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About the journal

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

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

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Image: A severe storm approaches the Gold Coast residential areas in October 2022

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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@aidr.org.au. All research articles are peer reviewed. The *Australian Journal of Emergency Management* is indexed by several indexing organisations.

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

Foreword

Rob Webb

CEO, AFAC

It's hard to fathom just how much our society has changed in 40 years, communities have changed, technology has changed and sadly so too have our disasters.

The advent of computers, machine learning and AI, particularly over the last 30 years have brought into sharp focus how we use tools but fundamental to it all is our ability to create, curate and record knowledge. The 1980's foresight to create and maintain a collection of emergency management knowledge has left a legacy that we will use for decades to come.

In the April edition of the *Australian Journal of Emergency Management* (AJEM), we continue celebrating 40 years of publication by looking back at the people and ideas that have helped shape the journal and the emergency management sector.

For AFAC, AJEM remains a cornerstone of how evidence, experience and insight are shared across the emergency management sector. It provides a trusted space where research meets practice, enabling practitioners, policymakers and leaders to learn from each other and strengthen collective capability over time.

This edition includes conversations with past journal contributors, who revisit their early articles, reflect on how their field has evolved, and share their perspectives on the future direction of AJEM. John Richardson, AIDR Executive Director reflects on AJEM's second decade, including how the emergency management field broadened and matured during this decade.

The research papers in this issue address critical questions emerging from recent disaster experience in Australia. Associate Professor Iftekhar Ahmed leads a paper on shelter after disasters, exploring the consequences of prolonged displacement and the limitations of temporary housing solutions in a context of housing shortages and rising regulatory costs.

Broader structural and social dimensions of disaster risk are explored in 2 further research papers. Dr Victoria Heinrich and team present research on flash flood warnings, examining how knowledge, experience and uncertainty are interpreted by both practitioners and the public, and identifying persistent gaps in understanding that complicate risk communication. Dr Silke Clausing examines the gendered impacts of disasters in Aotearoa New Zealand, highlighting how unpaid care responsibilities and employment disruption disproportionately affect women, and calling for stronger integration of gender equity into disaster law and policy.

The more we learn, the more society changes. As we look forward to the coming 40 years, we know that risk is changing in a complex and dynamic way. How our society will define knowledge is pointing to a range of new opportunities and threats. What won't change is the need to connect with our communities where they are in place and time.

AJEM remains a trusted place for shared learning and thoughtful debate. By connecting evidence with experience, the journal helps the sector adapt, improve and approach the future with confidence.

Vale
Philip Buckle

Remembering Philip Buckle, his drive and commitment.

Perhaps less known in current Australian emergency management circles than he should be, Philip Buckle was one of the pioneers and ground breakers of much of our approach to recovery and resilience building.

In 1983, Philip was the disaster management lead with the Victorian Government's Department of Premier and Cabinet when the Ash Wednesday bushfires swept across south-eastern Australia. One of his responsibilities was managing the distribution of funds to affected families which was very challenging. Philip created a new approach to recovery as he applied it, establishing a team that followed his lead over the months that followed.

The Victorian Government then recognised the need for a people-centred approach to recovery and established the Disaster Support and Recovery Unit within Community Services Victoria. Philip soon became its manager, leading the development of the community-centred approach to recovery that still underpins effective practice more than 40 years later.

In this role, Philip went on to establish recovery programs for bushfires, floods, and the Queen and Hoddle Street shootings. He also provided recovery advice and support to interstate colleagues, including after the Port Arthur shootings.

Throughout this period, Philip contributed to systemic change, being a key driver in the development of *Providing Psychological Services in Emergencies: Guidelines* (1999), *Community Development Handbook* (1999), *Community and Personal Support Services: Guidelines* (1997), and the *Disaster Recovery Manual* (1996).

A key part of Philip's contribution was his early interest in how systems could focus greater attention and investment on communities to build disaster preparedness. This evolved into research on resilience with co-authors Syd Smale and Graham Marsh, starting in the mid-1990s. It was this work that shaped so much of today's focus on resilience.

Philip migrated to Australia from the UK at a young age. A visit back to the UK in mid-life led him to realise it was time to return and spend more time with his family. This also marked a shift in his professional focus, to teaching in UK universities, then as a freelance consultant for international aid and resilience-building programs.

Philip designed plans to mitigate extreme events, supported and evaluated capacity-building globally, and collaborated with International Development Agencies across Central Asia and numerous other Asian countries.

His commitment, until the end of his life, was driven by a determination to test whether disaster risk reduction projects were truly effective for the people they were intended to serve. His concern was that there were often clear benefits for contractors, consultants, donors, and host governments, with too little demonstrable benefit for communities themselves.

Philip also undertook research initiatives to inform the sector globally, and he was a prolific author contributing often to the Australian Journal of Emergency Management.

To colleagues and team members, he was renowned as a significant practitioner-scholar in disaster recovery, resilience, and risk reduction. Across government, academia, and international agencies, his contribution to emergency management was deep and enduring.

All who knew him experienced his loyalty, commitment, principled approach, and quirky humour. We learnt a great deal from his insightful, questioning mind and his unwavering commitment to disaster-affected people. He challenged us to keep improving our practice, always reminding us that recovery should be shaped by affected people, and that they must have both a voice and the power to direct their own recovery. We carry a keen sense of the absence of his voice and writings, which so often pushed us to do better.

Philip's family, friends and colleagues feel his loss deeply.

Contributors:

Rene Buckle, daughter of Philip Buckle, and friends and colleagues

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The Australian Journal of Emergency Management (1996–2005): themes from the second decade

John Richardson

Executive Director,
Australian Institute for
Disaster Resilience

'I mean, can you imagine anybody taking a copy of The Australian Journal of Emergency Management with them to bed for night-time reading' quips Nicholas Kanarev (Vol 11/1, 1996) of the second decade of the *Australian Journal of Emergency Management* (AJEM). 'It's all gloom and doom.' The line is funny, but it also captures the journal's early seriousness and sets up how much the field broadened and matured over the following decade.

Across 1996–2005, AJEM shows a clear shift from practice notes toward stronger theoretical foundations and more complex problems: AIIMS, quality and risk management, volunteer management, risk communication, land-use planning, and (increasingly) community engagement. The first peer-reviewed paper appears in Volume 12, Issue 4 (1997) and the journal consistently features internationally themed contributions from authors outside Australia.

Several papers from this period strongly shaped my own thinking for Red Cross' Emergency REDiPlan. Handmer's *We are all vulnerable* in (Vol 18/3, 2003) helped shift the frame from deficits to strengths and resilience. Paton, Smith and Johnston's *When good intentions turn bad* in (Vol 20/1, 2005) distilled a practical truth – connected communities are prepared communities – that later informed the message 'Know your neighbours'. Morrissey and Reser (Vol 18/2, 2003) added an under-discussed dimension: psychological preparedness as a legitimate part of readiness.

The information age arrives late in the 1990s. McRae (Vol 11/4, 1996) predicts the World Wide Web will overtake fax as a source of weather and warning information. Fischer (Vol 14/3, 1999) flags the prospect of 'a potential new form of disaster' arising from large-scale computer system failure. McKinnon (Vol 13/3, 1998) captures the anxiety of the Millennium Bug – widely feared as a community-wide electronic threat, though it ultimately passed with little disruption.

Risk management becomes a dominant thread. Koob (Vol 11/2, 1996) sets the context, while Smith et al. (Vol 11/2, 1996) apply the risk management standard to community risk management. Later, Godber (Vol 20/3, 2005) examines tensions between local government, developers and residents over what counts as 'acceptable' flood risk.

Risk is also treated as social and contested. Young (Vol 13/2, 1998) argues perceptions of risk vary widely; Barnes (Vol 17/1, 2002) explores the community meanings that sit behind those perceptions. One implication is ethical as much as technical:

> *People can evacuate their homes as a cyclone approaches or choose to take part in certain hazardous activities, but they cannot avoid the results of another person's decisions.*

Yates (Vol 14/2, 1999) offers a pointed warning about leadership capacity:

> *Although the emergency services are good at developing good transactional leaders skilled in their specific craft, their structure and culture tends to limit the development of transformational leaders with broad outlooks and breadth of experience. The absence of this aspect of leadership can limit the ability of emergency service organisations to cope with a rapidly changing environment.*

Volunteerism is a persistent focus, culminating in Volume 20's special themed edition on volunteers. Topics range from legal aspects for their protection (Eburn Vol 18/4, 2003) to the relationship of volunteers and building

social capital (Fahey Vol 18/4, 2003). Reinholdt (Vol 14/4, 1999) identifies demographic challenges facing volunteer management that sound all too familiar: 'Factors such as population growth, rural and urban mobility, and increasing cultural diversity present challenges to service providers. These factors increase the demands for, and the complexities of, service delivery by volunteers, and create complex management issues.'

Case studies also illustrate a growing 'partnerships' approach. The Berri example (Pisanello et al. Vol 17/2, 2002) show community leaders engaged in emergency risk management planning, while Dovers (Vol 19/1, 2004) connects sustainability and disaster management through shared challenges such as uncertainty, integration across social – environmental – economic policy, and inter-agency coordination.

The 'prevention, preparedness, response and recovery' paradigm is repeatedly questioned. Tarrant (Vol 12/4, 1997) asks what a 'prepared community' actually means; Kelly (Vol 14/3, 1999) highlights the non-linear complexity of disasters; and Cronstedt (Vol 17/2, 2002) calls the dominant model outdated.

Governance and law become more prominent. Sarre and Doig (Vol 15/3, 2000) argue corporate recklessness can be a disaster driver and that risk considerations belong in governance structures. Dunlop (Vol 19/1, 2004) notes emergency service organisations operate in a far more legally complex environment than a decade earlier. Taylor (Vol 18/1, 2003) considers terrorism and corporate malfeasance within disaster classification, cautioning against losing context when analysing traumatic events.

'The recklessness, or reckless indifference, of corporate entities, often causes disasters' opens Sarre and Doig's paper (Vol 15/3, 2000) on the importance of embedding disaster risk considerations into corporate governance structures. 'A decade ago, emergency service organisations ("ESOs") were rarely sued, rarely questioned and rarely thought to be affected by legislation such as Occupational Health and Safety Acts. Today the situation is infinitely more complicated' writes Dunlop in her review of legal issues (Vol 19/1, 2004). Taylor (Vol 18/1, 2003) looks at how complex terrorism and corporate malfeasance could be brought into the classification of disasters. He cautions, 'In times of turbulence there is much to be said for putting traumatic events in appropriate context before considering their features in detail.'

Surprisingly, the first examination of warnings arises in 2002 with Pfister's paper (Vol 17/2, 2002) on the failure of warnings in Grafton. Warnings are revisited by Betts in Victoria (Vol 18/3, 2003), and by Molino et al. (Vol 17/2, 2002) in the Hawkesbury Nepean in NSW. In an alternative view, Kanarev (Vol 11/3, 1996) gives us an amusing tour through novel disaster prediction methods, including televisions, onions, and pets acting strangely. He channels his inner Fox Mulder:

> *It is unfortunate that science has hijacked the debate about what is and what is not acceptable material for study in emergency management. As a consequence, phenomena deemed paranormal has been ostracised to the periphery of scientific inquiry.*

This decade also sees the emergence of community safety and the shift from information to engagement. Neilsen and Lidstone (Vol 13/3, 1998) seek to underpin this in educational theory. Papers on cyclone awareness in schools in North Queensland (Berry and King Vol 12/2, 1998), fire awareness in Tasmania (Butters Vol 12/2, 1998), and the CFA's Bushfire Blitz street corner approach to community engagement in Victoria (Hill Vol 12/2, 1998).

Attention to economics and policy sharpens. Gentle et al. (Vol 16/2, 2001) outline the costs of disasters in Australia. The groundbreaking work arose out of a need to put the value of mitigation expenditure on a sounder footing than had previously been the case. Cost sharing policies, particularly the forerunner of the Disaster Recovery Funding Arrangements, comes under significant scrutiny on the lack of betterment provisions (Smith Vol 12/3, 1997) and the states for onerous requirements from the Australian Government (Gabriel Vol 12/1, 1997).

A notable expansion is the explicit focus on values beyond life and property. Spennerman (Vol 11/1, 1996) outlines the unnecessary loss of highly valuable cultural heritage resulting from the unintended consequences of well-intentioned mitigation measures. Volume 14, Issue 3 (1999) was focused on ecological disasters, recognising that emergency management is broader than 'life and property'. Dovers and Handmer (Vol 14/2, 1999) define 'ecological emergencies' as sudden-onset events where the subject is non-human, such as biological diversity, an ecosystem, a species, or a river system. Somewhat presciently, one of the papers examines the issue of Blue Green Algal blooms (Whittington Vol 14/3, 1999) – an early signal of environmental risk as a mainstream emergency management concern.

On considering values, trade-offs and decision making, Britton (Vol 16/4, 2001) quotes Dennis Mileti's clear eye critique:

> *Until people are ready to address the inter-dependent root causes of disasters and to do the difficult work of coming to negotiated consensus about which losses are acceptable, which are unacceptable, and what type of action to take, communities will continue a path toward ever-larger natural disasters. Part of the unlearning process requires people to be comfortable with shifting from 'disasters as acts of god' to 'disasters as acts of human intervention'.*

Local government emerges as central, as seen in Wapling's account of the 1993 Northeast Victorian floods (Vol 11/2, 1996) and later discussion of councils' roles in municipal emergency planning (Gabriel Vol 18/2, 2003).

Equity themes begin to surface more clearly. Wraith (Vol 11/4, 1996) bluntly asks, 'Where are all the women?', as gender and disaster impacts start to be treated as relevant to emergency management practice and research.

Emerging and novel topics include Drabek's piece on tourists in disasters, Salibury's paper on the anthrax outbreak in Victoria, and blue green algae. This interesting paper from Fletcher (Vol 17/1, 2002) examines impacts on residents 2 years on from storms in Wollongong in 1998. It is interesting for 2 reasons; the first being the first longer term impact presented, and the other being a study of a storm, an oft neglected subject. Exotic animal diseases, which received significant attention in the first decade of AJEM, is again featured in a themed Volume 9, Issue 3 (2004). The NSW Hailstorm in 1999 receives significant attention with Keys (Vol 14/4, 1999) examining the response, and Yeo et al. (Vol 14/4, 1999) examining the impacts and costs.

The psychosocial impacts of disasters are profiled throughout the decade, with a number of papers that consider the Port Arthur Tragedy (Harper Vol 12/1, 1997), the challenges of sensitively managing Disaster Victim Identification (Eyres Vol 17/1, 2002), the impact of trauma on journalists (MacMahon Vol 16/2, 2001), and Bryant's paper (Vol 14/2, 1999) on acute distress disorder as a predictor of post traumatic stress disorder.

Recovery also features significantly with Volume 13 (1998) featuring several papers, papers on Port Arthur, and special themed edition based upon the New Zealand Recovery Symposium, featuring a great array of recovery luminaries from the United Kingdom, New Zealand and Australia. Eyres, Coles, Buckle, Gordon, Coghlan, Norman are among the names (Vol 19/4, 2004). Eyres (Vol 14/3, 1999) provides us with the first examination of the importance of post disaster rituals and symbols in recovery.

Landslides in Australia have deadly outcomes. Leiba et al. (Vol 12/1, 1998) outline the deadly nature of landslides in Australia. Shortly after this was published, the tragic Thredbo disaster occurs. The first 12 months of recovery is detailed by Dawe (Vol 14/1, 1999): 'Most people thought that the community and its individuals would be substantially recovered within weeks, apart from the grieving of friends and relatives. … The reality has been more difficult.'

The concept of vulnerability and resilience emerges strongly across this decade. Buckle (Vol 13/4, 1999) refines community vulnerability. Buckle, Smale and Marsh (Vol 18/2, 2003) reframe risk to what is important to communities, and not agencies. King and McGregor (Vol 15/3, 2000) give us the first examination of the use of social indicators to determine social vulnerability. People with a disability are recognised as a neglected topic in emergency management and research (Parr Vol 12/4, 1997). The conclusion pulls no punches:

> *The continued failure of disaster mitigation policy to target the needs of persons with disabilities constitutes a serious violation of their human rights and fundamental freedoms.*

Multicultural communities also receive their first attention in 2003, with Mitchell's (Vol 18/1) paper on guidelines for emergency managers.

Yates (Vol 12/3, 1997) implores closer cooperation between Aboriginal affairs and the disaster mitigation policy communities. 'In particular, the disaster mitigation policy community needs to become engaged with the frameworks established to coordinate service provision to remote Aboriginal and Torres Strait Islander communities.' The Skertchlys (Vol 14/4, 1999) firmly place traditional Aboriginal knowledge at the centre of their paper:

> *The assured, direct and simple, renewable and enduring, traditional Aboriginal approaches to natural hazard counter-disaster capabilities, contrast markedly with many present by lifeline and hazard mitigation features and frailties integral to the complex, interlocking, advanced Western services, resources and infra-structure systems, upon which Information Age High Technology Human Settlements are now so critically dependent for survival.*

In Queensland, McLachlan's study (Vol 18/1, 2003) shows how understanding Indigenous communities' coping mechanisms can lead to better disaster management strategies. Hocke and O'Brien (Vol 18/2) also visit this theme of strengthening community capacity. Newman and Smith (Vol 19/1, 2004) detail Western Australia's approach to integrating risk management in remote Aboriginal communities.

And finally, the decade ends with Volume 20, Issue 4 (2005), *Notes from the Field: Australian Forward Assessment Team: Trip to Washington DC, USA* and a photo of the author of this piece, holding his 2 young daughters on return at the airport. He can no longer lift these 2 up in his arms.

A brief history[1] of Australian emergency management

John Handmer

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Abstract

This is a personal view of the history of emergency management (EM) in Australia, starting in the 1970s. It was at that time that EM shifted from a civil defence focus to emergency management. There are many interesting episodes and issues, but this brief sketch can touch on only some at the national level with occasional mention of NSW. The broad system - officials, volunteers, trainers, researchers - worked to steadily improve the EM system and outcomes. Nevertheless, today there is significant criticism of EM in major complex events from both the public and agencies. The article concludes with a comment on EM from the perspective of the public and the realities faced by emergency services.

Introduction – the 70s as a polycrisis

Fifty years ago, Australian emergency managers found themselves dealing with multiple major crises while transforming to a new approach (Wettenhall 1975). The 1967 Hobart interface fire was fresh in the minds of agencies across the country, when the 1970s started with Cyclone Ada bringing massive losses. In a decade of major disasters, 1974 was a standout. The year commenced with Cyclone Wanda and the Brisbane floods and finished with the near complete destruction of Darwin by Cyclone Tracy on Christmas Day. This was on top of extensive flooding throughout the Murray-Darling river system, and the 1970 flu epidemic with its high mortality rate (Brown et al. 2025). Disasters were not confined to natural phenomena. The worst of these was the 1977 Granville (Sydney) train crash. Other examples include: the 1970 Westgate Bridge collapse in Melbourne, the 1974 Tasman Bridge collapse in Hobart, and the Whisky Au Go Go nightclub fire.

The 1970s were also a tumultuous period in national politics with major institutional change and disruption in government, including in emergency management. Any historic assessment of Australian emergency management needs to appreciate that these were very challenging times – a 'polycrisis'.

This article sketches out a perspective on the evolution of Australian emergency management since the 70s. Partly because this is my personal view and partly because of its brevity, it is unavoidably very partial.[2]

This is a personal view

This article reflects my personal view, and there are many other views on the history of emergency management. It starts in the 1970s as my professional involvement with the sector commenced then. In 1976 I was researching the lower Shoalhaven flood hazard (Handmer 1976) and attended the first international disaster conference held in Australia, the *Natural Hazards Symposium* (Heathcote and Thom 1979). From mid-1977 I spent two years at the University of Toronto in an international environment, followed by a PhD at ANU on flood risk (Handmer 1984). At Australia's first national floodplain management conference in 1980, I reported on my Canadian work (Handmer 1980; Handmer and Milne 1981).

My first visit to the Australian Counter Disaster College (ACDC) at Mt Macedon was in 1979. As students, it was memorable to be hosted to a fine liquid lunch by the college directors, and to take advantage of the subsidised bar. After serving time working on flood risk in the

1. Note that a longer version of this article will be available in late 2026.
2. Broadly defined, emergency management in the sense of crisis management includes a wide range of organisations and sectors including fire and bushfires, welfare, health, biosecurity, industrial and transport, and other specialists – there is not the space to cover these here. Nor is there the space to cover the experiences of specific groups within Australian society.

UK and Australia, and two years in the Solomon Islands and Vanuatu, I started work with the new Bushfire Cooperative Research Centre (CRC) in 2003 with financial support from emergency management agencies, and joined the CFA as a volunteer fire-fighter. Following the Black Saturday fires of 2009, with many others, I worked with the Royal Commission and agencies on social science research and was also involved in the special report on extremes from the Intergovernmental Panel on Climate Change (IPCC 2012).

Overview of Australian emergency management 1970s to ~2020

When discussing the evolution of emergency management from civil defence, this overview (and most others) focus on the institutional structure rather than function. Many functions such as flood risk management, fire and bushfire risk reduction and response, recovery support, insurance, have distinct histories unrelated to, and much older than, civil defence. Rural people long had (mostly informal) place-based community organisations to help with locally frequent hazards – typically bushfires and floods.

The major trends in Australian emergency management were generally similar to those overseas, especially in the US, and to broad trends in Australian government.

Civil defence to emergency management

Until the early 1970s there were civil defence organisations with a war orientation at the national level and some states/territories. By the 1970s, these were in a crisis of purpose and identity.[3] The 1967 Hobart fires highlighted the need for major change (Jones 2019:21).

Change came in February 1974, when the Prime Minister announced that: 'Cabinet decided to create a Natural Disasters Organisation [NDO] which will absorb the existing Civil Defence Organisation and put new emphasis on the threat of floods, bushfires and other disasters… My telegrams have already been despatched [to state premiers]' (Whitlam 1974). The NDO[4] was created immediately following the 1974 Brisbane floods, with its first major operation being Cyclone Tracy in Darwin at the end of the year, but its genesis was in the 1967 Hobart fires (Jones 2019:21). The creation of the NDO and the state and territory emergency services formalised the move away from a wartime focus as the civil defence apparatus morphed into emergency management.

Even though it remained in Defence, the new organisation worked hard to shift the national culture. In taking over the ACDC (previously the Australian Civil Defence College, renamed the Australian Counter Disaster College), one of the tasks for the NDO was to 'establish a decent research capacity' (Jones 2019: xiv) and to produce a set of guides for the new emergency management focus. From the outset, the college was keen on collating relevant research; and there was much after the floods and Cyclone Tracy, including the first detailed Australian study of flood losses (SMEC 1975). The ACDC published the first compilation of emergency relevant Australian research, and the *Australian Counter Disaster Handbook* in 1980. This evolved through the 1980s into an all-hazards, all agencies, all strategies, and prepared community approach drawing on US work (Jones 2019:30). The ACDC practiced an inclusive approach bringing together agencies, researchers, the private sector and media, and started publishing *The Macedon Digest* (now AJEM) in 1986 at the initiative of the librarian, Robert Fleming.

However, in terms of broader risk reduction, much less was achieved, especially if it involved politics. Post-event recommendations in the 1950s and 1970s to limit exposure did not get far despite some strong attempts by NSW state agencies. There were, however, local flood related building regulations (Williamson 1975), which were abolished with the introduction of the national building code. Warnings were seriously inadequate in most areas. Progress was slow. A survey at a 1986 national meeting on flood warnings (Smith and Handmer 1986) found that the highest priority among officials was the need for institutional clarity. The possibility of a government-backed disaster insurance scheme was investigated in the 1970s, but was rejected by the then Treasurer, John Howard, as 'governments should not intervene in matters that can be left to the private sector' (Handmer 2002); an attitude largely mirrored today (Jones 2024).

> *We will abolish the concept of the 1 in 100 flood!*
> Liberal Party election brochure, 1983

Politics were involved in other ways as well. NSW local flood maps distributed for public information, became a political liability and were dumped by Premier Neville Wran on talkback radio (Handmer 1986).

Consolidating emergency management practice

Reflecting on the late 1980s, EM leaders encapsulated the system as: 'Interdepartmental Committees, BBQs, and back-stabbing' (IDCs make the formal system work, BBQs ensure that people talk and cooperate across silos despite the formal system, and back-stabbing allocates blame).[5]

3. Note that despite the major changes in the 70s, debate continued for many years, within the national bureaucracy, on the definition and functions of civil defence (Jones 2019).
4. There are a number of explanations for the name. For some including Roger Jones (2019), the name is understood to be the result of a typo as it was meant to be the National Disasters Organisation. However, I heard that it was a deliberate ploy to reflect the shift from a war focus, and to ensure that the organisation did not get involved in civil disputes like strikes or disturbances. Google's AI summary also states that the last minute change in name was to avoid offending the states by implying a takeover of their emergency management responsibilities.
5. This quote was sourced from the results of a survey at the workshop: Managerial Strategies for Building Inter-agency Co-operation held at the Australian Disaster and Emergency Management Conference: 6th March 1991, Sydney.

By this time the comprehensive Prevention, Preparedness, Response and Recovery (PPRR) and multi-hazards approaches had been formally introduced (Jones 2019:24), and there was considerable international engagement, especially in the South-west Pacific, through the IDNDR (International Decade for Natural Disaster Reduction). There was strong formal involvement by Australian Red Cross and other non-governmental organisations (NGO) at this time, for example, in the development of many key guides including the National Principles for Disaster Recovery in 1986. The ACDC functioned as a multi-sector focal point to promote good practice and raise the standard of EM nationally. A major change occurred in NSW when the new director, Major General 'Horrie' Howard moved the SES to Wollongong (in 1990), losing many existing headquarters staff in the process, and fundamentally changing its culture and focus.

The 1983 Ash Wednesday bushfires across Victoria and South Australia triggered research on community fire safety (Wilson and Ferguson 1984) and the long-term psychological impacts of disasters (McFarlane 1986). The 1989 Newcastle earthquake was a reminder of a long-downplayed risk and provided a major boost to Australian seismology as well as earthquake monitoring and building codes.

Our task is to manage community vulnerability
Chas Keys, personal communication, early 1990s

In pursuit of resilience (then termed vulnerability), many allied disciplines and sectors (e.g. health promotion, mass media, private sector, major NGOs, and a wide range of researchers, among others) contributed to ACDC. There was a heightened emphasis on warnings after the 1990 NSW floods (part of flooding across eastern Australia that year), which was a major media event as the Nyngan Levee was overtopped. This led to the development of the initial ACDC warning guide developed by a small ad hoc group (Elliott et al. 1995). Community education for safety and disaster risk reduction has a long history (Gilmore 1987) and during the early 1990s EMA took a leading role. This included action guides and innovatively the use of the 'Life. Be in it' campaign to develop and promote public awareness and education material on hazards (Handmer 1994).

Nevertheless, it was usual for meetings at ACDC to be mostly attended by men (reflecting the military and police involvement), apart from meetings to do with recovery and welfare which were predominantly attended by women. But this is not the full picture. At a 1991 disaster conference organised by a society and culture group (Baggett 1992), much was made of the critical, albeit informal, role of women in rural areas: handling communications in a kitchen with the central base radio and landline phone; coordinating fire-fighting across large expanses as they were often the only people with an overview of the event; while also undertaking catering, transport, first aid and homestead tasks. With increasing communication sophistication and the accompanying centralisation and system formalisation, some of these roles vanished. Other vital informal support continues to be under-acknowledged.

The NDO became Emergency Management Australia (EMA) in 1993 and ACDC became the Australian Emergency Management Institute (AEMI). At this time NDO/EMA had a close 'special relationship' with the state and territory emergency services (Jones 2019:32), for example co-funding planning officers to encourage more effort on risk assessment and preparedness. The 1994 Sydney bushfires, with RFS Commissioner Phil Koperberg masterfully managing the media, saw a large informal mobilisation including businesses from across eastern Australia.

I've seen a lot of risk assessments, but I've yet to see a difference in decision-making
Senior NERAG official, personal communication, n.d.

A risk-based approach was developed in the 1990s, driven in part by AEMI. Initially though the Australian/New Zealand Risk Management Standard 4360:1995, and then internationally through ISO 31000 Risk Management - Guidelines, which formed a basis for the National Emergency Risk Management Guidelines (NERAG), (EMA 2000; Jones 2013; Salter 1997). As part of the increasing interest in quantification and measurement, the Bureau of Transport Economics produced a detailed assessment of the costs of disasters in Australia (BTE 2001; updated by Handmer et al. 2016, 2018).

The Mandarins

Our role is to protect Australian lives and livelihoods – no, your role is to protect the Minister
Participants at an EMA gathering with the new management, personal communication. ~ 2000

At the turn of the century, EMA was moved from Defence into the Attorney-General's Department. Many welcomed the move, but there were implications. Defence seemed more relaxed about 'outsiders', actively seeking their involvement. It had also been task-focused, generally downplaying politics, in contrast to the national bureaucracy. At the same time, following 9-11, there was a rapid shift in government concerns from risk management to national security and counterterrorism (CT) (Jones 2019:35). Some functions of EM and CT were subsequently merged. To some at EMA it was like a mouse competing with an elephant, and in many ways the fields could hardly be more different. The national government was not the only one to restructure – something that became a habit. Some state jurisdictions changed frequently in the search for the illusory 'right' emergency management structure.

The research scene changed dramatically with the AFAC-led *Bushfire CRC*. At the time EM/AEMI were supporting my research group at RMIT University in Melbourne. By agreement these funds (and some researchers) were redirected to support a social science program within the Bushfire CRC where we worked closely with practitioners and AFAC.

Toughen up – take a spoonful of cement!
Australian slang

This became the era of resilience promotion, however 'the agencies have to hand over some power to those at risk for resilience to work, but they won't!' (senior Victorian official, personal communication, n.d.). Following the 2011 Brisbane floods, the *National Disaster Resilience Strategy* was launched (NSDR 2011). All states and territories ran with the idea: telling those at risk that they need to be resilient, while generally increasing their power and authority and reducing the space for people to take action (McLennan and Handmer 2014). This interest spawned the Australian Disaster Resilience Index developed by Melissa Parsons and team at the University of New England.[6] Another conceptual challenge was the tension between the humanitarian focus of much EM and the increasing focus on consequence management and demands for more prevention.

In an era of climate change, the first two decades of the new century were dominated by bushfires, severe record-breaking heatwaves and droughts (along with cyclones and floods), with enquiries and many recommendations, in particular for the 2009 Black Saturday Victorian fires. Very active research and practice climates and EM networks were established, such as the National Climate Change Adaptation Research Facility (NCCARF) based at Griffith University and in Victoria the Victorian Centre of Climate Change Adaptation Research based at the University of Melbourne (Keating and Handmer 2013). Although both of these are long gone, some of the key work continues. The extensive bushfires of 2019-2020 brought renewed demands for action on climate change as the fires were seen as symptoms of the changes. Former fire and emergency leaders have been very actively pushing for action through their group, Emergency Leaders for Climate Action (ELCA).

We need a nationally uniform approach
Common government sentiment

More recently, there has been a near explosion of strategies and frameworks, with the mission of creating a nationally uniform system to apply from central metropolitan areas to remote rural locations. It is not clear that this fits well with the aim of emergency management: 'to maintain the public's trust and confidence' (Mark Crosweller, personal communication, n.d.). It also goes against the closure of AEMI in 2015, and the end of the physical national focal point - and with it much informal cross-silo discussion and debate. This takes us into the current phase of Australian emergency management. EMA was merged into Home Affairs, becoming NEMA in 2022. The national research focus continued after the end of the Bushfire CRC and its successor, with the establishment of Natural Hazards Research Australia (NHRA).

…[E]very dimension of Australian society…is now part of the broader national security equation.
Langford, cited in ASM Admin 2025

Heather Smith (Keynote at the 2024 AIIA National Conference, Canberra) made a similar point about the securitisation of Australia. This highlights the formalisation and gradual militarisation of the sector – at the national level – also known in the sector as 'khakisation'. In part, this reflects the growing appreciation of the critical importance of the many complex networks that support contemporary life and economy, their potential for systemic cascading impacts, and our long-term lack of investment in system security. It can appear that we are almost back where we started with a wartime focus.

Comments on the people and agencies

There is not nearly enough space to mention, let alone do justice to the many issues and opportunities in Australian emergency management. Some of the issues seem chronic as they ritually appear in reviews and enquires; for example, communication and coordination between agencies, and public education. The fact that these come up at most public post-event reviews, suggests to some that the reviews are not taken seriously. To others, it shows how challenging it is to get these things right in constantly evolving social and government contexts. Another view is that the management of complex crises of the sort that are typically the subject of reviews will, by definition, be less than perfect. Public post-event enquiries are not established because there were no problems, and so cannot declare that all is well.

Here I comment on two areas: the people and agencies.

The people

People are often well served with local community development officers, community preparation meetings, emergency volunteer groups drawn from the community, and NGOs. However, they often find that agencies now care more about their processes, protocols and KPIs than about the suffering and needs of the people (Crosweller 2024; Easthope 2023, 2025).

People's resilience is welcome, but only on agency terms. In the early days of this review, people and communities often worked closely with the official system (Handmer

6. See https://adri.naturalhazards.com.au/#!/

and Maynard 2022), providing rapid local surge capacity. Recovery committees of the 1980s included a variety of non-government members (Smith and Handmer 1989). Now they might not even include the local government. Some recent studies report that some agencies work hard to undermine community efforts (Henderson 2024); and people can be forced to wait years for re-building approval, potentially rendering them homeless. Most communities do not want to be treated as incapable or irrelevant. They run themselves most of the time and want to be central to decision-making about local disaster risk reduction, including their resilience and recovery.

There are many kinds of 'communities' that can have very different experiences. A positive development over recent decades is the inclusion and explicit recognition of the agency and contribution of many of these, for example Indigenous people, women, and disability advocates, as having valuable roles in emergency management. For example, an important and overdue initiative was the establishment of the National Indigenous Disaster Resilience group at Monash University (Williamson and Wier 2021).

The agencies

Historically, emergency management was largely invisible most of the time. Now, emergency management agencies have much higher public and political profiles. The agencies have gone from being adaptable using informal assistance, to being highly credentialed, formalised, centralised, standardised and bureaucratised; attributes that work against flexibility and adaptability. In a permacrises world of systemic risks, this rigidity can undermine the ability of EM to deliver.

Agency frontline workers are a mix of career staff and volunteers who often work extraordinary hours, under great pressure, often without critical information and other resources, all under intense media scrutiny. Emergency managers are not omniscient and cannot know everything or foresee the future. Neither can they help everyone in the way they would like, even though there has been a normative assumption of a universal standard of service. Some agencies are accused of 'cultural incompetence' (for the UK, Easthope 2025), but in an increasingly multicultural society, agencies cannot come close to communicating with, and supporting, everyone in their preferred ways; and the outcomes of an event or situation are a matter of shared responsibility between all those involved. In the same way that agencies need to show compassion, they also need forgiveness from the public when – in the absence of negligence – things do not go smoothly (Crosweller 2024).

Learning and improvement should be continuous. AIDR and its predecessors are dedicated to this end. Some states also have agencies to help with learning. We could also consider learning from neighbouring countries, including those who on paper have far less capacity, as part of Australia's contribution to decolonising the dominant narrative.

An unfinished agenda?

Effectiveness

It would seem to be obvious that emergency management is now far more effective than historically. Much prevention, planning and response to relatively 'routine' emergencies (house fires, road crashes, etc. (Handmer and Dovers 1996, 2013), are now trained and equipped in ways unimaginable to those in the 1970s. Yet, technical failures, funding cutbacks, lack of surge capacity, regulation and compliance issues as well as straying from the task (of saving lives and property) in favour of other priorities and procedures, mean the outcome is too often not ideal.

The situation regarding large complex events seems different. We could ask how we would manage with a repeat of a Cyclone Tracy, a major earthquake or catastrophic interface fire (Handmer and Maynard 2022; see also Barnes 2008). Our systems, including insurance, were developed for definable 'events' but now we have a 'permacrisis' where 'events' merge. This is related to the need to understand and plan for cascading, systemic risks and their interactions. One view is that our systems struggle to meet the flexibility, adaptability or the imagination demanded by large complex crises driven by climate, economics and politics, among other causes.

Surge capacity

Closely related to flexibility and adaptability is the issue of surge capacity, which appears to have shrunk over the past several decades. This is primarily because the capacity is no longer seen to be within and across community and the whole of society – through formal and informal volunteers. In the eyes of emergency management leaders, it now comes primarily from government, especially uniformed services including defence and overseas militaries and firefighters. This can be slow, expensive, and the military are not trained for many types of emergency management operations. It can also undermine local resilience and has definite limits which are a small fraction of the capacity theoretically available from civil society and commerce.

Inclusion

EM can be criticised for not being inclusive of people's concerns, not being sufficiently culturally aware, and for failing to understand the long-term, emotional impact on affected communities. The field needs to work harder

on inclusiveness – although this comment applies across government, and much that EM is criticised for is under the authority of welfare, health, policing and other agencies, rather than EM.

Ultimately, emergency management is about supporting people and communities through crises, acknowledging their suffering and recognising that it may take a long time for people to 'recover'. An important question concerns how well highly bureaucratised, risk averse, politically sensitive organisations working closely with state security in an era of almost continuous crises, can do this, even with the most dedicated people?

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Looking back, thinking ahead

In this special segment for AJEM's 40th anniversary issues, we interview past journal contributors about their early articles, what has since changed in the fields they work in, and their ideas and suggestions for the future of AJEM.

Through their eyes: capturing decisions in motion

An interview with Jim McLennan

My first article in the *Australian Journal of Emergency Management* (AJEM) came out of a bigger research program led by my late wife, Mary Omodei, in her Complex Decision Research Group at La Trobe University (McLennan et al. 2005). Mary was known for developing an enhanced system of interviewing. We were not the only ones playing with this idea, but Mary was the first to publish an account in a refereed journal.

The concept was simple but groundbreaking: strap a video camera to someone's head to capture their field of vision, and record audio for ambient sounds. Mary's initial interest was improving the performance of orienteers. Back then, the only way to study their decision-making was through post-race interviews, which had obvious limitations. We wanted to capture decisions as they happened.

In 1994, we invited a British orienteer to Christmas Hills, Victoria. The cameras were enormous - think big stereo size - so we strapped one to the side of his head and packed the recorder in a backpack. Off he went, running the course and talking to himself. Later, we played the footage back and asked him to recall what was going through his mind. The richness of that data was incredible; what he noticed, his intrusive thoughts, and his priorities. It was a goldmine.

We expanded the research with Orienteering Australia, working with juniors to improve decision-making. One day, a local television crew turned up to cover a young orienteer who topped his HSC. They stumbled upon our work and got so excited they featured Mary's research on Channel 7. That is how Denis Rich from the MFB training college heard about it. He saw potential for firefighter training and reached out to us to try it out.

Soon, we were running a project with 12 station officers preparing for promotion assessment by conducting exercises in the role of incident controller. Olga Pavlou, a brilliant Honours student at Swinburne University where I worked then, spent three weeks at the old Abbotsford MFB training college, using the head mounted recording unit, recording exercises, and debriefing participants. The officers loved it: all passed, and Olga earned first-class honours for her thesis. We had fantastic data, but life intervened. I spent 2 months at Windsor Fire Station doing more fieldwork, and then Mary was diagnosed with cancer in 1999. That slowed everything down.

Eventually, I analysed the data and wrote the paper. AJEM accepted it, although it took two years before it was published in 2005. It hasn't attracted many citations – technology moved fast, and there were union concerns about video use – but the technique, now called own point of view (OPV) cued recall, found its way into sports, hospital emergency departments, anaesthesiology training, and police training. Emergency services? Not that I am aware of.

Reflecting on how emergency decision-making training has changed since then I would say honestly, not a lot. I recently did a literature review for our current research team[1] – published in AJEM last year – and found something surprising (McLennan et al. 2024). There is still this deeply held belief that simply taking part in the exercise is enough. People would deny it, of course, but that is what the limited evidence shows. The aim seems to be 'do the exercise', with little thought to evaluating what was learned. So, I am left with the same question I had back in the 1990s: how much actual learning goes on?

Looking ahead, I would love to see AJEM publish more practice-relevant, rigorous, and innovative research. The October 2024 issue was outstanding, and not just because one of my papers was in there. It was a bumper issue with research and relevant practice. I would like to see more of that. When I first encountered the journal in the late 1990s, it felt like a newsletter. Today, it is much stronger, but there is room for growth. Perhaps AJEM could also create a space for fresh ideas that invite discussion and inspire future research. After all, it is often the unconventional ideas that end up driving real change.

1. https://www.naturalhazards.com.au/research/research-projects/enhancing-decision-making-emergency-management

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Partners in tsunami planning and preparedness

An interview with Jane Sexton

The first article I published in the *Australian Journal of Emergency Management* (AJEM) was 'Tsunami planning and preparation in Western Australia: application of scientific modelling and community engagement' (Stevens et al. 2008). It was published as part of 2 special issues on risk assessment compiled by the late Trevor Jones. It was jointly written with Russell Stevens and Gordon Hall, two emergency managers from the Department of Fire and Emergency Services in Western Australia, or FESA they were called at the time, and I was at Geoscience Australia (GA).

After the 2004 Indian Ocean tsunami there was funding to look at what the tsunami risk would be like on the Western Australian coastline. There had been nothing done in that space prior to 2004. What made that project so good, and why we wrote the paper, was because of the partnership between the scientists and emergency managers. We were all learning at the same time. GA brought the scientific modelling, and the emergency managers brought the knowledge of their communities. It was GA's role to help translate the science for the emergency managers to then go and talk to their communities about local tsunami risk and translate that into their local plans.

In terms of research, it was the first piece of work where we brought together all these different people that looked after different inputs to modelling a tsunami from source to shore -whether it was bathymetry, onshore elevation, earthquake generation of tsunami – to the people who understood the onshore impacts like civil engineers at GA through to the local emergency managers. Lots of relationships had to be developed to do this project. It was the first time that tsunami inundation modelling was done in Australia (publicly available anyway), and probably one of the first places internationally that was doing inundation modelling. There was lots of offshore tsunami modelling at the time, but not as much onshore tsunami modelling because it is incredibly complex, requiring detailed data and high-performance computing. The project won the Australian Safer Communities Award in 2007 and the Asia-Pacific Spatial Excellence award in the same year.

Between 2008 and 2025, the computing power and techniques that underpin tsunami research have advanced significantly. Increases in the accuracy and timeliness from a scientific modelling point of view have been a major step change. Sometimes I do wonder how much has actually changed, as we are fundamentally still modelling inundation and developing an evidence base for decision makers – however what we do have now is so much richer and provides important uncertainty estimates.

For the emergency management sector though, there has been a lot of change. The first National Strategy for Disaster Resilience didn't exist when this paper was published. The notions of shared responsibility and systemic risks, as well as working with culturally and linguistically diverse communities and people with disabilities was not prominent in the conversations at the time, and this has improved significantly compared to 2000s.

Thinking about the future of AJEM, we could do something really novel and have video or audio pieces, in addition to the written pieces. That gives people a different way to contribute. Reflecting on historical events is always valuable because it helps people to understand where things have come from and how it has evolved. We don't always understand what it has taken to get to the point that we are at. AIDR could use the transformative scenarios[1] to think about what the journal might look like in the future. There's the Tech Horizons scenario, for example. AJEM is already becoming digital, but what do people and the community look like? What does the emergency management profession look like in 20 years? That might be something to consider for the journal and for AIDR more generally.

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1. https://naturalhazards.com.au/knowledge-modules/transformative-scenarios

Abstract

This paper analyses how legal and policy frameworks in Aotearoa New Zealand and internationally address gender equality during emergencies and disasters with a specific focus on unpaid caregiving and employment risks for women following disasters. Despite Aotearoa New Zealand's commitment to international instruments emphasising gender-responsive disaster laws and policies, domestic laws and policies are largely gender-blind or address gender considerations superficially. Meanwhile, national gender equity laws and policies often lack specific guidance for disaster contexts. The systematic failure to integrate disaster risk management and gender equity frameworks deprioritises care and disproportionately affects the economic wellbeing of women. This was observed during the Canterbury earthquakes over 2010–11, the COVID-19 pandemic of 2020–21 and Cyclone Gabrielle in 2023. This paper argues for a comprehensive, forward-looking national strategy for disaster management and gender. Recommendations include gender mainstreaming in all disaster laws and policies, which includes explicitly valuing and recognising care work and work disparities in disaster risk management frameworks.

Gendered fault lines: unpaid care and employment in disasters in Aotearoa New Zealand

Peer reviewed

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Introduction

Disasters disrupt all lives, but family relationships and caregiving responsibilities are particularly vulnerable (MacRae et al. 2021) with parents facing added challenges such as displacement, school closures and loss of support networks (Peek and Fothergill 2009). Despite the heightened need for care during crises, care remains undervalued and overlooked in disaster planning (Rooney et al. 2023). This reflects an historical pattern of treating caregiving as a private (Bridgeman 2007), female responsibility rather than a public priority (Matsopoulos and Luthar 2020). Disasters intensify existing inequalities with women disproportionately affected due to gendered roles, caregiving responsibilities and social and economic disparities (Neumayer and Plümper 2007; Masselot and Russell 2020). During disasters, women are typically expected to nurture while men take on protective roles (Always et al. 1998). Mothers are often urged to evacuate with children for safety, while fathers remain behind to maintain paid work and secure the home (Peek and Fothergill 2008). In this context, safe, reliable and affordable childcare is essential during disasters especially when support networks are disrupted and daycare services are limited (Enarson 2000; Peek and Fothergill 2009). The increased caregiving burden on women during and after disasters hinders their paid work, exacerbates financial challenges and reduces their involvement in emergency and recovery efforts (Enarson 2000; Juran 2012; Horton 2012; Peek and Fothergill 2009; Juran and Trivedi 2015; Robles and Benadivez 2021). These challenges are even greater for those facing multiple vulnerabilities (Crenshaw 1989; Arora 2022) underscoring the need for inclusive

laws and policies that promote resilience and reduce risk before, during and after crises. Women and girls face greater vulnerability, yet they are also key drivers of recovery, leading as caregivers, rebuilding communities and powering the workforce (Robles and Benavidez 2021).

This paper examined how Aotearoa New Zealand's legal framework addresses gender equality in disaster contexts, focusing on women's unpaid caregiving as well as employment risks[1] and offers a legal analysis of the national framework based on laws, policies and existing literature. Despite ranking 4th in the Global Gender Gap Report 2023 (World Economic Forum 2023), significant gender inequalities persist in Aotearoa New Zealand, worsening during crises. Women's work in Aotearoa New Zealand is dominated by unpaid care and domestic labour (Statistics New Zealand 2001; Deloitte and Westpac 2021; Sin 2022; Ministry for Women 2022a; UNDRR 2020; Hanna et al. 2023) with limited recognition and support despite representing a significant share of Aotearoa New Zealand's gross domestic product if measured (Ferrant and Thim 2019). High childcare costs (Ministry for Women 2022a; Gromada and Richardson 2021), inadequate leave policies and accessibility challenges (especially for Māori and Pasifika mothers (Sin 2022)) create significant barriers to workforce participation and long-term employment and disproportionately affect single mothers (André et al. 2023; Gromada and Richardson 2021). Workforce gender inequalities, including pay gaps and occupational segregation heighten women's economic vulnerability (Parker et al. 2021; Ministry for Women 2020, 2021a). Despite progress, disparities persist, especially for Māori, Pasifika, Asian and women with disability, as well as mothers. In addition, women in leadership positions are still lacking in the private sector (Ministry for Women 2024; Parker et al. 2021; Johnston 2024; Haar 2019).

This paper examines these challenges through the perspective of care during 3 national emergencies: the Canterbury earthquakes (2010–11), the COVID-19 pandemic (2020–21) and Cyclone Gabrielle (2023) (NEMA n.d.). To do so, the paper is divided into 5 sections. The first section provides an overview of the characteristics of women's work and care during disasters. Section 2 outlines Aotearoa New Zealand's obligations to women under the international framework. Section 3 demonstrates that the domestic legal framework for disaster risk management is largely gender blind. Section 4 highlights that gender equality law only marginally addresses disasters. The final section suggests a strategy to integrate gender and disaster considerations into Aotearoa New Zealand's legal frameworks aiming to improve outcomes for women as caregivers and workers.

The characteristics of women's work and care in disasters

The invisibility and low priority of caregiving responsibilities during disasters

Gender considerations have received little attention in research and policy during Aotearoa New Zealand's national emergencies. Research on the gendered effect of the Canterbury earthquakes and Cyclone Gabrielle remains scarce, while interest in gender issues surged during the COVID-19 pandemic, reflecting global trends. Despite this, little to no gender-disaggregated data was collected during these events and research on unpaid care work in Aotearoa New Zealand during the pandemic is limited. As Scobie and Sturman (2020, p.1) highlight:

> *…despite the halt to 'normal' economic functioning which Covid-19 has necessitated, the mostly un-waged and often unseen labour necessary to the ongoing function of our societies… has continued as normal in homes and communities across Aotearoa.*

Similarly, data on care and reproductive labour related to Cyclone Gabrielle is almost non-existent. This underscores both the lack of disaggregated data and the persistent disregard for work outside traditional economic productivity measures.

Beyond gaps in research and policy, women's representation in response-related decision-making has been notably absent. Studies show the importance of including women, mothers and girls in preparedness and recovery efforts. However, during the Canterbury earthquake recovery, the city leaders, government ministers, recovery teams, demolition crews and emergency services personnel featured in the media were overwhelmingly male (Gordon 2013).

Care is a central factor in disaster-related inequality. Yet care-related concerns were often deprioritised in favour of other issues. Research on women's experiences during and after the Canterbury earthquakes shows that they faced increased caregiving responsibilities due to disruption of infrastructure and care services. Women were often taking on family coordination roles while men assumed different tasks (McManus 2015). The report to the Convention on the Elimination of all Discrimination against Women (CEDAW) Committee (New Zealand Human Rights Commission 2012) highlighted that women were the primary support for families facing displacement due to housing and property loss after the Canterbury earthquakes and that women made up the majority of caregivers for the elderly, who comprised 15% of Christchurch's population.

1. While recognising that women, men and LGBTIQA+ individuals each face distinct challenges in disaster contexts, this article focuses on the disproportionate effects of disasters on women.

Despite these challenges, many women—particularly mothers—played a vital role in both community support and emergency management, actively contributing to the recovery efforts (Jennings et al. 2018). The Women's Voice study found that while men were recognised for their roles in search, rescue and reconstruction, women's crucial contributions as caretakers and organisers of informal networks (managing children, relocation and household tasks amid disrupted infrastructure) were largely overlooked (Gordon 2013).

Across the world, the COVID-19 pandemic highlighted the unequal distribution of unpaid care work, with women shouldering much of the domestic responsibility including caring for families and managing children's education during lockdowns while balancing paid jobs (Azcona et al. 2020; Craig and Churchill 2021; Deloitte and Westpac 2021; Alon et al. 2020). Though both mothers and fathers faced increased domestic burdens, mothers often took on a larger share (UN Women 2020; Power 2020). This trend was replicated in Aotearoa New Zealand where the government recognised that women were more likely to carry the burden of increased unpaid work such as childcare and caregiving responsibilities (Government of New Zealand 2023). A study of the first level 4 lockdown found that while the increased home workload was shared between mothers and fathers, it did not change the overall trend of women doing most unpaid care work and men holding most of the paid work (Deloitte and Westpac 2021). Women, particularly those with inter-sectional characteristics, were disproportionately affected due to unequal structures, power dynamics and social norms (Ministry for Women 2023).

Similarly, the increased care burden after Cyclone Gabrielle was obvious given the scale of disruptions of the floods as wells as school and childcare facilities closures (Gerritsen 2023). Yet little information could be found in relation to the unequal distribution of care during and in the aftermath of the cyclone.

The need to reopen schools and childcare centres is well recognised as a priority after disasters to re-establish a sense of normality for children and families (Mutch 2015). School reopening was given high priority after the Christchurch earthquake in 2011. The New Zealand Government and education authorities recognised the importance of restoring education quickly to provide stability for children and families. During the pandemic, a review of school and early learning centre closures in the initial lockdown considered the impact on 'essential' workers (disproportionally women) who had been unable to attend paid work due to caregiving responsibilities. While the primary motivation for these considerations may have been to sustain the health system, because many women held 'front-line' roles, the review highlighted the broader workforce effects of the closures. This included increased absenteeism and reduced productivity due to childcare needs. The review recognised the need for accessible support for whānau [extended family] especially for those already experiencing inequities (Ministry of Health 2020). The priority to reopen schools and childcare centres as well as support to disadvantaged families (however, without mentioning women) was recognised.

Despite this recognition, the importance of keeping schools open or prioritising their reopening is not (yet) reflected in an official 'pre-disaster' policy. The handling of schools and early learning centres before Cyclone Gabrielle illustrates that care giving responsibilities can remain a low priority. The Ministry of Education directed all Auckland schools, early learning services and tertiary institutions to close for 7 days under emergency regulations (Tertiary Education Commission 2023). This decision followed a request from New Zealand's National Emergency Management Agency (NEMA) to reduce traffic for storm-related repairs (1News 2023). However, the directive was rescinded just one day later following a review. The rationale for this reversal remains unclear and it is uncertain whether the potential gendered effects of the closures were taken into account in the decision-making process.

The disproportionate gendered effect on women's employment

Disasters have profound economic consequences, including widespread job losses. However, policy responses frequently overlook the gendered dimensions of these consequences. In doing so, they risk perpetuating or exacerbating existing labour market inequalities and structural disparities. After the Canterbury earthquakes, women, particularly rural and older women, experienced disproportionate job losses as well as an increase in casual, part-time work (New Zealand Human Rights Commission 2012; Masselot 2022). Labour market analysis revealed that while construction jobs in the Canterbury region, predominantly held by men, were on the rise, sectors like retail and accommodation, which employ mostly women, faced significant losses (New Zealand Human Rights Commission 2012).

The COVID-19 pandemic also disproportionately affected women's employment with women making up to 90% of pandemic-related redundancies in 2020 and sharp increases in precarious jobs by 2021 (RNZ 2020a; Masselot and Hayes 2020; Statistics NZ 2020). Māori and Pasifika women, already facing greater inequalities, were hit hardest (Thorpe et al. 2022). Nevertheless, the government prioritised funding for male-dominated 'shovel-ready' projects, with little focus on gender-equal economic recovery (RNZ 2020b). In addition, pandemic wage subsidies, administered by the Ministry of Social

Development, disproportionately benefited men, reflecting a gender imbalance in financial support (Ministry of Social Development 2020, 2022). The effects of the COVID-19 pandemic on women's employment were not addressed within mainstream policy frameworks but were delegated to the Ministry for Women. Early in the pandemic, the ministry cautioned that ostensibly gender-neutral policy responses were having disproportionate effects on women. In response to these concerns, the ministry implemented targeted support through its Community Fund to provide assistance to selected organisations focused on retraining and upskilling women who had lost employment as a result of the pandemic (Ministry for Women 2022b). It also advised that a structured approach to women's employment was needed. In a Cabinet paper entitled 'Building back better for women: Improving women's wellbeing and employment outcomes in response to COVID-19', the Ministry for Women outlined the need for a strategy to support women who were facing job losses and increased caregiving responsibilities (Ministry for Women 2021b). In 2022, the ministry released its strategy to address the effects of the pandemic on women's employment (Ministry for Women 2022a).

There is no easily available data or analysis on the effects of Cyclone Gabrielle on women's paid employment. Quarter 2023 market statistics show that the seasonally adjusted unemployment rate remained at 3.4% post-cyclone. Still, gender disparities exist. While the male unemployment rate decreased to 3.2% (a reduction of 1,000), it increased for women to 3.7% (an addition of 3,000), (Statistics New Zealand 2023a) implying a different effect on men and women. While the Household Labour Force Survey tracks reasons for reduced work hours, including 'bad weather', Statistics New Zealand has not provided gender-disaggregated data related to the higher than usual 'bad weather absenteeism' (Statistics New Zealand 2023b). The Ministry of Business, Innovation and Employment's monthly labour market fact sheet does not show gender disaggregated data (Ministry of Business, Innovation and Employment 2023). Similarly, it is not apparent that the specific response and recovery to the floods took gender considerations into account when it comes to employment initiatives. For example, the 2023 Budget for expanded and new employment programs to affected regions failed to include a gender perspective. The number of work-age people who received benefits was not gender-disaggregated (Ministry of Social Development 2023a). The Ministry for Women was seemingly not involved in the response and recovery. While special support was made available for people with disability, women with disability were not mentioned (Ministry of Social Development 2023b). This approach neglects the intersectional nature of vulnerability and stands in contrast to the ministry's recovery framework, which recognises the need for targeted consideration of specific groups, including women. The ministry explicitly notes that women are disproportionately affected in the aftermath of disasters. Women are also less likely to benefit from employment opportunities arising from post-disaster infrastructure investment, thereby exacerbating pre-existing gender disparities (Ministry of Social Development 2023c).

Aotearoa New Zealand's obligations under the international framework

The limited integration of gender and care considerations in Aotearoa New Zealand's disaster risk reduction and management frameworks is notable, particularly given its commitments under various international legal instruments that acknowledge gender as a vital dimension of effective governance. This section explores the extent to which gender is addressed within the international legal and policy frameworks to which New Zealand is a party, highlighting the normative emphasis these instruments place on the inclusion of gender-responsive approaches in disaster risk reduction and management. New Zealand has ratified or endorsed the following international instruments:

- *Sendai Framework of Disaster Risk Reduction 2015-2030* (UNDRR 2015) including its Gender Action Plan (UNDRR and UNFPA 2024)
- *Convention on the Elimination of all Discrimination against Women* [CEDAW] (United Nations 1997) including the Committees' General Recommendation No. 37 on Gender related Dimensions of Disaster Risk Reduction and Climate Change (CEDAW Committee 2018)
- *Agreed Conclusion of the 66th session of the UN Commission on the Status of Women* 'Achieving gender equality and the empowerment of Women and girls in the context of climate change, environmental and disaster risk reduction policies and programs' (UNCSW 2022).

These international frameworks emphasise 4 crucial aspects to advance gender equity in the context of disasters:

- Mainstreaming gender considerations in all disaster laws, policies and programs.
- Promoting meaningful participation and leadership of women, especially of marginalised groups, in all stages of disaster risk reduction.
- Enhancing gender statistics and data disaggregated by sex, ethnicity, age, race, disability and other characteristics to develop evidence-based efficient disasters policies and programs.
- Increasing allocation of resources to advance gender equality in the context of disasters.

Highlighting the issue of unpaid care, these instruments consider the issue during disasters and the need to

recognise and adopt measures to reduce, redistribute and value unpaid care and domestic work. They further support the adoption of provisions for gender-responsive economic recovery.

The *Sendai Framework for Disaster Risk Reduction 2015-2030* (UNDRR 2015) (Sendai Framework) is a global agreement adopted by Member States to guide countries in reducing risks and building resilience. New Zealand has endorsed the framework and committed to implementing its principles by aligning its national laws and policies accordingly. The Sendai Framework states that 'a gender, age, disability and cultural perspective should be integrated in all policies and practices, and women and youth leadership should be promoted' (UNDRR 2015, para. 19(d)). It emphasises the need 'to strengthen the design and implementation of inclusive policies and social safety-net mechanisms' (UNDRR 2015, para. 30 (j)). The participation and lead of women and other groups disproportionately affected by disaster in designing, resourcing and implementing gender-sensitive disaster risk reduction policies, plans and programs is further emphasised throughout the Sendai Framework (UNDRR 2015, para. 32; 36 (i) ff; 7).

The Sendai Gender Action Plan 2024 (UNDRR and UNFPA 2024) (GAP) is deemed essential to accelerate gender and inclusion aspects of the Sendai Framework and confirms the urgent need to decrease gender-related disaster risk by 2030. Objectives, aligned with Sendai Framework priorities, are to:

- increase the availability of disaggregated data and qualitative information on gender and disaster risk
- use gender analysis to generate and apply disaster risk knowledge in decision-making
- mainstream gender equality across disaster risk reduction laws, policies, strategies, plans and institutions
- increase meaningful participation and empowerment of women and gender stakeholders in disaster risk governance.

In addition, the GAP has the objective to increase funding allocations and improve access to financing for disaster risk reduction initiatives that advance gender equality (UNDRR and UNFPA 2024). Special actions to reach these objectives are foreseen in relation to the issue of unpaid care, such as the development of 'disaster response and early recovery plans and strategies that identify increases in unpaid care and domestic work that primarily fall on women and girls and address their negative impacts' (UNDRR et al. 2024, action 27, p.24). For example, the plan urges 'to plan in advance alternate support for childcare and education' (UNDRR and UNFPA 2024, action 27(d), p.24). With regards to paid work, the GAP recommends to:

> *… use gender analysis and joint planning with local women's organisations and other gender equality and inclusion stakeholders to prepare plans, strategies and assessments for gender-responsive economic recovery that promote decent work, livelihoods and relevant business opportunities to empower women and girls, and support gender equitable economic outcomes.*
> UNDRR and UNFPA (2024, action 28, p.24)

The Convention on the Elimination of All Forms of Discrimination against Women (CEDAW Committee 2010), ratified by New Zealand in 1985, aims for gender equity in areas such as politics, employment, education and health care. The Member States' obligations in relation to climate change and disaster risk have been specifically addressed in the committee's General Recommendation No. 37 (2018) 'on the gender-related dimensions of disaster risk reduction in the context of climate change' (CEDAW Committee 2018). The general recommendation is applicable to disasters caused by any hazard, including earthquakes, not only to disasters linked to climate change (CEDAW Committee 2018, para 13). The guidelines emphasise that Member States have obligations to ensure that all policies, legislation, plans, programs and budgets relating to risk reduction and climate change are gender-responsive (CEDAW Committee 2018, para 8; 26f, 42). Priority should be accorded to marginalised groups of women and girls, such as those from indigenous, racial, ethnic and sexual minority groups, women and girls with disability, older women, women heads of households or widows and apply an intersectional approach. The rights of women to participate at all levels of decision-making must be guaranteed in all climate change and disaster risk policies and programs (CEDAW Committee 2018). State Parties should identify mechanisms to collect, analyse and manage data disaggregated by sex, age, disability, ethnicity and region to inform gender-responsive national risk reduction and climate resilience legislation, policies, programs and budgets. Governments should promote increased budget allocations to respond to gender-specific disaster and climate change prevention, preparedness, mitigation and recovery (CEDAW Committee 2018, para 46).

In the context of unpaid care and paid employment, the general recommendations highlight the issues of unequal remuneration of men and women, gendered division of household labour and the undervaluing of the contribution in domestic, community and care work. During disasters, the guidelines recognise that the burden of caregiving and domestic work often increases, for example, due to destruction of housing and infrastructure and the absence of social protection systems. The result of such inequalities can contribute to increased vulnerability, and caregivers frequently have less time to engage in economic activities or to gain access to resources. Thus, gender-based discrimination limits the capacity of women to prevent

and adapt to the harm generated by disasters (CEDAW Committee 2018, para. 61f). State Parties therefore should invest in gender-responsive social protection systems that can reach all women, including women with disability. Equal rights to sustainable employment should be upheld in disaster prevention, management and recovery, while the unequal burden of unpaid and caregiving work performed by women must be acknowledged and addressed within disaster and climate change policies (CEDAW Committee 2018, para. 72).

The 66th session of the UN Commission on the Status of Women, a global policymaking body within the UN Economic and Social Council, focused on advancing gender equality and women's rights in the context of climate change, environmental sustainability and disaster risk reduction. At its session in March 2022, New Zealand reaffirmed its commitment to address the needs of communities facing multiple and intersecting forms of discrimination who are most affected by climate change and disasters. This included women and girls in all their diversity, particularly indigenous women, women in poverty, those with disability and those in rural or remote communities.

New Zealand also affirmed that, while disproportionately affected by disasters and climate change, women are also powerful agents of change (Tinetti 2022). The 2022 Agreed Conclusions recommended:

- the integration of a gender perspectives into disaster risk reduction policies and programs (UNCSW 2022, para (i))
- expanding gender-responsive finance for women's civil society organisations (ibid, para. (u). (z) (aa) ff)
- meaningful participation of women, especially those from marginalised groups, in all stages of disaster risk reduction (ibid, para. 56).

It recommended enhancing gender statistics and data disaggregated by sex, ethnicity income, age race, marital status, migration status, disability and other characteristics in the context of disasters to the develop evidence-based efficient policies and programs (ibid, para. 56).

The Agreed Conclusions 2022 highlight the gendered division of unpaid care and domestic work. It acknowledges that worsened gender division can limit women's ability to take part in decision-making processes, economic opportunities and to occupy leadership positions. The CSW stresses the need to recognise and adopt measures to reduce, redistribute and value unpaid care and domestic work, for example, through social protection mechanisms, affordable and quality social services and family friendly policies such as childcare, flexibility in working arrangements and maternity, paternity or parental leave (UNCSW 2022, para. 47f; (z) (jj); 57).

The 2030 Agenda for Sustainable Development, which New Zealand adopted in 2015 and committed to implementing its goals, contains goals regarding gender equality (Goal 5) and disaster risk reduction and climate change (goals 11 and 13). Goal 5 expressly recognises and values unpaid care work through the provision of public services, infrastructure, social protection services and promotion of shared responsibility within the house. It requires women's full and effective participation and opportunities for leadership. It is further understood that realising gender equality and the empowerment of women will make a crucial contribution to progress across all the goals and strategies (United Nations 2015).

In 1993, New Zealand ratified the Convention of the Rights of the Child (CRC), which outlines the rights and protection that should be afforded to children and recognises the rights and responsibilities of parents or legal guardians. State Parties are required to protect children from all harm while in the care of parents or legal guardians including effective procedures for the establishment of social programs to provide the necessary support for children and also for those who have the care of children (United Nations 1989). The CRC stipulates that states should do all appropriate measures to ensure the wellbeing of children, which includes support of parents in times of disasters and emergencies.

Gender blindness in Aotearoa New Zealand Disaster Risk Management Legal Framework

Despite New Zealand's international commitments through binding treaties such as CEDAW and the CRC and global policy frameworks including the Sendai Framework and the Agreed Conclusions of the Commission on the Status of Women, an analysis of disaster risk management and emergency legislation reveals a lack of gender consideration. Disaster laws and gender equity legislation largely operate in silos, failing to acknowledge that disasters exacerbate gender inequalities.

Hard 'disaster law' is gender-blind

The *Civil Defence Management Act 2002*[2] is the primary legislation governing disaster and emergency management in New Zealand. While emphasising the protection of life, property and the social, economic, cultural and physical wellbeing of the community, the Act fails to mention gender or women. The *Local Governance Act 2002*[3] (as amended in 2019), under which local authorities are granted significant responsibilities for preparing, responding and recovering from disasters, introduces 'four

2. *Civil Defence Management Act 2002,* at www.legislation.govt.nz/act/public/2002/0033/51.0/DLM149789.html.
3. *Local Governance Act 2002,* at https://nzlii.org/nz/legis/consol_act/lga2002182.pdf

well-beings' (social, economic, environmental and cultural wellbeing) to guide the decision-making and planning processes of local authorities. The Act fails to refer to wellbeing from a gender perspective, excluding the specific needs of men, women and people of diverse genders. The Act assumes that everyone is placed in similar situations, disregarding pre-existing inequalities based on gender roles. Participation in local decision-making is facilitated for Māori but fails to consider other groups that are disproportionally affected by disasters, including wāhine Māori. Emergency legislation, adopted under urgency in response to a disaster, has also lacked a gender-sensitive approach. These include the *Canterbury Earthquake Response and Recovery Act 2010*[4] (CERRA), the *Canterbury Earthquake Recovery Act 2011*[5] (CER Act), the *COVID-19 Public Health Response Act 2020*[6] as well as the *Severe Weather Emergency Legislation Act 2023*[7] and the *Severe Weather Emergency Recovery Legislation Act 2023*[8] after Cyclone Gabrielle. None of these Acts make any reference to gender or women. Alarmingly, this omission persists in the Emergency Management Bill (No.2)[9] introduced in December 2025 to reform the emergency management legislation and strengthen national disaster resilience.

As a result, New Zealand's disaster laws currently fall short of meeting international commitments. The CEDAW Committee, in General Recommendation No. 28, called for a shift from gender-neutral to gender-specific legislation as pre-existing inequalities might not be addressed (CEDAW Committee 2010). The committee urged the New Zealand Government to prioritise the perspectives of Māori and ethnic minority women and girls (CEDAW Committee 2018b).

'Soft disaster law' pays lip service to gender

Soft law such as non-binding guidelines, principles and frameworks play an important role in shaping decisions and complementing binding legislation. In New Zealand, gender considerations are commonly included in disaster risk management soft law, more so than in hard law, but typically only at a surface level. These documents focus on inclusive language without embedding a thorough, systematic approach to address gender issues in planning and response. For example, the *Civil Defence National Disaster Resilience Strategy 2019* (MCDEM 2019) (National Strategy), which outlines the vision and long-term goals for civil defence emergency management, mentions 'gender' once within the context of disaster risks and vulnerability. It states that vulnerability includes social vulnerability which refers, inter alia to gender (MCDEM 2019, para. 3.1).[10] ***Gender*** issues are overlooked in the remainder of the strategy, including in efforts to reduce vulnerability and achieve equity through policies, plans and practices (MCDEM 2019, para. 3.6). The strategy acknowledges that specific groups disproportionally affected by disasters include Māori, Pasifika, people for whom English is not a first language, people living with social and economic deprivation as well as people with disability, ill health or social or geographic isolation but fails to mention women or caregivers. Similarly, the strategy addresses the need to enhance the resilience of people disproportionally affected by disaster, including people with disability, children and youth, culturally and linguistically diverse communities and rural communities, but ignores women in all their diversities (MCDEM 2019, para. 4.4). While the strategy emphasises New Zealand's commitment to the Sendai Framework, it overlooks the obligation to include a gender perspective in all legislation and policies (MCDEM 2019, p.15). No gender perspective is found in the 18 objectives designed to progress the strategy's priorities.

The *National Civil Defence Emergency Management Plan 2015* (MCDEM 2015a) supports the implementation of the National Strategy by outlining operational details, roles and responsibilities. To achieve the strategic goals, the plan acknowledges risks, exposure and vulnerabilities before, during and after a disaster as well as the need to address them in policies and programs but does not take a specific gender lens (MCDEM 2015a, para. 88 (b)(ii) (e)). The plan also fails to take a gender approach when assigning responsibilities for welfare services to support individuals, families, whānau and communities responding to and recovering from emergencies (MCDEM 2015a, para. 62ff).

In the director's guideline designed to provide guidance to disaster management groups and associated agencies responsible for welfare service during emergencies (MCDEM 2015b), gender is mentioned once. Section 5 introduces the welfare services sub-functions, stating that welfare services should take an inclusive approach and consider vulnerable and hard-to-reach communities when planning, including consideration of 'gender'. This approach cannot be considered gender mainstreaming, particularly since gender is largely absent from the rest of the guidelines. For example, while the guidelines state that welfare services must contribute to ensuring that New Zealand meets its national and international human rights commitments, it only refers to age, disability and culturally and linguistically diverse communities (MCDEM 2015b,

4. *Canterbury Earthquake Response and Recovery Act 2010,* at www.legislation.govt.nz/act/public/2010/0114/31.0/DLM3233004.html.
5. *Canterbury Earthquake Recovery Act 2011,* at www.legislation.govt.nz/act/public/2011/0012/latest/DLM3653522.html.
6. *Public Health Response Act 2020,* at www.legislation.govt.nz/act/public/2020/0012/latest/LMS344134.html.
7. *Severe Weather Emergency Recovery Legislation Act 2023,* at www.legislation.govt.nz/act/public/2023/0004/latest/whole.html.
8. *Severe Weather Emergency Recovery Legislation Act 2023,* at www.legislation.govt.nz/act/public/2023/0017/latest/LMS825610.html.
9. Emergency Management Bill (No 2) 2025, at www.legislation.govt.nz/bill/government/2025/0236/latest/whole.html.
10. The paragraph states: *Vulnerability is the conditions which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards. (…) It also includes social vulnerability, which refers to damage to livelihood, social connections,* ***gender*** *and other factors that influence a community's ability to respond to, cope with and recover from a disaster.*

para 5.2.2). Similarly, a long list of potential vulnerable groups is provided for consideration when assessing risks to psychological wellbeing and risk reduction planning, but it omits women in all their diversities, including pregnant women and mothers/caregivers with newborns (MCDEM 2015b, para. 10.3). The director's guideline provides an entire section dedicated to care and protection services for children and young people (MCDEM 2015b, section 9) but mostly only applies to unaccompanied children and overlooks the need of caregivers who are accompanied by their children. Positively, the director's guideline offers several benefits especially relevant for carers and women. For example, the guideline includes financial assistance for household goods and services (MCDEM 2015b, section 11) including infant feeding supplies (MCDEM 2015b, section 11.3f). Reference to shelter and accommodation for displaced people includes support mechanisms for school and early childhood centres (MCDEM 2015b, section 12.2). Nevertheless, the guideline omits emergency services for childcare during childcare centre and school closures. In addition, while these provisions refer to families and children, women as primary carers remain invisible.

Gender equality law and its limited connection to disaster management

Disaster law frameworks pay limited attention to gender considerations and gender equality legislation likewise lacks provisions to adequately address the challenges arising in disaster contexts, particularly within the binding legal instruments. This mutual gap reflects a lack of integration and undermines efforts to advance equitable and effective disaster risk governance. For example, although the *Human Rights Act 1993*[11] prohibits sex discrimination, its general provisions offer limited guidance in disaster contexts. Likewise, various employment-related statutes address gender inequality but do not account for the distinct effects and disruptions caused by disasters. The *Equal Pay Amendment Act 2020* introduces a collective process to address systemic sex-based pay undervaluation and supports women's long-term resilience.[12] However, it lacks a forward-looking framework to guide response and recovery. From a care perspective, neither the *Oranga Tamariki Act 1989*[13] nor the *Care of Children Act 2004*[14] make explicit reference to disaster contexts, leaving the specific needs of parents and caregivers during emergencies largely unaddressed.

Soft law relating to gender equality tends to be nuanced, often acknowledging the intersection of gender, work and disaster response. However, a review of existing soft law reveals a fragmented set of policies that lack cohesion and fail to form a comprehensive framework to support gender equality through disaster risk management. For example, entitlements for caregiver's paid leave during disasters are inconsistent, depending on the nature of the leave and eligibility for payment. While Employment New Zealand has issued disaster-specific guidance to assist employers and employees, these remain piecemeal and lack legal enforceability (Employment New Zealand 2024). In principle, during disasters, provisions within an employment agreement or workplace policy stay in effect. Thus, employees who care for a sick or injured partner or dependants can take their leave entitlements under the *Holidays Act 2003*[15] and any additional leave can be negotiated with the employer 'in good faith'. However, the guidelines fail to consider the scenario where a caregiver cannot work while schools or daycare centres are closed. In this situation, employers are under no obligation to provide for 'cyclone leave' for example. While entitlement to leave is covered under employment law, certain payments of leave during disasters are regulated by the Ministry of Social Development and provided by Work and Income (Ministry of Social Development n.d.). The Civil Defence Payment is assistance for people in financial hardship following a disaster. It would cover, for example, a caregiver who has agreed leave without pay with their employer or has lost their job to care for a child because of school closure due to a disaster (Ministry of Social Development n.d.).

Soft law in this area tends to be reactive, short-term, without a monitoring and evaluation system and vulnerable to shifts in political leadership. Several initiatives introduced under the New Zealand Government during 2020–23 have been sidelined or discontinued. For example, the Women's Employment Action Plan 2022, developed in response to the pandemic, aimed to tackle structural gender inequalities in the labour market, particularly affecting Māori women (Ministry for Women 2022a). By addressing these disparities, the plan supported preparedness and resilience. However, this approach was abandoned in the National Government's Employment Action Plan of August 2024 (MBIE 2024).

The Women's Equality Strategy is still in 'engagement version' (Ministry for Women 2023). It acknowledges the disproportionate effects of economic, social and environmental shocks such as pandemics and severe flooding on women, particularly those experiencing intersecting forms of discrimination and disadvantage (Ministry for Women 2023). It recognises women's essential

11. *Human Rights Act 1993,* at www.legislation.govt.nz/act/public/1993/0082/latest/whole.html.
12. It should be noted that pay equity was amended under urgency by the *Equal Pay Amendment Act 2025, which increasing the threshold for raising pay equity claims by requiring claims to have merit and by increasing the threshold for what qualifies as work that is predominantly performed by female employee.*
13. *Oranga Tamariki Act 1989,* at www.legislation.govt.nz/act/public/1989/0024/latest/dlm147088.html.
14. *Care of Children Act 2004,* at www.legislation.govt.nz/act/public/2004/0090/latest/DLM317233.html.
15. *Holidays Act 2003,* at https://legislation.govt.nz/act/public/2003/0129/latest/dlm236387.html.

role in sustaining and rebuilding families and communities during periods of adversity and notes that climate change exacerbates existing inequalities. The strategy calls for efforts to strengthen resilience for those affected, particularly women. This involves addressing systemic discrimination and structural barriers pre-disasters to mitigate compounding effects. Strategy initiatives include provision of access to high-quality, accessible childcare as well as recognising and valuing unpaid caring responsibilities (Ministry for Women 2023). While the strategy provides a valuable insight into building resilience of women and identifies gaps and government tracking of its investment in women, a link of increased need for childcare and care during and after disasters is not made, nor other aspects relating to disaster response and recovery.

In 2019, an online tool 'Bringing Gender In' (Ministry for Women n.d.) was created to mainstream gender into policy processes. It provides examples of good practice, links to useful data sources and lists of non-government organisations that have expressed an interest in working with government agencies on women's issues. The online tool uses the Christchurch earthquake rebuild to illustrate the importance of applying a gendered perspective to all policies (Ministry for Women n.d.) and thus connects gender and disaster. This illustrates that, despite high labour demand during the rebuild, women's employment stagnated due to exclusion, not lack of interest. In response, the Canterbury Women in Construction Working Group was established to enhance women's participation through increased visibility and the incorporation of gender-sensitive monitoring and evaluation mechanisms. However, it remains unclear to what extent this analytical tool has been integrated into disaster risk management practices or whether its application and outcomes are subject to evaluation and oversight by policy makers.

Current gender equality strategies acknowledge the disproportionate effects of disasters on diverse groups of people, particularly women, but fail to translate this recognition into disaster risk management policies. There is no established legal or policy framework to guide emergency services or policy makers comprehensively before or after a disaster. Instead, new policies or strategies are created after each disaster, rather than applying lessons learnt to develop a proactive, pre-existing framework.

Way forward: a strategy on disaster and gender

This analysis of Aotearoa New Zealand's laws and policies demonstrate the lack of a consistent link between disaster risk reduction and management frameworks and gender considerations as required and recommended under the international framework. Aotearoa New Zealand laws and policies fail to incorporate lessons learnt from previous disasters. Currently, laws and policies lack a forward-looking, strategic framework to address the disproportionate effects of disasters on women. Using gender-neutral language in laws and policies or merely including gender terminology without using a differentiated approach, assumes that all people are equally situated without providing tools to address underlying inequalities. Thus, gender-neutral laws and policies can lead to different outcomes for disadvantaged groups and exacerbate pre-disaster inequalities, particularly around care and paid employment. It is argued that the New Zealand Government should develop a comprehensive, whole-of-government strategy that is forward-looking and gender-responsive and aligns with international legal obligations and commitments. Drawing on insights from past domestic disaster experiences, such a strategy would contribute to equitable and effective outcomes for women, men and non-binary individuals. Given the cross-cutting nature of disasters, it is imperative to foster policy coherence and institutional collaboration across sectors to bring about a genuinely gender-responsive approach (UNDRR and UNPFA 2024, action 11). Against this background, a number of recommendations are offered.

Gender mainstreaming in all disaster laws, policies and programs

The disaster and gender strategy should include a review of existing legislation, policies and budgets to adopt a gender-specific rather than a gender-neutral approach (CEDAW Committee 2018b). Gender specialists should support the review process, with collaboration encouraged at national, regional and local levels involving the Ministry for Women, human rights institutions, women's organisations and other stakeholders. Intersectional issues should be considered for women facing multiple disadvantage in the planning, response and recovery process (National Women's Alliances 2020).

The Ministry for Women's tool, Bringing Gender In, offers a valuable foundation for the systematic integration of gender considerations into policy development and implementation. To support consistent application, it is essential to establish robust monitoring mechanisms. However, in light of potential capacity limitations within the Ministry for Women, a pragmatic approach may involve delegating responsibility for monitoring and evaluation to individual ministries or agencies, enabling them to tailor gender-responsive oversight mechanisms to their specific policy domains.

Care work should be valued and recognised in laws and policies. This requires investment in gender-responsive social protection systems that support women in all their diversity. This could include greater support for childcare, expanded paid parental leave and flexible working conditions for

caregivers, both in everyday circumstances and during disasters (UNCSW 2022; Ministry for Women 2022b).

> *Crucially, a collective response is needed from the local to the national level to need new foundations of structural support and enabling infrastructure — from organisations and governments alike.*
> Australia reMADE (2024)

Government strategies must acknowledge the long-term economic effects of increased voluntary and caregiving responsibilities on women and explore ways to keep women engaged in income-earning roles (National Women's Alliances 2020). Recognising the social and economic value of care work during and after disasters can take various forms, including acknowledgment through remuneration and awards for caregiving. Policies should prioritise maintaining formal childcare and respite services both during and after disasters. In the case of pandemics, schools and childcare facilities should be classified as essential services. If childcare centres and schools are unable to operate, additional post-disaster support measures could include temporary childcare provisions, such as a paid emergency community care system. To enhance job security, leave entitlements should be expanded for those with increased caregiving responsibilities (e.g. by incorporating disaster leave for carers into work and income guidelines).

Some of these recommendations have previously been proposed by the Australian National Women's Alliances (2020) and the National Center for Disaster Preparedness (2021). Leave provision could also be reviewed to apply in disaster situations and enable carers to combine work and care. Inspiration could be taken from the European Union's Work-life Balance Directive,[16] adopted in 2019, which establishes a right to 5 paid days for care leave per year as well as leave for force majeure.

Further, specific gender-responsive employment policies must be implemented in the recovery process (New Zealand Human Rights Commission 2012; CEDAW Committee 2012). The tool, Bringing Gender In, suggests that this could involve collecting data on women's employment after disasters, examining gender disparities in employment during recovery and introducing initiatives to boost women's workforce participation in the aftermath (Ministry for Women n.d.). An intersectional lens would consider specific initiatives for mature and older women (New Zealand Human Rights Commission 2012).

Increase disaggregated data (sex, age, income, disability, ethnicity)

Additional efforts are needed to collect disaggregated data and better understand the effects across age, gender, ethnicity as well as other factors (New Zealand Government 2023; CEDAW Committee 2012). To create evidence-based policies and programs, the collection of disaggregated risk reduction and risk management data must be incorporated into the mandates of agencies responsible for gathering, analysing disaster risk data and developing risk information (UNDRR and UNFPA 2024; UNCSW 2022). Gender-responsive indicators and monitoring systems must be developed (CEDAW Committee 2018a) and monitoring and evaluation of policies and practices must include gender disaggregation and analysis of gendered effects (New Zealand Human Rights Commission 2012).

Meaningful participation and leadership of women in disaster risk reduction

Disaster response systems are often male-dominated (Pease 2024). To enable the meaningful participation of individuals of all genders, further research is required in the context of Aotearoa New Zealand. While women accounted for 80% of CDEM Group Welfare Managers in 2022, comprehensive data on gender representation across other roles remains limited. Although NEMA has taken a positive step with the *Diversity, Equity and Inclusion Plan 2024/25* (NEMA 2024), comparable efforts at the regional level are not evident. Adopting an intersectional and multi-stakeholder approach to disaster risk management can strengthen women's engagement in disaster recovery processes.

Increase allocation of resources to advance gender equality

Gender-sensitive funding and budgeting are critical to ensure that resource allocation advances gender equality. However, developments in Aotearoa New Zealand suggest a regressive shift in government commitment to budgeting and women's rights more broadly. Although in 2023 the Treasury required government agencies to incorporate gender budgeting into policy proposals, no processes were implemented in the 2024 Budget. The 2024 Budget involved the rescoping and reduction of key gender-related initiatives, including decreased investment in the Bringing Gender In tool and reduced contributions to the Public Service Commission's Equal Pay Taskforce (New Zealand Human Rights Commission 2024; The Treasury 2024). In addition, the 2025 amendments to the *Equal Pay Act 1972*[17] (passed with urgency) have curtailed women's capacity to initiate pay equity claims and signals a diminished prioritisation of gender equality.

16. *Directive (EU) 2019/1158 of the European Parliament and of the Council of 20 June 2019,* at https://eur-lex.europa.eu/eli/dir/2019/1158/oj/eng.

17. *Equal Pay Amendment Act 2025,* at www.legislation.govt.nz/act/public/2025/0021/latest/LMS1436393.html.

Cooperation of emergency management with gender experts

Collaboration between the emergency management sector, the Ministry for Women, human rights institutions, women's organisations and other stakeholders is crucial to ensure that disaster policies and responses are inclusive and address the diverse needs, vulnerabilities and strengths of all genders (Parkinson et al. 2023a). Therefore, a gender and disaster strategy must establish formal cooperation mechanisms that integrate gender experts at every stage of emergency management.

Gender training for policy makers and emergency services personnel

Effective gender training needs to be part of a broader strategy to reinforce institutional capacities for gender mainstreaming (Parkinson et al. 2023a). According to the International Training Centre of the ILO (n.d.), effective gender training can bring about change at 3 levels:

- rising awareness of the need to address gender inequality in policies
- enhancing knowledge of relevant international, national and institutional policies and laws that emphasise the importance of gender equality
- developing skills in the practical application of technical tools and guidelines to plan, implement and monitor gender-sensitive initiatives.

Guidelines on gender and disaster for emergency services organisations

The overall strategy on disaster and gender could be supported by guidelines for emergency management personnel. Such guidelines were developed in Australia in 2021 for agencies (their employees and volunteers) involved in emergency management relief and recovery and for senior emergency management policy and decision makers (Parkinson et al. 2024a). Specific guidelines for emergency management will provide clear direction for emergency management personnel on gender-related actions and help prevent gender issues from being deprioritised during the 'tyranny of the urgent' in the post-disaster environment. Instead, gender aspects can be integrated into disaster planning, response and recovery without being diluted among other policy considerations (Parkinson et al. 2024b).

Conclusion

Aotearoa New Zealand's gender-neutral approach to disaster risk reduction and risk management frameworks is failing to adequately support women and caregivers, as demonstrated by examining 3 national disasters of the Canterbury earthquakes, the COVID-19 pandemic and Cyclone Gabrielle. It also contravenes international standards and obligations. To effectively address the effects of disasters on different genders, a national strategy on gender and disaster is crucial. The strategy must include gender mainstreaming in all disaster laws and policies, explicitly addressing care work and work disparities within disaster risk management frameworks. This needs to be supported by disaggregated data collection, financial backing, inclusive participation risk management and inter-institutional collaboration. The current Emergency Management Bill No 2 fails to address this issue. Urgent legal reform is needed to align disaster law with gender equality to improve disaster risk reduction for all people in Aotearoa New Zealand.

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Shelter after disasters in Australia

Abstract

Australia has recently experienced a series of disasters that destroyed many homes and displaced many people. Different approaches to post-disaster shelter have been implemented in the wake of these events, including accommodation provided in hotels, caravan parks, social housing or 'temporary villages' using shipping containers and modular prefabricated dwellings (pods). While these initiatives have some positive outcomes, a range of problems are also evident, particularly the protracted nature of the displacement. For people without adequate insurance, or with limited options for relocation, and in an environment of housing shortages, access to permanent housing becomes uncertain and the makeshift solutions can have severe consequences. Given the increases in the frequency and magnitude of emergencies and disasters, living in such places is untenable. Further, the development of new building regulations such as the Bushfire Attack Level ratings to minimise disaster risk adds to costs and can impede access to permanent housing. There are few studies on shelter after disasters in Australia and this points to the need for in-depth research that can inform policy and practice.

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Introduction

A range of natural hazards affect Australia and, given the influences of climate change and population growth, these have resulted in larger and more frequent disasters in recent times. The effects of such disasters on housing have been extensive. Housing is a basic human necessity and is largely an immobile, high-value asset. Housing is often the sector that suffers maximum damage in disasters (Lyons 2009). Displacement and loss of shelter compound the event and can have long-term effects on economic security, safety, social connectedness, health and wellbeing. Significant resources and many years are required for housing recovery. As such, resilient housing is vital to shelter and safeguard people.

This is reflected in the Australian context. To explore this, this study examines 2 major events of the summer bushfires during 2019–20, where more than 3,000 houses were destroyed (NHRA 2023) and the severe floods in New South Wales in 2022 where more than 15,000 houses were destroyed or damaged in the Northern Rivers region and in the Central West. In the most affected town of Eugowra, more than 80% of buildings including houses were damaged (NSW Audit Office 2024). Shelter provision after disasters is the responsibility of state governments and indicative recovery costs for the New South Wales floods are more than $300 million spent in less than a year for temporary housing (NSW Audit Office 2024).

This study explored the outcomes of these investments and efforts. It draws on the cases of the 2 nominated disaster events, discusses the typical approaches to shelter provision and analyses the achievements and challenges. A key argument is made that the primary preoccupation is with temporary shelter provision and there is limited attention to support long-term, disaster-resilient solutions for permanent housing that could reduce the need for continually providing short-term temporary solutions. Another option is to build into policy and practice a vulnerability paradigm that places the shelter needs of people at the centre so that post-disaster interventions do not exacerbate or create vulnerability and, instead, support resilience.

Methods

The findings are derived from a focused review of literature. An integrative review approach was used, which involved synthesising data from different sources (Kutcher and LeBaron 2022). For this study, scholarly and grey literature including media reports were examined. It was important to review sources such as reports, policy documents and news stories that offered current and extensive information on the issues beyond academic publications.

The literature was reviewed in a critical synthesis approach where the aim was to examine problem areas identified in the literature and develop a narrative from the synthesis of those areas. It also followed an evaluative research paradigm by assessing the actions of relevant stakeholders and the related overall condition of the shelter and housing sector in Australia. The critical synthesis literature review was analysed thematically by ascribing manual codes to themes that emerged from the identified problem areas. These were grouped and clustered according to the codes to generate the findings. This process followed a thematic analysis strategy (Braun and Clarke 2019; Caulfield 2019) by first gaining familiarity with the literature then coding and developing themes, which then allowed reviewing, defining and naming the themes.

A search of literature was conducted using Google Scholar using the terms 'housing' and 'disaster' and 'Australia'. Results between January 2009 and March 2025 were included. Peer-reviewed and non-peer-reviewed literature was included given that there is an important body of grey literature to consider. Recent and relevant literature on the topic was limited and it was difficult to assess long-term outcomes of recovery after the 2019–20 summer bushfires and 2022 New South Wales floods. Therefore, the timeframe covered in this study stretches back to include the Black Saturday bushfires in Victoria in 2009. This allowed greater insight from the shelter recovery process. This paper serves as the background and foundation for future research as the outcomes of the recovery

Overview of shelter approaches

A foundational publication by Quarantelli (1982) suggests 4 main forms of post-disaster shelter being emergency shelter, temporary shelter, temporary housing and permanent housing. Quarantelli's definitions remain valuable in differentiating between 'shelter' and 'housing'. The former implies a form of short-term accommodation allowing a protective space for sheltering and sleeping while the latter provides longer-term accommodation and has more space and provision for daily necessities. These definitions imply a continuum from a disrupted immediate post-disaster situation to a stable long-term condition. However, this is an idealised concept and, in actuality, the progression is rarely linear. Indeed, stable housing may not eventually be attained or it might take a very long time to achieve.

The term 'shelter' has been used by international humanitarian agencies in post-crisis situations to mean accommodation for affected populations (Davis 1978; Quarantelli 1982; UNDRO 1982). The term has been applied primarily in the context of developing countries but has wider relevance. Recent conceptualisations in Australia indicate that three main forms of post-disaster shelter are recognised. These are emergency accommodation, temporary housing (NSW Audit Office 2024) and permanent housing, but the term 'shelter' is not generally used. Charlesworth and Fien (2023) distinguish between the early and later stages of accommodation as 'temporary shelter' (the initial 4 to 6 months) and 'temporary housing' (expected to serve for up to 2 years). In reality, so-called 'temporary' housing has been required for a more protracted period (see Lucas 2022). Facility conversion to establish relief and evacuation centres in schools, gymnasiums and community centres is also a common emergency shelter option as these facilities are fairly widespread across Australia.

Key issues in emergency and temporary shelter

Emergency shelter in Australia is typically provided in hotels and motels (NSW Audit Office 2024), caravan parks and via rental subsidies paid to people in private rental accommodation (DCHDE 2021). There is no available evidence on the extent to which such arrangements progress to long-term permanent housing as typically envisioned, nor how many people transition into permanent housing. According to the NSW Audit Office (2024), a survey conducted after the 2022 floods in the Northern Rivers showed that almost half of the respondents in emergency accommodation thought they would never be able to return home, while a similar proportion of people were uncertain about such a prospect. Compounding this, in remote and rural areas of Australia there is often a scarcity of hotels and motels (Charlesworth and Fien 2023) that further limits the options for emergency accommodation.

Temporary housing includes short- and medium-term accommodation typically in caravans or 'pods' usually made from shipping containers or custom-made shelters (Watt 2023). These are generally provided by Australian governments and often in partnership with non-government organisations such as Habitat for Humanity and Australian Red Cross. This was the case after the 2022 floods and 2029–20 summer bushfires (Aubrey 2020; Australian Red Cross 2021; Claughton 2021; Minderoo Foundation n.d.). In the Northern Rivers, it was decided to build 11 temporary villages via a congregate sheltering arrangement, with 546 dwelling units spread across the

villages (NSW Audit Office 2024). Nearly a year and a half after the floods, there were more than 700 people waiting for temporary housing. The temporary villages could not meet the need and people lived with friends or family, in emergency accommodation or experienced homelessness (NSW Audit Office 2024).

Temporary villages provide levels of functionality and possibility for recovery. Research by Charlesworth and Ahmed (2015) after the Black Saturday bushfires in Victoria in 2009 noted that temporary villages in bushfire-affected areas of Kinglake and Marysville were built with different communal facilities and in proximity to previous homes with access to social amenities. This enabled the communities to remain cohesive and provided a medium-term transitional solution for 18 months until permanent housing was built. While there were positive outcomes, there were also challenges. For example, people may not be accustomed to living in small dwellings in close proximity to other people and friction was inevitable. Despite the advantages, this cannot be a widespread solution because of the associated high cost and logistical demands as well as it not meeting the level of need required after large-scale disasters (NSW Audit Office 2024).

Following the Northern Rivers floods, there were issues of access and quality of post-disaster shelter and housing solutions. A key issue relating to temporary housing in pod villages was people's eligibility and access to these programs. Submissions to the Independent Flood Inquiry (O'Kane and Fuller 2022) detailed how homeowners were not eligible if they had accommodation support through their insurance policies. This had major financial consequences for homeowners with mortgages who had limited access to housing programs as well as the financial burden of their mortgages while funding alternative accommodation. These financial pressures left homeowners with mortgages trapped in flood-affected homes while they waited for decisions on their insurance claims (Ross and Hannigan 2024). Significant insurance delays were reported in the Deloitte (2023) investigation into the insurance industry's response to the floods. This report stated that there were over 34,000 open insurance claims related to property, vehicle and home contents that remained outstanding 12 months after the event (Deloitte 2023). These findings reflect the existing literature that suggests that insurance can be maladaptive when it fails to facilitate recovery (de Vet et al. 2019; O'Hare et al. 2016; Wamsler and Lawson 2011).

A temporary village with 'pods' in Lismore built after the 2022 floods.

Image: Courtesy NSW Reconstruction Authority (2024)

A temporary village in Kinglake, Victoria, was built after the 2009 Black Saturday bushfires.
Image: Courtesy of Peter Johns (2010)

O'Kane and Fuller (2022) found that the limited availability of alternative housing options in the Northern Rivers meant that many people lived in flood-affected houses. While not completely destroyed, many of these houses were unsuitable for habitation. Multiple submissions to the Independent Flood Inquiry showed that people dealt with cascading problems like mould growth after homes had soaked up floodwater for prolonged periods or by being exposed to extensive rain damage (O'Kane and Fuller 2022). This presented a health hazard for the residents and they reported respiratory issues and emotional stress associated with living in such conditions (Archibald-Binge 2022).

The lessons from the Northern Rivers floods prompted a different approach following a later flood in 2022 in the Central West region of New South Wales. In this case, after the initial emergency period, an 'At-Home caravan program' was implemented where people were provided with caravans and subsequently followed by a pod on their property. This was done instead of building temporary villages. It is reported that even people who were renting were provided this support in negotiation with the landlord or other property owner (NSW Audit Office 2024; NSW Government 2024a). This approach appears to have had positive outcomes as evident from similar initiatives of pods provided after the 2019–20 summer bushfires (Charlesworth and Fien 2023). According to an evaluation of the flood housing response, the outcomes after the fires were better than those in the Northern Rivers floods (NSW Audit Office 2024). However, it should be acknowledged that the scale of the disaster and consequent shelter needs were smaller and, thus, more manageable.

It is not clear whether all the affected people in the Central West could be supported with the 130 pods provided (NSW Government 2024b) or whether all the people in caravans could make the transition to pods or permanent housing. Caravans can only accommodate 2 to 3 people; they are not very suitable for families and are generally unsuitable for living in for an extended period. Even pods are not meant for habitation for more than a couple of years. According to Charlesworth and Fien (2023), pods are not habitable for more than a few months. Yet media reports document that people lived in caravans and temporary housing for several years after the summer bushfires (Lucas 2022; May 2022) and many people did not even receive temporary housing support after the Northern Rivers floods (NSW Audit Office 2024). The temporary villages in the Northern Rivers are expected to be dismantled after 5 years (NSW Audit Office 2024), which is well beyond the desirable period for this type of accommodation.

Various other issues are also evident. Insurance payouts for temporary accommodation tend to cover a short period, beyond which households face prospects of homelessness. Even with rental support from insurers and/or governments, there is often inadequate supply and availability of rental properties (Fitzsimmons 2021). Finding rental properties in areas that have been devastated is obviously a challenge, one that is exacerbated by ongoing rental shortages across Australia.

An intractable issue is the high associated costs (Heffeman et al. 2025) of elaborate processes of procurement, production, transportation, installation, removal, storage and maintenance of temporary housing such as pods. The Australian Government has embarked on a modular shelter program with the company Humanihut with a budget of 14.2 million (Watt 2023). These housing products provide a better short-term living environment with more space and amenities. However, whether this is justifiable in terms of cost and the potential for progression to achieve permanent, resilient housing is not yet known.

Availability of materials and tradespeople in the aftermath of a disaster are also key challenges (Charlesworth and Fien 2023; Tondorf 2022). Without the required numbers of qualified people to complete works, the recovery process is slow and leaves disaster-affected people in uncertainty. In the temporary housing program after the 2022 floods, $350 million was originally allocated to the response and recovery program. However, it required an additional $88 million and, even then, it could not cater to all the people in need of temporary housing (NSW Audit Office 2024). Temporary villages are indeed costly and cannot be a sustainable solution over the long term (Heffeman et al. 2025), especially with the growing incidence of severe disaster events.

Given the limited evidence on shelter recovery in Australia, many questions arise. How do people manage their shelter recovery? What is their trajectory towards permanent shelter solutions? What are the lessons for future shelter recovery policies and practices? Such questions, particularly in relation to those people experiencing poverty and marginalisation, are central to understanding social vulnerability (Fordham et al. 2013) in the post-disaster context.

Prospects for permanent housing

Permanent housing reconstruction is usually undertaken by homeowners with insurance funding, sometimes supplemented by grants from government and non-government organisations (Australian Red Cross 2021; Claughton 2021; NBRA 2020). However, there are widespread reports of difficulties negotiating with insurance companies, especially at a time when people are traumatised (Byrne 2024; Eriksen et al. 2020). There are also people who have insurance but then they learn it is inadequate (Fitzsimmons 2021). Charlesworth and Fien (2023) characterised this as 'privatisation of housing' and a 'replacement recovery' approach. Such an approach entails that insurance companies only pay for the cost of replacement of the destroyed house but not for any relocation cost or for 'building back better' (Clinton 2006; UNDRR 2015) to increase resilience to future disasters (Heffeman et al. 2025). After a disaster event building codes and standards are often changed to improve future resilience, which incurs extra costs for rebuilding that insurance companies may not cover. In other words, the insurance payouts can only assist to replicate pre-existing conditions of vulnerability that led to the destruction of the house in the first place.

The concept of 'building back better' for resilience to future events has been widely used since being posited by the former President of the United States and the UN's Special Envoy for Tsunami Recovery (Clinton 2006) after the 2004 Indian Ocean Tsunami. The concept is also espoused in the United Nations *Sendai Framework for Disaster Risk Reduction 2015-2030* (UNISDR 2015) as one of its 4 priorities. However, the goal of 'building back better' has been elusive in Australia because of the market-driven paradigm of post-disaster recovery led primarily by the insurance sector, as also noted by (Heffeman et al. 2025).

An example of this is the Bushfire Attack Level system that came into place after the 2009 Black Saturday bushfires to ensure safety of future housing. Proposals for building new houses are assessed for their bushfire risk according to factors such as location and environment and then measures in relation to building design, construction and materials need to be incorporated according to the level of risk. Generally, the higher the risk, the more expensive the measures. For people rebuilding, this can add a significant financial burden (Fitzsimmons 2021). As a new system following the Black Saturday bushfires, there were reports that expert assessors were not available and assessments were not always accurate (Charlesworth and Ahmed 2015).

Exceptions are sometimes made for households that have a low income and cannot rebuild their homes. However, even here, problems can arise as mentioned by a recovery worker in a panel discussion at a postgraduate course in the University of Newcastle. After the summer bushfires, 3 families that had lost their homes were promised new houses by the NSW Government. However, after waiting for almost 5 years they had not received a response and were still living in pods. The area had a high Bushfire Attack Level rating, but the families had long connections with the locality and did not want to move and, thus, lived there at risk to future bushfires.

Research on the 2022 floods demonstrate the critical dilemma faced by flood-affected households navigating

insurance (Mortimer 2024). In the aftermath of the floods, significant delays in insurance payouts left many homeowners in limbo: they were unable to fund their rebuild or relocate out of the floodplain. Many remained financially tethered to their land due to ongoing mortgage obligations, despite their homes being uninhabitable or damaged. Some flood-affected residents did not have the means to self-fund permanent relocation and their land and damaged homes became a source of financial entrapment (Mortimer 2024). Compounding this, government grants often excluded those with insurance coverage despite widespread reporting of lengthy delays and disputes in accessing those payouts (Deloitte 2023). These dynamics expose issues with the centrality of insurance in Australia's disaster governance arrangements (Eriksen et al. 2020). When insurance mechanisms fail to support timely and equitable recovery they function as instruments of residual risk transfer that benefits institutions while exacerbating household vulnerability (van den Honert and McAneney 2011). Such systemic failures reinforce prolonged displacement and inhibit pathways to long-term recovery.

For people whose home has been destroyed, they must continue to live on the disaster-affected block in order to obtain insurance support even though this exposes them to hazards. It is also likely that the market value of their land has decreased in the wake of the disaster. Without financial and other incentives to relocate to safer land, their vulnerability is perpetuated. Nonetheless, there are studies that show that despite the initial decline in market value, for example after the 2019–20 bushfires and the 2011 Brisbane floods, property prices had bounced back within a few years (Bendel 2025). With the scarcity of housing supply and high demand in Australia, the market seemed to adjust despite the potential future hazard risk. In the interim, as evident after the 2022 floods, because of the initial drop in house prices, large numbers of houses in affected areas were purchased at low prices (Gilmore and Naylor 2023). If these properties become rental housing, it can lead to renters living in high-hazard areas. This can exacerbate the burden of vulnerability being borne by people of lower socio-economic status (Lee and Van Zandt 2019). The permanent housing sector is primarily market-driven (Pawson et al. 2020). Governments and institutions are minor housing providers and do not have sufficient resources to respond to a crisis-driven housing need. They are reliant on the private sector to build housing and, as Australia is experiencing a chronic shortage of tradespersons and building materials (Build Australia 2023), it makes the provision of adequate housing all the more challenging.

The NSW State Government Resilient Homes Program (NSW Government n.d. a) developed after the 2022 Northern Rivers floods was created to help people into permanent housing.

There are 3 streams:

- Home buyback: The NSW Government offers to buy houses that are assessed to be in an area of high flood risk with support to the homeowner to access new land and housing elsewhere. More than 2,000 homeowners were eligible (MacKenzie 2024), however, an assessment reported 4,055 houses as uninhabitable (Smith 2022). Additionally, new homeowners, even if they had purchased a house in a disaster-affected area, are not eligible (Gilmore and Naylor 2023), which means that they remain exposed to future high-risk hazards. It is not clear if the buyback scheme addresses the problem adequately. A large-scale buyback scheme can be challenging and applicants need to wait for an extended period as was the case after the 2022 Northern Rivers floods (O'Kane and Fuller 2022).
- Home raising: The NSW Government provided up to $100,000 to homeowners in eligible areas to raise their house above flood level. However, flood level thresholds are increasing and repeat floods in Lismore and other flood-prone areas indicate that people can no longer live in low-lying areas even if their houses were raised on stilts in response to previous floods. The 2022 floods were more than 14 metres high and it is possible that future floods will result in higher river levels and greater areas of inundation (Siossian 2022). Even if a house is above flood level, people may become isolated inside the house and disconnected from utilities, food and other supplies. This is also the case where houses are built on raised mounds of land (particularly in farming locations within NSW river valley regions) and became isolated during flooding that cuts off road access. Thus, the long-term sustainability of house raising can be questioned.
- Home retrofit: Up to $50,000 is available to homeowners to repair or retrofit their affected property with flood-resistant construction and materials. If repair/retrofit costs exceed this amount and a homeowner does not have access to additional funds, it can lead to a difficult situation. Also, Australia is facing significant problems with the supply of building materials and labour (Build Australia 2023). After the 2022 NSW floods, there was an increased demand for materials and labour (Charlesworth and Fien 2023; Lucas 2022; Residential Tenancies Authority n.d.) and an escalation of prices (Lucas 2022). This is applicable for building both temporary and permanent housing. Hence, the feasibility of this approach may be limited.

Despite some shortcomings, the NSW Resilient Homes Program is the first of its kind and represents an attempt to address the issue of shelter after disaster events. While the program targets the Northern Rivers region, there is a need for similar initiatives in other parts of Australia that experience high-risk hazards. This affords an opportunity to learn how such initiatives can be planned and streamlined.

Discussion

The provision of shelter and housing during different post-disaster stages brings into focus the vulnerability paradigm, which attributes the negative effects of disasters on systemic and structural factors such as poverty, marginalisation and inequality, also known as 'social vulnerability' (Fordham et al. 2013). As highlighted by (Scandlyn et al. 2013, p.43), 'With few exceptions, the poor and marginalised are most vulnerable to disasters, whether they live in rich or poor nations'. This is reflected in Australia in relation to shelter after disasters. For example, in the Victorian coastal town of Mallacoota ravaged by bushfires in 2020, Lucas (2022) reported that elderly people were living in makeshift shelters for more than 2 years. Similar predicaments were faced in other bushfire-affected areas by elderly and retired people due to lack of rental options from insurance companies (Fitzsimmons 2021). Fitzsimmons (2021) reported that people in local indigenous communities experienced housing recovery hurdles due to inadequate insurance and limited access to construction services. Charlesworth and Fien (2023) noted limited housing options for overcrowded communities and the NSW Audit Office (2023) recorded inadequate and inappropriate engagement approaches.

Another area of concern relates to renters displaced by emergencies and disaster whose long-term housing needs are often unaccounted (Heffeman et al. 2025). Most housing support is targeted at property owners. For example, after the 2022 floods in the Central West, pods were available for people who owned private property. For renters, caravans were provided if they were able to receive permission from the landlord (NSW Government 2024a). Despite the problems of living in caravans long term, people lived in such arrangement for many years. The Queensland Government has a provision for renters in crisis (Residential Tenancies Authority, n.d.) but this is only for a period of 2 weeks (Queensland Government 2023). People who are unable to secure rental accommodation within this time face uncertainty and this can be exacerbated by a shortage of affordable and available rental housing (AHURI 2022). There is minimal discussion on the displacement experiences of people who were homeless prior to the disaster events. The Australian Government has identified that there is a housing supply problem (e.g. Sheth-Patel 2024) and the urgent provision of adequate housing after emergencies and disaster adds to the problem. Lucas (2022) reported that, in regional areas, there is a 'property boom' and high rental and building costs make it more difficult for people experiencing poverty to recover after disaster events.

The Resilient Homes Program serves 7 local government areas in the Northern Rivers that were affected by the 2022 floods. However, a much wider regional spread can be expected to be affected by future floods. Large-scale planning seems to be missing. Indeed, a lack of state-level planning and lessons-sharing was found in the evaluation of the flood housing response, including the lack of a strategy to meet temporary housing demand and long-term transition from temporary to permanent housing (NSW Audit Office 2023).

Another issue was the bureaucracy involved in housing support processes. For example, the Resilient Homes Program factsheets details the many requirements to meet eligibility criteria and access support (e.g. NSW Government n.d. b). Experiencing a disaster can be traumatic and many people may be in a crisis state long after the disaster. Bureaucratic processes can be challenging in such circumstance and may be associated with processes of procuring housing materials, transport and installation as well as recruiting skilled workers, which can contribute to delays (Charlesworth and Fien 2023; Fitzsimmons 2021; Lucas 2022; NSW Audit Office 2023).

Conclusion and further research

Australia experiences significant challenges in designing and delivering effective post-disaster shelter programs. A house is usually the most expensive asset someone owns or inhabits and rebuilding after a disaster is an expensive process. Given the pressures of housing supply scarcity, escalating costs and supply shortages, there will likely be an increase in the numbers of people displaced by disasters in the future.

To improve the safety and wellbeing of people and communities, significant reforms are needed to the systems and processes to provide short-term shelter and long-term housing for people affected by disasters. Some of these reforms need to be enacted by governments, including investment in disaster preparedness, response and recovery phases and streamlining bureaucratic processes. Some reforms must be enacted by the private sector (potentially via regulation), particularly the insurance sector, to fairly and adequately protect against the social and economic effects of disasters. Some changes will be required of individuals, families and communities that face difficult questions about the level of disaster-related risk they live with and their values of place and connections to community. It should not be assumed that people have choices in such scenarios. For many people, there are economic, social and other constraints that limit their capacity to mitigate risks. There are also a range of complex systems and determinants that influence the capacity for effective shelter and housing responses. These include the general housing market as well as levels of poverty, discrimination and health. The complexity of this situation, and the understanding required to improve housing outcomes for people displaced by disasters, mean that further research is needed to inform evidence-based policy and practice.

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Abstract

Knowledge of the hazards, protective actions and the language used in warning messages is essential for safety and informed decision-making particularly during flash flooding and hazardous weather events. Equally important for effective risk communication is knowledge of what recipients already know and the inclusion of context and uncertainty information in forecasts and warnings. There is limited empirical research about how people interpret warnings based on their levels of knowledge and past experiences. A survey of 1,235 people was conducted to understand people's knowledge of the causes of flash flood, the risks, effects, protective actions and definitions as well as interpretations of terms of likelihood used in rainfall warnings. Survey results showed that the hypothesis that emergency management practitioners had more knowledge of flash flood than the public was only partially supported. Results showed gaps in understanding, in particular, the verbal probabilistic terms of 'likely' and 'possible' that are used in rainfall warnings were interpreted inconsistently. This presents a challenge when communicating uncertainty. This study shows the need to improve the communication of uncertainty in forecasts and warnings and advises the use of defined numerical probabilities with verbal terms.

Flash flood knowledge and uncertainty communication in warnings: an Australian study

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Introduction

Flash floods are generally difficult to predict and, when they can be predicted, there is often little time remaining before onset (WMO 2012). This makes flash flooding challenging to forecast, warn for and leaves those at risk with reduced capacity to take timely and appropriate protective actions. Being caught unaware by flash flooding, crossing flood waters and exposure during outdoor activities are leading causes of flood-related fatalities in Australia (Fitzgerald et al. 2010; Haynes et al. 2009, 2017). According to Deloitte Access Economics (2021), severe storms and floods are among the most economically costly types of high-risk hazards in Australia each year. To effectively communicate risk, it is important that people receive the information, understand the message and the potential effects of the hazard as well as what actions they can take to protect themselves (Kuligowski et al. 2024; Lazrus et al. 2016; Paton 2019).

Multi-hazard early warning systems are identified as a cost-effective tool and can reduce economic losses and provide a 10-fold return on investment (UNDRR and WMO 2024; WMO 2022). End-to-end early warning systems integrate risk knowledge, hazard monitoring and forecasting, warning dissemination and communication as well as preparedness and response to enable people to take timely action to reduce their risks (UNDRR and WMO 2024; WMO 2022, 2024). Community resilience and safety is dependent on effective, people-centred warning systems that deliver relevant and actionable information to those at risk (Argyris 2005; Dallo et al. 2022; Kirchhoff et al. 2013; WMO 2022).

To be informed and reduce risks, communities need early warnings (Box et al. 2016). Communication techniques and warning messages should be evaluated

to assess their effectiveness and help prevent unintended outcomes (Dallo et al. 2022; Nickerson 1999; Sutton et al. 2025). People's understanding of forecasts and warnings and their response can be improved through revisions to products and services and changes in forecast design (Carr et al. 2016; Demuth et al. 2013; WMO 2024). Research, for example, Cawood et al. (2018), Dufty (2014) and Hamilton et al. (2019) shows that flash flood warning systems in Australia (including forecasting, warning messaging and salient communications) require improvement to enhance early warnings and support informed decision-making.

Communication is a key factor for risk interpretation, decision-making, actions and responses and, therefore, greatly affects the consequences of severe weather and natural hazard events (Khan et al. 2017). While information-seeking pathways (that is, how individuals search for further information before taking action once aware of a threat) may be different during flash flooding to those for slow-moving floods, people used similar sources of information; effective (good) communication is key (Ryan 2018). Effective communication requires a reasonably accurate understanding of what others know (Lazrus et al. 2016; Nickerson 1999). Misjudging their knowledge can lead to communication difficulties and misunderstandings. Furthermore, understanding the perspectives and decision-making contexts of people helps in the communication of actionable knowledge (i.e. information that is usable and relevant to help people in making informed decisions about their safety, risk and actions) (Argyris 2005; Dallo et al. 2022; Lazrus et al. 2016).

How weather information is communicated including presentation, language, framing and visualisation can influence risk perception and decision-making (e.g. Clive et al. 2023; Demuth et al. 2013; Stephens et al. 2019). Users need both a forecast and an indication of how confident they can be in it to enable decisive actions and reduce the need for contingency planning (Fischhoff 1994). Uncertainty can lead to maladaptive behaviours, including delaying decisions (Lipshitz and Strauss 1997) or seeking additional confirmatory information (Wood et al. 2018). This increases the potential for harm in high-risk situations where quick decisions may be needed, such as in flash floods. Furthermore, if uncertainty is not expressed in a forecast, people lack information relevant to decision-making and may guess the levels of certainty/confidence/likelihood (Fischhoff 1994; Joslyn and Savelli 2010; Morss et al. 2008; Stephens et al. 2019). Guessing the certainty incorrectly can lead to exceedingly cautious or highly risky actions (Fischhoff 1994). Empirical research shows that the inclusion of uncertainty information or probabilities in weather forecasts and warnings can help prevent miscommunication and improve decision-making interpretations and proficiency (Joslyn and Savelli 2021; Ripberger et al. 2022; WMO 2008).

Probabilistic information and forecasts are becoming more readily available and qualitative and quantitative descriptions of probability (i.e. uncertainty information) is more likely to be included in future weather services and risk communications (Ripberger et al. 2022; Stuart et al. 2022). Appropriately communicated uncertainty or probability information can improve people's decision-making proficiency and lead to greater trust in the information (Joslyn and Savelli 2021; National Research Council 2006; Ripberger et al. 2022). However, warning messages and risk communication studies show that verbal expressions of uncertainty and probability, such as 'likely' and 'possible' can be interpreted differently by different individuals (Fischhoff 1994; Ho et al. 2015; National Research Council 2006). Interpretation and comprehension are influenced by the context in which information is used, the decision-maker's circumstances and how the information is framed (Doyle et al. 2019; Joslyn and Savelli 2021; National Research Council 2006). Thus, it is important to examine if probability terminology and uncertainty information is interpreted by users as intended by the providers of a forecast (Fischhoff 1994; Ho et al. 2015).

Preparedness and response to hazards like flash floods are shaped by factors including knowledge, skills, behaviours, attitudes, experience, social context, demographics, risk perception, uncertainty and self-efficacy (Eiser et al. 2012; Paton 2019; Sherman-Morris 2013). Understanding how these factors influence poor outcomes across diverse communities and contexts helps to inform effective and locally relevant risk mitigation approaches (Haynes et al. 2017; Lazrus et al. 2016; Taylor et al. 2018). To competently respond to a flash flood forecast or warning an individual requires knowledge of the hazard and what to do or how to stay safe (Paton 2019). This process involves identifying, personalising and prioritising the risk, recognising the need for action to ensure safety or risk mitigation and assessing the resources, capacity and ability to take the appropriate protective actions (Eiser et al. 2012; Paton 2019; Slovic 2016). Decision-making in real-world situations, such as operational forecasting, emergency management and responding to severe weather events, can be characterised as decision-making under uncertainty. In these dynamic environments, people (actors) are making decisions with incomplete information (Lipshitz and Strauss 1997; Klein et al. 1993; Eiser et al. 2012). Under time pressure and high-risk conditions, people rely on their experience, intuition and pattern recognition to make decisions (Klein 2015; Klein et al. 1993). However, to make 'good' or competent decisions, expertise (i.e. knowledge and skills) are important (Klein 2015; Klein et al. 1993). Education and training to develop expertise can help people to make more proficient decisions and increase safety and efficiency (Klein 2015; Klein et al. 1993).

Knowledge and experience are also important in perceiving risk and responding to weather warnings (Eiser et al. 2012; Paton 2019; Sherman-Morris 2013). However, the influence of knowledge and experience on risk perception, decision-making and preparedness can be contradictory and warrants further investigation. For example, knowledge and past experience may increase or decrease perceived risk and preparedness depending on circumstances, the hazard and the individual (Box et al. 2016; Demuth 2018; Paton 2019). People may overestimate their knowledge levels and abilities (perceived knowledge) compared to their actual (objectively measured or assessed) knowledge (Casteel 2023; Lichtenstein and Fischhoff 1977; Nunley and Sherman-Morris 2020). This overconfidence bias can place people at greater risk of decision errors and harm (Lichtenstein and Fischhoff 1977). Experts often have more opportunities to gain experience and feedback in their specialist areas, greater knowledge about a hazard and associated risks and employ different (more effective) decision-making strategies to make highly reliable and accurate judgements (Morgan et al. 2002; Klein et al. 2017; Klein 2015). Anecdotally, it may be assumed that emergency management practitioners have more knowledge and experience than people in the community (i.e. the public) and a greater understanding of weather hazards, preparedness and protective actions.

Studies exploring community and emergency management communication, preparedness and response to flash flooding in Australian contexts remain scarce. There is evidence that the general understanding of flood risk among communities is relatively low (Metrix 2019). Similarly, there is limited research into the depth of knowledge held by emergency management practitioners regarding flash floods, particularly in relation to flash flood predictability, how they differ from riverine flooding and the types of locations that are most at risk. Australian research has examined flood risk communication and warning design (Tippett et al. 2021; Mehta et al. 2022; Taylor et al. 2019), flash flood fatalities and behaviour (Hamilton et al. 2019; Haynes et al. 2009, 2017, 2018) and information pathways (Bird et al. 2012; Ryan 2018). However, public perceptions of verbal probability terms such as 'likely' and 'possible' and understanding of technical terminology such as 'heavy' and 'intense' in the context of rainfall forecasts or warnings has not been systematically tested in Australian populations.

Aim

This exploratory study aimed to establish a baseline understanding of public and emergency management knowledge of flash flooding with a particular focus on how people interpret the communication of uncertainty in weather warnings related to such events. For the purposes of this study, the term ‘emergency management’ is used broadly to encompass salaried workers, volunteers, organisations and individuals involved in the provision of services and the organisation and management of resources to deal with emergencies, including prevention, response and recovery (AIDR 2023). Study participants self-selected as being currently or previously involved in the emergency services (emergency management sector) or not (categorised as the public group).

Research questions were:

- RQ1: What are the levels of knowledge of emergency management practitioners and the public about the causes, dangers, predictability, and appropriate protective actions related to flash floods?
- RQ2: Are there differences between emergency management practitioners and the public regarding their knowledge of flash flood?
- RQ3: Do people understand the terminology used in forecasts and warnings?

Materials and methods

Design

An online survey was used as a part of an inter-disciplinary and mixed-methods research project for Natural Hazards Research Australia - Flash Flooding Case Studies to Improve Predictions and the Communication of Uncertainty. The survey explored people's perceptions of flash flooding in the Australian context. It focused on factors that influence warning response including flash flood knowledge, risk, uncertainty and terminology used in Bureau of Meteorology (the Bureau) heavy rainfall warning messages. This paper uses a subset of the survey findings to test hypotheses and answer research questions.

The hypotheses for this study were:

- H1 - Public perceive flash flood to be more predictable (forecasting difficulty) than emergency management.
- H2 - Public have lower perceptions of the importance of various environmental factors that contribute to flash flood risk than emergency management.
- H3 - Public have lower flash flood knowledge (including definitions, causes, terminology/rainfall types, protective actions) than emergency management.
- H4 - Public have lower perceptions of how likely various impacts are during a flash flood than emergency management.
- H5 - Interpretations of the uncertainty and rainfall terminology used in forecasts and warnings varies.

Ethics

The research design and survey materials were reviewed by the research team following the guidelines of the

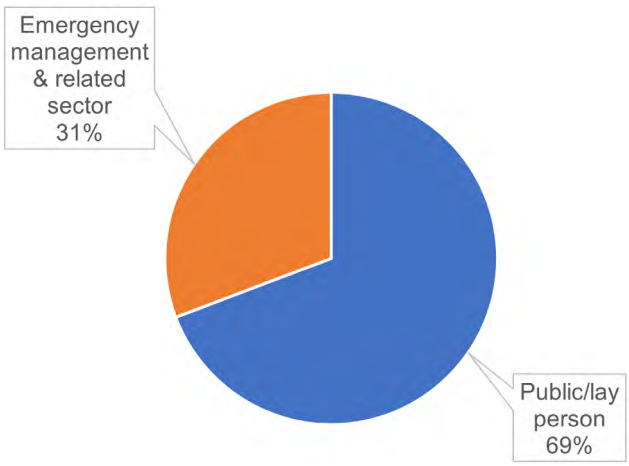

Figure 1: Number of participants from the emergency management and related sectors and public group.

National Statement on Ethical Conduct in Human Research (NHMRC et al. 2023) and criteria for low-risk research. The data collection and survey questions were considered in line with the *Privacy Act 1988* and the Bureau's Privacy Threshold Assessment Tool (rated low level risk). No private, sensitive, identification nor personal information was intentionally solicited or collected. All respondents were over 18 years and participation was anonymous. Before starting the survey, participants were provided with information about the study and all gave informed consent. The consent included permission to store and use deidentified data for future related research.

Measures

The online survey contained 20 questions and took an average of 16 minutes to complete. The complete survey instrument is available at https://osf.io/pg5f9/?view_only=d0ec04200bca4981a827efb79a509240. The variables examined in this study:

- Perceived knowledge was measured using 5 items, original and adapted from Clive et al. (2023); Heinrich (2022) and Nunley and Sherman-Morris (2020). Items measured perceived flash flood knowledge, self-efficacy and knowledge of rainfall terminology on a 5-point Likert scale from 'Strongly disagree' (1) to 'Strongly agree' (5). This scale showed good reliability α =.794, ω =.795 (mean sum score 21.32, SD 3.17) and structurally the items loaded onto one factor that explained 55% of the variance.
- Flash flood predictability (forecasting difficulty) was measured using one item, 'Flash floods are easy to forecast', on a 5-point Likert scale from 'Strongly disagree' (1) to 'Strongly agree' (5).
- Importance of flash flood risk factors measured knowledge of flash flood risk factors by rating 8-items/factors adapted from Morss et al. (2016) on how important each environmental factor was for determining flash flood risk on a 5-point Likert scale from 'Not at all important' (1) to 'Extremely important' (5) with a 'Don't know' option. This scale showed lower reliability that is acceptable for preliminary research (Peterson 1994) α =.671, ω =.674 (mean sum score 24.53, SD 3.44). Structurally, the items loaded onto one factor that explained 39% of the variance.
- Assessed knowledge drew out aspects of general flash flood knowledge such as knowing the causes and definition of flash flood, rainfall terms used by the Bureau and protective actions as measured using 4 multiple-choice questions, original and adapted from Morss et al. (2016). Responses that were completely correct were scored as 1 (Correct), partially correct and incorrect answers scored as 0. Correct scores were summed to give an overall assessed knowledge score.
- Knowledge of flash flood effects assessed risk or perceived harm was measured by rating 8 items adapted from Morss et al. (2016) on how likely each item is to occur in a flash flood event on a 5-point Likert scale from 'Not at all likely' (1) to 'Extremely likely' (5), with a 'Not sure' option. This scale showed good reliability α =.851, ω =.853 (mean sum score 30.25, SD 5.20). Structurally, the items loaded onto one factor that explained 50% of the variance.
- Terminology included uncertainty communication comprehension measured with questions adapted from Morss et al. (2016) and based on common terminology and heavy rain warning messaging issued by the Bureau at the time of survey construction. Each participant was randomly allocated to a group that received 2 of the 4 warning message questions where the verbal terms 'likely' or 'possible' and hazard type (heavy rain/flash flood) varied (see Figure 12).
- Confidence was measured by participants rating their confidence that the answer they provided was correct on a scale of 0-100% following a number of the questions including knowledge of flash flood definitions, 'heavy' and 'intense' rainfall, causes of flash flood, protective actions and the likelihood of flash flooding or heavy rainfall given a warning message.
- Experience with flood hazards and professional involvement was recorded. Participants were categorised as public or emergency management sector using the question 'Are you currently or have you ever been involved with emergency services? (including, as a professional, volunteer, training, water sector, crisis management, weather services, warning services, emergency management)' to allow comparisons between groups.

- Demographics examined the geographic spread of responses and participants were asked for their main residential postcode. No further demographic information was collected to comply with privacy and ethics considerations.

Procedure

Participants over 18 years old were invited to complete the online survey. The convenience sample was recruited through snowball sampling that leveraged the networks of the Bureau and Natural Hazards Research Australia. This included sharing the survey link via emails, social media, Bureau user groups, the BOMIdeas emailing list, newsletters, public meetings and conferences.

Participants viewed a study information sheet and gave informed consent before proceeding with the survey. In a 'within-' and 'between-groups' design, participants were randomly allocated to one of 4 groups/conditions. Participants received identical questions except in the terminology/warning message section where each treatment condition received alternative wording. Following Nunley and Sherman-Morris (2020), perceived knowledge was examined before assessed knowledge. Multiple-choice responses and matrix tables randomly displayed options. The survey was pilot tested by the research team and colleagues prior to public release. The survey was open from 22 February to 13 May 2024. A total of 1,454 responses were received, of which 219 were incomplete. Incomplete responses were deleted, leaving a sample of 1,235 responses to be analysed. The emergency management (n = 380) and public (n = 855) groups were the same sample size for all group comparison tests.

Data analysis

In this exploratory mixed-methods study, quantitative (numbers) and qualitative (open text) data were collected. Quantitative data was statistically analysed using MS Excel and JASP. Non-parametric tests were used as the data did not meet all the assumptions of normality. Cronbach's alpha (α), coefficient omega (ω) and principal component factor analysis (promax rotation) were used to examine scale reliability, structure and dimensionality. Mann-Whitney U tests were used to compare between groups (emergency management and public) and test our hypotheses. Quantitative analyses were reported as statistically significant at alpha $p < .05$.

Results

Participants

Participants were Australian residents aged 18 years or older comprising members of the public and individuals from communities associated with Bureau stakeholders including first responders and those engaged in emergency services (Figure 1). Participants (n = 1,235) were geographically spread around Australia (Figure 2). Over half had experienced some form of flooding (Figure 3), 38% in an urban environment, 31% in a rural setting.

Knowledge of flash flood

Most participants indicated agreement to strong agreement with the flash flood knowledge statements, showing high perceived knowledge of terminology and protective behaviours relating to heavy rainfall warnings and flood (Figure 4). Thus, participants believed that they knew about flash floods, rainfall terminology and protective behaviours relating to heavy rainfall warnings and flash flood. Emergency management participants reported slightly higher perceived knowledge scores than the public. This difference was statistically significant (Mann-Whitney U tests (U) = 134395.50, $p = <.001$, SE Rank-Biserial Correlation = -.137 95% CI [-0.206, -0.066]).

Most participants disagreed with the statement 'flash floods are easy to forecast' (Figure 5). This statement was examined using a Mann-Whitney U test to test the hypothesis that the public has lower perceptions of flash flood predictability (forecasting difficulty) than those in emergency management (H1). Hypothesis H1 was not supported ($U = 158814.50$, $p = .506$ (not significant), SE Rank-Biserial Correlation = -.022 95% CI [-0.092, 0.047]).

Participants rated the importance of various environmental factors that contribute to flash flooding (Figure 6). Comparison of the total importance of flash flood risk factors scores showed that emergency managers perceived the items as more important overall compared to the public group ($U = 135079.50$, $p < .001$, SE Rank-Biserial Correlation = -.132 95% CI [-0.202, -0.062]). There was support for the hypothesis that the public have lower perceptions of the importance of various environmental factors that contribute to flash flood risk than emergency management (H2). Comparison of the emergency management to public responses for individual scale items showed no significant statistical differences for 'the amount of rain in the last 24 hrs' and 'past history of flash flooding at the location'. Emergency management rated all other risk factor items as more important.

We assessed participants' actual flash flood knowledge across several survey questions relating to the definition of flash flood, rainfall terminology, causes of flash flood and appropriate protective actions. Hypothesis H3, that the public has lower flash flood knowledge than the emergency management group was tested using Mann-Whitney U tests for each of these questions.

Results show that most participants knew the causes of flash flooding (Figure 7). There were no statistically significant differences between emergency management and public groups apart from the item 'short bursts of heavy rainfall such as from thunderstorms' (Table 1). Thus, there was limited, partial support for hypothesis H3, that the public has lower flash flood knowledge than emergency management around the causes of flash flood.

There were no statistically significant differences between emergency management and public group's definitions except for the item 'flooding that happens within 6 hours of rain falling' (Figure 8 and Table 2). Thus, there was limited, partial support for hypothesis H3, that the public have lower knowledge of flash flood definitions than emergency management.

Results show that 66% of participants knew that the difference between heavy and intense rainfall is that 'over the same time period, intense rainfall corresponds to a greater amount of rainfall' (Figure 9). There were no statistically significant differences between emergency management and public group's knowledge of intense and heavy rainfall (Table 3). Thus, hypothesis H3, that the public has lower flash flood knowledge around the terms used to describe rainfall than emergency management was not supported.

Results show that participants knew appropriate actions and behaviours to keep themselves safe if they received a warning for heavy rainfall that may lead to flash flooding (Figure 10). There were statistically significant differences between emergency management and public groups for the items 'watch for changing weather conditions' and 'check for advice and updates from your local emergency services and/or radio station', which were more often selected by emergency management participants when compared to the public (Table 4). Overall, emergency management participants selected all appropriate responses (correct score) more often than the public participants and this difference was statistically significant. There was support for hypothesis H3, that the public has lower knowledge of appropriate protective actions in response to flash flooding than emergency management.

Total knowledge scores (sum of correct responses across the 4 knowledge questions) were low overall. In comparing total knowledge scores, the emergency management group had slightly higher scores (mean 1.15, SD 1.08) than the public group (mean 0.97, SD 1.06) and this difference was statistically significant, supporting H3 (U = 178249.0, p =.004, SE Rank-Biserial Correlation =.097 95% CI [0.028, 0.166]). While H3 (that public had less flash flood knowledge) was partially supported, overall, emergency management participants were more confident than the public that their responses to the 4 knowledge questions were correct. This assessment was accurate when we compare total assessed knowledge scores. The group differences in confidence were statistically significant (Tables 1, 2, 3 and 4).

Participants were asked to rate how likely they thought the various impacts would be during a flash flood event (Figure 11). There were no statistically significant differences between the emergency management and the public groups. The hypothesis that the public has lower perceptions than emergency management participants of how likely various flash flood impacts are during a flash flood event (H4) was not supported.

Interpretations of uncertainty terminology in heavy rainfall warnings

Participants received 2 of 4 warning messages depending on the random group allocation (Figure 12). The warning messages were identical apart from the use of terms of 'likely' or 'possible'. Participants were asked to indicate the likelihood (per cent chance) of either flash flooding or heavy rain. A follow-up question asked respondents to indicate their confidence in the likelihood value they reported.

Comparing the reported likelihood values between groups, Kruskal-Wallis tests show that there was a statistically significant difference in likelihood values reported between the different hazard (flash flood, heavy rain) and wording conditions (likely, possible); hazard (H (1) = 377.03, p <.001), terminology wording (H (1) = 19.96, p <.001). Comparing likelihood values reported within subjects, Wilcoxon signed-rank tests showed that participants perceived a statistically significant difference in the mean likelihood of flash flooding or heavy rainfall when the words 'possible' and 'likely' were used. (Group 1 W = 5262.00, p <.001, SE Rank-Biserial Correlation = -.332 95% CI [0.086, -0.173], Group 2 W = 2291.50, p <.001, SE Rank-Biserial Correlation = -.595 95% CI [-0.094, -0.463], Group 3 W = 1829.00, p <.001, SE Rank-Biserial Correlation = -.844 95% CI [0.078, -0.794], Group 4 W = 19119.00, p <.001, SE Rank-Biserial Correlation =.884 95% CI [0.081, 0.914]).

These results support our hypothesis (H5) that participants have different understandings and interpretations of the terminology used by the Bureau in heavy rainfall warnings and forecasts. Raincloud plots show the distributions of the likelihood values reported by participants, visualising the differences found (Figure 13). Higher likelihood values were more often reported for the 'likely' term. The spread or range of values was narrower when likely was used in the warning message. In the warning scenarios participants generally reported higher likelihoods for the occurrence of heavy rainfall than for flash flood events.

Table 5 shows a summary of the hypothesis testing results.

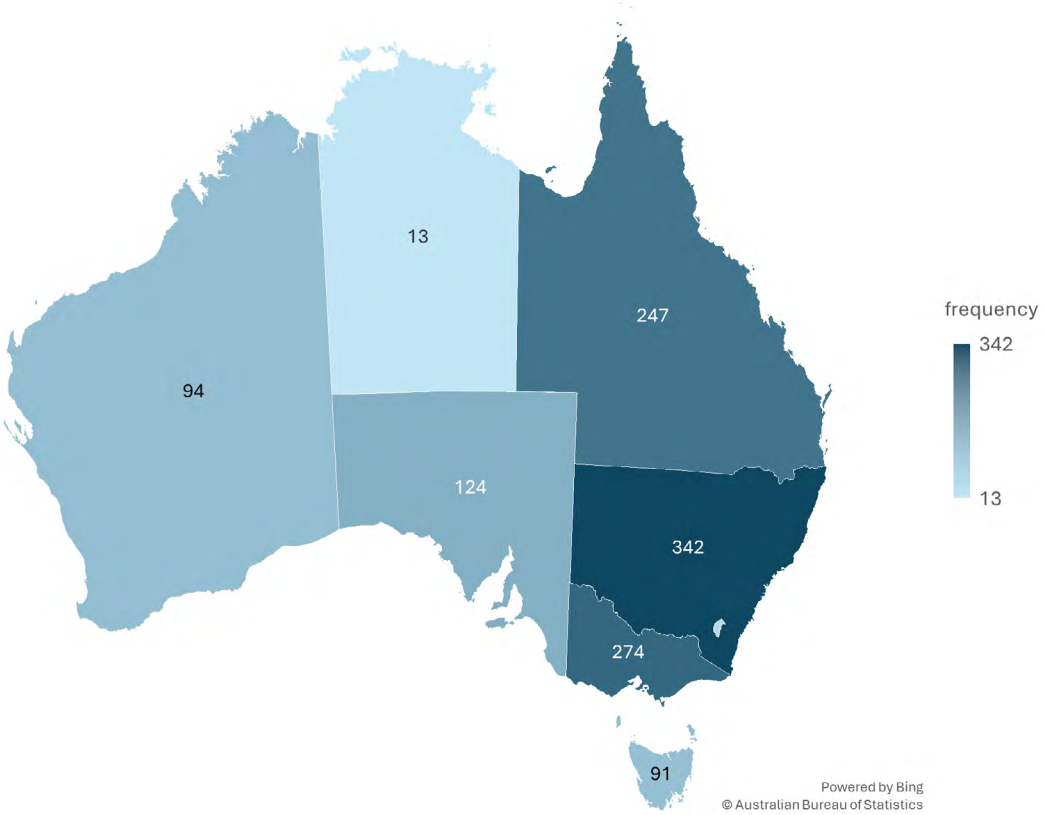

Figure 2: Number of participants by state (from provided postcode). Note: not all participants provided postcodes.

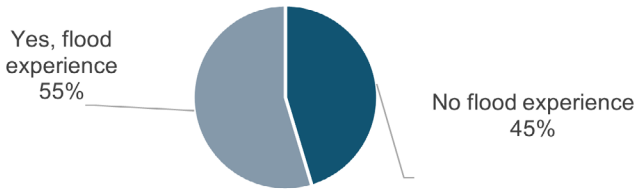

Figure 3: Participants' past flood event experiences.

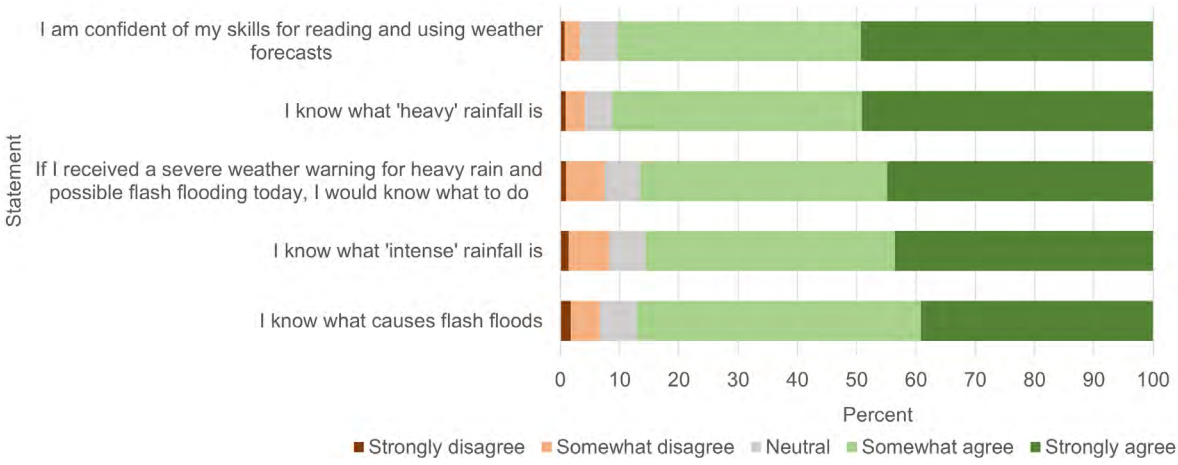

Figure 4: Participants' subjective assessments of their knowledge levels (perceived knowledge); 'how much you agree or disagree with each statement'. Participants reported agreement with most statements indicating higher perceived knowledge.

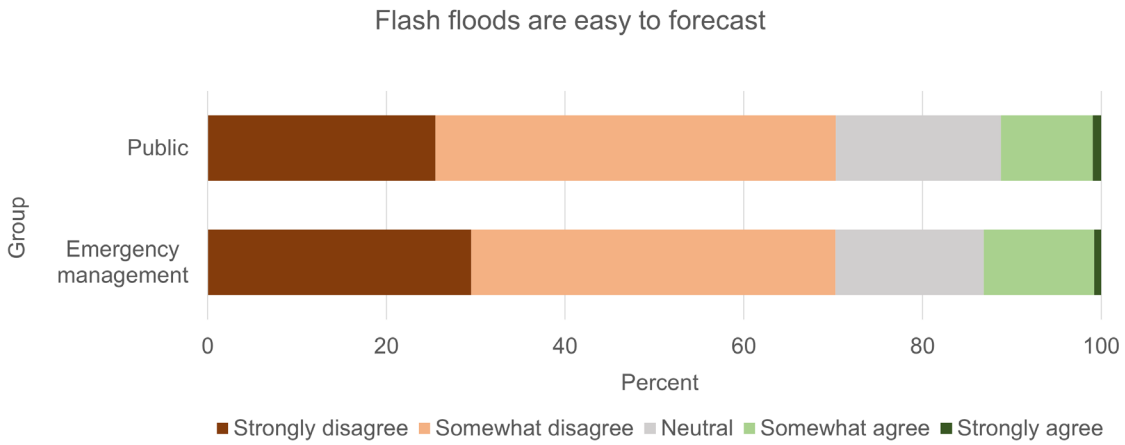

Figure 5: The public and emergency management participants' perceptions of the predictability of flash floods. Agreement with the item 'flash floods are easy to forecast'.

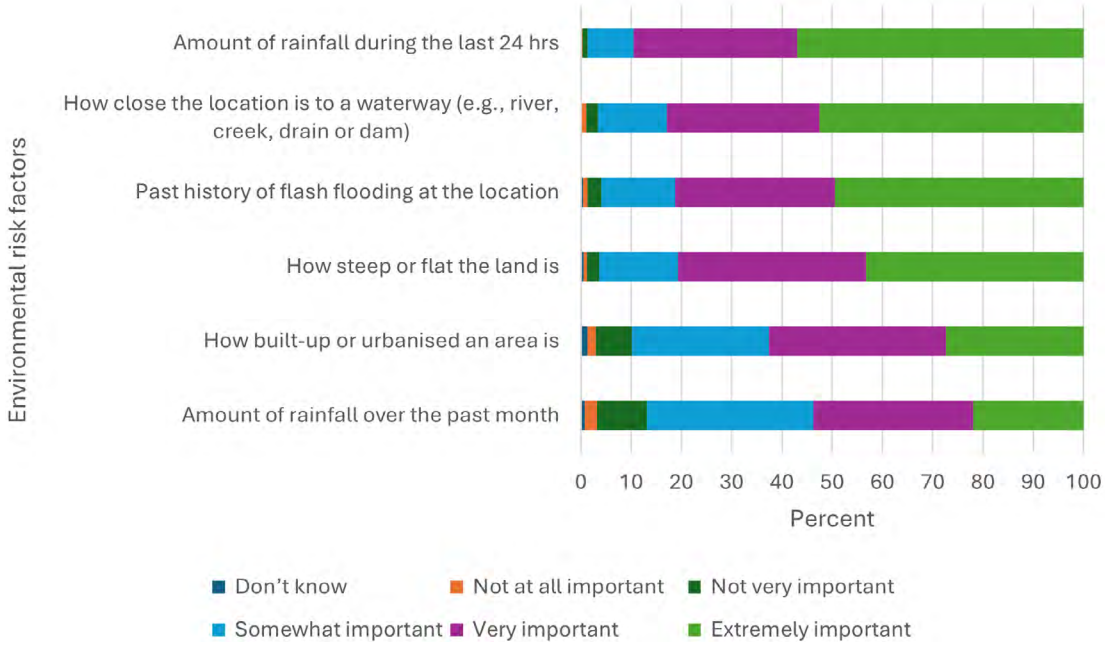

Figure 6: Rating of the importance of each factor in determining the risk of flash flooding at a given location. All these factors influence flash flood risk and some are not well known.

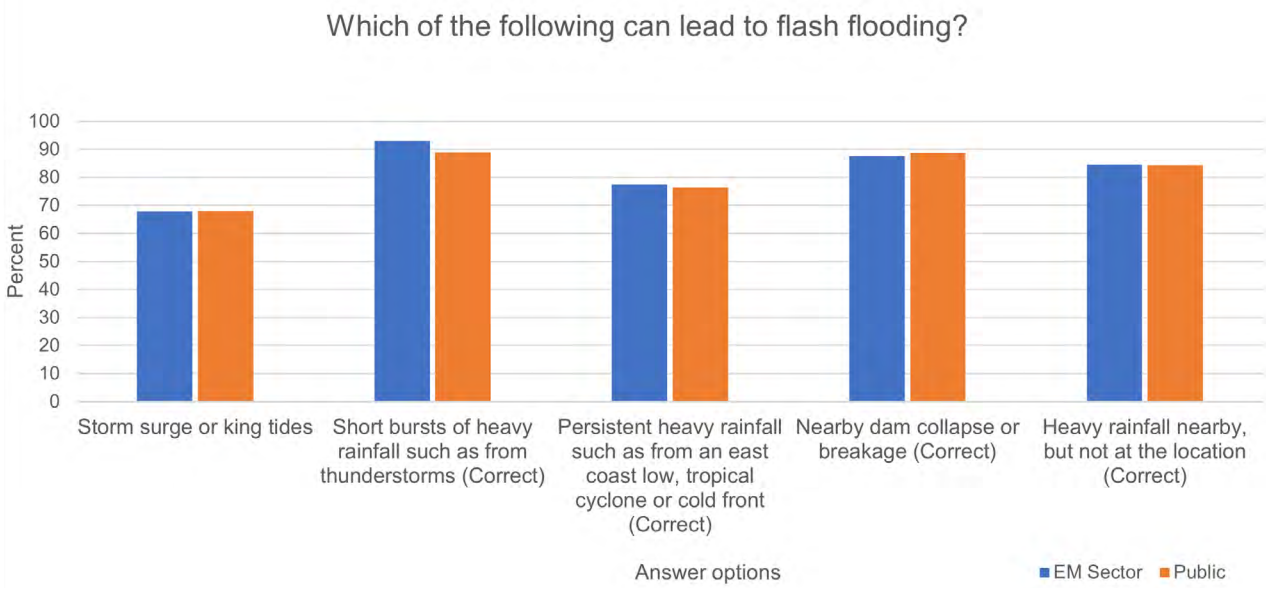

Figure 7: Assessed knowledge of the causes of flash flooding. All correct responses, no incorrect responses selected = emergency management 9%, public 8%. Mean confidence answer provided is correct = emergency management 82%, public 78%.

Table 1: Comparison between emergency management and public groups on their assessed knowledge of the causes of flash flooding.

				95% CI for Rank-Biserial Correlation	
	U	*p*	Rank-Biserial Correlation	Lower	Upper
Short bursts of heavy rainfall such as from thunderstorms	156132.5	.034	-0.039	-0.108	0.031
Storm surge or king tides	162545	.984	5.848×10-4	-0.069	0.07
Persistent heavy rainfall such as from an east coast low, tropical cyclone or cold front	161025	.736	-0.009	-0.078	0.061
Nearby dam collapse or breakage	164302.5	.563	0.011	-0.058	0.081
Heavy rainfall nearby, but not at the location	162212.5	.948	-0.001	-0.071	0.068
FF knowledge 3 correct Which of the following can lead to flash flooding?	164112.5	0.552	0.01	-0.059	0.08
How confident you are that the answer you just provided is correct.	183622.5	< .001	0.13	0.061	0.198

Note: For the Mann-Whitney test, effect size is given by the rank-biserial correlation.

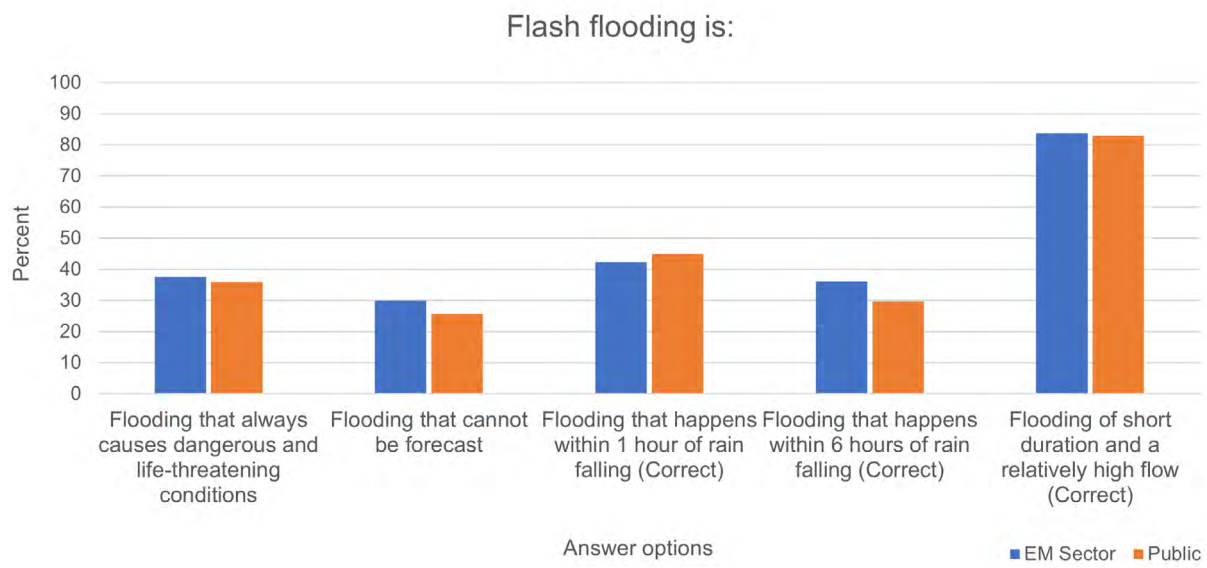

Figure 8: Assessed knowledge of the flash flooding definitions. All correct responses, no incorrect responses selected = emergency management 5%, public 3%. Mean confidence answer provided is correct = emergency management 75%, public 70%.

Table 2: Comparison between emergency management and public groups on their assessed knowledge of flash flooding definitions.

				95% CI for Rank-Biserial Correlation	
	U	*p*	Rank-Biserial Correlation	Lower	Upper
Flooding that happens within 1 hour of rain falling	166582.500	0.406	0.025	-0.044	0.095
Flooding that cannot be forecast	155515.000	0.119	-0.043	-0.12	0.027
Flooding that happens within 6 hours of rain falling	152142.500	0.027	-0.063	-0.133	0.006
Flooding that always causes dangerous and life-threatening conditions	159647.500	0.561	-0.017	-0.087	0.052
Flooding of short duration and a relatively high flow	161405.000	0.780	-0.006	-0.076	0.063
FF knowledge 1 correct Flash flooding is:	165205.000	0.138	0.017	-0.053	0.087
How confident you are that the answer you just provided is correct.	187219.500	< .001	0.152	0.084	0.220

Note: For the Mann-Whitney test, effect size is given by the rank-biserial correlation.

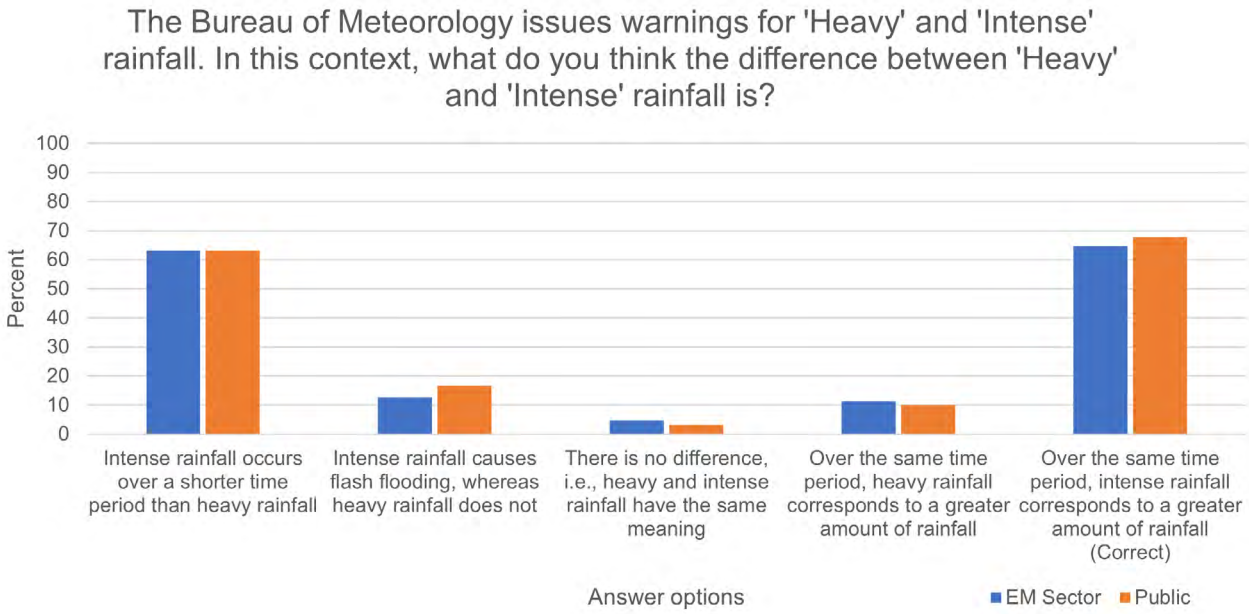

Figure 9: Assessed knowledge of the differences between 'heavy' and 'intense' rainfall. All correct responses, no incorrect responses selected = emergency management 28%, public 28%. Mean confidence answer provided is correct = emergency management 74%, public 71%.

Table 3: Comparison between emergency management and public groups on their assessed knowledge of the differences between 'heavy' and 'intense' rainfall.

				95% CI for Rank-Biserial Correlation	
	U	*p*	Rank-Biserial Correlation	Lower	Upper
Intense rainfall occurs over a shorter time period than heavy rainfall	162640	.969	0.001	-0.069	0.071
Intense rainfall causes flash flooding, whereas heavy rainfall does not	169100	.066	0.041	-0.029	0.11
There is no difference, i.e. heavy and intense rainfall have the same meaning	160075	.211	-0.015	-0.084	0.055
Over the same time period, heavy rainfall corresponds to a greater amount of rainfall	160407.5	.505	-0.013	-0.082	0.057
Over the same time period, intense rainfall corresponds to a greater amount of rainfall	167485	.286	0.031	-0.039	0.1
FF Knowledge 2 correct the difference between 'Heavy' and 'Intense' rainfall is?	161167.5	.776	-0.008	-0.078	0.062
How confident you are that the answer you just provided is correct.	174989	.030	0.077	0.008	0.146

Note: For the Mann-Whitney test, effect size is given by the rank-biserial correlation.

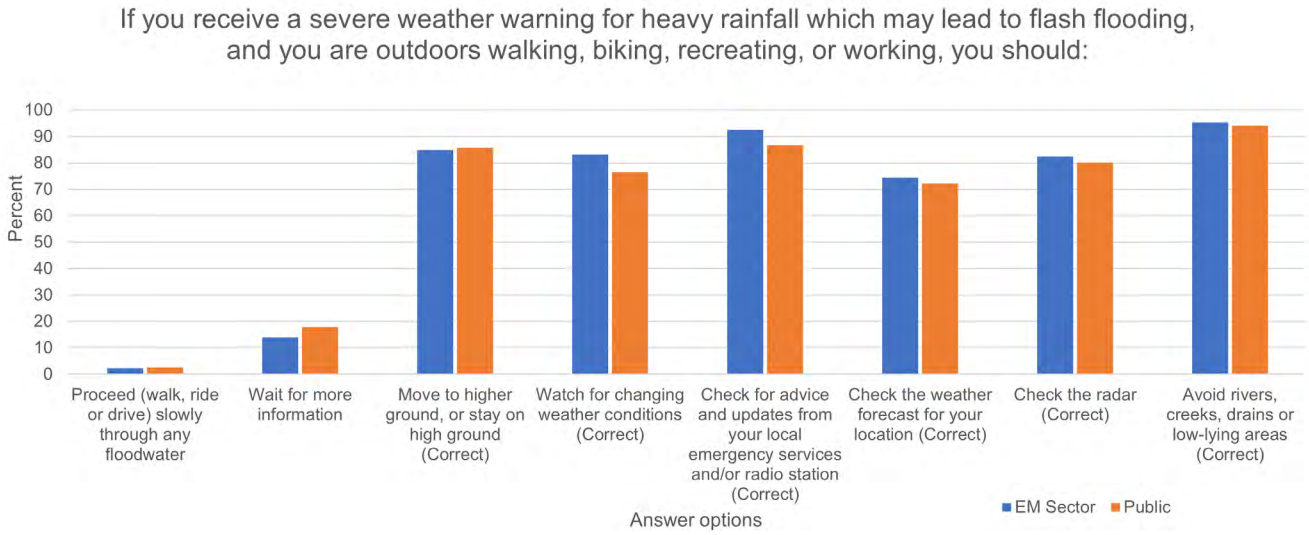

Figure 10: Assessed knowledge of appropriate protective actions. All correct responses, no incorrect responses selected = emergency management 41%, public 32%. Mean confidence answer provided is correct = emergency management 84%, public 80%.

Table 4: Comparison between emergency management and public groups on their assessed knowledge of appropriate protective actions.

				95% CI for Rank-Biserial Correlation	
	U	*p*	Rank-Biserial Correlation	Lower	Upper
	163637.5	.736	0.007	-0.062	0.077
Watch for changing weather conditions	151620	.008	-0.067	-0.136	0.003
Check for advice and updates from your local emergency services and/or radio station	152760	.002	-0.060	-0.129	0.010
Proceed (walk, ride or drive) slowly through any floodwater	162972.5	.743	0.003	-0.066	0.073
Wait for more information	168862.5	.086	0.039	-0.030	0.109
Check the weather forecast for your location	158697.5	.400	-0.023	-0.093	0.047
Check the radar	158792.5	.354	-0.023	-0.092	0.047
Avoid rivers, creeks, drains or low-lying areas	160645	.430	-0.011	-0.081	0.059
% all correct responses, no incorrect responses selected	177127.5	.002	0.090	0.021	0.159
Mean confidence answer provided is correct	187820.5	< .001	0.156	0.087	0.223

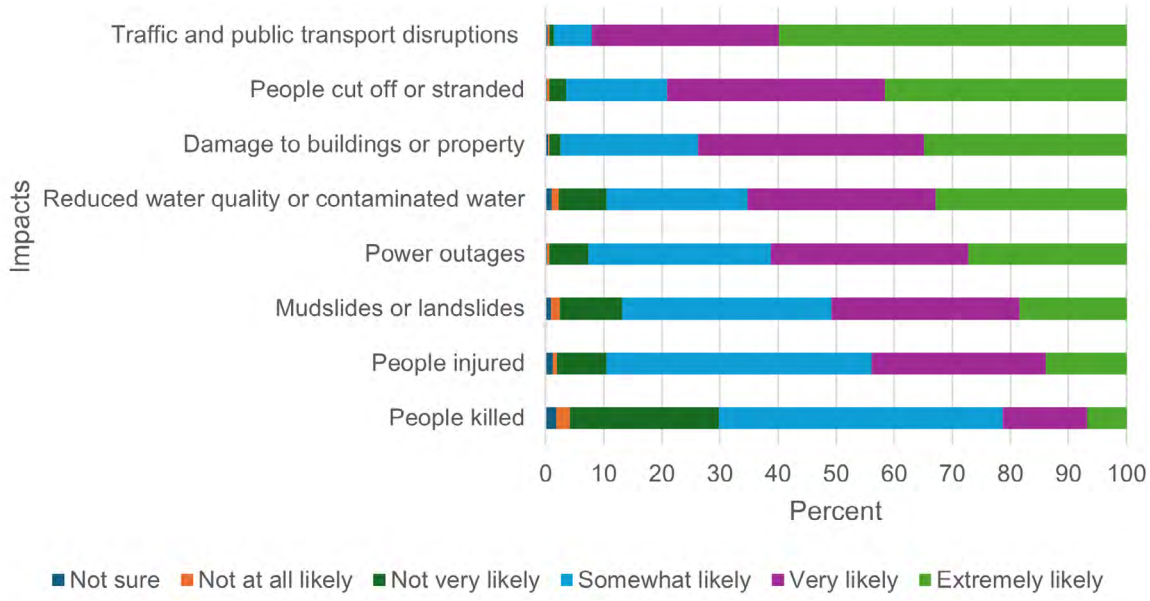

Figure 11: Ratings of likelihood of different events occurring in a flash flood event.

Group 1

HEAVY RAIN which may lead to FLASH FLOODING is likely.

- What do you think the likelihood (percent chance) of FLASH FLOODING is?

HEAVY RAIN which may lead to FLASH FLOODING is possible.

- What do you think the likelihood (percent chance) of FLASH FLOODING is?

Group 2

HEAVY RAIN which may lead to FLASH FLOODING is likely.

- What do you think the likelihood (percent chance) of HEAVY RAIN is?

HEAVY RAIN which may lead to FLASH FLOODING is possible.

- What do you think the likelihood (percent chance) of HEAVY RAIN is?

Group 3

HEAVY RAIN which may lead to FLASH FLOODING is likely.

- What do you think the likelihood (percent chance) of FLASH FLOODING is?

HEAVY RAIN which may lead to FLASH FLOODING is likely.

- What do you think the likelihood (percent chance) of HEAVY RAIN is?

Group 4

HEAVY RAIN which may lead to FLASH FLOODING is possible.

- What do you think the likelihood (percent chance) of FLASH FLOODING is?

HEAVY RAIN which may lead to FLASH FLOODING is possible.

- What do you think the likelihood (percent chance) of HEAVY RAIN is?

Figure 12: Heavy rain warning messages viewed by each group in the random conditions.

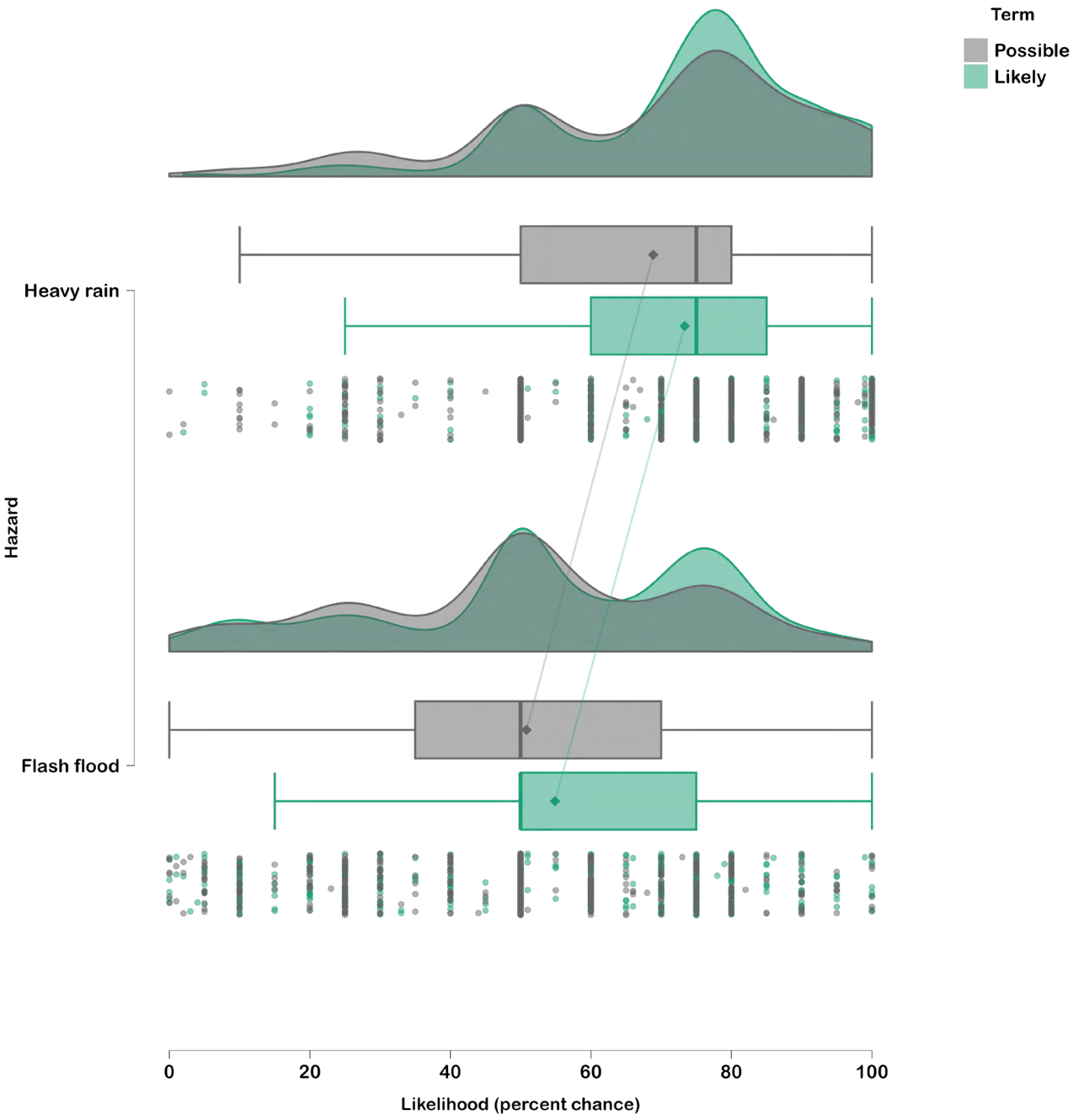

Figure 13: Raincloud plots visualising the density of the likelihood values in each condition. Comparison by hazard of the wording 'likely' and 'possible'.

NOTE: In interpreting the warning message, participants reported higher values for possible heavy rain than flash flood, and higher values for heavy rain than flash flood likelihood in the likely wording condition. Reported values ranged from 0 to 100%. Means are shown for each condition (Likely wording condition: Heavy rain likelihood M = 73.35, SD = 18.17), (Possible wording condition: Heavy rain likelihood M= 68.87, SD 22.08), (Likely wording condition: Flash flood likelihood M = 54.89, SD = 23.82), (Possible wording condition: Flash flood likelihood M = 50.84, SD = 23.39) (JASP software 2025).

Discussion

Preparedness involves developing knowledge and capacities across individuals, communities, organisations and governments to anticipate, respond to and recover from weather hazard events (Paton 2019). Many factors influence community and individual preparedness and warning response capacity, capability and competency, and, thus, people's ability to make appropriate decisions and stay safe during severe weather events like flash flood (Eiser et al. 2012; Paton 2019; Sherman-Morris 2013). This study examined public and emergency management practitioners' perceptions and knowledge of flash flood and interpretation of uncertainty terms used in severe weather warnings for heavy rainfall.

To answer research questions, participants rated their flash flood knowledge (perceived knowledge), then measured their assessed knowledge and interpretations of uncertainty terms. Five hypotheses were used to examine if there were differences between emergency management and the public's perceptions and knowledge (Table 5). The findings reveal variability in knowledge levels across individuals and between the public and emergency management groups with some consistent gaps in understanding identified across both cohorts.

The results showed an inconsistent interpretation of verbal probabilistic terms such as 'likely' or 'possible', highlighting a critical communication gap in current heavy rainfall warnings. Results suggest that current approaches to conveying uncertainty are insufficient and that flash flood remains poorly understood.

Forecasts and warnings that are most effective to support decision-making and desirable public safety outcomes provide understandable, actionable weather and uncertainty information (Argyris 2005; Dallo et al. 2022; Lazrus et al. 2016; Stuart et al. 2022). Behaviour-orientated flood warnings may improve public understanding and motivate appropriate actions (Mehta et al. 2022). While appropriately communicated probability information in forecasts improves decision quality and trust, vague and unclear wording can lead to miscommunication and misunderstandings (Greer et al. 2020; Doyle et al. 2019; Ripberger et al. 2022). These findings underscore the need for clear, standardised forecasts and warnings that communicate hazard risk via a range of communication approaches including verbal probability terms, context and numerical probabilities.

Flash flood knowledge

Hypothesis H1 was not supported. The absence of statistically significant differences in participant assessments of flash flood forecast difficulty suggests a consistent understanding between emergency management and the public regarding the general predictability of such events. While we expected that emergency management participants would perceive flash floods as being difficult to forecast, the public respondents shared this perception. This suggests that across both cohorts, perceptions align accurately with realities around the difficulty in predicting flash flood events.

Participants rated the importance of various flash flood risk factors. Overall, knowledge of environmental and situational factors contributing to flash flood risk was incomplete. While most participants recognised the importance of recent rainfall, fewer identified other critical factors such as land use or antecedent conditions.

Table 5: Summary of hypothesis tests comparing perceptions and knowledge of flash flood, terminology and language used in Bureau warnings.

	Hypothesis	Variables	Test result
H1	Public perceive flash flood to be more predictable (forecasting difficulty) than emergency management.	Flash flood predictability (forecasting difficulty):	Not supported
H2	Public have lower perceptions of the importance of various environmental factors that contribute to flash flood risk than emergency management.	Importance of flash flood risk factors	Supported
H3	Public have lower flash flood knowledge (including definitions, causes, terminology/rainfall types, protective actions) than emergency management.	Causes of flash flooding Definitions of flash flood Difference between heavy and intense rainfall Protective actions	Partially supported Partially supported Not supported Supported
H4	Public have lower perceptions of how likely various impacts are during a flash flood than emergency management.	Knowledge of flash flood effects	Not supported
H5	Interpretations of the uncertainty and rainfall terminology used in forecasts and warnings varies	Terminology - uncertainty communication comprehension	Supported

Participants commonly associated recent rainfall (previous 24 hours) with flash flood risk but were less likely to consider longer-term rainfall accumulation (e.g. over the past month). Urbanisation was rated as 'very' to 'extremely' important by 63% of participants, potentially reflecting learnt experience. However, this may highlight a gap in public education for people in high-risk areas with limited exposure to flash floods. Hypothesis H2 was supported in that emergency management participants rated certain risk factors as more important, indicating a potentially deeper awareness of the influence of local conditions on flash flood risk.

Hypothesis H3 was partially supported. There were no significant differences in assessed generalised flash flood knowledge between the public and emergency management groups. The hypothesis that the public and emergency management groups would have different levels of knowledge of the definition and causes of flash flood and rainfall terminology was partially supported. Participants mostly defined flash flooding as 'flooding of short duration and relatively high flow'. Knowledge of the causes of flash flooding varied and over 67% of participants considered that storm surge or king tides could cause flash floods. Only about one-third correctly identified that flash flooding can occur within 6 hours of rainfall onset and 63% incorrectly believed that 'intense rainfall' always occurs over a shorter period than 'heavy rainfall'. This is not true in general as the distinction between the terms, as defined by the Bureau, is driven by the amount of rain in a given time period, determined by the Annual Exceedance Probability (AEP). For severe weather and very dangerous storms, these thresholds are above 10% AEP depth for heavy rainfall and above 2% AEP depth for intense rainfall, both over a given period between 30 minutes and 6 hours (BOM 2025).

Misunderstandings of forecast terminology, such as this distinction between 'heavy' and 'intense' rainfall, were evident for both groups, supporting research that suggests technical terminology in warnings can be confusing (Box et al. 2016; Greer et al. 2020; Mehta et al. 2022). Good risk communication and warning practices suggest that simple language, no jargon and minimal use of well-explained technical information, is preferable to enhance comprehension (Greer et al. 2020; Kuligowski et al. 2024; Olson and Sutton 2025). Visual information or infographics may help to explain complex and technical concepts (Greer et al. 2020). Future studies could explore the use of language, visuals and message design to aid comprehension and personalisation of risk in Australian contexts.

In support of hypothesis H3, knowledge of appropriate protective actions and the effects of flash floods were generally higher among emergency management participants. Risk perceptions around potential effects and consequences were also mixed, with hypothesis H4 not supported. While transport disruptions were widely seen as likely, few participants perceived human injury or death as probable outcomes, mirroring results in the USA (Morss et al. 2016). Perceptions of a lower likelihood of fatalities may be related to lower intentions to take protective actions (Morss et al. 2016). This suggests a potential under-estimation of personal risk and highlights directions for future research.

Over 94% of participants knew to avoid waterways and low-lying areas. Although most respondents claimed to know what to do in response to a flash flood warning (perceived knowledge), only 30% of the public and 40% of emergency management participants correctly identified all appropriate protective actions (assessed knowledge). This finding supports other studies that people may overestimate their knowledge levels, placing themselves at greater risk (Casteel 2023; Lichtenstein and Fischhoff 1977; Nunley and Sherman-Morris 2020). Future studies could investigate, in Australian weather hazard contexts, if this overconfidence puts people at greater risk (Klein et al. 2017; Lichtenstein and Fischhoff 1977). Notably, 17% of participants indicated they would 'wait for more information', a potentially dangerous delay given the short lead times typical of flash flood events. This finding indicated the need for further research into decision-making under time pressures and the influence of public messaging on response.

Compared to the public group, emergency management participants had higher perceived knowledge, (slightly) more assessed knowledge and higher confidence in the accuracy of their assessed knowledge. These results are consistent with the literature on expertise and decision-making proficiency (Lichtenstein and Fischhoff 1977; Klein et al. 2017; Klein 2015). Professional weather forecasters and emergency managers are more confident in their knowledge and able to more accurately judge their specialist knowledge levels and are more likely to make better or more proficient decisions within their areas of expertise (Klein et al. 2017).

These findings provide guidance on future directions for research, education and engagement. A focus on increasing emergency management and public understanding of flash flood and related warning messages should be tempered by the knowledge of the important role of other factors on decision-making and response. Reliance on objective or assessed measures of knowledge that leads to a knowledge deficit approach to risk and science communication have their limitations (Simis et al. 2016; Olson and Sutton 2025). How people view or characterise the 'public' and attitudes towards social sciences can also perpetuate knowledge deficit models and communication and engagement challenges (Simis et al. 2016). Knowledge deficit models can lead to incorrect assumptions such as that education about technical terms will lead to direct behavioural change (Olson

and Sutton 2025). Furthermore, warning messages should be written with the assumption that recipients have no hazard knowledge (Greer et al. 2020). Response to warning information is complex and decision-maker contexts, environmental cues, social, behavioural, political and cultural factors influence message interpretation and response (Lazrus et al. 2016; Mulder et al. 2019; Paton 2019).

Although this study showed differences in knowledge between the public and emergency management groups, these should not be overplayed. The emergency management sector is highly diverse and includes a range of salaried staff and volunteer roles with different expertise and knowledge. Recognition of this diversity in emergency management and the public underscores the need to avoid assumptions about knowledge to ensure that communication is fit-for-purpose for intended audiences.

Communication of uncertainty terminology and interpretation of warning messages

For hypothesis H5, participants reported a range of values for the likelihood (per cent chance) of heavy rainfall or flash flood occurring. Results show statistically significant differences in the likelihood values they assigned depending on the wording used in the warning ('likely' and 'possible') and the hazard event type ('heavy rainfall' vs. 'flash flooding') (see Figure 14). This suggests that these terms and heavy rainfall warnings are interpreted differently. Findings align with previous research showing that verbal probability terms are inherently 'fuzzy' and context-dependent (Teigen 2023; Doyle et al. 2019; Patt and Schrag 2003). This discrepancy exposes a critical gap in how uncertainty is communicated and understood.

The study highlights a mismatch between community interpretations and widely recommended definitions of key terms. For example, the World Meteorological Organization (WMO 2008) recommends using 'likely' to describe events with a 70–89% chance of occurring and 'possible' for probabilities between 30–44%. In contrast, the Common Alerting Protocol (CAP) (OASIS 2010) considers certainty and defines 'likely' as exceeding approximately 50% probability and 'possible' as falling below that threshold. Although participants generally perceived 'likely' as conveying greater certainty than 'possible', their interpretations showed significant overlap between the 2 terms, underscoring the ambiguity in understanding. Responses did not align with the standards set by either WMO or CAP. Importantly, there is no universal standard for verbal probabilities or phrases, and the associated likelihoods vary across organisations, countries, disciplines and domains (Teigen 2023; Ho et al. 2015; Doyle et al. 2019). Guidance often lacks practical advice for practitioners, including how to communicate uncertainty to decision-makers, when such communication is appropriate, and how context may influence these interactions (Doyle et al. 2019). To overcome these challenges in communicating uncertainty and to better support decision-making, further research and participatory approaches are needed to facilitate 2-way dialogue and engagement within emergency management agencies and communities (Doyle et al. 2019; Kirchhoff et al. 2013). This includes understanding the varied needs for uncertainty information and developing defined, standardised and decision-relevant uncertainty terminologies, language and typologies for Australian contexts (Doyle et al. 2019).

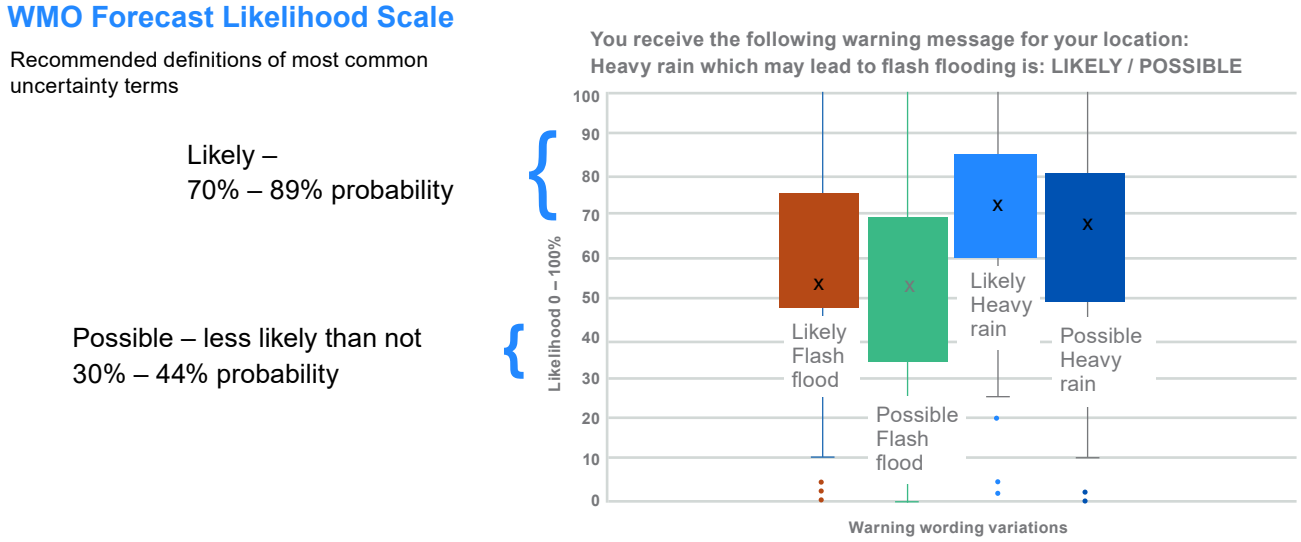

Figure 14: Box plots of the survey responses show a wide spread in perceived likelihood. Values range from 0% to 100% for the terms 'likely' and 'possible'.

Previous research, including examination of Bureau surveys by Handmer and Proudley (2007), suggest that the public in Australia does understand the functional use of numerical probability statements in weather forecasts. However, confusion arises regarding the interpretation of these probabilities, such as a '30% chance of rain', particularly in relation to the likelihood, timing and location of a specific event. Ambiguity exists around verbal descriptor terms such as 'fine' and a lack of shared understanding between forecasters and the public was reported (Handmer and Proudley 2007). Despite these challenges, research suggests that people make better decisions when uncertainty information is included rather than omitted (Han and Joslyn 2025; Joslyn and Savelli 2021; Ripberger et al. 2022). It should be noted that how uncertainty is visually communicated in a forecast can influence comprehension and resultant decisions (Clive et al. 2023; Joslyn and Savelli 2021; Stephens et al. 2019). Research in the USA shows that the public prefers that numbers and phrases are used together to communicate weather information and may perceive forecasts as more reliable when numeric probabilities are included (Rosen et al. 2021; Burgeno and Joslyn 2023). The communication of uncertainty is important to the successful mitigation of risk and public safety (Doyle et al. 2019; National Research Council 2006; WMO 2008).

Implications of inadequate communication of uncertainty in warnings

Uncertainty is a dynamic and complex concept and people vary in how they define or deal with it (Doyle et al. 2019, 2023; Lipshitz and Strauss 1997; Morss et al. 2005). Uncertainty plays a critical role in shaping risk perception, decision-making and preparedness (Carr et al. 2016; Lipshitz and Strauss 1997; Doyle et al. 2019). From the perspective of natural hazards and the communication of scientific information, there are 3 sources of uncertainty: the data, the actors and the known and unknown unknowns (Doyle et al. 2023). For example, uncertainty about forecasts, such as the expected height of floodwaters or the timing of an event, can influence public and emergency management behaviour, complicating decision-making, planning and emergency response (Doyle et al. 2023; Haynes et al. 2018; Waring et al. 2020). Conflicting information in warning messages, contradictory environmental cues and forecast inconsistency or inaccuracy may also create increased uncertainty, making it harder for people to act decisively (Dootson et al. 2022; Joslyn and LeClerc 2013; Su et al. 2021). In the context of flood risk management, there are numerous additional sources of uncertainty in estimating flood risk (Morss et al. 2005; WMO 2012). Decision-makers may need to cope with 3 types of uncertainty: 'inadequate understanding', 'undifferentiated alternatives' and a 'lack of (or incomplete) information' (Lipshitz and Strauss 1997, p.158). Some sources of uncertainty may be assessed and reduced through, for example, collecting more information or changing plans, while others may be unavoidable or not relevant to a decision-maker (Morss et al. 2005; Lipshitz and Strauss 1997; Orasanu et al. 2004).

In weather forecasts and warnings, uncertainty is inherent and often expected by decision-makers (Joslyn and Savelli 2010; Savelli and Joslyn 2012; Greer et al. 2020). Lipshitz and Strauss (1997) express uncertainty as a sense of doubt that blocks or delays action. Uncertainty about a situation can lead to delayed decisions and poor outcomes, especially when individuals have poor situation awareness, engage in maladaptive coping activities or behaviours such as 'milling' (looking for further information or confirmation) (Lipshitz and Strauss 1997; Waring et al. 2020; Wood et al. 2018). However, research suggests that the inclusion of numeric uncertainty estimates (probability information) increases trust in the forecast, provides relevant information to decision-makers and helps overcome negative effects of forecast inconsistency and inaccuracy leading to increased certainty, improved decision quality (better decisions) and greater caution (Burgeno and Joslyn 2023; Han and Joslyn 2025; Su et al. 2021; Ripberger et al. 2022). Future research could examine verbal probability terms, use of numerical probabilities with verbal probabilities, visual communication of uncertainty and the use of defined probability ranges to see if they are understood as intended. This work could examine if improved communication of uncertainty in warnings leads to efficient and informed decisions that enable timely actions that reduce risk.

Limitations

A snowball sampling method was used meaning that the sample was not representative of the Australian population. As such, the findings are less generalisable and the limited demographic information available from the survey data makes it difficult to examine group differences beyond the binary of public or emergency management. There is no data related to age, sex/gender or psychological, social or economic factors that may influence flash flood knowledge, perceptions or response to warnings. The research literature shows that psycho-social factors are important to effective risk communication. Future research could consider these factors.

The scales used in this study were developed as a part of exploratory research. The perceived knowledge, importance of flash flood risk factors and knowledge of flash flood effects scales showed good reliability. However, after analysis, further refinement and testing of the assessed knowledge questions is recommended due to the low scores. These questions may have been confounded or confusing to participants.

Past flood experience can influence preparedness and warning response (Box et al. 2016; Morss et al. 2016). Over half of the participants had some form of flood experience, highlighting the need for further research to improve understanding of how past hazard experiences influence risk awareness, warning reception, comprehension, response and proactive and maladaptive behaviours in Australian contexts, particularly if flood events are becoming more frequent or extreme. Future research could examine what past flood experience entails to develop a nuanced and explicit understanding (Demuth 2018). It is important to account for individual differences as these can shape how people perceive and assess risk and uncertainty, influence their behaviour and preparedness and affect how they respond to warnings and take protective action (Dallo et al. 2022; Demuth 2018; Doyle et al. 2019; Paton 2019).

This study focused on testing text versions of heavy rainfall warnings. Future research could explore how visual elements and numerical probabilities affect people's interpretation of uncertainty information. It would also be useful to investigate the qualitative interpretation of terms such as 'likely' and 'possible' and examine the language used in warnings and forecasts (e.g. Olson and Sutton 2025) and how these affect decision quality.

Conclusion

Findings and recommendations from this research will help frame how future services and products can be developed to improve risk and uncertainty communication during flash flood events. In operations, applying good-practice recommendations for warning communication, such as using simpler language, clarifying and explaining technical terms and standardising and using numerical and verbal expressions of uncertainty or probability together could have immediate benefits and improve the communication of risk and uncertainty.

These findings highlight several areas where targeted education and professional development are needed. Improving public understanding of flash flood definitions, risk factors and appropriate responses, especially in high-risk or newly urbanised areas, could enhance resilience and reduce response delays during critical events.

The use of verbal probability terms in weather warnings may not effectively convey intended levels of risk and certainty. Participant interpretations of 'likely' and 'possible' varied widely and often did not match official definitions. These findings highlight the need for clearer, standardised communication of forecast uncertainty and targeted public education to improve understanding and response to severe weather events and warnings.

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The road to timely, relevant and consistent flood warnings: a City of Gold Coast case study

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Abstract

Climate projections indicate increasing frequency of intense rainfall events across Australia, even in regions where the average rainfall is planned to decrease or stay the same. When these events are rapidly unfolding, informing and warning communities are often the only, and therefore most important, actions local disaster coordinators can take. This paper shares insights from the City of Gold Coast as it sought to improve its community warning systems over time. Key innovations included establishing preformatted flood warning areas with automated threshold-based warnings and deployment of an opt-in alerts system that reached 60,000 subscribers. These enhanced systems provided near real-time warning capability during flooding events during December 2024 and reduced the manual intervention required as well as improved message consistency. This model demonstrated effective local government adoption of public information and warnings systems and allows transferable lessons for other jurisdictions. Success factors include multi-agency collaboration, community-centred design and integration of automated systems with human oversight.

Introduction

Severe weather events pose increasing challenges to Australian communities, with climate change projecting more frequent intense rainfall events even in regions where average precipitation may decrease (Bureau of Meteorology and CSIRO 2024). Such rapid-onset events challenge those responsible for local emergency and disaster management where timely, relevant and consistent community warnings are often the primary protective action available during the critical early phases of a response. Following major events such as the Black Saturday bushfires in 2009 and the Queensland floods in 2011 and 2022, the emergency management sector in Australia has undergone significant evolution. Each event has highlighted the critical importance of effective community warning systems while revealing persistent challenges for local government capabilities (Inspector-General of Emergency Management 2022). These challenges are particularly acute for metropolitan areas with diverse geography, multiple catchments and significant transient populations.

This report is a case study of the evolution of the emergency warning system at the City of Gold Coast (Council) between 2017 and 2025. This analysis examined how a large local government systematically addressed warning system limitations through technological innovation, multi-agency collaboration and community-centred design approaches. This study contributes to understanding local government emergency and disaster management capabilities and offers transferable lessons for similar jurisdictions facing rapid-onset hazard challenges.

Background

The Gold Coast in Queensland is a major tourist destination with a population of over 750,000 people (projected to exceed 1 million by 2046) and has over 12 million visitors each year (State of Queensland 2023). This coastal area has a diverse landscape including 80kms of rivers and streams, 774 hectares of lakes, dams and canals and 70km of coastline that

A severe storm approaches the Gold Coast residential areas in October 2022.

Image: David Youssef

has some of the most popular beaches in Australia (City of Gold Coast 2025c). While the city has a subtropical climate, it also has a long history of tropical cyclones, East Coast lows and other rapid-onset severe weather. These events have resulted in significant loss of life, infrastructure damage, economic affects, community disruption and environmental deterioration.

Under the *Disaster Management Act 2003 (Qld)*[1], local government authorities, including the Council, are required to have a disaster management plan that 'ensures the community is aware of ways of mitigating adverse effects of an event, and preparing for, responding to and recovering from a disaster' (Queensland Government 2003, p.40). Accordingly, in 2018 the Council developed the City of Gold Coast Disaster and Emergency Dashboard (henceforth referred to as 'dashboard'), which is a public information and warning online platform (City of Gold Coast 2025a). While the dashboard provided public information and warnings, there was a need for this information to be better timed and locally relevant.

2017: Cyclone Debbie

In 2017, Ex-Tropical Cyclone Debbie triggered heavy rainfall of over 600mm in 24 hours in some areas of the Gold Coast and caused extensive damage to infrastructure and homes, with significant flooding in both the northern and southern parts of the city (MacKenzie 2017). Warnings were issued and it was evident that the community accessed the dashboard, but there was room for improvement. A review of the system by MacKenzie (2017) highlighted the need to enhance publicly available information during adverse events. As a result of this review, the city's Disaster and Emergency Management Unit was tasked with enhancing the emergency warning system.

Staff were confronted with numerous challenges, particularly given the city size, community diversity and the region's complex riverine catchments.

1. *Disaster Management Act 2003 (Qld),* at www.legislation.qld.gov.au/view/pdf/inforce/current/act-2003-091.

These challenges raised questions:

- Relevance of public information and warnings:
  - How can we make sense of the situation at the local level in numerous locations simultaneously?
  - Which local factors, such as catchment characteristics and tidal movements, should be considered?
  - How can we leverage geolocation to produce community mapping that includes potential flood extents, potential and actual flooded roads and relief centre locations?
  - How can we provide locally relevant flood levels including water levels (minor, moderate and major flood levels, road levels, etc.)?
- Consistency in public information and warnings:
  - How should we draft timely, relevant and tailored messages including calls to action and advice (with partner agencies)?
  - In what way should we consult with adjoining local government areas to achieve message consistency and avoid community confusion?
  - How can we ensure consistency in messaging when sending Australian Warning System-compliant messages, SMS and, if necessary, emergency alerts and publishing to both the Queensland Government warning website and local government dashboard?
- Timeliness in public information and warnings:
  - How can we achieve detailed specialist analysis of rainfall forecasts?
  - How can we ensure quick analysis of live rainfall and river gauge data?
  - When should we send messages for maximum effectiveness
  - When should we achieve necessary approvals to send warnings?
  - How can we make sure to acknowledge that state-based warning system resources are finite and should be focused on areas perceived to have the greatest need of the warnings?
  - How can we achieve all the above across multiple catchments and communities simultaneously?

2018: Introducing the Flood Intelligence System

In 2018, the Disaster and Emergency Management Unit made improvements to the dashboard taking into consideration the identified challenges. These included better access to flood-hazard information including types of flooding across the city, adopting Bureau of Meteorology educational materials and establishing flood gauge classifications (see Figure 1). While these improvements were a step in the right direction, they still

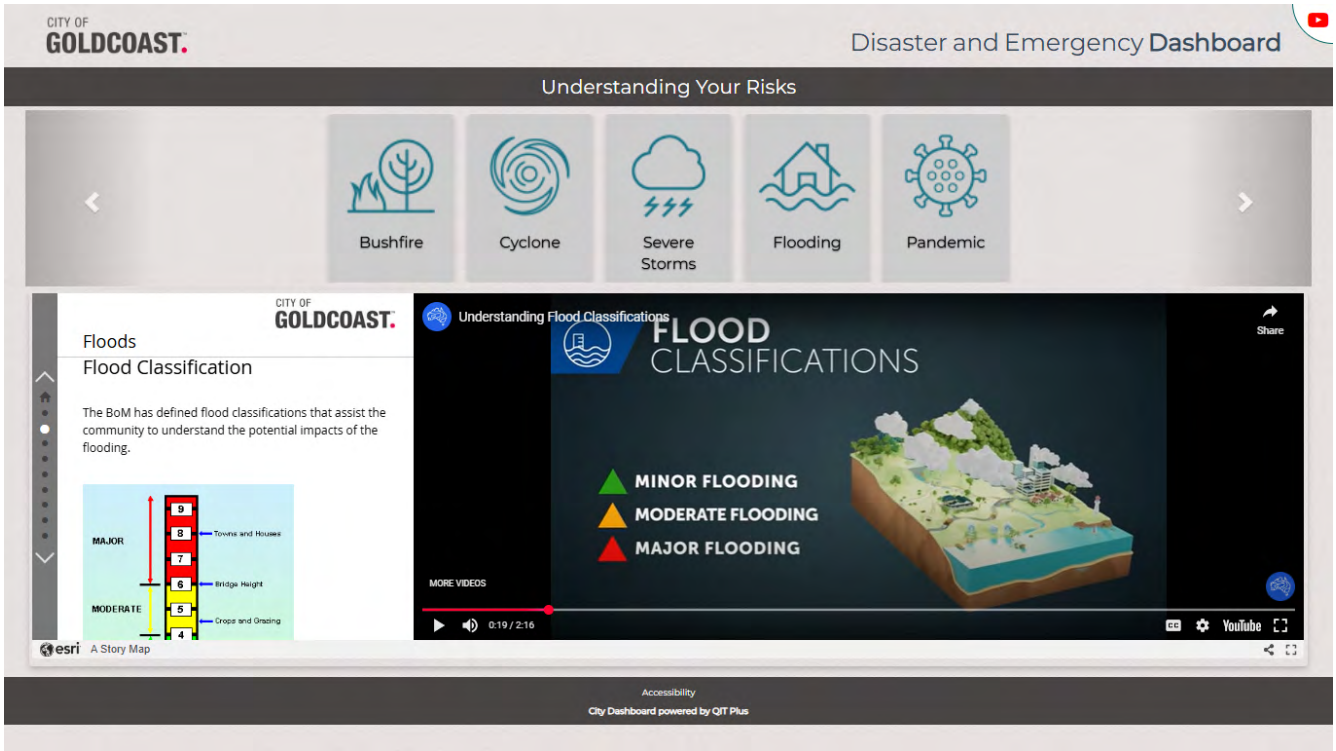


Figure 1: The Gold Coast disaster and emergency dashboard was improved and updated in 2018.
City of Gold Coast (2025a)

did not allow for timely and locally relevant warnings. To add this would require technical enhancements as well as training to enable staff in the Local Disaster Coordination Centre to adequately interpret data from the rainfall and river gauges network in order to draft warnings.

Two pilot projects were rolled out during the year. The first aimed to help staff understand and interpret the incoming data, especially in terms of interpreting data from the rainfall and river gauges network. A Flood Intelligence System module was also integrated into the council's Incident Management System (see Figure 2).

The second aimed to enhance the timeliness of public warnings. The Flood Intelligence System allowed for flood warnings to be issued to the public via the dashboard, social media platforms and, where thresholds were met, emergency alerts. The system became the first line of intelligence and operated 24 hours a day, 7 days a week to alert the Disaster and Emergency Management Duty Officer and decision-makers when river or rainfall triggers were met.

Upon receiving an alert, the Local Disaster Coordination Centre may be activated and flood modelling specialists may be tasked to conduct detailed flood modelling through advanced technology (known as the Flood Emergency Decision Support System). The analysis is fed back to the Local Disaster Coordination Centre that decides whether to issue a public warning. A key enabler of the Flood Intelligence System is the river and rainfall radio telemetry network. The network provides access to over 100 rainfall and river gauges and means monitoring occurs in the background 24 hours a day. While not addressing all the challenges listed the Flood Intelligence System and the work implementing it, was a large step in the right direction.

2022: Severe weather event

Over February and March 2022, another rainfall event classed as an 'extreme multi-day rainfall causing significant flooding' by the Inspector-General of Emergency Management, hit southeast Queensland, including the Gold Coast (Inspector-General of Emergency Management 2022, p.12). Warnings were issued throughout this event through many different channels including 'Emergency Alerts, the Bureau of Meteorology weather warnings, opt-in systems, social media, radio and television' (Inspector-General of Emergency Management 2022, p.13). These warnings varied significantly in their timeliness, consistency and relevance and some communities did not receive the warnings.

Following this event, members of some affected communities said that they felt information provided did not adequately prepare them for the rapid-onset nature of the event, particularly in relation to residential over-floor flooding (i.e. the height of the flood level). A review conducted by the Inspector-General recommended that 'all local governments [should] offer an opt-in system and develop strategies to increase the number of subscribers who elect to use this service' (Inspector-General of Emergency Management 2022, p.77). These outcomes and recommendations deepened the Council's commitment to improve its public warning capabilities.

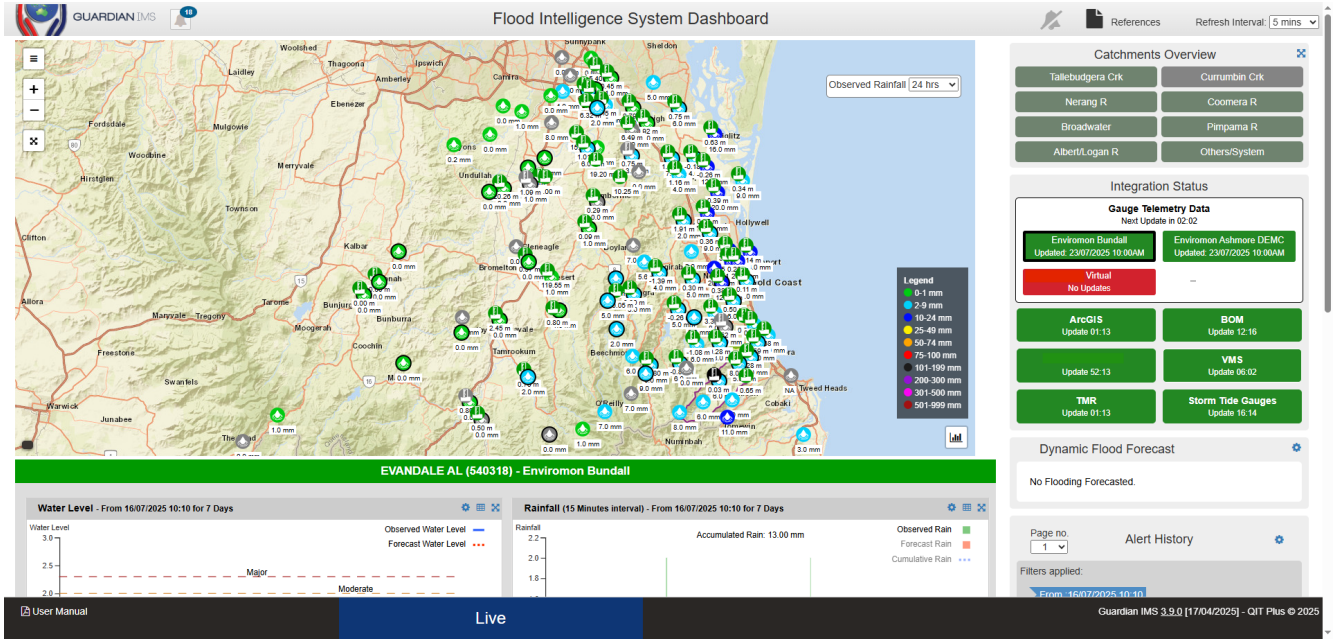


Figure 2: A Flood Intelligence System was incorporated into the Incident Management System.

2022: Launching opt-in messaging - GC Alerts

In August 2022, the Council launched GC Alerts. This is a free service allowing people to sign up for direct SMS and email notifications of potential hazards. Signing up involved filling out a registration form on the Gold Coast Dashboard (see Figure 3).

The information used to issue GC Alerts is sourced from the Bureau of Meteorology, the Flood Emergency Decision Support System, the Flood Intelligence System and staff analysis; all of which contribute to timely flood warning. For example, local river and rainfall gauge information is fed to the Incident Management System, which can then directly notify decision-makers on the potential need to release a warning product through GC Alerts.

As part of the Get Ready Queensland[2] initiative to increase community awareness about how to prepare for extreme weather events, an educational campaign was launched to encourage the community to subscribe to GC Alerts. This is an going campaign both in face-to-face and digital engagement. Opt-in messaging is another step to provide timely, accurate and relevant emergency alerts for people in the City of Gold Coast.

2023: The Australian Warning System

In 2022, an extreme weather event raised issues that were explored by the Inspector-General who found:

> *…there are constraints of the Emergency Alert system and the telecommunications infrastructure it relies on… There appears to be a general lack of awareness by local governments regarding the emergency alerts system's constraints' particularly when multiple local governments are requesting warnings at the same time.*
> (Inspector-General of Emergency Management 2022, p.64)

Alerting and warning the community, it appeared, was not only about the timeliness and local relevance but also was a tight alignment with national warning systems to ensure consistent messaging.

In 2019, research by Metrix (2019) assessed community perceptions of existing warning systems and identified potential improvements that could make warnings clearer and increase potential for people to take action during hazard events. More than 14,000 people across Australia were surveyed or interviewed and inputs were gathered from multiple Australian emergency services and hazard agencies.

2. Get Ready Queensland, at www.getready.qld.gov.au.

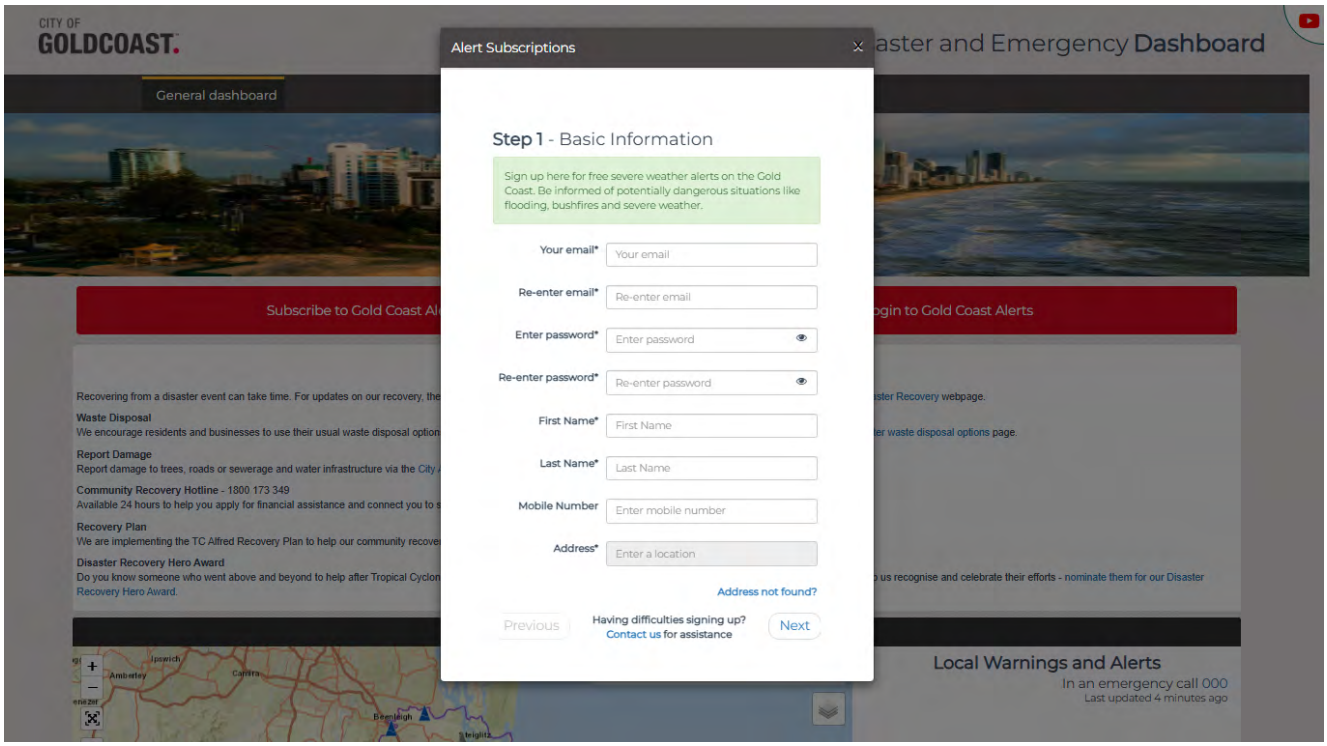
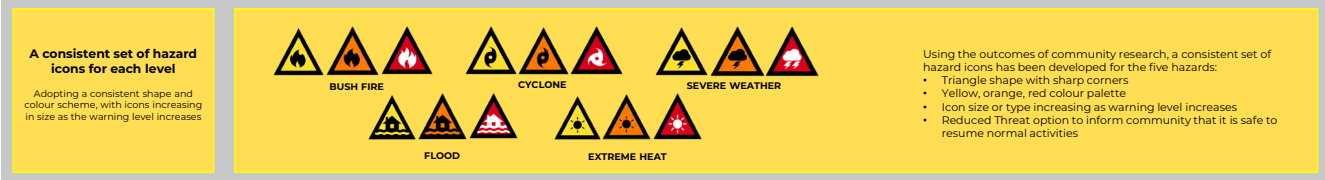


Figure 3: Dashboard sign up form.
Source: City of Gold Coast (2025a)



Australian Warning System icons.

Source: AIDR website, www.australianwarningsystem.com.au

Informed by this research, work commenced on an Australian Warning System, which was aimed at standardising warning messages across Australia. The system was implemented in Queensland in November 2023. During that year, all warning products issued by the city via the dashboard, GC Alerts and social media complied with the new national standards.

2024: Developing preformatted flood warning areas

Aside from opt-in messaging and alignment between national and local emergency alerts, the Inspector-General recommended:

> *…that all local governments that do not have preformatted messages and polygons engage with Queensland Fire and Emergency Services and determine whether their Local Disaster Management Group capability could be improved through the development of preformatted polygons and messages.*
> (Inspector-General of Emergency Management 2022, p.15)

In line with this recommendation, the Local Disaster Management Group established a working group comprising of the City of Gold Coast, State Emergency Services, Queensland Fire Department, Queensland Police Service, the Department of Transport and Main Roads as well as internal business units of the council to identify communities at risk of flooding and establish preformatted polygons called Flood Warning Areas. Additional advice was sought from the State Disaster Coordination Centre Warnings Unit, QIT Plus (incident management system vendor) and other subject matter experts as needed. Over a 6-month period commencing in September 2024, 6 flood warning area workshops were conducted.

The purpose of the flood warning areas was twofold. First, pre-established flood warning areas can help community identify potential hazards. For example, information about heights of local roads can help people understand how their area might be affected during a flood and helps them to prepare accordingly. Second, and most importantly, flood warning areas improved the Disaster Management and Emergency Unit's ability to warn the community rapidly during severe weather events through GC Alerts and the dashboard.

Setting these up involved integrating the Flood Intelligence System with the Bureau of Meteorology's local classifications of minor, moderate and major flooding to establish flood warning areas (Bureau of Meteorology 2013) (see Figure 4). Work included incorporating an Australian Warning System-compliant message, for example, by warning against driving into flooded areas and providing guidance on safe evacuation routes. While moderate and major flooding events may not occur in a resident's lifetime, the flood warning areas and associated warnings are available to help community members make the best-informed decisions to prepare for or act during an extreme weather event. In addition, flood warning areas include properties, not necessarily to indicate a direct

Community information events raised awareness about the updated warning system.

Image: Fannie Couture

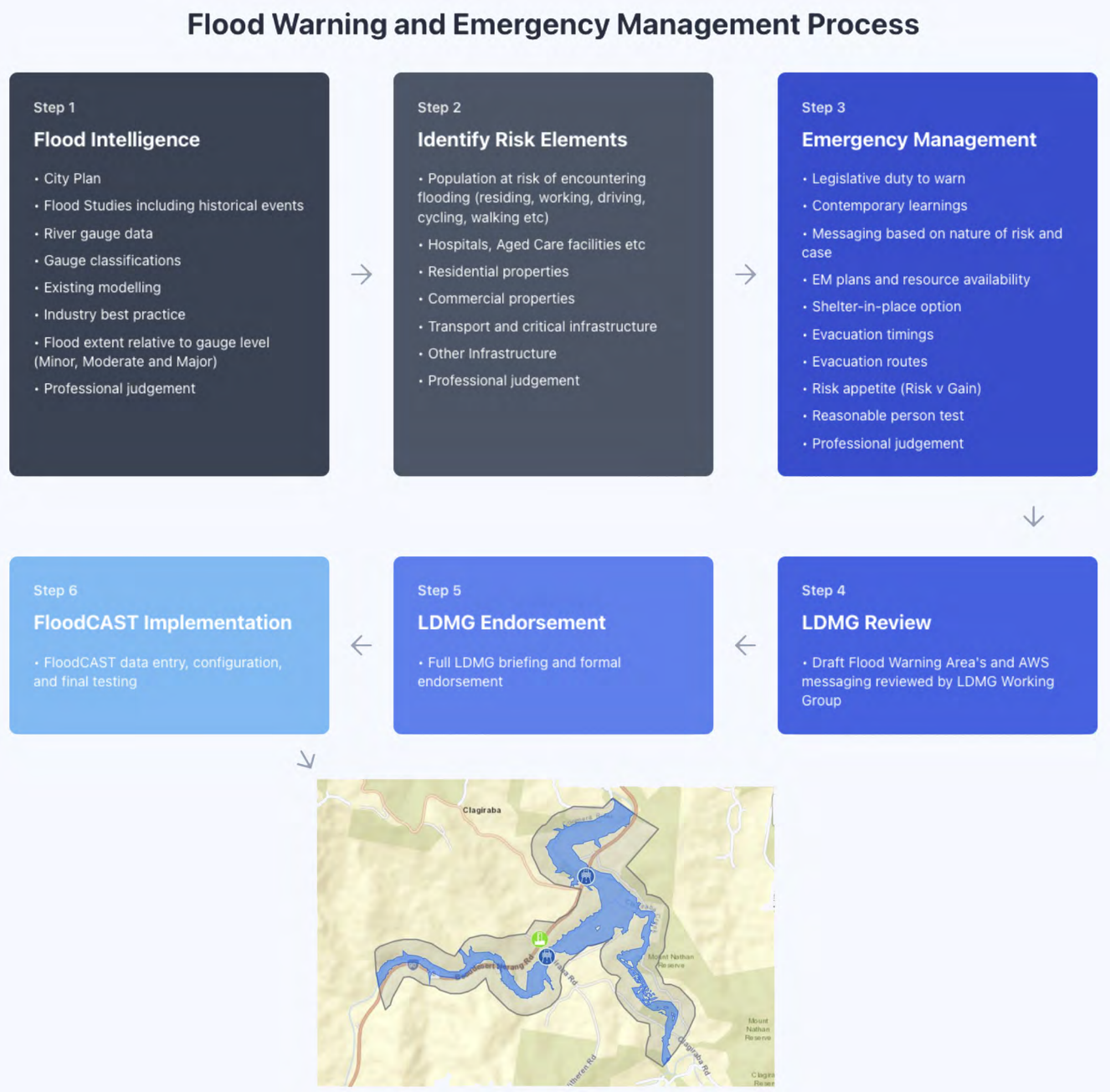


Figure 4: Flood warning areas methodology.

Source: City of Gold Coast

risk of flooding, but to suggest that some roads in the area could be affected. It is important to note that, based on risk analysis and factors including topography, many properties may not need to be included in warning areas. This information allows community members to develop their own emergency plans suited to their circumstances and location.

Several criteria were used to establish flood warning areas:

- The risk of a community or infrastructure at risk of flooding
- A local river gauge with current flood classification (minor, moderate or major)
- Pre-determined flood model results and extents based on specific rain scenarios
- Advice from the working group.

The flood warning areas and associated Australian Warning System templates were developed in consultation with working group members and were based on discussions and analysis of the following:

- existing model results based on specific rain intensity scenarios
- emergency management factors
- the collective knowledge of each government department and agency as to previous events, risk and best practice advice to the community.

While the flood analysis and warning processes were technically advanced, they required staffing or remote support. The Flood Warning Areas allowed for an automated first step to warning the community. These changes were deployed and formed the basis of warnings provided during the New Years Day flooding event in 2024.

2023–24: A windy, wet and hot Christmas and New Year

On 25 December 2023, a severe weather event developed in southeast Queensland that greatly affected the Gold Coast. There were destructive winds peaking at 160km/h, 53mm of rain, frequent lightning and large hailstones that caused widespread damage to homes, businesses and infrastructure. The powerful winds resulted in significant effects, including a fatality, community isolation, fallen trees and power lines, damaged roofs and buildings, widespread electricity outages and disrupted communications. From 28–30 December, the region endured a 3-day low-intensity heatwave with temperatures climbing to 40°C and elevated humidity levels. Many Gold Coast residents and businesses experienced power outages and communication difficulties during this period. Another round of severe storms hit on 1 January 2024, bringing damaging winds and torrential rain. Some areas recorded over 500mm of rain, leading to additional flooding and property damage across the region.

During this event, the council was building the next version of GC Alerts incorporating the flood warning areas. A dashboard test environment was under review (not public-facing) and showed that 3 locations would have been identified at the minor and moderate flooding levels and would have initiated automatic warnings to GC Alerts subscribers in near real-time. This automated system subsequently replaced the former method that involved the Disaster and Emergency Management Duty Officer drawing a manual polygon and issuing the warning by inserting relevant details to that catchment. This method took, at best, 20 minutes and was particularly challenging due to a Duty Officer being required to undertake other activities including briefing the Local Disaster Coordinator.

Flood Warning Areas Multi-Stakeholder Working Group meeting in September 2024.

Image: David Youssef

2025: Integrating warning innovations in GC Alerts and dashboard

Encouraged by early results, further enhancements were implemented in February 2025 to strengthen the Council's ability to provide timely, relevant and consistent information during severe weather events. The enhancements were:

- integration of preformatted polygons - formal integration of local flood warning areas into the dashboard
- storage of preformatted Australian Warning System messaging - storing of pre-drafted warning messages for each Flood Warning Area, which are compliant with the Australian Warning System
- linking the Flood Intelligence System to Flood Warning Areas - providing 24/7 monitoring of the river and rainfall gauges across the city, to enable issuing of warnings relating to specific flood warning areas
- interactive map in messaging - facilitating near real-time alerts and information that allows subscribers to geolocate themselves on an interactive map, determine if they are in a warning area and provide them clear directions in line with the Australian Warning System on actions they should consider taking
- interactive dashboard - the dashboard was enhanced to include effective messaging and to feature an interactive community warning map (platform) to deliver near real-time warnings and advice to the community.

2025: Tropical Cyclone Alfred

In March 2025, the newly integrated emergency warning system was put to the test with Tropical Cyclone Alfred. The cyclone had wind gusts of up to 107km per hour, heavy

rainfall with some regions receiving more than 1,000mm of rain. Around 140,000 households were without power. Throughout the event, 16 emergency alerts and 30 GC Alerts were issued (via email/SMS) totalling 1.18 million SMS messages sent in what was considered timely, accurate and consistent. GC Alerts resulted in a 400% increase in subscribers from 16,000 before the event to almost 60,000 one week after the event. The dashboard received 3.21 million views and 50,000 site visitors downloaded the City of Gold Coast app. Feedback during and after the event was majority positive on the relevance and timeliness of warnings. The Council successfully became the single point of truth for the community in a time of deep uncertainty and when the need for consistent, timely, accurate and relevant information was needed.

The future

The Council has a clear purpose in providing timely, relevant and consistent emergency warnings. While the integrated system developed and described here was based on 5 flood warning areas, a total of 20 flood warning areas have been established and this information shared with the community via the dashboard (City of Gold Coast 2025b). In the longer term, it is anticipated that more than 30 flood warning areas encompassing up to 40% of the Gold Coast region will be established.

While these enhancements are an important step in the provision of emergency warnings, as technology advances, further improvements will be achieved. The analysis of 'big data', machine learning and rapid developments in AI will facilitate greater real-time predictive capability that can improve warnings and community safety. Flood warning areas are expected to change over time based on factors such as urban development and insights gained from rainfall events.

Acknowledgment

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From Tohoku to Queensland: advancing tsunami preparedness through science and collaboration

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Introduction

In 2011, a severe earthquake and tsunami in Tōhoku in northern Japan was a stark reminder of the devastating power of natural hazards. The magnitude 9.1 earthquake and the resulting tsunami caused widespread destruction, claiming nearly 20,000 lives and displacing hundreds of thousands of people (NOAA 2021; National Geographic Society 2025). The Tohoku event was a reminder of the critical importance of preparedness, understanding of the hazard and effective evacuation planning in mitigating the effects of catastrophic events.

In 2015, the United Nations declared World Tsunami Awareness Day (held on 5 November each year) to raise tsunami awareness and share innovative approaches to risk reduction. With the 15th anniversary of the tragedy occurring on 11 March 2026, it is timely to recognise the advances made by disaster management groups in Queensland to understand and address the state's tsunami risks; efforts exemplified by the work undertaken in the Gladstone Regional Council area through the project 'Tsunami risk assessment for the Gladstone Regional Area' (the Gladstone tsunami project).

The Tsunami Guide for Queensland (Queensland Fire and Emergency Services 2024) notes that southern Queensland is more likely to experience higher levels of tsunami hazard (based on offshore wave height) than other parts of the state's coastline. The area from Agnes Waters to Yeppoon (including Gladstone) is identified as one of the top 10 most hazardous locations in Queensland. The Gladstone tsunami project under the Australian Government Coastal and Estuarine Risk Mitigation Program was developed and has delivered robust inundation modelling to inform the development of evacuation planning for the Gladstone region.

2024 Tsunami Guide for Queensland (Queensland Fire and Emergency Services 2024)

Tsunami evacuation zones in Queensland[1] were determined following national guidance that used a heuristic approach to identify areas less than 10 metres above sea level and within 1 kilometre from the coast that are at risk of inundation (AIDR 2025). While this method provided a conservative baseline for evacuation planning, recent studies suggest

1. Tsunami evacuation areas for Queensland, at www.fire.qld.gov.au/prepare/tsunami/evacuation-areas.

it may overestimate the areas at risk in parts of Australia (Kendall et al. 2024). The detailed modelling developed through the project, supplements the current heuristic evacuation mapping to provide greater insights into areas of potential inundation, including critical infrastructure such as the Gladstone port facilities.

Strong, collaborative relationships between agencies, local governments and community partners are fundamental to Queensland's disaster management arrangements,[2] underpinning the coordinated and flexible approach to effective preparedness, response and recovery. The project was a collaborative effort between several select organisations, each contributing expertise and resources, brought together under a Project Advisory Group.

The Queensland Fire Department worked closely with Geoscience Australia, which provided advanced modelling and technical expertise as well experience with similar studies in Western Australia[3] and New South Wales.[4] The Gladstone Regional Council played a vital role by integrating local knowledge and developing evacuation mapping and planning. The modelling relies on high-quality onshore and offshore elevation data and tide gauge data that was provided by the Department of Environment, Tourism, Science and Innovation and Gladstone Port Corporation. Other partners in the project group included the Queensland Police Service; the Queensland Reconstruction Authority; Gladstone Ports Corporation; Mutual Aid Group Gladstone and the Department of Environment, Tourism, Science and Innovation.

The project focused on tsunamis generated by earthquakes along major Pacific Ocean subduction zones, which are the most common sources of tsunami threats in the region. The modelling provided a detailed understanding of potential inundation zones under various tsunami scenarios. The results were designed to align with the Joint Australian Tsunami Warning Centre (JATWC) warning categories[5] to maximise practical application for emergency responses.

The findings of this project are particularly significant for the Gladstone region due to its critical port infrastructure and low-lying areas that are exposed to coastal inundation. By integrating local knowledge with the results of the modelling, emergency services planners, local governments and disaster management groups can establish effective tsunami evacuation zones, preparedness and response strategies. This initiative enhances community safety and also strengthens the region's resilience to future tsunami events. Recognising the diverse sources of tsunami risk, the Australian Tsunami Advisory Group subsequently initiated the Understanding tsunami risk to Australia from volcanic sources project with Natural Hazards Research Australia, which aims to address knowledge gaps by developing scenarios to assess the onshore tsunami risk posed by volcanic activity in the south-west Pacific, south-east Indian and north-east southern Oceanic regions.

Inundation modelling

The methodology used to developed detailed tsunami inundation hazard information was an integration of scientific expertise and advanced computational techniques, building off successful applications in Western Australia and New South Wales. The inundation modelling addressed the limitations of traditional heuristic methods, by providing a more precise and actionable understanding of the tsunami hazard for the region.

At the core of the project was a Probabilistic Tsunami Hazard Assessment (PTHA), a framework to combine the hazard from multiple tsunami scenarios. Scenarios were selected from Geoscience Australia's PTHA18 database (see Davies 2018) of earthquake-generated tsunamis from major subduction zones. For each scenario used in this framework, a hydrodynamic solver was designed for the Gladstone region to simulate tsunami wave propagation. The modelling used nested grids to refine the resolution in areas of interest to ensure that the results were accurate (by validation with observed events in the region) and relevant to local conditions. As an example, Figure 1 displays nested grids at different levels of resolution as green, yellow and orange boxes for modelled maximum water levels generated by the 2007 Solomon Islands tsunami event.

A key feature of the methodology was the use of Monte Carlo techniques (Davies et al. 2022) to approximate tsunami inundation hazards across a broad spectrum of scenarios. This approach allowed computational limitations associated with directly modelling all possible scenarios to be overcome. By sampling hundreds of earthquake-tsunami events, the Monte Carlo method provided robust statistical insights into the likelihood and extent of inundation for different scenarios informing the warning categories issued by the JATWC, including No Threat, Marine Warning and Land Warning. These warning categories were used to define model-derived inundation zones, which serve as the foundation for evacuation planning.

2. Disaster management arrangements, at www.qra.qld.gov.au/recovery/recovery-governance/queensland-disaster-recovery-arrangements.
3. Mapping and modelling the impact of earthquake-generated tsunamis on the coastal communities of Western Australia, at www.ga.gov.au/scientific-topics/community-safety/projects/mapping-and-modelling-the-impact-of-earthquake-generated-tsunamis-on-the-coastal-communities-of-western-australia
4. AFAC25 NSW tsunami inundation modelling project, at www.afac.com.au/resources/afac25-nsw-tsunami-inundation-modelling-project-.
5. Warning categories, at www.bom.gov.au/resources/learn-and-explore/tsunami-knowledge-centre/about-tsunami-warnings.

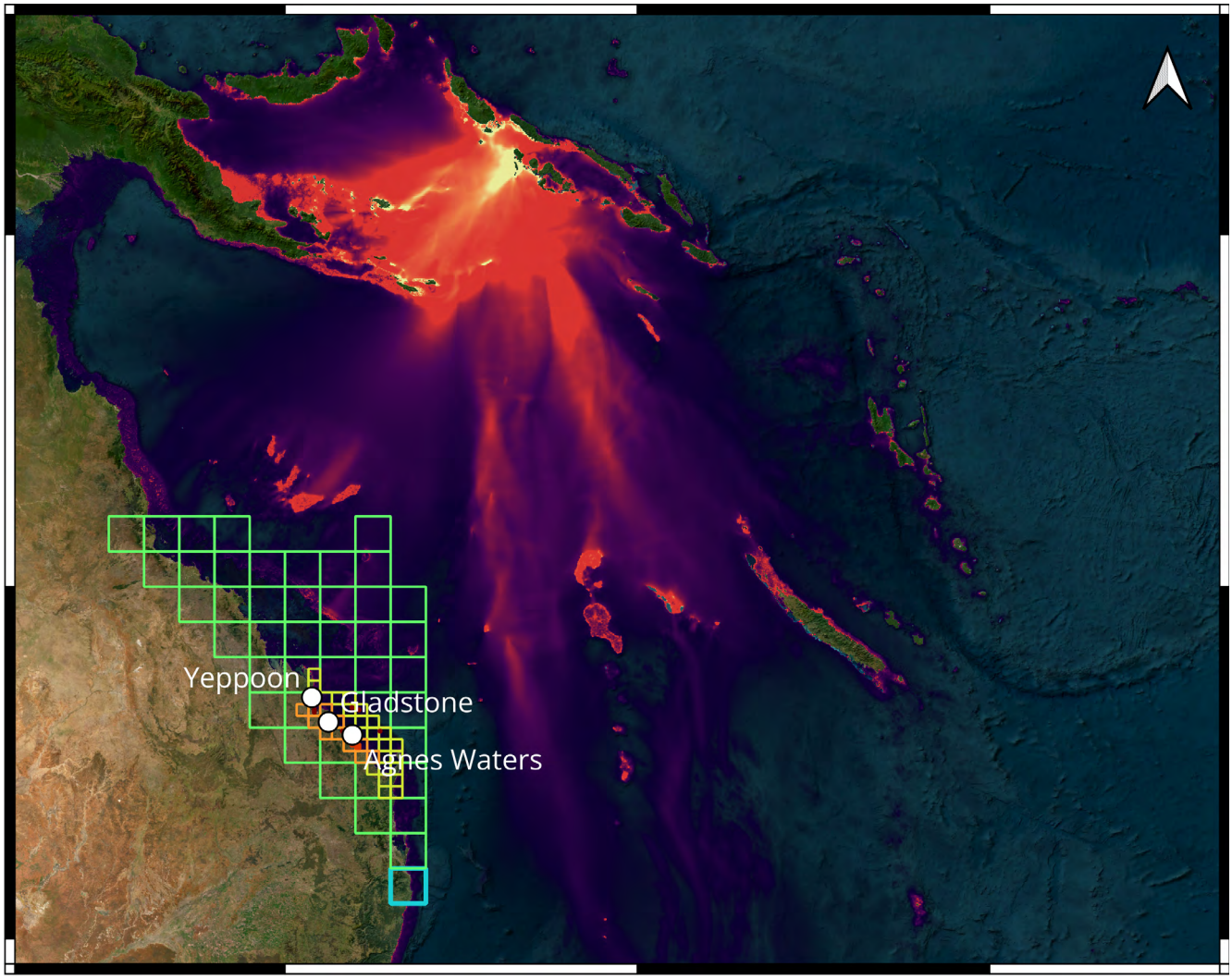

Figure 1: Modelled maximum water level for the Solomon Islands 2007 tsunami with nested grids used in the Gladstone project.
Source: Macaulay and Davies (2025)

A comparison between the inundation modelling and current evacuation mapping (based on the heuristic approach) showed a potentially larger designation of evacuation zones than may be necessary (see Figure 2, which displays a comparison between inundation modelling and evacuation mapping based on the traditional heuristic evacuation zones). While the current heuristic ensures a conservative approach, it can result in unnecessary evacuations and place undue stress on communities and emergency services organisations. While the modelling cannot identify which scenario(s) will eventuate, it incorporates conservative assumptions such as using a high tide and merging inundation footprints from multiple scenarios to allow for precise evacuation zones and to reduce overall disruption to communities.

The probabilistic methodology used for the inundation modelling is regarded as best practice in tsunami hazard modelling with a similar method used in New Zealand. This is the first time it has been implemented in Queensland. By applying lessons learnt from other jurisdictions, this project set a new benchmark for tsunami risk assessment in Queensland.

Exercise Capricorn Surge

Exercise Capricorn Surge was conducted 30 July 2025 by the Gladstone Local Disaster Management Group at Gladstone to assess the application of modelling outputs and inform tsunami response strategies. Participating agencies included Gladstone Regional Council, Queensland Fire Department, Queensland Police Service and Gladstone Ports Corporation. The discussion-based exercise simulated a high-impact tsunami scenario triggered by a large undersea earthquake in the South West Pacific Ocean. The exercise generated discussion on the unique challenges posed by such low-probability high-consequence events with limited warning time.

The exercise had 6 objectives:

- Understanding tsunami warning products and escalation triggers.
- Clarifying roles and responsibilities among agencies.
- Applying tsunami modelling to inform response decisions.
- Assessing risks to vulnerable communities and critical infrastructure.
- Developing public information and warning strategies.
- Exploring early recovery and transition planning.

As the exercise unfolded, participants engaged in dynamic discussions and decision-making processes. The modelling from Geoscience Australia provided detailed insights into potential inundation areas and helped participants to assess evacuation zones and identify critical infrastructure at risk. This data-driven approach meant response strategies devised were based on scientific evidence to improve effectiveness of the exercise.

One of the most pressing challenges highlighted during the exercise was the short arrival time of the simulated tsunami. This reinforced the importance of having accurate and timely evacuation plans in place that were already tailored to the geographical and industrial characteristics of the local region. Participants reviewed and refined these plans to improve future implementation in a real-world setting. The exercise provided opportunities to revise public information and community warning approaches to focus on the need for clear, consistent messaging and effective coordination across agencies.

At the conclusion of the exercise, recommendations were developed to address the challenges identified and enhance the region's response and recovery arrangements. Recommendations included refining evacuation mapping, improving public warning systems and integrating tsunami response actions into evacuation and road operations plans. The exercise showed the importance of continuous re-evaluation and improvement so that emergency management plans remain effective and responsive.

Conclusion

The 2011 Tohoku earthquake and tsunami was a reminder of the significant effects of low-probability and high-consequence disasters such as tsunamis. This project reviewed the proactive actions taken by key state organisations to manage tsunami risk in the Gladstone

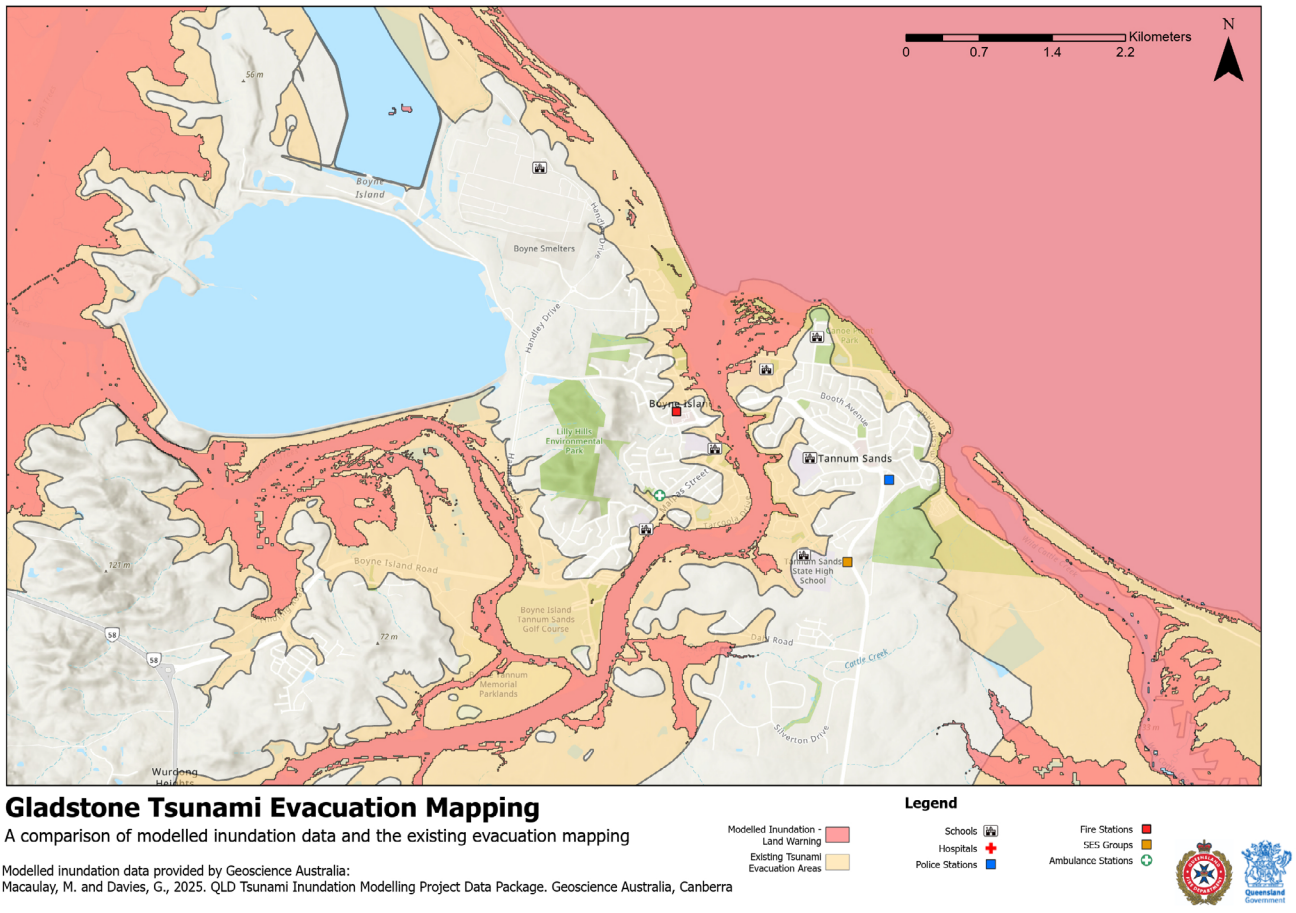

Figure 2: Comparison between inundation modelling and current evacuation mapping.

region. By supplementing an heurestic approach approach with advanced inundation modelling, this project provided a detailed and actionable understanding of tsunami hazard. The integration of scientific expertise, local knowledge and stakeholder input means that the region's evacuation planning is accurate and practical. Exercise Capricorn Surge operationally tested modelling outputs and allowed stakeholders to identify and address critical challenges, such as the short warning times associated with tsunamis and the protection of critical infrastructure. The exercise also generated actionable recommendations to enhance disaster preparedness and response for the Gladstone region.

Acknowledgments

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Disaster disinformation is bulldozing the community trust we rely on

Dr Barbara Ryan

Formerly University of Southern Queensland

Emergency agency communicators are our bulwark against this current threat. Are your comms teams ready?

The Bondi shooting AI-generated Australian Federal Police press conference video[1] was a shock to us all on top of a pile of disinformation swirling about every aspect of that terrible event. It brings the disinformation menace right into the emergency management sector bailiwick and I think we are not ready for it.

It's not like there have not been warnings. Ten years ago, east coast American communities affected by Superstorm Sandy were hit with fake images of sharks swimming in inland streets, photos that had been altered to exaggerate storm damage, emergency instructions that were wrong, news that the New York Stock Exchange was under water[2] (it wasn't) and that the power company had disconnected electricity to Manhattan (it hadn't). Superstorm Sandy turned out to be ground zero for natural hazard disinformation.

Hurricanes Harvey and Irma (2017) saw exponential disinformation evolution when fake news was crossed-pollinated with wild conspiracy theories and reposted by the US President and other politicians. For example, 'illegal' immigrants were receiving all the disaster relief and the government was geo-engineering the weather. And then there was the report about Black Lives Matter blocking disaster aid, the Mayor of Houston missing in action and mosques that were refusing shelter to non-Muslim Houston residents and hoarding aid. You can see a complete list on the Media Matters website.[3]

From a distance, it is ridiculous. But it has real effects for response and recovery operations and agencies. Their communication teams need to pay attention.

In Kerala, India, in 2018, widespread flooding killed nearly 500 people and some of those deaths were thought to be as a result of the way people and agencies responded to disinformation spread on WhatsApp.[4] Among the worst was that a dam was about to burst; Peechi Dam gates were about to be opened; Kerala 'doesn't need money'; most of the affected people are from rich or middle-class families and don't need help; donations to the Chief Minister's Disaster Relief Fund will be misused; and sundry scams encouraged people to donate to bogus relief organisations. Emergency operations were halted and worried householders clogged roads in efforts to unnecessarily evacuate out of what they thought would be the path of the dam water. False reports of road closures also hindered passage of rescuers to the affected areas.

In Australia, there is a general feeling of being protected but we regularly see cloud seeding[5] and other weather manipulation and 'chemtrails' narratives pop up in online conversations about cyclones, especially if they are followed by a rain bomb. The old 'plague of arsonists' climate crisis denial narrative comes out every bushfire season.

The Australian Associated Press and other sites do a great job of identifying and debunking fake news, like December's fake 'breaking news' of Australian storms with video of a typhoon in the Philippines standing in for a storm in Brisbane.[6] But politicians and agencies in many countries are strangely silent, even though there are important ways to get ahead of these narratives. This is shown to best effect by the Indian Government during the Kerala floods in 2018.

Dealing with disinformation in disaster

The disinformation fight should kick off before the impact phase of a disaster using 'inoculation' techniques that have been shown to work since the idea was first proposed in 1961. Inoculation is simple to integrate into existing communication approaches using 2 tools: prebunking and (if you have the resources) debunking. Information inoculation is literally a 'vaccine against brainwash'.

Studies show it is successful against climate disinformation, propaganda and conspiracy theories. In a study by Traberg et al. (2022),[7] testing inoculation against climate change fake news, a 'passive' communication effort (such as social media posts, media advisories and spokesperson warning of what to expect in a video clip) decreased belief in and sharing of disinformation by 33%. In the same study, a more active method decreased belief and sharing by 75%.

Active methods include workshops or community engagement programs or a game that helps people identify when and how they are being misled. Then you need platforms you can use to flag these scenarios and a creative way of implementing your prebunking efforts.

Once you become good at the prebunking, debunking – that is, trying to refute disinformation that is already out there – becomes easier because the prebunking efforts enlist an army of disinformation warriors in your followers who will pounce on disinformation whereever it arises.

Where does it come from?

Disinformation has a great framework of the C5 interaction model.[8] This 2025 model describes the context, causes, content and the cycle of amplification as well as the consequences of disinformation and how these interact. The 'causes' component of the model helps us understand both the creators of disinformation and their motives.

Creators can be explained using 3 categories: human/non-human (bots and AI swarms), individual/organisation and non-state/state actors. It's easy to assume that all originators are human and individual but Needham (2025)[9] reported that sowing division by state actors is alive and well in Australia.

Motives are classified as ideological (political, religious, some other belief system such as libertarian or sovereign citizen) or financial. Cloud seeding is ideological coming from a conspiracy theory. Claims that only immigrants will get flood relief is based on political ideologue, and scamming 'donations for flood survivors' is financially motivated.

What better place than an unfolding disaster to sow political or ideological division or to set up a scam than when people are under stress and, in many cases, looking for somewhere or someone to lay the blame?

It's a simple approach that can easily fold into normal communication programs. However, it can be daunting because disinformation, especially any bot-driven versions, seems unbeatable and we want to believe that it can't happen during disaster. But communities are intelligent and caring, and, after inoculation efforts, can be empowered with information and confidence.

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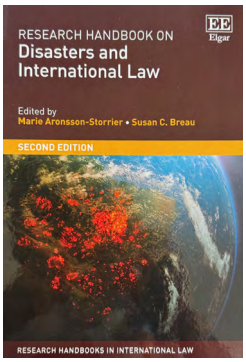
Disasters and International Law: Research Handbook on International Law



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Disasters and International Law presents a comprehensive and intellectually sound examination of international disaster law, drawing together contributions from 26 authors with varied academic backgrounds and perspectives. Edited by Marie Aronsson-Storrier, and Susan C. Breau, this second edition explores the conceptual, doctrinal and critical dimensions of the field and offers in-depth engagement with the human-nature relationship, constructions of risk, structural vulnerability and the limitations of existing legal frameworks.

Thought-provoking chapters include an acknowledgment by Marie Aronsson-Storrier about the 'human-nature' dualism in the 'west', which has been brought into instruments and language on disaster risk and management, with indigenous views being essential to be not a countermeasure but core perspectives that are integrated. The issue of credibility and its relationship with law-making and the testimonial justice theory is examined in light of indigenous views often being considered fringe or alternative. This ties in with the chapter by Scott Williams in which he explores the concept of risk and the 'dishonourable harvest' with questions around 'property' and their 'bundles of rights' and how these drive international risk reduction law while, at the same time, not recognising that these concepts permit 'violence' through lack of recognition and protection for nature. This is done with a focus on changing our environment rather than looking at ourselves.

Liam Bagshaw discusses how law, including international disaster law, is a mechanism by which vulnerabilities are concreted, as is wealth, power and influence, to continue hegemony of particular values that serve those who stipulate them. This makes a natural connection with Johns Hopkins' examination in his chapter of why many Pacific Island states are reluctant to enter into international agreements. This puts context around why smaller nations are often alert to how international disaster law has been used and remains a potential mechanism of exploitation. Hugo Cahuenas, Laura Carrion and Juan Felipe Idrovao Romo provide valuable contributions on gender-based violence and human mobility. They explain why women are less likely to leave disaster zones and how laws, among other factors, play a part in perpetuating these vulnerabilities.

This handbook is aimed at legal researchers and postgraduate students specialising in international disaster law. Only one contributor acknowledges practical experience in disaster management operations (Australia), which underscores the work's orientation towards theoretical legal scholarship rather than applied practice. This academic focus manifests as a relative paucity of practical legal guidance for students and emergency management practitioners seeking operational insights. The editors have positioned this as a research handbook rather than an instructional textbook for entry-level students or field practitioners.

An omission is the absence of any substantive treatment of animal disaster law, despite its growing political and social prominence across multiple jurisdictions, including the United States, Australia, New Zealand and Italy. This absence is noteworthy given that, when the New Zealand Government sought public submissions on the Emergency Management Bill 2004, the majority of respondents identified the inclusion of animal disaster law provisions as the most important legislative priority.[1]

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