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About the Journal

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

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Image: Lyndon Mechielsen, Newspix.

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

Foreword

Professor John Handmer, RMIT University

Welcome to the April issue of the *Australian Journal of Emergency Management*. As with most Australian summers, the last few months have provided confirmation of the importance of effective warnings, understanding risk and being resilient. We experienced the usual range of emergencies although some, such as the prolonged heat, were worse than expected, and the deadly event in the form of thunderstorm asthma was unexpected.

The issue of water safety, not necessarily on the radar of those used to thinking of major events, was highlighted by the unfortunate number of fatalities with nearly 300 dying nationally last year. Near unprecedented wildfires in the U.S. and Chile are reminders, among many, that the hazards we face are also experienced elsewhere.

Exchanging and learning from experience and ideas, whether from events in Australia, our near neighbours or other parts of the world can occur in many ways. One important way is through the research pages of this journal. AJEM is and should be concerned with Australian and New Zealand research about local issues and also with research from elsewhere that has relevance for Australian and New Zealand emergency management. The journal's Editorial Advisory Board exists to help ensure this is the case. Most issues of the journal, as with this issue, contain Australian research and work from overseas of potential relevance to Australian and New Zealand practitioners. Issues of community participation, warnings, crowdsourcing and resilience are mainstream issues for emergency managers.

It is often asked what role research has and how it adds to the experiences of those tasked with managing emergencies. Accounts of experience are usually personal and necessarily written within the constraints of the multi-dimensional politics of the organisation, sector and political masters. These accounts can offer deep insights likely unobtainable any other way. They can also be overly positive or lie somewhere in-between. The emergency management sector needs these insights and they are an essential part of learning and improvement.

Research complements these accounts and insights by providing arms-length or independent evidence and advice in the sense of a broker rather than auditor. It can also perform an auditing function, as when evaluating policy or practice. Another important contribution is to be forward-looking, for example by helping to identify the attributes of a culture of resilience that would apply to a future society rather than one based on what the society might have been, or by examining emerging technologies for potential roles in warnings and information provision. A positive characteristic of much emergency management research, illustrated by this journal, is the close involvement of practitioners. This can take the form of funding for work on issues identified by the sector or close collaboration at every stage of the research.

For research to be of value we need to have confidence in its integrity and quality—something that assumes heightened importance in an era of fake news and alternative facts. Quality control is generally achieved through transparent peer review by the global scientific community and, increasingly, through the use of online discussion forums. I would like to thank those who help this journal and the sector by performing this role.

Professor John Handmer
School of Science, RMIT University
Chair, AJEM Editorial Advisory Board

Research helps fire protection in Bangladesh

Dylan Bruce

Research into how Australian children are involved in bushfire preparations around the home is being applied to disaster preparedness in slum communities of Bangladesh.

Dr Briony Towers, through her PhD research with the Bushfire CRC completed in 2011, found that including children in the development of an emergency management plan greatly increased its effectiveness.

'If children are given the opportunity to access knowledge and information and to be involved in emergency management planning, they actually have really great ideas that can improve the plan for the household and their community,' Dr Towers said.

Focusing on child-centred disaster risk reduction in Australia for her PhD, Dr Towers has continued her child-focused work as a research fellow for RMIT University. She is also involved with the Bushfire and Natural Hazards CRC.

Dr Towers is assisting World Vision Australia to deploy a fire detector device, produced by the South African social enterprise Lumkani, in Bangladeshi slums. The Lumkani device is a sensor that, on detecting rapidly rising temperatures, sends alerts to all other nearby Lumkani devices and to the mobile phones of owners.

World Vision Australia was recently involved in the Google Impact Challenge, which allows the public to vote for a charity project to receive $750,000 in funding. While not taking out the overall prize, World Vision Australia was granted $250,000 by Google and plans to deploy the Lumkani device in settlements in Bangladesh. Estimates show that the losses from fires in these settlements could be halved with the device.

Dr Towers' previous work with the Bushfire CRC has taught her important lessons about the role of children in disaster preparedness and she is applying this to her work on this project.

The Lumkani is small but will make a big difference in communities in Dhaka.

Image: World Vision Australia

With structures packed tightly together in slums, fires can spread very quickly.

Image: World Vision Australia

'My PhD gave me a lot of insight into the importance of understanding children's knowledge and experiences from their perspectives. I met kids who had been given genuine roles in their family's plan and they were able to give me detailed descriptions of how to defend a property and what the different dangers are that you need to be thinking about.

'These kids were telling me all this information that is consistent with the advice of the fire agencies. That was because they had been given a genuine role in their family's emergency response plan,' she said.

According to Dr Towers, children who are included in the planning phase can become competent in making decisions at a young age, preparing them for future roles as community decision-makers.

'They can actually be making really good decisions about disaster risk reduction now as children and young people,' she said.

In her work in Bangladesh, Dr Towers will apply the lessons learned from her research to support the deployment of the Lumkani device.

'Making sure children and young people have a seat at the table when a decision is being made about implementing the warning system and making sure they have the information they need to genuinely participate is really important. There might be some training workshops specifically for children where they have the opportunity to ask questions and see how the detector works,' Dr Towers said.

Research is backing up the deployment of Lumkani in Dhaka.

Image: World Vision Australia

The Lumkani device has already been rolled out successfully in parts of Africa and is easy to install.

Image: World Vision Australia

Enriching leadership of volunteers in the emergency services

Associate Professor Michael Jones and Dr Yoke Berry, Bushfire and Natural Hazards CRC and the University of Wollongong

While some of us spend lazy hot summer days in the pool, thousands of volunteer firefighters and support crews battle fires and floods across the country. And it's not just in summer. Emergency services volunteers are there for us rain, hail or shine; 365 days a year.

In Australia, it is economically impractical to employ the number of emergency service workers to adequately respond to fires or other natural hazards such as storms and floods. As a result, Australia benefits from the benevolent support of around 235,000 emergency services volunteers, many of whom have followed in the footsteps of their family's tradition to volunteer. This volunteering is a way of life for many in communities and has been for a long time. Volunteer fire brigades were established as early as the mid-19th century and emergency and rescue agencies, such as the State Emergency Services, have their origins in the Civil Defence established in the 1950s.

Volunteer brigades and units are managed by the volunteers themselves. This quasi-independence of volunteer groups on the one hand, and the corporate environment of paid staff in a regional, district or head office on the other hand, can sometimes cause tensions especially related to communication and authority along hierarchical structures. However, these tensions also occur within volunteer groups where effective leadership is a critical element for job satisfaction and for the retention of recruits. As a result of these problems many volunteer-based emergency service agencies experience high rates of volunteer turnover. In some cases, this is as high as 20 per cent volunteer turnover each year and it can be that as much as half of all new recruits leave within the first two years.

Volunteer turnover is an economic liability to volunteer-based agencies. Training, uniforms and protective equipment are expensive. More importantly, volunteer turnover has a bearing on operational capacity, flexibility, resilience and, to some degree, morale. Research on poor volunteer retention is valuable for the emergency sector. Finding out why this happens and developing ways to improve volunteer retention, has been the focus of a Bushfire and Natural Hazards CRC project with the University of Wollongong team of Associate Professor Michael Jones, Associate Professor Dominique Parrish, Vivien Forner, Dr Joakim Eidenfalk, Dr Senevi Kiridena and Dr Yoke Berry to investigate changes in volunteer leadership behaviour.

The research found that there was no need for a leadership program *per se*, as most agencies offer a variety of programs that meet the traditional needs of leadership development. Instead, the interdisciplinary team, all experienced in leadership, were keen to find other angles for developing changes in leadership

Research helps to identify why volunteers leave and looks at ways to improve volunteer retention.

Image: Country Fire Authority

Emergency service volunteers are trained and equipped for when they are needed the most.

Image: Brenton Edwards, CFS Promotions Unit

behaviour. A Self Determination Theory was identified as a simple method to introduce to volunteer leaders.

Self Determination Theory recognises that there are three basic psychological needs people have in relation to optimal functioning and wellbeing:

- Autonomy – having the opportunity to express personal initiatives and ideas.
- Belonging – perceiving to be part of the group.
- Competence – feeling effective through positive feedback and appropriate training.

The 'ABC' of Self Determination Theory has been taught to people who interact with others in diverse environments such as homes, workplaces, schools, sports, universities and volunteering. Organisational research shows that when Self Determination Theory principles are applied in the workplace, employees and volunteers are more motivated, engaged, satisfied with their jobs and also less likely to want to leave the organisation.

The team developed a nine-week program, Inspire.Retain.Engage, that consisted of:

- one day of learning about leadership and Self Determination Theory and generation of ideas
- nine weeks of on-the-job application and active reflection on the principles of Self Determination Theory with the support of an online mentor
- a final day of reflection and sharing within communities-of-practice.

The program was piloted with volunteer leaders in 2014 with the NSW State Emergency Service and the NSW Rural Fire Service. It was delivered again in 2016 to volunteer leaders and staff of Victoria State Emergency Service and Queensland Fire and Emergency Services.

In terms of outcomes, the statistical effectiveness of the program on behavioural change in the participants, and job satisfaction and turnover intention of team members, showed that the Inspire.Retain.Engage training and the use of Self Determination Theory had a positive impact on the retention of volunteers.

More longitudinal measures would be beneficial in providing an in-depth evaluation of the Inspire.Retain.Engage program. The team is satisfied that the simple tools offered to volunteer leaders, staff and their organisations (the program was made available to all emergency service agencies in Australia) will be beneficial to their lives, to their agencies and to their communities.

Research is showing that advancing leadership skills in volunteers helps to retain them.

Image: ACT State Emergency Service

For more information about this research visit **www.bnhcrc.com.au**.

Building skills for psychological recovery after disaster

Hansika Bhagani, Australian Institute for Disaster Resilience

In the aftermath of a disaster up to 20 per cent of people affected can suffer from post-traumatic stress disorder (PTSD). While response times vary across countries and across disasters, the Psychological First Aid (PFA) model is well-known and well-used in emergencies. The need for mental health treatment for those who continue to suffer beyond the immediate aftermath of a disaster is also well recognised.

For Dr Patricia Watson from the U.S. National Center for PTSD, what was missing was a way to support survivors beyond the early days to help them bridge the days and months following disaster.

Speaking at an AIDR and Australian Red Cross-hosted event on psychological recovery in Melbourne last month, Dr Watson noted: 'There's a lot of different ways of knowing about disaster intervention. There's a lot of wisdom out there that cannot be quantified by research. Our job is to put it all together.

'For the vast majority of people affected by a disaster event, information is enough. Getting people information and getting them connected to resources can help. They will get back on their feet and you don't need to apply financial resources to give them more significant types of intervention.

'For those who are not helped completely by information, there is a PFA model we developed. Then we created a model that goes between PFA and mental health treatment,' she said.

The Skills for Psychological Recovery program was developed by the National Child Traumatic Stress Network and the National Center for PTSD with contributions from individuals involved in disaster research and response. It is an evidence-informed modular intervention that helps those affected by trauma to gain skills to manage distress and cope with post-disaster stress and adversity. Delivered by mental health professionals, crisis counsellors and other disaster recovery workers, it can be delivered in a variety of settings over just a few visits.

'In the U.S. there is a crisis counselling program that is put in place in local communities after presidentially declared disasters. That program is funded by the Federal Government and it is started at around four weeks after the disaster. The government agency that funds the program asked us to create an intervention

Dr Patricia Watson presented at the psychological first aid forum.
Image: AIDR

that would give crisis counsellors the ability to teach skills to people.

'The program they had was primarily supportive listening and connecting people to resources. They realised that they needed more for some people. They needed to empower people to stand on their own two feet and get on with their lives.

'We created an intervention that was evidence-informed but also could be used in a flexible way, because after disaster we can't ensure that people can come for five sessions or more. These interventions have to work even if you only see people only once or twice,' she said.

The Skills for Psychological Recovery teaches six main skills:

- **Gathering information and prioritising assistance** helps survivors identify their primary concerns and pick the best strategy to focus on.
- **Building problem-solving skills** teaches the tools to break problems down into more manageable chunks, identify a range of ways to respond and create an action plan to move forward.
- **Promoting positive activities** guides participants to increase the number of meaningful and positive activities in their schedule with the goal of building resilience and bringing more fulfilment and enjoyment into their lives.
- **Managing reactions** helps survivors to better manage distressing physical and emotional reactions by using such tools as breathing retraining, writing exercises and identifying and planning for triggers and reminders.
- **Promoting helpful thinking** assists participants to learn how their thoughts influence their emotions, to become more aware of what they are saying to themselves and replace unhelpful with more helpful thoughts.
- **Rebuilding healthy social connections** encourages participants to access and enhance social and community supports while keeping in mind the current post-disaster recovery circumstances.

Dr Watson indicated that behind it all is still that basic PFA model of supportive listening

'Supportive listening is the foundation. You can't really move into teaching skills before you have a relationship that's based on empathy, good connection with the person and good listening skills. Often times people might not be ready to learn these skills and you have to have to go back and forth between supportive and active listening and teaching skills. It's a back and forth dance,' she said.

And there are those who will still need referral to mental health treatment

'Some people will have repeated or ongoing traumatisation. Many people might be fine in the early phases after a disaster but they've got ongoing adversity and that's one of the highest risk factors that we've seen. If they lose their home or their job or they have to move, that can create a whole tumble-down effect for them.

'Mental health treatment should always be an option for people who have been severely traumatised or who have a history of other traumas or other mental health issues. It isn't always available in every community but it should always be part of a spectrum of services,' she said.

The Skills for Psychological Recovery program has had good evaluation results from implementation both in the U.S. and internationally.

'It was shown that those who were treated by counselling centres that used Skills for Psychological Recovery had fewer stress reactions. The counsellors themselves endorsed the program as being very helpful for the people they worked with. And there was also a significantly lower referral rate for mental health treatment,' Dr Watson noted.

Yet there's still more work to be done, especially when it comes to removing the stigma of asking for psychosocial support after a traumatic event.

'People still don't like to seek help for anything that seems emotional or mental. People compare themselves to others after disaster and they may feel like other people need services more than they do and they shouldn't use the services and resources that are available. A lot of people like to handle things the way they've always handled things and they use the basic coping mechanisms they've used in the past.

'For a good proportion of people that may be satisfactory. A lot of people don't always know the line between being able to handle a traumatic event on their own and benefiting from receiving more professional help or structured help. They don't always understand what the need is, or why it would be important. They feel like it means they're weak if they ask for help,' she said.

To find out more about the Skills for Psychological Recovery program, go to **www.ptsd.va.gov/professional/materials/manuals/skills_psych_recovery_manual.asp**.

Virtual reality for a new climate: Red Cross innovations in risk management

Pablo Suarez, Associate Director for Research and Innovation, Red Cross Red Crescent Climate Centre

How can we help people and organisations experience the humanitarian consequences of climate change and extreme events? The Red Cross Red Crescent Climate Centre has worked with partners to explore virtual reality (VR) to blend playful interactivity with innovative approaches to data visualisation for risk management.

Imagine you are attending the United Nations Climate Conference in Marrakech, Morocco. Most information about changing climate risks put you, as the audience, in a passive mode, whether via narrative form (text and audio) or via two-dimensional visual interfaces (such as maps and graphs on paper or a flat screen). Now imagine you can try something different. Your full body becomes integral to the intellectual process of understanding and using data. Your body becomes the interface; linking science to decisions through a memorable, immersive experience in virtual reality.

Through VR, you, like hundreds of other participants from around the world, have serious fun while confronting two tasks: predicting Arctic sea ice volume for the coming decades, and managing flood operations through forecast-based financing downstream of a dam in the West African nation of Togo.

In the first experience, you are invited to depict the likely future of our changing planet. VR goggles take you near the North Pole. A 3D graph takes shape, spiraling in front of you at floor level depicting sea ice volume throughout 1980. You notice Arctic sea ice reaches its maximum around April, and its minimum in September. As darkness takes over the Arctic the simulation continues with additional years spiraling upward until pausing near the present, at about chest level. Over 35 years of changing sea ice, the volume on the first of September has dwindled from about 15,000 cubic kilometres in 1980 to less than 5000 in 2016.

Viewed from above, projected on a flat surface, the graph looks like Figure 1. But when fully immersed in this virtual reality space, you experience the three-dimensional data visualisation in a very different way; walking around it or even *through* it, examining patterns from different angles, literally inhabiting the data environment (Figure 2). Global warming becomes palpable. You wonder, what should we expect for the coming decades?

Virtual Reality at the 2016 United Nations Climate Conference in Marrakech, Morocco.

Image: Pablo Suarez

Figure 1: Data visualisation of Arctic Sea Ice in two dimensions (image courtesy VISYON).

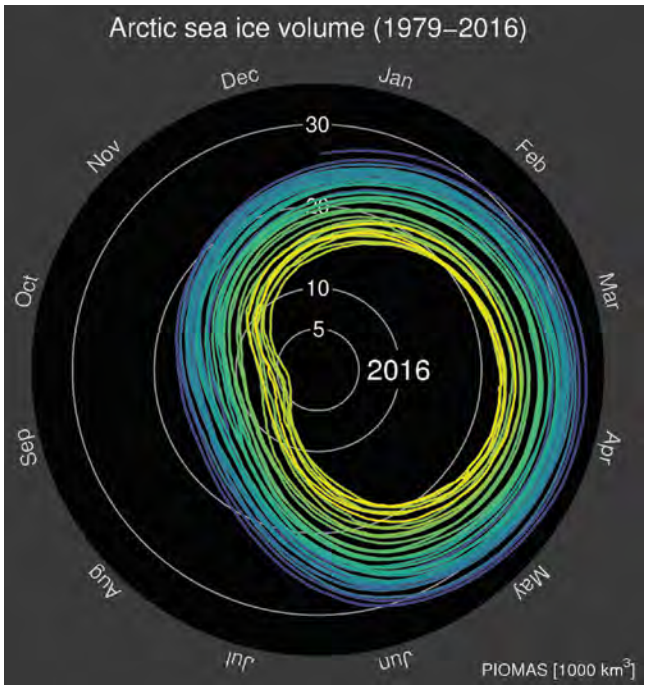


Image: Ed Hawkins

Figure 2: Data visualisation of Arctic Sea during immersive virtual reality (image courtesy VISYON).

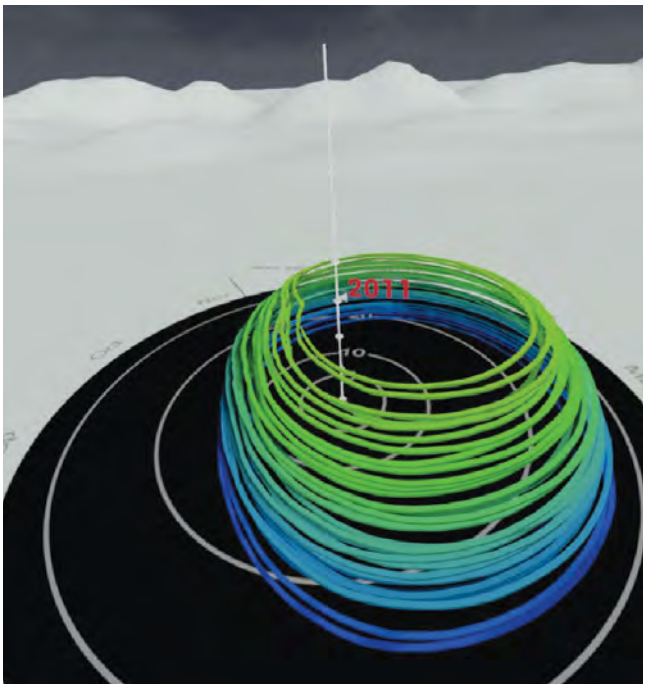


Image: Ed Hawkins

The VR depiction of rainfall, reservoir level and timing of overspill captures real-world data from the Nangbéto Dam in Togo.

Image: VISYON

The VR voiceover explains that you are holding an unusual paint brush. If you push the button while you move or rotate, your eyes will see what your brush creates, painting with light in the virtual reality space.

You are invited to 'paint the future' of the Arctic. How will sea ice evolve?

Your task is to create a visual depiction of data for another 35 years. The year 2050 is depicted as a semi-transparent horizontal plane above your head. Will there be Arctic sea ice in September 2050? If so, how much? If not, when exactly do you anticipate the data will show zero ice? Not an easy decision. You use your body to reach up to the future and physically place the exact VR location of the amount of ice by the middle of the century, or the timing of its end; likely in your lifetime. You wonder, will we witness our planet without Arctic sea ice?

Like many participants, you may find that engaging in this data-informed, artistic depiction of the future can lead to an 'A-ha' moment of understanding the serious, and potentially imminent, nature of the system-wide change occurring in our global climate.

Rethinking humanitarian systems: from disaster response to forecast-based financing in Togo

In the second VR experience you become a Red Cross worker in the Mono River Basin, downstream of Togo's Nangbéto hydropower dam. If flooding occurs, you must mobilise your team and deliver humanitarian aid. Almost a decade of virtual disaster management experience

When a flood hits, players must ring the bell to alert humanitarian workers, stamp an emergency funding request, wait for funding to materialise and load boxes of relief items on vehicles that will deliver aid to affected communities.

Images: VISYON and Pablo Suarez

is delivered in just a few minutes, with real-world data depicted for rainfall, dam reservoir levels, overspills, and floods. Every few years, you witness excessive rains that fill the reservoir beyond its capacity. Whenever this happens, dam operators must release water to prevent the structure from breaking. The rapid inundation that follows the spillage threatens the villages in the floodplain downstream.

When flooding hits, the voiceover tells you: 'Quick! Ring the bell to call the attention of your disaster management team. It's time to help the inundated communities!' You must physically shake the virtual bell with your real hands. Immediately a vehicle arrives, ready to deploy relief items. But the truck is empty: money is needed to help. Your next task is to stamp the emergency funding request. When the money finally arrives and procurement is completed, you pick up the virtual boxes with relief items and load them on the truck, which in turn drives to the affected villages. Delays are likely, even inevitable. As is often the case in the real world, communities receive assistance weeks or even months after an extreme event hits.

You notice a link between rainfall intensity, water levels in the dam, and timing of overspill, but what can you do with such knowledge when funds are only available after the flood? At this time you learn that there's a better way to manage this flood risk. It's less expensive and less time intensive. The approach is forecast-based financing[1] for disaster preparedness. In essence this is financial preparedness for disaster preparedness.

1 Coughlan de Perez E, van den Hurk B, van Aalst M, Jongman B, Klose T & Suarez P 2015, Forecast-based financing: an approach for catalyzing humanitarian action based on extreme weather and climate forecasts. Natural Hazards and Earth System Science vol. 15, no. 4, pp. 895-904.

Participants experience the contrast between the normal (i.e. delays in post-disaster funding as during the floods in 2010) and forecast-based financing advantages (as occurred during the floods in 2016).

Images: Pablo Suarez and VISYON

Virtual reality offers discovery and inspiration for climate risk management.

Image: Pablo Suarez

You learn that in Togo, the Red Cross and its partners have developed an innovative self-learning algorithm to trigger early action based on a warning of flood risk. Your next VR task is to set up this system. You must pre-stamp a revised funding request so that when the forecast indicates a river flow in excess of your danger level, the system will automatically activate and fund your team's work. A Data Sculpture evolves in front of you, depicting river flow over time including peaks associated with previous flood impacts. To define the danger level you must move a virtual plane that indicates the amount of river flow that is deemed too much, thus becoming the trigger for financing disaster preparedness activities.

In the last simulated year, as was the case in the real world in September 2016, forecast-based financing triggers funding for early action measures, just days before flooding hits villages along the Mono River. In 2010, it took 34 days from dam overspill to emergency funding release[2].

Conclusions

These two virtual reality experiences have enabled hundreds of participants to explore how science and finance can work in alliance to act faster and avert disasters. VR helps participants to envision the magnitude and implications of the changing global climate. This innovation[3] is traveling to events worldwide, offering discovery and inspiration. The remarkable possibilities offered by this rapidly evolving, and increasingly affordable, VR technology merits additional exploration by humanitarian and development organisations interested in new learning and dialogue modalities for disaster management.

Acknowledgments

The virtual reality experiences described in this article were co-designed with James Morgan and developed by VISYON Digital Services, with support from the Global Facility for Disaster Reduction and Recovery. Additional support provided by Frank Antonelli, Janot Mendler de Suarez, Julie Arrighi, Regie Gibson, the German Red Cross and the Development and Climate Days at UNFCCC COP.

2 Reuters AlertNet 2016, Virtual reality puts players in driving seat on disaster. At: **www.climatecentre.org/news/798/at-d-c-days-virtual-reality-puts-players-in-driving-seat-on-disaster**.

3 For more information, see **www.climatecentre.org/vr**.

Victoria's Survive and Thrive Program

Jane Hayward AM, Teaching Principal, Strathewen Primary School

In the eight years since the Black Saturday bushfires devastated our community, my staff and I have faced many challenges in our small school. Many of these were what we'd have expected to deal with post-disaster, but many were beyond what we'd ever considered. We managed all that came with being displaced and operating from our temporary setting, while dealing with the challenge of rebuilding our school.

We worked closely with students and families as they dealt with disbelief, anger, grief and loss. Student and family wellbeing underpinned every decision we made. Never did we imagine the reality of the timeline of what is generally referred to as 'recovery'. We've learned that there is no end date to this journey and that the idea of getting back to normal is an interesting one.

For many years events, things managed with ease in other schools, had to be very carefully handled in our setting. Hot days, strong winds, a helicopter passing overhead, all meant the close monitoring of our kids. Our weeks were structured and organised so that there were no surprises. Our students needed consistent boundaries and needed to feel safe and secure at all times. Regular fire and evacuation drills were referred to as an 'Emergency Practice', so that the word 'fire' wasn't mentioned, and often these drills took up to an hour and half to implement. Our evacuation processes always went smoothly, everyone knew what to do, but the question time which inevitably followed a drill was always hard going. 'But what if the wall was glowing?' or 'What if we couldn't go that way because a tree fell and blocked our way?' Our children had lived experiences and knew so much.

Students for Strathewen Primary School participate in field trips and learn the science of fire.

Image: Jane Hayward

Students and teachers work together to understand the hazards of fire.

Image: Jane Hayward

In 2016, the opportunity to be involved in the CFA's Survive and Thrive program came our way thanks to our local Strathewen Arthurs Creek brigade and their connection with Jamie McKenzie, who had a pilot program running with Anglesea Primary School. This provided the opportunity for our group of ten grade five and six students to work with experts and community volunteers on a program aimed at learning about fire risk in our local area and learning to love where they live. The success of our first year of involvement in this program has far exceeded expectation.

Students have participated in field trips, researched local wildlife and learnt the science of fire. They are able to use tools like whirling hygrometers, inclinometers, moisture meters and McArthur meters. They are able to collect information on air moisture, fuel load and fuel moisture levels to determine the Fire Danger Rating (FDR) for the day. They know how fire travels and how to prepare for the fire season. Using this knowledge, students came up with a story and created a claymation movie showing what a family living in a bushfire prone area like Strathewen needs to do depending on the FDR for the day. The film 'If you care, stay aware, be prepared- a message from Gem Gem' has been really well received, with thousands of views online (CFA Facebook and Youtube). Their film is already being used as an education tool in many schools.

Our students have certainly thrived on gaining knowledge and they've been completely engaged in this program. Their level of understanding is incredible. They have presented information sessions to community groups and enjoyed every aspect of their learning. The knowledge they now have has given them a deeper understanding of bushfire risk and what we all need to do to stay safe. We have the next stage of our program planned for this year and 2017 promises to deliver more great learning opportunities.

The students thrive on gaining knowledge and have been very engaged in the program.

Image: Jane Hayward

Educate the child, educate the community

Nathan Maddock, Bushfire and Natural Hazards CRC

Primary schools students across NSW are now front and centre in state-wide bushfire plans, based on research that identified the importance of involving children in active bushfire preparations for the benefit of the whole community.

Bushfire and Natural Hazards CRC research is supporting bushfire education for primary school students in NSW. The NSW Rural Fire Service is using findings, along with the knowledge, skills and experience of researchers, to develop a bushfire education kit.

The 'Guide to Working with School Communities' is being rolled out to all schools by the NSW Rural Fire Service. The guide follows the earlier publication of the *Making a bushfire plan? Involve your kids!* ebook, available nationally and based on the same principles; if you educate children on hazards safety, their families and the community will also benefit.

This line of research is being led by the CRC's Dr Briony Towers at RMIT University. It has already provided fundamental insights into how children learn about bushfires and how they share those learnings with their families. Collaboration with the NSW Rural Fire Service is continuing and the team will evaluate the guide over upcoming fire seasons. Evaluation will gather data to measure its impact on community safety.

The team ensures that collaboration is at the heart of the research at every stage. Researchers and end-users are involved in all aspects of the study, from undertaking the research to developing usable plans and writing journal papers. This collaboration will produce benefits when the study reaches maturity and is embedded across the country.

NSW Rural Fire Service Commissioner Shane Fitzsimmons launches the 'Guide to Working with School Communities'.

Image: Ben Shepherd, NSW Rural Fire Service

Queensland IGEM: results achieved so far

Iain MacKenzie, Queensland Inspector-General Emergency Management

The vision for the Queensland Office of the Inspector-General Emergency Management (IGEM) is to be a catalyst for excellence in emergency management. Central to achieving this is a genuine need for commitment to authentic and thorough engagement—from the ground up. This is essential for real change and enhanced confidence in Queensland's disaster management arrangements.

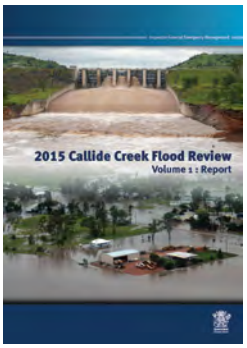
In 2014 our stakeholders from across the sector worked closely with the newly established Office of the IGEM to build the foundations for future work. Through this consultation we now have our first Strategic Plan[1] and the Emergency Management Assurance Framework, and Queensland's first Standard for Disaster Management[2].

Assurance activities

Using the Framework and the Standard as foundations, IGEM has undertaken comprehensive assurance activities. These are:

- eight reviews
  - 2014 Callide Creek Flood Review
  - Review of Local Government's Warning Capability
  - Review of State Agency Integration at a Local and District Level
  - Review of Cyclone and Storm Tide Sheltering Arrangements
  - Review of Seqwater and SunWater Warnings Communications
  - Review of Aboriginal and Torres Strait Islander Council's Capability to Deliver Disaster Management Responsibilities
  - Review of Capability at a District and Local Level: Warwick disaster district
  - Mackay District and Local Capability Review
- two discussion papers
  - Evaluation of Emergency Management Training and Exercising
  - Analysis of Disaster Management Exercises (an analysis of documents relating to 152 disaster management exercises carried out between 2010 and 2015 to identify trends, innovation and good practice)
- a research paper into best practice emergency supply
- a commissioned evaluation of the improvement in the State Disaster Coordination Centre; Room for Improvement Report June 2014

Importantly, the evidence-based recommendations coming from these reviews have been strongly embraced. Of these recommendations, 99 per cent have been accepted by the entities involved. My strong desire is for the findings and recommendations to be considered as opportunities for improved outcomes to the community as this is where our collective focus needs to be.



Enhancing disaster management excellence

To enhance disaster management excellence at the local level, the IGEM has developed:

- an online process to assess local and district disaster management plans
- an online prioritisation tool for entities to undertake a 'health check' of their disaster management arrangements against the Standard
- a series of fact sheets, Accountabilities in Practice, for disaster management practitioners.

1 IGEM Strategic Plan. At: **www.igem.qld.gov.au/reports-and-publications/Pages/Strategic-Plan.aspx**.

2 IGEM Standard for Disaster Management. At: **www.igem.qld.gov.au/assurance-framework/Pages/standard.aspx**.

Inspector-General Iain MacKenzie and 2017 IGEM Champion of Change Award recipient, Cheryl-Lee Fitzgerald, Executive Manager Emergency Management, Queensland Fire and Emergency Services.

Image: IGEM

Workshops explaining the Standard have been held across Queensland for members and chairs of local and district disaster management groups. This has proved beneficial to build the level of communication, collaboration and partnering with our disaster management stakeholders.

As part of this, a Disaster Management Officer Network was established to allow local practitioners to connect, keep up with developments in disaster management arrangements and associated doctrine and to share and develop their skills, knowledge, resources and ideas. The network ran a three-day forum in Cairns in May 2016 and has now grown to over 70 officers from more than 50 local governments and one member from the Local Government Association of Queensland.

Our focus on collaboration, partnerships and engagement continues through:

- creating the IGEM Advisory Panel for practical advice from stakeholder groups
- publishing the e-newsletter 'IGEM Connect', going out to 1200 subscribers
- partnering with local disaster management practitioners in the Wide Bay and North Burnett region to study disaster management arrangements for seniors living in their own homes
- partnering with individuals and agencies through initiatives such as GovHack
- establishing online platforms to support networking and encourage good practice and sharing of ideas
- developing a multi-faceted research framework with industry and the tertiary sector for high-quality research that contributes to continuous improvement in practice and community outcomes
- creating a partnership with Queensland University of Technology on a range of activities (IGEM hosted a student intern to research potential uses of immersive technologies such as augmented reality and virtual reality)
- progressing the Queensland disaster management lexicon
- presenting the IGEM Champion of Change Award[3].

The IGEM also meets with mayors and senior executives from local governments throughout Queensland. My staff frequently address local and district disaster management group meetings, speak at local, national and international conferences and participate in exercises, workshops, forums and symposiums.

Impacts and outcomes so far

Our ground-up approach has been well-received as reflected in stakeholder satisfaction with our work. Overall, 83 per cent of our stakeholders were either 'satisfied' or 'very satisfied' with the services and advice provided by the IGEM.

I am proud of the outcomes achieved and the improvements delivered so far by the sector, some of these include:

- changes to legislation with the Water Legislation (Dam Safety) Amendment Bill
- development of the new policy by the Department of Communities, Child Safety and Disability Service: People with vulnerabilities in disasters – a framework for an effective local response
- better systems in place via the new flood gauge network in the Callide Valley
- keeping communities informed
- identifying opportunities like immersive technologies and data sharing
- Queensland Fire and Emergency Services progression of integrated risk-based planning with stakeholders
- developing consistent disaster management terminology
- improved information and warnings systems for those living downstream from dams.

My goal for the coming years is to take the excellent work so far to the next level and to deliver the best possible disaster management arrangements for all Queensland.

For more information visit the IGEM website at **www.igem.qld.gov.au.**

3 The Champion of Change Award was established to create equity and diversity in the workplace. It is open to those who actively champion change to bring about greater equity for women in the Queensland disaster management sector.

The Australian Natural Disaster Resilience Index

Dr Melissa Parsons and Dr Philip Morley, University of New England, Armidale, NSW

Society has always been susceptible to natural hazards. While the occurrence of these events generally cannot be prevented, the risks can often be minimised and the impacts on people and property reduced.

Natural hazard management policy throughout the world is increasingly being aligned to ideas of resilience. The *National Strategy for Disaster Resilience*[1] outlines how Australia should aim to improve social and community resilience with the view that resilient communities are in a much better position to withstand adversity and to recover more quickly from extreme events. However, there is a distinct need to assess resilience to identify areas of strength, areas for improvement, plan future actions and have a baseline condition from which to measure progress.

To address this, researchers from the Bushfire and Natural Hazards CRC teamed with various emergency service agencies around Australia to develop an index of disaster resilience and, for the first time, assess the state of disaster resilience Australia-wide. The Australian Natural Disaster Resilience Index[2] will produce a consistent spatial assessment of the current state of disaster resilience across Australia and report results as a State of Disaster Resilience report. The Index will also provide input to macro-level policy, strategic planning and community engagement activities at national, state and local government levels.

Disaster resilience

Three aspects of disaster resilience are common across the many definitions of disaster resilience:

- the ability to absorb or accommodate the effects of an external disturbance or stressor event
- the ability to recover and return to a functioning state or to persist following an event
- the capacity to learn, adapt or transform.

For the Australian Natural Disaster Resilience Index, disaster resilience is defined as the capacity of communities to prepare for, absorb and recover from natural hazard events, and the capacities of communities to learn, adapt and transform towards resilience. Importantly, this definition highlights not the actual realisation of resilience but the capacities for resilience.

> **Disaster Resilience:** the capacity of communities to prepare for, absorb and recover from natural hazard events, and the capacities of communities to learn, adapt and transform towards resilience.

There are two approaches to assessing disaster resilience. Bottom-up approaches are locally based and survey individuals or localised communities using a scorecard of indicators such as preparation, exposure, resources and communication. An example of a bottom-up approach to assessing disaster resilience is the scorecard approach developed in Australia by Paul Arbon and colleagues at the Torrens Resilience Institute[3]. In contrast, top-down approaches are often intended for use at broad scales and use secondary spatial sources such as census data to quantitatively describe the characteristics of a community that contribute to disaster resilience. Because it is difficult to survey individuals or local communities at a national scale, the Australian Natural Disaster Resilience Index uses a top-down approach. The Index assesses resilience based on two sets of capacities—coping capacity and adaptive capacity.

Coping capacity enables people and organisations to use their available resources and abilities to face adverse consequences. These are the factors influencing the capacity of a community to prepare for, absorb and recover from a natural hazard event.

Adaptive capacity is the ability of a system to modify or change its characteristics and behaviours to cope with actual or anticipated stresses. These factors enable the adjustment of responses and behaviours through learning, adaptation and transformation.

1 Attorney-General's Department 2011, *National Strategy for Disaster Resilience*. At: **www.ag.gov.au/EmergencyManagement/Documents/NationalStrategyforDisasterResilience.PDF**.

2 Australian Natural Disaster Resilience Index project. At: **www.bnhcrc.com.au/research/resilient-people-infrastructure-and-institutions/251**.

3 Assessing community disaster resilience using a balanced scorecard: lessons learnt from three Australian communities. At: **https://ajem.infoservices.com.au/items/AJEM-31-02-09**.

The Australian Natural Disaster Resilience Index will, for the first time, assess disaster resilience at a national scale in Australia using a standardised approach.

The Index assesses resilience based on two sets of capacities: coping capacity (availability of resources and abilities to face adverse consequences) and adaptive capacity (adjustment of responses and behaviours through learning, adaptation and transformation).

Results of the Index will be reported as a State of Disaster Resilience report and corresponding maps.

Researchers and emergency service agency staff from around Australia have teamed up to design the Index and to use the results in various policy and program settings.

Together, coping capacity and adaptive capacity help to answer the question: 'How able is a community to prepare for, absorb and recover from a natural hazard event and to learn, adapt and transform to build disaster resilience?'

Index structure and indicators

Figure 1 shows the hierarchical design of the Australian Natural Disaster Resilience Index. The first level of the hierarchy comprises the coping and adaptive capacity dimensions. Nested within these are eight themes expressing the main elements of coping and adaptive capacity. The lowest level is the indicator sets that measure the status of a theme.

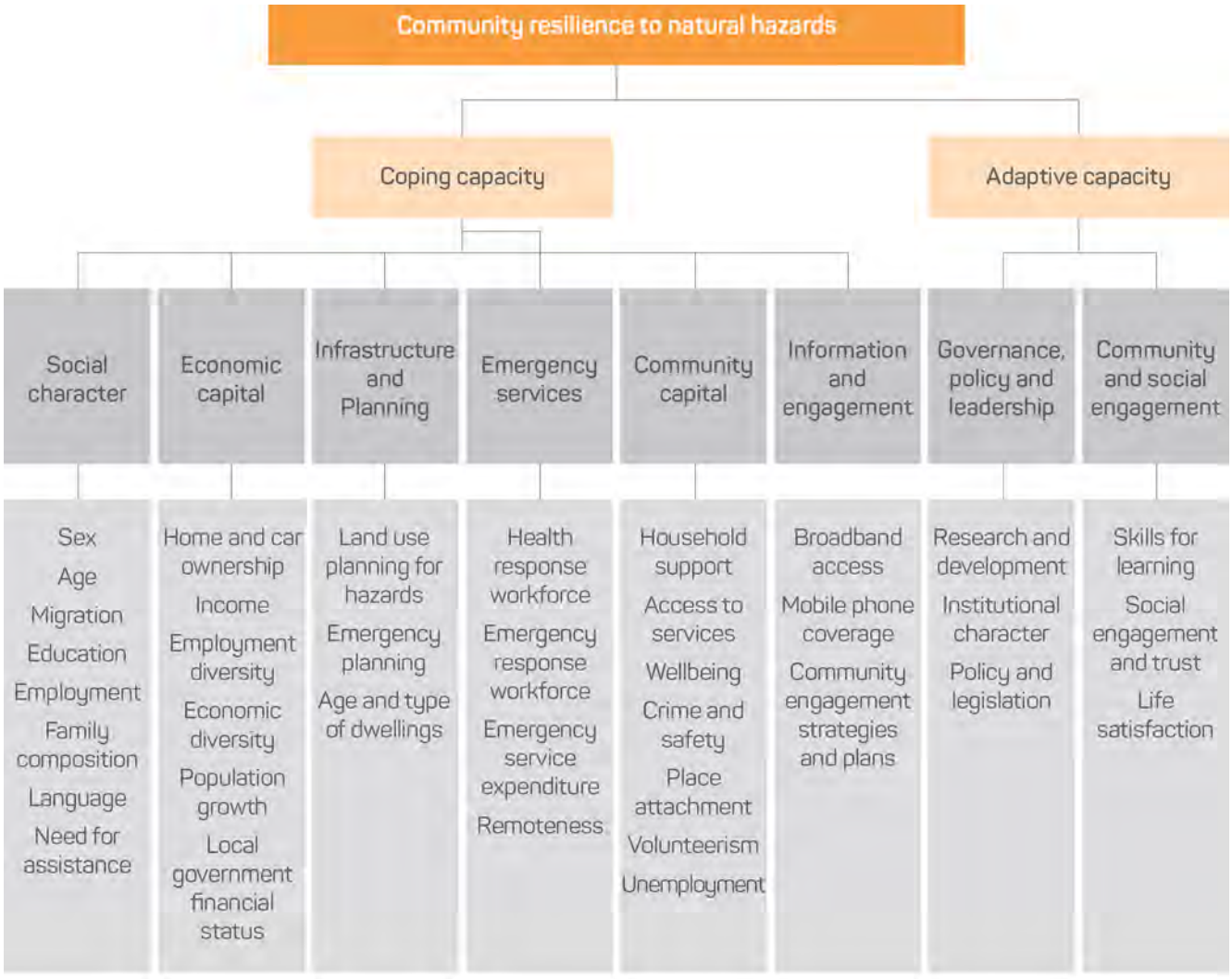


Figure 1: The structure of the Australian Natural Disaster Resilience Index. For brevity, indicators are listed as general areas.

Table 1 explains the coping and adaptive capacity themes. The coping capacity themes encapsulate the factors influencing the resources and abilities that communities have to prepare for, absorb and recover from natural hazard events. The adaptive capacity themes encapsulate institutional and social learning, flexibility and problem solving.

The social, economic, government, infrastructure and community indicators used in the Australian Natural Disaster Resilience Index are consistent with those used in previous assessments of disaster resilience worldwide. The Australian Index innovates by including important elements of emergency management in Australia such as emergency services, emergency planning, land-use planning and community engagement. The Australian Index also advances the field of disaster resilience assessment by incorporating adaptive capacities related to learning, adaptation and transformation.

Computing the Index

The Index is computed from the indicators in each theme using various statistical techniques. Each theme can be reported separately and will be spatially represented as maps. For any location in Australia, users will be able to access a corresponding set of information about natural hazard resilience. The Index will provide a snapshot of the current state of resilience at a national scale and results will be released as a State of Disaster Resilience report. The Australian Disaster Resilience Index will provide a layer of information for use in policy development and planning as well as create a benchmark against which to assess future change in resilience to natural hazards. It can also be an overlay for risk maps to assess the intersections between resilience and risk.

The project is funded by the Bushfire and Natural Hazards CRC and has three distinct stages: conceptual development[4], data collection and analysis and the final stage of revision and reporting. It began in mid-2014 and will continue until June 2018 after which a fourth stage of agency implementation and utilisation activities will continue through to June 2020.

Table 1: Definition and description of coping and adaptive themes.

Theme	Definition	Description of theme
Coping capacity		
Social character	The social characteristics of the community.	Represents the social and demographic factors that influence the ability to prepare for and recover from a natural hazard event.
Economic capital	The economic characteristics of the community.	Represents the economic factors that influence the ability to prepare for and recover from a natural hazard event.
Infrastructure and planning	The presence of legislation, plans, structures or codes to protect infrastructure.	Represents preparation for natural hazard events using strategies of mitigation or planning or risk management.
Emergency services	The presence of emergency services and disaster response plans.	Represents the potential to respond to a natural hazard event.
Community capital	The cohesion and connectedness of the community.	Represents the features of a community that facilitate coordination and cooperation for mutual benefit.
Information and engagement	Availability and accessibility of natural hazard information and community engagement to encourage risk awareness.	Represents the relationship between communities and information, the uptake of information about risks and the knowledge required for preparation and self-reliance.
Adaptive capacity		
Governance, policy and leadership	The capacity within government agencies to learn, adapt and transform.	Represents the flexibility within organisations to adaptively learn, review and adjust policies and procedures, or to transform organisational practices.
Social and community engagement	The capacity within communities to learn, adapt and transform.	Represents the social enablers within communities for engagement, learning, adaptation and transformation.

4 Parsons M, Glavac S, Hastings P, Marshall G, McGregor J, McNeill J, Morley P, Reeve I & Stayner R 2016, Top-down assessment of disaster resilience: A conceptual framework using coping and adaptive capacities. International Journal of Disaster Risk Reduction, vol. 19, pp. 1–11.

Enhancing emergency warnings

Nathan Maddock, Bushfire and Natural Hazards CRC

With the multitude of warnings issued when an emergency hits, how can emergency services ensure their critical safety advice is received and acted upon, rather than dismissed as noise? Bushfire and Natural Hazards CRC research undertaken through the Queensland University of Technology is helping emergency services warn communities when danger strikes.

The research involves testing the wording and structure of warning messages to better understand how messages are understood and how they might be translated into direct action. The Connecting Communities and Resilience team, led by Professor Vivienne Tippett, is supporting both individual organisations and national initiatives, providing reviews and assisting with the development of evidence-based warning doctrine.

The researchers are collaborating closely with the industry, with the Inspector-General of Emergency Management Queensland, Queensland Fire and Emergency Services, Emergency Management Victoria, Victoria State Emergency Service, Country Fire Authority, NSW State Emergency Service, Country Fire Service, the Department of Fire and Emergency Services Western Australia and the Bureau of Meteorology all requesting reviews of their warnings information.

Katherine Philp, Manager Regional Engagement at the Bureau of Meteorology, believes the research is providing valuable insights that will make a difference.

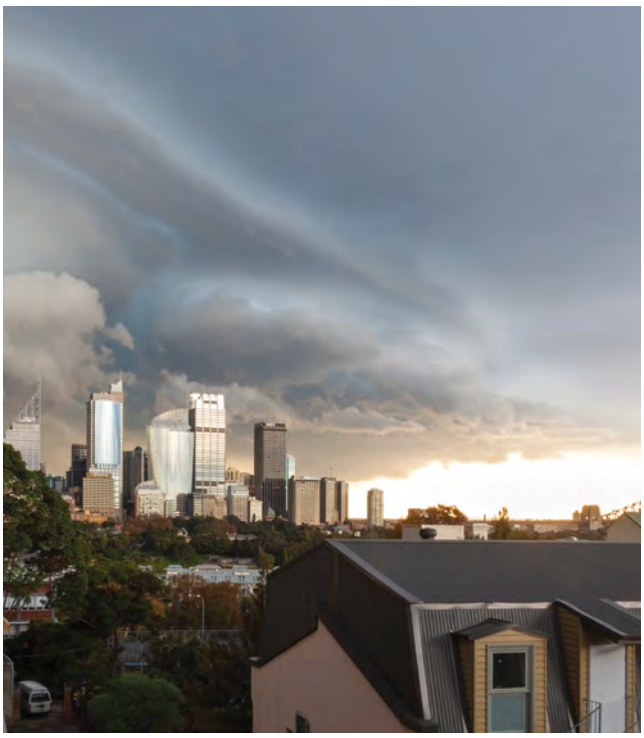
'We are working to constantly improve our communication, particularly during severe weather, so the observations and findings of this research are of huge interest,' Ms Philip said.

Local councils are also benefiting. The Bundaberg Regional Council is looking at the frequency of their warnings, the wording of the information they disseminate during an emergency, and the delivery methods.

'Improvements to existing, pre-formatted warnings will be captured in the next review of the Bundaberg Local Disaster Management Plan and subordinate plans,' said Matt Dyer, the council's Disaster Management Officer.

The council is also considering how to involve the community in future warnings development and identifying how local citizens could best receive warnings that are effective and timely.

'Minds have been expanded; opportunities have been glimpsed and a realisation had that there is an existing and emerging body of information that can be integrated into local arrangements. The Bundaberg Local Disaster Management Group is proud to model an example of how to build relationships across sectors to the greater disaster management good,' Ms Dyer said.



Research is informing emergency warnings for storms, fires, floods and cyclones.

Image: cksydney, Flickr

SEQwater, a statutory authority in Queensland, is also benefiting from the study. The organisation has sought input from the team on how to improve their messaging about releasing water from dams during a flood. The aim is to achieve proactive action by the community.

This research has wide-reaching implications. The Australian Broadcasting Commission local radio in Wide Bay, Queensland is working with the research team to look at ways they can improve their emergency broadcasting.

50 years of firebombing operations

James Kightly, Vintage Aero Writer

On 6 February 2017, a small ceremony at Benambra in Victoria marked the 50th anniversary of the first organised operational firebombing flights in Australia. Back in 1967, two Piper Pawnees airplanes contracted from Alpine Aviation made the first operational drops of fire retardant on a small fire caused by lightning-strike in north-eastern Victoria. It was what has become a classic application of firebombing.

Both pilots involved, Ben Buckley and Bob Lansbury, now in their eighties, still fly and are still friends. Ben attended the commemorative event and spoke about that day back in 1967.

'We'd dump on the flanks and then across the head of the fire. The fire would burn up to it, but the Phos-Chek would supress the burn, able to slow it right down, and then the ground team went in to make it 'safe' afterwards,' he said. Of the ceremony, he added: 'Yes, I understand it was the first official—I see they've put that it, 'official' – fire bombing effort in Victoria—and Australia.'

Previous experiments, and fire spotting aside, this was the first operational job. And the progress has been huge. In the 2015–16 season under National Aerial Firefighting Centre contracts, 127 sophisticated aircraft operated across Australia and undertook 2525 firebombing operations and 2411 other fire and emergency support operations, making more than 29 500 firebombing drops. These drops delivered in excess of 68 million litres of fire retardant and suppressant across the country.

Bob Lansbury flying one of the Pawnees used that day, VH-GWS, here seen on a later aerial seeding flight.

Image: NAFC

The Benambra firebase in full use a few years later, with a Fletcher F-24. being loaded with retardant.

Image: Tim Crawford

Forests Commission Overseers Noel 'Mopsy' Fraser (left) and Neil Hodge in front of a Transavia Airtruk in the early 70s. Both men were involved in setting up the original trials and the mixing base.

Image: Ben Buckley

Reflections on Tasmania's Black Tuesday 1967

Hansika Bhagani, Australian Institute for Disaster Resilience

The worst bushfires in Tasmania's history, the Black Tuesday bushfires of southern Tasmania, involved 110 separate fire fronts that tore through 2640 square kilometres of land across the region. Many small towns were burned to the ground. The fires claimed 62 lives in a single day with 900 injured and thousands of people left homeless. In terms of loss of property and loss of life, Black Tuesday is considered to be one of Australia's worst disasters.

Tasmania Fire Service's Gerald Crawford was just 14 years old then and remembers 7 February 1967 well.

'I was going to high school just north of Hobart. I remember there being a lot of smoke. It was very hot and windy, but we didn't know what was going on because there was no technology like we've got these days to let people know what was happening.

'It was a very strange day in that everyone went home from school at midday. I was from a farming area and it was impacted by the fires, which would have been the same for a lot of the other boys who were at school as well. I went back to the boarding house with a few other boys not knowing whether our families and our properties were still safe.

'In most areas the phone lines were down. It was at least two, if not more, days before my mother rang. Mum let me know that our house and property were safe but one of my grandparent's farms had been completely wiped out,' he said.

Mr Crawford attributes the survival of his grandparents to luck rather than planning.

'In those days, no one had a fire plan. In country areas no one took much notice. There was the odd fire or two and they dealt with them, but large fires like that were beyond the imagination and scope of most people. In the built-up areas of Hobart and a lot of the towns that were burnt out, people there would never have imagined what happened that day.

'I went back to school and life went on the same as it normally does after a disaster event. Things started to be rebuilt and people got back to some normality. In some cases it took years and years on farming properties to get back to normality where they'd lost everything or a significant amount of stuff; to get all the fences back, stock up and running. You can't do that overnight. It takes years. And to lose 62 people in one day in a small populated area like Tasmania was a major catastrophe,' he said.

Only five years later Mr Crawford joined the Rural Fires Board; a new authority with a big mandate.

'As a result of Black Tuesday, the Rural Fires Board of Tasmania was set up. Prior to that there was no effective firefighting force for areas outside of the major metropolitan areas in Tasmania.

'There were some brigades but they were very rudimentary compared to what we've got today. The Rural Fires Board job was to set up lots of volunteer brigades across all of Tasmania, which they did very successfully. We also embarked on a very large program of putting in fire trails in different areas. As the years went on, a lot of those things just slowly went away. The volunteer system kept going but our preparations with fuel reduction burning and trail work just died off. It's only in the last two years, after the fires in Dunalley in 2013, that Tasmanians have started to put the pressure on the government to form a fuel reduction unit to look at burning off strategic areas throughout the state,' he said.

Mr Crawford's 45 years in the Tasmania Fire Service has mostly been in operations. He is set to retire later this year and is keen to reflect on the changes that have come in through increased firefighting capability and technology since Black Tuesday.

'We've certainly come a very long way since 1967. We've got a lot of programs now that our communities can become involved in. Our school fire education program teaches kids about fire safety in the home and a bit about bush firefighting. We've got our juvenile fire lighter intervention programs where we deal with kids who are lighting fires and try and put them on the right track. We've got fire safety home visits where we look at homes for elderly people and give them an assessment as to whether their home is safe and things they should do to reduce their risk in a house fire.

'We've got very good brigades in most areas. We're starting to suffer, as most other states are, in relation

Gerald Crawford, Mathew Healey, DPAC Bushfire Recovery Unit and the late Mayor of the Central Highlands, Ms Deidrie Flint OAM.

Image: Gerald Crawford

to volunteer numbers in remote areas. Fifty years ago a lot of the larger farms had a considerable number of people working on them and those people were available to join the local brigade. These days with the changes in technology and methods of farming, lots of the large farms might have only one or two people. The numbers are not there to sustain a lot of our more remote brigades,' he said.

Prior to 1967, Mr Crawford explained, the warning system for residents was rudimentary.

'The warning system was someone saw smoke, they rang the police and the police would ring the local fire warden who would make phone calls to get people to help put the fire out.

'These days we have spotter flights, we have fire towers and people with mobile phones are reporting fires.

As soon as there's a bit of smoke you can guarantee the fire is reported. On our database we can see whether that fire is one that is lit with a permit, if it's a non-permit fire, or if it's not one of those two, it's a wildfire and we can dispatch a brigade and deal with it,' he said.

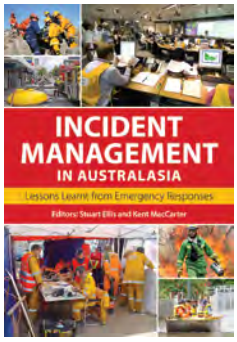
Yet Mr Crawford is pragmatic about the chances of a Black Tuesday re-occurring.

'Mother Nature and fire are two things that are uncontrollable in a lot of cases. Since 1967 we've had the 2009 fires in Victoria and fires in Western Australia and NSW where people have been lost. Fires will always happen. It's a question of when. If it's getting dry, there will be more fires and those fires will be harder to contain. But people have reliable avenues now to seek advice, either from Tasmania Fire Service through the phone or online, or through local radio. The information is there, people just have to access it,' he said.

The Bushfire and Natural Hazards CRC has released a free documentary that relates the incredible stories of the fires. The film was developed by the Bushfire CRC in 2005 with the support of the Tasmania Fire Service. Watch it online at **www.bnhcrc.com.au/resources/presentation-audio-video/3361**.

The Tasmania Fire Service has a new online resource: Stories of the '67 Fires at **www.67bushfires.fire.tas.gov.au**.

Incident Management in Australasia: Lessons Learnt from Emergency Responses



Dr Valerie Ingham, Charles Sturt University

Edited by Stuart Ellis and Kent MacCarter

CSIRO Publishing: Clayton, Victoria

ISBN 9781486306176

Despite the encouragement to do so, it is a brave person who writes of their 'could have done better' moments for public release. The Australiasian Fire and Emergency Service Authorities Council and the book's ten contributors have recognised the need to move beyond blame and better prepare aspiring incident managers through a frank reflection on the thoughts, feelings, fears and triumphs associated with tough incident management.

The book is a compilation of experience, exhilaration and warning and it makes inspiring reading. All contributors clearly present their organisation and jurisdiction to provide readers with their situational context. Systems, processes and acronyms are briefly outlined and minimal pre-knowledge is assumed. As the editor, Ellis states that this book is not to be viewed as academic, but rather it contains the stories of incident managers.

Each contributor puts their heart on the line to explore a particularly challenging incident in which they were heavily involved. The book is specifically compiled for those who are hungry for the inside story of incident management. It is also for those aspiring to lead in catastrophic unpredictable situations where decisions must be made rapidly with sparse pieces of information, conflicting reports and lots of background 'noise'. Each of the ten incidents takes the writer 'beyond our knowledge, skills, experience and imagination' (Crosweller, p. 175). The lessons learnt across the book move from the subtle echoes of warning and caution to obvious enthusiasm for the job of incident management.

Euan Ferguson and Mark Crosweller engage themselves in every page, revealing thoughts and reflections not evident in the report writing style of other contributors. The range of writing styles is a strength of the book. In the Wangary Fire (Chapter 1) Ferguson explains how he negotiated the public – private terrain of self-management. The account of the Hobart Myer building fire by Gavin Freeman is a fast-paced narrative of a difficult to decipher fire. Freeman is a natural story teller and his gripping description is interspersed with wry humour.

Trevor White's reflection on the 2011 Victorian floods provides a candid description of the triumphs and failures of communicating information and warnings to the community. White also provides a helpful progress report on changes made since the Victorian floods. This significantly strengthens his contribution as the reader can see the application of lessons learnt, a feature shared by Greg Leach (Linton fires), but generally absent for other chapters. Bob Conroy's description of firefighter entrapment during a routine hazard reduction burn at Mount Kuring-Gai Kuringai is a sobering recount of tragic events. His poignant lessons learnt focus on the nature of gruelling inquiries and public scrutiny, providing a cautionary note to all aspiring incident managers. Other chapters range from a chemical spill (Leigh Swift), a petrochemical fire in Adelaide (Roy Thompson), a couple of floods (Bundaberg, John Watson) and Stuart Ellis contributes from the 2011 Christchurch earthquake.

Quite unselfconsciously this book reflects the struggle of Australian emergency services to realign a male dominated arena, as there are no female contributors. Readers are not made privy as to how contributors were selected. Was it magnitude of incident? diversity of incident? volunteered to write?

A fuller introduction, including an encapsulation of the brief provided to the writers, and whether the chapters are designed to be read sequentially or in any order for maximum benefit, would better situate readers. In addition, the book was weakened by the missing last chapter. In such a challenging and complex collection of incidents I would not expect a simplistic compilation of 'lessons learnt', however some effort could have been made to debrief the common and disparate chapter threads into a concerted appeal for the future development of incident managers. This would have strengthened the purpose and application of the work as a whole.

Case studies naturally lend themselves to reflection and lessons learnt. I feel certain that any number of educational programs will greatly benefit by assigning readings from this book. I highly recommend *Incident Management in Australasia: Lessons Learnt from Emergency Responses* as a candid reflection on leadership in time-pressured incidents.

ABSTRACT

There is growing recognition within the Australian emergency management sector of the need to engage communities as core partners, where they are considered equals in risk-related decision-making processes that affect them (Attorney-General's Department 2013). There is, however, little guidance available to practitioners about how best to involve communities in risk reduction processes and little evidence on which to build approaches. To address these gaps, the New South Wales State Emergency Service (NSW SES) instigated a pilot program to investigate and evaluate methods to involve communities in flood emergency planning within three NSW communities. This paper outlines the pilot process, the design of programs and evaluation results.

Community participation in emergency planning: NSW State Emergency Service case study

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Introduction

Emergency planning in Australia has traditionally been inwardly focused on the roles, responsibilities and strategies of emergency management agencies (Gissing 2016). In recent years, however, there has been greater recognition of the need to involve the community in emergency planning (Comrie 2011, Paton & McClure 2013, Pearce 2003), where community members are considered equal partners in decision-making relating to mitigation, preparation, response and recovery.

Traditional emergency management approaches have recognised citizens as spectators rather than active participants in decision-making (Wehn *et al.* 2015). This is reflected in the practice of many emergency service community engagement approaches that have employed multiple one-way communication tools to inform and educate the public about the risks they face (Attorney-General's Department 2010).

Many top-down or one-way approaches to communication assume the community to be a uniform group of individuals with the same values and needs (O'Neill & Wales 2004). This view is simplistic and the process of effectively informing the public is far more complex (Arnstein 1969). It is critical that the design and implementation of programs for communities be based on a good knowledge of the community (Phillips *et al.* 2011). Without such knowledge, programs may fail to take into account the public's experience, knowledge, interests, concerns, fears, values, priorities and preferences, and ultimately fail (Bier 2001, Bird *et al.* 2009, Bird *et al.* 2010, Haynes *et al.* 2007, Haynes *et al.* 2008). When communities are not involved, they may also question decisions that have been made during response operations (Pearce 2003).

In order to gain a greater understanding of the community, various participatory-based methodologies may be applied including scenario planning, citizen science (Goodchild 2007), future search, citizen's juries (Brown 2006), crowdsourcing (Bird *et al.* 2012), focus groups, drills (Wood & Gilk 2013) and participatory mapping. However, while there is a growing number of case studies using participatory approaches in emergency management, community participation in planning and decision-making has not been well evaluated. There are often difficulties in successfully evaluating the effectiveness of engagement programs due to the length of time it takes for behaviour change to occur and that true preparedness benefits cannot

be measured until an emergency or disaster occurs. When evaluated, however, positive benefits have been identified (Benson *et al.* 2016, Daellenbach *et al.* 2015, Risk Frontiers 2016, Redshaw *et al.* 2016, Jamshidi *et al.* 2016, Cottrell 2005). Benefits include stronger local relationships, enhanced social capital and improved understanding of risks (Haynes & Tanner 2015, Daellenbach *et al.* 2015). Positive benefits of participatory-based approaches have also been identified in the evaluation of public health and environmental management programs (Bath & Wakerman 2015, Reed 2008, Curtis & Lockwood 2000, Charnley & Engelbert 2005, Luyet *et al.* 2012). Nevertheless, it must be acknowledged that public participation is not without risk. Processes can be time consuming and expensive and they can generate stakeholder frustration, identify new conflicts or fail to empower a broad cross section of the community (Luyet *et al.* 2012).

The *National Strategy for Disaster Resilience Community Engagement Framework* places strong emphasis on the need to work with communities, stating that engagement means:

> *'working in partnership with the community, building on existing networks, resources and strengths, identifying and supporting the development of community leaders and empowering the community to exercise choice and take responsibility'* (Attorney-General's Department 2013, p. 3).

The framework acknowledges that community engagement must be central to the business of the emergency management sector, being fully embedded within its culture, vision, policies, procedures and practice (Attorney-General's Department 2013).

Positively, there is a growing policy shift both within Australia and abroad to move towards participatory-based approaches. For example, the 100 Resilient Cities Challenge identifies shared ownership of decision-making as an integral attribute of a city that can withstand, respond to and adapt more readily to shocks and stresses (100 Resilient Cities 2016). This same sentiment lies behind the realisation by the U.S. Federal Emergency Management Agency (FEMA) of the need for a community-centric approach (FEMA 2015). The *Sendai Framework for Disaster Risk Reduction 2015–2030* also advocates a 'shared responsibility' model (UNISDR 2015, p. 6), where sharing refers to community involvement in disaster risk reduction.

There are numerous examples in Australia, including those led by the NSW SES, of the application of community participatory-based approaches. Some of these include NSW SES involvement in townships of Eugowra (Gissing *et al.* 2007), Uranquinty (Leckie & Richards 2015) and Uki community-based planning projects including the Blue Mountains Heads Up For Fire Project (Redshaw *et al.* 2016), Emergency Management Victoria's community emergency management model (Emergency Management Victoria 2016), ACT and NSW Fire and Rescue Community Fire Units (Risk Frontiers 2016, Lowe *et al.* 2008), initiatives by local governments such as Melton and Wyndham councils' Emergency Ready Communities programs (Mason *et al.* 2016) and faith-based communities developing plans such as the Jewish Emergency Management Plan in Victoria (JEMPvic Community Support 2016).

Reed (2008) emphasises the need to abandon a toolkit approach in favour of placing emphasis on participation as a process, which is underpinned by an appropriate philosophy and considers on a case-by-case basis how best to engage relevant stakeholders. Irvin and Stansbury (2004) showed that if community members are misled into thinking their decisions will be implemented but in practice they are ignored then resentment may result. This paper outlines the development and results of a pilot program led by NSW SES to pilot and evaluate methods to enhance the involvement of communities in emergency planning.

Methodology

Two consulting groups, Risk Frontiers and Molino Stewart Pty Ltd, were engaged to assist NSW SES to undertake the project. The objective of the project was to design and test an evidence-based framework for the application of engagement processes that enable community participation in emergency planning. A range of localised strategies to engage communities in NSW SES-led emergency planning are defined.

A review of the international literature and a series of interviews with subject matter experts were undertaken to develop a series of evidenced-based principles to base the design of engagement programs upon. Based on the design principles, consultation with local community stakeholders, social analysis and an understanding of local flood risks, a series of engagement activities were designed for piloting across three different communities – Narrabri (northwest NSW), Burringbar/Mooball (north coast NSW) and Chipping Norton (southwest Sydney) (see Figure 1). These locations were chosen by NSW SES based upon their flood-prone nature, buy-in by local volunteers and to involve a variety of coastal, regional and metropolitan communities.

Key characteristics of these communities are:

- Narrabri has a population of 6000 people and has significant riverine flood risk affecting large parts of the town. The most recent major floods occurred in 1998 and 2000.
- Burringbar and Mooball are small adjacent towns with a combined population of approximately 1000 people. Flash flooding can affect properties within the towns and can result in the communities becoming isolated with less than six hours lead time.
- Chipping Norton is located in the Georges River catchment near Liverpool, Sydney. Flooding from the Georges River can affect large parts of the area. The most recent severe floods prior to the pilot were in 1986 and 1988 (Bewsher Consulting 2004). Minor flooding within the Chipping Norton area has also occurred since the pilot in June 2016.

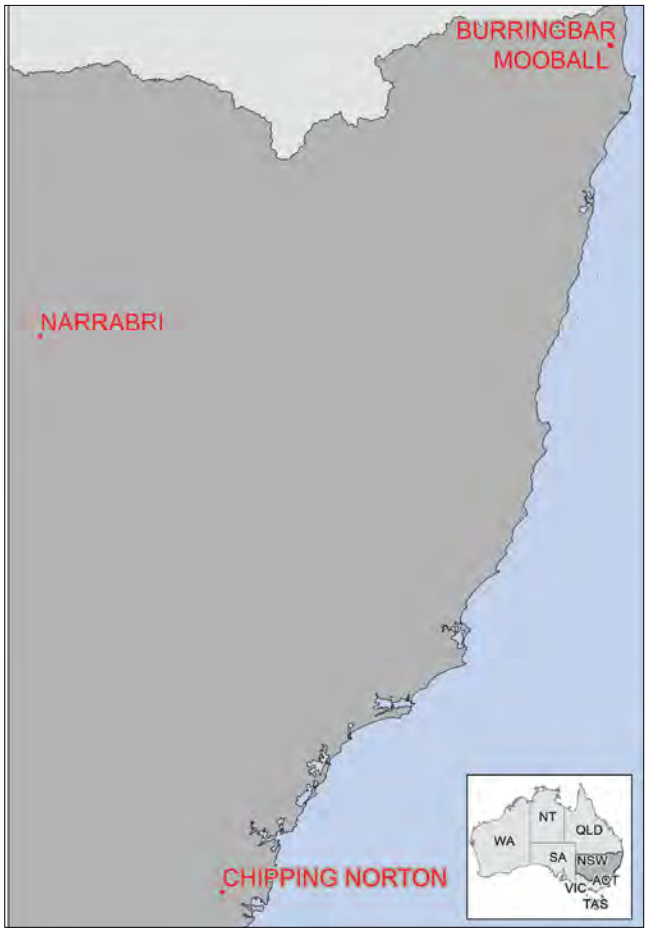

Figure 1: Location of pilot communities in NSW.

Reference groups consisting of community members, NSW SES members, local councils and other emergency services were established across the three pilot communities to assist in understanding the community and gaining local perspectives of the best methods for engagement. Due to time constraints members were recruited by direct invitation from the NSW SES after initial consultations with individual community members and a high-level social network analysis. Community members recruited were generally regarded as community leaders representing specific community networks. The groups were established with community participation in Narrabri and Burringbar/Mooball. Despite attempts no community representatives (i.e. non-NSW SES members) were recruited in the Chipping Norton area. Reference group meetings lasted for around two hours and were led by an independent facilitator. One meeting was held in each pilot community with follow-up conversations occurring with specific members on an as-needed basis.

Specific objectives were set for each pilot community. These included, among others, improving evacuation plans (Narrabri), developing flood plans (Burringbar/Mooball) and improving flood awareness and acknowledgement of the need for planning (Narrabri, Chipping Norton, Burringbar/Mooball).

Pilot engagement activities of workshops and online exercises (Narrabri and Chipping Norton only), were conducted across the three pilot areas from 27 April 2016 to 8 May 2016. The workshops were attended by community members and supported by NSW SES members. The workshop activities, tailored to each community, included small group discussions to consider warning systems and evacuation planning, social network mapping exercises, presentation of previous community-led initiatives, participatory mapping and group discussion of previous flood experiences.

Online engagement using Facebook and the NSW SES Have Your Say website was largely focused on motivating discussion by posing a series of questions related to emergency planning including:

- How can people and local communities better prepare?
- What is the best way to receive flood warnings?
- If you were told to evacuate where would you go and how would you get there?
- How can you and the community get back to normal after a flood?

Community attendance registered in the workshops were:

- Narrabri – 15 people
- Burringbar/Mooball – 16 people
- Chipping Norton – 5 people.

Across the groups, the age of participants varied from under 20 years old to older than 70 with representation across all adult age groups. Some 59 per cent of participants were male and 36 per cent female. Most described themselves as either a resident of a flood-prone community or a community or service group member. In total, 85 per cent of participants had previously experienced a flood.

In addition to these activities, a series of interviews was undertaken with a variety of NSW SES community engagement staff and managers to assess the capacity and culture of NSW SES to support community participation in emergency planning.

The evaluation of the project was summative in nature. It focused on the process involved and the outcomes of the project, and was undertaken in a structured manner. Primarily, success indicators were measured based on perceived achievement of the objectives stated in the design of each of the pilots.

Specific methods undertaken to evaluate the pilot project included:

- Qualitative structured interviews with key stakeholders involved in the project. This included NSW SES, local government representatives and an independent facilitator. Interviews explored the key successes and challenges of the pilot, identified future opportunities and evaluated the achievements of the activities against the program objectives.
- Surveys to collect quantitative data to ascertain possible changes as a result of pilot activities. Participants completed a short survey either online or via hardcopy survey forms before and after the engagement activities in each of the pilot areas.
- Analysis of social media posts and associated analytics to ascertain levels of community engagement with questions posed by NSW SES.

Pilot results

The pilots were well supported by the NSW SES members involved. Although the number of community members directly engaged through the process may be viewed as small, the process engaged with leaders who have influence within their communities. It was identified via the post-activity survey that these participants already had (57 per cent), or intended to, (83 per cent) spread the word within their communities.

Significant benefits were identified within the Narrabri and Mooball/Burringbar pilots including:

- improved relationships between NSW SES and the community
- a wider appreciation by the community of flood risks and emergency management problems
- improved awareness of NSW SES roles and of the NSW SES local Flood Plan
- improved awareness by community members of their roles
- improved engagement capacity of NSW SES volunteers and staff, having gained awareness and experience of implementing methods involving community participation.

In the regional pilots there appeared to be enough momentum generated to see relationships continue to develop and for local community initiatives to be built. NSW SES have continued to build on these relationships after the completion of the pilots.

Though not as successful due to issues relating to the limited time available and the inability to gain traction with the local community, the Chipping Norton pilot still provided benefits:

- Improved knowledge of NSW SES volunteers and staff about local flood risks and community engagement techniques.
- Confirmation of the challenges involved with engaging with metropolitan communities, where community networks are diffuse, and not necessarily defined by a geographical area.

Engagement through workshops in Narrabri appeared to be more successful than online engagement. In Chipping Norton both the opportunity to engage face-to-face and online did not generate significant community interest.

Community reference groups consisting of community leaders to assist in the design of engagement approaches were found to be beneficial, though it is important that members of these groups understand their roles and the purpose of the group.

Community members were mostly positive about their involvement with all suggesting they would encourage others to take part in emergency planning activities. Participants identified advantages of the process as an opportunity to share their experiences and to engage with authorities about flood issues. The disadvantages identified related to the lack of time to explore issues in full and the opportunity cost of their attendance.

Key challenges that were identified through the pilot process:

- The need to allocate time based on consultation with the community, and to not dictate timelines to the community. Time was a critical limitation across the three pilot areas, resulting in insufficient time to engage with communities to the extent desired.
- The need for an existing awareness of flood risks. This was illustrated in the community of Burringbar where community leaders did not believe there was a flood risk and subsequently did not engage in the pilot. This points to the need for participatory-based approaches to be supported by engagement methods focused on raising the critical flood awareness of communities.
- A skilled and independent facilitator is highly valuable as existing conflicts or issues can make it difficult to initially engage with communities.
- Engagement with other agencies is important to gain support for initiatives. This can take time and a range of engagement methods to achieve support.

Results of interviews to assess the capacity of the NSW SES to support participatory approaches underlined the importance of the organisation's culture in the approach. Actions identified to build a supportive culture include:

- achieving buy-in from senior leaders
- having a clear strategy and an evidence base to support engagement method
- continued evaluations to measure success and identify learnings
- building organisational community engagement capacity.

Discussion

Based on a review of the international literature, interviews with subject-matter experts and the results of the pilots, the following principles were developed to inform the design of future participatory-based programs.

Understand the community – the implementation of community-based planning should be based on a thorough understanding of the full diversity of the at-risk population in terms of needs, vulnerabilities and resiliencies (Daellenbach *et al.* 2015, Phillips *et al.* 2011). Stakeholders include the community, local government and non-government organisations, businesses and other emergency services need to be well understood and represented within engagement processes.

Engage early and often - community involvement should be considered from the beginning and throughout the engagement process (Reed 2008, Luyet *et al.* 2012).

Allow sufficient time – timeframes should be identified with the community and not dictated to them (Luyet *et al.* 2012).

Be flexible and tailor approaches – participation methods should be tailored to the context (Paton & McClure 2013, Reed 2008). There will not be one single approach that

works across all contexts or every time, the process needs to be flexible (Daellenbach *et al.* 2015). A flexible approach is required to account for the complexities and the various commitments of community members, including time (Young 1998).

Agree on objectives from the outset – objectives need to be agreed among participants, especially the community from the beginning (Reed 2008).

Acknowledge the community as equals – community members must be empowered to participate and be acknowledged as equal partners where their input is recognised as an important and equal contribution to decision-making. Equality must also exist between participating community members (Reed 2008).

Engage in two-way dialogue – community participation should be based on mutual respect and trust and involve two-way deliberative dialogue dealing with the public value of propositions. This results in decision-making that is negotiated between all relevant stakeholders in a transparent manner. Community expectations need to be managed. Where community members will not be able to influence a decision then participation is not appropriate and communities should be made aware of why (Reed 2008).

Use skilled facilitation expertise – facilitation perceived as independent, open to differing views, approachable and across technical details is essential to achieving an effective outcome (Reed 2008, Attorney-General's Department 2010, Luyet *et al.* 2012).

Use expert and local knowledge – institutional, scientific and local hazard risk knowledge, including that provided by emergency service members and local communities, must be used. Two-way learning between participants should be encouraged (Reed 2008, Young 1998). There may be a need to raise critical hazard awareness prior to implementing participatory-based approaches.

Use and build social capital – strong social capital including local relationships and local capacity is as a critical enabler. Community involvement in planning should be designed to build and support social capital (Dufty 2010).

Evaluate programs – a process of frequently evaluating and learning is essential to ensure the improvement of future programs (Australian Government 2010, Charnley & Engelbert 2005, Dufty 2010). Communities should be involved in the evaluation process and evaluation design should be considered from the outset. Learnings should be incorporated into future practice (Charnley & Engelbert 2005).

Foster a culture of community participation – an organisation's culture and leadership must champion the involvement of community members in decision-making throughout the disaster management cycle (Reed 2008, Attorney-General's Department 2013).

Conclusion

The evidence obtained from the pilots and associated research shows there are significant benefits to adopting participatory-based approaches to emergency planning and in building community resilience. Though only small numbers of people were involved in the pilots, engagement occurred with community leaders, and there is evidence that these people have, or intend to have, discussions about the activities within their networks.

The adoption of participatory-based approaches to engage with communities is encouraged throughout all phases of the disaster management cycle. However, the approach should not be seen as a silver bullet for generating behaviour change or building resilience. To be successful approaches need to be combined with other methods of community engagement and have the capacity to experiment within individual communities to ascertain the most effective approach. There is not a standard one-size-fits-all approach to involving the community, however, a series of evidence-based principles have been provided to guide the development, implementation and evaluation of participatory-based approaches to emergency planning. Fixed organisational-based objectives should also be avoided, as ultimately, these should be negotiated with communities so as to reflect their concerns and values.

To be successful the culture of emergency management agencies must be considered. Without a supportive culture a successful uptake of participatory-based approaches is likely to be unsuccessful. The emergency management sector must continue to build on its rhetoric regarding embracing communities and adopt a true community-centric approach to emergency management, recognising community engagement as equal to emergency response functions, and that the community is an equal and active participant in emergency management. Not only will the emergency management sector's approach need to change before events, its engagement with the community will need to become more open and foster community trust across all other elements of the disaster management cycle.

Further work is required to test the effectiveness of the design principles in metropolitan communities, possibly using a social, faith-based, cultural or business network engagement approach rather than one defined by a geographical area.

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Emergency preparedness through community sector engagement in the Blue Mountains

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ABSTRACT

There is an expectation that communities exposed to potential disaster events will make preparations for themselves (COAG 2011). However, communities are frequently underprepared for the onset and results of disaster and a default response is to rely on emergency services organisations. This reliance is exacerbated by the presence within communities of highly vulnerable individuals who, because of age, infirmity or isolation, require additional levels of assistance by responders. Partnerships between community organisations and emergency services organisations can build preparedness by using programs that increase emergency response awareness. This paper provides a study of two partnership programs established by the community and emergency services sectors in the Blue Mountains, New South Wales. These programs successfully raised the level of emergency preparedness and community resilience to disasters.

Introduction

According to Thomas and Lopez (2015), the frequency of climate-related natural disasters is rising and communities need to assess their risks and prepare for emergency events. The *National Strategy for Disaster Reduction* (COAG 2011) calls for increased responsibility on the part of communities and individuals, however what constitutes community responsibility is not completely clear.

Community organisations include neighbourhood houses or centres, and other agencies that deliver family and community services. Community organisations inherently have a deep understanding of their community, have strong networks and employ local residents. In NSW neighbourhood centres are mandated by the Department of Family and Community Services to enable connections within communities and build capacity and community wellbeing. Although some community organisations may be connected with emergency services organisations and agencies, they are not generally included in emergency planning and response. Being effectively involved in emergency planning is an important contribution to their mission to enhance community wellbeing.

Sharing responsibility at a community level involves partnerships with emergency services organisations and other government and non-government organisations with roles to play in emergency and disaster management (e.g., Red Cross, Rural Fire Service (RFS), State Emergency Services (SES) and Police). Partnerships of this nature allow different levels of connection within the community and provide programs at household, neighbourhood and community levels.

Research in Australia and elsewhere indicates that households are often not adequately prepared for a disaster even in disaster-prone areas (Cretikos *et al.* 2008). Adequate preparation can help to reduce the immediate damage of a disaster as well as equip people to look after themselves in the immediate aftermath of the event (Kapucu 2008).

Previous research on connected communities indicates that people in the Blue Mountains did not have adequate resources or assistance to manage during a disaster. In particular, people with chronic conditions such as mental illness, people living alone, single parents and people over 75 years of age were less likely to cope adequately and recover quickly. This situation is exasperated as some people are in all three categories (Redshaw *et al.* 2015).

Householder preparedness includes developing family communication and evacuation plans, maintaining a disaster supply or emergency kit and being informed about home emergency preparedness (Diekman *et al.* 2007). A key aspect of community resilience is preparedness, which is considered to include cultivation of individual wellbeing and intentionally engaging in preparedness, so that readiness becomes more than risk management; it becomes an integrative, fluid and health-promoting state that facilitates adaptive post-disaster trajectories (Gowan *et al.* 2014).

Community networks in the complexity of preparedness include personal and contextual factors such as health status, self-efficacy, community support and the nature of the emergency (Levac *et al.* 2012). Ratnam and colleagues (2016) include 'place attachment', which is bonding of people to place, as a factor of people's risk perception. In addition, interaction between neighbours has been shown to be effective in motivating people to prepare for disaster (Paton *et al.* 2008). It is evident that if householders begin to embrace preparedness measures others in the vicinity will also be inclined to do so. Promoting discussion among neighbours to consider required measures increases the likelihood of action being taken.

Kim & Kang (2010) argue that:

> *Building a community-level communications environment where individuals can develop an integrated connectedness to different community storytellers (such as the local media, community organisations and neighbours) should be the first and most critical step in helping residents prepare for various natural disasters.* (Kim & Kang 2010, p. 484)

Kim & Kang (2010) show that community organisations play an important role in community communication. Their findings indicate that pre-disaster messages about damage and consequences were more likely to motivate people to act. People who believe 'it won't happen to me' are more likely to relate to impacts on the community than on themselves (Kim & Kang 2010, p. 484).

People involved at a community level are essential to extend engagement and preparedness. For this paper the communities of the Blue Mountains (which is heavily forested and subject to bushfires) are examined. The purpose is to evaluate and present the effectiveness of fire preparedness initiatives.

Case Study: Blue Mountains fire preparedness

Communities in the Blue Mountains are frequently confronted with the threat of fire. The community sector and the emergency services sector have come to work with each other in a partnership that bolsters the overall capacity and ability to reach households and assist the community members with specific needs when planning responses to events. After major fires in 2013, a working group was formed with both sectors represented. The working group initiated the Blue Mountains Sustainable Approaches to Fire and Emergencies (BSAFE) project. The project was designed to build on a number of existing, stand-alone community engagement and education activities and household preparedness learning practices.

Analysis of the outcomes of two preparedness initiatives are reported here. The principles derived from the analysis have general applicability across different disaster scenarios.

More Than a Fire Plan

More Than a Fire Plan (MTFP) is a structured, two-hour seminar held in central locations in the lower, mid and upper Blue Mountains with presentations from emergency services personnel. The information provided allows people to understand the functions of each service. In the seminars the RFS presents on preparedness and Red Cross presents on emotional preparedness. Presentations from SES and Police are included where officers are able to attend.

Meet Your Street

Meet Your Street (MYS) events are barbecues organised in local parks in settlements in the Blue Mountains. The events are attended by neighbourhood centre staff and RFS representatives. At these events a survey was used for staff to have conversations with people about fire preparedness.

Communities in the Blue Mountains are surrounded by bush and frequently confronted with the threat of fire.

Image: Mary Lou Keating

Method

Procedure

Ethical approval for conducting the research was provided by Charles Sturt University. At each MTFP and MYS event participants were asked to complete a survey. Preparedness questions included whether householders had talked about fire preparedness plans, made evacuation plans, practiced their plans, created emergency kits, prepared the house and grounds for bushfire and had contact details of neighbours.

Post-survey follow-up included contacting participants in the programs who had agreed to be contacted. This was initially by email and then by phone to complete the follow-up survey. The follow-up survey contained basic demographic and preparedness questions based on the initial survey.

Participants

Preparedness programs evaluated under the BSAFE project directly reached over 500 households within the Blue Mountains, with 533 surveys completed. Table 1 shows the number of events and surveys completed. Follow-up responses were obtained with 61 participants. The total number of participants across all programs was fairly evenly distributed across the Blue Mountains villages, with about half of all participants living close to bushland and one third of participants living two or more streets away from bush areas. Approximately two-thirds of participants were female and one third male.

Table 2 provides the age distribution of respondents. About half of the attendees surveyed at MYS events were under 50 years of age, whereas participants at MTFP events tended to be older.

Table 3 shows that most respondents in all groups lived with other people. The proportion of respondents living alone was lower for MYS.

Follow-up surveys were completed by 41 MTFP participants and 20 who attended MYS. The follow-up survey included questions on preparedness measures that could be correlated with the original surveys. There were additional questions relating to conversations and events that had occurred since attending the program.

Results

At MYS events, an average of 33 per cent of respondents said they had met new people. As getting to know more people in the local area, and even better, in their own street, has been demonstrated to increase preparedness (Levac *et al.* 2011, Paton *et al.* 2008, Diekman *et al.* 2007), this can be considered a successful outcome of the MYS program.

Table 4 shows findings on the development of emergency plans from respondents contacted during the preparedness programs (during the intervention) and from respondents contacted for follow-up (post intervention). The data collected was qualitative in nature (the respondents either had undertaken, or had not undertaken, the task referred to in the question). The two sample groups (during intervention and post intervention) were of different sizes and therefore the analysis worked with proportions rather than numbers. It was also assumed that the samples had been drawn independently and randomly from a during-intervention population and a post-intervention population. The significance of the changed levels of responses observed was tested using

Table 1: Event number, totals and gender of those surveyed.

Event	Number of events	Number of surveys	% of males	% of females
Meet Your Street	21	356	32	68
More Than a Fire Plan	6	177	34	66
Total	**27**	**533**	**33**	**67**

Table 2: Survey respondent age groups for each type of event.

Event	<34	35–49	50–59	60–69	70–84	85+
Meet Your Street	17	33	30	15	5	0
More Than a Fire Plan	6	12	29	33	19	1

Table 3: Household composition of respondents for each type of event.

Event	Living with others	Living alone
Meet Your Street	89	11
More than a Fire Plan	75	25

Gatherings with local people for Meet Your Street.

Image: Mountains Outreach Community Services

the z stastic for the difference between two population proportions (see Keller & Warrack 1997, pp. 472–474) with the null hypothesis that there was no difference between population responses during intervention ($p1$) and population responses post intervention ($p2$).

In the initial survey, it was found that although 76 per cent of participants from across the two programs said they had talked about an emergency plan within their household, a much smaller percentage had done anything about it. Of concern was the fact that only 59 per cent of respondents had an emergency plan in place and only 33 per cent of total respondents had actually practiced their plan.

The post-intervention findings were considerably more encouraging. For example, there were significant increases in the numbers who had created an emergency kit, practiced an emergency plan, prepared the house and obtained neighbours' contact details. The results suggested that an increase in the numbers making an emergency plan had risen, although the test statistic lay just outside of the conventional critical value in this case. Of particular interest was the large increase in the proportion of householders who had prepared their home for an emergency.

Although there was no increase in any of the categories for which action was planned, the results showed that those who had previously planned to prepare their house had done so, resulting in a significant fall in this category.

Given the unequal samples and the assumption of randomness and independence, care must be taken in attributing the observed differences to intervention (although they are consistent with the expected impact of intervention on the reported outcomes). A better approach would have been to conduct a matched pairs experiment. In the current context, this not possible as no matching of data between the initial survey and the follow-up survey had been undertaken.

Table 4: Comparison of survey responses during and post intervention.

	$\hat{p}1$	$\hat{p}2$	$\hat{p}1 - \hat{p}2$	z
(A) In Place				
Talked about what I should do	0.76	0.79	-0.03	-0.51084
Created an emergency kit	0.44	0.61	-0.17	-2.52503
Made an emergency plan	0.59	0.70	-0.12	-1.78154
Practiced emergency plan	0.33	0.54	-0.21	-3.09944
Prepared house	0.89	-0.25	-0.25	-4.21008
Neighbours' contact details	0.60	0.74	-0.14	-2.14778
(B) Plan to do				
Talked about what I should do	0.13	0.08	0.04	-0.21926
Created an emergency kit	0.39	0.36	0.03	-0.15161
Made an emergency plan	0.23	0.26	-0.03	-0.69888
Practiced emergency plan	0.35	0.36	-0.02	-0.15501
Prepared house	0.08	0.16	0.16	2.84118
Neighbours' contact details	0.20	0.20	0.00	-0.55172
(C) No Response				
Talked about what I should do	0.12	0.08	0.03	0.797299
Created an emergency kit	0.18	0.03	0.14	2.879949
Made an emergency plan	0.19	0.03	0.15	2.996879
Practiced emergency plan	0.32	0.10	0.22	3.53652
Prepared house	0.12	0.03	0.09	2.367067
Neighbours' contact details	0.20	0.07	0.14	2.595058

Notes: $\hat{p}1$ = proportion during intervention; $\hat{p}2$=proportion following intervention. z = approximately standard normally distributed test statistic. The null hypothesis $H_0 = (p1 - p2) = 0$. z values in excess of 1.96 indicate that the difference is significant to at least the 95 per cent level of confidence.

In addition to the information provided in Table 4, more than half of the participants across the two programs reported they had conversations in their street since attending a program. More than 60 per cent reported having a conversation with particular neighbours about emergency situations. Higher proportions of those attending MTFP functions had conversations with people in their street (54 per cent), with neighbours (76 per cent) and others outside their area (83 per cent) since the workshop. Approximately 40 per cent of those who attended MYS had conversations in their street, 60 per cent with particular neighbours and 70 per cent with friends and family members.

Respondents from both MTFP and MYS were asked, in the follow-up only, who they would seek help from in an emergency. Responses are reported in Table 5. Very few nominated emergency services organisations or community organisations as their source of assistance and slightly more indicated that they would rely on family or friends. By far the majority said that they would not need help.

Table 5: Sources of emergency assistance.

Survey responses	% of total responses
Emergency services or civil defence would help me	5
Family or friends would help me	10
I don't know who would help me	8
I or my family wouldn't need help, I could evacuate myself	59
My neighbours would help me	7
People living in my home with me would help me	8
Someone from a community organisation would help me	3

The follow-up survey included questions on the level of confidence respondents have in taking particular actions when confronted with a bushfire event. The responses are reported in Table 6 and indicate, as might be expected, that people are more confident about taking shelter or evacuating than they are about combating the event. In keeping with this, more people had defined plans to leave and few had plans for circumstances where they might have to stay in place.

Discussion

The results of the initial survey indicate that, as is the case with many disaster-prone areas (Cretikos *et al.* 2008), communities of the Blue Mountains were poorly prepared for bushfire. The benefits of appropriate preparation (Kapucu 2008) and the engagement of community organisations (Kim & Kang 2010) were recognised by the community. Action was taken to address the issues of individual preparedness, particularly in relation to home emergency preparedness (Diekman *et al.* 2007), engaging in preparedness (Gowan *et al.* 2004) and a higher level of community networking (Levac *et al.* 2012, Ratnam *et al.* 2016, Paton *et al.* 2008).

In keeping with the *National Strategy for Disaster Reduction* (COAG 2011) the Blue Mountains community has undertaken a number of community-based interventions to improve preparedness for bushfire. The effectiveness of two interventions (MTFP and MYS) was considered. Surveys conducted following the interventions indicate that there had been a substantial improvement in the preparedness for bushfire, especially with respect to preparing homes for an emergency. These intervention programs contributed to spreading awareness and to bringing about more detailed awareness.

Further research would examine whether initial contact through programs such as MYS results in further engagement and detailed planning through attendance at other programs. Additional research would also gauge the importance of MTFP for the engagement of other groups, with a potential focus on vulnerable and at-risk individuals and households. It is also suggested that future research should adopt a matched pairs approach to examine the impact of intervention.

To avoid burdening households during a bushfire or emergency situation, responsibility for other community members or neighbours should focus on raising awareness about the need for an emergency plan and assistance with

Table 6: Confidence levels when dealing with emergency events.

	% indicating level of confidence to act*				
Actions during an emergency event	1	2	3	4	5
Defending home	22	20	30	20	7
Remaining in home when power lost and roads closed	7	16	16	38	23
Sheltering in home when no time to evacuate	23	23	18	23	13
Evacuating area	11	13	23	25	28
Confronting emergency	15	8	51	16	10

*Level of confidence scaled 1(lowest) to 5(highest).

developing the plan. In some circumstances checking up on neighbours is appropriate to ensure they have received the necessary information and are able to communicate with others. For those who have no family or others to assist them, it is important that they are assisted by local organisations.

Two approaches, MYS and MTFP, were designed using community development and capacity building practice frameworks. The use of community education, community engagement, community participation and community capacity building is the basis of each of these approaches and speaks strongly to their transferability and sustainability. This is particularly so when responsibility for delivery is accepted by locally embedded community organisations such as neighbourhood centres that work in partnership with emergency services organisations to deliver the programs.

Conclusions

The findings of BSAFE demonstrate that the partnership between emergency services organisations and community organisations has led to greater and more successful community engagement. More household preparedness events were held in 2014-2015 and more households were reached on the issue of bushfire preparedness.

The two household preparedness programs (MYS and MTFP) are premised upon a partnership approach between emergency services organisations and community organisations. Community-based organisations are embedded in communities and, as a part of their core business, they have a defined role in building sustainable approaches to community preparedness and readiness.

Continuing to develop partnerships and involvement of communities in disaster preparation and planning is important for optimising shared responsibility and increasing community resilience. Engagement tools and activities are central to the approach and monitoring developments via ongoing data collection and analysis is important for evaluation.

Acknowledgements

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A community-based disaster coordination framework for effective disaster preparedness and response

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ABSTRACT

A primary challenge during disaster response is allocating the right task forces to the right locations at the right time. The disaster field is a dynamic environment, and, ideally, search and rescue tasks should be completed as soon as possible. The disaster response team should take advantage of local volunteers who are willing to take part in the disaster response.

Most preparedness systems for disaster response and coordination are oriented toward a large-scale view of disaster events. Natural and man-made events have increased in number and severity and adding new tools, technologies and simulation models to existing national preparedness systems improves resource coordination at the community level. These methods help emergency managers effectively coordinate available community resources with the objective of minimising the number of casualties and reducing the operation-response completion time.

This research describes a framework, the Disaster Multi-Agent Coordination Simulation System, which is a decision-support system. The system helps response managers in a community-based response operation who want to test and evaluate all possible team design configurations and select the highest-performing team in the pre-phase of disaster response.

Introduction

Rapid and efficient response will always have a positive effect during and after any disaster. Recent disaster incidents have allowed a better understanding of what is required for more effective response to the emergency situations that can develop into disasters.

There is little doubt that effective disaster response requires preparedness and strategic planning prior to the disaster event. In addition to many other factors, the evaluation of emergency response resources—including task forces, non-government organisations and emergency volunteers—in a designated community has been shown to have a significant impact on the effectiveness of the disaster response operation (Isdr & Ocha 2008). Recently, the U.S. Federal Emergency Management Agency (FEMA 2016) highlighted the important role of local communities, the private sector, and trained emergency volunteers in disaster response and recovery. FEMA has also articulated the need to assign more responsibilities to these groups as have other governments, including Australia via its *National Strategy for Disaster Resilience* (COAG 2011). Trained neighbourhood (or community-based) emergency volunteers can be extremely effective, as they are familiar with local conditions and vulnerabilities (Israel *et al.* 1998). A disaster response team with locality-specific information can carry out tasks in the shortest time. In this paper high-performance teams are considered to be effective teams.

Response team performance

Designing an effective team is a critical and challenging problem. Team performance is directly affected by choice of coordination mechanism, organisational characteristics and configuration of the various response teams for a mission scenario (Wong *et al.* 2011). Forming an effective team is a decision-making challenge in which a response manager must evaluate hundreds of possible combinations while taking design configurations into account. Design configuration factors, which affect team performance, include:

- team size
- volunteer preparedness level and experience
- volunteers' starting point

- the maximum time they can work in a team before taking a break
- team centralisation
- team distribution
- building destruction levels
- disaster-intensity levels
- possible roadblocks
- transport networks availability
- task segmentation
- coordination strategies.

This study's contribution to this area of research is the development of the Disaster Management Coordination simulation (DMCsim) system, which is a decision-support system that could assist emergency response managers to form effective teams. The DMCsim provides a platform to test, evaluate and optimise team performance (i.e. efficiency) under different configurations.

To develop the DMCsim system, an agent-based simulation (ABS), geographic information systems (GIS), machine-learning techniques, and optimisation algorithms were used. Using Anylogic software enabled the development of an ABS that inputs a large amount of data relating to team member characteristics and the disaster-operation environment. It also enables teams to include complex behaviours and interactions that emerge from individual agents with simple behaviours. The DMCsim works with machine-learning techniques such as clustering and market-based auctioning algorithms. The DMCsim data-analysis engine uses advanced statistical method, design of experiments (DOE) to test, evaluate and identify a robust design. An important contribution is a visual interface that allows users to interact with the system's configuration and observe the operation and team movements.

The DMCsim offers the following benefits:

- Provides a flexible and scalable tool to evaluate the performance of a response team (e.g. Community Emergency Response Teams (CERTS) in the U.S., State Emergency Services (SES) in Australia, Tehran Disaster Mitigation and Management Organisation (TDMMO) in Iran) and any other volunteer response teams.
- Provides a decision-support system for emergency managers to design optimal team configurations.
- Integrates advanced technologies (such as GIS) that provide a precise operation environment.
- Applies simulation modeling to design an agent-based simulation.
- Applies machine-learning algorithms to simulate geospatial task clustering, task allocation and communication.
- Calculates operation-completion time based on a configuration scenario.
- Applies data-mining techniques and statistical approaches such as DOE and robust design to test, evaluate, and optimise configuration scenarios to find the optimal one.
- Provides a community-based emergency response team performance evaluation framework.

This paper outlines existing preparedness systems and disaster management coordination tools and the unique advantages of the DMCsim system. The methodologies and technologies used for developing the DMCsim system are described. A case-study scenario for an earthquake response operation in a neighbourhood in Tehran city shows the potential for improving the community-based emergency response.

FEMA urban search and rescue team at Moore, Oklahoma, 22 May 2013.

Image: Andrea Booher, FEMA

National preparedness systems and disaster management coordination tools

In the U.S. emergency response includes elements such as preparedness, mobilisation, operation and resilience. This breadth of responsibilities and emergent dynamic tasks make emergency response complicated. A community's resilience is dependent on the disaster's disruption level and the community's level of preparedness.

Several national preparedness systems have been established. These begin at the local level with community or neighbourhood emergency response volunteer teams. Some examples of these are Community Emergency Response Teams (CERTS) in the United States, the State Emergency Services (SES) in Australia and the Tehran Disaster Mitigation and Management Organisation (TDMMO) in Iran. All are overseen by a regional or Branch Disaster Response Team and, at the top of the responsibility pyramid, National Disaster Response Teams.

Various disaster coordination management systems have been developed to assist communities following disasters, such as NEMIS (FEMA 1998), DEFACTO (Schurr *et al.* 2005), ALADDIN (Jennings *et al.* 2006) and DRILSIM (Balasubramanian *et al.* 2006). However, communities that seek to conduct advance planning for a disaster, or that are already engaged in recovery efforts, face a number of challenges when using these systems.

The NEMIS framework was improved by FEMA but is constrained by context and does not offer adequate application mechanisms, such as disaster response coordination and task-allocation optimisation. The current NEMIS framework fails to address the pre-phase (contingency planning) stage of disaster response.

DEFACTO enables emergency managers to evaluate communications among, and the coordination of, the parties involved in a disaster operation but it is unable to use GIS technology. It therefore does not have a task-allocation-strategy element because it lacks location information for responders.

ALADDIN is a user-centric system that helps to design and model a decentralised system that can combine data from heterogeneous sources to carry out a certain action. Its drawbacks are that it lacks an interactive user interface and only receives input tasks as microtasks, such as search and rescue for a specific building.

DrillSim can simulate communications among responders who are also included in the flow of information and predefined task assignments. However, switching to a different disaster environment requires considerable system adaptation. In addition, it is not possible to test a first responder's ability using different configurations.

In comparison, DMCsim can create numerous scenarios and test team performance in diverse configurations. It integrates GIS technology into simulation models and can create numerous scenarios in any community. Using the DMCsim, the user has the option to change the configuration manually and observe the virtual response operation and agents' movements. A machine-learning technique, the K-means Clustering Algorithm, is applied in the simulation. This allows the user to cluster microtasks into macrotasks to make them more manageable.

Methods

The DMCsim conceptual model has four components. The first is the capability to input real disaster-scenario data into the system in a disaster situation when a massive amount of data is generated. This includes building information, structural damage, casualty reports, unusable roads, sizes of volunteer teams, available equipment, etc. The capability to input and use such data means the simulation scenario will closely resemble the real situation and allow the response manager to coordinate the response better.

The DMCsim next component is its configuration capabilities. Coordinating a response team involves many unknown factors and tasks, such as the time required to perform specific tasks, limited resources, unstable buildings and communication problems. Using constant or variable configuration factors in the DMCsim makes it possible to analyse the operation's performance under different coordination configurations.

Efficient and consistent communication is essential for response teams to effectively complete their tasks. The DMCsim allows design of simulation scenarios that are more realistic and closer to an actual field operation and works in conjunction with the DMCsim task-allocation capability. Task allocation is perhaps the most important element. Effective task allocation has a direct effect on the efficiency levels of first-response teams. Because these teams must work in such a dynamic environment, effective task allocation requires the combination of coalition-formation and market-based auctioning algorithms. Evaluation of different task-allocation strategies in a disaster response scenario identifies each strategy's value for the real mission.

The DMCsim system also has a DOE and optimisation capability. This is a built-in experimentation and optimisation framework using DOE techniques that allows emergency managers to test and evaluate possible scenarios for theoretical situations, search for the best team-design factors and determine the optimal response-operation scenario as quickly as possible.

By gaining experience in a simulated environment, emergency response managers and emergency response volunteers can develop a greater sense of preparedness and be better equipped to make correct decisions prior to a disaster event. Figure 1 shows the framework for the evaluation of a community-based emergency response team's performance in a response operation. This framework was adapted from the model used by TDMMO.

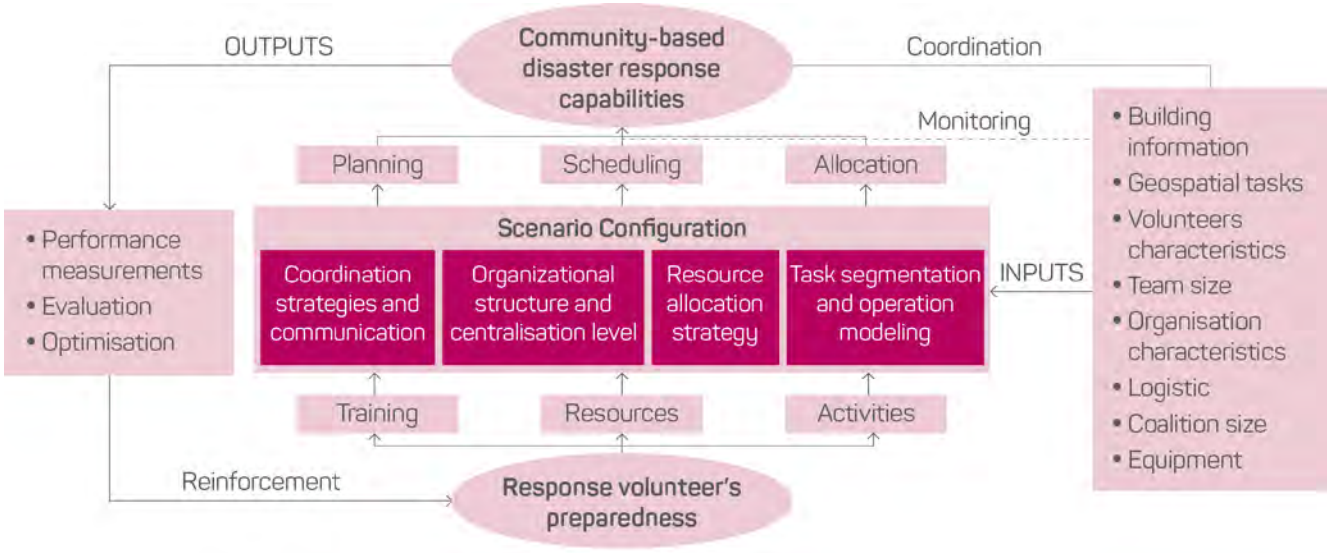

Figure 1: DMCsim community-based emergency response team performance evaluation framework (adapted from TDMMO).

Input data and case-study scenario

Scenarios created by the DMCsim are intended to evaluate disaster-operation performance in communities. An essential aspect of each scenario is the job structure and available tasks that must be performed during a disaster response.

To evaluate the DMCsim system the city of Tehran in Iran, was selected as a case-study scenario for a community-based disaster response operation. The recent *World Disasters Report* (IFRC 2014) listed Iran among the countries that has experienced the highest number of major seismic events and resulting fatalities. Numerous reports predict that Tehran will suffer from a major earthquake in the near future (Ashtari 2010). A model of building and human loss estimation for Tehran city in a severe earthquake scenario studied by Mansouri and colleagues (2010) estimated total structural damage of 72 per cent and a possible death rate of 33 per cent.

Input data to the DMCsim system can be classified in two groups: real data and simulation-generated data. Real input data consists of community data and volunteer information. Community data includes geographic and demographic data related to the response-operation field, such as each building's location, structure and number of residents as well as roads, transportation networks, hospitals, etc. For this case-study modeling, the area vulnerability data collected by the Japan International Cooperation Agency (2000) was used. Information on volunteers, which consists of their preparedness, individual characteristics, skills, experience, team size and equipment are determined by the system's user. In the real-case scenario, this detail could be replaced by existing information about response volunteers.

Simulation-generated data include the overall tasks and geospatially clustered tasks that emerge in the disaster environment. Task information consists of the reconnaissance, search, rescue, HAZMAT, medical and logistical tasks that are directly related to the real community data. DMCsim uses geospatial clustering to further segment the field of operations and, in turn, the relevant tasks become more manageable. The DMCsim can also leverage the potential loss estimation analysis generated by techniques offered by FEMA's Hazus[1] application. This is one of the GIS-based tools most frequently used by disaster managers. It offers methodologies and models that enable practitioners to estimate casualties from floods, hurricanes and earthquakes. In this study, the same methodologies that Mansouri and co-authors (2008) adopted to estimate casualties in their Tehran case-study disaster scenario are used. Figure 2 shows the case-study community-input data illustrated in the GIS platform.

The DMCsim requires geospatial information but domain problems must be defined. For the purpose of this study, a section of District 17 in Tehran, of approximately 0.62 sq km, was used. The area contains 41 urban blocks and 320 buildings.

Results

The DMCsim system was validated and verified using a combination of methods such as verifying the problem domain by subject-matter experts, testing for system internal validity, analysing system sensitivity and comparing data generated by the simulation to results from the District 17 study conducted by Vafaeinezhad and co-authors (2009). To further test and evaluate the DMCsim system, we used DOE technique and designed a response-operation experimentation for the case study scenario. The experimentation result allows the performance to be optimised by screening design factors and choosing the best level for each.

The DMCsim result and evaluation for this case study experimentation demonstrates that if, for instance, an earthquake of level 1 intensity or damage level hit the study area and available responders were deployed to

Figure 2: Input data illustrated in GIS to use in the DMCsim for District 17 of the city of Tehran, Iran simulation.

1 FEMA Hazus overview at **www.fema.gov/hazus-mh-overview**.

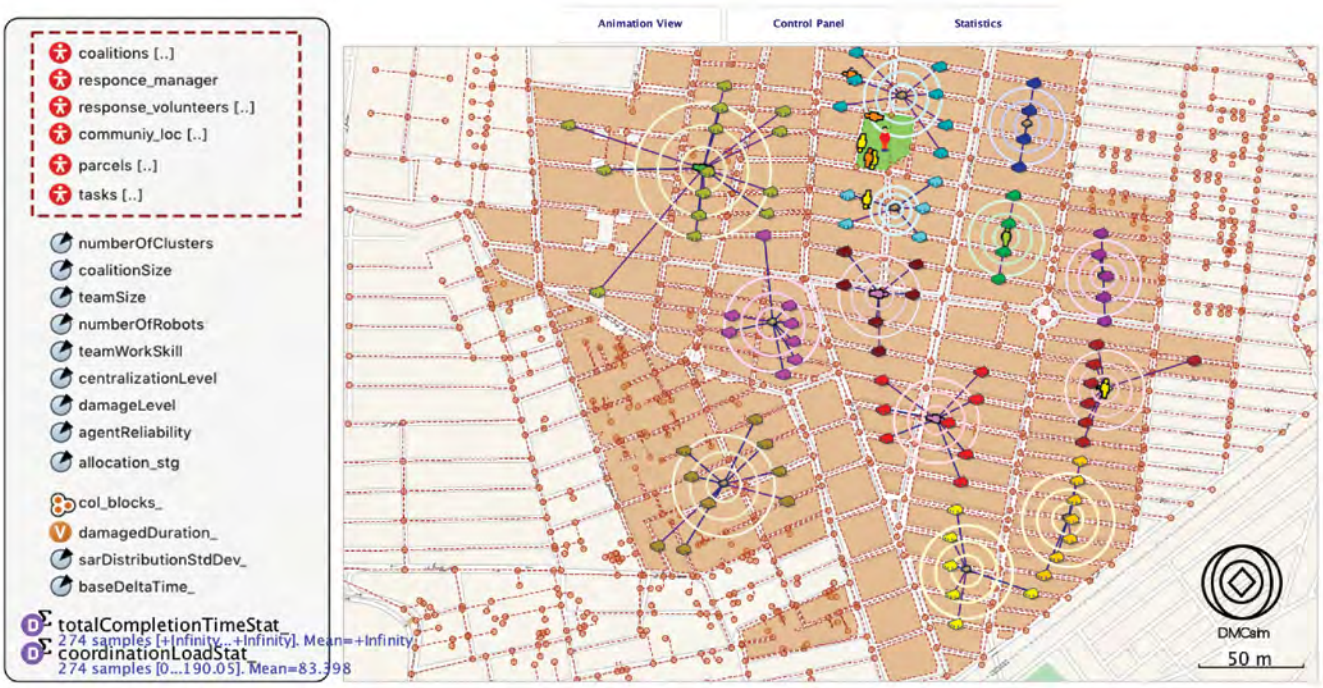

Figure 3: The DMCsim interface for a response-operation scenario in District 17 of the city of Tehran, Iran simulation.

the operation field without any coordination strategy, the predicted response operation time would be about 1886 minutes. However, if the optimisation methods suggested by the system were used and the optimal coordination strategies were employed, the operation time would decrease to 1614 minutes. This is a 14.4 per cent improvement in operation performance. Performance also shows significant improvement for scenarios with earthquakes of levels 2 and 3. Performance improvement is 21.1 per cent and 19.8 per cent respectively (refer Table 1).

Table 1: Potential operation performance increase by disaster coordination system.

Earthquake damage level	Predicted response operation time in minutes	Optimised response operation time in minutes	Potential operation performance increase
Damage level 1	1886	1614	14.4%
Damage level 2	2232	1861	21.1%
Damage level 3	2550	2146	19.8%

Conclusions

The DMCsim is a decision-support system that assists local emergency managers, practitioners and planners to test and select optimal coordination tactics for community-based disaster response teams prior to mounting an actual disaster response operation.

A competent response manager should be able to design an appropriate team and effectively lead it to complete its assigned tasks within a minimum timeframe. By employing a DMCsim model, local community emergency managers could predict response-operation performance and take necessary steps to improve it. These include choosing appropriate coordination methods and task-allocation approaches and training volunteers based on specific job priorities.

The DMCsim is not solely for use in evaluating emergency and disaster scenarios; it can also be used in a number of other areas by private and public decision-makers, emergency managers and systems analysts. The system can be modified and extended, and can be very effective for the following purposes:

- **Training** – the DMCsim offers interactive visualisation making it highly suitable for training purposes. It can help teams to understand task assignments, team formation and individual activity value to overall team performance.
- **Operation planning** – emergency managers can create scenarios and evaluate them to get a better sense of team performance under the specific scenario configuration using specific resources.
- **Coordination of emergency response teams** – enables emergency managers to assess new situations and alter coordination strategies to effectively deploy teams. It can also be used to motivate volunteers to become more involved in the emergency response.
- **Evaluation** – the identification of weaknesses and potential destruction to communities can increase community resilience prior to the disaster event.

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Microtasking: redefining crowdsourcing practices in emergency management

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ABSTRACT

This paper examines the roles, types and forms of virtual microtasking for emergency information management in order to better understand collective intelligence mechanisms and the potential for logistics response. Using three case studies this paper reviews the emerging body of knowledge in microtasking practices in emergency management to demonstrate how crowd-sourced information is captured and processed during emergency events to provide critical intelligence throughout the emergency cycle. It also considers the impact of virtual information collection, collation and management on traditional humanitarian operations and relief efforts.

Based on the case studies the emergent forms of microtasking for emergency information management were identified. Opportunities for continuities, adaptations and innovations are explained. The contribution of virtual microtasking extends to all supply chain strategic domains to help maximise resource use and optimise service delivery response.

Introduction

The ubiquity of Internet technologies enables the creation of new forms of digital labour that leverage the data-processing skills of the crowd. Prior barriers to human mobility, participation and engagement such as geographical remoteness and incumbent organisations and practices are rapidly dissolving in the digital age (Manyika *et al.* 2014). The transition from hierarchal to distributed network structures, from proprietary ownership to open-source standards and models of exchange that include contributory as well as market transactions (Rejeski 2012, Benkler *et al.* 2013) is underwritten by a multiplicity of established and emergent rules and practices.

The role and contribution of distributed human-computation practices to the development of virtual information and communication platforms for crisis and emergency management is opening new areas for research. Human-computation practices were initially created by 'spontaneous' groups of locally affected citizens using mobile devices and social media networks. These organically self-organised groups shared information and insights as emergencies and natural disasters unfolded. Subsequent to these early instances of information crowdsourcing, innovative and self-organising work units have developed that use the 'cognitive surplus' of the crowd and 'aggregated intellectual skills' to gather and process critical emergency information.

To date, much of the research emphasises the role of technology over the social implications of digital labour. This paper examines the structures and practices of these virtual processes through a focus on digital labour and microtasking for emergency management as an evolving socio-technical adaptation. Microtasking merges the capabilities of distributed human cognition with communication technology to address a range of information management challenges during emergency situations that could improve logistics response.

Microtasking is sometimes conflated with terms such as 'crowdsourcing', 'microwork', 'crowdwork' and in some cases 'human computing'. Likewise, the term crowdsourcing has been used alongside human computation, collective intelligence, or social computing (e.g. Quinn & Bederson 2011, Michelucci 2013). The intersections between these domains are noted as they coincide in their focus on horizontal processes that engage large numbers of individuals working towards clearly defined goals. Research on crowdsourcing has already provided comprehensive reviews of the many definitions of the term

(e.g. Estellés-Arolas & González-Ladrón-de-Guevara 2012, Hossain & Kauranen 2015). Yet, microtasking as a specific modality of crowdsourcing procedures, has received little attention until recently.

The methodology for this inquiry began with a literature review conducted through online searches of various databases. An emergency case-study approach was used to examine the microtasking approaches of three distinct entities to consider the implications and logistic potential of these practices.

From crowdsourcing to microtasking

Microtasking, as shown in Figure 1, is a special sub-type of human computation where tasks involving different degrees of complexity are divided into smaller and independent microtasks (Luz *et al.* 2014). The literature has identifies some defining elements when it comes to:

- size – a large number of small unit tasks that are aggregated to form a large project
- scale – undertaken by a large number of distributed individuals
- temporal and spatial span – short tasks conducted online either individually or collaboratively
- human intelligence involvement – tasks cannot be fully automated and include routine and specialist skills.

Microtasking entails the modularisation of problems into microtasks of varying granularity that are processed by a distributed digital labour force. These microtasks are published on computational platforms (e.g. Mechanical Turk, CrowdFlower or ShortTask) that distribute tasks to crowds of workers. The most recent microtasking platforms include the use of blockchain technologies to support large-scale, decentralised collaboration based on distributed governance models (e.g. Backfeed). Through the use of blockchain technology, an open distributed database can be established to record inputs from volunteers, which once entered cannot be altered retroactively.

The key distinction between microtasking initiatives such as crowd science projects, commercial platforms and virtual information management for disasters and emergencies is the open availability of the information products that these systems produce. Crowdscience initiatives are premised on the 'open sharing of intermediate inputs'. Commercial platforms have exclusive property rights, while the crowd-sourced emergency information is subject to increasing demands for privacy and confidentiality (due to the vulnerability of disaster-affected populations, particularly unaccompanied minors).

There are two basic models of microtasking practice that are differentiated on the basis of task definition, process management, participant incentives and the nature and purpose of the final product (Novak 2013: pp. 422–425). The first model, Amazon's Mechanical Turk, invites participants to conduct 'small-scale, granular tasks for a few cents apiece' (Bollier 2014: p. 33). This model is structured as a linear workflow system whereby distributed individuals execute basic

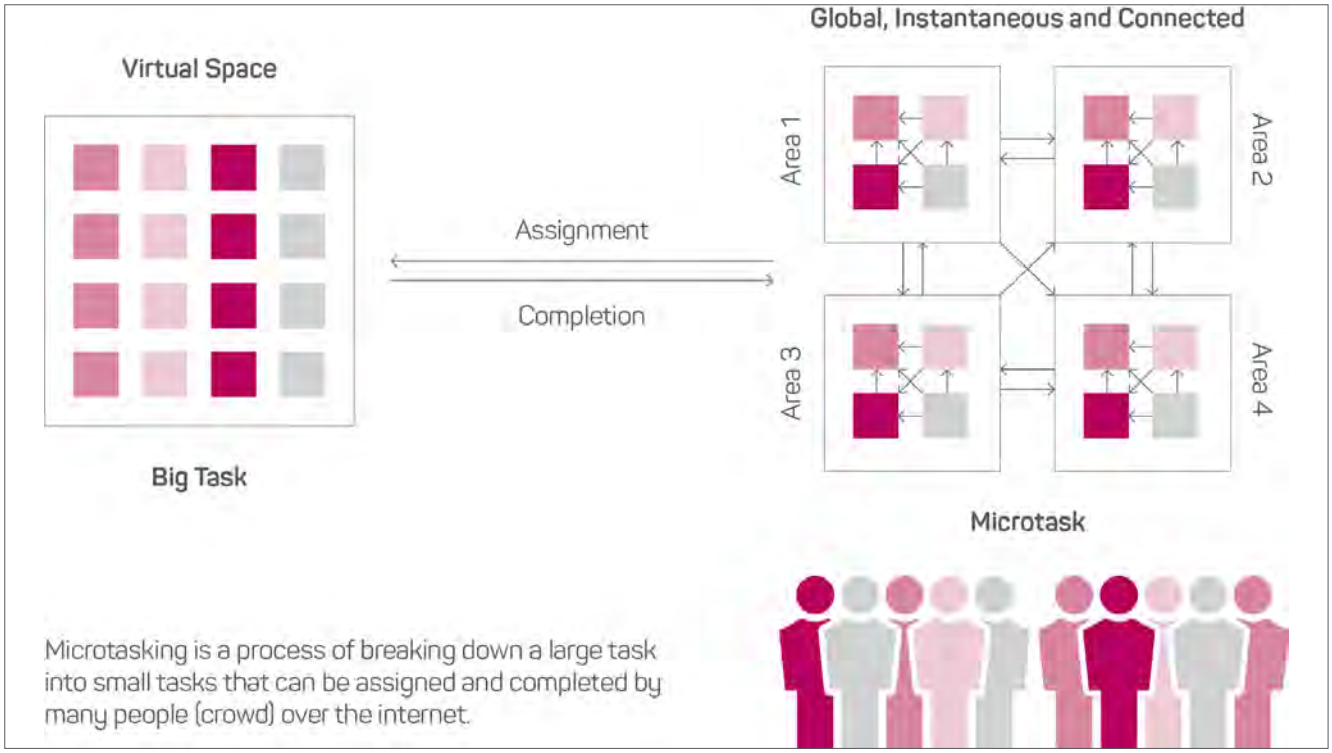


Figure 1: Framing microtasking routine in a virtual space.

tasks or 'atomic units' requiring minimal skills or 'little cognitive effort' for financial reward (Novak 2013, p. 422, 431–33). The tasks are predetermined and conducted independently as 'parallel work' and in some cases are aggregated later towards a larger task (Novak 2013, p. 423). 'Atomic' tasks occupy a problem area that is 'well-structured' with modes of execution that are 'well mapped out' and require little interactivity between individual workers (Franzoni & Sauermann 2013, p. 10). The purpose of this form of microtask is to minimise costs but obtain 'high-quality results' (Saito *et al.* 2014, p. 401). However, the emphasis on labour flexibility as a cost-saving strategy has drawn criticism that this type of crowdwork is 'exploitative labour' (Kittur *et al.* 2013) and may be regarded as the reinvention of digital and virtual 'sweatshops' (Blumberg 2013a, p. 3, Bollier 2014, p. 34); a new form of Tayloristic assembly line production (Novak 2013, p. 422) or unsatisfying 'assembly-line piecework' (Kittur *et al.* 2013, p. 1).

Platforms such as UpDesk allow skilled individuals to access fee-for-service projects, and InnoCentive, invites participants to select research and technical tasks for payment as a form of 'enterprise crowdsourcing' (Bollier 2014, p. 6, 34). The tasks offered on these platforms conform to the definition of 'macro' tasking as specified by Saito and colleagues (2014, p. 400). The atomic or primitive microtask requires individuals with basic skills to perform simple tasks that are centrally managed as commercial projects (Novak 2013, p. 422). These projects solicit open mass participation but both their processes and products are closed and subject to intellectual property agreements (Franzoni & Sauermann 2013, p. 9).

Blumberg (2013b, pp. 6–7) identifies a set of common characteristics for atomic microtasks:

- tasks are simple and repetitive
- task workers are single-user
- task execution is non-interactive
- tasks do not require expertise or high-level skills.

He contrasts these features with an evolved form of crowdsourcing that entails recruiting 'many minds' for sophisticated problem-solving projects (2013b, pp. 5–7). The literature suggests that microtasking has evolved from the atomic prototype to also include new forms of knowledge production that requires workers to interact in order to address complex problems.

The common features of microwork that span these initiatives in emergency management include:

- the engagement with crowd-generated disaster intelligence
- the modularisation of tasks to process this intelligence
- the lateral and collaborative nature of the workflow
- the use of open-source digital platforms
- the deployment of a digital volunteer workforce.

Differences emerge in how each initiative is structured and managed, how volunteers are recruited and the extent to which processes are formalised or remain flexible. The following case studies review three different examples of operational practices that use microtasking as a workflow methodology. The focus is on task definition, process management and the nature and purpose of their information management goals.

Case study 1: Emergent microtasking – Haiti Mission 4636

Mission 4636 is an example of an emerging, organic, volunteering initiative that arose during the 2010 Haiti earthquake crisis. A detailed empirical analysis of Mission 4636 can be found in Munro (2013). Mission 4636 was established in partnership with the local telecommunications provider Digicel, to allow the local population to send information through SMS about their situation and needs. At the time, 75 per cent of the population owned a cellphone and around 70-80 per cent of cell phone towers were still operational after the earthquake). The number 4636 was advertised as the medical emergency number through local and diaspora radio stations and through word-of-mouth.

The purpose of Mission 4636 was to gather the SMS information and process it into structured reports. The messages received on the 4636 site were mostly in Kreyòl or French and did not encode the sender's location. Within weeks 2000 Kreyòl and French speaking volunteers from 49 countries were recruited to translate the messages. They were mainly recruited through Facebook and personal networks as there were concerns about reliability, privacy and security issues with an open-call process.

Using a basic microtasking platform, volunteers read, translated and structured messages according to different categories and geolocated callers onto a map and documented missing person information. These formed the four classes of sub-tasks: translation, categorisation, mapping and documenting.

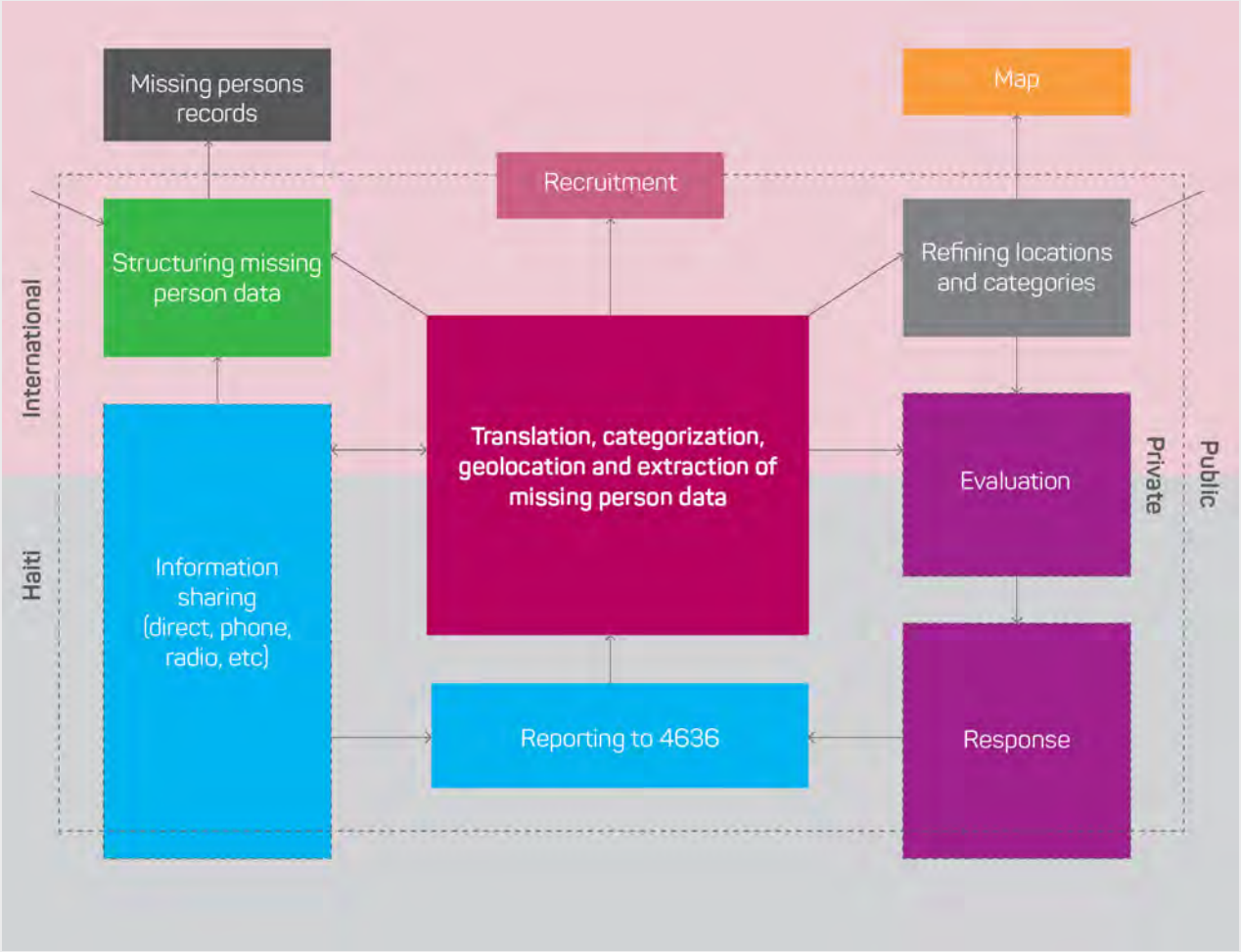
Tasks were undertaken by volunteers on computers using a split screen format with the unstructured report on the left and the relevant plug-in on the right. After these microtasks were completed, the restructured and classified data was sent in English to relevant international response agencies. These agencies defined the types of reports that could be 'actionable' and later in the process specified the categories of data that would be most useful (Munro 2013, p. 216). In this case the leading agency was the U.S. military under the supervision of the U.S. State Department.

Case study 1: continued

The respective labour allocation ratios for all tasks (translation, categorisation, mapping and documenting) were respectively 25:5:20:10. The largest task was the translation component, which underwrote and enabled the following tasks and, as Munro (2013) states, the work undertaken by other agencies such as Ushahidi-Haiti (2013, p. 229). Task execution was also supported by a collaborative facility of a basic chat room application. Approximately 1000 workers used this facility to discuss issues such as correct translation for vernacular idioms and acronyms as well as the correct location of areas with non-official place names. This system of peer review improved the quality and accuracy of information (Munro 2013, pp. 230–36).

The main purpose of Mission 4636 was not search and rescue or targeted medical response but to establish situational awareness, monitor changing conditions, track needs and vulnerabilities and direct aid to large populations (Munro 2013, pp. 218–19). These populations included at-risk and vulnerable groups, as well as hospitals and clinics outside the national capital that required supplies. The U.S. military received these structured reports as 'the main responders to messages sent to Mission 4636' (Munro 2013, p. 216, 218, 255).

Mission 4636 established an operational model that has become the template for subsequent virtual initiatives, with the 'development of workflows and protocols to…inform response, recovery, and rebuilding efforts' (Liu 2014, p. 403). At that time the mission was an emergent and improvised response but has become an established or extending model and virtual crisis information is now an established 'feature of crisis events' (Cobb *et al.* 2014, p. 3).



The 4636 Emergency Response Process shows the flow of information and collaboration used in Haiti.

Source: Munro 2013. At: **http://robertmunro.com/research/Mission_4636_Haiti_2010_SMS.pdf**.

Case study 2: Hybrid microtasking – Humanity Road

The second operational practice is illustrated by Humanity Road, an initiative that transitioned from beginnings in 2010 as an 'emergent' digital volunteer group to an incorporated not-for-profit organisation. Starbird and Palen (2013) demonstrate how a virtual organisation provides a technology-supported 'civic response' to emergencies by monitoring 'social media' posts (mainly Twitter) and processing received data to 'create information resources for victims and responders' (Starbird & Palen 2013, p. 1). The organisation structure comprises a core group of volunteers who act as a leadership group and recruit from a global spread of 'episodic volunteers' during a crisis so that volunteers can formally register or activate when needed. The work of the organisation spans the emergency cycle and operates between declared emergencies (Starbird & Palen 2013, p. 3).

The workflow during an emergency is structured by 'pre-articulated tasks' that have been tested in prior events and are also flexible and adaptable to accommodate necessary changes and improvise for unanticipated contingencies. These adaptations may subsequently be formally incorporated as routine work practices (Starbird & Palen 2013, p. 5). The main objective is to collect, verify, filter and synthesise relevant information from social media sources and restructure data into standardised reports as resources for the disaster-affected populations and response agencies (Starbird & Palen 2013). After a disaster strikes the Humanity Road management group decide how they can contribute and what resources are required.

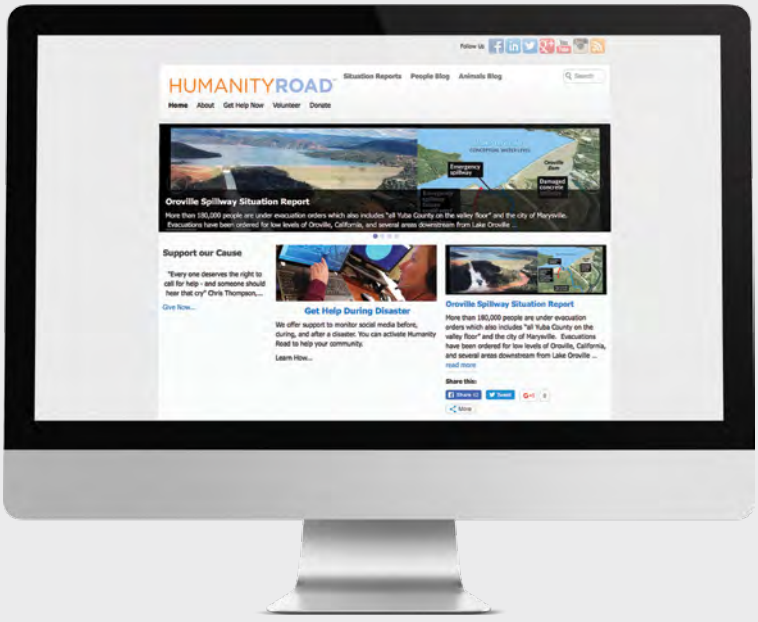
The main objective is to ascertain situational awareness by:

- identifying on the ground and official sources
- gathering and verifying this information
- sharing data through the platform's Urgent Events window.

An Event Diary document is established and is coordinated by an editor. Once an event is posted into the Urgent Events window, the leadership group activate a Disaster Desk on a Skype chat platform. This desk has designated areas as virtual workrooms where volunteers can access and process relevant disaster-related information.

Different categories of information are posted into segregated windows and include an account of the disaster event; websites and Twitter accounts to consult, official hashtags to follow, official warnings and hospital and shelter details. Useful information and updates from official sources are also 'amplified' and re-routed to target groups and to the public. The activity responds directly with updates to people within disaster zones (2013, p. 4).

As Cobb and co-authors (2014, p. 3) suggest '... emergent organisations of remote actors connected through social media are now a feature of the disaster response milieu'. Humanity Road spans both 'emergent' and 'established' dynamics. It has established stable routines that have been tested in prior events and incorporates 'episodic' volunteers that converge for single events and are open to and actively incorporate spontaneous 'emergent' volunteer practices.



Source: Humanity Road website **http://humanityroad.org/.**

Case study 3: Agency-driven microtasking – Virtual Operations Support Team

The Virtual Operations Support Team (VOST) model was established in 2011 during a series of emergencies in the U.S. and has been subsequently replicated on a global scale. VOSTs process crowd-sourced information on behalf of emergency agencies that lack relavant capacity or resources. They also mediate between agencies and the engaged community (Reuter 2014). VOST organisations comprise both volunteer and emergency personnel as known 'trusted agents' who are pre-accredited to perform tasks when emergencies unfold.

The role of a VOST is to process crowd-sourced information through a distributed task-assignment structure using cloud-based tools in alignment with formal response agencies (Cloutier 2014). During an emergency, VOSTs operate as a virtual organisation but are distinguished from other volunteer groups as they have 'a formal connection with an emergency response team during an event' (Cobb *et al.* 2014, p. 6). They respond to requests from official agencies that also determine reporting parameters and have structural interoperability and procedural standardisation with these organisations (Cobb *et al.* 2014, p. 6).

The VOST workflow begins with the establishment of an event-specific incident workbook segmented into different work pages. Remote volunteers sign in through Skype to the team leader account and log their details on the General Availability Table work page. The team leader sets out the workflow tasks and tools for volunteers. The main tasks for designated workers include:

- conduct searches of relevant sites and Twitter hashtags
- log relevant information onto a curation page
- post-emergency location information to a crowdmap.

There is also a collaborative facility (chat room) that hosts a 'backchannel conversation' process whereby workers discuss the value and accuracy of incoming information (Cobb *et al.* 2014, p. 5). The team leader will aggregate the data to a predesigned template and send reports to agencies at times predetermined by an agency manager. As Cobb and co-authors (2014) suggest, although the workflow practices of a VOST is 'collaborative, the interoperability between VOSTs and official agencies accrues to an alignment in organisational structures' (2014, p. 5). The microtasking function to process information sits within a hierarchical structure.

The VOST acts as an information management bridge between official agencies and the crowdsourcing public during emergencies. The VOST model may have originated as an 'extending' formation (non-routine tasks with existing structures) but has quickly become an 'established' formation (formal tasks with existing structures) with an authorised organisational structure and a formal reporting relationship with official agencies on whose behalf it manages information in the digital sphere. In this respect they are also an 'extending' structure as they conduct what are currently non-routine tasks for an existing emergency management structure. VOSTs use volunteers with professional emergency experience in the digital sphere although there will be a point when digital operations will become an 'established' practice. Although the VOST model has been replicated across many countries it is an operational format that is focused on domestic emergencies.

Source: Cheryl Bladscoe, CRESA **www.slideshare.net/dgsweigert/virtual-operations-support-team.**

Conclusion

This paper examined the role, types and forms of virtual microtasking for emergency information management to enhance collective intelligence processes to improve emergency response. The three examples presented demonstrate the functions of microtasking and the role in emergency management. The continuum that was drawn from microtasking for emergency management shows clear differences in terms of task structure and complexity as well as task management. While some tasks are simple or atomic, for example, checking and listing relevant websites, other tasks are more complex, such as translation, interpretation and classifying visual data.

Case studies demonstrate that tasks are generally structured and not ill-defined although the eventual aggregation of processed data contributes to a defined understanding or situational analysis. The modularisation and structure of the workflow is such that experienced volunteers can self-select tasks that are more complex or require technical knowledge with new entrants assigned to simple tasks. In this respect the skills and experience of digital labour contributes to a structuring effect and supports self-organising. Task management along the continuum also requires mixed approaches, that is, combinations of orchestrating, monitoring, guiding, trouble-shooting and directing. The information management continuum requires informed decision-making

whereby task modules are structured to facilitate a workflow and processed information is aggregated into reports. Thus, microtasking contributes to different stages of the emergency cycle.

The account of Mission 4636 and HR indicate the role of a 'management team' with oversight over the workflow, and decision-making responsibilities. However, these roles are tactical and not directive. The management team appear to make decisions collectively or decisions are brought about by the logic of the process. The collaborative function evident in all three studies also addresses the significant 'cognitive load' and the stress that volunteers experience when processing a large volume of incoming data within a restricted time window and provides a virtual timeout with mutual support.

The case-study approach adopted in this paper has limitations. All the case studies represent post-event occurrences, which didn't consider real-time social media uptake of volunteered information. Future research should evaluate the value of microtasking for emergency management agencies over the emergency lifecycle which includes pre, during and post disaster phase. Furthermore, the relative merits and costs of the three approaches should be examined to assess their appropriateness to different types of disasters. Time ambiguity and resource scarcity often impede the effective and efficient response to an emergency call. Emergency organisations should update the processes, tools, training and organisational culture to enhance organisational resilience to enable rapid response to emergency needs and changes in situated environments (Mees *et al.* 2016) while still controlling costs and quality.

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ABSTRACT

Youth misuse of fire is a multifaceted, complex, and dangerous phenomenon. In response to this problem, Fire and Rescue NSW and Juvenile Justice NSW established a memorandum of understanding to facilitate firefighter involvement in the provision of fire safety education during Youth Justice Conferencing for young people who commit fire-related offences. Despite being used for over a decade, conferencing for youth misuse of fire is yet to attract theoretical analysis or empirical investigation. To partially fill this void, a theoretical analysis of Youth Justice Conferencing for youth misuse of fire was conducted. Comparative analysis revealed that child-centred disaster risk reduction offers a scaffold to explain and justify the mechanisms operating in Youth Justice Conferencing for youth misuse of fire. This theoretical alignment has implications for both Youth Justice Conferencing and child-centred disaster risk reduction.

Youth Justice Conferencing for youth misuse of fire: a child-centred disaster risk reduction mechanism

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Introduction

Youth misuse of fire (YMF) refers to any illegitimate use of fire or incendiary materials by a person under the age of 18 years (Pooley & Ferguson 2015). YMF is a multifaceted problem concerning a highly complex and heterogeneous population (Martin *et al.* 2004). The behaviour is difficult to predict and unlikely to be deterred by punishment alone (Houvouras & Harvey 2014). As a result, reduction of YMF relies heavily on prevention (McDonald 2010) and is increasingly becoming the responsibility of fire services (Haines *et al.* 2006). In response to this problem, Fire and Rescue NSW (FRNSW) and Juvenile Justice NSW established a memorandum of understanding to facilitate firefighter involvement in Youth Justice Conferencing convened for young people who have committed a fire-related offence. The aim of this paper is to document a theoretical analysis of an empirical investigation of the situation. First, the scope of the YMF problem in Australia, and New South Wales, is presented. One response to the problem is briefly described. The method employed to conduct a theoretical analysis of this response is outlined, followed by an overview of child-centred disaster risk reduction (CCDRR) and Youth Justice Conferencing for YMF. The discussion reveals that CCDRR and conferencing for YMF are theoretically aligned and that CCDRR provides a scaffold that explains and justifies the mechanisms operating in Youth Justice Conferencing for YMF.

The scope of YMF

Existing literature relating to YMF has predominantly emerged from the United States and United Kingdom. However, there is a growing body of knowledge from Australia and, more specifically, from NSW. The Australian Institute of Criminology (2005) estimated that three-quarters of all deliberately lit fires were attributed to young people. Muller (2008) conducted an analysis of official arson statistics between 2001 and 2006, which revealed that 23 per cent of all arson defendants in NSW were under the age of 17 years. Bryant (2008) conducted an investigation into 280,000 vegetation fires attended by 18 fire agencies throughout Australia over a five-year period.

Based on secondary data maintained by fire services, Bryant (2008) found 24 per cent of vegetation fires were attributed to young people. In the same study, Bryant (2008) conducted an analysis of data derived from NSW fire services between 1997 and 2002. Bryant (2008) found that non-deliberate fires attributed to young people accounted for between 0.4 and 16 per cent of all vegetation fires. These fires peaked during the summer holiday season. In fact, the highest recorded number of fires in NSW attributed to young people occurred during the 2001-2002 bushfire crisis, now widely referred to as 'Black Christmas' (Bryant 2008). Although this study only included non-deliberate vegetation fires attributed to young people, the data highlights the significant number of vegetation fires for which young people were responsible and the heightened risks involved when these fires were lit during conditions conducive to fire spread.

These findings should be considered with caution despite providing insight into the scope of the YMF problem. Evidence suggests that:

- fires are only responded to or investigated when they cause personal or property damage (Tomison 2010)
- of fires responded to or investigated, a high proportion categorised as 'cause unknown' are likely to be the product of YMF (Bryant & Willis 2006)
- fires that occur outdoors are reported more often than fires that occur indoors (Corcoran *et al.* 2007)
- around half of all indoor fires occur as a result of YMF (Lowenstein 2003).

Misuse of fire by young people is regarded as a covert behaviour that is difficult to detect and empirically investigate.

Although the true prevalence of YMF is undetermined, the risks associated with the behaviour are high. In 2011-2012, estimates reveal there were 44,925 incidents of arson nation-wide, costing approximately $2.3 billion (Smith *et al.* 2014). The NSW Bureau of Transport Economics (2001) found that between 1967 and 1999, bushfires accounted for over half (57 per cent) of the total injuries caused by natural disasters in Australia. Ronan and Towers (2014) point out that structure-fire fatalities occur at seven times the rate of bushfire fatalities. An incident outcome analysis of YMF recorded by FRNSW and the NSW Rural Fire Service revealed that, as a result of the 26,380 instances of YMF committed between July 2004 and June 2014 in NSW, 4097 people were evacuated, 414 suffered injury, 43 required rescue and 10 fatalities occurred (Pooley 2015). These statistics provide an indication of the risks associated with YMF. However, a recent study conducted in Sweden found single data sources, such as fire service data or police data, under-report fire injuries and fatalities by approximately 20 per cent (Jonsson, Bergqvist & Andersson 2015). YMF is thus conceivably more problematic than existing literature indicates.

The response to YMF

In response to the YMF problem in NSW, FRNSW and Juvenile Justice NSW signed a Memorandum of Understanding (MoU) in 2006. This MoU emerged out of a mutual, legislative obligation to reduce misuse of fire by young people in NSW. FRNSW is one of two primary response agencies for fire in NSW. The organisation's purpose and functions are governed by the *Fire Brigades Act 1989* (NSW). Section 6(1) indicates that it is the duty of the Commissioner to take all reasonable measures for the prevention and suppression of fire. This provision places a legislative obligation on FRNSW to prevent YMF.

Juvenile Justice NSW is the primary response agency for youth delinquency and crime in NSW. Juvenile Justice NSW works to prevent and reduce crime and recidivism by building safe and resilient communities and diverting people from the criminal justice system (NSW Government 2015). Juvenile Justice NSW is obligated to prevent YMF that meets the threshold of criminalisation and to divert young people away from criminal justice intervention where appropriate.

The MoU (2016) governs firefighter participation in Youth Justice Conferencing convened for young people who commit fire-related offences. The MoU states that a firefighter will attend conferencing in the role of a participant and will:

- provide fire safety education to the young person
- suggest fire-safety-related tasks to include within the young person's outcome plan
- monitor relevant components of the outcome plan to determine compliance and completion.

This collaboration helps to educate the young person about the consequences of misuse of fire and teach them safe fire practices.

Method

Youth Justice Conferencing for YMF has operated for over 10 years but has not undergone theoretical analysis or empirical investigation. To partially fill this void, theoretical analysis of Youth Justice Conferencing for YMF was undertaken to explain and justify the mechanisms operating within the program. Data included existing literature and documentation. Data was collected from major criminal and public policy databases, the Australasian Legal Information Institute, Hansard, the Juvenile Justice NSW and FRNSW websites, Google and Trove searches. Juvenile Justice NSW and FRNSW internal documentation were accessed. Data was summarised and comparatively analysed to identify commonalities and inconsistencies. Comparative analysis revealed theoretical alignment. This has implications for both Youth Justice Conferencing for YMF and CCDRR.

Child-centred disaster risk reduction

Risk reduction refers to measures that mitigate the frequency or intensity of losses (International Risk Management Institute 2016). Disaster risk reduction narrows this scope, referring to systematic efforts to analyse and reduce the causal factors of disasters associated with natural and man-made hazards (United Nations Office for Disaster Risk Reduction 2016). Child-centred disaster risk reduction tailors these efforts towards children and young people (Towers *et al.* 2014). Mechanisms employed include disaster resilience education, school emergency management and community-based programing (Towers *et al.* 2014). The primary objective of CCDRR is to enhance knowledge and strengthen skills in children and young people so they understand disaster risk and are able to participate in mitigating risk (Towers *et al.* 2014).

CCDRR is a relatively new concept, yet the body of knowledge has grown considerably in recent years (Ronan *et al.* 2016). The three main pillars of disaster risk reduction, and thus CCDRR, are:

- prevention and mitigation
- preparedness
- response and early recovery (United Nations Children's Fund 2016).

The importance of this comprehensive and integrated approach was highlighted in the Yokohama Message in 1994 (International Decade for Natural Disaster Reduction 1994). Since that time education programs have been increasingly used around the world to prepare children and young people for disasters associated with natural and man-made hazards, to prevent or mitigate the risks and consequences associated with these hazards, and to enhance response and recovery by engendering resilience (Ronan & Towers 2014). Such programs have been found to improve preparedness, perception of risk, awareness of appropriate safety behaviours and resilience (Ronan & Towers 2014).

Youth Justice Conferencing for YMF

Youth Justice Conferencing is one of three graduated sanctions legislated under the *Young Offenders Act 1997* (NSW). The juvenile justice mechanism helps divert young offenders away from state intervention and future criminal behaviour. Youth Justice Conferencing is based on the philosophy of restorative justice (Parliament of NSW Legislative Assembly June 22 2002, p. 7446). Restorative justice is 'a process whereby all the parties with a stake in a particular offence come together to resolve collectively how to deal with the aftermath of the offence and its implications for the future' (Marshall 1996, p. 37). Conferencing involves bringing a young offender and their support group face-to-face with their victim(s) or their representative(s), and their support group (s47 *Young Offenders Act 1997* (NSW)).

The purpose of conferencing is to create and implement an outcome plan for the young person to complete. Outcome plans for bush fire/arson juvenile offenders must include a fire safety education component, assistance in clean-up operations or the treatment of injured animals, and payment of compensation (s8 Young Offenders *Regulation 2016* (NSW)).

Conferencing for YMF as a CCDRR mechanism

Conferencing for YMF can be positioned as a CCDRR mechanism. Firefighter participation in conferencing in NSW is administered by the FRNSW Community Safety Directorate. The objective of the Directorate is to manage risk, on and off an incident ground, through risk management within strategic policy, management responsibilities and operational functions (FRNSW 2016). One mechanism implemented to reduce risk, improve safety and protect the community is conferencing for YMF (FRNSW 2016). Where CCDRR manages risk associated with man-made hazards like YMF (and conferencing for YMF aims to manage risk), the program can be strategically positioned as a CCDRR mechanism.

The applicability of CCDRR to conferencing is supported through a mutual aspiration to attain Article 6 Convention on the Rights of the Child that proposes the State has an obligation to ensure the survival and development of young people (United Nations 1989). CCDRR uses a multidisciplinary approach and draws from the fields of health, urban planning, public policy, education and emergency management within government and non-government realms (Tatebe & Mutch 2015). In line with this approach, conferencing for YMF is facilitated by two arms of state government; FRNSW and Juvenile Justice NSW. Both organisations have legislative obligations to prevent YMF from occurring. In addition, conferencing brings stakeholders of YMF together. These stakeholders include the offender and their support group, the victim(s) and their support group, a firefighter, and other members of the community affected by the offence (s47 *Young Offenders Act 1997* (NSW)). Conferencing for YMF thus involves state government intervention alongside community participation to provide fire safety education to young people and their families.

CCDRR prioritises the education and agency of young people (Plan International 2010). Plan International developed a toolkit for CCDRR that describes best practice as that which unpacks risk, making it visible and transparent, so that young people have the capacity to make informed decisions about how much risk to accept and how it can be managed. Ronan and Towers (2014, p. 1) suggest that CCDRR helps young people 'connect the physical world and science with the social world and human factors'. Conferencing for YMF theoretically attains this benchmark. It provides young people with access to knowledge and information through fire safety education that unpacks and makes transparent the risks

of YMF. Fire safety education provided by firefighters in the context of conferencing helps to manage risk by:

- providing fire safety advice to young people and their families to improve preparedness
- informing young people about the consequences of their behaviour that has implications for response and recovery
- reducing the likelihood of reoffending and, thus, preventing and mitigating the risk of YMF.

Fire safety education provides young people with the knowledge to make informed decisions about safe fire behaviour and how fire risk can be managed.

CCDRR promotes the participation of young people in understanding and managing the risks associated with disasters. This tenet aligns with Article 12 Convention on the Rights of the Child that states a young person has the right to express their opinion and to have that opinion taken into account in any matter or procedure affecting them (United Nations 1989). Conferencing for YMF is led by an adult who mediates discussion between all participants (s60 *Young Offenders Act 1997* (NSW)). Although conferencing for YMF is an adult-initiated and mediated program, decision-making is shared with young people. In fact, young people maintain the right to reject the whole, or any part, of their outcome plan regardless of the views of other conference participants (s52(4) *Young Offenders Act 1997* (NSW)). This power of veto gives young people the right to express their opinion and have that opinion taken into account. Further, outcome plans are an obligatory component of conferencing as they provide the mechanism through which young people repair harm caused by their offence and mitigate the likelihood of similar harm occurring in the future. Outcome plans provide a process through which young people can take direct action to reduce the risks associated with their own YMF. As a CCDRR program, conferencing for YMF is an adult-initiated mechanism which vests decision-making power in young people. It aligns with the sixth rung on Hart's (1992) ladder of participation and is an example of what Hart described as true child participation.

The theoretical alignment of CCDRR and conferencing for YMF is supported by shared respect. The CCDRR Toolkit (Plan International 2010) states that the views of children and young people should be respected to ensure full participation and engagement with CCDRR programs. This reliance on respect is shared by conferencing for YMF. One aim of conferencing for YMF is to disapprove of offending behaviour within a culture of respect without disapproving of, or punishing, the young offender (Harris 2001). The role of conference participants is to support the young offender through the conferencing process, to elicit shame associated with the offending behaviour, not the self (Harris 2001). Both CCDRR and conferencing for YMF enable the sharing of young people's opinions and perspectives alongside mutual respect between young people and other participants.

Plan International (2010) listed two desired outcomes of CCDRR programs: democratic outcomes and developmental outcomes.

Democratic outcomes

Democratic outcomes include citizenship change where young people become aware of their rights and use this power to participate in decision-making processes, and institutional or systems change, where young people are involved in the process of decision-making and are accountable for disaster management. Democratic processes that give young people the power to create opportunities are used within conferencing for YMF to achieve democratic outcomes. Young people must give voluntary consent to participate in conferencing (s36 *Young Offenders Act 1997* (NSW)). If young people decide to participate, they are actively involved in the decision-making process of their outcome plan. Young people make suggestions as to the type of tasks they can complete to make reparation for their behaviour. While other conference participants also engage in this process, the young offender maintains the right to veto components or the entirety of the plan (s52(4) *Young Offenders Act 1997* (NSW)). If vetoed, all or any component of the outcome plan may be re-negotiated until agreement is reached. These consultative processes allow young people to be involved in decision-making processes and to negotiate outcomes. However, the opportunity to engage in conferencing only arises as an alternative to more punitive options. Voluntariness is therefore constrained as the decision to participate is influenced by the ramifications associated with non-participation (referral back to police or the court). Further, gatekeepers, such as police and the courts, are vested with the power of discretion to determine which individuals are granted access to conferencing. Although this discretion is bounded by legislation that specifies that offences must not involve sexual, serious drug or traffic offences, or one involving the death of a person (s8 *Young Offenders Act 1997* (NSW)), there exists evidence to suggest discretion may be applied differentially by gatekeepers (Murphy *et al.* 2010). Conferencing for YMF is therefore limited in its capacity to attain CCDRR principles because access to democratic and consultative processes is mediated by legislation and gatekeeper discretion. Nevertheless, when considered in the criminal justice context, conferencing for YMF is the only mechanism in NSW that gives young people the power to decide whether or not to participate, and a voice to negotiate outcomes. Conferencing for YMF is the most voluntary, democratic, and consultative of the juvenile justice mechanisms available in NSW.

Developmental outcomes

Developmental outcomes include capacity change as a result of increased knowledge, skills and abilities gained through education, training or workshops, and wellbeing change as a result of changes related to risk reduction (Plan International 2010, p. 74). One of the main principles of conferencing is to promote the development of young people by providing the impetus for capacity and wellbeing change (s34 *Young Offenders Act 1997* (NSW)). In accordance with s8 Young Offenders Regulation

2016 (NSW), young people are provided with fire safety education and fire safety-related tasks to expand their knowledge and strengthen their skills. The aim is to initiate cognitive and behavioural changes that reduce the risk and impact of future YMF. Such changes are likely to occur when YMF manifests from a lack of fire safety education or poor fire safety skills. Changes are not expected to occur when YMF manifests as malicious behaviour or as a symptom of psychopathology (McDonald 2010). The relationship between fire safety education and behavioural change is also mediated by adaptive capacity, a young person's cognitive capacity to adapt to additional information gained through social interaction (Bandura 1971). If targeted towards young people who possess adaptive capacity yet engage in YMF due to a lack fire knowledge and skill, conferencing for YMF offers an avenue through which CCDRR developmental outcomes may be attained.

Conclusion

Despite some limitations, CCDRR and conferencing for YMF are theoretically aligned. CCDRR provides a scaffold that explains and justifies the mechanisms operating in conferencing for YMF. Conferencing for YMF can be defined as a CCDRR mechanism where the program has been strategically positioned as a risk reduction strategy that involves collaboration between government and non-government agents. The program provides young people with access to knowledge and information through fire safety education to enhance preparedness, improve response and recovery, and prevent and mitigate the risks and consequences of YMF. Conferencing for YMF acts as a democratic mechanism through which young people engage in voluntary, participatory, and consultative processes, within a culture of respect, to take direct action to engender capacity and wellbeing change. In return, conferencing for YMF has the potential to act as a CCDRR mechanism, contributing to an increasing number of programs that strengthen understanding of fire risk and how risks related to fire can be managed.

The applicability of CCDRR to conferencing for YMF suggests that there may be other programs not traditionally defined as CCDRR mechanisms that aid CCDRR principles. Further, findings derived from CCDRR research may be used to inform the mode of delivery of fire safety education in conferencing to align with CCDRR best practice. This is necessary as fire safety education delivered by firefighters, as well as the resources used, have not been evaluated in the context of conferencing. It is recommended that CCDRR researchers partner with juvenile justice and fire agencies to develop evidence-based fire safety education plans and resources for use within conferencing. This advancement will enable the development and implementation of in-built monitoring and evaluation mechanisms, as recommended by Towers *et al.* (2014), to determine the capacity of fire safety education delivered by firefighters in the context of conferencing to change fire-related cognitions and behaviours in young people. Although further theoretical and empirical inquiry is required to evaluate conferencing for YMF as a CCDRR mechanism, this analysis provides a theoretical foundation upon which further investigation may transpire.

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Conflict of Interest

The author is a full-time firefighter with Fire and Rescue NSW. The author's PhD research involves the collection of data from Fire and Rescue NSW. The author's employment is not a requirement of, and has no bearing on, the conduct of the research, nor does the research require, or have a bearing on, the author's employment. This potential personal conflict of interest was made transparent throughout the ethics process to the Queensland University of Technology Human Research Ethics Committee, Juvenile Justice NSW and Fire and Rescue NSW. The relationship was deemed to have no bearing on the ethical conduct of the research.

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ABSTRACT

Cyclone Pam was one of the strongest cyclones to hit the south-west Pacific. In 2015 it struck some of the most populated parts of Vanuatu, resulting in extensive damage. Remarkably, only 11 deaths related to the cyclone were recorded. There has been some media attention to this good news and the logical questions are: why was the death toll low, and are there lessons for other countries? This paper examines the cyclone effects and explores possible reasons for the relatively low loss of life. Considerations include effective warnings and the high degree of self-reliance within communities, as well as aspects of the cyclone, in particular, the absence of a storm surge and major flooding in the area.

Cyclone Pam in Vanuatu: learning from the low death toll

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Introduction

The south-west Pacific island nation of Vanuatu is ranked as the world's most vulnerable to natural disasters in the *World Risk Report 2014* (United Nations University 2014). This assessment was based on the country's location in the South Pacific and its exposure to natural hazards, along with its susceptibility and limited coping and adaptive capacities. Given this, it would seem reasonable to expect that Vanuatu would be seriously impacted when, in April 2015, one of the strongest cyclones on record hit some of the most populated parts of the country. As expected, there were significant impacts on most sectors of the economy. This included food crops, infrastructure and buildings. Estimates were that about 80 per cent of the national housing stock was damaged or destroyed (Secretariat of the Pacific Community 2015). Telecommunications ceased functioning in most areas. Infrastructure and food crops were badly damaged, with many tree crops lost. Water supplies were damaged or contaminated with salt water leaving nearly half the population (110,000) in need of clean drinking water (OCHA 2015). There was much speculation by government, non-government organisations (NGO) and the media that the death toll would be high. Vanuatu President, Baldwin Lonsdale, described the storm as 'a monster that has devastated our country' (News.com 2015). The United Nations had unconfirmed reports of 44 people killed in one province alone. 'A disaster of this magnitude has not been experienced by Vanuatu in recent history—particularly in terms of the reach of the potential damage and the ferocity of the storm' (Sune Gudnitz in UN-OCHA 2015).

However, the actual death toll was much lower than expected. Eleven deaths were attributed to the cyclone, with four of these being people in or attempting to move their boats. The reasons for this are important as low death tolls during major disasters are much desired but often elusive. The Vanuatu experience of Cyclone Pam could offer valuable insights.

Vanuatu

The Melanesian island nation of Vanuatu consists of a chain of about 80 islands spread over 1300km of the south-west Pacific Ocean. The island chain lies in the cyclone belt and is threatened by an average of two cyclones a year. There are active volcanoes in the area and major earthquakes are frequent. This exposure underlies the nation's number one ranking in the *World Risk Report 2014*. Infrastructure is very limited and transport logistics and communications are challenging. Most wastewater is unmanaged and food and water security pose more challenges. An exception to this general pattern is the recently established successful mobile phone network.

The population of the country is about 253,000. Most Ni-Vanuatu (people of Vanuatu) live in rural areas and most (90 per cent) are engaged in subsistence food production and fishing. Languages of Bislama, English and French are widely spoken in addition to about 100 local languages. There are two major towns: Port Vila the capital with about 50,000 people and Luganville with some 15,000 people. Port Vila has large informal settlements with many squatters. These informal settlements do not have official sanction and are generally based on agreements with local land owners. Faith-based organisations and NGOs play key roles especially in disaster recovery and, to some extent, in preparedness. The formal economy is narrowly based and largely dependent on tourism, international aid programs and some agricultural exports. Vanuatu's Human Development Index ranking in 2015 was 134 out of 187 countries and territories. The United Nations lists it as a 'least developed country' (United Nations 2015).

Cyclone Pam hits Vanuatu

Category 5 Cyclone Pam was the most intense tropical cyclone in the southern hemisphere in 2015 and the second most intense tropical cyclone ever in the South Pacific basin. Cyclone Pam was second after Cyclone Zoe in 2002 with a central pressure of 896hPa on March 14, and high wind speeds at one minute of 270km/h, ten minute 250km/h (similar to cyclones Orsen and Monica). A maximum gust of 320km an hour was reported. The previous most damaging cyclone to hit Vanuatu was the Category 3 Cyclone Uma in 1987.

Damage was extensive especially on the islands of Efate, around Port Vila and on the southern islands of Tanna and Eromango.

Despite its severity, some of Cyclone Pam's attributes reduced the risk:

- The cyclone moved relatively slowly as it headed towards Vanuatu giving time for warnings and preparation.
- The cyclone hit the populated areas in the islands of Tanna and Eromango during daylight hours (Port Vila was hit at night). This allowed people on the islands to monitor the direction of the cyclone and shelter accordingly.
- Populated areas were not subject to significant damaging storm surges, landslides or flooding.

The first two factors were highlighted by local people as important contributors to the low death toll. This research also showed that the absence of major flooding was important. The majority of deaths from tropical cyclones (including typhoons and hurricanes) are the result of flooding either from the sea or heavy rain and landslides. While it is beyond the scope of this paper to examine why the storm surge was small in this case, it should be noted that damage was limited because any surge that did occur was not near heavily populated areas (the cyclone made landfall on Efate island on the opposite side to the location of Port Vila).

Many factors influence surge size including storm intensity, cyclone central pressure, size (measured by the 'radius of maximum wind'), angle of approach to land and the quadrant involved (with the left front quadrant of the cyclone having the strongest onshore winds in the southern hemisphere) and the characteristics of coastal and near shore features such as bays and reefs. Offshore bathymetry is also important and the state of the tide can be critical. Deep water nearshore, a wide bay protected by reefs, a cyclone approach coinciding with low tide and with the right hand quadrant making landfall first, would all contribute to a low storm surge.

The research approach

A desktop study was conducted of the cyclone and the factors related to the reported fatalities. This was supplemented with information from contacts in Vanuatu. The desktop work was primarily based on internet searches and included Vanuatu print media. In addition to a wide range of government, individual and NGO website posts, blogs, media stories and interviews, there were formal reports on the cyclone and its immediate aftermath by NGOs. A news report by Bolitho (2015) identified text warnings, traditional building styles and preparedness as key factors in the low death toll.

A field visit to Vanuatu was undertaken in August 2015, five months after the cyclone. Discussions were held with local contacts including the Prime Minister and government ministers at the time of the cyclone, people running the emergency management office, officials working in the emergency management effort, representatives from the telecommunications authority, local business operators and major NGOs. In all there were about 15 discussions. Participants were fully informed about this study and the associated research on the role of digital volunteers in emergency management (see Acknowledgements). Apart from senior politicians and agency staff, people talked under an assurance of confidentiality. The original intent was to visit the affected areas of Tanna. However, logistic and other problems meant researchers stayed on the island of Efate. A Tanna perspective was provided through discussions with people from Tanna held in Port Vila and via media and online sources. A visit to the worst affected areas would have added confidence in the results, as would detailed community surveys about the warning messages, preparedness, shelter and attitudes and actions. Time, resources and practicalities mean that the research was limited and results need to be interpreted with this in mind.

Low death toll

Factors important in the low death toll were identified as:

- effective warnings
- self-reliance and traditional knowledge and preparation
- training and evacuation
- shelter and housing.

These factors are in addition to the cyclone attributes identified earlier.

Effective warnings

The effectiveness of Vanuatu's early warning system was universally recognised as a key factor influencing the low death toll, especially when comparing the impacts to previous cyclones where phone network coverage and mobile accessibility were very limited. Initial warnings were issued days ahead of the cyclone reaching Vanuatu (refer Figure 1, Figure 2). Warnings took the form of advice on preparations and safety. These messages were broadcast via radio and especially text messages; the latter reaching most of the at-risk population (World Bank 2015). There are about 66 mobile phone subscriptions per 100 people and 90 per cent of the country is covered (World Bank 2015). Warnings were also broadcast by radio but there was evidence that some areas were not reached by this medium. In a review of modern communication across the Pacific, Noske-Turner and colleagues (2014) state that there were no formal agreements for the use of SMS in emergencies in Vanuatu. The National Disaster Office has been working on putting this in place for some time (Volunteer Service Abroad 2014).

The then Prime Minister, Mr Joe Natuman, commented that the cyclone moved slowly giving enough time for warnings. There was a view that many of the fatalities in previous cyclones resulted from people moving their boats to safety at the last minute. The longer warning time available for Cyclone Pam meant that many owners were able to move their boats in safety, although four people died in or while moving boats.

The two national mobile phone providers (Telecom Vanuatu and Digicel) made the official SMS cyclone warnings and all text messages free following a request from the Prime Minister. It was widely believed this was the most effective way to contact the majority of people quickly both before (with details of the cyclone's progress) and after impact (with health information and details of food distribution) (Arbon 2016). The emergency text messages included the threat level and the direction and location of the cyclone. The text-based warnings were widely re-distributed reaching much of the population. This is based on estimates of the number of people receiving pre-cyclone advice by text and the widespread ownership of phones. SMS messaging on cyclone preparedness sent several weeks before Cyclone Pam reached an estimated 120,000 people in all provinces. A media article by Willie (2015) describes the approach in more detail and a World Meteorological Organization (2015) report details these warnings.

There is no certainty as to what action people took when warned, but reports confirm people were not taken by surprise. Cyclone tracking maps are a useful part of early warning systems. They allowed people to track the progression of the cyclone via coordinates sent by SMS and radio messages. Maps also detail information on cyclone intensity and other attributes broadcast by radio and mobile phone messages (Tafea PDC 2015).

Although pre-cyclone warnings via emergency SMS messages appear to have been effective, post-cyclone effectiveness was limited by the number of mobile towers left standing. Cyclone Pam destroyed all but one of the mobile towers in Port Vila resulting in no communication with other provinces. The two telecommunications companies were encouraged to share the available resources while repairs were undertaken. The first repairs to damaged towers were made within days. A number of satellite phones were also distributed across the provinces and islands for official communication.

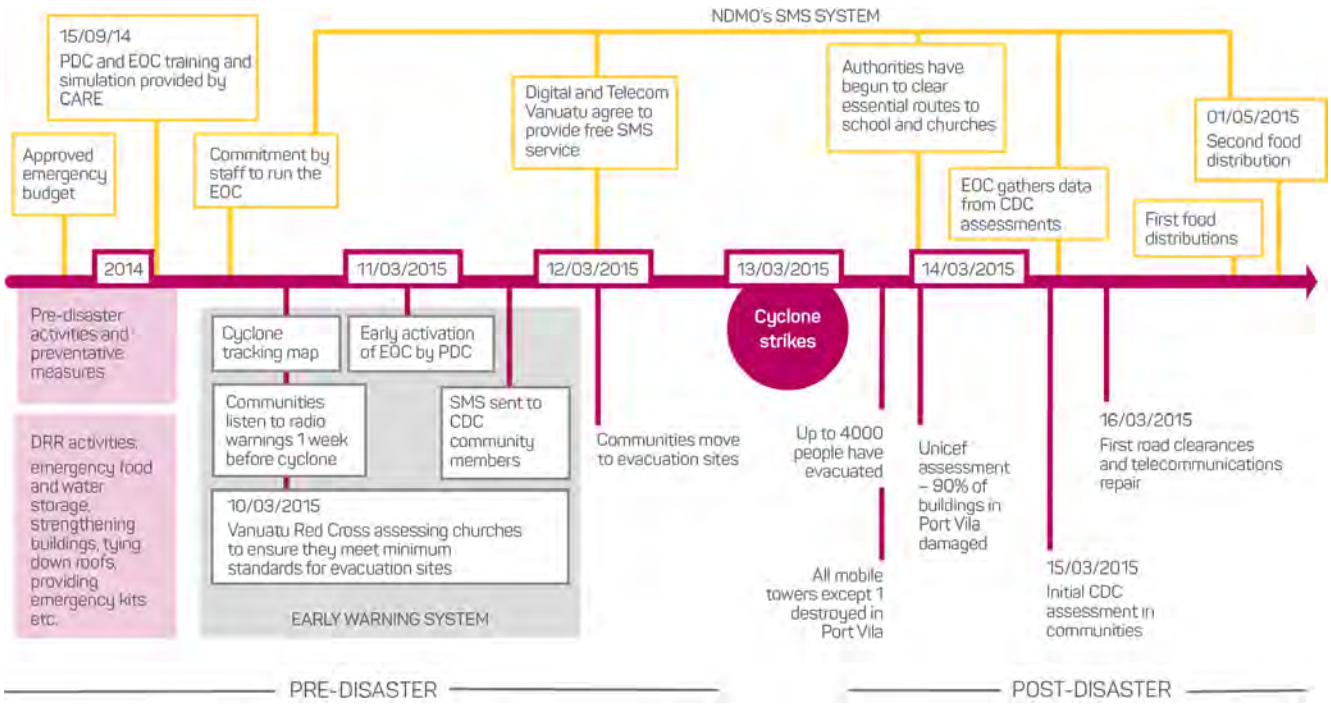

Figure 1: Cyclone Pam timeline.

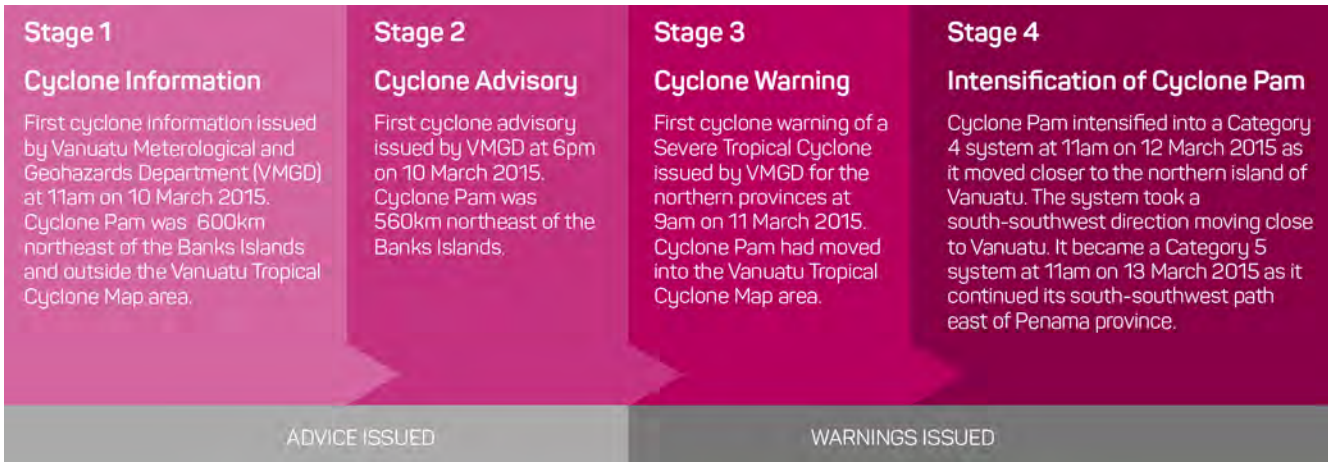

Figure 2: The four stages in the tropical cyclone early warning system in Vanuatu for Cyclone Pam. Advice was issued during stages one and two. Warnings were issued in stages three and four.

Self-reliance and the use of traditional knowledge and preparation

Vanuatu's exposure to, and considerable experience with, cyclones means that the people are accustomed to these events and have developed coping mechanisms. These include a mix of traditional preparedness activities and self-reliance. Two main areas of traditional knowledge were emphasised: knowledge of traditional indicators of an approaching cyclone and traditional building styles including the use of traditional 'cyclone houses'. Preparedness and post-cyclone coping mechanisms were also contributors to recovery following the cyclone.

Although SMS warnings proved effective, some people do not have phones or live in areas without mobile phone coverage. As a result people on remote islands use traditional knowledge to detect the onset of a cyclone. For example, the abundance of a particular plant or the flight of a particular bird is thought to indicate the approach of a cyclone. These signs traditionally trigger activities such as cutting down the leaves of banana plants to prevent the trees from collapsing, tying down roofs, and storing food and water.

Knowledge and activity ascribed to tradition is useful in reducing cyclone impact and improving safety. The Vanuatu government promotes the use of such methods as a form of self-reliance and preparedness (McNamara & Prasad 2014). In a study of a 1999 tsunami, Walshe and Nunn (2012) found that both traditional knowledge and a recent tsunami-awareness program were important factors in the low death toll. However, traditional knowledge and beliefs have long faced challenges from missionaries, colonial authorities, modernity and, now, from environmental change. There is a view (supported by Walshe and Nunn 2014) that younger Ni-Vanuatu are more interested in modernity than tradition. This has major implications for traditional knowledge when nearly 60 per cent of Ni-Vanuatu are under 24 years old. Traditional knowledge and beliefs exist, but education in this area is declining and has a diminished role. Cyclone Pam highlighted the decrease in traditional famine crop gardens and storage of emergency food rations. In addition, the increasing incidences of crop diseases and theft and a rise in preference for imported food provide new challenges (Warrick 2012).

Cyclone recovery tradition has been largely replaced with a reliance on government, NGOs and international aid. This is not necessarily a recent phenomenon. Barr (1992) made a similar observation in his review of disaster planning in Vanuatu, Warrick (2012) cites studies of food relief after cyclones in 1939 and 1972. Schreider (1957) comments on food aid dependency in his study of typhoons on the Micronesian island of Yap.

Training and evacuation

Experience from previous cyclones is a factor in improving safety, however, training and evacuation are vital to survival. Many of those whose houses collapsed moved to a variety of shelters including roots of banyan trees, pig trenches, thick bush and caves. The effectiveness of evacuation in Tanna was helped by the fact that the cyclone hit during daylight hours.

Efforts were made by NGOs and government to evacuate people prior to the cyclone considered particularly vulnerable to flooding around Port Vila. The evacuation targeted both formal and informal settlements deemed at-risk based on local hazard maps. However, Save the Children found that the evacuation was hampered due to people's resistance to leave their homes and the government's reluctance to issue a code red alert. Although people were aware of the onset of the cyclone they weren't fully aware of the possible magnitude of what was about to hit. About 4000 people were evacuated, 1000 of whom were in Port Vila (Humanity Road 2015).

Evacuation centres were established to be somewhere people slept at night, while daylight hours were spent salvaging and rebuilding their homes. It was noted that although the rebuilding process was very quick, rebuild was to pre-existing standards and vulnerabilities. People rebuilt in the same locations with exactly the same materials as before (Shelter Cluster 2015, Barber 2015). Given the circumstances and the absence of alternatives, rapid rebuilding probably makes good sense: with many people on the edge of the cash economy with little alternative housing or livelihoods, with rebuilding

being straightforward and low cost, and with Category 5 cyclones being historically very rare. At the time of writing, some remote villages are still not rebuilt.

Area councillors noted that previous training by the Community Disaster Committee (CDC) and Provincial Disaster Committee, simulation exercises conducted by CARE in 2014 and the Vanuatu Humanitarian Team (an inclusive group with NGO and government representatives) in 2013, had been important. This training ensures that key provincial and local government representatives had some training in what to do during a large scale emergency response. Disaster response materials and kits were distributed to CDC members by aid organisations prior to the cyclone. The kits included solar power radios, containers for emergency water storage and information on water and sewage hygiene. The Red Cross helped identify 'safe houses' for evacuation. CARE was able to reach 4060 people with intensive help and follow-up. Vanuatu is so widely spread that this task is very challenging and, to date, programs have only reached approximately two per cent of the population.

Shelter and housing – traditional and modern

Most construction in Vanuatu is informal and unregulated, apart from the central areas of Port Vila and Luganville. Traditional building materials dominate the more remote villages, while in other areas construction uses a mixture of materials as in the low-cost housing around Port Vila. This low-cost housing is constructed of a mix of 'modern' materials (cement, iron roofing etc.) but not built to building standards or codes. This makes communities more vulnerable to building damage and injury during natural events (Shelter Cluster 2015).

Local people believe that a factor in the low death toll and serious injuries was the widespread use of lightweight materials, in particular thatch, used in traditional houses. This meant injuries from falling masonry or flying metal cladding were rare. Similarly, post-cyclone injuries from dislodged traditional building materials were low. A report following Cyclone Pam by the Vanuatu Shelter Cluster found that buildings in the traditional style survived better than houses with cement sheeting and iron roofing and houses built using traditional materials but in modern styles (Shelter Cluster 2015). The research suggested that traditional roofing materials either survived the winds better, or if not, were easily repaired.

A report by Save the Children came to different conclusions:

> *'Roofs constructed from natangura leaves and other thatch suffered greater damage than roofs made of corrugated iron, and walls made of bamboo suffered greater damage than walls made of corrugated iron or concrete.'* (Barber 2015)

Barber (2015) also found that in the aftermath of the cyclone, corrugated iron and concrete were significantly easier to access for reconstruction and repairs than natural materials such as thatch and bamboo.

Traditional houses constructed to be cyclone shelters, made entirely of local materials, present another form of disaster-related traditional knowledge. They were seen by many as an effective form of shelter during Cyclone Pam (Shelter Cluster 2015). These 'cyclone houses' were promoted after Cyclone Innis (February 2009) that destroyed many of the 'normal' thatched houses. These cyclone houses are again being promoted by the government in rural areas after Cyclone Pam. 'This is the type of housing we should be building' stated the then Prime Minister—with the only on-land deaths apparently caused by dislodged heavy building materials. Cyclone houses have thicker thatch (than normal traditional houses) and a roof that extends to ground level. At least one end of the house is rounded to reduce wind resistance, the door is kept as small as possible and the frames are buried in the ground. The building materials are lashed together (rather than nailed) allowing the buildings to flex and bend without breaking up (Barr 1992).

The different views on housing style and materials highlight the limitations of the available studies, and the complexity of vulnerability. Traditional housing materials might not be as resistant as modern materials to high winds, but are less likely to kill or injure people. Informal settlements in Vila used modern materials in construction. There are few places in Vanuatu (Barber 2015) or indeed worldwide where housing is built to withstand Category 5 conditions. It is unclear that it is realistic or even desirable for all housing to be at such a standard; however, emergency shelters can be. One approach to address this is being trialled on Tanna. 'Nev houses' are prefabricated, flat-packed houses designed for extreme winds and for local Vanuatu needs. Thus, both traditional and modern approaches to cyclone-secure housing are being pursued.

Conclusions

Cyclone Pam was a Category 5 event that passed directly over some of the most populated islands of Vanuatu in March 2015. There was extensive damage. However, far fewer people died than expected for a nation ranked at number one by the World Risk Report.

This study examined the factors identified as contributing to the low toll: effective timely warnings spread via mobile phone texts, self-reliance, preparation and knowledge of appropriate actions from both traditional knowledge and modern sources, training and evacuation, aspects of local housing and, critically, that the cyclone did not result in major flooding or storm surges in populated areas. There was strong endorsement of warnings sent by text, which have, to some extent, replaced warnings broadcast by radio. While texts are regarded as more effective, people also drew on traditional indicators for warnings. These may become less reliable in the context of environmental change. There was evidence that traditional housing fared better but this was disputed by a major NGO report (Barber 2015).

Increased emphasis on tradition is advocated by many, but avoiding modernity and the cash economy is difficult. People need money to pay for school, health care, some food and mobile phones. Without phones warnings cannot be received. The reasons for the low death toll can be viewed as a combination of traditional and modern aspects of community, telecommunications and government and NGO interventions.

It seems evident that a high degree of self-reliance combined with reliable, timely and informative warnings, and knowledge of what to do, saves lives. Critically, warnings and preparation appear to have been taken seriously. While Cyclone Pam was a Category 5 event, it moved slowly enough for warnings to be issued and did not bring on a damaging storm surge. We cannot be sure that the result would have been as good if there had been significant flooding—although government officials argued that they were aware of the possibility and took precautions.

Such extreme and historically rare events are expected to increase in frequency because of both climate change, and increasing exposure of humans and their activities to cyclones and other hazards. The Cyclone Pam experience suggests that the human cost can be minimised, but the destruction highlights the limits of preparations and adaptive capacity. This raises the question of how far a country should, and can, go to prepare for such rare events. However, locally appropriate and timely warnings and maximum message reach and take up, accompanied by preparedness training, is possible for most events. Other factors that underpin effective resilience are the involvement of civil society, government and NGOs in preparedness, strong support from commercial phone service providers and community leadership.

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