Australian Institute for Disaster Resilience

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## AUSTRALIAN JOURNAL OF EMERGENCY MANAGEMENT

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**COVER**

Image: Michael Ross, Newspix
Motorists stranded by floodwaters over the Tamborine Oxenford Road in Wongawallan, following heavy rain in the region. Gold Coast, Queensland 2010.

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The *Australian Journal of Emergency Management* is Australia's premier journal in emergency management. Its format and content is 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 and 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 (AIDR), 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 emphasises empirical reports but may include specialised theoretical, methodological, case study and review papers and opinion pieces. The views in this journal are not necessarily the views of the Australian Government or the members of AIDR.

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# Foreword

## Dr Michael Rumsewicz, Editor-in-Chief, Australian Journal of Emergency Management

This is an exciting time for the *Australian Journal of Emergency of Management* (AJEM) as it moves into a new era with the Australian Institute for Disaster Resilience.

In the emergency management sector, doing things as they have always been done is no longer an option. The complex demands of technological change, regional geo-politics, rising expenditures, shared responsibilities, and the need to shift the focus from response to mitigation, all add to the relevance of this journal in particular, and more generally the broader work of the Institute.

I see the AJEM as a documenter of lessons learnt, an explorer of new models of thinking about disaster resilience, and as an advocate for research to improve emergency management in Australia and New Zealand, and throughout our region.

Information sharing is not just about pushing information out in a printed and online journal format. Technology lets us communicate using a variety of media, shaped to the different ways people take up information. It is important to work beyond traditional formats by creating forums for discussing, critiquing and reshaping information to maximise its value. The Institute, supported by the AJEM, will be a significant contributor to this information-sharing network.

In the last few years in Australia each state and territory has dealt with significant natural events; major fires, supercell thunderstorms and east coast lows, cyclones, heatwaves, storms and floods. There are also longer-term conditions forecast such as drought and climate change that will affect the country.

Close by in recent times, Fiji was hit by the strongest cyclone ever recorded in the southern hemisphere, Indonesia experienced terrorist attack, and Christchurch in New Zealand continues to experience earthquakes. These are all reminders that preparation is an ongoing effort when emergencies can strike with little warning.

Australia has an ongoing responsibility to better understand and contribute support to regions beyond its shores. This regional cooperation enabled firefighters from New Zealand to provide support to Tasmania and Victoria this southern fire season, and Australians were sent to New Zealand, Fiji, Vanuatu, the Solomon Islands, and elsewhere in recent years to assist during and after disasters events.

At the same time there is increasing pressure on expenditure as the cost of emergency-related activities escalates. The Productivity Commission report[1] recommended a greater focus on mitigation activity to reduce the long-term cost of recovery but did not identify how such mitigation efforts should be funded. Meanwhile, the Australian *National Strategy for Disaster Resilience* places significant emphasis on the sharing of responsibility for disaster resilience across entire communities.

So, what is the role of the AJEM in this changing environment? Over the coming year we will be reshaping it to ensure continued relevance to its audiences and integrate it with the Institute's suite of resources and activities.

Be part of this journey, let us know your ideas, bring your creativity to this effort – it's your journal: ajem@aidr.org.au.

**Dr Michael Rumsewicz**

Editor-in-Chief
Australian Journal of Emergency Management
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1 Natural Disaster Funding Inquiry report. At: www.pc.gov.au/inquiries/completed/disaster-funding/report.

# Perceptions of risk and connection to landscape

By Brenda Leahy, Communications Officer,
Australasian Fire and Emergency Service Authorities Council

Tonimbuk, population 317, is about 90km east of Melbourne beside the Bunyip State Forest. It is one of Victoria's many pretty and, sometimes, dangerous places. In summer, when heat, wind and fuel conditions converge into severe fire weather, the natural beauty of the densely-forested landscape turns Tonimbuk into a place of high bushfire risk.

Local residents, Mike and Elaine Harrison, like so many others, co-exist with the risk because Tonimbuk is 'home'.

Filled with 40 years of memories, of family, friends, lives lived and lost; home for the Harrisons is much more than the house, possessions or a place on a map. It's about deep connections with the landscape, beyond the front gate, to the local town hall, the scrubby ridges, pastures and thickly forested hillsides.

'No matter where you are, when you come back it's like putting on a good old comfortable coat. You're home,' explains Mike Harrison. His story of home within his beloved landscape features in an innovative, online training and development toolkit published by the Australasian Fire and Emergency Service Authorities Council.

The *House, Home and Place: A Visual Mapping Tool Kit* for fire and land managers uses stories to help explain why people want to live in fire-prone communities. It helps illustrate some of the values and beliefs that shape their connections to home and place.

Image: Tom Lowe, Polyarnyi Productions

Mike and Elaine Harrison say a sense of connection to landscape is part of their response to bushfire risk.

The toolkit is based on the research of Professor Ruth Beilin and Dr Karen Reid of the University of Melbourne from their 'Social Construct of Fuels in the Interface' project for the Bushfire CRC.

In their studies, the researchers found that emergency services agencies could benefit from 'stepping into the shoes' of local residents to understand their perspectives on bushfire in the landscape and their responses to risk. Factors investigated included what people meant by 'house', 'home' and 'place' and what things they valued in terms of their homes and communities, and why.

According to Dr Reid, using this local knowledge and insights would help agency staff to support people to anticipate and reduce the risks to their homes and communities.

## Place-based approach

Mike Wouters, one of the project's advisors from the South Australia Department of Environment, Water and Natural Resources (DEWNR), wanted to understand why residents did not appear to assess hazard and risk in the same way as agencies, or respond as they had expected to general fire safety messaging. The key question was: What did people value most in their homes and communities?

A place-based approach, according to Dr Reid, helped explain how residents attached meaning to environments in their everyday lives and how this influenced their thinking about risk.

'The field work with our colleagues from DEWNR confirmed that people were not ignorant of bushfire risk.

'It showed that their understanding of risk was far more complex, reflecting their sense of self and how they individually valued assets. For example, trees, wildlife or buildings were inseparable from the broader landscape context. This laid the ground work for the development of the toolkit,' she said.

The findings highlighted that people's sense of home and place extended well beyond the house to being

part of the local landscape, according to Mike Wouters. This had implications for bushfire education as, traditionally, he says, some fire safety messaging had focused on the 'house' and the structural or physical aspects of preparation, such as cleaning gutters and making fire breaks.


During the project, the researchers also held workshops with the South Australia Country Fire Service, the Tasmania Fire Service and Victorian fire and land management agencies, the Country Fire Authority, Department of Environment Land Water and Planning, Emergency Management Victoria and Parks Victoria.

The *House, Home and Place: A Visual Mapping Tool Kit* features a package of videos, including personal stories and a range of printable resources on how to use and apply the information.

The toolkit is essentially a visual mapping method and interview technique delivered in a workshop format. The method can be used by anyone interested in working with communities to strengthen capacity and to mitigate and recover from natural hazards.

Residents work in small groups and are helped to sketch, or 'mud map', their home within the local environment and to reflect on how they live within and use that space every day. As they talk, draw and interact, they are encouraged to consider hazards and risks, such as bushfire.

A key benefit of this method, according to Dr Reid, is that it can start productive conversations about risk and how to manage it. These free-flowing conversations, she says, reveal insights that cannot be gleaned from typical question-and-answer style interviews or surveys.

'The process of visual mapping helps unlock deeper-held intuitive ways of knowing. It helps explain why certain things are important, and provides an opportunity to pause and reflect on the decisions we make and the actions we take. In this way, the deeply held assumptions we make about the landscape are reflected right back at you on the paper.

'It doesn't matter whether you're a local, a land manager, firefighter or scientist, we all draw on our intuitive ways of knowing, as well as our rational knowledge.

'But the intuitive is much harder to access than the rational way of knowing, because it's deeply embedded in our thoughts and assumptions. By going through this process we can understand better where people are coming from,' Dr Reid said.

## The human side of risk

Communication consultant, Tom Lowe, was engaged to translate the research into a tool for practitioners. He used video storytelling and narrative to put a human face on complex and abstract concepts.

'Managers and practitioners often talk about people's values in broad terms. This may be because everyone has a slightly different take on the world, and it would be almost impossible to take into account the depth and breadth of views that are out there.

'As a result, we tend to gloss over the reasons for people's connections to place in an attempt to avoid overcomplicating decision making,' said Mr Lowe.

In developing the toolkit materials, he aimed to demonstrate what connects people to their surroundings as well as bring to the fore the stories behind people's view of the world.

**... their understanding of risk was far more complex, reflecting their sense of self and how deeply held values were inseparable from the broader landscape context.**

'Fire and land managers don't necessarily need to remember every individual story, or respond to everyone's demands, but I do think it is important to be aware of the richness of experience that lies behind each story.

'By starting from the ground up, and engaging in discussions with local people about their connections to place, practitioners should be able to extract a more detailed sense of where people agree and where they disagree.

'The toolkit materials will not provide decision-makers or communities with all of the answers, but they should give people the confidence to start a discussion and not be afraid to listen to people's stories,' Mr Lowe said.

Access the toolkit at http://tinyurl.com/jdp89bo

Other related resources at www.bushfirecrc.com/research/event/2014-drivechange-06

# Knowing fire: exploring the scope and management of the tacit fire knowledge of agency staff

**Anthony English, Parks Victoria, explains the uses and value of tacit knowledge to meet the objectives of fire agencies in Victoria. ®**


## ABSTRACT

**Tacit knowledge is knowledge that is not easily written down and derives from observing and doing. It is drawn from a person's subjective insights and intuitions. It is not easily expressible and is difficult to formalise or transfer. Tacit knowledge is a key driver of personal decision-making. This paper explores the extent to which the tacit knowledge of fire held by staff in land and fire agencies is valued, critiqued and used by these agencies. It is argued that while the role of tacit knowledge in shaping fire practice is substantial, its scope and influence is poorly understood. The paper draws on research in workforce planning and knowledge management, as well as the author's operational fire experience to review how agencies in Victoria could recognise and use tacit knowledge to drive emerging strategic objectives.**


## Introduction

In 2015 the Victorian Government released a document titled 'Safer Together: A new approach to reducing the risk of bushfire in Victoria' (State of Victoria 2015). Drawn from the hard-won lessons of the last few fire seasons this report emphasises that government and the community will take a new and collaborative approach to identifying and managing fire risk. The concept of knowledge is a critical element of the document. It emphasises that using scientific research and modelling, as well as local community understanding of landscape, will drive this change.

It is timely then to analyse more closely what constitutes fire knowledge. This paper focuses on one element that, like community-based knowledge, has tended to be overlooked. This is the tacit knowledge held by staff of land and fire agencies in Victoria. It explores the extent to which staff member's tacit fire knowledge is valued, critiqued and used.

Fire knowledge is attained by staff in a range of ways. Training and related activities focusing on the transfer of formal or explicit knowledge are important components of knowledge development. However, much if not most, knowledge development is the result of practical involvement in fire management and can be classed as tacit knowledge.

Tacit knowledge is knowledge that is not easily written down and derives from observing and doing. It is drawn from subjective insights and intuitions, is context specific, is not easily visible or expressible, is difficult to formalise or transfer, and is a key driver of personal decision-making (Kakabadse, Kouzin & Kakabadse 2001, Linde 2001, Stenmark 2001). It is argued here that tacit knowledge, and its use, is one of the primary determinants of how staff members apply fire management on the ground. People use their tacit knowledge to respond to situations in the field, and to interpret and apply formal training and agency procedures and policies.

The tacit knowledge referred to here exists at a variety of scales. It can include personal understanding of fire behaviour in specific landscapes, or awareness of how lighting patterns can be used to achieve planned burn objectives. Such knowledge, despite its elusiveness, is critical to the development of fire practice as it reflects the development of insight gained from years of observation, trial and error.

## Drawing out and recognising tacit fire management knowledge

There are at least five primary reasons why fire agencies need to recognise and draw out the tacit fire knowledge of staff.

1. Tacit knowledge is a primary determinant of staff behaviour, decision-making and performance. An employer can only manage and understand the skill base of their employees and gain insight to their work practices and culture if they appreciate the scope and form of their tacit knowledge and its influence on their decisions.
2. Tacit knowledge is valuable and pivotal to driving organisational performance. It forms part of what Cabrera and Cabrera (2005) refer to as the

'human capital' of organisations. In a fire agency it represents knowledge that can drive and generate efficiencies, overcome problems and provide insight for more formal research and planning. It contributes to what Roux *et al.* (2006) refer to as the co-production of knowledge across the science-operational divide.

3. Despite its value and influence, it can be fragile and easily lost. When an experienced staff member leaves they can take with them knowledge and insights that cannot be replicated or easily captured in explicit forms like manuals and procedures.
4. Tacit knowledge has local and cultural dimensions that can have a resonance with the community. Unlike explicit or formal knowledge, tacit knowledge and associated ways of working may reflect awareness of the needs, values and views of the local communities which agencies serve. Staff may use their tacit knowledge, which includes their social awareness, as a context to carry out their work in ways that engender community support and partnership.
5. An organisation that recognises internal tacit knowledge will be better able to recognise the knowledge that exists in the community as it will be open to learning and engagement in its truest form.

Most importantly, recognition of staff tacit knowledge is an essential pre-cursor to the development of innovative organisations. Roux and colleagues (2006) demonstrated that recognition is essential to the 'co-development' of knowledge across the science management divide. They argue that innovation in land management practice is constrained in agencies by the presence of separate 'operational' and 'research' cultures that struggle to communicate and share knowledge. Valuing and drawing out the tacit knowledge of operational staff is shown to be a critical factor in breaking this barrier down.

In Victoria, this divide is real, and perhaps best illustrated by the challenge of integrating fire ecology practice into operational fire management. The initial interviews conducted with staff revealed that they possess significant knowledge about the relationship between fire and ecological condition. Despite this, they are rarely asked to reveal, critique or discuss this knowledge and have little direct exposure to structured fire ecology research programs.

## Understanding the tacit dimension in fire management

As Stenmark (2001) notes, tacit knowledge can be elusive. We are not necessarily aware of the tacit knowledge that we possess, we may have little personal reason to share it, and may perceive sharing it as a reduction of competitive advantage. Its elusiveness can hide the fact that tacit knowledge is highly valuable and a critical driver of personal behaviour, attitudes and performance.

Sitting behind tacit knowledge is the formal or explicit knowledge that is relayed to staff in training courses, manuals and procedures. Referred to by researchers such as Polanyi (1966) as 'context-free theory', this formal knowledge is then applied, used and reshaped in its application to suit specific circumstances in practice. It is here that tacit knowledge shows its influence as staff members rely on the observed behaviour of their peers, their personal experience, and their interpretation of procedures, to direct their actions and decisions.

Blair and colleagues (2010a, 2010b) argued that land and fire agencies in Victoria have tended to see knowledge as an object to be imparted, rather than as a process that is embedded in social systems and personal experiences. This has meant that formal rather than tacit knowledge has been a focus of knowledge development and exchange systems in these agencies. They argue that this view of knowledge has restricted agency capacity to recognise and respect community-based fire knowledge. It is argued that this view of knowledge has also impacted on the recognition and understanding of staff member tacit knowledge by land and fire agencies.

Image: Anthony English

Ecological burning in a Parks Victoria grassland reserve, south of Ballarat.

## Methodology

Two methods were used to conduct a preliminary assessment of the scope and influence of staff member tacit knowledge on fire practice in Victoria. The first involved the author's personal review of how fire knowledge has developed, and is developing. This approach shows the observed value of reflection as a learning tool (Kakabadse, Kouzin & Kakabadse 2001). The second involved conducting a small number of interviews with staff who focused on their own knowledge development, and on specific elements of their tacit knowledge. This approach relied on the efficacy of learning history approaches to organisational knowledge gathering and exchange (Linde 2001, Department of Defence 2010, Parent & Beliveau 2007, Elliot *et al.* 2009).

### Personal reflection

Review of the author's personal experience in fire management can be used to shed light on the way that tacit fire knowledge is developed and used by individual fire practitioners. Personal tacit knowledge builds as one plans and conducts subsequent planned burns. For example, the author's awareness of how different vegetation and fuel types respond to varied lighting patterns continues to develop each season. This allows refinement of tactics that enhance crew safety, and the achievement of burn objectives that balance agency and community expectations. Familiarity builds over time as one plans and conducts subsequent planned burns, particularly with how different vegetation and fuel types in central Victoria responded to varied fire lighting patterns. This knowledge and perspective has been shaped by conversations with others (social), developed within a specific set of landscapes and activities (context), shaped by training, observation and doing (process), and by sight, sound and smell (modes of being). This personal experience of knowledge development accords with the definition of knowledge applied by Blair and co-authors (2010a). It reveals that formal training in planned burning is only one element in knowledge development and, in turn, only one influence on how to conduct activities on the ground. Therefore direct experience influences how to place the formal or explicit knowledge gained at training into a context.

The author's observation of work practices by teams at planned burns reveals the critical role played by tacit knowledge in shaping fire practice. This observation suggests that individual teams derive localised techniques for applying fire to the landscape. Observation of individual teams that have derived localised techniques for applying fire to the landscape during planned burning that reflects their particular knowledge of landscape and fire behaviour. When discussing tactics and techniques it is common for staff to refer to previous experiences to illustrate the insight they gained over time. This reflection is used to help justify or explain the way they carry out their work. It is not unusual to hear staff referring to crews sent to work in their area from other locations as requiring specific direction to ensure that they work in a way that matches local conditions and, by extension, associated norms and expectations. Published research has revealed similar insights to the role played by past experience (tacit knowledge) in shaping staff decisions and actions. A good example is cited in Elliot, Omedei & Johnson (2009) who report that staff experience of near misses and accidents is a major influence on their future planning and decision-making.

### Interviews with staff

The small number of interviews conducted with experienced staff revealed information about how tacit fire knowledge is developed and applied. These interviews explored specific elements of a person's tacit knowledge. Staff members were asked to reflect on how their understanding of the influence of variables such as season, vegetation types, crew behaviour and terrain on planned burning outcomes had developed across their career. This revealed the complex inter-play that exists between explicit and tacit knowledge and reinforced the hidden but critical role played by the latter in shaping both decisions and outcomes.

Using the outcomes of these interviews and author reflection, Table 1 shows some of the key factors that may be critical in shaping staff tacit fire knowledge in a fire agency. Their relevance and influence needs to be tested through structured inquiry.

## Organisational strategies for recognition and transfer of tacit knowledge

Significant research has been undertaken that explores how organisations can tap into and facilitate the transfer and sharing of tacit knowledge (Kakabadse Kouzin & Kakabadse 2001, Stenmark 2001, Cabrera & Cabrera 2005, Roux *et al.* 2006). A common thread that occurs is that agencies need to understand what tacit knowledge is, and then understand how it is used, withheld and shared by individuals within organisations.

This body of research reveals that tacit knowledge can be leveraged, exchanged and transferred within an organisation if a number of elements are present. Fundamentally organisations need to understand what Cabrera and Cabrera (2005) refer to as the 'social-psychological determinants' of knowledge sharing. They discuss the theories of reasoned action, social capital, social dilemma, and social exchange to highlight four propositions.

1. Positive attitudes toward knowledge sharing in an organisation will be positively related to intentions to share knowledge (theory of reasoned action).
2. Social ties and shared language help create an environment that supports knowledge sharing (social capital theory).
3. Trust and group identification encourage positive attitudes toward knowledge sharing (social capital theory).

**Table 1:** Potential factors shaping the development and use of staff tacit fire knowledge.

| Factor | Knowledge impact |
|---|---|
| New legislation, policy and operating procedures. | Generates changed procedures and practices that over time become embedded in staff behaviour and norms. As an example, comparison of workplace safety practices over the last 20 years reveals that significant change has occurred in staff behaviours and expectations associated with safe working procedures. |
| Community based debates and expectations, for example about the value and conduct of prescribed burning. | Staff members are embedded in social systems so they absorb debates and points of view being expressed in the community. This and their personal values shape their attitude toward fire practice over time. |
| New technology and equipment. | Staff members learn how to do tasks differently and more effectively. This can accelerate staff capabilityand innovation and generate flow-on changes in fire practice. |
| Personal experience over time such as exposure to different seasonal conditions and landscapes. | Improved staff awareness of factors that shape decision-making and the outcomes, such as the relationship between fuel types, topography, fire behaviour and operational tactics. |
| Team dynamics. | Staff may have access to significant levels of tacit knowledge within their teams. This knowledge helps form workplace norms or peer-generated views about tactics, standards and procedures. See for example Hayes, Omedei & Johnson 2013. |
| Change in a staff member's personal fire role such as from a fire fighter to a planner or incident controller. | Staff will re-evaluate their knowledge as they move into different roles and become exposed to different expectations, perspectives, information and systems. |

4. Perceived rewards and expectations of reciprocity are required to encourage knowledge sharing (social dilemma theory).

Kakabadse and co-authors (2001), like Blair and colleagues (2010a, 2010b) argue that knowledge sharing is a 'socialization process' and not simply the provision of information in explicit forms such as manuals and procedures. They highlight the presence of trust and an egalitarian culture is essential to support tacit knowledge exchange. This is echoed in the research of Edmondson and Lei (2014) who refer to the concept of 'psychological safety'. When this is present, people share and express ideas without fear of negative repercussions. Establishing a workplace culture where this is possible requires leadership and an explicit recognition of the value of tacit knowledge.

## Current approaches in Victoria

This research can be used to assess how current approaches to knowledge management in fire agencies in Victoria may support or constrain the recognition and transfer of tacit knowledge.

### Positive dimensions

There are positive dimensions of tacit knowledge review and exchange in Victoria:

- The ongoing informal conversations, mentoring and debates about fire practice that occur at the local team level. These may constitute small or local communities-of-practice. Roux and co-authors (2006) define a community-of-practice as a self-forming collective of individuals who share knowledge about a matter of common interest, and who develop individual and collective knowledge through sharing stories, insights and information.
- The presence of extensive and high-quality formal training that has the effect of increasing the confidence and self-efficacy of staff. This provides them with a context as individuals in which to develop and review their tacit knowledge. Publications used in fire training have at times sought to combine operational and research based knowledge (Tolhurst & Cheney 1999).
- A strong sense of team and shared identity that allows some elements of social capital theory to thrive (Cabrera & Cabrera 2005).

In addition, the use of systems of competencies for fire roles is also bound up with the management and recognition of knowledge. Operationally, there are also numerous knowledge gathering or exchange processes in place that are routinely used in fire management settings. Common tools are debriefs, or After Action Reviews (AARs) that occur after events such as a prescribed burn or, on a larger scale, after a fire season. AARs can identify important improvements to practice that can be implemented by teams on the ground. The improvements identified are often derived from the expression of, or reference to, staff tacit knowledge.

### Negative dimensions

These positive elements are combated by a number of factors:

- A tendency (as noted previously) for agencies to view knowledge as an object to be imparted, rather than being a process (Blair *et. al* 2010a). This generates a consequent lack of recognition of tacit knowledge and an inability to understand how staff knowledge is used in context.
- An emphasis on hierarchical structures that support command-and-control that run counter

to the importance of egalitarian workplace cultures (Kakabadse, Kouzen & Kakabadse 2001) and psychological safety (Edmondson & Lei 2014) in supporting knowledge exchange within organisations. This specific challenge has been noted as affecting emergency services organisations in Australia (Owen *et al.* 2015)

- A related fragmentation of operational and research knowledge sets and a retention of the operational-science divide (Roux *et al.* 2006). This mitigates against the co-production of knowledge.
- A strong reliance on formal knowledge management techniques such as AARs and debriefs that reflect a preference for hierarchical structures.

## Changing the approach

Four changes are needed by land and fire agencies to develop new approaches to knowledge exchange and development.

1. Establish new workplace systems such as communities-of-practice , cross-functional teams, and performance management norms that create an egalitarian workplace culture and support the interaction between researchers, community and staff members.
2. Adopt new forms of operational analysis that explore how staff use and develop their knowledge in context. Oral history and learning history approaches (Parent & Beliveau 2007) to knowledge gathering and review should form core elements of this approach. This may involve but not be limited to, pre-event review of the operational and policy context that staff rely on when planning an activity. This could be followed by observation of staff behaviour and decision-making at actual events, and then by post event interviews and comparative analysis that explores how tacit and explicit knowledge have variably influenced staff decision-making and action.
3. In line with this, agencies should rethink the design of existing knowledge exchange processes such as AARs to better support recognition and evaluation of staff tacit knowledge. This can be connected to more formal processes and ongoing conversations occurring within communities-of-practice and other egalitarian forums. AARs could adhere more closely to the community-of-practice model and allow for constructive debate rather than old-style military review. The Students of Fire model, (Stebbing & Strickland 2014) is an example of a community-of-practice that is already active and could be adapted to suit agency needs.
4. Tap into the revolution occurring in the design and conduct of serious accident investigation by United States land and fire agencies. Exemplified by Pupulidy (2009), this work recognises that decision-making in dynamic situations like wildfires is shaped by tacit knowledge. In this setting, investigations focus not on finding errors and ascribing blame to individuals. Instead, they seek to understand the context in which decisions were

Image: Tony Morris, Parks Victoria.

Aerial view of planned burning operations conducted in 2015 at the Macedon Regional Park, central Victoria.

made and the conditions which prompted them to be formulated. This approach is a shift away from simple casual analysis to one that replaces use of hindsight with recognition of how knowledge is used by staff in certain circumstances. Pupulidy's review of the Panther Fire Fatality Incident[1] in California in 2008 is an illustration of the presence of tacit knowledge in a workplace and its influence on decision-making. It also highlights how tacit knowledge can be adapted and used to drive improvement. This approach can be broadened beyond accident investigation to looking at how tacit knowledge is used in standard operational settings.

If designed well, adopting these four changes could form a self-sustaining loop of knowledge development and exchange.

## Conclusion

Recognition of staff tacit knowledge and its effect on operational practice is a critical step if agencies are to achieve strategic objectives in land and fire management. Numerous benefits would flow from this for the agencies involved and the communities they serve. It would contribute significantly to agency adaptability, openness to learning from the community, and the ability to exchange ideas and knowledge across the science-operations divide.


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1 Panther Fire Fatality Incident. At: www.wildfirelessons.net/orphans/viewincident?DocumentKey=bf7fa21a-4c22-4d58-b568-a1dec4aa2945.

# Science in Motion: integrating scientific knowledge into bushfire risk mitigation in southwest Victoria

Dr Timothy Neale and Dr Jessica K. Weir, Western Sydney University, and Professor Stephen Dovers, Australian National University, discuss the interface between science, policy and practice through a case study of bushfire risk mitigation. ®

## ABSTRACT

**Scientific knowledge and scientific uncertainties play a significant role in the mitigation of natural hazard risk. As such, the natural hazards sector is often represented as 'science-led' or 'research-led'. However, in actuality, relationships between scientific research, policy and practice are neither simple nor linear, and there are presently few studies that focus on the layers of practitioners who find themselves mediating these relationships. In order to provide insight into the integration of scientific knowledge, this paper considers the findings of a case study of bushfire practitioners in the Barwon-Otway area of southwest Victoria. This region has recently been the site of multi-agency efforts to reduce the residual bushfire risk using the PHOENIX RapidFire bushfire simulator. The paper concludes by posing several questions relevant to this and other risk mitigation contexts.**

## Introduction

Both natural hazards management and social research into natural hazards are typically driven by ideas and debates about human life and property. How do we reduce their exposure, and increase their resilience, to inevitable and unpredictable hazard events? In this, policies and practices have been a significant focus, while the layers of practitioners and decision makers (or simply 'practitioners') who mediate between official policy, actual practice and scientific innovation have had relatively little attention. Frequently, in studies of the sector, individuals are conflated with an agency or sector and actual practices are conflated with policy guidelines. There are many possible explanations for this research gap, but the result is that insights into the crucial relationship between physical science, policy and practice within the sector generally emerge only in extraordinary circumstances, such as when we celebrate a technological breakthrough or in the aftermath of a disaster. The first situation can perpetuate the idea that using new scientific evidence, or transitioning to a new policy, is a smooth process. The second situation often leads to an emphasis on short-term culpability rather than the long-term causes (see Eburn & Dovers 2015).

Two widespread misconceptions shape how we understand the relationships between policy, practitioners and physical science. The first is the 'pipeline model,' which suggests there is a linear relationship between science and policy; one gives answers to the other's questions (Jasanoff 2003). However, in reality, decisions about both research and policy priorities are social and political, rather than being deduced from empirical analysis. As political scientist Brian Head has suggested (2008, p.1), there are three forms of knowledge that lead to 'evidence-based policy'. These are systematic scientific research, program management experience, and political judgement. In short, empirical research (or 'science'), regulations and practice are interdependent and contingent (Hunt & Shackley 1999). Having 'policy-relevant' research or near-perfect predictions of future conditions will not make a significant difference where there are robust institutional limitations on the integration and use of new knowledge (Bosomworth 2015, Howes *et al.* 2015).

The second misconception is the assumed direct relationship between policy and actual practice. As researchers and practitioners know, this relationship is more often an elastic one, shaped by the capacities, affordances, and limitations of a given situation (Hickey *et al.* 2013). It is evident that policies are sometimes unachievable (whether due to resource shortfalls, shifting priorities, or other factors) and are often vague. Statutory objects stated in enabling legislation are typically very broad, allowing for further specification in subsidiary policy or regulations, and for flexibility in implementation and definition at the appropriate level of governance. What fire and emergency managers are meant to achieve is inevitably uncertain (Eburn & Dovers 2014), which allows judgement to be applied, but also leaves room for argument over the relative success or failure of practice. Additionally, history indicates that innovation in hazard management often requires practice to move ahead of policy, as practitioners test options better fitted to emergent

research and current circumstances. In such a context, personal and professional experience, and the local knowledge of members of the community, are all necessary supplements to official rules and available evidence.

So, though it is not uncommon to hear that good science provides good evidence for good policy, these 'good' things are neither unambiguous in their qualities nor their sequence in actuality (Sarewitz 2004). Researchers, policy makers and practitioners all begin their work *in medias res* – or 'in the middle of things' – encountering an existing world of received wisdom, diverse incentives, and institutional cultures. For each, the parameters of enquiry and action may be beyond their control, strong evidence may not influence policy makers, or effective policy may face problems too urgent to wait on greater certainty. In fact, in devising and implementing strategies to reduce the probabilities and consequences of future events, risk mitigation is rife with uncertainties. In some cases their negotiation may present little obstacle, whereas in others the spectrum of 'known unknowns' may have to embraced rather than overcome (Neale & Weir 2015).

The recent history of bushfire risk mitigation in Victoria is an exemplar of the asynchronous rhythms of science, policy and practice, made possible by institutional and political factors outside the influence of any one agency or individual. Victoria is among the world's worst regions for disastrous fires (Gill, Stephens & Carey 2013, p. 493), a fact that has elicited an evolving series of policy responses including, after the 2009 Black Saturday fires, a commitment to treat five per cent of public lands with prescribed burning annually.[1] While implementing this policy, the Department of Environment, Land, Water & Planning (DELWP, formerly DEPI) has also piloted a new strategy to measure and plan bushfire risk mitigation using a two-dimensional bushfire simulator (PHOENIX RapidFire, or 'PHOENIX'), building on a history of model development and science-policy interaction. The research project focused on one specific pilot region, the Barwon-Otway area of southwest Victoria to assess how new forms of scientific knowledge were being assimilated into mitigation policy and practice. This forms one of three case studies, developed to support practitioners to explain, justify and discuss risk mitigation practices to sector professionals, the public, the media, and others.[2]

## Case study and method

The Barwon-Otway area consists of over one million hectares of high bushfire hazard area in southwest Victoria. In the past two decades, its eastern coast has increasingly become a destination for tourists. This significantly increases the population during the bushfire season along the forested coastal corridor most exposed to high-intensity landscape fires between Torquay and Wye River.[3] Since 2009, the area has been used by the DELWP, in collaboration with other agencies and local governments, as a pilot site to investigate a 'risk-based' alternative strategy to the established mitigation policy (DEPI 2014). To simplify significantly (see Ackland *et al.* 2014), the alternative involves simulations and comparisons.

First is the generation of loss estimates from three suites of bushfires simulated within PHOENIX. Fires under 'worst case' (i.e. FFDI 130) weather conditions are simulated in landscapes in which there is:

- no history of planned or unplanned fire
- all public land has been burnt
- accidental fires and prescribed burning treatments have occurred.

Given the model can predict house losses from fire intensity, the three suites can be compared to reveal the baseline risk, the benefit of mitigation, and the residual risk. A more complex arrangement, also trialled, compared multiple asset losses across multiple suites of scenarios. In the words of one expert review, these techniques represent 'world's best practice' (Burrows *et al.* 2014) and provide a scientific method to both test and demonstrate the efficacy of forms of mitigation such as prescribed burning.

This case study was chosen in the anticipation that bushfire practitioners involved in this area would offer insights into the integration of science into policy and practice. To this end, 22 practitioners from the area were interviewed in November 2014 and October 2015. A brief summary is presented of their reflections on the integration of scientific knowledge and the primary uncertainties they encountered.

## Integrating science

> *'It's the old saying, "all models are wrong but some of them are useful"'* Barwon-Otway practitioner.[4]

Social studies suggest that scientific models tend to be treated as 'truth machines' and as instigators, rather than participants in change. However, the practitioners in this study were cautious to identify both the limits and pitfalls of modelling and the many conditions that were necessary for its use. This meant, for example, being careful to describe the suites of simulations as 'quite good' or 'better than useful,' while also maintaining a clear enthusiasm to quantify risk; 'before PHOENIX,' as one said, 'we had nothing to gauge the effectiveness or the efficiency of our planned burn program'. Consequently, the availability of spatial datasets was cited as a condition of possibility for the new strategies, including meteorological and fire behaviour data relating to historical exemplars and also data on flora and fauna distribution and other

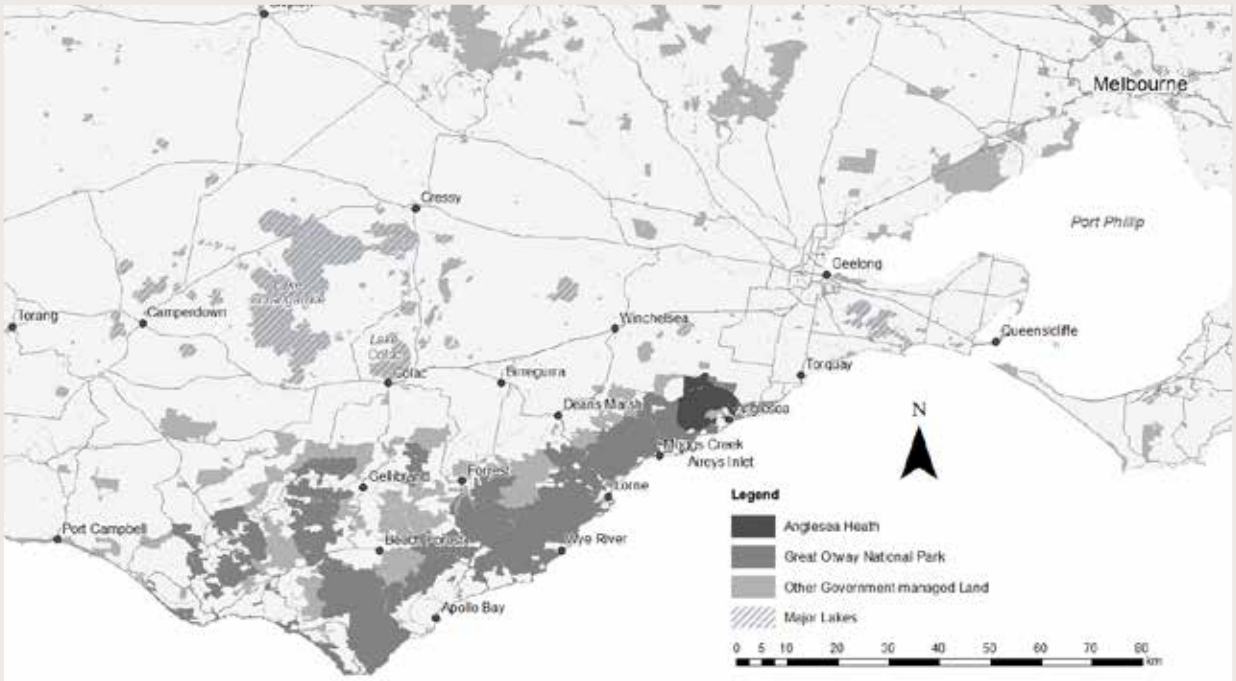
1 With the endorsement of the Inspector-General for Emergency Management, the Victorian Government has moved to a version of the risk-based approach outlined in this paper.

2 For more on the project see: www.bnhcrc.com.au/research/economics-policy-and-decision-making/232.

3 This paper and the research it draws on were completed prior to the Wye River fire in December 2015.

4 All quotes, unless otherwise noted, are from interviews with practitioners (not named).

**Figure 1:** Map of the Barwon-Otway area showing public lands managed by government agencies.




Source: Andrew Edwards

inputs. The successful integration of the model, and the confidence expressed in it, were linked to separate initiatives across multiple agencies.

Perhaps just as important as the model was the construction of what several described as a 'learning space' within which planning could be developed. This involved three factors. First was the existence of both formal and informal links between multiple agencies, providing the mandate for collaboration and the social conditions for it to occur. While prior initiatives were cited as important (e.g. Integrated Fire Management Planning), specific personal relationships were also frequently mentioned. 'If you have the rapport and the relationship, it works,' as one noted. Second, practitioners identified the influence of personal links with researchers and research institutions developed over several years. As one stated, 'it's not automatic that scientists and policy makers and practitioners will communicate'. Third, the pilot involved community and sector stakeholders in knowledge exchange, including an advisory group convened in multiple workshops over 18-24 months to provide feedback on model outputs. These three factors elicited a collaborative atmosphere in which 'having a go' was encouraged, to quote one, even if 'the science isn't perfect by any stretch of the imagination'. The alternative, it was openly acknowledged, was an approach in which '[we] would be just doing something and be guessing that it works'.

Institutional particularities within bushfire agencies were also reported as crucial to creating change. The most important was the leadership of senior managers and what some labelled a 'generational change'. Such agencies are typically conservative institutions, in that the management of natural hazards can lead to conditions in which established policies and practices are preferred (Rayner, Lach & Ingram 2005). To 'take the risk' of making changes, one noted, 'you've got to fight through some fairly strong headwinds'. In this instance, the position of multiple senior figures at both state and regional levels was seen as decisive, fostering interest in the model-based approach within agencies and among policy makers. The compliments to this were, on the one hand, individuals both inside and outside these agencies who were resistant and, on the other, 'a new generation of fire managers willing to try stuff'. None of these groups were simply homogenous, as, for example, the 'new generation' had a variety of tertiary qualifications and expressed diverse opinions about prescribed burning, management priorities, resident responsibilities, and other important issues. Nonetheless, what they shared was an enthusiasm for the search for alternative ways of measuring and managing risk.

## Managing uncertainties

Encountering and managing uncertainties is a key aspect of natural hazards management. In this instance, practitioners identified uncertainties which illustrated both the value and limits of modelling. One of the key purposes of the Barwon-Otway pilot was to investigate how assets and values beyond human life and property, such as flora and fauna, natural resources, and social values, could be incorporated into risk calculation. Unsurprisingly, while most practitioners indicated they were confident they understood risk to 'a discrete element' such as houses, where spatial data and causal relations were clear, discussions of other impacts brought up significant


An area recently treated with prescribed burning at Moggs Creek, Surf Coast, Victoria.

uncertainties. 'The ecological stuff is, of course, a minefield of uncertainty,' for example, due to deficits in understandings of surrogacy between species. Several practitioners indicated that 'all [measures] are laden with assumptions and errors and biases,' but testing and constructing such data was a necessary part of progress requiring significant ongoing effort and investment. Assets and values other than human life must be *countable* to 'count' in such contexts. As one practitioner concluded, 'The key will be to be able to get [all] metrics right so that people can make informed decisions around what we're doing'.

At the same time, 'the unpredictability of how people will react and what they will do' during bushfires is the most significant uncertainty they face. 'The big unknown is people' in both modelling and management, more generally. This is paradoxical, in that though human life is the central concern of policy makers and practitioners alike, in a 'worst case' bushfire 'people will lose lives as a result of decisions that they made... [and less] as a result of activities that we did or didn't do'.

This is not to suggest practitioners did not think they could not affect the loss of human life, but that it is simultaneously the most important, least calculable, and least controllable variable in their work. As such, many practitioners identified how their own professional and local knowledge are necessary supplements, used to 'ground truth' modelling and inform decision-making. Several participants noted that, while agencies have historically been reluctant to release scientific assessments of risk, explicit modelling might help increase bushfire awareness. Such information is imperative to reducing risk to the public and, to a lesser extent, professional risk to themselves. The ethic, as one noted, should be 'about being open and transparent with the public'.

The third key uncertainty relates to the context in which the capacities of science can be actualised. As practitioners stated, natural hazards risk management is necessarily a politicised field. It is shaped by a mix of policy settings, community expectations, and institutional cultures. Bushfire management, for example, is affected by both internal factors, such as institutional conservatism, and external factors, such as responses by policy makers and the public to climate change, research into the effects of smoke, government expenditure, and many other factors. Notably, practitioners identified the modelling strategies as, to quote one, 'giving us something to stand on' in this changeable context. Several pointed out that though the use of PHOENIX generated a wealth of new questions. It also gave new ways of speaking 'up' convincingly to policy makers and 'out' to stakeholders.

## Concluding questions

For the Barwon-Otway practitioners in this study, the transition to a risk mitigation strategy more attuned to current scientific research was neither driven solely by technology, nor was it inevitable. Its conditions of possibility were at once technical, cultural, political, and institutional, shaped by forces both for and against change. Overall, even participants who expressed contrasting views about the efficacy of prescribed burning described the transition very positively in its having provided a different basis for decision-making. As one stated, '[now] the effectiveness of the overall program can be based around something that's a little bit more objective.' Given the Victorian Government's 'brave and positive' commitment to expand the model-based strategy in mid-2016 (Penman 2015), it is worth concluding with several questions about the use of scientific knowledge now raised by this work.

The purpose of making various assets and values measurable was to produce data concerning the benefit of agency efforts. Here was a method for estimating how many species will likely be negatively affected if there is no prescribed burning, for instance, or how many houses will likely be lost if a burning program is

increased or reduced. Almost all practitioners identified the multiple practical benefits of such 'objective' measures to the planning and justification, though several also noted how such measures revealed the limits of government intervention as such. If, on the one hand, suites of simulations quantified the risk removed by agencies, it also, on the other, revealed the extent to which the risk in the landscape is beyond their efforts.

So, as the strategy is extended, how will explicit quantification reshape the distribution of responsibilities between agencies and communities? Notably, while the previous policy focused upon an area target, the risk-based approach contains no explicit benchmarks. The hope, several stated, was that the revelation of residual risk would 'start a conversation' about the distribution of responsibility.

The PHOENIX simulations are highly technical, generated using datasets and parameters whose selection and limitations are not easily explained. This complexity, combined with both the commitment of many practitioners to greater transparency, and the public interest in bushfire, raises two further questions. How much of the data generated in such scientific assessments should agencies release? How much effort should agencies devote to disseminating this information? While, as Eburn and Handmer argue (2012, p. 19), there 'is no legal impediment to releasing reasonably accurate hazard information,' there are clear disincentives to releasing information that may vary in its rigour, has the potential to harm at-risk communities financially, or reflects negatively on government departments. As bushfires and their socionatural and socioeconomic costs become more severe in fire-prone regions due to climate change (Hughes & Steffen 2013), these are likely to become key questions for everyone engaged in the interface between scientific research, policy and practice.

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# Preparing for disaster: preparedness in a flood and cyclone prone community

**Katerina Kanakis and Dr Connar J. McShane suggest that emergency planning that targets both social connectedness and self-efficacy may be most effective in enhancing preparatory behaviours.**


## ABSTRACT

**Research suggests that the perception of a threat, high levels of self-efficacy, and high levels of social connectedness and trust may facilitate engagement in preparatory behaviours for severe weather events. To identify the psychosocial determinants of preparatory behaviours in cyclone- and flood-prone communities, a questionnaire was completed by 275 (103 males, 169 females, three not identified) participants from a north Queensland community. The results from this study show that perceived susceptibility to a future severe weather event, social connectedness, and self-efficacy significantly predict part of the variance in preparatory behaviour. Therefore communicating personal vulnerability to an event, providing information on how to undertake recommended preparatory action, and increasing engagement in the community may contribute to effective preparation at the community level.**


## Introduction

Being prepared for an extreme weather event can help individuals and communities manage the consequences that the event brings (Sattler, Kaiser & Hillner 2000). Individual and social factors can play important roles in facilitating individual preparation for a future extreme weather event (Ramirez, Antrobus & Williamson 2013, Poussin *et al.* 2014, Benight & Bandura 2004, Terpstra 2011, Grothmann & Reusswig 2006, Astill & Griggs 2014, Bonanno *et al.* 2007, Sattler, Kaiser & Hillner 2000, Pennings & Grossman 2008). Australian research has investigated individual preparation concerned with bushfires (Paton, Burgelt & Prior 2008, Whittaker *et al.* 2013, Penman *et al.* 2013) however these behaviours are generally different to those required for other extreme weather events such as floods and cyclones. It is important to identify factors that predict preparedness to enhance the effectiveness of preparatory information communicated by governments and emergency services organisations to susceptible communities.

Research suggests that the first step in encouraging adaptive behaviours for preparing for an extreme weather event, is for the individual to *perceive* a threat to which they need to respond (Witte 1992, Sattler, Kaiser & Hillner 2000, Terpstra 2011, Grothmann & Reusswig 2006). Perceived threat can be conceptualised as the combination of the perceived susceptibility to and perceived severity of the threat (Witte 1992, Maloney, Lapinsky & Witte 2011). Research investigating cyclone or hurricane and flood preparedness found that perceived threat significantly predicted preparation (Sattler *et al.* 2000, Grothmann & Reusswig 2006, Tempstra 2011). As such, part of the challenge for increasing preparedness in individuals is to ensure the nature of the threat is well communicated. Perceptions of threat of future severe weather events can be influenced by the source of the threat communication (Astill & Griggs 2014) with research suggesting that people are more likely to prepare if the information is communicated from a trusted source (Ramirez, Antrobus & Williamson 2013). Further, research indicates that levels of trust and quality of connections that a person has within a community can help preparedness (Ramirez, Antrobus & Williamson 2013, Pennings & Grossman 2008, Terpstra 2011). This suggests that those who seek more information from reliable sources and have good relationships within the community would be better informed about the situation and thus more likely to make the necessary preparations.

Perceptions of threat and behavioural intentions are also influenced by evaluations of past experiences. Prior experience with a severe weather event can influence the way a threat is perceived (Pennings & Grossman 2008, Usher *et al.* 2013). As individuals experience the world around them differently (Paton, McClure & Burgelt 2006), experiencing a previous natural disaster or extreme weather event may influence their perception of a future threat. However, researchers are divided on this issue with some supporting the premise that prior experience lowers preparedness (Briere & Elliott 2000) while others suggest that experience is beneficial in increasing preparedness (Sattler, Kaiser & Hillner 2000, Bonanno *et al.* 2007). Yet much of this literature has investigated


The main street of Ingham during the 2009 floods.

populations in which the event occurs relatively infrequently (Suls *et al.* 2013, Watanabe *et al.* 2004, Bonanno *et al.* 2007). As such, the role of experience in increasing preparedness remains unclear.

Yet, recent research suggests that the role of threat perception and past experience may play a lesser role in preparedness behaviour than previously expected. Specifically, recent research suggests that individual coping appraisal plays a bigger role in adaptive outcomes (Poussin, Bolzen & Aerts 2014). 'Self-efficacy' is the belief that one has the ability and capacity to perform the behaviours necessary to produce a desired outcome (Witte 1992, Bandura 1998). As such, once an individual has actually perceived a threat, high levels of self-efficacy can allow the individual to start making the necessary preparations.

The aim of this study was to investigate the preparatory behaviours of a cyclone- and flood-prone community when an event threat was not present. Given the likelihood of increases in frequency or severity of cyclone and flood events (Middelmann 2007), it is important to understand the level of preparation currently undertaken and how this can be improved. This study seeks to clarify the role of threat appraisal, coping appraisal, experience and social factors in determining the level of individual preparedness in flood and cyclone vulnerable communities.

## Method

### Participants

The rural north Queensland community of the Hinchinbrook Shire has a population of approximately 11 700 people (Australian Bureau of Statistics 2015) and was chosen as the target population due to the high frequency exposure to cyclones and floods (Australian Bureau of Meteorology 2011b, Australian Bureau of Meteorology 2011a). Residents were recruited through convenience sampling and at community events and forums to participate in the project. This included markets, meetings, and disaster-preparedness events. The project was advertised in the local paper and the local council website added a link to the online version of the survey. A total of 275 (103 males, 169 females, three not identified) participants completed the questionnaire. The average age of participants was 55.55 years (SD = 17.51, range = 18-89). Participants had been residents of the Shire for an average of 35.55 years (SD = 23.12, range = .25-81). Of the participants, 77 per cent had previously experienced damage to their property as a result of a severe weather event.

### Measures

The questionnaire was available in hard copy and online formats. The questionnaire included demographic items such as age, gender, dependent children, and marital status, in addition to study-specific questions. For example, the type and quantity of preparatory

behaviours that individuals performed before a flood or cyclone was measured using a list of preparatory behaviours (adapted from Sattler, Kaiser & Hillner 2000 and the Queensland Government Disaster Management Preparation Checklist (Queensland Government 2011)). Three frequency scores were calculated from a list of where participants sourced information for an upcoming weather event. These information sources included from others within the community (family and neighbours), from media (television, radio and internet), and from community services personnel (police, SES, area warden and local council). Respondents provided a 'yes' or 'no' if they had experienced property damage as a result of a previous weather event. As the entire community is affected by flooding and cyclones (Australian Bureau of Meteorology 2011a), this was used as a measure of experience.

Perceived susceptibility and severity were measured using single items (see Table 1). Social support was measured through two social support sub-scales from the COPE Inventory (Carver, Scheier & Weintraub 1989). Social connectedness was measured using items from a social capital scale (Onyx & Bullen 2000, Woodhouse 2006). Trust was measured through items adapted from the Organisational Trust Inventory-Short Form (Cummings & Bromiley 1996). The New General Self-Efficacy Scale was used to measure self-efficacy (Chen, Gully & Eden 2001). Further information about each of the scales is detailed in Table 1.

### Procedure

Participants were given an information sheet about the study and a consent form. Participants who completed the paper copy of the questionnaire did so at the site of recruitment. Some participants chose to take the paper copy home and send it to the research supervisor at a later date. Some participants opted to complete the online version of the questionnaire. The questionnaire took approximately 20 minutes to complete and participation was voluntary. This project was approved by the James Cook University ethics committee (H5053).

## Results

Table 2 shows the means and standard deviations for 'susceptibility', 'severity', amount of 'preparatory behaviours' endorsed, amount of 'information' sources sought, 'social support', 'social connectedness', 'trust', and 'self-efficacy'.

The frequencies and percentages of 'preparatory behaviours' that the participants endorsed are presented in Table 3. The majority of respondents endorsed most of the 'preparatory behaviours'. 'Having a torch' was the most frequently endorsed item. Only two of the items were endorsed by less than 50 per cent of the respondents. The least frequently endorsed item was 'sandbagging internal drains'.

**Table 1:** Description of scales used in this research.

| Scale | Survey example items | Number of items | Response format | Cronbach's Alpha |
|---|---|---|---|---|
| **Susceptibility** | *Indicate the likelihood of you experiencing a weather event or warning in the next 12 months.* | 1 | 5-point Likert scale<br>1 = Very unlikely future event occur<br>5 = Very likely future event occur | - |
| **Severity** | *Indicate the likelihood of you receiving property damage as a result of a weather event in the next 12 months.* | 1 | 5-point Likert scale<br>1 = Very unlikely future damage<br>5 = Very likely future damage | - |
| **Social support** | *I try to get emotional support from friends or relatives.* | 8 | 4-point Likert scale<br>1 = I usually don't do this at all<br>4 = I usually do this a lot | >.8 |
| **Social connectedness** | *Do you think that your community feels like home?* | 11 | Yes-no format<br>1 = no, 2 = yes | >.7 |
| **Trust** | *I think most people I talk to tell the truth.* | 9 (3 reverse scored) | 7-point Likert scale<br>1 = strongly disagree<br>7 = strongly agree | >.8 |
| **Self-efficacy** | *I will be able to achieve most of the goals that I have set for myself.* | 8 | 7-point Likert scale<br>1 = strongly disagree<br>7 = strongly agree | >.9 |

**Table 2:** Descriptive statistics of threat, preparatory behaviour, information, social factors and self-efficacy.

| Scale | N | Sample range | Sample Mean (SD) |
|---|---|---|---|
| Susceptibility | 272 | 1-5 | 4.12 (.80) |
| Severity | 269 | 1-5 | 3.22 (.95) |
| Preparatory behaviours | 271 | 5-20 | 16.77 (2.49) |
| Information | 271 | 1-10 | 4.70 (1.96) |
| Social support | 265 | 8-32 | 18.22 (6.34) |
| Social connectedness | 275 | 1-11 | 7.73 (2.42) |
| Trust | 274 | 12-63 | 46.86 (8.25) |
| Self-efficacy | 275 | 8-56 | 45.47 (6.07) |

Pearson correlations were conducted to investigate the relationship between each of the variables that were investigated (Table 4). 'Experience of damage', 'susceptibility', 'information' (people, media, community services), 'social connectedness', and 'self-efficacy' presented significant, but weak, correlations with 'preparatory behaviour'.

A hierarchical multiple regression was performed for 'preparatory behaviour' as the dependent variable with 'experience of damage', 'susceptibility', 'information' (media, community services), 'social connectedness', and 'self-efficacy' entered as independent variables in blocks. Table 5 displays the $R^2$, $R^2$ change, unstandardised regression coefficients (B), and the standardised regression coefficients (β). The final model of predictors explained 19 per cent of the variance in 'preparatory behaviour' with 'susceptibility', 'social connectedness' and 'self-efficacy' being the only significant predictors.

To examine whether 'experience of damage' influenced the determinants of 'preparatory behaviour', another hierarchical multiple regression was performed. 'Preparatory behaviour' was entered as the dependent variable with 'susceptibility', 'information' (media, community services), 'social connectedness', and 'self-efficacy' entered as independent variables in

**Table 3:** Frequencies and percentages of endorsed preparatory behaviours.

| Preparatory Behaviour | Frequency | Percentage |
|---|---|---|
| Sandbag internal drains and toilets to prevent sewage backflow | 47 | 17.1 |
| Evacuation plan | 130 | 47.3 |
| Taped windows with strong tape | 204 | 74.2 |
| The property is checked for corrosion, rotten timber, termite infestations and loose fittings | 216 | 78.5 |
| Emergency kit (may include spare batteries, essential medication, important documents and cash in a sealed bag) | 218 | 79.3 |
| Disconnected all electrical goods | 228 | 82.9 |
| Trees and overhanging branches are trimmed | 229 | 83.3 |
| Generator or fuel for cooking without power | 240 | 87.3 |
| Roof is kept in good condition and checked regularly | 246 | 89.5 |
| Gutters and downpipes are kept clear | 247 | 89.8 |
| Fuel for generator and/or car | 248 | 90.2 |
| Ensure home, contents and car insurance is current and adequate | 249 | 90.5 |
| Portable radio | 251 | 91.3 |
| First aid kit | 255 | 92.7 |
| Identified where and how to turn off the main supply for water, power and gas | 255 | 92.7 |
| Stored enough fresh water for three days | 258 | 93.8 |
| Secured outdoor furniture and garden items | 259 | 94.2 |
| Identified the strongest room in the house | 260 | 94.5 |
| Three days worth of non-perishable food and can opener | 273 | 99.3 |
| Torch | 274 | 99.6 |

**Table 4:** Correlations of individual factors, social factors and preparatory behaviour.

| Factor | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Age | - | | | | | | | | | | | |
| 2. Experience damage | .07 | - | | | | | | | | | | |
| 3. Susceptibility | -.08 | .12* | - | | | | | | | | | |
| 4. Severity | .09 | .27** | .35** | - | | | | | | | | |
| 5. Information People | -.25** | -.04 | .19** | .05 | - | | | | | | | |
| 6. Information Media | -.26** | .05 | .12* | .08 | .21** | - | | | | | | |
| 7. Information Community services | -.00 | -.05 | .12* | .10 | .30** | .21** | - | | | | | |
| 8. Social Support | -.06 | .01 | .04 | .04 | .25** | .07 | .29** | - | | | | |
| 9. Social connectedness | .05 | .04 | .03 | -.06 | .12* | .06 | .20** | .18** | - | | | |
| 10. Trust | .04 | .01 | -.05 | -.15* | .06 | .07 | -.03 | .06 | .27** | - | | |
| 11. Self-efficacy | -.02 | .13* | .07 | .10 | -.04 | .00 | .09 | .10 | .21** | .26** | - | |
| 12. Preparatory behaviour | -.04 | .13* | .18** | .12 | .01 | .15* | .23** | .10 | .27** | .09 | .31** | - |

* Significant at .05 level, ** Significant at .01 level.
Note: Due to missing data, the number of participants in each cell varies from 259 to 275. The significance levels shown take these differences into account.

blocks, with the data split by the 'experience of damage'. Due to insufficient numbers within the 'no' group (n = 61), only the 'yes' group (n=213) regression is discussed. Table 6 displays the $R^2$, $R^2$ change, unstandardised regression coefficients (B), and the standardised regression coefficients (β). For those who had experienced damage, 19 per cent of the variance in 'preparatory behaviour' was explained by the final model of predictors with 'information from the media' being the only non-significant predictor.

## Discussion

This study aimed to identify factors that predict preparatory behaviour of individuals within a cyclone- and flood-prone community. Previous research suggested that an individual's perception of a threat, high levels of self-efficacy and high levels of social connectedness and trust would facilitate preparatory behaviours. The results from this study partially support this. Findings indicated that if individuals *perceived* they were susceptible to a future weather event, felt connected to the community and were confident in their ability to manage challenges, then they were more likely to endorse more preparatory behaviours. However, perceived susceptibility weakly predicted preparatory behaviour in both the general sample as well as those with a prior experience of property damage; with the strongest predictors in both cases being social connectedness and self-efficacy. As such, planning that targets both social connectedness and self-efficacy may be most effective in enhancing preparatory behaviours. This could be achieved through designing campaigns for cyclone- and flood-prone communities that encourage individuals to check on their neighbours or hold community preparation days (e.g. working bees) before weather events. This could help increase individual perception of social connectedness. Furthermore, emphasising the preparatory behaviours that individuals can do themselves and how to do them effectively can help increase individual self-efficacy.

Previous research regarding the importance of experience was conflicting. In this study, prior experience of damage was not found to predict the endorsement of preparatory behaviours. Given that most of the sample reported experience with an event suggests there was not enough variance within the sample to determine the predictive validity of experience with past events. Nonetheless, given that three-quarters of the sample had undertaken 18 of the 20 recommended preparatory actions indicates that communities that experience a high frequency of extreme weather events are likely to engage in a high number of preparatory behaviours. This is also supported by results that indicate the same predictors were present for preparatory behaviours for those who had experienced damage compared with predictors for the total sample.

Interestingly, perceived severity was not correlated with preparatory behaviour. This is in contrast to previous findings where the importance of both perceived susceptibility and perceived severity is noted (Maloney, Lapinski & Witte 2011, Witte 1992). This suggests that within cyclone- and flood-prone communities, the severity of the event may not influence preparatory behaviour. This may be due to the nature of the weather event with similar preparatory behaviours required regardless of the predicted severity of the event. Further, the unpredictability of potential outcomes may mean that individuals feel the need to prepare for the worst probable outcome.

Of the preparatory behaviours, having an evacuation plan and sandbagging internal drains were not endorsed by the majority of participants suggesting they did not perceive them as necessary to perform before a cyclone or flood. The low frequency of engaging in evacuation planning may be due to perceived difficulties in escaping the path of the cyclone or area of flooding, taking into consideration the relative distance of the Hinchinbrook Shire to major urban centres outside of Far North Queensland. Therefore, residents may require more information supporting the need for or importance of these behaviours to reduce adverse outcomes.

## Conclusion

The results of this study suggest that increasing the perception of susceptibility, social connectedness and self-efficacy is one avenue that facilitates an individual's preparation for a severe weather event. Additionally, increasing access to emergency preparedness information from emergency and community services organisations may increase preparation. These suggestions can be easily implemented targeting the factors that facilitate individual preparatory behaviours for future weather events thus increasing the likelihood of positive outcomes. These findings are limited by the sample size and effect sizes. Future research is required that explores the predictive validity of these factors.

**Table 5:** Regression of experience, susceptibility, information, social connectedness and self-efficacy on preparatory behaviour.

| Variables Entered | $R^2$ | $R^2$ Change | B | β |
|---|---|---|---|---|
| 1. Experience damage | .00 | .00 | .39 | .07 |
| 2. Experience damage | .03 | .03** | .26 | .04 |
| Susceptibility | | | .55 | .18** |
| 3. Experience damage | .04 | .01 | .25 | .04 |
| Susceptibility | | | .51 | .17** |
| Information - Media | | | .36 | .11 |
| 4. Experience damage | .07 | .03** | .35 | .06 |
| Susceptibility | | | .46 | .15* |
| Information - Media | | | .26 | .08 |
| Information – Community services | | | .32 | .16** |
| 5. Experience damage | .12 | .05*** | .29 | .05 |
| Susceptibility | | | .46 | .15* |
| Information – Media | | | .26 | .08 |
| Information – Community services | | | .23 | .12* |
| Social Connectedness | | | .23 | .23*** |
| 6. Experience damage | .19 | .07*** | .09 | .02 |
| Susceptibility | | | .43 | .14* |
| Information - Media | | | .31 | .09 |
| Information – Community services | | | .20 | .10 |
| Social connectedness | | | .17 | .17** |
| Self-efficacy | | | .11 | .27*** |

* Significant at .05 level, ** Significant at .01 level, *** Significant at .001 level.

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**Table 6:** Regression of susceptibility, information, social connectedness and self-efficacy on preparatory behaviour of participants with experience of damage.

| Variables Entered | $R^2$ | $R^2$ Change | B | β |
|---|---|---|---|---|
| 1. Susceptibility | .02 | .02* | .49 | .16* |
| 2. Susceptibility | .04 | .02* | .47 | .15* |
| Information - Media | | | .45 | .14* |
| 3. Susceptibility | .08 | .04** | .46 | .15* |
| Information - Media | | | .33 | .11 |
| Information – Community services | | | .39 | .21** |
| 4. Susceptibility | .14 | .06*** | .46 | .15* |
| Information – Media | | | .34 | .11 |
| Information – Community services | | | .31 | .17* |
| Social Connectedness | | | .22 | .23*** |
| 5. Susceptibility | .19 | .05*** | .46 | .15* |
| Information – Media | | | .36 | .11 |
| Information – Community services | | | .25 | .14* |
| Social Connectedness | | | .21 | .22** |
| Self-efficacy | | | .09 | .23*** |

* Significant at .05 level, ** Significant at .01 level, *** Significant at .001 level.

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# Motorist behaviour during the 2015 Shoalhaven floods

**Andrew Gissing, Katharine Haynes, Lucinda Coates, and Chas Keys, Risk Frontiers, examine the effectiveness of warnings and road signage on motorist behaviour.** ®

## ABSTRACT

**People entering floodwaters by vehicle constitutes a major cause of flood fatalities in Australia and globally. Over the 20 years to 2014, 81 people have died attempting to drive through floodwaters. These comprise 43 per cent of all flood fatalities for this period. Despite Australian emergency services agencies mounting behavioural change campaigns and urging people not to enter floodwater, the behaviour persists. This paper draws on fieldwork carried out during flooding in the Shoalhaven region of NSW, Australia, in August 2015 to examine the effectiveness of the current combination of warnings, education and road signage to stop motorists entering floodwater. The fieldwork identified that 84 per cent of drivers at a monitored site, notably males and four-wheel-drive (4WD) vehicles, dismissed road closure signs and drove into floodwater. It is plain that further work is needed to reduce the frequency of motorists entering floodwater. This requires the development of a holistic approach including education, regulation and engineering measures.**

## Background

Australia has a long history of flooding, with many towns, cities, and roads at risk of inundation. Flooding is a result of a variable climate of dry spells and flooding rains. Floods can vary in speed of onset from minutes to weeks. Flooding has also been identified as Australia's second most deadly natural hazard with Australia's extreme heat being the deadliest (Coates *et al.* 2014b). Recent flood events in Australia illustrate the dangers of flooding—in particular, those associated with motorists deliberately entering floodwater (Coates *et al.* 2014a).

Floodwaters can submerge vehicles, or sweep them away. As little as 30cm of still floodwater is sufficient to float a small passenger vehicle, and 50cm for a 4WD (Shand *et al.* 2011). Moreover, drivers may be unable to see what lies beneath flood waters. Large sections of roads often deteriorate or wash away. Significant velocities are also associated with flash flooding. Such events are considered more dangerous to motorists and passengers (Terti *et al.* 2015).

People entering floodwaters by vehicle constitutes a major cause of flood fatalities in Australia and globally (Ashley & Ashley 2008, Diakakis & Deligiannakis 2015, FitzGerald *et al.* 2010, Jonkman & Vrijling 2008, Jonkman & Kelman 2005, Sharif *et al.* 2012, Sharif & Chaturvedi 2015, Terti *et al.* 2015, Yale *et al.* 2003). Over the 20 years to 2014, the PerilAUS database, maintained by Risk Frontiers, shows that 81 people have died in Australia attempting to drive through floodwaters. These comprise 43 per cent of all flood fatalities over this period. The data shows that 35 per cent of these people were driving 4WDs (Gissing *et al.* 2015). In a similar study by FitzGerald and colleagues (2010), 48.5 per cent of flood deaths in Australia were found to be vehicle-related.

Not surprisingly, a large percentage of flood rescues performed by emergency services agencies are also of people from vehicles. Haynes and co-authors (2009) analysed flood rescues performed during the Hunter Valley floods of June 2007 and found that 36 per cent of rescues had been from vehicles. These rescues inherently put emergency services personnel at high risk.

## Why drivers enter floodwaters

In the United States, Ashley and Ashley (2008) found that 63 per cent of fatalities during a flood occurred in vehicles. Similarly Špitalar and co-authors (2014) found that 68 per cent of flash flood fatalities were vehicle-related. Jonkman and Vrijling (2008), in a review of flood deaths across Europe and the United States, identified that 32 per cent of deaths were associated with vehicles; the most significant of all flood fatality causes. In Greece, vehicle-related deaths were identified as the most common cause, constituting approximately 40 per cent of all flood fatalities (Diakakis & Deligiannakis 2015).

International research indicates that motorists drown through a variety of ways:

- while in their vehicle as a result of the vehicle being submerged or swept away (Drobot, Benight & Gruntfest 2007, Kellar & Schmidlin 2012, Yale *et al.* 2003)
- while attempting to escape a vehicle by trying to swim or walk to safety (Drobot, Benight & Gruntfest 2007, Kellar & Schmidlin 2012, Yale *et al.* 2003)
- by being ejected from a vehicle (Kellar & Schmidlin 2012).

Vehicles can be deliberately driven into floodwaters, can enter floodwater unexpectedly (Yale *et al.* 2003), or be parked and suddenly surrounded by floodwater (Diakakis & Deligiannakis 2013). However, motorists often deliberately enter floodwaters to reach a destination (Coates 1999, Diakakis & Deligiannakis 2013), to rescue someone, to recover something (Diakakis & Deligiannakis 2013), or to evacuate (Becker, McClure & Davis 2011).

Explanations for motorists deliberately entering floodwaters include people:

- not taking warnings seriously (Drobot, Benight & Gruntfest 2007)
- not understanding the dangers (Drobot, Benight & Gruntfest 2007)
- underestimating the risk (Diakakis & Deligiannakis 2013, Maples & Tiefenbacher 2009)
- being impatient and thinking that they are invincible (Franklin *et al.* 2014).

Motorists may develop a false sense of security from being inside a vehicle (Jonkman & Kelman 2005, Diakakis & Deligiannakis 2013, Maples & Tiefenbacher 2009). It is also possible that motorists may struggle to appreciate flood conditions, such as the depth and speed of floodwaters and the influence such conditions may have on vehicle stability (Yale *et al.* 2003, Diakakis & Deligiannakis 2013). It is also suggested that drivers may recognise the risk but fail to personalise it, believing that the risk does not apply to themselves, therefore demonstrating 'optimism bias' (Pearson & Hamilton 2014).

Ruin, Gaillard and Lutoff (2007) concluded that drivers with the longest routes to travel and those with no prior flash flood experience were most likely to underestimate the level of risk associated with entering floodwater in a vehicle. However, previous flood experience has also been associated with a greater likelihood of drivers entering floodwater (Pearson & Hamilton 2014).

The time of day has been identified as a possible contributor to this risk-taking. Analysis of vehicle-related fatalities in Greece and the United States show that most fatalities occurred at night (Diakakis & Deligiannakis 2013, Špitalar *et al.* 2014, Maples & Tiefenbacher 2009) when motorists were unable to see flooded roadways. They may therefore enter floodwater by accident (Špitalar *et al.* 2014) or are unable to judge the depth and speed of water due to poor visibility (Maples & Tiefenbacher 2009). Alcohol and drugs may also have an influence (Jonkman & Kelman 2005), as well as social pressures caused by passengers within the vehicle (Pearson & Hamilton 2014).

## Drivers at high risk

Analysis of demographic trends relating to fatalities in the United States reveals that the majority of motorist flood deaths are by people aged 20 to 69 years (Kellar & Schmidlin 2012), while Diakakis and Deligiannakis (2013), in their analysis of data from Greece, found most victims were aged 40 to 69 years. However, Drobot, Benight & Gruntfest (2007) found that younger drivers (18-35 years) were more likely to indicate that they would be willing to drive into floodwater.

Males are overrepresented in motorist flood death statistics (Diakakis & Deligiannakis 2013, Kellar & Schmidlin 2012, Jonkman & Kelman 2005, Drobot, Benight & Gruntfest 2007, Sharif *et al.* 2012, Maples & Tiefenbacher 2009). Franklin and colleagues (2014) found that more males enter floodwater in vehicles than females. This higher rate of male deaths has been attributed to the risk-taking behaviour of males generally (Jonkman & Kelman 2005).

Vehicle-related flood deaths are avoidable. Despite Australian emergency services agencies mounting campaigns such as the FloodSafe program[1] and urging people not to enter floodwater, the behaviour persists. There is scant research into the influence of road signage and barricades on driver behaviour, despite some research recommending steps be taken to improve road signage (Diakakis & Deligiannakis 2013). Fieldwork conducted during this study helps identify the effectiveness of road closure barricades in influencing motorist's behaviour and provides insights into the effectiveness of community engagement campaigns and flood warnings.

## Study and methodology

Flooding around the Shoalhaven River, NSW, on 26 August 2015, provided the opportunity to observe the decision-making of motorists posed with the choice of whether or not to enter floodwaters. In the months and years before the flooding, the NSW State Emergency Service had undertaken community engagement programs with the key message to motorists not to enter floodwaters. During the flood, warning messages were released via broadcast media, websites and social media with messaging not to enter floodwaters. Road closure barricades were erected near flooded road sections to close roads and to dissuade motorists from travelling along them.

The research team were located near a 'road closed' sign that blocked passage along a flooded road north of

1 SES FloodSafe. At www.floodsafe.com.au.


Researchers used an observation place near a 'road closed' sign in the town.


The research location included a local road closed by floodwaters. There were no depth markers or side railings along the section of flooded road.

the township of Nowra. The road is typically used as a back road by local traffic between the major highway and an industrial estate. The road was closed in both directions, but road-closed barricades were erected on one side of the road only, allowing access along the opposite side. The floodwater depths over the road were estimated to range from 10 to 30cm over approximately 50 metres with water flowing slowly. An alternate flood-free route was available for motorists to use, though it is not known if motorists were aware of its existence.

Over the course of nearly two hours during afternoon daylight hours, decision-making of drivers was recorded according to the number of vehicles entering floodwater, the type of vehicle, and the gender of the driver. More general observations were also made about the behaviour of motorists, the number of passengers in vehicles and an estimate of the age of drivers. From the observation site, vehicles were recorded travelling in both directions, but it was not possible to record the gender of the driver in all instances due to tinted vehicle windows, rainy conditions, and the speed at which vehicles passed. Vehicle types recorded were based on observations of the size and shape of the vehicles observed rather than a typology of vehicle manufacturers and models.

## Results

Observations were recorded of 154 motorists in total. Of these, 84 per cent of drivers chose to ignore road closure signs and drove through the floodwater. Some motorists were influenced by the behaviour of other drivers, only proceeding through the floodwater after another vehicle had already entered. Similar behaviour was observed in respect to motorists turning around, with other motorists turning back after the initial driver had done so.

The types of vehicles driven through the floodwater varied in size and type as shown in Figure 1, though 4WDs and SUVs were the most frequent (48 per cent). Of those vehicles that turned around, two-wheel-drive utilities and sedans and station wagons were the most frequent vehicle types, as shown in Figure 2.

The vast majority of drivers who drove into the floodwater where gender could be determined were male. Figure 3 shows the breakdown by gender.

The age of the drivers varied significantly. All age groups were observed entering floodwater. The number of passengers in the vehicle also varied from zero to a school bus full of children. Vehicles from some local and government agencies were also driven through the floodwater, as well as two P-plate and one L-plate restricted license drivers. A few drivers also drove through the floodwater, simply to turn around and drive back through the floodwater again.

## Discussion

This research shows that, on the whole, motorists ignored road-closed signage. It suggests that motorists:

- ignore both warnings and community education messages not to enter floodwater
- are not receiving, or are not complying with, messages to not enter floodwaters
- may have previous experience of flooding on this specific road and that experience gives them confidence to proceed.

Further work is clearly needed to reduce the frequency of motorists entering floodwater and requires the development of a holistic approach comprising of a continuum of measures including education, regulation and engineering measures (Gissing *et al.* 2015).

**Figure 1:** Numbers of vehicles entering floodwater by vehicle type.

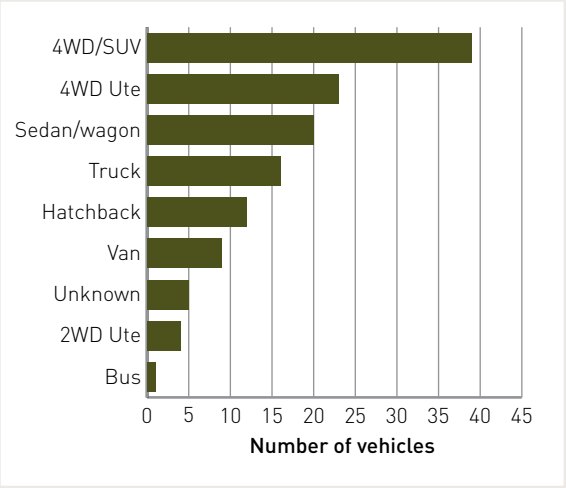
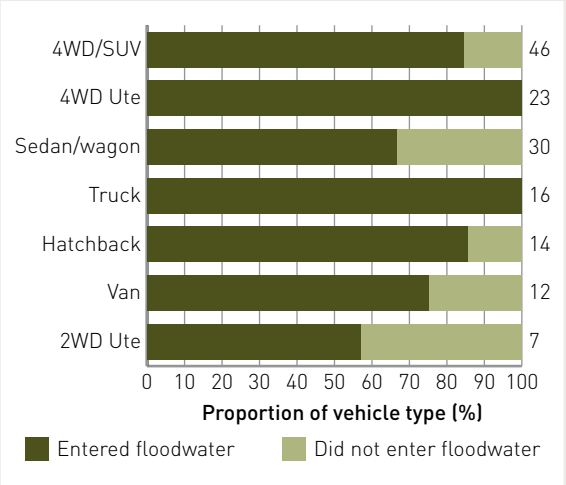
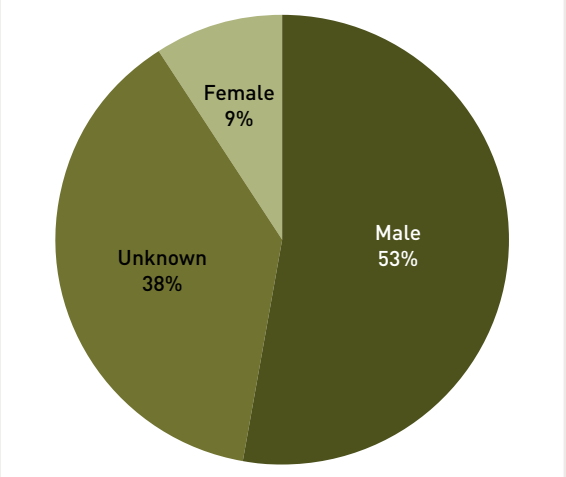



**Figure 2:** Proportion of vehicles entering floodwater by vehicle type.




Notes:
1. Numbers at right describe the number of vehicles in each category
2. 1 bus and 5 unknown vehicles are not shown

**Figure 3:** Percentage of drivers who drove into floodwater by gender.




This research highlights the limitations of 'road closed' signage to influence driver behaviour. In this example, the use of a single lane barricade was clearly ineffective. The erection of barricades aims to dissuade motorists from entering floodwater. Due to the portable nature of barricades, motorists are able to move them or possibly drive around them. Flooding may also occur before authorities can establish barriers. In this case study the effectiveness in dissuading motorists to proceed past the closure could have been higher if barricades blocked access across the full width of the road, or if the barricades had been manned by emergency services personnel. The ability to deploy barricades is also dependent on the availability of sufficient flood warning time, the number of signs available, and the human resources to do so.

Similar research in the context of warning signage at railway crossings has revealed that passive warning signs have low rates of compliance. Motorists continue to cross railway lines. Higher rates of compliance resulting in motorists stopping are achieved by more active systems involving flashing lights and boom gates (Tey, Ferreira & Wallace 2011). Further research could examine how signage and barricades could be improved to assist in modifying motorist behaviours.

This fieldwork also suggests the limited reach and effectiveness of community education and warning messages not to enter floodwater that have been the primary approach used by emergency services organisations. The 'Turn Around Don't Drown' campaign[2] has run in the United States for some ten years and is internationally recognised. However, evaluation of campaigns has been limited. To be successful the campaigns must use messages and communication channels that target risk groups (in particular males) and involve multiple partner agencies, not just the emergency services. Partner agencies include road safety groups, peak motorist groups, water safety bodies, insurance companies and schools. Perhaps car manufacturers could be dissuaded from showing advertising imagery that may encourage drivers to enter floodwater (Gissing 2015).

Several emergency service vehicles entered the floodwater without any observed emergency reason and without sirens or warning beacons activated. Work is also needed to educate workers from government agencies about the importance of not driving through floodwater. A discussion with a National Roads and Motorists' Association (NRMA) roadside assistance driver about driver decision-making was held during the field work. The driver had turned around and taken the alternative route. The driver said that the NRMA was a peak motoring body that advocated safety and that driving through floodwater would send the wrong message to other motorists. As the research indicated, motorist behaviour – whether to enter floodwater or to avoid it – is influenced by viewing other motorist actions.

2 National Weather Service, 'Turn around don't drown'. At: www.nws.noaa.gov/os/water/tadd.


US National Weather Service 'Turn around don't drown' road sign.


The Queensland Government's 'If it's flooded, forget it' campaign logo.

Regulation is frequently used to change behaviour. Examples include enforcing speed limits and eliminating smoking from many public spaces. Regulation, however, has historically not been widely effective across all Australian jurisdictions to stop motorists entering floodwater, possibly due to enforcement resource limitations. Queensland Police have used the enforcement of driving laws during floods and drivers have been convicted of careless driving, resulting in fines, license disqualification, and custodial sentences. Motorists who remove temporary barriers to allow their vehicle to pass could also be prosecuted. In removing the barriers they 'open' the road to other vehicles and encourage risk-taking actions.

Road closure information could be streamed to vehicle-based GPS systems that may enhance driver awareness of local flood hazards and allow for alternate route planning to occur. Likewise, improved flash flood warning systems may allow for the closure of some roads before flooding occurs. Though enhancing safety this measure may, however, be criticised for causing unnecessary disruption if flooding does not eventuate.

## Conclusion

A challenge for policy makers in developing a holistic approach is the lack of evidence regarding the effectiveness of road closure interventions. Evaluation of existing activities is critical to assess the current influence on actual behaviour. Research is required to understand driver behaviour and to test and evaluate the effectiveness of new measures.

This study was limited to observing motorists decision-making in relation to relatively shallow and slow-moving floodwater. Further observational research would be beneficial to contribute to the findings of this paper and to inform the design of interventions, specifically to better understand demographics and the influence of vehicle passengers. To really understand the factors behind motorists' decisions to enter floodwater it would be of benefit to interview motorists directly after they have driven through floodwater.

Motorists entering floodwater is a significant contributor to total deaths during a flood. The issue should not be regarded just as an emergency management problem but one also related to road safety and drowning prevention. Current measures being used have not proven successful in dissuading motorists from entering floodwater. Implementation of an holistic, national approach to reduce incidents of motorists entering floodwaters is needed.

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## Turn Around Don't Drown: U.S. National Weather Service

See this video at www.youtube.com/watch?v=el6mIlHKrVY.

Just 15cm of fast-moving water can knock over an adult and 30 cm of water can float a small car. Fast flowing water can carry vehicles away.

These are the messages illustrated in a simple reconstruction video by the U.S. National Weather Service.

Flooding is one of the leading causes of weather related fatalities and most deaths occur in motor vehicles when people attempt to drive through flooded roadways. This is because people underestimate the force and power of water, especially when it is moving.

It is difficult to tell the exact depth of water covering a roadway or the condition of the road below the water.

***It is never safe to drive or walk through flood waters.***

# New generation flood forecasting and decision support system for emergency management

Dr Hamid Mirfenderesk, Don Carroll, Elton Chong, Ali Jafari, Nafis Hossain, Ryan van Doorn and Scott Vis, Gold Coast City Council, explain decision support systems and detail such a system being used by Gold Coast City Council for flood emergencies. ®

## ABSTRACT

**The evolution of decision support systems (DSS) has generally been in pace with the advancement of computing and communication technologies. More recently, there has been an enormous enhancement of computing power and internet bandwidth, coinciding with a proliferation of web-based technologies. This has opened up new opportunities in terms of using complex modelling for flood forecasting and communicating the projections. However, a literature review shows that many of the contemporary DSS in the field of flood emergency management employ surrogate or simplified flood modelling systems. The reason is that undertaking complex flood simulation models has been considered as infeasible in the short time available during a flood emergency. This paper challenges that paradigm. The desire for this paradigm shift is underpinned by the recent advent of Graphic Processing Unit (GPU) flood modelling systems and sophisticated web-based GIS systems that can better present the results of these models. Furthermore, it is proposed that there should be a move away from model-based systems to open systems that can house modelling engines and communicate the outputs effectively for decision-makers. This approach promotes user-focused communities that can cross agency and proprietary lines and reduce costs and promote the maintenance of developed systems. Emergency management decision-making is usually threshold based, and accordingly, outputs should be produced that facilitate this type of decision-making. This paper describes the framework and the working prototype of a flood emergency decision support system (as a proof of concept) that is in operation and supports tactical and strategic decision-making during flooding on the Gold Coast.**

## Introduction

Flood risk exists when all the components of risk, i.e. hazard, vulnerability and exposure overlap. Best practice flood risk management manages this risk through mitigating all three components of risk (Mirfenderesk, Corkhill & Lawler 2011). Hazard can be lessened through building flood mitigation infrastructure and through flood sensitive catchment management (e.g. minimising the disruption to natural surface and groundwater runoff systems). Exposure can be reduced through appropriate land-use planning and setting flood planning levels above defined flood levels. However, there is a limit to the extent that hazard and exposure can be mitigated. A flood that overwhelms all the protective measures and inundates cities is always possible. This is called residual risk and is managed through emergency management and has a symbiotic relationship with floodplain management.

Residual risk can be addressed partly through reducing a community's vulnerability to flooding. A good flood warning system and flood emergency management operations are essential to the reduction of residual flood risk. Such measures warn people of an impending threat and assist them to protect life and minimise flood damage. Emergency management is a complicated task and requires solving a multitude of non-structured, semi-structured and ill-structured problems in a very short period of time. These problems include but are not limited to, regular forecasts of the flood situation, detection of at-risk people and assets, assessment of available response time and identification of aid delivery mechanisms. Finding instant solutions to these issues requires processing a huge amount of data in a short period of time, necessitating the use of an effective and robust decision support system.

## Contribution to the body of knowledge in an historical context

Flood emergency decision support systems have been used by flood emergency managers for decades. In the 1980s and 1990s these systems were usually data-driven and in the form of hard copy flood maps, graphs, tables and other documents. Advances in computer technology since the 1990s have enabled developers to enhance the capabilities of these systems by

incorporating computer flood models in the DDS. Due to limited computer speed at the time, these models were limited to point forecasting, based on lumped hydrological modelling (Caddis *et al.* 2015, Moffett *et al.* 2015, Smythe, Newell & Druery 2015). This means that model forecasts were limited to the prediction of water levels at a few critical locations in a catchment. A more effective flood emergency management system is better served by surface forecasting, i.e. predictions of water level, flow velocity, and time history of variations of these parameters at every location of risk within a catchment. Point forecast shortcomings have been addressed partly through interpolation of point forecasts and using 'precooked' and historical flood maps as a surrogate for surface forecasting. This approach has a number of limitations. It lacks accuracy, is limited to maximum flood surface, and lacks any information about the timeline of flooding and its temporal and spatial evolution throughout the flood event.

Computer technology advancement and the development of GPUs (primarily used for fast-moving computer games) are now used to solve the governing differential equations of flood flow. This has significantly reduced solution computations times, thereby providing a unique opportunity for the developers of DSS to incorporate fully dynamic surface forecasting capacity into contemporary systems. A review of literature shows this capacity has not as yet been fully integrated into flood emergency DSS.

One of the contributions of this study to the body of knowledge is to demonstrate applicability of GPU computing technology in flood emergency DSS development. This study describes the development of a new generation flood emergency DSS for the Gold Coast that is capable of model-based surface forecasting. This system provides emergency managers with model-based surface forecasts and flood evolution timelines at every at-risk location within a catchment. This is a capability that DSS developers could only dream of a few years ago.

In terms of communication, flood emergency decision support systems have undergone substantial changes in years. This has been due to the advances in communication technology. A proliferation of web-based applications coinciding with the availability of ever-increasing Internet bandwidth has enabled DSS developers to communicate the outputs of DSS more effectively and to a increasing number of audiences (Smyth, Newell & Druery 2015, Hart, Milligan & Reichard 2015, Powter, Rose & Gray 2015, Caddis *et al.* 2015, Moffett *et al.* 2015, Salter *et al.* 2015, Druery & McConnell 2015, Mifenderesk 2009, Mirfenderesk & Cox 2010). The majority of the contemporary flood emergency DSS employs proprietary web page applications to provide flood forecasts via mobile devices. It can be said that current DSSs are in step with technology. The contribution of the proposed system to the body of knowledge is that it demonstrates that the communication element of a DSS can be built based on open source web applications. This makes the development, operation and maintenance of DSS more affordable and accessible.

## Features of a flood emergency decision support system, capable of answering decision-maker questions

Research of literature shows that there is little consensus regarding the definition of a decision support system (Sauter 1997, Parker & Al-Utabi 1986, Simonovic & Savic 1989, Thierauf 1988, Guariso & Werthner 1989). In the context of this paper, a DSS is defined as 'an interactive computer-based system that helps emergency managers in tactical and strategic decision-making during a flood emergency'. It helps decision-makers use data and predictive models to identify problems and identify steps in decision-making to solve a wide range of emerging problems (unstructured, semi-structured, ill-structured and structured) that they may confront during a flood emergency.

The development of a DSS starts with understanding the needs of the people who are going to use the system and working backwards, ensuring that these needs are met. To do this the elements of an ideal DSS are its:

- ability to generate timely warnings
- comprehensiveness
- accuracy
- speed
- flexibility
- ease of construction, operation and maintenance
- accessibility and the effectiveness of system communication to a wide range of audiences.

### Ability to generate a timely warning

A warning should be timely and issued only when an action is required. The scope of warning should be limited to the area of interest. Regular status reports of the weather or river conditions over a large area that requires no action can cause fatigue in emergency managers. The language used for warnings should be easy to understand.

### Comprehensiveness

The information should be complete. Complete information must answer three fundamental questions, i.e. who needs help, how much time is there, and how the help can be provided. This requires identifying:

- the assets that will be inundated
- the level of inundation
- the timeline of inundation
- the connecting roads to the vulnerable asset
- the timing of any road cut offs
- the location of high velocity flows.

In effect water level hydrography at the location of any vulnerable asset and all roads connecting to vulnerable assets needs to be forecast.

### Accuracy

It is important to convey accurate information to emergency managers and to the community. An underestimation of a threat can result in damage and possibly loss of life. Overestimation of a threat gradually erodes community confidence and causes public complaint regarding the adverse effect of inaccurate information on their property values.

### Speed

Emergency management is a time critical exercise and the speed of information flow can make or break an operation. A DSS needs to be flexible and respond quickly to any type of question. There is always a trade-off between speed, accuracy and comprehensiveness of information.

### Flexibility

Flexibility allows decision-makers to map alternative scenarios so as to answer 'what if' queries. Decision-makers should be guided by most optimistic, most pessimistic and in-between scenarios through using the results of these 'what if' exercises.

### Ease of construction, operation and maintenance

Local authorities are responsible for assessing the impact of natural hazards on their communities, and, as such, they are the main users of flood emergency decision support systems. Local governments generally have limited resources and may not be equipped adequately to deal with complex systems. Such systems will generate high overheads for their maintenance and operation and usually become too costly for a typical local authority. Thus there is a need for open and shared systems integrated with local corporate systems to promote ease of maintenance and corporate 'buy in'.

### Effectiveness of user interface

A DSS should provide a user interface that allows the user to interact with the system and allow for the incorporation of the subjective assessments of system operators and users. Such an environment allows the user to obtain answers to 'what if' scenarios.

## Gold Coast City Council Flood Emergency Decision Support System

The Gold Coast City Council uses a fully automated flood emergency DSS in four tiers. Each tier of operation is triggered by the previous tier and the comprehensiveness of the output information increases progressively with each tier. The system has two modes of forecasts, namely data-driven and model-driven modes. A communication-driven module facilitates communication of information between the system and its users. The data-driven module is operated in Tier 1, the model-driven module is operated in tiers 2 and 3. Tier 2 provides point forecasts and Tier 3 provides surface forecasts. The communication-driven module is operated in Tier 4. A schematic of the proposed DSS is shown in Figure 1.

The tiered and modular nature of the proposed DSS helps better use of resources during a flood event and minimises fatigue during a lengthy flood emergency. Every tier deals with a certain degree of risk and mobilises resources in proportion to the risk.

1. **Tier one – rainfall analysis (warning module).** This is a data-driven module that has the capacity for data warehousing, data processing and information analysis. The information generated at this tier answers the question 'should the Disaster Coordination Centre be mobilised'. This information is generated automatically in a fraction of a second. This module automatically interrogates more than 80 ALERT rain gauges across the city. It then undertakes a frequency analysis of the measured data and compares it to historical statistical data by using Intensity-Frequency-Duration (IFD) curves for each gauge location. These curves can be downloaded from the Bureau of Meteorology for any location. In parallel the system downloads rainfall forecasts from the Bureau of Meteorology web page and generates catchment-based IFD curves for each catchment of the city. The system analyses both sets of IFD curves. Once the measured and predicted rainfalls cross certain exceedence thresholds, the system automatically sends warning messages to emergency managers. The frequency of this exercise can be set at any rate, depending on the situation. For the Gold Coast City Council this is done hourly. Figure 2 shows one of the typical graphic outputs of this module.
2. **Tier two – point forecasting module**. This module is model-driven and has an emphasis on access to and operation of hydrological models and analysis of their outputs. This module is triggered once Tier 1 issues a flood warning. The information generated in this tier answers the question 'are

**Figure 2:** A typical catchment wide IFD curve and IFD analysis based on predicted rainfall.

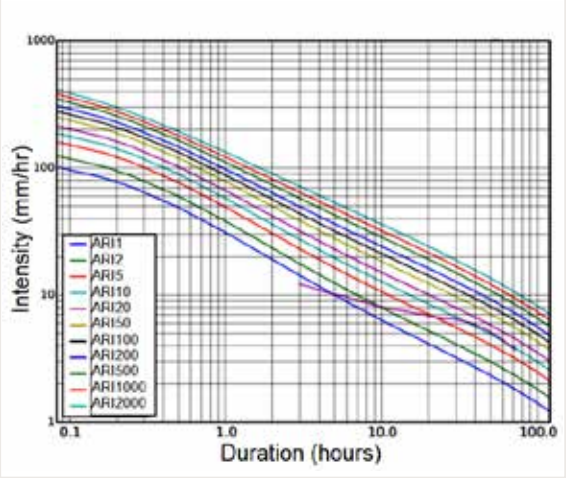
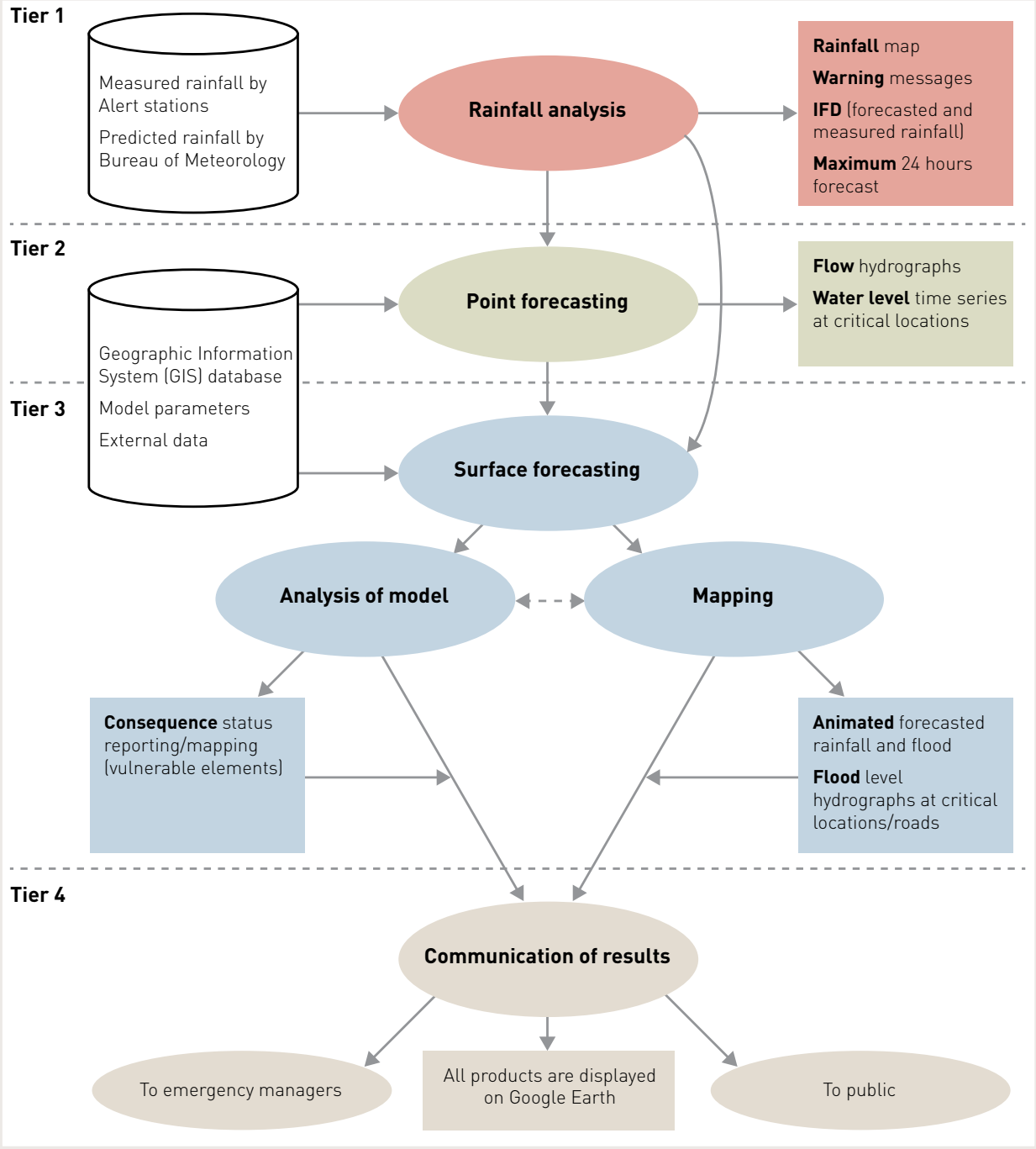


**Figure 1:** Decision support system structure.

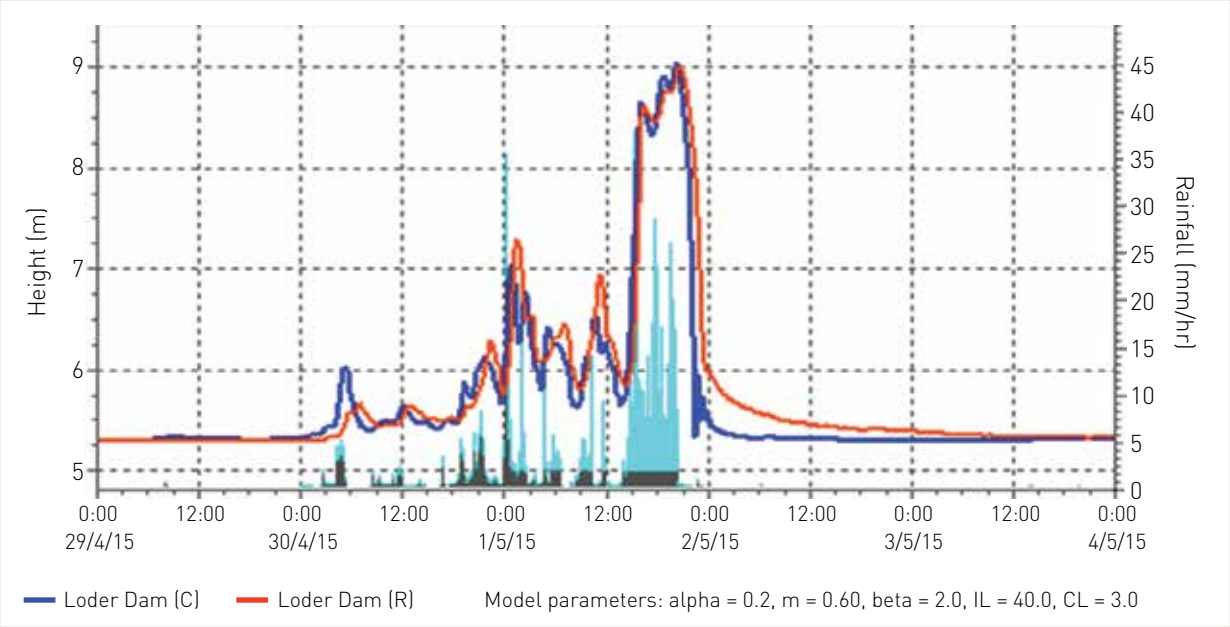



the consequences of an impending flood high enough, requiring actions such as evacuation'. Information at the second level is generated in less than a minute. This module comprises of two main elements:

a) A fully automated process administrator (control centre), comprising of a suite of computer programs. This sub-module is data-driven and has two roles.
   - To provide an effective user interface to test 'what if' scenarios.
   - To control the flow of data into, out of and through the system (between modules). For instance, it imports the real-time rainfall and water level gauge data and prepares them for use as input to hydrological and if necessary hydro-dynamic modelling (Tier 3).

b) An integrated hydrological model. This component is model-driven and generates two main outputs.
   - Point water level forecasts at critical control points generally in the upper reaches of the catchments such as dam walls. This output provides decision-makers with a quick assessment of the city's dam storage

**Figure 3:** Predicted water level at Loder Dam based on recorded rain.




capacity to absorb the flood and if not, potential downstream impacts.

- Point forecasts of flood flows at input points for incorporation into hydro-dynamic models of the city's floodplains.

Figure 3 shows a typical output from this tier. The graph shows the recorded and predicted flood profile at a large detention basin based on the recorded rainfall (shown as light blue bars). The proposed DSS produces graphs similar to Figure 3 at all critical locations across the city in a matter of minutes and sends them automatically via email to decision-makers.

3. **Tier three - surface forecasting module.** This is a model-driven module responsible for the generation of comprehensive information regarding the consequences of an impending flood. This module provides emergency managers with all the information they need for informed decision-making and actions, such as rescue and evacuation operations. This module is comprised of two main components.
   a) A suite of detailevd two-dimensional hydro-dynamic models for all the city's catchments. The models are informed both by the inflow from hydrological models and rain on the urbanised section of the catchment. The models are two-dimensional and have very short run times, depending on the location and prevailing flooding conditions.
   b) A suite of computer programs operating within the Council's ICT systems for the analysis of the output of these models. This module provides the following information:
      - flood extent and flood depth information across the city
      - evolution of the flood surface over time across the city.

Figures 4 to 7 show a hypothetical flood. Figure 4 shows a snapshot of the surface inundation animation that is generated in Tier 3. Figure 5 shows how information on inundated houses is displayed by the system. Figure 6 shows how the system generates a global picture of inundated roads. Every colour is associated with a level of inundation. Figure 7 shows how by clicking on any point of interest a time series of water level variation will pop-up on the window. It shows when water depth on a road passes 30cm and 60cm thresholds and shows when roads will be open again.

This module enables the system to be used in post-disaster recovery, as it generates the timeline of rising and falling flood levels based on two-dimensional hydro-dynamic model results. This information allows decision-makers to prioritise recovery and clean-up programs.

4. **Tier four - communication module.** This module is communication-driven and is designed to facilitate decentralised group decision-making. Decision-making is based on a set of comprehensive and easy-to-understand flooding and flood consequence information that is accessed via the Internet. The system allows for the exchange of information through a number of freely available web-based applications such as Google Earth and Google Maps via KML/Z files. These files can be easily emailed and once an email is received by decision-makers, a graphic display of information (KML/Z file) can be displayed using Google Earth. The display includes the following graphic materials:
   a) a map animation of both measured and forecast rainfall across the city

b) a map animation of the potential flood evolution across the city

c) a map identifying all the affected properties and vulnerable assets such as childcare centres, age care centres, schools and healthcare centres. Clicking on the identified affected assets, more detailed information such as depth of inundation and contact details will be displayed on the screen

d) a colour-coded map showing all inundated roads and the level of inundation

e) a map displaying the flood level hydrograph at critical locations. By clicking on the desired location the flood level hydrograph is displayed. This map shows when an access road to a specific vulnerable asset is cut off and for how long.

**Figure 4:** Snapshot of inundation animation.

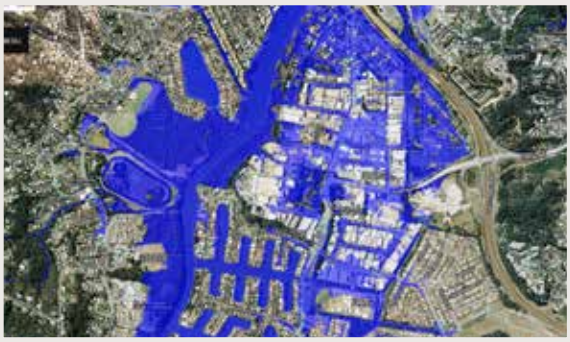
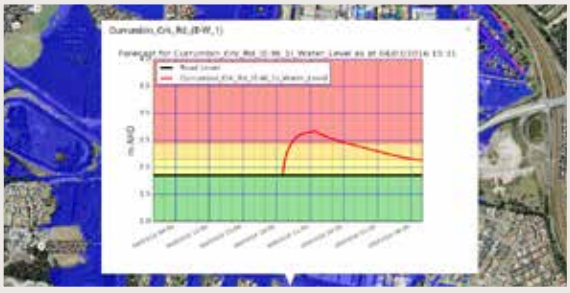


**Figure 5:** Inundated houses during a hypothetical flood.

**Figure 6:** Colour-coded inundated roads during a hypothetical flood.

**Figure 7:** Time history of flood level variation on a road.



## Discussion

This paper describes the framework and working prototype of a flood emergency decision support system (as a proof of concept) that is currently in operation and supports both tactical and strategic decision-making during a flood emergency on the Gold Coast. The study demonstrates that computing technology and Internet bandwidth has reached a level where generating comprehensive model-based surface forecasts and communicating this information quickly is now possible. The paper describes the criteria for an ideal DSS for real-time flood emergency management and demonstrates how the Gold Coast City Council's DSS meets these criteria.

The system's warning module (Tier 1) automatically undertakes an analysis of rainfall across the city and provides an assessment of the rainfall exceedence probability for each of the city's catchments. This analysis is then used to estimate hazard levels and provide timely and realistic warnings to decision-makers. Warnings are only issued when prescribed thresholds are exceeded, which reduces fatigue among emergency managers due to routine issue of non-actionable warnings. This complements available warnings by state and federal agencies to the city's Disaster Management Unit, who provide warnings based on point measurements and forecasts at selected locations for major river systems.

The proposed system achieves comprehensiveness and accuracy using surface forecasting of two-dimensional hydro-dynamic modelling. Two-dimensional modelling is the only viable option for achieving spatially-accurate forecasts particularly in tidally influenced floodplains. The outputs of a real-time two-dimensional model contain all the information that an emergency manager may require, in particular the timeline of events, such as when access to a particular vulnerable asset will be cut off and for how long. The accuracy is further enhanced as the system allows real-time calibration of hydrological modelling using observed rainfall.

The proposed system achieves the required speed by using the latest hardware (GPU) and software technology for modelling and analysis of information. The system can produce point forecasts in the matter of minutes and surface forecasts between 10 and 30 minutes, depending on the location and type of required information. These run times will be further reduced in the near future with the ongoing development of this technology.

Ease of construction, operation, maintenance and communication of the proposed system is achieved by leveraging corporate IT maintenance systems, using open source software and maximising the use of existing tools where available.

Flexibility of the system is achieved through an effective user interface. Users can interact with the system and undertake 'what if' scenarios. System output is available to users via the Internet in graphic form and in an easy-to-understand style. The capacity for undertaking 'what if' scenarios also makes the system suitable for emergency planning exercises.

The proposed framework improves contemporary DSS in the field of flood emergency management by inclusion of a model-driven module for real-time two-dimensional simulation of events. This module greatly improves the comprehensiveness and accuracy of the system. The building blocks of the proposed DSS are generally freely available and use software packages available within most local authorities. This makes the construction of such a system within the reach of most like organisations as it reduces operational and maintenance costs and greatly improves cross-organisational and inter-agency collaboration.

Although the system is designed for operation during a flood emergency, it can be used for emergency planning or post-disaster recovery.

The lessons learned through developing the DSS are:

- start with emergency management decision-makers and work backwards
- ensure there is an emergency management operation mode for the whole organisation and that switching to this mode is automatic and seamless. All the security, resourcing and technological issues must have been addressed prior to the emergency and not during an emergency
- a DSS should focus on adaptive decision-making that results in optimum outcomes
- corporatise the DSS as much as practical to leverage existing corporate maintenance and backup procedures.

The next step for the Gold Coast DSS is to integrate the DSS with the local community and industry to maximise the tangible benefits of the system in the day-to-day business of the community. This will also guide future development.

## Acknowledgement

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# Organisational resilience and emergency management

**Dr Bernard Mees, Professor Adela J. McMurray and Professor Prem Chhetri, RMIT University, consider the concept of resilience in volunteer-based emergency services organisations.**


## ABSTRACT

**The concept of resilience figures prominently in discussions of disaster risk reduction, emergency management and community safety. Overwhelmingly, such discussions view resilience as a highly desirable characteristic of communities. Policies and practices of emergency services organisations imply that a major role of such organisations is to promote and foster community resilience. Yet there is little appreciation of the importance of resilience as a necessary characteristic of emergency services organisations. In this paper we argue that emergency services organisations need to address their own resilience issues in order to properly fulfil their community protection responsibilities. The concept of organisational resilience in relation to Australia's volunteer-based emergency services organisations is discussed and the importance of organisational climate and organisational culture in relation to organisational resilience is stressed.**


## Introduction

The concept of resilience or the ability to rebound has become a favoured theme in emergency management in recent years. Emergency management organisations in Australia have embraced the notion of resilience in much of their organisational literature as have the governments that they report to. Yet much of the talk of resilience evident in such literature – and moreover in terms of actual practice – assumes that resilience is something that the emergency management agencies aim to foster in the communities they serve. Little or no focus on the way in that the emergency management organisations may themselves become more resilient is evident in policy or practice in Australian emergency management bodies (e.g., Cole & Buckle 2004).

Achieving organisational resilience, however, is a complex process that centres on the management of physical and human resources, strategy setting, and the assessment of risk. The management of organisational resilience is typically not formally articulated and does not often involve a deliberative or comprehensively planned approach to organisational adaptability, performance and recovery from disruption, crisis or stress. The volunteer-based nature of many of the key state and territory emergency management services in Australia makes the relevant organisations particularly prone to internal risk. The lack of a clear and well-developed commitment to organisational resilience is made all the more striking by the less structured nature of the volunteer-based emergency management organisations in Australia than is common in more fully professionalised sectors.

This paper accordingly draws on different frameworks of organisational theory to establish the variety of ways resilience can be enhanced in emergency services organisations. These frameworks are ways to analyse, critique and propose different ways that resilience can be enhanced. It is argued that an awareness of such frameworks may be significant in assisting emergency management bodies to better manage organisational risks, rather than relying on arbitrary, informal and largely outward-looking approaches to resilience. The focus is on the notion of organisational climate as a key, but often-neglected perspective from which to understand resilience in emergency management organisations.

## Emergency services in Australia

Australian emergency services organisations have developed historically in an *ad hoc* manner. Fire services were professionalised in urban areas in the 19th century, much as were health services. But the rural and regional emergency management organisations have never been thoroughly professionalised and only became subject to formalised organisation following the disastrous Victorian bushfires of 1943-44 (Collins 2009). Other emergency services bodies were established in the 1950s as an extension of wartime homeland defence strategy, with the original Australian Civil Defence Service (modelled on the similarly-named body in the UK) remaining a volunteer-based series of organisations after the various state and territory bodies were renamed State

Emergency Services (SES) in the 1970s. The SES bodies are similar to the rural and regional state and territory fire services in being largely community-based organisations managed by a small body of full-time employees who rely on a much larger number of volunteer staff.

As such, much of the language of 'community' that has grown up about municipal and health services in Australia is more clearly germane to the largely volunteer-staffed bodies that respond to natural hazard events, especially bushfire, storm and flood (Fairbrother *et al.* 2014). With increasing prolonged periods of hot weather and incidence of flood and storm attributed to climate change, the nature of these services has come under increased scrutiny, particularly since the 2009 Black Saturday bushfires in Victoria, which killed 172 residents in rural and peri-urban areas and resulted in the Royal Commission into the bushfires (Teague 2010).

In 2012 the Victorian Government released the *Emergency Management Reform White Paper* that summarised the changes required to emergency management in the wake of the recommendations of the Bushfires Royal Commission (Victorian Government 2012). The Council of Australian Governments (COAG) had also adopted the National Strategy for Disaster Resilience in 2011 (COAG 2011). One of the key themes stressed in the White Paper (unsurprisingly) is resilience. Both the local SES and the Country Fire Authority (CFA) subsequently adopted the theme of resilience quite prominently. The Victorian SES Annual Report for 2012-13 (SES 2013) is entitled 'Building Community Resilience' and the CFA used 'Towards Resilience' as the subtitle of its 2013-18 strategic plan (CFA 2013). Emergency Management Victoria's official 'Shared Vision' for 2015-18 is 'Safer and more resilient communities' (EMV 2015) and similar references to 'resilient communities' have become typical of public policy initiatives in emergency management elsewhere in the country. Yet what resilience might mean for the emergency services organisations is never articulated in this literature. The notion of resilience seems instead to have been appropriated from international disaster management discourse and not fully integrated into established organisational practice.

## Organisational resilience

Vogus and Sutcliffe (2007) define resilience as 'the maintenance of positive adjustment under challenging conditions such that the organization emerges from those conditions strengthened and more resourceful.' And internationally, the concept of resilience has been increasingly adopted in disaster management, particularly in terms of an extension of the notion of sustainability (United Nations 2012). Alexander (2013) explains the adoption of the term in disaster risk reduction literature as a reflection of its employment in ecological science, particularly after the pioneering work of Holling (1973). What is especially lacking in the reports and communications of emergency management agencies in Australia, however, and particularly the volunteer-based organisations such as the state and territory SES and bushfire services, is a focus on making the agencies themselves more resilient. The term 'resilience' is not used other than in terms of community capacity building in publications such as the Victorian SES *Building Community Resilience Annual Report* (SES 2013) or Emergency Management Victoria's four-year strategic plan (EMV 2015). The term is always used in terms of building 'resilient communities' (or 'resilience in communities'), not of the resilience of the organisations themselves. Resilience is also conceptualised primarily in terms of community resilience in much of the research commissioned by organisations such as the Attorney-General's Department and the Bushfire and Natural Hazards CRC. The Australian Emergency Management Institute (AEMI) offered a professional development course on organisational resilience in the for-profit sector, that focused on organisations 'being change-ready, networked and having appropriate leadership and culture' (AEMI 2013). But nothing similar seems to have developed within Emergency Management Victoria or similar bodies where human resource management capacity is typically undeveloped, under-recognised and underfunded. Yet there has long been a disagreement in organisational studies concerning what resilience is and what it should mean in a management context.

The notion of resilience has generally been employed in three different manners in organisational studies. Most broadly, the notion of organisational resilience has typically centred on organisations that experience events comparable to natural disasters (Coutu 2002, Hamel & Valikangas 2003). In this literature, resilience is seen as associated with enabling business continuity in the face of severe economic risk such as that associated with an environmental accident, a major new entrant in a market or the collapse of a significant customer base or supplier (Lengnick-Hall & Beck 2005, Sheffi 2006). Resilience has thus been primarily related to governance, risk management and strategy in the organisational studies literature. This is the manner in which 'resilience' is understood in the *Organisational Resilience Position Paper* (Australian Government 2011) and similar publications such as the *Insider Threat to Business* (Attorney-General's Department 2010).

Yet the notion of resilience has been more recently used in terms of strengthening organisational capabilities at the level of human resource management (Norman, Luthans & Luthans 2005, Lengnick-Hall, Beck & Lengnick-Hall 2010, Nilakant *et al.* 2013). A focus on the resilience of individual members of staff is evident in recent studies (Luthans, Youssef & Avolio 2007), but the notion is typically used in a more broadly predicated manner. A focus on resilience is promoted in this emerging literature as representing a new approach to leadership and organisational performance (Coldwell 2010, Everly, Strouse & Everly 2010). In this way the notion of resilience has come to impinge on approaches to staff recruitment, development and retention, and particularly organisational culture and organisational climate.


Image: Victoria SES

Part of organisational resilience is the leadership qualities of its people.

Under the influence of climate change research, organisational resilience has also been analysed in terms of four key dimensions of:

- capacity and capability
- susceptibility
- adaptability
- organisational culture and climate (Adger *et al.* 2004, Pelling *et al.* 2008).

Figure 1 shows the interrelationships and interdependencies of these dimensions that have been argued in this literature to underpin the nature, scale and characteristics of organisational resilience. From this perspective, the capacity and capability of an organisation is typically expressed in terms of its workforce (i.e. number, quality, skills and experience of employees) and other material, financial and technological resources. But organisations that are reliant on large numbers of volunteers and are directly dependent on volunteer staff to deliver emergency services would be expected to be more susceptible to disruption. The quality or state of being affected, influenced and impacted by internal and external disruptions reflects the level of organisational susceptibility. Adaptation can be characterised as the ability to modify behaviour to cope with current or predicted stressors (Adger *et al.* 2004) and organisational adaptability is related to the institutions and networks that enable the organisation to learn, gain knowledge and experience, and then make adjustments to system perturbations (Pelling *et al.* 2008). Organisational culture and commitment would similarly be expected to add to the ability of an organisation to cope with unexpected demand arising from an unplanned event. Organisational culture and climate would be expected to underpin and influence both the other dimensions to some degree, and they are generally accepted to be strongly influenced by organisational leadership. It is an understanding of the relationship of organisational culture to climate as well as leadership; however that seems most lacking in current emergency services literature.

**Figure 1:** Underlying dimensions of organisational resilience.


## Organisational culture and organisational climate

The notion of organisational culture was first popularised by Schein (1985) and has been widely contested in organisation studies (Morrill 2008). It chiefly concerns the 'basic assumptions about the world and the values that guide life in organizations' (Schneider, Ehrhart & Macey 2013). According to advocates of the notion, the culture of an organisation provides a context for the creation of meaning for its members; its shared assumptions, beliefs and values. Organisational culture is principally informed by firm-specific intangibles such as the philosophy of an organisation's founders, employee socialisation and the espoused values of its management according to key proponents of the notion such as Schein.

The less well known concept of organisational climate, however, stresses more patently measurable perceptions of staff regarding issues such as stress, morale, work/life balance and employee engagement – i.e. the shared perceptions of policies and practices among employees (McMurray 2003). Organisational climate contrasts with organisational culture as it is

chiefly concerned with 'the meanings people attach to interrelated bundles of experiences they have at work' (Schneider, Ehrhart & Macey 2013). Yet the two concepts – culture and climate – are typically considered to be inter-subjective and held to facilitate, or create barriers to, organisational adaptation and change. Hence a focus on both organisational culture and climate should be expected to help managers develop ways to embed resilience in an organisation.

The notion of organisational climate has its intellectual roots in Koffa's (1935) 'behaviour environment' and has proved less controversial than that of organisational culture. The relative congruence of organisational climate with the individual value systems of employees is now often considered a crucial determiner of an organisation's success and has proved a key concern of leadership studies (Altmann 2000). Yet organisational climate is often neglected in the literature on organisational resilience. Whitman and colleagues (2013), for example, omit any mention of organisational climate from their business resilience benchmarking metrics.

Nonetheless the beliefs that inform the value systems embodied in organisational culture and climate act as part of the work integration process that influences an employee's functioning fit (or misfit) in an organisation's behavioural context (Kirsh 2000). The value systems of organisational culture and climate have implications for an employee's organisational commitment, effective functioning and productivity, and hence their personal contribution to an organisation's capacity to engender resilience. To date no 'one-size-fits-all' organisational climate instrument has been developed and tested, although instruments to discern other associated climates such as creativity and change (Isaken & Lauer 2002), and work climate and innovation (Mohyeldin & Suliman 2001) have emerged. Climate has been measured in respect to national cultures and results indicate, for example, that employees from an individualistic culture (such as that in a developed country such as Australia) are more sensitive to organisational climate than their counterparts working in collectivist cultures (Tan *et al.* 2003). These results support the literature's theoretical and empirical consensus that organisational climate is a multi-dimensional and complex psychological phenomenon, and is context specific.

Yet in a world characterised by 'VUCA' factors (volatility, uncertainty, complexity and ambiguity), organisational leadership is typically seen as the key determinant of organisational culture. Organisational climate reflects perceptual agreement about organisational practices embracing organisational structure, management support, reward, risk-taking, participation in decision-making, communication, conflict, a sense of belonging, acceptance of teamwork and organisational image (Arabaci 2010). Shared elements of organisational culture and climate are broadly associated in recent literature with leadership practices. For example, commitment (Gormley & Kennerly 2010), trust (Sani 2012), the human resource aspects of organisational life (McMurray 2003), the predisposition to report bad news and information irregularity (Tan *et al.* 2003), empowerment (Mok & Au-Yeung 2002), the construction of innovation (Dulaimi, Napal & Park 2005) and organisational learning have all been held to be associated with organisational culture and climate. Each of these factors can reasonably be taken to contribute to the relative ability of an organisation to both build resilience in itself as well as to engage in building capacities in the community. Leadership seems essential to managing the kind of organisational climate that would enable the establishment and embedding of resilience into an organisation's culture and, in turn, its work in the community (Choudhury 2011).

## Community and organisation

A key factor of community organisations is their voluntary basis. Volunteers are integral to not-for-profit organisations that are (or are supposed to be) embedded within their communities. Emergency services organisations in Australia are predominantly comprised of volunteers and are tasked with addressing the needs of stakeholders and communities increasingly prone to 'VUCA' factors. Yet levels of engagement among volunteers can vary quite markedly between age groups, localities, services and functions (Victorian Auditor-General's Office 2014).

The Victorian Auditor-General's Report into how the CFA and SES manage their volunteers stressed how *ad hoc* and limited the human resources strategies adopted by the agencies were (Victorian Auditor-General's Office 2014). Poor human resource data management, high rates of churn and declining numbers of volunteers in relation to the overall population have occurred in the face of an increasing number of emergency events and increasing numbers of members of the public calling on emergency services assistance. The focus on community or external resilience has arisen at a time when organisational capacities of the emergency services have been subject to increasing stresses and challenges. A more holistic approach to resilience is required if such organisations are to continue to meet the needs of the communities they serve.

Organisations with an established high level of internal resilience should be better prepared for crises and better equipped to withstand setbacks. They should be expected to have a greater ability to recover from and adapt to adverse impacts and in some instances even come through a crisis in a stronger position than before. In order to encourage resilience in the community, capabilities for resilience must be built up in emergency services organisations. The complex relationships between full-time employees, the various kinds of volunteers and their levels of engagement, and the community more generally can only be enhanced by a focus on how the long-established psychological notions of culture and climate may be employed to strengthen and improve the capacity for resilience of communities and their relevant community organisations. Perceptions and assumptions of staff (both full-time and volunteer) clearly contribute to

the relative levels of organisational and community resilience observable in the increasingly challenging environment faced by emergency management services throughout Australia.

## Conclusion

The focus on disaster resilience as a form of community capacity building has largely overshadowed the notion of organisational resilience in Australian emergency management. Resilience is a key theme in emergency management discourse in Australia (and increasingly internationally) but it is often conceptualised only in terms of the community at large rather than a commitment to building resilience in the organisations tasked with serving the public. Resilience is a concept that can be used at the personal level, the organisational, the regional and the national. Driven by a risk-management agenda originating at the highest point of this scale, the articulation of resilience has yet to be fully developed through to the operational levels in Australian emergency services.

Indeed even when it is used to describe internal capacities, the concept of resilience is often employed in a manner that does not reflect recent findings in organisational psychology. Rather than just focus on leadership and culture, research has consistently shown that it is essential to concurrently investigate and manage organisational climate in order to embed resilience into organisational practices. If the recent focus on resilience is to be applied more broadly to disaster management, much greater investment in human resource management and focus on determiners of organisational culture and climate is required in the relevant emergency services agencies than is presently the case. Organisational culture and climate are widely held to be significant determinants of organisational performance and are key elements in determining an organisation's success. If paid explicit attention to by managers, both concepts may provide emergency services organisations with sources of resilience, effectiveness and advantage that they currently lack. Organisational culture and climate are key conceptual frameworks that managers should pay more attention to when proposing ways to enhance capability, capacity, adaptability and action in emergency services agencies.

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Image: Victoria SES

Volunteer organisations contribute significantly to community capacity in emergency management.

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# Assessing community disaster resilience using a balanced scorecard: lessons learnt from three Australian communities

Imogen Ramsey, Dr Malinda Steenkamp, Andrea Thompson, Dr Olga Anikeeva, Professor Paul Arbon and Professor Kristine Gebbie, Torrens Resilience Institute, describe the implementation of the Community Disaster Resilience Scorecard in three Australian communities.

## ABSTRACT

**In 2012, the Torrens Resilience Institute (TRI) developed a balanced Scorecard for communities to assess their disaster resilience using an all-hazards approach. The Scorecard assesses four components of community resilience: connectedness, risk and vulnerability, procedures that support disaster planning, response and recovery (PRR), and PRR resources. The recommended process for completing the Scorecard is for the community to form a representative working group and meet three times over a few weeks to discuss and score the items.**

**From June 2014 to June 2015, the TRI evaluated the Scorecard. Prospective local councils received information about the Scorecard via circulars from local government associations. Sixteen councils expressed interest and three of these implemented the Scorecard. This paper reports on the findings from three communities that implemented the Scorecard.**

## Background

In December 2009, the Council of Australian Governments (COAG) adopted a national resilience-based approach to disaster management, recognising that a cooperative effort is required to strengthen the local capacity and capability of Australian communities to withstand and recover from disaster events (Australian Government 2011). The *National Strategy for Disaster Resilience* (NSDR) was established to support the development of disaster resilience, and sets out how the nation should strengthen partnerships, improve understanding of the risk environment, and build adaptive and empowered communities. In recent years Australian governments, organisations and communities have collaborated on reforming emergency management approaches to develop and embed the goals of community disaster resilience.

The TRI supported the NSDR through research that clarified the definition of community disaster resilience. According to Arbon (2014), 'community resilience is a process of continuous engagement that builds preparedness prior to a disaster and allows for a healthy recovery afterwards' (p. 12). In recent years, various organisations have developed measurement frameworks for disaster resilience (Building Resilient Regions 2010, Cutter *et al.* 2008a, 2008b, Emergency Volunteering 2011, Longstaff *et al.* 2010, Renschler *et al.* 2010, UNDP Drylands Development Centre 2013), although few have been designed specifically for use by communities (Arbon *et al.* 2014). A detailed discussion about these tools has been published in a review by the United Nations Development Programme (Winderl 2014). In 2012, with assistance from communities, the TRI developed the Community Disaster Resilience Scorecard and Toolkit: a balanced tool for communities to assess their disaster resilience using a participatory methodology (Arbon *et al.* 2012). The Toolkit defines a resilient community as one where members are connected and able to work together in the event of an emergency in order to:

- function and sustain critical systems, even under stress
- adapt to changes in the physical, social or economic environments
- be self-reliant if external resources are limited or cut off
- learn from experience to improve over time.

The Community Disaster Resilience Scorecard and Toolkit was trialled by four Australian communities in 2012. The findings showed that the Scorecard helped communities to better foresee threats and risks, engage with emergency management agencies, acquire a sense of community and social capital, and take collective responsibility to reduce the socio-economic impact of disruptive challenges and disasters (Arbon *et al.* 2012).

In June 2014, the TRI commenced a 12-month evaluation of the Scorecard (Arbon *et al.* 2015). Three communities (two from Tasmania and one from Victoria) successfully implemented the Scorecard in early 2015 as part of this evaluation.

**Figure 1:** The four pillars of resilience assessed by the TRI Scorecard.


Source: TRI Toolkit at www.flinders.edu.au/tri.

## Method

### Recruitment

Representatives from local government associations (NSW, NT, Qld, SA, Tas, Vic and WA) distributed information about the project to prospective councils via circulars. Sixteen communities expressed interest and participated in a teleconference to learn more about the Scorecard and the evaluation project. Two teleconferences were held in July and September 2014.

### Follow-up

Of the original 16, three went ahead and implemented the Scorecard.[1] About 25 guided telephone interviews and follow-up conversations were conducted. The interviews were based on semi-structured questions but conversations evolved naturally, as led by the interviewees. Correspondence between the TRI and the three participating communities was maintained throughout the project and assistance provided where required. Site visits to two of the communities occurred in February 2015, and the third community was contacted via email and telephone due to the timeframe of implementation.

## Results

Some councils reported barriers to implementing the Scorecard. These included a lack of senior management support, a lack of operational support, competing initiatives, insufficient resources, and individual levels of interest. These challenges are discussed in the evaluation report (Arbon *et al.* 2015). The results from the three communities that implemented the Scorecard are described as case studies.

## Case study 1: a comprehensive and inclusive approach

### Background

In one Tasmanian municipality interest in the Scorecard originated with the emergency management (EM) coordinator, supported by the EM committee and the mayor. The local government area included residential and rural areas, a larger, predominantly urban district and several small surrounding towns; some with large transient populations. The council's EM structure had recently converted to a community-based group but still included expert input from agencies. The council's EM sector had a strong community-resilience focus and recognised the importance of macro- and micro-level practice to deliver effective response and recovery actions.

### Process

Six representatives from the EM committee agreed to use the Scorecard within their respective areas and with support from council. It was proposed that once the individual exercises were completed, the central council would collate the separate community exercises to produce an overall municipal rating.

An initial meeting was held with the EM committee, representatives from the selected communities and project staff from the TRI. The Scorecard was met with a generally positive response from the committee, with more than one member commenting on its potential long-term value. However, a few members voiced concerns about their ability to initiate and manage the process. The representatives decided they would be more comfortable with a facilitator overseeing the process in each community to ensure consistency.

Council officers identified and invited members in each community to form working groups. The response rate was high, with most invited members agreeing to be involved. An experienced facilitator was appointed and consulted. Following this, the group decided to trial the exercise in one community with the support and oversight of an EM committee representative. Once the trial and a review of the processes were complete, the council would discuss the next area for consultation.

At the time of writing, the Scorecard has been implemented in three distinctly different communities within the municipality: two small urban areas with homogenous populations and one geographically spread area, characterised by a number of small population pockets. Each community held the recommended three meetings of an explanatory session, a meeting to discuss and allocate scores, and a review of the scores and subsequent recommendations for the council. In each community the facilitator managed the process, the council provided relevant Census data, and the municipal EM coordinator chaired the working group.

1 Valuable insights were also gained from interested communities that did not implement the Scorecard. Detailed findings about all sixteen communities (including those who did not implement the Scorecard) are presented in the complete project evaluation report (Arbon *et al.* 2015).

### Outcomes

The EM coordinator provided written and verbal feedback to the TRI following completion of the Scorecard in the first two communities. Of note was the involvement of people from various community agencies in the process that prompted others to recognise the importance of connectedness and engagement in promoting resilience. According to the EM coordinator, more than ten community members expressed interest in assisting with the development and implementation of recommendations from the Scorecard assessment. It was his view that such enthusiasm should be harnessed in order to achieve more community acceptance of actions and recommendations from government agencies, local government and service providers.

Of the Scorecard approach, he noted that the working groups had recognised the importance of balancing subjective contributions with factual information. A number of participants had gained valuable insight as a result of interpreting relevant Census data.

The council plans to repeat this process for the remaining three communities and to compile a consolidated report of their findings and recommendations at the conclusion of the project. The EM coordinator also proposed scheduling a de-briefing meeting to allow representatives of the working groups to share their experiences and identify strengths and challenges unique to each community. It is anticipated that the Scorecard will have an important role to play in conveying messages to decision-makers. The council is seeking to modify the participatory approach of the exercise to evaluate their capacities and capabilities.

## Case study 2: the straightforward approach

### Background

A second Tasmanian council was highly proactive in implementing the Scorecard. The council area includes a major town and eight smaller communities, with a total population of approximately 6500 people.

### Process

The council team (comprising three staff) attempted to recruit working group members through established formal council processes, including advertising in local media. They received few responses and subsequently used their 'local insider' knowledge to directly invite key community members known to be well connected and representative of the local population. This approach was successful and most invited members agreed to participate. The working group consisted of 12 individuals from different communities in the area, and included newly-elected members, the school bus driver, business owners, EM officers and the local priest.

Three meetings were organised as recommended. A central governance approach was adopted, whereby the council assumed a key role in facilitating the meetings and providing demographic and other relevant information. One of the council's team had sufficient experience and credibility to be accepted as chair. He was aware of diverse views within the working group and ensured that representatives had an equal opportunity to be heard in the discussions.

During the first meeting, members consolidated information about their communities' demographics and environmental settings. The second meeting consisted of the further compilation of information and the completion of the Scorecard. Although a third meeting had been scheduled to consolidate and plan for a way forward, the working group continued with this part of the exercise on the day of the second meeting.

### Outcomes

Through the process of completing the Scorecard, council members agreed that information about EM planning was not known nor understood in the community. For example, there were discrepancies between the scores allocated by EM personnel and those by community members to Scorecard items. It was common for emergency personnel to indicate that an issue had been addressed and allocate a high score, whereas community members were not as confident about the relevant issues, and would often prefer to allocate a lower score. This unexpected finding prompted the council to review its approach to disseminating EM information.

Council members sought advice from the working group members as to how information about planned disaster assistance could be made more accessible to the community, which resulted in several practical solutions. The council prepared information to be incorporated into their new residents information kit, such as relevant telephone numbers, links to specific plans available on the council's website (e.g. bushfire survival booklet, checklists for leaving early or staying and defending), and Red Cross and emergency alerts. A working group member distributed this information in the community where she resided via a self-funded mail drop.

Engagement with the Scorecard process helped to establish ties between the local government, community leaders and other authorities. This, in turn, facilitated a better understanding of the various roles that these groups play in emergency planning and response and the resources available to the community. This was not well known previously. There are plans for the Scorecard exercise to be repeated in some of the smaller communities.

## Case study 3: training community leaders

### Background

A rural Victorian municipality with a population of around 8500 people adopted a unique approach to implementing the Scorecard. The Scorecard was to be used within the framework of a resilience leadership

program, which ran for six months from November 2014 to May 2015 and involved 22 community members, representing eight townships in the shire. The program formed part of a raft of resilience-based initiatives that the community development team planned to implement over the next few years. It provided opportunities for community members to understand the impact of disaster events on small communities, create strong relationships and networks, and improve their capacity to respond effectively in emergency situations. Key topics included disaster planning, response and recovery cycle, leadership styles, project planning and the roles of emergency services and agencies.

Interest in the Scorecard was led by the community development team leader and supported by a proactive council, which had a central focus on community-action planning and a vision to build empowered and self-sufficient communities. The shire had experienced a 14-year drought, bushfires and minor flooding in recent years, as well as a major disruptive event in one of its communities. This previous disaster experience, combined with a supported local resilience strategy, were key contextual factors that drove interest in, and implementation of, the Scorecard.

The community members participated in the Scorecard exercise in a way that aligned with their own definition of resilience. Across the municipality, good leadership was perceived as being critical to the formation of resilient networks. The leadership program had subsequently been introduced to equip local residents with the knowledge, resources and skills necessary to make their communities truly capable and resilient. By incorporating the Scorecard exercise into their leadership program, the community members took ownership of the resilience-building process.

### Process

An invitation to community members to attend an information session about the resilience leadership program was advertised in the local newsletter. The preliminary session with the interested volunteers was held to define resilience in their local context and discuss the inherent characteristics of resilient communities. A total of 24 representatives from ten small communities participated in the program and used the Scorecard to benchmark individual communities and develop resilience profiles. The exercise was undertaken individually but volunteers could work together to answer questions. The program was overseen by a facilitator, who also chaired a feedback session after its completion.

### Outcomes

Feedback from volunteers was that the Scorecard was at too high a level with some of the industry language not relatable or well understood, and that it assumed that the population was homogenous. The volunteers also did not know where to find information on procedures that support community disaster PPR, or the required statistical data. Despite these challenges, the volunteers understood the *value* of the tool and felt it could be adapted for easier community use.

The community development team acknowledged they did not spend a lot of time with the volunteers to prepare them to use the Scorecard. Individuals did not complete the exercise with the support of the group or facilitators, nor as part of a well-prepared workshop. The team was aware there would be some difficulties associated with this approach but wanted to trial the Scorecard initially and share feedback.

The way forward identified by the leaders was to use their assessments and develop action plans to implement. They also produced a detailed document with advice, comments and recommendations for improving the Scorecard.

## Discussion

The case studies demonstrate that implementing the Scorecard is a valuable exercise for community engagement as well as building resilience. Despite each of the three councils adopting a unique approach to implementing the Scorecard, some key insights about the process are transferable.

- The working group is a powerful conduit for community engagement, community insight (for council) and multi-directional communication.
- Many working group members emerge as willing participants in ongoing community resilience initiatives, but require further direction and mandates from council.
- Formation of the working group can be difficult, particularly when dealing with sections of the community that do not usually engage with councils (e.g. new residents or day commuters).
- The working group chair has an important role in managing the process. It is the chair's responsibility to ensure that all members have equal opportunity to participate in answering and scoring the questions, and that experts do not dominate the discussion.
- The Scorecard assists councils to better understand community members' perceptions of risk, as well as the role and responsibilities of different agencies during disruptive events. It also allows non-council working group members to learn more about the role of council.
- The process of implementing the Scorecard can deliver practical secondary outputs in the short-term. The case studies led to improved information dissemination to community members and revision of disaster management plans.

Overall, it was observed that successful implementation of the Scorecard occurred where there was alignment of senior management support with initiative at operational level. The three case studies are examples of where this alignment occurred. Local, state and national contexts are critical factors that influence the interest in, and uptake of, the Scorecard. An existing resilience agenda, strong EM focus and vulnerability to disaster were key contextual factors that sparked interest in the Scorecard, while the

availability of resources, funding and structural support served as an impetus for action.

The case studies demonstrate that the Scorecard can be used successfully in different ways, in different contexts and for various purposes. It is important that a community assumes ownership of the Scorecard exercise by pre-identifying desired outcomes and undertaking the process in a way that is considerate of the unique concerns and needs of its members. It is also important that the Scorecard working group is representative of the whole community as far as possible. Having diverse perspectives expressed in the process was found to strengthen outcomes.

## Conclusion

The Scorecard addresses key components of resilience based on elements of physical, organisational and social capital, which all communities possess to varying degrees. The Scorecard exercise can identify strengths and weaknesses, and provides a point-in-time snapshot of resilience for communities. The case studies highlight the community development potential of the Scorecard process, which provides a useful framework for community cohesion.

The Scorecard is an avenue for the EM sector, local councils and community-based groups to connect to address gaps in resilience. The case studies provide insight into aspects of the Scorecard process that facilitate resilience-building, and demonstrate that outcomes and experiences will vary across communities. Further testing of the Scorecard will consolidate recommendations and investigate whether they are applicable to other state and national contexts.

The project findings suggest that effective implementation of the Community Disaster Resilience Scorecard can support the development of programs and the allocation of funds. This is an effective way to build community resilience and to reduce the socio-economic impact of future disruptive events, emergencies and disasters.

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## TRI Community Resilience Scorecard items

| | |
|---|---|
| **1. How connected are the members of your community?** | |
| 1.1 | What proportion of your population is engaged with organisations (e.g., clubs, service groups, sports teams, churches, and library)? |
| 1.2 | Do members of the community have access to a range of communication methods to gather and share information during times of emergency? |
| 1.3 | What is the level of communication between local governing body and population? |
| 1.4 | What is the general relationship of your community with the larger region or rest of the Shire? |
| 1.5 | What is the degree of connectedness across community groups? (e.g. ethnicities/sub-cultures/age groups/ new residents not in your community when last disaster happened) |
| **2. What is the level of risk and vulnerability in your community?** | |
| 2.1 | What are the known risks of all identified hazards in your community? |
| 2.2 | What are the trends in relative size of the permanent resident population and the daily population? |
| 2.3 | What is the rate of the resident population change in the last 5 years? |
| 2.4 | What proportion of the population has the capacity to independently move to safety? (e.g., non-institutionalised, mobile with own vehicle, adult) |
| 2.5 | What proportion of the resident population prefers communication in a language other than English? |
| 2.6 | Has the transient population (e.g., tourists, transient workers) been included in planning for response and recovery? |
| 2.7 | What is the risk that your community could be isolated during an emergency event? |
| **3. What procedures support community disaster planning, response and recovery?** | |
| 3.1 | To what extent and level are households within the community engaged in planning for disaster response and recovery? |
| 3.2 | Are there planned activities to reach the entire community about all-hazards resilience? |
| 3.3 | Does the community actually meet requirements for disaster readiness (informed public, communication plans, regular drills or exercises, etc.)? |
| 3.4 | Do post-disaster event assessments change expectations or plans? |
| **4. What emergency planning, response and recovery resources are available in your community?** | |
| 4.1 | How comprehensive is the local infrastructure emergency protection plan? (e.g., water supply, sewerage, power system) |
| 4.2 | What proportion of population with skills useful in emergency response/ recovery (e.g., first aid, safe food handling) can be mobilised if needed? |
| 4.3 | To what extent are all educational institutions (public/ private schools, all levels including early child care) engaged in emergency preparedness education? |
| 4.4 | How are available medical and public health services included in emergency planning? |
| 4.5 | Are readily accessible locations available as evacuation or recovery centres (e.g., school halls, community or shopping centres, post office) and included in resilience strategy? |
| 4.6 | What is the level of food/water/fuel readily availability in the community? |

# Twitter turns ten: its use to date in disaster management

Neil Dufty, Molino Stewart Pty Ltd, examines the adoption of Twitter in times of disasters over the past ten years


## ABSTRACT

**This article explores current literature to identify the main uses of Twitter in emergency management over the past ten years in Australia and overseas. It finds several uses across the 'disaster cycle' including as a medium for identifying hazard risk, community engagement for disaster mitigation and preparedness, early warning communication, crowdsourcing to provide real-time information, emotional support, identifying needs and vulnerabilities of affected communities, and allocating resources during recovery. This paper concludes by examining some relatively untapped uses of Twitter in building disaster resilience including for social capital formation, capacity building, disaster virtual communities-of-practice, and social change.**


## Introduction

Twitter, a micro blogging form of social media, was founded by Jack Dorsey and associates in San Francisco in 2006. It was originally developed to be an urban lifestyle tool for friends to provide each other with updates of their whereabouts and activities. However, with its changed tagline from 'What are you doing?' to 'What's happening?' it has developed into a reporting and communication medium useful in many fields including emergency management.

## Twitter use

*We Are Social* (2016) estimated in early 2016 that 31 per cent of the world's population were active social media users, with 10 per cent annual growth in users recorded. As shown in Figure 1, approximately 66 per cent of social media users accessed Facebook, while about 14 per cent (320 million) used Twitter. Twitter growth is slower than the average global growth rate for social media.

There is an uneven spread of the use of social media use across the world. For example, in North America 59 per cent of the population use social media, while only 11 per cent in Africa and South Asia (India, Pakistan, Sri Lanka and Bangladesh) use social media (*We Are Social* 2016). There are very low levels of Twitter use in some countries such as China that have their own language social networks, while other countries have usage rates above the global average, such as the United Kingdom (19 per cent), United States of America (19 per cent), Saudi Arabia (19 per cent), and Malaysia (18 per cent).

In Australia, 58 per cent of the population used social media in 2016 with 41 per cent using Facebook and 10 per cent (2.4 million) using Twitter (*We Are Social* 2016).

According to Sensis (2015), in Australia 'females and younger Australians (below 40 years) are the most prolific social networking users with much greater proportions in these cohorts using social media *per se* and more frequently than others'. However, more males than females use Twitter.

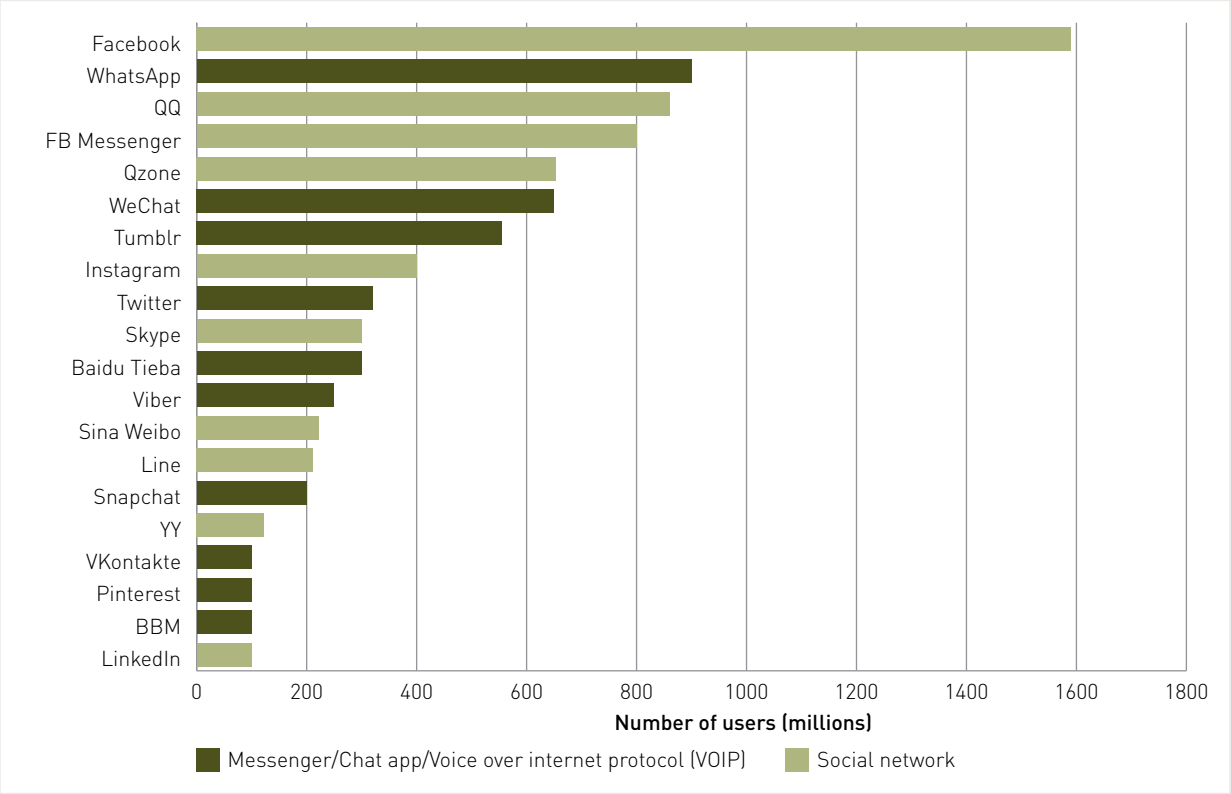
Approximately 32 per cent of Australians have never used social media, with 61 per cent of those over 65 years having never used social media (Sensis 2015).

## Unique characteristics of Twitter for emergency management

A large proportion of the research into the use of social media in emergency management has focused on Twitter, even though the global uptake of Facebook is substantially higher, and despite Facebook being used more extensively in disasters to date (Irons *et al.* 2014). This is largely because Twitter has some unique characteristics that are, at this stage, more useful to disaster management and research.

Twitter is a microblogging communication technology that allows users to distribute short messages (tweets) on the World Wide Web or through smartphone apps. Over the years, various additional features have been included in the backend and the interface e.g. facilities for picture upload and display, automatic shortening of URLs to save characters in tweets. Through an API (Application Programming Interface), third-party applications which offer additional functionalities can be connected to the service.

**Figure 1:** Global use of social media platforms in 2016.




Source: *We Are Social* 2016.

Twitter provides those involved in emergency events with some features not shared by other forms of social media such as Facebook. The basic concept guiding the use of Twitter is the idea of 'following'. Becoming a follower of a user is similar to subscribing to their updates that are added to those from other sources being followed. With Facebook and other social network sites, social relationships are required to be reciprocal. However, with Twitter this is not necessarily the case. The resultant social networking relationships can thus provide an insight into human behaviour, connections and sentiment before, during and after a disaster.

As opposed to Facebook posts, tweets are generally publically available and therefore provide succinct real-time information from a range of sources to all as a story unfolds. This can be likened to receiving a spool of news headlines on a particular topic including an unfolding emergency event. The use of hashtags, consisting of the '#' symbol followed by a word or phrase enables the news spool to be categorised to allow people to focus on a particular event (e.g. #QLDfloods) or theme (e.g. #bushfires). Twitter's 'trending topic' functionality promotes a shared use of certain hashtags for current events or contribution to ongoing conversations.

Bruns and Burgess (2011) indicate that 'Due to the specific communicative affordances of the Twitter platform, it lends itself especially well to the dissemination of breaking news from a range of sources, essentially in real time, to a wide network of users who can rapidly form an *ad hoc* public around the event or issue when news with a high degree of perceived global interest breaks on Twitter, it travels around the world with unprecedented speed.' (Bruns & Burgess 2014, pp. 374-375).

Twitter also allows for further sharing of information and networking through the use of replies and retweets. In both cases, communicative references to other Twitter users are not only made visible, but navigable as well. This benefits those experiencing the event, those wanting to know more about it, and those wanting to help including emergency and humanitarian agencies.

Twitter has proven more resilient than Facebook to government blockage in some parts of the world as shown in the 2011 uprising in Egypt (Kavanaugh *et al.* 2012).

According to Schmidt (2014, p. 6), Twitter differs from other online applications in that there is no 'shared location' where users and their contributions become visible (as in a blog posting or Facebook status update with subsequent comments).

## Uses of Twitter across the disaster management cycle

Social media platforms, including Twitter, have been used and analysed for use in disasters particularly since the 2010 Haiti earthquake. Several researchers

such as Bruns and Burgess (2014, p. 374) and Athanasia and Stavros (2015) provide extensive lists of Twitter use during and after these disasters.

Other researchers have attempted to summarise the uses of social media for emergency management based on this research. Alexander (2014) identified seven ways in which social media can be used in disaster risk reduction and crisis response:

1. A listening function - social media enables managers to listen to those affected by the event.
2. Monitoring a situation - monitoring social media traffic helps reactions to events and to better help affected people by learning what they are thinking and doing.
3. Integration of social media into emergency planning and crisis management – social media are used with traditional media e.g. to issue warnings.
4. Crowdsourcing and collaborative development - information provided from social media by those affected can be very valuable to disaster managers e.g. through crisis mapping.
5. Creating social cohesion and promoting therapeutic initiatives - social media can help people feel part of certain initiatives and promote volunteerism.
6. The promotion of causes - social media can be used to launch fundraising appeals for disasters.
7. Research - the understanding of social reactions to stress, risk and disaster can be enhanced by the use of social media.

Kaminska and Rutten (2014) identified the main uses of social media across the four pillars of the disaster management cycle being prevention and mitigation, preparedness, response, and recovery. They found three main areas where social media platforms and applications have been used successfully or show promise:

- public information
- situational awareness
- community empowerment and engagement.

Table 1 was constructed using the findings of these summative analyses of social media use and an extensive search of white and grey literature relating to the specific use of Twitter in emergency management and research. Table 1 provides an overview of the main uses of Twitter across the four pillars of the disaster management cycle. 'Warning' has been added as pillar between 'Preparedness' and 'Response' due to the large amount of Twitter usage identified for this aspect of disaster management.

As shown in Table 1, much of the documented use of Twitter in emergency management has occurred for warning, response and recovery. The main use of Twitter in mitigation and preparedness has been for public education and engagement even though, according to Dufty (2015, p. 16), 'It appears that social media is "underutilised" in countrywide disaster risk reduction public awareness strategies and a greater understanding of its potential and benefits is required'.

Of the main uses identified in Table 1, the most researched Twitter activities are: as an additional means of emergency communication (e.g. Simon *et al.* 2014), crisis mapping and big data analytics (e.g. Meier 2015), sentiment analysis (e.g. Ahmed & Bath 2015), and crowdsourcing or 'citizen science' (e.g. Tapia, LaLone & Kim 2014).

## Concerns with Twitter use

The unique characteristics of Twitter provide opportunities for emergency management but also for misuse. Potential misuse needs to be understood and managed by emergency managers. Numerous studies have illustrated the negative use of Twitter in this field. For example, Gupta, Lamba and Kumaraguru (2013) found a large amount of fake content (29 per cent of tweets) and over 6000 malicious accounts relating to the main hashtags used in the 2013 Boston Marathon bombing. Weimann (2014) observed that 'Twitter has recently emerged as terrorists' favourite Internet service, even more popular than self-designed websites or Facebook, to disseminate propaganda and enable internal communication'. Gupta *et al.* (2013) identified 10,350 unique tweets containing fake images that were circulated on Twitter during *Hurricane Sandy*. However, 86 per cent of tweets spreading the fake images were retweets, hence few were original tweets.

Although Twitter can be used to misinform, several studies have shown considerable use of trustworthy sources. For example, Thomson *et al.* (2012) found that for the hashtag #fukushima used in the Fukushima nuclear disaster close to 70 per cent of synthesis-derivative tweets (tweets containing some form of third-party information) were based on highly-credible sources.

## Possible future uses in disaster resilience

Several researchers have identified ways in which Twitter can be more effectively used in the future for emergency management and resilience. Bruns (2012) sees the potential of Twitter as a crisis-detector network. He notes that 'The great, demonstrable strength of Twitter, after all, is that it is more than a mere broadcast medium – it enables everyday users to report from their own perspective, to provide updates on the local situation'.

'What would be much more valuable would be an approach which could enable a frictionless crowd-sourcing process - the automatic detection, aggregation, and evaluation of tweets that may point to a genuine emergency, in a way which can pick up the weak signals (rising water levels, the smell of smoke, the sensation of a tremor) before they are recognised as a genuine crisis. Used this way, Twitter would become a fine-tuned human seismograph, except for more than earthquakes alone'. (Bruns 2012, p.17)

Reuter, Heger and Pipek (2013) examined ways in which the capacity of emergency volunteering—both real and

**Table 1:** Main uses of Twitter in emergency management identified in research.

| Use | Mitigation | Preparedness | Warning | Response | Recovery |
|---|---|---|---|---|---|
| Situational awareness | | | ✓ | ✓ | ✓ |
| Psycho-social support | | | ✓ | ✓ | ✓ |
| Threat detection | | | ✓ | | |
| Crowdsourcing | | ✓ | ✓ | ✓ | ✓ |
| Communication | ✓ | ✓ | ✓ | ✓ | ✓ |
| Public education and engagement | ✓ | ✓ | ✓ | ✓ | ✓ |
| Crisis mapping | | | | ✓ | ✓ |
| Disaster reconnaissance | | | | ✓ | ✓ |
| Sentiment analysis | | | ✓ | ✓ | ✓ |
| Post-disaster evaluation | ✓ | | | | |
| Big data analytics | ✓ | ✓ | ✓ | ✓ | ✓ |
| Navigating to safety | | | ✓ | ✓ | |
| Crisis social media volunteering | | ✓ | ✓ | ✓ | ✓ |
| Risk assessment | ✓ | | | | |
| Fundraising | | | | | ✓ |
| Conduct search and rescue | | | | ✓ | |
| Coordinate emergency resources | | | ✓ | ✓ | ✓ |
| Damage assessment | | | | | ✓ |
| Social network analysis | | | | ✓ | ✓ |

virtual—could be further developed using Twitter. They identified challenges for 'real' emergency volunteer groups that may be at least partially met with the help of social media and how the enlisting of virtual crisis volunteers could embolden those volunteers in the field.

Because of its public access and functionality to categorise information via hashtags, Twitter lends itself well to developing virtual communities-of-practice to help disaster-related learning. It has the potential to help learning for community disaster resilience. Zhang and colleagues (2015) explored the development of virtual communities-of-practice after *Hurricane Sandy* and noted the resulting more participatory nature of community learning, although there was 'marginal evidence of capacity building across all components of the organizational learning cycle'. An example of a Twitter virtual community-of-practice used by emergency managers interested in social media is accessed via the #smem hashtag.

Due to its unique social networking relationships, Twitter has the potential to build 'social capital' – a proven factor in community disaster resilience (Aldrich 2012). Hofer and Aubert (2013) found that 'the non-reciprocal friendship model of Twitter (i.e. the distinction between following and being followed) results in different effects on perceived social capital (both bridging and bonding) than do classical social networking sites such as Facebook.

Twitter has also shown its capability for social change during and after events. Many observers of the uprisings in Iran in 2009 and the Arab states in 2011 heralded the use of social media. Some went so far as to declare the Iranian protests a 'Twitter Revolution'. Analysis of Twitter posts from demonstrations in Egypt showed that individuals actively tweeting from Egypt demonstrated characteristics of opinion leaders (Kavanaugh *et al.* 2012).

## Conclusion

Twitter is ten. Although it does not have the same global uptake as Facebook, its unique characteristics have enabled it to become more valuable than other social media to disaster management and research.

Based on research, the main uses of Twitter in emergency management are as an additional means of communication, for crisis mapping for response, for understanding the sentiment of those affected, and in sharing real-time information between the community and emergency managers.


As it moves into its next decade, Twitter could also be used in disaster management in the following ways:

- as a crisis-detector
- to build capacity of real and online volunteers
- to help disaster resilience learning through VCoP
- to build social capital for disasters
- to make positive social change following disasters.

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### About the author

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# Notes from the Field

## Managed by us mob: helping remote northern communities face natural hazards

**Nathan Maddock, Communications Officer, Bushfire and Natural Hazards CRC**

Deep in Arnhem Land in the Northern Territory, perched on a small hill above the banks of the often-flooded Roper River, lies the community of Ngukurr. When the rains come each wet season, the community is cut off by road and the crossing over the mighty river becomes impassable.

Bushfire and Natural Hazards CRC researchers from the Research Institute for the Environment and Livelihoods at Charles Darwin University and the University of New England visited the Ngukurr community in June 2015 for a workshop with local representatives. They camped beside the lily-covered Yarriowarda billabong (Yellow Water in English).

Cherry Daniels, a senior Elder of Ngukurr said, 'Yarriowarda is the place of kangaroo dreaming. The white gums resemble the kangaroos. It is a special place.'

Four CRC projects were represented at the workshop, which was joined by local community members and researchers from the Aboriginal Researcher Practitioners' Network (ARPNet) who are conducting the research on the ground for the CRC.

ARPNet is a network of Indigenous research practitioners in northern Australia who are trained in participatory and other research and evaluation tools, primarily in the field of natural resource management and livelihoods. Community-based Aboriginal researchers make it possible for research to be conducted in the first language of the participants, using locally-adapted participatory tools, with due attention given to local cultural sensitivities. ARPNet Director for Research and Training and CRC researcher Dr Bevlyne Sithole said this is not the only advantage.

Image: Hmala Hunter-Xenie, AR

Kingswood Dirdi, ARPNet member, surveying Otto Dann, Gunbalanya resident, about perceptions of natural hazard risk.

'They [local community members] do not feel like they are being researched. It feels like they are having a conversation with someone they trust,' Dr Sithole said.

Along with Ngukurr, the CRC's Scoping Remote North Australian Community Resilience project has undertaken on-the-ground research in Gunbalanya (also known as Oenpelli), another Arnhem Land community. Further north and closer to the coast, Gunbalanya is situated in a river basin and is regularly affected by cyclones and flooding.

The CRC research will benefit the communities living in the environment along the coast of northern Australia, explained Dr Sithole.

'These Indigenous communities face many natural hazards on a regular basis. They feel like they are often unprotected and unprepared because of their socioeconomic situation. They worry a lot about their survival and their wellbeing.

'It is crucial that we engage with communities and talk to them about what is happening on country, so that we can find out how to bring the resilience back to the communities; understand what needs strengthening and what we should prioritise,' Dr Sithole said.

### Protecting local knowledge

'At the moment communities feel very vulnerable. There is a worry that the young people are not fully aware of the risks from natural hazards.

'In the old days, the old people in the community knew how to react to natural hazards. They knew which places to go to and ways to read the weather and nature. They could tell way before something happened that it was going to occur, and there were some people who knew how to control weather or natural events,' said Dr Sithole.

This awareness and knowledge is much reduced; in some places it is being lost as time goes on.

Before the workshop 22 ARPNet researchers spent several weeks in both Gunbalanya and Ngukurr talking with community members and completing 188 interviews. The benefits of the CRC researchers attending the Ngukurr workshop are many, said Dr Sithole.

'The best thing about meeting on country is that it is easier to relate to the information when you can see where it is coming from, when you can really see the landscape and the challenges faced. You hear firsthand the community researcher's feedback and analysis of the situation.

'These communities can be isolated for four or five months a year during the wet season. Being on country, we can go and see the high-water mark. It makes it more real. It is clear what is affected and the range of challenges presented,' Dr Sithole said.

It is not just the immediate environmental barriers that come into focus. Feeding the family is also a challenge with natural hazards: from the rising cost of food, to reduced opportunity for hunting and collecting. In some instances there is an added burden to feed multiple families.

'We can go to the local shop and see the prices. Then we hear within the community that these already high costs go up substantially when there is a natural disaster,' said Dr Sithole.

## What has been discovered?

The disaster preparedness of the Ngukurr and Gunbalanya communities is often linked to the seasons. Water levels in the rivers and billabongs fluctuate greatly between the wet and the dry. During the dry, fire produces lots of smoke in both areas. Their locations, relative to hills and rock outcrops, can be both an advantage and a disadvantage.

Stories about vulnerability and safety are connected to people's views about housing quality and infrastructure. Most of all, stories about vulnerability related to an absence of people on country and a weak connection to culture, traditional ceremonies and traditional structures. Strong advocacy was expressed for bringing old ways back and putting people back on country to strengthen the connection to country and to reinvigorate the coping capabilities within families.

Traditional ceremonies are a large part of how Aboriginal communities cope with and manage natural hazards. In today's world these ceremonies do not occur as frequently as they used to.

Ceremonies require the commitment of many. However, the 'modern' jobs that people hold often mean that the availability of the senior people required to hold a ceremony is just not there. Ceremonies take time and leave from employment does not allow for this. Ceremonies need to be recognised formally as a crucial part of managing country.

Dr Sithole explained, 'We found that the communities are already weakened by other factors [other than emergencies]. Natural disasters just make this weakness worse.

'When we interviewed people in the local communities, we were talking about big disasters and we found it became irrelevant. The size [of the event] did not matter. Any disaster leaves an impact on anyone who is already vulnerable. Any small bushfire, any small flood—that really affects a community in a fundamental way. It becomes seriously exacerbated in a big disaster,' Dr Sithole added.

Connectedness to country is fundamental in remote communities. Their way of life depends on this relationship and, as communities become increasingly connected to the outside world, this vital bond has been weakened.

'People feel safe to a certain extent in remote areas because it is their landscape. But that is not to say they are not aware of the harshness of the environment. It is accepted that the landscape is harsh and that there will be some challenges. At the moment they feel that there is not enough information available to them, from either their traditional ways or the modern ways, to allow them to be better prepared.

'Often I will hear comments like, "We heard that the climate is changing. Maybe for us Aboriginal people it is changing too fast. Maybe it will be very hard for us to change so quickly",' said Dr Sithole.

The notion of a safe place understandably differs to that held in other communities. For a cyclone, a safe place for these remote communities does not always refer to a cyclone shelter, as not all communities have such a shelter. It can refer to a brick house belonging to a relative. Improved housing remains a key issue in Ngukurr and Gunbalanya, especially the provision of cyclone-coded housing and shelters. A key point that Dr Sithole raised was that the design of shelters must reflect cultural norms and practices that might affect how these facilities are used.

**'We heard that the climate is changing. Maybe for us Aboriginal people it is changing too fast. Maybe it will be very hard for us to change so quickly.'**

Sheltering from a natural hazard in an Aboriginal community is not as simple as having one shelter that everyone can access. As part of their culture, different family members are required to avoid others in their family because of avoidance relationships.

'People need to meet their cultural obligations and be safe too,' Dr Sithole explained.

Community-wide emergency plans are another issue for remote communities. Less than a third of the surveyed population in Gunbalanya, and just over a half in Ngukurr, knew there was an emergency plan. Many


**Dr Bevlyne Sithole briefs the ARPNet research team in Ngukurr.**


**Dean Yibarbuk, ARPNet Co-Chair and team leader for the Gunbalanya research, recording a completed matrix activity on perceptions of natural hazard risk over time.**

of these people had not seen the plan, which is held at the local police station.

Dr Sithole noted that to understand this issue, one must appreciate the extent of Aboriginal incarceration in the Northern Territory, and the relationships that communities have with the police.

'There is a reluctance for most people to go visiting the police station and openly ask questions about emergency management,' Dr Sithole said.

The research found that all aspects of emergency management can be improved, not only preparation and response. Recovery after a natural disaster is also a key factor. Many people within communities have skills that can be called on in an emergency situation, but are not used.

'Jobs like operating machinery and chainsaws are required in the clean-up, but local people can feel excluded from the response and are not employed to do these tasks. People from Darwin often come in and are given these responsibilities while locals are given menial tasks.

'The Ngukurr and Gunbalanya communities are recommending a skills register of local people so the government is aware of the local response capability. These people can be called on within their community, or another community nearby, to assist in emergency responses.

'They also want government to consider identifying individuals in the community as part of a disaster response team whose skills are developed over time and can operate in communities to help in times of disasters,' Dr Sithole said.

Emergency preparedness, response and recovery in remote communities across northern Australia is not much different from in other locations around the country. It is about people, and Dr Sithole said a people-focused message comes through loud and clear in the research findings.

'For any planning or talking about emergencies, Aboriginal people should be central. They want to be part of it and know what is going on. From just knowing what resources are available, who is doing what, to knowing what houses are coded to different cyclone categories, to being involved and doing their part,' said Dr Sithole.

ARPNet Co-Chair and team leader for Gunbalanya, Dean Yibarbuk, agreed that people are paramount.

'Government needs to see us as capable people who can be involved in planning and responding to disasters.

'The big message from this project for us mob is to find a way to get government to recognise that ceremony is important and that it is a big part of how we as a people understand and manage disasters,' Mr Yibarbuk said.

Find out more about this research at www.bnhcrc.com.au.

# Anniversary of the 1931 Hawke's Bay earthquake

By Mischa Hill, Emergency Management Advisor, Wellington Region Emergency Management Office

**This year marks the 85th anniversary of one of the worst disasters in New Zealand's history.**

On 3 February 1931, a magnitude 7.8 earthquake occurred in the Hawke's Bay region of New Zealand, causing extensive damage to much of Napier city and Hastings (*The Daily Telegraph* 1931, Dowrick 1998). The total death toll was 256 and much of Napier's CBD was destroyed by fires that began within minutes of the earthquake and rapidly swept through the city (Callaghan 1933, Thomas *et al*. 2006).

This event caused the largest loss of life and most extensive damage of any quake in New Zealand's history. However, behind this tragedy is a remarkable recovery story. The Hawke's Bay we see today is a reflection of a host of key decisions and strategies in the reconstruction following the 1931 event.

The recovery process following the Hawke's Bay earthquake was one of the first large-scale examples (in New Zealand) of embedding techniques to reduce the risk of future disaster in the reconstruction of a city. These activities were underpinned by three key strategies:

- reconstruction was initiated immediately after the disaster
- reconstruction relied on a decentralised, integrative decision-making process
- reconstruction was a balance between continuity and change (Hill & Gaillard 2013).

Response activities persisted for a month after the earthquake hit and were facilitated by the creation of the Napier Citizens Control Committee. 'The methods adopted were to co-operate both local residents and outside experts and workers.' (*The Daily Telegraph* 1931, p. 91).

The committee was later superseded by the Napier Reconstruction Committee, led by two commissioners, to facilitate the permanent reconstruction. The committee comprised of local architects, lawyers, planners and businesses (*The Daily Telegraph* 1931, Conly 1980, Annabell 2012). Interestingly, even 80 years ago, Napier was following what is now thought of as international best practice—a city that paid attention to long-term recovery in the immediate days following the disaster, and to a process where locals were an active part of the long-term recovery.

Many architectural, engineering and infrastructure solutions were considered after the event to reduce the risk of further disasters. Some of these included widening streets and restricting the height of buildings within the CBD, splaying of building corners, abandoning cornices, regulating the construction of verandas and placing lifelines underground (Annabell 2012, Campbell 1975, Conly 1980, McGregor 1998). Many more initiatives were explored but due to the earthquake occurring in the great depression, funds were limited (Chapple 1997). There was also a balance in play with ensuring that 'every citizen was to get his business going again as soon as possible' (Barton 1932, p. 73).

The reconstruction of Napier, not only contributed to disaster risk reduction at a local level, but also at the national level. The disaster was a catalyst for some key national legislation: a national building code by-law, a Town and Planning Act giving jurisdiction to local authorities to implement regulations on design

Image: Smith, R Trevor, Alexander Turnbull Library, Wellington, New Zealand

Wairoa River Bridge, Wairoa, Hawke's Bay, under repair after the 1931 Hawke's Bay earthquake.

standards, and a nationwide insurance scheme that covered all New Zealanders (most people did not have insurance at the time) (O'Riordan 1971, Britton 1981, New Zealand Standard Institution 1935, Childs 1972).

For those in Hawke's Bay, this year is a time to remember those who lost their lives, their family and friends in the disaster. It is also a time for New Zealand to reflect on the lessons the Napier event taught. This event changed the future for New Zealand and paved a way for how disaster risk reduction can be successfully implemented post-disaster as a balance of continuity and change.

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Men working on the road and buildings in Emerson Street, Napier, after the earthquake of 1931.


One of many memorial boards scattered throughout Napier City to commemorate the earthquake.

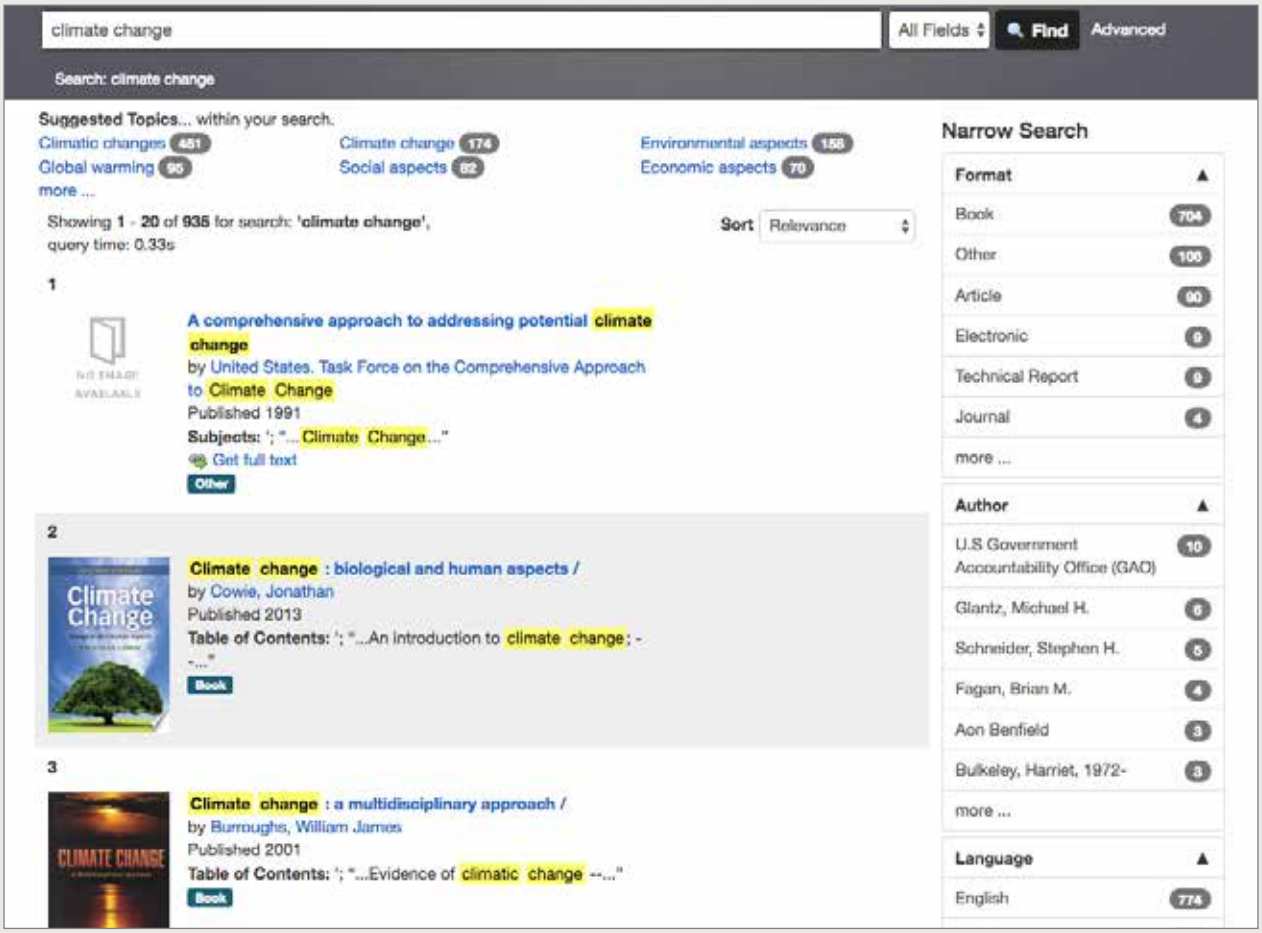
# EM Online: Natural Hazards Center Library, University of Colorado

**www.colorado.edu/hazards/**

The Natural Hazards Center Library at the University of Colorado in the U.S.A. is a collection of hazards resources about how society copes with natural hazards and catastrophic events. The library currently has over 40,000 items covering topics of climate change, terrorism, emergency management, biographies of pioneers in earthquake research, and much more. The collection contains a wide spectrum of information for researchers and practitioners.


HazLib is the new library catalogue that was launched in November 2015. It contains many new features that give users more options and navigation to access the holdings is easier. Among the new features are improved search options for multifaceted searching and users can customise results based on author, topic, and other elements. Along with the ability to save, cite and export search results, HazLib can serve full-text copies of certain documents.

Developers are still in the process of populating HazLib. If users are unable to find what they're looking for they can click on the Ask a Librarian link and easily connect with library staff who can help to find a particular resource, answer research questions, conduct fee-based customised catalogue searches or connect users with disaster experts.



# EM Online: Queensland Government floodwater safety

**floodwatersafety.initiatives.qld.gov.au/anatomy-of-an-incident**

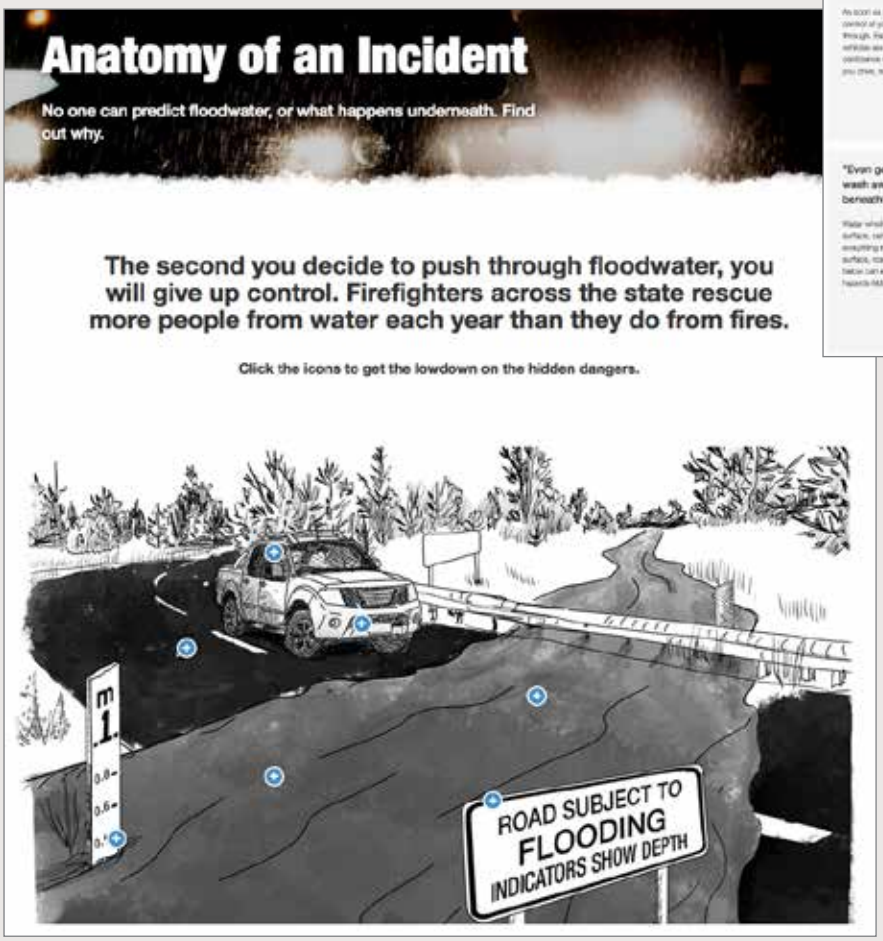
Queensland Fire and Emergency Service rescue more people from floodwaters than fires annually.

Many drivers don't understand the risks when driving into floodwater and often feel pressured to do so by other drivers, or their own strong desire to get home in severe weather.

The flood safety website has great information to help drivers understand risk and what actions they should take. While the flood map and other information may be specific to Queensland, it serves as a good starting point for all drivers.

The site includes information about floodwater risk, having a backup plan if roads are flooded, and understanding what may lie beneath flooded roads. Having a Plan B can help drivers avoid dangerous floodwater by knowing and using alternative routes, identifying safe locations to wait for the water to recede, and making prior arrangements for family.

The site also has a fact and fiction section to highlight the errors in some common ways of thinking and acting. It also has videos of people giving first-hand accounts and reflecting on their experiences with floodwater.

# National Emergency Management Projects 2015–16

**The Attorney-General's Department awarded 22 National Emergency Management Projects grants for 2015–16. These projects help Australian communities to prepare for, respond to, and recover from natural disasters and emergencies.**

| Recipient | Project title | Funding |
|---|---|---|
| Australia and New Zealand School of Government | Developing a national monitoring and evaluation framework for disaster recovery programs | $120,000 |
| Nous Group | Delivery and implementation of recovery and impact assessment guidance material | $94,000 |
| Women's Health Goulburn North East Inc | All on Board: incorporation of National Gender and Emergency Management Guidelines | $96,030 |
| Geoscience Australia | 10-minute bushfire hotspot updates from Himawari-8 | $250,000 |
| Geoscience Australia | Improving national situational awareness | $200,000 |
| Australasian Fire and Emergency Service Authorities Council in partnership with the Attorney-General's Department, Emergency Management Australia | A capability roadmap: building emergency management in Australia | $200,000 |
| Country Fire Authority Victoria | Development of the improved assessment of grassland fuels and fire behaviour | $320,000 |
| University of Adelaide | National extreme heat warnings: investigating regional temperature triggers and responses | $170,000 |
| Volunteering Australia | Future directions for emergency management volunteers | $150,000 |
| State Emergency Management Committee Secretariat (Western Australia) | Keeping our mob safe – strategy revision | $150,000 |
| Vicdeaf | All hands on deck: preparing Auslan signers for an emergency | $240,000 |
| University of Adelaide | Developing bushfire and heatwave information resources with CALD communities | $145,000 |
| Central Queensland University | Building the disaster resilience of the homeless community and services | $82,676 |
| State Emergency Management Committee Secretariat (Western Australia) | State-level risk assessments: assistance to states and territories | $185,000 |
| Bureau of Meteorology | National flash flood information repository | $330,000 |
| Queensland Farmers' Federation | Disaster resilience planning for Australian agriculture | $257,000 |
| Geoscience Australia | Development of flood vulnerability models for non-residential properties | $130,000 |
| Bushfire and Natural Hazards Cooperative Research Centre | Development of simulation and gaming software | $27,500 |
| Public Safety Business Agency (Queensland) | Capability development sub-committee project officer | $120,000 |
| Ministry for Police and Emergency Services (New South Wales) | Community engagement sub-committee project officer | $120,000 |
| State Emergency Management Committee Secretariat (Western Australia) | Risk assessment, measurement and mitigation sub-committee project officer | $120,000 |
| Department of the Chief Minister (Northern Territory) | Recovery sub-committee project officer | $120,000 |

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- **Resilient Australia Photography Award**
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- **Resilient Australia National School Award**
  The winners of the state and territory Resilient Australia School Award are considered for this Award.
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