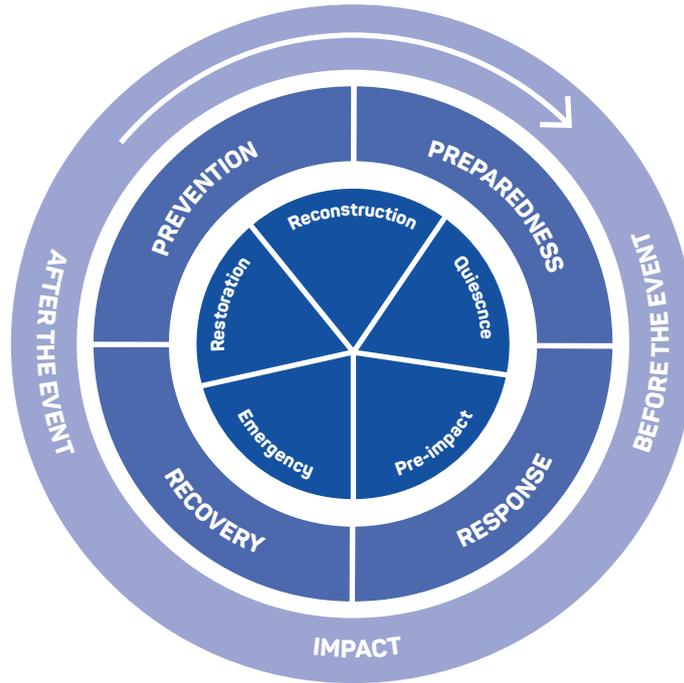


Figure 4: The emergency management model as a continuum.

Source: Coppola (2015), p.13)

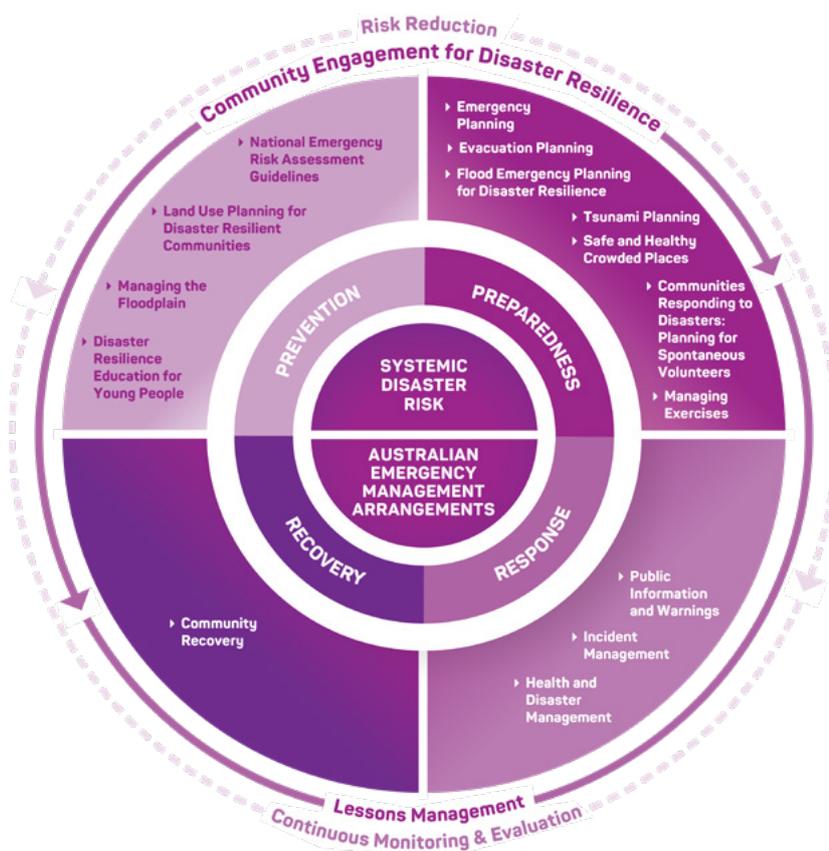


Figure 5: The emergency management cycle is represented as a 'policy landscape'.

Source: AIDR (2021)

Figure 7 shows the quadrants on a plane that are expressed in terms of resource use (Kelly 1999, p.26). The value of this model is that it does not envisage a situation where no resources are needed: what changes are the proportions.

A variation on the PPRR model comes from the NSW RFS in Figure 8. The value of this representation is the suggestion of a wave flow of events within a linear model. This reflects the perception of firefighters oriented to response while acknowledging the broader PPRR range of activities.

The PPRR model is not without its critics. Rogers (2011) expressed concern that the conventional PPRR cycle does not include ‘anticipation and assessment’ of risk sufficiently in the

cycle to properly inform national resilience (Rogers 2011, p.54). Cronstedt (2002) argued that the model is agency-focused rather than community-focused (Cronstedt 2002, p 11). Gabriel (2003) criticised the model because it is solely emergency-focused. Gabriel (2003) writes that it is inappropriate to concentrate on response and the necessary recovery when the emphasis ought to be on the community through treatment or risk reduction. Linton (2021, pp.5–6), while agreeing with Gabriel’s (2003) criticism, claimed that the PPRR model has a value and should be allowed to evolve to focus on disaster risk reduction. With PPRR enshrined in NSW emergency management legislation, the framework continues to define how government agencies plan for and manage emergencies.

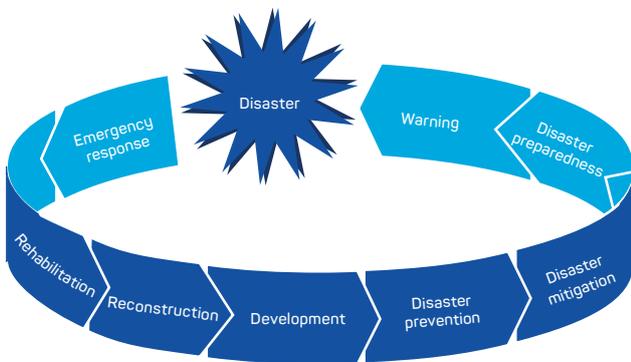


Figure 6: The emergency management cycle shown as a circular Mobis strip.

Source: Kelly (1999), p.26

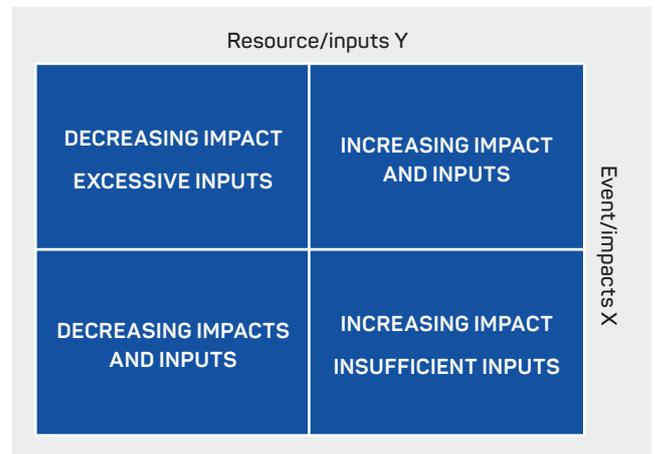


Figure 7: The emergency management process phase shown in terms of resource use.

Source: Kelly (1999), p.26

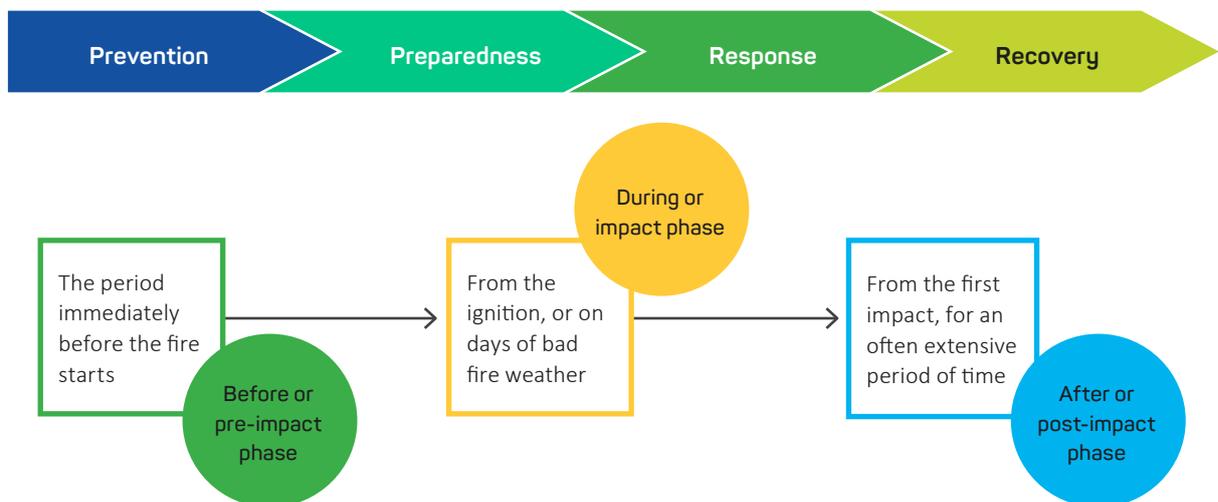


Figure 8: The emergency management cycle shown as a wave of events occurring along a linear phase of an event.

Source: NSW RFS (2019)

## AIIMS, PPRR and agencies in NSW

AIIMS and PPRR differ fundamentally. AIIMS has been adopted and used operationally in emergencies across Australia and New Zealand for 20 years. PPRR is a theoretical framework used to explain the work of emergency management. Unlike AIIMS, which requires agencies to comply with its practices, PPRR provides a means of situating the work of different agencies and authorities within emergency management phases but provides no guidance as to operational practice. While it is reasonable to observe that PPRR is theoretical and AIIMS is practical, theoretical frameworks have value in guiding the planning for the necessary activities of a community faced with emergencies.

AIIMS assumes that there are 2 states of existence: incidents and normality. It notes that emergency management activity can be referred to in phases: before, during and after ‘to return to a new normality’ (AFAC 2017, p.3). The use of PPRR is acknowledged but the activities under the framework ‘may be neither linear or sequential’ (AFAC 2017, p.10). AIIMS guides combat agency activity for incidents, not the entire PPRR cycle. In AFAC (2017), ‘The wording throughout this AIIMS manual is aligned to response activities; however, AIIMS is equally applicable to recovery activities’ (p.2). AIIMS is designed for preparedness, response and recovery:

*Emergency service agencies routinely work together in responding to and resolving incidents. Indeed, it is more likely the exception that an agency will work alone in preparedness, response and recovery. (AFAC 2017, p.1).*

AIIMS assumes there will be inter-agency cooperation for the duration of the incident. Once the incident is over, the unity of command ends when the IMT is stood down and the different agencies resume business-as-normal.

During a large incident, an AIIMS IMT may move through the preparation, response and recovery phases. For example, during the 2019–20 bushfires in NSW, the IMT based at Katoomba was stood up because of a fire at the base of Echo Point. At the same time, the Gosper’s Mountain fire was moving south and the Green Wattle complex fire was moving north. This resulted in operations addressing the immediate threat while crews were preparing fire trails and the IMT did detailed planning for the arrival of the 2 larger fires. As the southern and northern fires arrived, personnel working the functional areas transitioned seamlessly from preparation to response. As the fire threat was reduced, some personnel transitioned to recovery. Figure 9 shows that in a very complex incident with multiple fire fronts, the overlaps between the different phases can be extreme (Simpson, Bradstock & Price 2019, pp.12–13). This is particularly true in flood events that effect different parts of river systems.



Figure 9: A typical transition from preparation to response to recovery in an emergency event.

PPRR is not a practical guide for a workplan. In all agencies, not only combat agencies, prevention/mitigation runs concurrently with preparedness, often with little sense of a distinction. During incidents, recovery, at least in theory, begins when the incident starts (AFAC 2017, p 97). The NSW RFS and land management agencies, like local government and NSW Parks and Wildlife Service, have roles in prevention/mitigation. In the example provided from the Blue Mountains, for mitigation, NSW RFS and the NSW Parks and Wildlife Service conducted hazard reduction burns. Those agencies and the Blue Mountains City Council maintained fire trails and trained personnel. These agency prevention/mitigation and preparation measures are ongoing components of each organisation’s work, interrupted by emergencies when AIIMS arrangements are put in place. Mitigation is not a component of AIIMS work but preparedness is. This is different from agency preparedness work that is not concentrated on hazards of a current incident. Once an incident begins, the agency prevention/mitigation and preparedness works ceases to support the preparedness, response and recovery under AIIMS. When the incident is resolved and the IMT is stood down, the organisations resume their normal business practices (Figure 10).

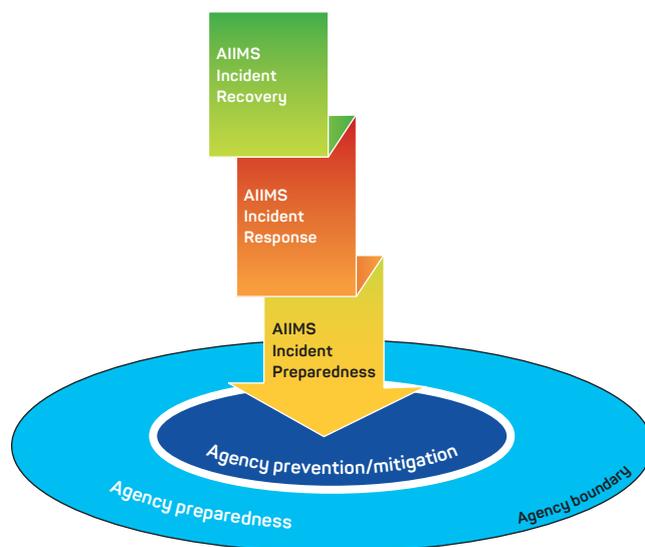


Figure 10: Agency preparedness and prevention/mitigation and AIIMS PPRR in an incident. Note: the agency boundary is breached by AIIMS.

## Mitigation and preparedness: whole-of-government use of AIIMS

Setting aside the organisational difficulties, the AIIMS structure offers a very sound way of managing prevention/mitigation and agency preparedness. Agencies have specific obligations in relation to mitigation. The NSW *Rural Fires Act 1997* includes a legislative base for the ‘prevention, mitigation and suppression of bush and other fires in local government areas (or parts

of areas) and other parts of the State constituted as rural fire districts' (*Rural Fires Act (NSW) 1997*, s.3). The principal instrument provided in the Act is the Bush Fire Co-ordinating Committee (BFCC), which is tasked with the formation of Bush Fire Management Committees (BFMC) across the state (*Rural Fires Act (NSW) 1997*, p.3). Recommendation 7 of the *Final Report of the NSW Bushfire Inquiry* looks to the development of resource allocation protocols between NSW RFS and FRNSW (Owens & O'Kane 2020, p.108). However, Recommendation 8 goes much further:

*Recommendation 8: That, to strengthen cross-agency accountability and deliver improved bush fire risk management outcomes:*

- a. *BFCC members from NSW government agencies are at the level of Coordinator General/Deputy Secretary/ Agency Head/Deputy Commissioner (or equivalent)*
- b. *the BFCC ensures all Bush Fire Risk Management Plans, Operation Coordination Plans and Fire Access and Fire Trail (FAFT) Plans are compliant with the timeframes outlined in section 52 of the Rural Fires Act as soon as practicable*
- c. *the BFCC develops a risk-based performance auditing cycle to ensure Bush Fire Risk Management Plans, Operation Coordination Plans and FAFT Plans are fit-for-purpose and any opportunities for improvement are identified and actioned*
- d. *the NSW RFS considers the best way of enhancing the transparency of BFCC decision-making, for example by publishing BFCC membership and minutes on its website*
- e. *the BFCC endorses the annual statement to Parliament on the likely fire risk and the effectiveness of planning and preparation*
- f. *relevant agencies review Bush Fire Management Committee (BFMC) membership and confirm to the NSW RFS that members have sufficient discretion and authority to agree and implement risk mitigation activities at the local level*
- g. *the NSW RFS Commissioner amends the BFMC Policy to require BFMCs to refer unresolved issues to the BFCC for resolution. (Owens & O'Kane 2020, p.115)*

Recommendation 8 goes to the very heart of bushfire prevention/mitigation for agencies. Arguably, the implementation of this recommendation requires a major change in procedures, particularly at the coordination level across agencies through a whole-of-government strategy. The BFCC will depend on the cooperation of agencies without any powers of compliance and with no command-and-control functions.

The *Final Report of the NSW Bushfire Inquiry* also makes recommendations related to preparation. Recommendation 6 addresses what the inquiry saw as deficiencies in preparation by agencies for the recent fires: 'The Inquiry has identified a series of initial priorities for training to ensure that firefighting practice

keeps up with new and emerging research' (Owens & O'Kane 2020, ps.101, 103). Recommendation 9 speaks to the available firefighting workforce, either from NSW agencies or from outside the state (Owens & O'Kane 2020, p.120). Recommendation 15 addresses community engagement (Owens & O'Kane 2020, p.143). Recommendation 16 looks at the need for inter-agency support for tourist bodies and Recommendation 17 seeks to address deficiencies in the provision Safer Neighbourhood Places (Owens & O'Kane 2020,ps.145, 148). Recommendations 18–33 refer to additional matters that fall under the preparation rubric (Owens & O'Kane 2020, pp.ix-xiv). Most, if not all, of these recommendations require inter-agency cooperation within a PPRR framework.

The structure of AIIMS is suited to progressing these recommendations. Current inter-agency cooperation seeks to use collaborative committees like the BFCC. Such committees, common across bureaucracies, struggle for traction because agency representatives are necessarily driven by each agency's priorities. Figure 11 represents how, with a whole-of-government strategy, using AIIMS principles of flexibility, management by objectives, functional management structures, unity of command and span of control, governments can achieve coordination across agencies, as it does during major incidents with a command approach to breach agency boundaries and co-opt agency personnel. A whole-of-government IMT would need to be a permanent entity, supported by appropriate legislation and regulation, coordinating some of the work of current agencies. A particular advantage of using AIIMS is that agency assumptions and self-imposed limitations in scenario planning are lessened, leading to much better preparation for the worst-case scenario (Gissing, Eburn & McAneny 2018, p.7; Jenkins & Edwards-Winslow 2003, p.49; Kahane 2012; Reos Partners 2021). Deficiencies can be identified and addressed before they become problematic or even fatal. In relation to prevention/

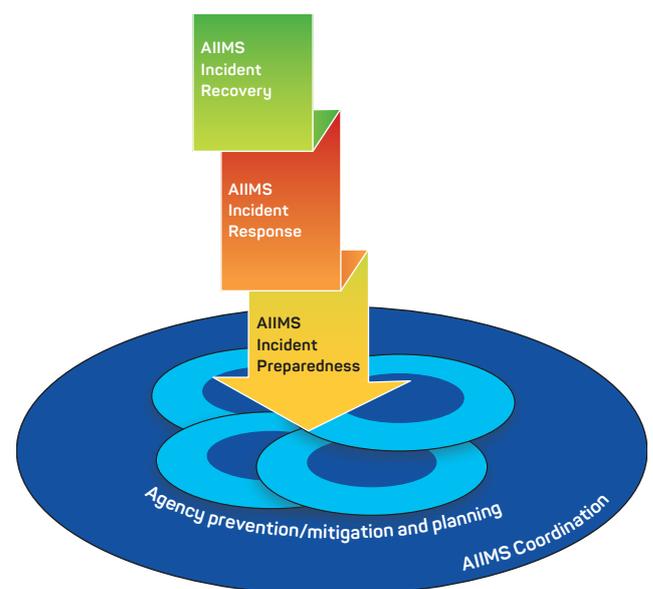


Figure 11: AIIMS coordination for state-level prevention/mitigation and planning.

mitigation, a particular challenge is the acceptance by agencies of risk ownership. It is likely that such ownership will become clear under AIIMS (Young & Jones 2018, ps.49, 53). Resilience NSW would be an obvious body to manage this whole-of-government structure with its public focus on preparation, rescue, recovery and broader emergency management including the State Emergency Management Plan (NSW Government).

## Recovery: a role for AIIMS at state-level as well as in IMTs

Recovery after the 2019–20 bushfires has been problematic, in part due to the number of communities that suffered. Figures 9 and 10 show recovery within AIIMS as the responsibility of an IMT although, under AIIMS, recovery can be transferred to another organisation (AFAC, 2017, p.62). In AIIMS terms, recovery is incident specific and a responsibility of each IMT, drawing

support from other agencies as needed. Figure 12 shows how the AIIMS functional areas would work in supporting recovery specific to an incident. IMTs have long lacked the resources to manage recovery. For example, in the wake of the 2013 Linksview fire in the lower Blue Mountains, a separate recovery organisation, relying on the Red Cross and local government and non-government resources, was set up. Recovery does not feature strongly in NSW RFS training for volunteers. The NSW RFS, relying on a volunteer workforce at brigade level and a small salaried staff, while having the capability, lacks the capacity to support recovery and must draw on other agencies. Even if each IMT that operated during the 2019–20 bushfires was able to handle recovery, effective coordination of resource use across NSW would still have been necessary. It is unfortunate that the terms of reference for the NSW Bushfire Inquiry excluded recovery (Owens & O’Kane 2020, p.6). A significant outcome of the experiences of 2019–20 was the recasting of

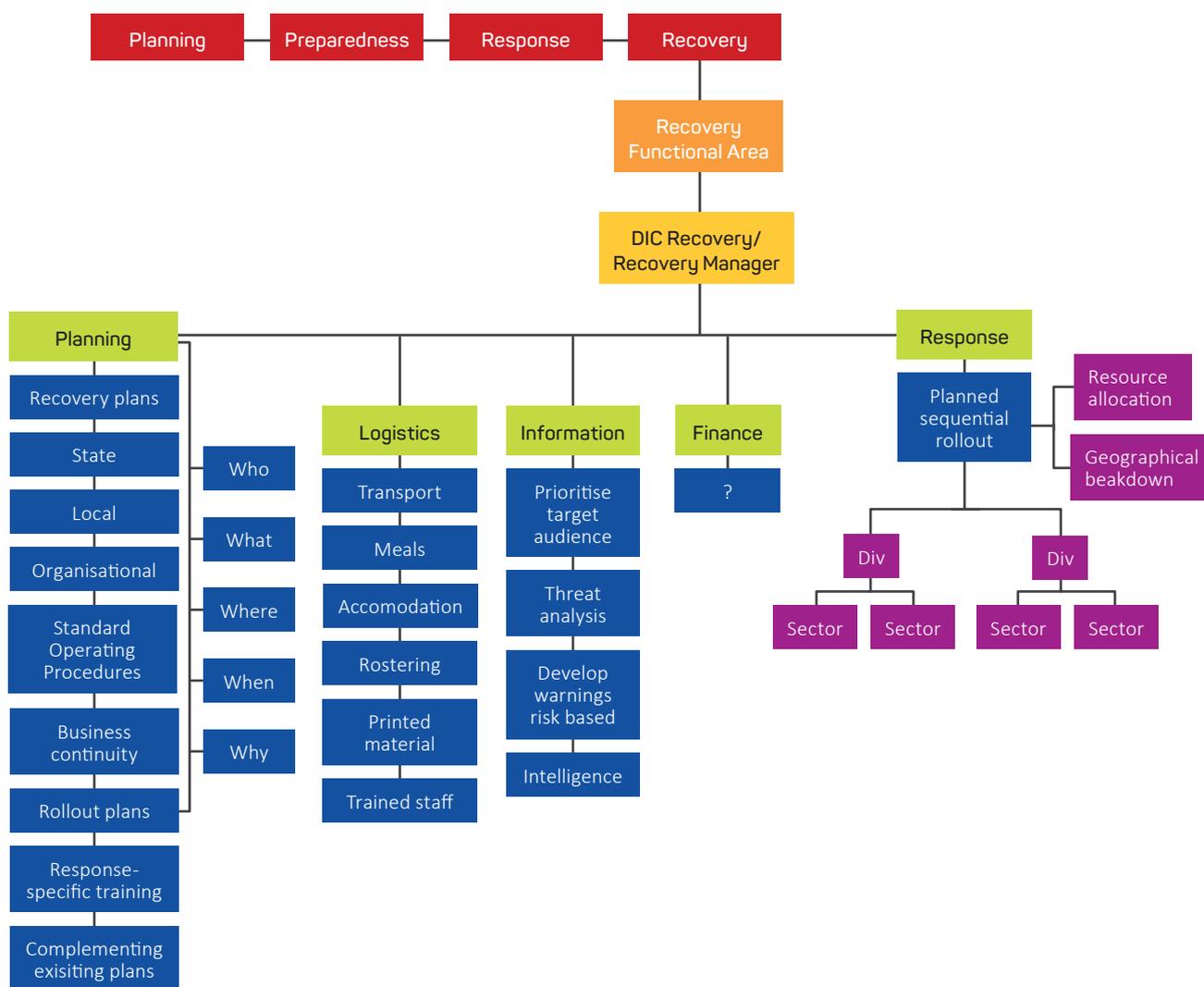


Figure 12: An example of AIIMS functional areas in support of recovery.

the Office of Emergency Management as Resilience NSW with a specific responsibility in preparation and recovery within the PPRR framework. Empowering Resilience NSW in a whole-of-government strategy using AIIMS could provide the means to address circumstances that led to its formation. Resilience NSW has released a NSW Recovery Plan (Resilience NSW 2021). This is an admirable start, but it remains that the *State Emergency and Rescue Management Act 1989* will be used to create a permanent entity to develop high-quality plans for and across NSW. When NSW faces challenges like those of 2019–20, recovery would benefit from using AIIMS command-and-control structures.

## Conclusion

The nature of the threats to communities due to climatic events is evidenced by the 2019–20 bushfires that led to recommendations in the *Final Report of the NSW Bushfire Inquiry* (Owens and O’Kane 2020). The BFCC looks to implement some recommendations but its role is confined to the statutory responsibilities of the NSW RFS (Bush Fire Co-ordinating Committee 2021). The State Recovery Plan is an excellent start. A comprehensive strategic response would lie with Resilience NSW and its State Emergency Management Committee (*State Emergency and Recovery Management Act 1989* (NSW), s.15). AIIMS provides a means of working across agencies to enhance the safety of communities in NSW and Resilience NSW is well placed to progress a whole-of-government response. To leave response to recommendations to individual agencies would put NSW at risk of being subject to the lack of appropriate prevention/mitigation, preparation and recovery that emerged from the 2019–20 bushfires.

There is little dispute that AIIMS is a robust and valuable system for incident management in Australia and New Zealand. PPRR, on the other hand is something of an orphan: obviously there but owned by none. Nevertheless, the value of the framework has not been seriously questioned as a conceptual framework for describing the transition from normality to disaster and back to a new normality. In many respects, PPRR operates at a strategic level while AIIMS is tactical. This paper has attempted to clarify what PPRR means during an incident. While prevention/mitigation are clearly pre-incident, preparedness has a different complexion in normality than during an incident under AIIMS. For Resilience NSW, AIIMS provides an appropriate means of carrying out recovery using a whole-of-government strategy for coordinating the work of agencies in prevention/mitigation, preparedness and recovery for the benefit of NSW.

## References

Adams M & Attiwill P 2011, *Burning Issues: sustainability and management of Australia’s southern forests*. Collingwood: CSIRO Publishing.

Attorney-General’s Department 2011, *National Strategy for Disaster Resilience*. Canberra. At: <https://knowledge.aidr.org.au/resources/national-strategy-for-disaster-resilience/>.

Australian Institute for Disaster Resilience (AIDR) 2021, *Systemic Disaster Resilience Handbook*. Melbourne, Victoria. At: <https://knowledge.aidr.org.au/resources/handbook-disaster-risk/>.

Anderson MB 1985, *A reconsideration of the linkages between disasters and development*. *Disasters*, vol. 9, no. 1, pp.46–51.

Atkinson S, Brown G, Fisher R, Fitzgerald Z, Rickards L & Keating A 2021, *Preparing emergency services for operations in a climate-challenged world*. *Bushfire and Natural Hazards CRC*, Melbourne, Victoria.

Australasian Fire and Emergency Service Authorities Council (AFAC) 2013, *The Australasian Inter-service Incident Management System*, Melbourne, Victoria.

Australasian Fire and Emergency Service Authorities Council (AFAC) 2017, *The Australasian Inter-service Incident Management System*, Melbourne, Victoria. At: [www.afac.com.au/initiative/aiims](http://www.afac.com.au/initiative/aiims).

Bush Fire Co-ordinating Committee (BFCC) 2021, *Conduct of Business: Charter*. At: [www.rfs.nsw.gov.au/\\_\\_\\_data/assets/pdf\\_file/0006/214629/Bush-Fire-Co-ordinating-Committee-BFCC-Charter.pdf](http://www.rfs.nsw.gov.au/___data/assets/pdf_file/0006/214629/Bush-Fire-Co-ordinating-Committee-BFCC-Charter.pdf).

Clode D 2018, *A Future in Flames*. Balmain: Ligature Pty Ltd.

Conway G 2012, *AIIMS Doctrine: have we got the fundamentals right?* *Australian Journal of Emergency Management*, vol. 27, no. 2, pp.54–57. At: <https://knowledge.aidr.org.au/resources/ajem-apr-2012-aiims-doctrine-have-we-got-the-fundamentals-right/>.

Coppola DP 2015, *Introduction to International Disaster Management (Third edition)*. Amsterdam: Elsevier/ Butterworth-Hein. At: [www.loc.gov/catdir/enhancements/fy1606/2014955858-d.html](http://www.loc.gov/catdir/enhancements/fy1606/2014955858-d.html).

Cronstedt M 2002, *Prevention, Preparedness, Response, Recovery an outdated concept?* *Australian Journal of Emergency Management*, vol. 17, no. 2, pp.10–13.

Cuny F 1985, *What has to be done to increase the effectiveness of disaster interventions*. *Disasters*, vol. 9, pp.27–28.

Department of Home Affairs 2018, *National Disaster Risk Reduction Framework*. At: [www.homeaffairs.gov.au/emergency/files/national-disaster-risk-reduction-framework.pdf](http://www.homeaffairs.gov.au/emergency/files/national-disaster-risk-reduction-framework.pdf).

Gabriel P 2003, *The development of municipal emergency management planning in Victoria, Australia*. *Australian Journal of Emergency Management*, vol. 18, no. 2, pp.74–80.

Gissing A, Eburn M & McAneney J 2018, *Planning and capability requirements for catastrophic and cascading events*. In *Non-peer reviewed research proceedings from the Bushfire and Natural Hazards CRC and AFAC Conference Perth*, pp.5–8.

Howes M, Grant-Smith D, Reis K, Bosomworth K, Tangney P, Heazle M, McEvoy D, Burton P 2013, *Rethinking disaster risk management and climate change adaptation: Final Report*. National Climate Change Adaptation Research Facility.

Jenkins BM & Edwards-Winslow F 2003, *Saving city lifelines: Lessons learned in the 9–11 terrorist attacks*. Mineta Transportation Institute College of Business, San José State University.

Kahane A 2012, *Transformative scenario planning: working together to change the future (1st ed. ed.)*. Berrett-Koehler Publishers, San Francisco.

Kelly C 1999, *Simplifying disasters: developing a model for complex non-linear events*. *Australian Journal of Emergency Management*, vol. 14, no. 1, pp.25–27.

Linton N 2021, *The PPRR Model in Emergencies and Disasters: Is it Relevant Today*. At: <https://nlinton.net/pprr-model-emergencies-disasters/> [23 October 2021].

Mullins G 2021, *Firestorm: battling super-charged natural disasters*. Viking.

Murphy T 2021, *Major Incidents Reports 2020–21*. Melbourne, Victoria. At: [www.aidr.org.au/news/major-incident-report-2020-21/](http://www.aidr.org.au/news/major-incident-report-2020-21/).

Neal DM 1997, *Reconsidering the phases of disasters*. *International Journal of Mass Emergencies and Disasters*, vol. 15, no. 2, pp.239–264.

National Interagency Incident Management System (NIIMS) 2004, *National Wildfire Consulting Group*.

NSW Government 2018, *New South Wales State Emergency Management Plan*. At: [www.NSW.gov.au/sites/default/files/2021-04/state-emergency-management-plan-emplan.pdf](http://www.NSW.gov.au/sites/default/files/2021-04/state-emergency-management-plan-emplan.pdf).

NSW Rural Fire Service 2019, *Community Field Liaison Training Slide Deck v.3.1*.

Owens D & O’Kane M 2020, *Final Report of the NSW Bushfire Inquiry*. At: [www.dpc.nsw.gov.au/assets/dpc-nsw-gov-au/publications/NSW-Bushfire-Inquiry-1630/Final-Report-of-the-NSW-Bushfire-Inquiry.pdf](http://www.dpc.nsw.gov.au/assets/dpc-nsw-gov-au/publications/NSW-Bushfire-Inquiry-1630/Final-Report-of-the-NSW-Bushfire-Inquiry.pdf).

Petak WJ 1985, *Emergency management: A challenge for public administration*. *Public Administration Review*, vol. 45, pp.3–7.

Quarantelli EL, Lagadec P & Boin A 2007, *A Heuristic Approach to Future Disasters and Crises: New, Old, and In-Between Types*. In H. Rodríguez, E. L. Quarantelli, & R. R. Dynes (Eds.), *Handbook of disaster research (ps.xxxi, 611)*. New York: Springer.

Reos Partners 2021, *Transformative Scenarios in a climate challenged world*. *Bushfire and Natural Hazards CRC*, Melbourne, Victoria.

Resilience NSW 2021, *NSW Recovery Plan*. At: [www.nsw.gov.au/sites/default/files/2021-04/Supporting-Plan-Recovery.pdf](http://www.nsw.gov.au/sites/default/files/2021-04/Supporting-Plan-Recovery.pdf).

Rickards L & Keating A 2021, *Implications of climate change for emergency services operations*. *Bushfire and Natural Hazards CRC*, Melbourne, Victoria.

Rogers P 2011, *Development of Resilient Australia: enhancing the PPRR approach with anticipation, assessment and registration of risks*. *Australian Journal of Emergency Management*, vol. 26, no. 1, pp.54–58.

Rubin CB (Ed.) 2012, *Emergency Management: The American Experience 1900–2010*. Boca Raton: CRC Press.

Rural Fires Act (NSW) 1997, [www.austlii.edu.au/cgi-bin/viewdb/au/legis/nsw/consol\\_act/rfa1997138/](http://www.austlii.edu.au/cgi-bin/viewdb/au/legis/nsw/consol_act/rfa1997138/).

Simonović SP 2011, *Systems approach to management of disasters: methods and applications*. Hoboken, NJ: John Wiley & Sons.

Simpson H, Bradstock R & Price O 2019, *A temporal framework of large wildfire suppression in practice, a qualitative descriptive study*. *Forests*, vol. 10, p.884.

State Emergency and Recovery Management Act (NSW) 1989, [www.austlii.edu.au/cgi-bin/viewdb/au/legis/nsw/consol\\_act/searma1989331/](http://www.austlii.edu.au/cgi-bin/viewdb/au/legis/nsw/consol_act/searma1989331/).

Tierney KJ 2007, *Businesses and Disasters: Vulnerability, Impacts, and Recovery*. In H. Rodríguez, E. L. Quarantelli, & R. R. Dynes (Eds.), *Handbook of Disaster Research (p.xxxi, p.611)*. New York: Springer.

Ulubasoglu M 2018, *Disasters and economic resilience: Income effects of the Black Saturday Bushfires on disaster-hit individuals*. In *Non-peer reviewed research proceedings from the Bushfire and Natural Hazards CRC and AFAC Conference Perth, 5–8 September 2018*.

United Nations Office for Disaster Risk Reduction (UNDRR) 2015, *Sendai Framework for Disaster Risk Reduction 2015–2030*. Geneva. At: [www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030](http://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030).

Wendling C 2010, *Explaining the emergence of different European Union crisis and emergency management structures*. *Journal of Contingencies and Crisis Management*, vol. 18, no. 2, pp.74–82.

Young C & Jones R 2018, *Valuing recovery through risk ownership*. *Australian Journal of Emergency Management*, vol. 33, no. 1, pp.48–54.

## About the authors

**Alan Holley** was a NSW Police Officer for 34 years. He was the Local Emergency Management Officer in the Blue Mountains of NSW for 8 years, looking at emergency management from the perspective of local government and local government delivery of services and capacities. He has been an NSW RFS volunteer since 1978 delivering on-ground services and NSW RFS services at district and state levels.

**Dr Tony McArthur** began teaching in 1975 and was an assistant principal and administrator with the Catholic Education Commission NSW and Catholic Schools NSW. His responsibilities included emergency management support involving system design, training and operation. He has served in the NSW RFS since 1992.



Australian Government  
National Recovery and Resilience Agency



FRIDAY 26 AUGUST 2022

# National Recovery Forum

📍 Adelaide Convention Centre

[AIDR.ORG.AU/RECOVERYFORUM](https://aidr.org.au/recoveryforum)





Australian Government  
National Recovery and Resilience Agency

Australian Institute for  
Disaster Resilience 

**RESILIENCE IN A RISKIER WORLD: ADAPTING  
AND TRANSFORMING FOR THE FUTURE**

# adrc 22

Australian Disaster  
Resilience Conference

**REGISTRATION  
NOW OPEN**

📅 24 – 25 August 2022  
📍 Adelaide Convention Centre

➔ [AIDR.ORG.AU/ADRC](https://aidr.org.au/adrc)

  [#ADRC22](https://twitter.com/ADRC22)