Highlights and Achievements 2013–2021
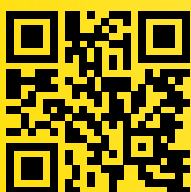
Showcasing eight years of the Bushfire and Natural Hazards CRC

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DRIVING CHANGE
RESEARCH IN USE

Driving Change curates the best and latest research from the Bushfire and Natural Hazards CRC.

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Australian Government
Department of Industry, Science, Energy and Resources

AusIndustry
Cooperative Research Centres Program

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Showcasing eight years of the Bushfire and Natural Hazards CRC

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ABOUT US

VISION AND AIMS

The Bushfire and Natural Hazards CRC's vision was to be the preferred and trusted source of research and knowledge in bushfire and natural hazards.

The CRC was created with a mission to:

REDUCE THE RISKS FROM BUSHFIRE AND NATURAL HAZARDS	**CONTRIBUTE TO THE NATIONAL DISASTER RESILIENCE AGENDA**
REDUCE THE SOCIAL, ECONOMIC AND ENVIRONMENTAL COSTS OF DISASTERS	**BUILD INTERNATIONALLY RENOWNED AUSTRALIAN RESEARCH CAPACITY AND CAPABILITY**

The Bushfire and Natural Hazards CRC conducted research between 2013–2021 to contribute to building a more disaster resilient Australia.

The centre drew together all of Australia and New Zealand's fire and emergency service authorities, land management agencies and non-government organisations with the leading experts across a range of scientific fields to explore the causes, consequences and mitigation of natural hazards.

The CRC coordinated a national research effort in hazards, including bushfire, flood, storm, cyclone, earthquake, heatwave and tsunami.

Eight years of Australian Government funds under the Cooperative Research Centres Program were matched by support from state and territory government organisations, research institutions and NGOs.

The research program was developed under the direction of end-users, in conjunction with researchers.

The CRC has provided a long-term knowledge base that directly supports emergency services and other government and non-government agencies in protecting their communities through work to prevent, prepare for, respond to and recover from natural hazards.

Way back in 2013, the natural hazards sector, through the Bushfire and Natural Hazards CRC, agreed on a grand vision – to reduce the risks, costs and impacts of natural hazards in Australia and to contribute to the national disaster resilience agenda. Right from the beginning, all the partners in the CRC got together and established a set of four ideal goals that, if met, would achieve this vision.

So how did we all go? The CRC was a sum of its parts, and with more than 250 researchers and over 300 end-users, from more than 50 partners around Australia and New Zealand, we have worked hard and delivered research ready for use. In most cases, as you'll see in this book, our work is already being used by our partners, keeping communities safe. But did we meet the goals? This book provides a demonstration of the eight-year journey and here are some of the highlights of how we reached each goal.

Reduce the risks from bushfire and natural hazards:

- Our research has been particularly impactful in the interconnected fields of predictive services, and community information and warnings. Our work has contributed to major advancements in the understanding and modelling of severe weather, severe bushfire behaviour and development of a fire-atmosphere modelling capability linked to the Bureau of Meteorology's ACCESS weather model. The CRC's research has also enabled firefighters to be warned of when a pyrocumulonimbus – a fire thunderstorm and the most dangerous bushfire conditions – is likely to develop.
- The current and the next generation of operational fire behaviour models are built around new science in areas such as soil, landscape and fuel moisture, remote sensing and fire detection, and fire coalescence.
- Early in the CRC, researchers oversaw the development of the business model for the new fire danger ratings scheme, which in 2021 was in the early stages of implementation.
- Our research has transformed warnings and public information campaigns to prepare and protect communities threatened by flood, bushfire, cyclone, storm and heatwave. Evidence-based warning messages are now delivered to at-risk populations in the face of imminent threats and long-term public safety campaigns are now better targeted.
- We have developed many tools and capabilities that have been built into national systems that are widely used by end-users, including those hosted by the Bureau of Meteorology and Geoscience Australia, as well as individual emergency service agencies.

Reduce the social, economic and environmental costs of disasters:

- We have been able to demonstrate in greater detail

Dr Richard Thornton. Photo: Australian Academy of Science.

the economic toll of natural hazards, through an analysis of different parts of the economy before and after a hazard. Our research has helped develop a baseline measure of what the current costs of natural hazards are so that future economists and emergency managers can measure and reduce the ongoing cost of hazards – in lives, landscapes and infrastructure – in our communities.

- We have shown how economists can assign value to aspects of natural hazard impact that are either difficult to value, such as social costs, or have intangible value. This means mitigation planning can be better targeted to reduce risk and meet budgets.
- We have worked with the Traditional Owners of the land in remote parts of northern Australia to collaboratively develop best practice for preparation for, response to, and recovery from, natural hazards.
- With agencies and Indigenous groups across northern Australia, we created new tools that help manage the many fire abatement projects, generating revenues from carbon credits for remote communities.
- We have also developed new products that allow our partners to better manage the landscape for fire on a year-round basis. This had led to a range of social, economic and environmental benefits, and ultimately, safer and healthier communities in high fire-risk areas.
- We have increased the capability to conduct 'what-if?' analyses when making key policy and implementation decisions that factor in future demographic, climate and societal shifts.

Contribute to the national disaster resilience agenda:

- We have pioneered the mapping of resilience to hazards across Australia – a capability that is already being used by a range of government and private sector partners to assess and improve the resilience of our communities.
- Our development of a broader understanding of resilience led to the development of new frameworks of risk ownership, which strongly influenced the development of the Australian Government's

Dr Katherine Woodthorpe AO.

National Disaster Risk Reduction Framework in 2018.
- Our work in understanding children's needs and roles in disasters, as well as their role in building resilience, has influenced the thinking of many forums of the United Nations Office for Disaster Risk Reduction and has inspired many local initiatives across Australia, in schools and communities.
- The production of Australian Seasonal Bushfire Outlooks, which are used throughout governments, agencies and local communities, has ensured that communities are better prepared for upcoming fire seasons.

Build internationally renowned Australian research capacity and capability:

- As a trusted institution, the CRC and its researchers have been invited as speakers and visitors at many international forums, including in the United States, Canada, Europe and the Asia-Pacific region. Richard was one of a few speakers at a special forum held by the Organisation for Economic Cooperation and Development in Paris in early 2020, discussing the growing challenge to economies from bushfire.
- We have hosted many international visitors, who have sought out the CRC for examples on how to undertake collaborative natural hazards research.
- We have grown our international networks over the years, now

with links to key research groups across the world. The CRC has worked with more than 30 different research groups internationally to bring the best of global natural hazard science to Australia.

The CRC's research, knowledge and tools have been widely incorporated into everyday use by its partners and are helping improve the understanding of the risks from natural hazards. Thanks to the work of the CRC and its partners, the community is now better prepared for the inevitable impacts of hazards in the future.

This book covers a small sample of the work that the CRC has pioneered over its life. It showcases the highlights and, read together with its companion documents, *Hazard Notes 2013-2021*, *Postgraduate Research* and *Research Posters*, you can see the enormity of what can be achieved through a dedicated and collaborative national research centre of sufficient scale to tackle specific and important goals.

The legacy of the CRC will be the transition of these capabilities, insights and networks into the new national centre for disaster resilience and disaster risk reduction.
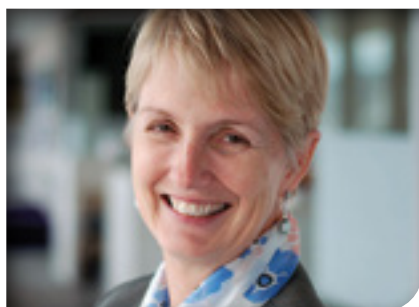
Dr Katherine Woodthorpe AO,
Chair

Dr Richard Thornton,
Chief Executive Officer

Bushfire and Natural Hazards CRC

Dr Laurie Hammond.

Dr Katherine Woodthorpe AO.

The Bushfire and Natural Hazards CRC was an incorporated not-for-profit public company limited by guarantee. The company, Bushfire and Natural Hazards CRC Ltd, was registered in May 2013 and began formal CRC operations on 1 July 2013.

The CRC's funding period closed on 30 June 2021. Leading up to the closure, the CRC was working with the Commonwealth Government to develop the new national research centre for disaster resilience and disaster risk reduction.

The Governing Board met several times a year between 2013 and 2021, usually in different capital cities around Australia. In-person meetings were held in conjunction with a research event or an informal stakeholder partner event to enable the Board to meet regularly with members, end-users, researchers, students and other key stakeholders.

The Board was chaired by independent directors.

Dr Laurie Hammond was appointed independent Chair of the CRC when it began in 2013 and was integral to the growth and development of the centre. Laurie passed away at the end of 2018.

Dr Katherine Woodthorpe AO was appointed Chair in early 2019 and steered the CRC through its final years as well as establishing a secure long-term future for natural hazards research.

At the closure of the CRC, the nine-person Board consisted of five male and four female directors (including the Chair).

GOVERNING BOARD MEMBERS 2013–2021

NAME	INDEPENDENT/ORGANISATION	TERM
CHAIRS		
Naomi Brown	Independent	Interim Chair to August 2013
Dr Laurie Hammond	Independent	Appointed August 2013, Deceased November 2018
Dr Katherine Woodthorpe AO	Independent	Appointed March 2019 – present
DIRECTORS		
David Place	South Australian Fire and Emergency Services Commission	Appointed April 2013, Resigned May 2015
Tony Sheehan	Attorney-General's Department	Appointed April 2013, Resigned November 2015
Stuart Ellis	AFAC	Appointed June 2013, Resigned December 2019
Kathy Gramp	Independent	Appointed December 2013 – present
Lee Johnson	Queensland Fire and Emergency Services/Independent	Appointed December 2013 – present
Craig Lapsley	Emergency Management Victoria	Appointed December 2013, Resigned August 2018
Prof Alistair Robertson	Independent	Appointed December 2013, Resigned April 2019
Naomi Stephens	NSW National Parks and Wildlife Service	Appointed December 2013 – present
Katherine Jones	Department of Home Affairs	Appointed November 2015, Resigned May 2018
Karl Sullivan	Insurance Council of Australia/Independent	Appointed November 2015 – present
Doug Smith	Queensland Fire and Emergency Services/Queensland Police Service	Appointed November 2016 – present
Mark Crosweller	Department of Home Affairs/Independent	Appointed May 2018 – present
Dr Greg Ayers	Independent	Appointed July 2019 – present
Dr Stephanie Rotarangi	Country Fire Authority	Appointed July 2019, Resigned December 2019
Paul Smith	Country Fire Authority	Appointed Nov 2018, Resigned June 2019
Sandra Whight	Bureau of Meteorology	Appointed March 2020 – present

KEY STAFF 2013–2021

NAME	ROLE
EXECUTIVE	
Dr Richard Thornton	Chief Executive Officer
Dr John Bates	Research Director
Dr Michael Rumsewicz	Research Director
David Bruce	Communications Director
Trevor Essex	Company Secretary
Leanne Beattie	Executive Assistant
Carol Mourdoukoutas	Executive Assistant
PARTNERSHIPS	
Sarah Mizzi	Partnership Development Director
Dr Paul Perry	Partnership Development Director
Lyndsey Wright	Contract Research and Education Manager
RESEARCH AND UTILISATION	
Dr Desiree Beekharry	Core Research Program Manager
Loriana Bethune	Utilisation and DELWP Program Manager
Dr Matthew Hayne	Research Utilisation Manager
Greg Christopher	Research Utilisation Manager
David Boxshall	Research Services Team Leader
Nicklaus Mahony	Research Services Project Officer
Kelsey Tarabini	Research Services Project Officer
Andrew Yin	Research Services Project Officer

NAME	ROLE
COMMUNICATIONS	
Nathan Maddock	Communications Manager
Bethany Patch	Communications Officer
Vaia Smirneos	Events Officer
Amy Mulder	Communications Officer
Freya Jones	Communications Officer
Friedo Ligthart	Graphic Designer
Catrin Harris	Graphic Designer
Radhiya Fanham	Communications Assistant
Gabriel Zito	Communications Assistant
Costa Haritos	Communications Assistant
FINANCE	
Kate Eagles	Financial Controller
Anna Nikitina	Finance Officer

The staff of the CRC, as of 2019.

PARTNERS IN RESEARCH 2013–2021

AGENCIES

ACT Emergency Services Agency

Bushfires NT

Country Fire Authority, VIC

Country Fire Service, SA

Fire Emergency New Zealand

Fire and Rescue NSW

Metropolitan Fire and
Emergency Services Board

New Zealand Fire Service Commission

NSW Rural Fire Service

NSW State Emergency Service

NT Fire and Rescue Service

Queensland Fire and Emergency Services

Queensland Police Service

SA Metropolitan Fire Service

SA State Emergency Service

Southern Rural Fire Authority, New Zealand

Tasmania Fire Service

Tasmania State Emergency Service

Victorian State Emergency Service

WA Police

Women and Firefighting Australasia

FEDERAL GOVERNMENT

Attorney-General's Department

Bureau of Meteorology

Commonwealth Government

Commonwealth Scientific and
Industrial Research Organisation

Department of Defence

Department of Home Affairs

Geoscience Australia

STATE GOVERNMENT

ACT Parks and Conservation Service

ACT Territory and Municipal Services

Bushfire Recovery Victoria

Department of Biodiversity,
Conservation and Attractions, WA

STATE GOVERNMENT

Department for Communities
and Social Inclusion, SA

Department of Environment, Land,
Water and Planning, VIC

Department of Environment and Water, SA

Department of Fire and
Emergency Services, WA

Department of Housing and
Public Works, Qld

Department of Jobs, Precincts
and Regions, Vic

Department of Justice, NSW

Department of Justice, Vic

Department of Parks and Wildlife, WA

Department of Planning and
Environment, NSW

Department of Planning,
Lands and Heritage, WA

Department of Planning, Transport
and Infrastructure, SA

Department of Premier and Cabinet, SA

Department of Premier and Cabinet, Tas

Department of Primary Industries,
Parks, Water and Environment, Tas

Department of Science, Information,
Technology, Innovation and the Arts, Qld

Department of Transport
and Main Roads, Qld

Emergency Management Victoria

Inspector-General for Emergency
Management, Vic

National Parks and Wildlife Service, NSW

Northern Territory Government

Office of Emergency Management, WA

Office of Environment and Heritage, NSW

Office of the Inspector-General
Emergency Management, Qld

Parks Victoria

Parks and Wildlife Services, Tasmania

Queensland Reconstruction Authority

Resilience NSW

Roads and Maritime Services, NSW

Safer Together, Vic

STATE GOVERNMENT

SA Fire and Emergency
Service Commission

SA Water

Territory and Municipal Services,
Australian Capital Territory

LOCAL GOVERNMENT

Australian Local Government Association

Cairns Regional Council

City of Ipswich

Knox City Council

Lockyer Valley Regional Council

Maroondah City Council

Tablelands Regional Council

Yarra Ranges Council

ASSOCIATIONS

Australasian Fire and Emergency
Service Authorities Council

Australian Red Cross

Australian Road Research Board

Council of Australian Volunteer
Fire Associations

Fire Protection Association of Australia

Hydrology and Risk Consulting

RSPCA Queensland

Volunteering Queensland

ACADEMIC

Australian Catholic University

Australian National University

Charles Darwin University

Charles Sturt University

CQUniversity

Curtin University

Deakin University

Edith Cowan University

Federation University

Flinders University

ACADEMIC

Griffith University

James Cook University

La Trobe University

Macquarie University

Massey University, New Zealand

Monash University

Murdoch University

Queensland University of Technology

RMIT University

Southern Cross University

State University of New York, United States

Swinburne University

University of Adelaide

University of Alberta, Canada

University of Auckland, New Zealand

University of British Columbia, Canada

University of Canberra

University of Canterbury, New Zealand

University College, United Kingdom

University of Gothenburg, Sweden

University of Huddersfield, United Kingdom

University of Idaho, United States

University of Melbourne

United Nations University

University of Newcastle

University of New England

University of New South Wales

University of Otago, New Zealand

University of Queensland

University of South Australia

University of Southern Queensland

University of the Sunshine Coast

University of Sydney

University of Tasmania

University of Technology Sydney

University of Tennessee, United States

ACADEMIC

University of Twente, Netherlands

University of Western Australia

University of Wollongong

Victoria University

Western Sydney University

COLLABORATIONS

Aboriginal Carbon Fund

Aboriginal Victoria

Aither

Arthur Rylah Institute

Asian Disaster Preparedness Center

Ausgrid

Australian Building Codes Board

Australian Institute of Disaster Resilience

Beyond Blue

Boeing

Coastal Resilience Center, United States

Coffey Consultancy

Desert Research Institute, United States

Dja Dja Wurrung Clans Aboriginal Corporation

DLR German Aerospace Center, Germany

Ecosystems Research Group

Energy Networks Australia

Essential Energy

Federation of Victorian Traditional Owner Corporation

FireNinti Consulting

Firesticks Alliance

Forest Practices Authority

Hospital Research Foundation

Human Performance Science

Instinct and Reason

Insurance Council of Australia

Integrated Research on Disaster Risk

Karlsruhe Institute of Technology, Germany

COLLABORATIONS

Landgate

Leadbeater Group

Life Saving Victoria

Los Alamos National Laboratory, United States

Melbourne Water

MWH Global

Natural Decisions

North Australian Indigenous Land and Sea Management Alliance

Planning Institute of Australia

Powercor Australia

Powerlink

Public Safety Business Agency

Research Institute for Knowledge Systems, Netherlands

Risk Frontiers

Royal Life Saving Australia

Roy Morgan

SA Power Networks

Save the Children

Steel Reinforcement Institute of Australia

Surf Life Saving Australia

Sustainable Timber

TasNetworks

Taungurung Clans Aboriginal Corporation

United Energy

VicRoads

Western Power

RESEARCH PROGRAM LEADERS 2013–2021

For more details on the research leaders, end-users and project aims,
see the full Research Program at www.bnhcrc.com.au/research.

NAME	ORGANISATION	NAME	ORGANISATION
Dr Paul Barnes	Queensland University of Technology	Dr Phil Morley	University of New England
A/Prof Chris Bearman	CQUniversity	Dr Krishna Nadimpalli	Geoscience Australia
A/Prof Tina Bell	University of Sydney	Dr Timothy Neale	Deakin University
A/Prof Jennifer Boldero	University of Melbourne	Dr Scott Nichol	Geoscience Australia
Prof Ross Bradstock	University of Wollongong	Prof David Pannell	University of Western Australia
Prof Andrew Campbell	Charles Darwin University	Dr Melissa Parsons	University of New England
Dr Imtiaz Dharssi	Bureau of Meteorology	Prof Charitha Pattiaratchi	University of Western Australia
Dr Felipe Dimer de Oliveira	Macquarie University	A/Prof Valentijn Pauwels	Monash University
Dr Thomas Duff	University of Melbourne	Dr Mika Peace	Bureau of Meteorology
A/Prof Patrick Dunlop	Curtin University	Prof Trent Penman	University of Melbourne
A/Prof Michael Eburn	Australian National University	Prof Abbas Rajabifard	University of Melbourne
Dr Andrew Edwards	Charles Darwin University	Prof Bruce Rasmussen	Victoria University
Dr Veronique Florec	University of Western Australia	Dr Karin Reinke	RMIT University
Prof Lisa Gibbs	University of Melbourne	Dr Harald Richter	Bureau of Meteorology
Prof John Ginger	James Cook University	Prof Kevin Ronan	CQUniversity
Andrew Gissing	Risk Frontiers	A/Prof Jeremy Russell-Smith	Charles Darwin University
Prof Michael Griffith	University of Adelaide	Prof Sujeeva Setunge	RMIT University
Prof John Handmer	RMIT University	A/Prof Jason Sharples	University of New South Wales
Dr Katharine Haynes	University of Wollongong	Stephen Sutton	Charles Darwin University
Glenn James	North Australian Indigenious Land and Sea Management Alliance	Dr Mel Taylor	Macquarie University
Prof David Johnston	Massey University	Prof Graham Thorpe	Victoria University
A/Prof Michael Jones	University of Wollongong	Prof Vivienne Tippett	Queensland University of Technology
Prof Roger Jones	Victoria University	Dr Briony Towers	RMIT University
Prof Simon Jones	RMIT University	Dr Robert van den Honert	Macquarie University
Dr Jeff Kepert	Bureau of Meteorology	Prof Albert van Dijk	Australian National University
Prof David Lawrence	University of Western Australia	Dr Jessica Weir	Western Sydney University
Dr Thomas Lorian	Macquarie University	Dr Marta Yebra	Australian National University
Prof Holger Maier	University of Adelaide	Celeste Young	Victoria University
Dr Tariq Maqsood	RMIT University		
Prof Alan March	University of Melbourne		
Dr Matthew Mason	University of Queensland		
Dr Blythe McLennan	RMIT University		
Dr Ilona McNeill	University of Melbourne		
Dr Khalid Moinuddin	Victoria University		

Photo: NSW SES

Photo: Veronique Florec

THE VALUE OF CRC RESEARCH

Australian communities are greatly benefiting from eight years of research into the response, recovery and mitigation of natural hazards, according to an independent report.

SGS Economics & Planning was commissioned to undertake an evaluation of the value delivered by the Bushfire and Natural Hazards CRC since its inception in 2013. The 2020 results outline the many and varied benefits of the CRC's research to the Australian community.

The CRC's work was closely guided by the needs of its end-user partners, working across the before, during and after spectrum of natural hazards, including bushfire, flood, storm, cyclone, tsunami, earthquake and heatwave.

> *"The CRC's reliability as a source of respected truth and knowledge enables it to be a pillar upon which decisions are made by agencies." (CRC partner survey response)*

A survey of CRC end-users—including emergency services, the Australian Government, states and territories, local government, businesses, households, regional and rural communities, landowners, infrastructure providers, volunteers and academia—shows that the CRC has strengthened research capacity in natural hazards and the environment, using and building capacity in leading researchers from around the country.

With more than 300 completed research projects, involving around 250 researchers and 150 PhD students across Australia and New Zealand, the CRC has generated benefits for its end-users and the wider Australian community that SGS groups under three key benefit areas:

- **As a large, independent and trusted institution**, the CRC provided trusted advice for the community and efficient planning and decision making for government and emergency services.
- **As a network of knowledge holders for natural hazards**, the CRC enabled knowledge sharing, collaboration and education of experts from a range of fields at both a national and international level, producing new research, innovation and products for end-users.
- **As a creator of higher impact and new research**, the CRC delivered information, products, services and tools that drive better decision making, behavioural changes in the community, and improved disaster recovery.

SGS found that, for every dollar invested in the CRC, six dollars of benefit was received by end-user partners—reducing loss of life and injury, reducing government costs, and reducing insurable losses. This 6:1 economic return of six dollars is expected to deliver a total benefit of $513 million over the 15-year period of 2013-14 to 2027-28.

Benefits into the future

A separate 2020 report found that the CRC's research value to Australia was up to $850.1 million over 15 years.

The Risk Laboratory, the International Institute for Applied Systems Research and Strahan Research were commissioned to undertake an assessment of the value of the research delivered by the CRC, which would be used alongside the independent evaluation of SGS Economics & Planning.

The evaluation found that for every dollar spent on the CRC, there was a seven dollar return and concluded that this represents outstanding value for Australia.

The assessment estimated the total value of four distinct pathways to value, expanding the potential value of research, highlighting the range of strategic areas that publicly funded research enhances, and indicating the main ways the CRC added value.

The four pathways to, and sources of, value are:

- **project level impacts**, including improved agency policy or practice, cost savings and effectiveness, and impacts resulting from the combined value to the fire and emergency management sector of all projects and other work
- **training and capacity building**, including impacts on the development of the skills, expertise and capacity of people in the emergency management sector, and the proactive creation of active networks and communities of practice
- **knowledge generation**, including the production of both formal codified knowledge (published papers, reports, PhDs, etc.) and informal knowledge through seminars, conferences and networks of practice
- **broader social and economic impacts**, including the value of avoided loss and damage that can be attributed to CRC research.

Summing the value of each of the pathways, the total value of CRC research is estimated at $850.1 million, which is based on the benefits that have accrued since 2018 and continue over 15 years to the year 2032.

The Hon Senator Kim Carr MP speaks about CRC research at a Senate Estimates Committee hearing in March 2020.

BENEFITS OF THE BUSHFIRE AND NATURAL HAZARDS CRC

TO AUSTRALIA

FOR EVERY $1 INVESTED IN NATURAL HAZARDS RESEARCH, $6 IS SAVED

THROUGH REDUCING
LOSS OF LIFE AND INJURY

REDUCING
GOVERNMENT COSTS

REDUCING
INSURABLE LOSSES

MEANING, THE
EXPECTED SAVINGS
OVER A 15-YEAR
PERIOD* WOULD BE

$513 million

DELIVERS
RELIABLE, NECESSARY
AND UNBIASED
INFORMATION

ENABLES
KNOWLEDGE SHARING,
COLLABORATION AND
EDUCATION OF EXPERTS

HIGH IMPACT RESEARCH
THAT HAS SAVED LIVES,
BUSINESSES, PROPERTY
AND INFRASTRUCTURE

*2013–14 TO 2027–28
SOURCE: THE VALUE OF THE BUSHFIRE AND NATURAL HAZARDS COOPERATIVE RESEARCH CENTRE (2020), SGS ECONOMICS AND PLANNING

RESEARCH DELIVERED

This book demonstrates how the CRC has delivered on its promises, made back in 2013.

In meeting its mission, the CRC has created:

1 **COLLECTIVE STRENGTH AND RESEARCH CAPACITY**
The first 'C' in CRC is all about being a cooperative – a network of local, national and international projects, with a pool of ideas and resources.

2 **A FORUM FOR KNOWLEDGE**
The CRC has created a space for discussion, learning and development of natural hazards science and disaster resilience in Australia through regular conferences, activities and publications.

3 **CAPACITY OF PEOPLE**
With the creation of new knowledge through research, the CRC developed the skills and knowledge of partners, researchers, students and the community.

4 **A RESEARCH LOOP**
The business of the CRC was to conduct focused research into operations and policy, with a strong feedback loop of allowing operations and policy to inform new research. This makes the CRC dynamic and responsive, with all partners an essential part of that research loop.

5 **RESEARCH IN USE**
This is the final step – when the CRC harnessed its collective strength, created a forum for knowledge and managed the research loop, it then developed a capacity in its people (both researcher and agency personnel) to deliver research that is relevant, accessible and ready to be used.

1 COLLECTIVE STRENGTH AND RESEARCH CAPACITY

The strength of the CRC laid in its collective nature. As a cooperative research centre, the CRC was a collection of people and individual organisations that each brought a range of values to the whole.

The CRC operated as a hub, with more than 250 researchers and over 300 agency staff, in Australia and internationally, directly involved in the research projects and many more indirectly involved. The collective strength was an efficient and effective way to advance the science of natural hazards.

The benefits were mutual. All partners had access to all research outputs and contributed to the development of new research projects based on their own needs.

The CRC provided a research capacity that is not feasible at the individual state or territory or agency level, or with any one university or research organisation. Core funding through the Australian Government's CRC Program, combined with contributions from all partners (cash and in-kind), created a pool of resources large enough to tackle research questions at the national scale.

This pooled investment created research capacity that CRC partners leveraged in many ways:

National research priorities

An extensive series of workshops were conducted from 2015–17 to explore major issues across hazards, resilience and the community. The workshops were conducted in collaboration with CRC partners and other major representative stakeholders, including Australasian Fire and Emergency Service Authorities Council (AFAC) groups and networks, the Bureau of Meteorology, and fire and emergency service agencies, plus other relevant community and industry groups.

The workshops identified the critical national issues that could be addressed by research. Those issues continue to influence natural hazards research programs across Australia.

The outcome of the workshops was the publication of a national natural hazards emergency management research priorities statement: *Issues, Priorities, Directions* (July 2017).

This publication was considered and noted by the Council of Australian Governments' Australia-New Zealand Emergency Management Committee in June 2017.

National institute

The 2015 launch of the Australian Institute for Disaster Resilience commenced a partnership between the CRC, AFAC, the Australian Red Cross and Emergency Management Australia to develop and share knowledge for the broad emergency management sector, including all CRC partners. The Institute delivers products and services around Australia that have been developed to support a disaster-resilient Australia.

The CRC took the lead role in the Institute's *Australian Journal of Emergency Management*, an internationally recognised journal for scholarly-based research and analysis.

The work of the CRC was also recognised as integral to Australia's national capacity for research by Australia's Chief Scientist, who highlighted in a research capability mapping report (Office of the Chief Scientist, 2020) that the CRC conducted and coordinated important interdisciplinary research that supports the development of cohesive, evidence-based policies, strategies, programs and tools to build a more resilient Australia.

The Hon Prime Minister Scott Morrison invited the CRC to Parliament House after the 2019-20 bushfires to discuss current and future contributions of research to bushfire response and recovery. CRC Chair Dr Katherine Woodthorpe AO and Research Director Dr John Bates met with Prime Minister Morrison and the then Minister for Industry, Science and Technology, the Hon Karen Andrews MP, in February 2020 to talk about building a bushfire-resilient Australia.

United Nations' International Strategy for Disaster Reduction

The CRC was the national coordinator for a United Nations-backed committee that promotes and supports disaster risk reduction research around the globe. The Integrated Research on Disaster Risk (IRDR) National Committee for Australia is sponsored by the United Nations' International Strategy for Disaster Reduction, the International Council for Science and the International Social Science Council.

Through this arrangement, there were many opportunities for the CRC and its partners to align projects with the international disaster risk reduction strategy.

Researcher Prof Kevin Ronan represented the CRC at several IRDR workshops and meetings on the implementation of the Sendai Framework for Disaster

CRC Chair Dr Katherine Woodthorpe AO, the Hon Prime Minister Scott Morrison, CRC Research Director Dr John Bates and then Minister for Industry, Science and Technology the Hon Karen Andrews MP. Photo: Office of the Prime Minister.

Attendees at the 2017 North Australia Fire Managers meeting in the Kimberley, WA.

Risk Reduction. Researcher Prof John Handmer was Chair of the IRDR Scientific Committee and was involved in the Sendai Framework endorsement at the 2015 Third UN World Conference on Disaster Risk Reduction, and later at Global Platform for Disaster Risk Reduction 2017.

Each year, the CRC observed the annual International Day for Disaster Risk Reduction on 13 October with public panel discussions supported by the Emergency Management Australia. These events – co-hosted with partners around Australia and online in Melbourne, Sydney, Perth, Brisbane, Adelaide and Canberra – featured panels of speakers from a range of organisations who explored Australia's contribution to disaster risk reduction at home and in our region.

International research

In addition to the many project links with international organisations, natural hazards research findings were promoted through peak organisations, including the Australian Academy of Science, the Group of Eight, the French Embassy, the International Association of Wildland Fire and others. The CRC had an agreement with the New Zealand Natural Hazards Research Platform and Memoranda of Understanding with the US Forest Service, the Association for the Development of the Industrial Aerodynamics (Portugal) and the Coastal Resilience Centre of Excellence (University of North Carolina, US). In Europe, the CRC was a partner in the Horizon 2020 research FirEUrisk and other research projects on fire risk, as well as being a partner of the Australian-French Association for Research and Innovation that actively promotes the development of innovation between France and Australia.

Commissioned research

The CRC conducted research on a consultancy basis, mainly with its partners.

The Victorian Department of Environment, Land, Water and Planning extended its contract research program that began with the Bushfire CRC, across multiple projects on fire behaviour and fuels, planned burning, bushfire smoke dispersal and remote sensing.

Post-event studies are highly valued by end-user partners and are an effective way to gather important data after a major hazard. Community-focused research was completed after major bushfires in NSW in 2013, 2017, 2018 and the Black Summer fires of 2019-20; SA in 2014 and 2015; and WA in 2014. Partners benefiting from this research are the NSW Rural Fire Service, SA's Country Fire Service, and WA's Department of Fire and Emergency Services.

The July 2020 announcement of funding for a new national research centre for natural hazards, to follow the CRC, was accompanied by an immediate $2 million grant for baseline studies into the causes and impacts of the Black Summer bushfires of 2019–20. Much of this research will transition into the new long-term centre.

Tactical Research Fund

This Fund encouraged the development of short-duration research projects meeting near-term needs of partners. These 14 short-term funded projects addressed strategic issues of national significance. Research was undertaken on how to improve the Australian Incident Reporting System, preventing residential fire fatalities, synthesising recommendations from natural hazard inquiries and reviews, assessing community resilience, preparing emergency services for climate change, helping young volunteers with their mental health, and issues with building cladding and firefighting foam, amongst others.

Funds for quick response

Support was provided for researchers to travel to areas affected by natural hazards, ensuring that the impacts and perishable data were captured in a timely manner. This 17 projects helped to identify significant research questions arising from major natural hazards and provided a context for developing more extensive research proposals.

Examples of how the fund was used include studies on the impact of heatwaves in the NSW Northern Rivers region and in western Sydney, how the June 2016 East Coast Low in NSW affected the homeless, post-fire recovery in northern NSW rainforests after the 2019–20 bushfires, coastal dune destabilisation after the 2016 fires in WA, recovery from the 2019 floods in Townsville and the 2021 floods in NSW, and more, with all reports published on the CRC website.

CEO Dr Richard Thornton with Her Excellency Anne Plunkett, Australian Ambassador to Portugal, and Prof Domingos Viegas of ADAI, University of Coimbra. In 2014, the CRC and the Portugal-based Association for the Development of the Industrial Aerodynamics agreed to share staff and information in research, management, and policy with a Memorandum of Understanding signed at the 7th International Conference on Forest Fire Research in Coimbra.

2 A FORUM FOR KNOWLEDGE

The CRC created a forum to learn and share knowledge. The national network of partners produced a lively forum for discussion, ideas, problems, issues, questions, answers and debate, where the new knowledge was benchmarked, compared and measured.

Knowledge and learning for partners and for community was at the core of the CRC business – to get that right is a major achievement for the CRC.

A program of interactive and engaging events, publications and online activities for the natural hazards sector and for the research community, as well as the general public, was a key part of advancing the research of the CRC.

The aim of all this activity was to make direct connections with people interested in the outcomes of the research program, and to encourage them to get involved, be engaged and be a part of the progress of the CRC.

Annual conference

Each year, the CRC and AFAC co-hosted an annual conference in a capital city, along with the partner organisations from that state. The CRC was prominent throughout the conference, in particular at the opening day Research Forum, which attracted as many as 460 participants at a single event. The full conference attracts up to 3200 people and the CRC had a prominent display in the exhibition hall that featured up to 190 exhibitors from the fire and emergency services and related industries, the majority of which were small-to-medium enterprises (SMEs) active in both Australia and New Zealand. Annual conferences with the CRC have been in Wellington (2014), Adelaide (2015), Brisbane (2016), Sydney (2017), Perth (2018) and Melbourne (2019).

Northern fire forums

Fire managers from across the north of Australia met each year to discuss topics of interest to the tropical savannas at the North Australia Fire Managers forum. These forums were coordinated and chaired by the CRC and hosted on a rotating basis by partners in Queensland, the Northern Territory and Western Australia, and included participation from AFAC, the Bureau of Meteorology, many universities and all fire and land management agencies across the northern regions of Australia. Regular sessions included updates on local research projects, weather and climate outlooks, preparations for upcoming fire seasons, new technology and fire modelling software, cultural land management with Indigenous rangers, carbon credits and fire management, and community engagement. Field trips to local burning sites offered extended learning opportunities on the issues impacting decisions on fire management.
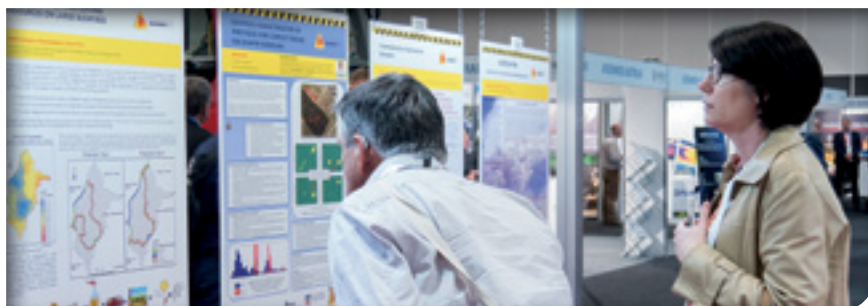
Laurie Hammond Orations

Former Chair of the CRC, Dr Laurie Hammond, sadly passed away in 2018. The annual Dr Laurie Hammond Oration was then established in his honour, to celebrate the value of natural hazard research. The inaugural Oration was presented by Prof Mary O'Kane AC at the close of the CRC Research Forum at AFAC19 powered by INTERSCHUTZ conference. The second Oration was presented online by Dr Alan Finkel, the then Chief Scientist of Australia, as part of National Science Week in 2020. Recordings of both Orations are available on the CRC's Hazard Channel.

Networks

Broad science networks were enhanced by partnerships with key bodies, including the Australian Academy of Science, the Group of Eight universities, the French Embassy, the International Association of Wildland Fire and the United Nations' Office for Disaster Risk Reduction.

The CRC was a key partner in the annual Australian and New Zealand Disaster and Emergency Management conference in Queensland, the Emergency Management Conference in Victoria and the biannual Australasian Natural Hazards Management conference between Australia and New Zealand. It took a prominent role in the Emergency Media and Public Affairs conference, the Floodplain Management Australia conference and several international conferences, plus many rural fire and emergency

The annual CRC conference with AFAC featured (clockwise from left) an interactive trade display, a dedicated day for CRC research presentations, the Laurie Hammond Oration – pictured here with Prof Mary O'Kane in 2019, and a large display of research posters.

service regional conferences in New South Wales, Queensland, South Australia, Western Australia, Tasmania and Victoria.

International conference links

The CRC was a lead partner in both the 5th and 6th International Fire Behaviour and Fuels conference held concurrently in 2016 in Melbourne and Portland (United States), and in 2019 in Sydney, Albuquerque (United States) and Marseille (France). Hosted by the International Association of Wildland Fire, the CRC was a lead international partner across all locations.

Around 300 people attended the conferences in Melbourne and Sydney, with several hundred more across the other cities. Keynote sessions and panel discussions were live streamed between each city.

Many CRC researchers and postgraduate students presented their research during the conferences. Highlights included panel sessions on cultural burning and women managing their career in science and fire management. The CRC was heavily involved in all facets of the conferences, such as program and logistics, as well as contributing media management, photography and social media during the events.

The International Conference on Forest Fire Research, held every four years in Portugal, was partnered with the CRC on several occasions, with the CEO and senior researchers invited to deliver keynote addresses.

The International Fire Behaviour and Fuels conferences gathered expertise from around the globe and featured specialist talks including the 2019 live panel in both Australia and the United States on "What happens when women thrive – a life and a career in fire.".

Natural hazards conference

Is our current state of knowledge in natural hazards adequately preparing us for an extreme weather event of a scale that is beyond our experience?

This was the premise of a major event for the CRC – the 12th Australasian Natural Hazards Management Conference, in Canberra in 2019. An international audience of 150 people participated, covering a range of organisations from different fields, all of whom had an important role to play when dealing with the impacts of natural hazards. This included research, emergency management, emergency services, insurance, media, telecommunications, transport, infrastructure, energy, social services, local government and health. The conference moved away from the usual conference model with a series of expert panels and audience participation exploring the impacts of the complex

cascading scenario, developed in conjunction with the Bureau of Meteorology. Keynote addresses were given by CRC board member Mark Crosweller (Australian National Resilience Taskforce), Jo Horrocks (New Zealand Ministry of Civil Defence and Emergency Management) and Dr Animesh Kumar (United Nations Office for Disaster Risk Reduction, Asia and the Pacific).

The conference was sponsored by the Australian Government/ Department of Home Affairs and supported by the Australian Institute for Disaster Resilience, and Integrated Research on Disaster Risk, which is part of the International Science Council and the United Nations Office for Disaster Risk Reduction. A full report on the impacts and outcomes of this conference was sent to all participants and is on the CRC website.

A complex hazards scenario was the focus of the Australasian Natural Hazards Management conference in 2019, with an opening address by Dr Animesh Kumar (pictured, right), United Nations Office for Disaster Risk Reduction, Asia and Pacific.

Outputs for industry and community

A range of products were developed to suit the needs of the CRC partners and the public. These include publications, reports, briefing papers, videos, webinars, case studies and tools for operational people in partner organisations.

Hazard Notes, the CRC's research briefing papers, are publicly available online and are distributed through an extensive email database that includes staff in partner organisations, government, SMEs, small rural fire brigades and State Emergency Service units, and regional councils. They are also widely shared and engaged with on social media. *Hazard Notes* are produced regularly with more than 100 currently available.

The CRC's Hazard Channel is a collection of more than 200 research videos for targeted audiences. Some videos are brief explainers on particular reports, others are profiles of researchers in the field or agency staff making use of the outputs. Conferences, webinars, seminars, media conferences and training sessions are also recorded and available.

The *Australian Journal of Emergency Management* was a CRC-led initiative, out of a partnership with the Australian Institute for Disaster Resilience. With a long history in the sector, this is the premier journal for emergency management in Australia, covering all hazards and all emergencies, with a print and online circulation of 5500. As an academic publication, the journal is regarded in its field within the national and international community for strong scholarly research underpinned by evidence.

Fire Australia, a quarterly magazine with a circulation of 6000, is a further avenue for research promotion and is produced by the CRC jointly with the Fire Protection Association of Australia and AFAC.

In the media

The CRC was frequently sought for comment from a range of regional, national and international media. Through the CEO, Research Director and experts across many disciplines, the CRC was well-positioned to provide media comment that supports agency partners.

As an Affiliate Partner of the Australian Science Media Centre, the CRC was a key supporter of the promotion of Australian science. This partnership placed the CRC's natural hazard research in prominent view of science journalists around Australia and internationally. Many international media frequently reached out for expert opinion, emphasising the CRC's position as an authority on natural hazards research.

Coverage in traditional media was amplified through the social media channels of the CRC and its partners. Social media provided an important channel to reach

The annual conference attracted public attention with a media conference on the Seasonal Bushfire Outlook and CRC researchers in high demand for interviews.

individuals and groups in addition to the regular CRC networks, including regional communities, volunteer brigades and units, local government, politicians and international researchers.

Peak media times centred around the CRC's Seasonal Bushfire Outlooks, the Research Forum, the annual conference and major hazard events (bushfires, floods, storms and cyclones), which were enhanced by strong ongoing links with ABC Emergency.

By the end of the CRC, there were almost 17,000 engaged followers connecting across Facebook, Twitter, YouTube and LinkedIn.

FIRE FUELS SCIENCE FORUM

A National Fire Fuels Science Forum was moved from Canberra in March 2020 to an online webinar format in May due to COVID-19, in partnership with the Australian Academy of Science. The webinars were a scaled down version of the original forum due to the format, but the aims were the same:

1. to assist the 2020 Royal Commission and the state inquiries in understanding the issues and solutions in managing the landscape for fire

2. to bring together leading scientists to determine the state of science of prescribed burning – what is known, what is unknown, what is in agreement, and what is in dispute.

The first webinar covered why hazard reduction is so difficult to undertake, and so divisive. Four expert panellists presented their views: Dr Sarah Harris (Country Fire Authority), Sascha Rundle (ABC Emergency Broadcasting), Oliver Costello (Firesticks Alliance) and Justin Leonard (CSIRO). Attendance was extremely strong, with 522 people attending from

12 countries. All states and territories of Australia were represented.

The second webinar covered the science of hazard reduction: what do we know and what are the knowledge gaps? Panellists were: Dr Neil Burrows, Prof Mike Clarke (La Trobe University), A/Prof Tina Bell (University of Sydney), Dr Philip Zylstra (Curtin University) and Prof Mark Adams (Swinburne University of Technology). Attendance remained high with 497 people watching.

The third and final webinar rounded out the series with a discussion of the potentials and limitations when applying hazard reduction burning. Dr Adam Leavesley (ACT Parks and Conservation Service) gave a practical perspective, referencing the ACT's Orroral fire in 2020 as an example of the effects of planned burning on bushfire suppression and landscape. Dr Valerie Densmore (WA Department of Biodiversity, Conservation and Attractions) outlined one of the pitfalls and complications of prescribed burning in practice—the effects and changes of fuel moisture differentiation. Ruth

Ryan (HVP Plantations) provided a plantation industry perspective, including the need for risk modelling that considers social and cultural implications. Lastly, Dr Simon Heemstra (NSW Rural Fire Service) explained the ways that fire services use science to improve the practice, application and communication of hazard reduction burning.

The series enabled an informative and accessible discussion of the issues, science, constraints, beliefs, culture, truths and myths around hazard reduction burning in Australia. Videos of each webinar, all the presentations, plus background papers are on the CRC website.
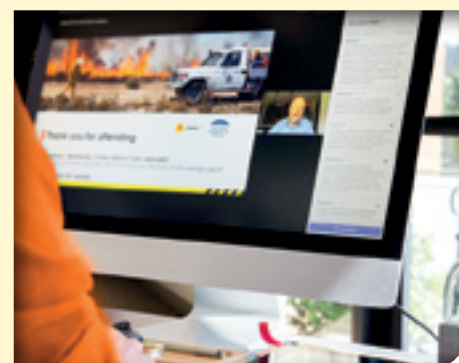
Many CRC researchers, students and staff attended the Research Advisory Forum in Hobart in 2016.

3 CAPACITY OF PEOPLE

The CRC built and maintained the skills and knowledge of partners, researchers, students and the community. With this increased capacity:

- partners are more confident to do their job
- researchers are more engaged and focused on the use of their research
- the community is better informed and more prepared.

More than 300 people across the CRC's 50 partner agencies have been involved in the development and ongoing engagement within the projects. The research has been in use right from the start with a clearly directed transition from the phase of data-gathering into utilisation.

The integrated research project teams of end-users and researchers created a capacity and capability in each group, and therefore within each partner agency, even as the individuals within these groups have changed over the eight years of the CRC.

The CRC has also built a capacity and capability of highly skilled researchers to undertake focused research for the sector. More than 250 researchers, from the professorial to the post-doctoral level, were spread across almost 30 universities in Australia and New Zealand.

In addition, the CRC built this capacity with a new cohort of researchers at the postgraduate level working on natural hazards science. Over the eight years, the CRC had 150 postgraduate students – 56 scholarship and 94 associate. The CRC more than exceeded its initial target of 34 PhD completions for the full life of the CRC, with 88 students completing their studies as of May 2021.

Awards

CRC Recognition
Each year CRC researchers and end-users were recognised at annual conference for their contributions to natural hazards science.

One of the early awards was presented to Prof Kevin Ronan, CQUniversity, in 2015, for advancing the international standing of the CRC. Sadly, Kevin passed away in early 2020, but his contribution was immense, particularly through his work establishing a major theme of research incorporating the rights of the child into the disaster risk reduction agenda.

Individual CRC recognition was awarded to:

Researchers – outstanding research:
Dr Mel Taylor, Macquarie University.

Dr Briony Towers, RMIT University.

End-users – outstanding contribution:
John Schauble, Emergency Management Victoria.

Students – special recognition as CRC ambassadors:
Billy Haworth, University of Sydney.

Steve Sutton, Charles Darwin University.

Research and end-user teams – outstanding achievement in research collaboration:
Prof Vivienne Tippett, QUT and Andrew Richards, NSW State Emergency Service.

Prof Holger Maier, University of Adelaide and Ed Pikusa, Department of Envirnonment, Water and Natural Resources, South Australia.

Dr Blythe McLennan, RMIT University, and Amanda Lamont, Australian Institute for Disaster Resilience.

Annual awards recognised excellence from CRC researchers and end-users. From left: the late Prof Kevin Ronan (CQU); CEO Dr Richard Thornton with Billy Haworth (University of Sydney); Dr Blythe McLennan (RMIT) and Amananda Lamont (AIDR) with Dr Thornton.

Dr Marta Yebra, Australian National University, and Dr Adam Leavesley, ACT Parks and Conservation.

CRCA Excellence award

The CRC Association awarded the CRC with its highest award for the CRC sector in 2019 – the Excellence in Innovation Award. This was awarded to life-saving work of CRC researchers on changing how warnings for hazards and emergencies are worded, timed and targeted.

Led by Prof Vivienne Tippett (Queensland University of Technology) and Dr Katharine Haynes (Macquarie University and the University of Wollongong), the collaborative research groups have combined to equip emergency service agencies around Australia with better-targeted long-term public safety campaigns, as well as evidence-based warning messages delivered to at-risk populations in the face of imminent natural hazard threats.

Emergency media awards

The Emergency Media and Public Affairs (EMPA) conference presented many awards to the CRC.

In 2018 CRC research by Dr Mel Taylor, Macquarie University, on how to best plan for animals in an emergency took out the inaugural EMPA research award, while the QUT project on emergency warnings led by Prof Vivienne Tippet was highly commended.

In 2019, research by Dr Josh Whittaker at the University of Wollongong and Mel Taylor at Macquarie University on the 2017 NSW bushfires community preparedness won the award for best research, while research on conflicting cues out of Queensland University of Technology by Dr Paula Dootson, A/Prof Dominique Greer, Dr Sophie Miller and Prof Vivienne Tippett was highly commended.

In 2020, highly commended by EMPA was research on the motivations, experiences and emotions of State Emergency Services volunteers. The research team, comprising Dr Darja Kragt, Dr Aleksandra Luksyte (University of Western Australia), A/Prof Patrick Dunlop, Dr Djurre Holtrop, Prof Marylène Gagné (Curtin University) and Hawa

Muhammad Farid (University of Western Australia), provided insights and data nationally to help develop new recruitment and retention strategies for SES volunteers.

Dr Josh Whittaker and Dr Paula Dootson both impressed judges at the 2019 Emergency Media and Public Affairs awards.

The highest award at the CRC Association conference in 2019 went to CRC and QUT research into community warnings. Photo: CRC Association.
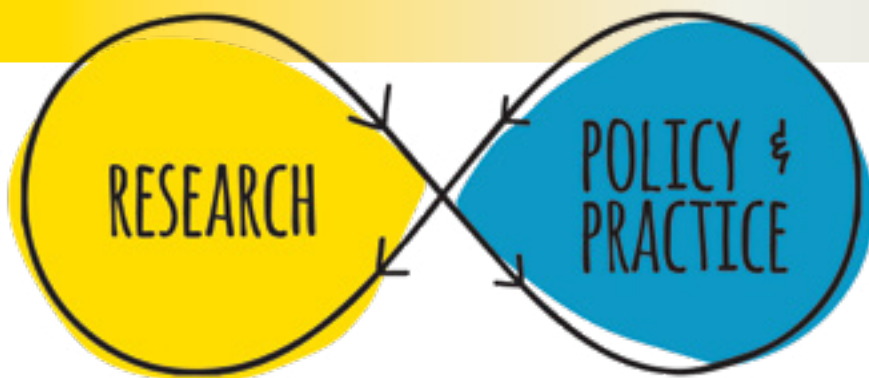
4 RESEARCH LOOP

Over the eight years of the CRC, the ongoing development of the research program included extensive engagement with end-users, researchers and the broader community with a stake in natural hazards management.

Under the watch of the CRC's International Science Advisory Panel, the research program was mapped for progress of utilisation opportunities and to develop new projects.

Major outcomes for research utilisation include the many conferences where these publications were presented and discussed with end-users and the use of the research by partners, as outlined in the case studies throughout the Driving Change chapter of this book.

The CRC ensured that the research both informs practice, and that the practice informs the ongoing and new research. Integrated project teams of researchers and end-users were in place for every project to ensure the projects were informed by, and remain focused on, the needs of the partner organisations.

Ongoing and active engagement between researchers and end-users was crucial to the success of each project.

End-user representatives on each project provided essential input, including:

- framing and an ongoing review of the research questions
- enabling access to data, information or people
- identifying potential uses of research outputs
- advising the project on how the research can be made more valuable to all partners and other potential end-users.

The end-user representatives on projects were from across:

- all states and territories
- all fire, land and emergency service agencies
- all types of sectors, including policy departments, operational agencies and nongovernment organisations.

Research Advisory Forums

The most visible example of this research loop process is the regular Research Advisory Forums. Research Advisory Forums were held in all states and territories.

These two-day gatherings provided the opportunity for CRC partners, researchers and end-users to gain a complete overview of all the research activities and shape the future direction of each project. Around 120 people attended each forum, with roughly half being researchers and half end-user representatives.

Science advice

The International Science Advisory Panel provided strategic advice and review of the research program to the Board of the CRC. It was chaired by Prof Carmen Lawrence of the University of Western Australia and included Dr Mark Finney of the US Forest Service, Prof Gavin Smith of the University of North Carolina and Dr Anthony Bergin of the Australian Strategic Policy Institute.

5 RESEARCH IN USE

Achievements and outcomes

The online resource Driving Change sorts and prioritises the major findings of the CRC and puts them in a real-world context.

The idea behind Driving Change began at the close of the Bushfire CRC and has continued into the Bushfire and Natural Hazards CRC. Driving Change embodies the premise that you don't set up a research centre to keep things going the way they have always gone. The creation of new insights and knowledge enables partners and the community to change the way they approach natural hazards for the better. This new resource helps tell that story from across the eight years of the CRC's research program.

Major outcomes and highlights of research utilisation are outlined in the following Driving Change section, including case studies, tools, projects and resources, all grouped around themes of research use.

Research Advisory Forums brought together researchers with end-users twice a year, pictured here in New South Wales in 2015 (above) and in South Australia in 2014 (below).

DRIVING CHANGE

HOW DID OUR RESEARCH DRIVE CHANGE?

The critical role of science and research has never been more apparent than in recent years, when natural hazards have caused damage and destruction of diverse communities, homes, infrastructure and fragile natural environments.

Over eight years, the priority for the Bushfire and Natural Hazards CRC was to conduct research that was useful, high-quality and partner-driven.

Our partners have shaped and supported all of our research, whether it be Australian and New Zealand emergency services agencies, leading universities, land management agencies, research organisations, or the many government departments and non-government and community organisations we have worked with.

Through the development of cohesive and evidence-based policies, strategies, programs and tools, the CRC has hit the Sweet Spot – building a more resilient Australia to benefit not only the emergency management sector but the whole community. By prioritising meaningful collaboration and striving for research excellence, CRC research is driving change.

This section showcases the best and the latest research from the CRC, grouped around themes according to how the research is being used – by agencies, government and the community. Each Driving Change theme within this section presents the key findings and achievements of CRC research. For a more extensive account of these highlights, see Driving Change online resource.

BLACK SUMMER

Photo: Ned Dawson/NSW Rural Fire Service.

"The scale of the disaster season Australia experienced last summer was unprecedented, and the horrific Black Summer bushfire lingers in the national psyche. Although floods, cyclones and bushfires are a natural part of the Australian landscape, we must continue to improve our resilience and response efforts to ensure their impact on lives, communities and the environment is minimised. This is where sustained, long-term funding for natural hazards research plays a pivotal role and why the Australian Government is committed to a new 10-year national research centre."

THE HON DAVID LITTLEPROUD MP, MINISTER FOR AGRICULTURE, DROUGHT AND EMERGENCY MANAGEMENT

OVERVIEW

The Bushfire and Natural Hazards CRC was granted Australian Government funding to explore the immediate issues arising from Australia's devastating 2019–20 Black Summer. Building on existing knowledge developed through CRC research, the Black Summer suite of projects covers three themes – understanding the extreme fire behaviour and what

contributed to it; the integration of cultural land management practices into fire prevention; and community engagement, participation and behaviour.

The projects provide insight, data and knowledge and a basis for further study into what happened during Black Summer. The research will be further developed in the new national centre for natural hazards research.

The research is strongly aligned with the outcomes of several jurisdictional post-fire inquiries and reviews, as well as the 2020 Royal Commission into National Natural Disaster Arrangements. All recommendations from these inquiries have been added to the Inquiries and Reviews Database to ensure a richer source of data to learn from.

TOOLS

INQUIRIES AND REVIEWS DATABASE

sorts through 315 emergency management inquiries and reviews, including almost 4,200 recommendations, across Australia since 1886. The data can be sorted by disaster and inquiry type, date and jurisdiction, providing an opportunity to compare recommendations, track inquiries and learn from the lessons of the past.

INQUIRIES BY HAZARD TYPE **315**

ALL HAZARD **85**

STORM **7**

BUSHFIRE **113**

CYCLONE/WINDSTORM **3**

STRUCTURE FIRE **19**

FLOOD **22**

TSUNAMI **2**

BLACK SUMMER VICTORIAN BUSHFIRE CASE STUDIES

www.bnhcrc.com.au/research/
understanding-and-mitigating-hazards/7935

Owen Salkin

Natural Systems Analytics

BLACK SUMMER BUSHFIRES: SOUTH AUSTRALIA RECONSTRUCTIONS

www.bnhcrc.com.au/research/
understanding-and-mitigating-hazards/7940

Dr Hamish Clarke
Dr Alexander Filkov
Dr Karin Reinke
Prof Simon Jones

UNIVERSITY OF WOLLONGONG AUSTRALIA

RMIT UNIVERSITY

THE UNIVERSITY OF MELBOURNE

ANALYSIS AND CHARACTERISATION OF BUSHFIRE-MEETS-PRESCRIBED BURN BLACK SUMMER FIRES IN NSW

www.bnhcrc.com.au/research/
understanding-and-mitigating-hazards/7937

Dr Owen Price

UNIVERSITY OF WOLLONGONG AUSTRALIA

MODELLING FIRE WEATHER INTERACTIONS USING THE ACCESS-FIRE MODEL

www.bnhcrc.com.au/research/
understanding-and-mitigating-hazards/7923

Dr Mika Peace

Australian Government
Bureau of Meteorology

SOIL AND FUEL MOISTURE PRECURSORS OF FIRE ACTIVITY DURING THE 2019-20 FIRE SEASON

www.bnhcrc.com.au/research/
understanding-and-mitigating-hazards/7928

Paul Fox-Hughes

Australian Government
Bureau of Meteorology

USING EARTH OBSERVATION TO BETTER UNDERSTAND THE EFFECTS OF AERIAL FIREFIGHTING

www.bnhcrc.com.au/research/
understanding-and-mitigating-hazards/7926

Dr Karin Reinke
Prof Simon Jones

RMIT UNIVERSITY

COMMUNITY-LED RECOVERY

www.bnhcrc.com.au/research/
understanding-and-mitigating-hazards/7930

Prof Lisa Gibbs

THE UNIVERSITY OF MELBOURNE

INDIGENOUS FIRE AND LAND MANAGEMENT – IMPACT AND SUSTAINABILITY

www.bnhcrc.com.au/research/
understanding-and-mitigating-hazards/7931

Ricky Archer

NAILSMA

DISASTER RESILIENCE

Photo: Austockphoto.

> "This research leaves decision makers with little doubt that there's work to be done, and little excuse not to do it."
>
> MARK CROSWELLER, ETHICAL INTELLIGENCE

OVERVIEW

Bushfire and Natural Hazards CRC research has changed the way Australian emergency services, land managers and governments view resilience. The new method is based on the premise that, to reduce both the risk and cost of natural hazards, we need an integrated approach that considers multiple hazards and involves a range of mitigation options at the local, state and national level.

A combination of tools and insights are providing options for these emergency managers to choose the safest and most effective ways to improve the resilience of their communities.

These include:

- the first national index on the capacities for disaster resilience in specific Australian communities
- a hands-on guide for local communities on recovery post-disasters
- a resource that identifies the varied impacts of disasters across different demographics and sectors
- scenario modelling to support decisions on reducing the potential impacts of natural hazards
- a tool for generating estimates of non-financial benefits to justify the use and allocation of resources for hazard mitigation efforts
- a suite of training and other materials that are improving the disaster resilience capacities of individuals and communities across northern Australia.

TOOLS

AUSTRALIAN DISASTER RESILIENCE INDEX

is an industry-first assessment of the state of disaster resilience across Australia, providing a clear pathway to improve decision making about planning, development, policy, engagement and risk assessment. The Index helps communities, government and emergency services take informed and practical steps to improve the disaster resilience of their local communities.

GUIDE TO POST-DISASTER RECOVERY CAPITALS

is a practical guide that supports wellbeing and decision making during emergency recovery by identifying seven community capitals – natural, social, financial, cultural, political, built and human – and highlighting the important interconnectedness between each of them.

Dr Melissa Parsons from the University of New England explaining the Australian Disaster Resilience Index.

🔸 A MODEL FOR RELIEF AND RECOVERY

Ensuring communities are safe and resilient in the face of natural hazards is fundamental to emergency management organisations.

The research project *The Australian Natural Disaster Resilience Index: A system for assessing the resilience of Australian communities to natural hazards*, led by Dr Melissa Parsons at the University of New England, developed the Australian Disaster Resilience Index, which is improving the understanding of disaster resilience, helping communities, governments and organisations to develop the capacities needed for adapting and coping with natural hazards.

While the study is assessing resilience across the country, Emergency Management Victoria is embedding the national findings to develop a better understanding of resilience at the state level. It has used the national research as baseline data to build a 'living' resilience index within the organisation, explains EMV's research coordinator Dr Holly Foster.

"We have used the research as a basis for the Victorian platform, adapting it to our resilience needs in Victoria," Holly says.

"Its primary function is as a relief and recovery tool, exploring the characteristics and attributes of communities to enable a better understanding of what relief and recovery would be required if an emergency were to occur. We want to be able to proactively meet community needs."

It is only through the collaborative approach taken by the research team that mutually beneficial outcomes have been possible, with Emergency Management Victoria's learnings feeding back into the larger national approach.

In Western Australia, the framework from the Australian Disaster Resilience Index has been adopted by the Department of Fire and Emergency Service to frame their monitoring and evaluation framework, assessing their programs to ensure they support specific disaster resilience outcomes.

The Index was launched nationally in mid-2020, and Dr Parsons worked closely with the Australian Institute for Disaster Resilience on a series of training workshops in various states and territories in 2021.

THE AUSTRALIAN NATURAL DISASTER RESILIENCE INDEX: A SYSTEM FOR ASSESSING THE RESILIENCE OF AUSTRALIAN COMMUNITIES TO NATURAL HAZARDS

www.bnhcrc.com.au/research/resilienceindex

Dr Melissa Parsons

OPTIMISING POST-DISASTER RECOVERY INTERVENTIONS IN AUSTRALIA

www.bnhcrc.com.au/research/postdisastereconomics

Prof Mehmet Ulubasoglu

RECOVERY CAPITALS

The Recovery Capitals project investigated two complementary areas of research relating to the long-term recovery of communities in Australia and New Zealand after a disaster. It sought to increase understanding about interacting influences of different forms of capital (community capital) on mental health and wellbeing. To help guide decision-making, it addressed the missing link between existing community resilience indicators and disaster resilience frameworks. The project aimed to produce resources to guide long-term recovery strategies for communities post-disasters.

The CRC funded the project, which began in 2017, and the University of Melbourne and Massey University in New Zealand were the lead collaborators. The project has encouraged new partnerships with Northeastern University, Deakin University and Wellington Emergency Management Office, Fire and Emergency NZ and NZ Red Cross. A range of organisations endorsed the project, including Australian Red Cross (lead end-user), NZ Red Cross, emergency

The cover illustration from the Guide to Post-disaster Recovery Capitals. Illustration: Oslo Davis.

RECOVERY CAPITALS

www.bnhcrc.com.au/research/communityrecovery

Prof Lisa Gibbs

THE UNIVERSITY OF MELBOURNE

MASSEY UNIVERSITY

service agencies, national and state government departments, and various university groups.

Massey University investigated how a person's history of residential mobility might influence their willingness to dissolve social ties. The primary focus has been to provide answers to the questions why people move, how their history of mobility plays out in disaster situations, how movement affects the social capital of the left-behind community and the community migrated to, and how we can use this learning to increase the social capital in these communities.

The University of Melbourne examined the enablers and barriers to successful recovery by looking into the many forms of capital and their interactions in disaster recovery. The various forms of capital explored included natural, cultural, human, social, political, built and financial resources. The study also used case studies to build understanding of potential areas of improvement and to recognise the features of successfully recovered communities. The research will play a critical role in community recovery efforts.

Project findings

After every major disaster, some people move. While disaster-prone locations are often able to reproduce long-established settlement patterns, the demographic characteristics of residents may change. Previous literature reviews showed significant knowledge gaps about demographic issues and a lack of understanding behind temporary displacement, relocation, migration and resettlement after a crisis.

There was also a shortage of research into long-term disaster recovery response, with previous knowledge based on disaster planning, prevention and response. It was also noted that recovery is a complex process, and processes cannot be divided between short and long-term actions. Rather, a transition phase occurs as needs and progress change over time, which can delay the attainment of long-term disaster recovery goals. The recommendations suggested there is a need for a national monitoring and evaluation framework that focuses on long-term recovery, whereas most evaluations actually focused on the immediate and short-term response and lacked consistency.

The overall findings showed that local communities and their associated capitals were a key element to a successful recovery. Community engagement is essential and should be centred around immediate, short, medium and long-term recovery policies and programs. The research also showed decision-makers needed to have a greater focus on restoring the environment and the community. The strategy must be in line with the traditional response to restoring the built environment.

The research highlighted elements that impede community recovery. For example, insecure land tenure, poor land-use practices, inadequate land access and weak administration can increase community vulnerability. Infrastructure planning is essential. Effectiveness in recovery can also be undermined by the community's social and economic conditions before a hazardous event, which can prolong the time it takes to reconstruct. Economic circumstances, population trends and demographics can affect

efforts. A firm economic base can help communities that have access to financial assets and a strong business community to rely on. The wealth of the household is a large indicator of the willingness to move elsewhere; other factors are the individual's health, their wellbeing and connectedness to the community.

Governments play a critical role in how communities recover after disasters. Most successful strategies have pre-determined policies, good planning and a degree of flexibility. In particular, local governments play a leading role, and strong local leadership is paramount to successful long-term recovery.

A new research-backed resource – the Guide to Post-Disaster Recovery Capitals – has been designed to support wellbeing and decision making during emergency recovery. The guide can be applied to any type of emergency, large or small. It aims to enhance wellbeing after disasters by supporting evidence-based decision making of individuals, organisations and governments.

The initial project funding was complemented by $1.2 million in-kind contributions from 17 partners:

- Australian Red Cross
- New Zealand Red Cross
- Wellington Region Emergency Management Office
- Fire and Emergency New Zealand
- Emergency Management Australia, Department of Home Affairs
- The Leadbeater Group
- Resilient Melbourne
- Social Recovery Reference Group
- Regional Arts Victoria
- Rural Solutions SA, Department of Primary Industries and Regions
- Emergency Management Victoria
- Country Fire Authority
- State Emergency Service Victoria
- Creative Recovery Network
- Department of Economics, Deakin University
- Professor Aldrich, Northeastern University
- Department of Social Work, University of Melbourne.

Each year on 13 October the CRC hosted a public forum on disaster resilience to mark the United Nations' International Day for Disaster Risk Reduction. The event has been held in various capital cities including Adelaide in 2018 (top left) and Brisbane in 2019 (top middle).

In 2020, CRC researcher Prof Lisa Gibbs, University of Melbourne, led an online discussion with experts from around Australia from organisations including the Australian Red Cross, the ABC and local government. The event also featured Craig Reucassel (top right) from ABC TV's three-part documentary series Big Weather (and how to survive it), which launched on the same day.

IDDRR2020:
IT'S ALL ABOUT GOVERNANCE AND BIG WEATHER
bnhcrc.com.au/2020-disasterday

ECONOMICS, MITIGATION AND VALUE

Photo: Veronique Florec.

> "One of the things that really sets this research apart is that it's trying to dive into the very rich and deep datasets that are relied upon for a lot of public policy."

ED PIKUSA, DEPARTMENT FOR ENVIRONMENT AND WATER SA

OVERVIEW

Governments and emergency management agencies are being supported by Bushfire and Natural Hazards CRC insights as they make decisions today to reduce the impacts of the natural hazards of tomorrow.

There is increasing urgency to consider how disaster risk might change into the future, what impacts this is likely to have, what the potential costs are, who will be most affected and, most importantly, what can be done to reduce this risk.

CRC research has supported a holistic approach across several academic disciplines that takes into account community values, vulnerabilities and resilience, future changes in population and demographics, climate change, multiple hazards, cascading events, adaptation, as well as a range of risk reduction strategies.

One project has co-developed a conceptual, modelling and decision support framework in conjunction with more than 40 end-user organisations in four states (South Australia, Western Australia, Tasmania and Victoria).

Another has helped natural hazards managers justify the use and allocation of resources for mitigation efforts. This study has developed a tool for generating estimates of a range of hazards management options that allows land managers to assess intangible benefits such as lives saved, health and environmental benefits, and social values. For example, a small prescribed burn might cost a lot of money and take time and resources, but what that burn protects cannot be measured by just money.

Other work is supporting emergency managers at local, state and national levels through the development of the first national index on the capacities for disaster resilience in specific Australian communities (see pages 20-21), plus a resource that identifies the varied impacts of disasters across different demographics and sectors.

TOOLS

VALUE TOOL FOR NATURAL HAZARDS

is an online database of peer-reviewed intangible economic values associated with the impacts of natural hazards, such as health or social values. The values are designed to be incorporated into other economic analyses, such as the Economic Assessment Screening Tool.

ECONOMIC ASSESSMENT SCREENING TOOL

allows users to determine the economic benefits of natural hazard risk mitigation options, and to compare the relative benefits of these options. Using values sourced from the Value Tool for Natural Hazards, the Economic Assessment Screening Tool can estimate the value for money derived from different investments in mitigation, showing cost effective mitigation for a given budget.

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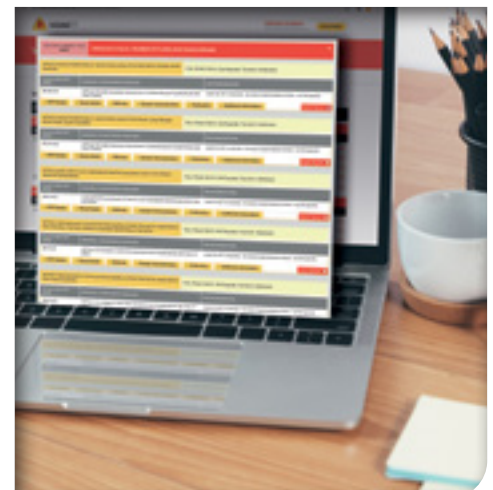
'WHAT IF' QUESTIONS

What if an earthquake hit central Adelaide? A major flood on the Yarra River through Melbourne? A bushfire on the slopes of Mount Wellington over Hobart?

'What if?' scenario modelling by the Bushfire and Natural Hazards CRC is helping government, planning authorities and emergency service agencies think through the costs and consequences of various options on preparing for major disasters on their urban infrastructure and natural environments and how these might change into the future.

The CRC research is based on the premise that to reduce both the risk and cost of natural hazards, an integrated approach is needed that considers multiple hazards and a range of mitigation options. The *Improved decision support for natural hazard risk reduction* project, led by Prof Holger Maier and Dr Graeme Riddell at the University of Adelaide, has completed case studies for Adelaide, Melbourne, south west Western Australia and and the whole of Tasmania.

Adelaide, Melbourne and the whole of Tasmania were the first group and, based on their success, work began in Western Australia in 2017, funded through the National Disaster Resilience Program.

South Australia – greater Adelaide. Hazards identified were bushfire, coastal and riverine flooding, and earthquake. The first prototype of the UNHaRMED software application for greater Adelaide was completed and delivered in 2017, and end-user training was also conducted at that time. The software has been installed on government computers within the fire management section of the Department of Environment and Water. A State Mitigation Trial Exercise was held in August 2019.

Victoria – greater and peri-urban Melbourne. Hazards identified were bushfire, coastal and riverine flooding, and earthquake. The first prototype of the UNHaRMED software application for greater and peri-urban Melbourne has been completed with end-user training held in August 2019.

Tasmania – whole of state. Hazards identified were bushfire, coastal flooding, and earthquake. The Tasmanian Government wanted to operationalise and incorporate UNHaRMED into existing systems but lacked the internal capacity to achieve this.

Consequently, the Tasmanian Government employed a dedicated person full time for one year to assist with the operationalisation and adoption of UNHaRMED across government agencies in Tasmania.

Western Australia – south west corner. Hazards identified were bushfire, coastal flooding, and earthquake. A working group was established with the Western Australian Government to determine the best way to integrate UNHaRMED into existing processes. Rigorous and detailed testing of bushfire modelling has led to improvements which will be incorporated into policy scenarios.

At the national level several early initiatives are underway including:

- The National Resilience Taskforce in the Department of Home Affairs used the outputs of the project to shape frameworks and develop a national disaster risk reduction capability
- A project led by the Bureau of Meteorology has used the research products to map national heatwave vulnerability

Taking into account future changes in demographics, land use, economics and climate, the modelling analyses areas of risk both now and into the future, tests risk reduction options, identifies mitigation portfolios that provide the best outcomes for a given budget, and considers single or multiple types of risk reduction options, such as land use planning, structural measures and community education. CRC partners, along with local governments have been engaged in the entire process, from direction on the hazards to include and feedback on process, to advice on how the modelling will be used when complete and by whom.

The modelling for Adelaide incorporates flooding, coastal inundation, earthquake and bushfire, as well as land-use allocation. Expected impacts of these hazards have been modelled from 2015 to 2050 with an annual time step under different plausible future scenarios that were developed by end-users, showing the change in risks in different localities.

The integrated nature and comprehensive data available is exciting, says Mike Wouters, Manager Fire Knowledge and Mapping at South Australia's Department of Environment and Water.

THE VALUE OF DISASTER RESEARCH

www.bnhcrc.com.au/research/policy-and-economics-hazards/5954

Prof John Handmer

RMIT UNIVERSITY

IMPROVED DECISION SUPPORT FOR NATURAL HAZARD RISK REDUCTION

www.bnhcrc.com.au/research/riskreduction

Prof Holger Maier

THE UNIVERSITY of ADELAIDE

"We have not had access to this type of technology before," he says.

"We need to be thinking at least a decade ahead, and this research will help us with that."

The Melbourne and Tasmania case studies incorporate bushfire, flood, coastal inundation and earthquake risk in Melbourne, and bushfire, coastal inundation and earthquake risk for Tasmania.

The powerful nature of the system is its biggest assets, believes Country Fire Authority Deputy Chief Officer Alen Slijepcevic.

"We will need to rely on modelling to help us more and more into the future. We do not have the luxury of waiting 20 or 30 years to assess the impacts of our land management decisions," Alen says.

This project is an outstanding example of the collaborative CRC process, and incorporates findings from other CRC work on recognising non-financial benefits of management and policy for natural hazards, for example, the economic, social and environmental benefits of prescribed burning, the vulnerability of buildings to hazards, such as how they can be made more resilient through cost-effective retrofitting for improved safety, and the benefits and understanding of community resilience efforts like improved warnings, community engagement, education, volunteering and community resilience.

INTANGIBLE VALUE

Not everything that is important can be assigned a dollar value; just as the benefits of mitigating risk do not always add up to monetary values. Intangibles are important to land managers and community members alike, but how are these values, such as protecting biodiversity, taken into account when making land management decisions?

The 2015 Productivity Commission's report on natural disaster funding arrangements in Australia found that there is an over-investment in post-disaster reconstruction and an under-investment in mitigation. In 2017, the Australian Business Roundtable for Disaster Resilience and Safer Communities noted the soaring total costs of disasters and urged more targeted investment in infrastructure and community resilience programs.

The *Economics of natural hazards* project led by Dr Veronique Florec at the University of Western Australia has helped natural hazards managers justify the use and allocation of resources for mitigation efforts. The study has developed two tools that can inform economic analysis relating to natural hazards.

The Value Tool for Natural Hazards can be used when generating estimates of non-financial benefits and undertaking integrated economic analysis of management options. It allows land managers to assess intangible benefits such as lives saved, health and environmental benefits, and social values. A small prescribed burn might cost a lot of money, and take time and resources, but what the burn protects cannot be measured just by money.

This has enabled South Australia's Department of Environment and Water to not only take into account the costs of undertaking prescribed burning on private land, but to also effectively measure the benefits to ecosystems, lives and the way of life of people who live in the area.

Previously, these non-market values were not taken into account, underselling the benefits provided by prescribed burning in some areas.

Ed Pikusa, the Principal Risk and Audit Coordinator at the South Australian Department for Environment and Water, is the lead end-user overseeing the development of the project. "The website and guidelines on the Value Tool make the outputs of one part of this research project accessible and transparent for practitioners."

The second tool is the Economic Assessment Screening Tool, which allows users to determine the economic benefits of natural hazard risk mitigation options, and to compare the relative benefits of these options.

This tool uses values from sources including the Value Tool. It can be used to understand the value for money that managers can expect from investing in a single mitigation option, or to compare the relative benefits of a range of mitigation options, including the impacts on tangible (market) and intangible (non-market) values that can be affected by natural hazards.

This work has benefited other CRC research, with the tool used by a Geoscience Australia team to inform the cost benefit analysis of flood mitigation work in Launceston.

A STRATEGIC ANALYSIS OF PREVENTABLE RESIDENTIAL FIRE FATALITIES

www.bnhcrc.com.au/research/
policy-and-economics-hazards/3927

Andrew Gissing
Lucinda Coates

RISK FRONTIERS

ECONOMICS OF NATURAL HAZARDS

www.bnhcrc.com.au/research/naturalhazardeconomics

Dr Veronique Florec
Prof David Pannell

THE UNIVERSITY OF WESTERN AUSTRALIA

Research led by Dr Veronique Florec at the University of Western Australia, pictured here speaking to the emergency management sector at the 2017 AFAC/CRC annual conference in Sydney, developed a range of tools and training sessions for fire managers on the economics of resource allocation for mitigation efforts.

Prof Holger Maier and his team of researchers at the University of Adelaide, alongside international collaborators at the Dutch Research Institute for Knowledge Systems and German Karlsruhe Institute of Technology, developed new software that is helping governments and emergency services better understand the costs and consequences of mitigation options now and into the future.

EDUCATION AND COMMUNICATIONS

> "Communities under the immediate threat of fire, flood, storm or cyclone are now likely to be much safer because fire and emergency services are now able to warn them, in a way that communities are more likely to take action. This is because of the research that's been conducted."
>
> **AMANDA LECK, EXECUTIVE DIRECTOR, AUSTRALIAN INSTITUTE FOR DISASTER RESILIENCE**

OVERVIEW

Australian lives are being saved by Bushfire and Natural Hazards CRC research that is shaping warnings and public- and school-based information campaigns to prepare and protect communities threatened by flood, fire, heatwave and other natural hazards.

The goal of the projects under this theme was to save lives and empower communities to act to ensure their safety – and the safety of their families and their animals – and to equip emergency management agencies to make better decisions on the planning and targeting of resources.

The research has improved community warning messages, enabled better targeted long-term public safety campaigns, identified best practice approaches to animal emergency management, and placed children at the centre of household and community disaster risk reduction and resilience education campaigns.

The Education and Communications theme has had a strong utilisation focus from the start, with the research teams actively engaged with emergency services agencies, government departments and local community groups.

TOOLS

PUBLIC INFORMATION AND WARNINGS HANDBOOK

was published by the Australian Institute of Disaster Resilience in 2018 and draws on CRC research to shape warnings and public information campaigns that protect communities threatened by natural hazards, including structures and language styles for specific audiences, such as high-risk groups and non-English speaking communities.

PROJECTS

AN ANALYSIS OF BUILDING LOSSES AND HUMAN FATALITIES FROM NATURAL DISASTERS

www.bnhcrc.com.au/research/buildinglosses

Dr Katharine Haynes

UNIVERSITY OF WOLLONGONG AUSTRALIA

LOOKING BACK CAN PREVENT FUTURE FLOOD DEATHS

Bushfire and Natural Hazards CRC research is informing community flood warning campaigns, emergency services training and national policy initiatives, with the project *An analysis of building losses and human fatalities from natural hazards*, led by Dr Katharine Haynes at Risk Frontiers and Macquarie University, investigating the circumstances of all flood fatalities in Australia from 1900 to 2015.

The study explored the socio-demographic and environmental factors surrounding the 1,859 flood fatalities over 115 years, finding distinct trends in relation to gender, age, activity and the circumstances of the death. These trends were analysed in the context of changes to emergency management policy and practice over time.

The research has informed community flood warning campaigns, emergency services training and national policy initiatives, with emergency services able to target warning messages to high-risk groups and high-risk behaviours based on the evidence from over a century of fatalities, injuries and building losses. These included children, teens, young adults and their parents; those who drive into floodwaters; and 4WD owners.

The NSW State Emergency Service used the findings of the research for its FloodSafe community campaigns and training, while the Queensland Fire and Emergency Services has used it to inform its 'If it's Flooded, Forget it' campaign.

The 2017 campaign by the NSW State Emergency Service featured a series of videos, with real people recounting their experiences of attempting to drive through floodwater, the consequences of their actions, and why no one should ever drive through floodwaters. Each video was backed by data from the research showing who is most at risk during a flood.

Andrew Richards at the NSW State Emergency Service says it was vital that the campaign was backed by research.

"As a consequence of risky behaviour, flood fatalities and rescues are a constant issue for emergency services. We are trying to increase public safety, to educate people to make the safe choice, and we think that the best way to achieve this is by highlighting true stories about what has happened to people when they have tried to drive through floodwaters," Andrew said.

"The research from the CRC was key as it showed to us where we needed to focus our safety efforts.

"Thanks to the research we were able to target effective audiences that are prone to driving into floodwater, as well as providing statistics and evidence to back up our campaigns," he said.

In 2019, this research, combined with separate CRC work that analysed the structure and tone of warnings messages, was recognised for its contribution to saving Australian lives in natural hazards with the Cooperative Research Centres Association's Excellence in Innovation award.

The research has also made its mark on a national level, contributing significantly to investigations into preventing flood fatalities by the Prevention of Flood Related Fatalities Working Group of the Community Engagement Sub-committee of the Australia–New Zealand Emergency Management Committee. It was recognised by the Emergency Media and Public Affairs conference as leading research making a difference in public safety, receiving a highly commended research award in 2018.

BETTER WARNINGS TO ENSURE ACTION

Australian lives are being saved by Bushfire and Natural Hazards CRC research that is shaping warnings and public information campaigns to prepare and protect communities threatened by flood, fire, heatwave and other natural hazards.

The insights from researchers at the Queensland University of Technology are equipping emergency service agencies around Australia with better-targeted long-term public safety campaigns as well as evidence-based warning messages delivered to at-risk populations in the face of imminent natural hazard threats.

The goal of the project was to save lives and empower communities to act to ensure their safety, by improving community warning messages.

The impact of the *Effective risk and warning communication during natural hazards* project has been

MANAGING ANIMALS IN DISASTERS: IMPROVING PREPAREDNESS, RESPONSE, AND RESILIENCE THROUGH INDIVIDUAL AND ORGANISATIONAL COLLABORATION

www.bnhcrc.com.au/research/animalsindisasters

Dr Mel Taylor

MACQUARIE University
SYDNEY·AUSTRALIA

EFFECTIVE RISK AND WARNING COMMUNICATION DURING NATURAL HAZARDS

www.bnhcrc.com.au/research/riskcommunication

Prof Vivienne Tippett

QUT Queensland University of Technology

dependent on close collaboration with the emergency service agencies from the beginning. This allowed the work to be shaped and directed at important stages.

In 2019, this research – combined with separate CRC work that drew lessons from analysing human and property losses in floods – was recognised for its contribution to saving Australian lives with the Cooperative Research Centres Association's Excellence in Innovation award.

Through active testing of the wording and structure of warning messages agencies have a better understanding of how messages are understood and translated into direct action. The team, led by Prof Vivienne Tippett, has supported broader initiatives in emergency communications and warnings, not just for individual organisations, but also at the national level by providing reviews and assisting with the development of evidence-based warnings doctrine.

Researchers contributed to the development of the National Emergency Management Handbook on Public Information and Warnings and the companion guide Warning Message Construction: Choosing Your Words, both published by the Australian Institute for Disaster Resilience in 2018. The publications drew directly on the research to give guidance on the key considerations for writing effective warning messages, including structures and language styles for specific audiences, such as high-risk groups and non-English speaking communities.

Warnings save lives and empower people to act, says Amanda Leck, Executive Director, Australian Institute for Disaster Resilience.

"Communities under the immediate threat of fire, flood, storm or cyclone are now likely to be much safer because fire and emergency services are now able to warn them, in a way that communities are more likely to take action. This is because of the research that's been conducted.

"What was missing previously was an evidence-base to guide emergency services in how to structure warning messages in a way that the community is much more likely to take action and take the action that emergency services are asking of them in what is often a very high stressful environment for those community members."

State-based emergency service agencies have drawn from the project and have collaborated

at the national level to determine a style and structure for their official public messages.

Queensland Premier Annastacia Palaszczuk credited the warnings research, combined with CRC fire mapping tools, with saving lives and the township of Gracemere, in the November 2018 fires. "The reason why we've put the map out is to show very clearly that Gracemere was directly in the line of this fire," she said. "That is why we took the action that we did to evacuate the town and thankfully the town was defended and containment lines are now well established." (29 November 2019, *Courier Mail*).

The Bureau of Meteorology has recently completed a review of its suite of national warnings across 11 warnings services based on the attributes contained in Australia's Total Warning System, the development of which was based on the CRC research for the Public Information and Warnings Handbook.

Changing the focus of warning messages has been the key, believes Anthony Clark, Director Corporate Communications at the NSW Rural Fire Service.

"This research is a really important piece of the puzzle. It is a game-changer for us as we had been sending out information and warnings in a format that met the needs of the emergency services. This research tips the process on its head and puts the community first and foremost. Emergency services are forming warning messages with the community in mind,

CHILD-CENTRED DISASTER RISK REDUCTION

www.bnhcrc.com.au/research/childcentredriskreduction

Dr Briony Towers

RMIT UNIVERSITY

FLOOD RISK COMMUNICATION

https://www.bnhcrc.com.au/research/floodriskcommunication

Dr Mel Taylor
Dr Katharine Haynes

MACQUARIE University
SYDNEY·AUSTRALIA

UNIVERSITY OF WOLLONGONG AUSTRALIA

Insights from researchers including Dr Paula Dootson, at the Queensland University of Technology, have equipped emergency service agencies around Australia with better targeted long-term public safety campaigns and warning messages.

so we can get the best possible response from the community in a time of disaster," Anthony says.

In South Australia, the Country Fire Service has used the findings to change its warning messages, ensuring they are simpler and easier to understand, explains Fiona Dunstan, Manager Information Operations.

"We've looked at our warnings and restructured and reprioritised the content to make sure the critical information was upfront. This ensures timely, targeted and meaningful information is provided to the community," Fiona says.

Country Fire Service warnings are now much shorter – previously they were three pages long. Now the vital information is on one page.

The Queensland Fire and Emergency Services have used the research findings to influence community behaviour when the communities' capacity to act rationally may be impaired.

"The research results are highly valuable and provide emergency service agencies with sound principles to follow," explains Hayley Gillespie, Executive Manager Media at QFES.

"These include using clear, direct language, structuring information in easily understood formats, and linking agency communications to other credible information sources. All of these strategies, and others the research covers, will help people to quickly make sound decisions that could save lives and property."

The study has seen close collaboration between the research team and the emergency services sector, with other organisations to have their warning information reviewed include the Inspector-General of Emergency Management Queensland, Emergency Management Victoria, Victoria State Emergency Service, Country Fire Authority, the Department of Fire and Emergency Services Western Australia and the Bureau of Meteorology.

SCHOOL-BASED EDUCATION FOR DISASTER RISK REDUCTION

Educating children and youth about disaster risk reduction and resilience is now front and centre around Australia, based on research that has identified the valuable role that children play in the safety of their households and communities.

The importance of educating children on hazards and disasters was recognised both in the 2009 Victorian Bushfires Royal Commission and the 2011 National Strategy for Disaster Resilience. The Bushfire and Natural Hazards CRC project *Child-centred disaster risk reduction*, led by the late Prof Kevin Ronan (CQUniversity) and Dr Briony Towers (RMIT University), evaluated disaster risk reduction and resilience programs in Australian primary and secondary schools to find out how these programs contribute to the mitigation and prevention of disaster impacts on lives and property.

Bushfire education has been evaluated in several states, including New South Wales, Victoria and Western Australia. In Victoria, the Country Fire Authority and State Emergency Service used the research to design a student-centred, inquiry-based, disaster resilience education program for students at year levels 7, 8 and 9. The program was assessed to inform strategies for scaled implementation in schools across the state.

CFA's Survive and Thrive program for students in Grades 5 and 6 has also been evaluated in both Anglesea and Strathewen, with the findings informing the development of community-based approaches to bushfire education to specific high-risk areas around Victoria. The Strathewen component has also demonstrated the value of bushfire education for children in fire affected communities and will provide a guiding model for future recovery programming. In recognition of this effort, Strathewen Primary School won the 2019 Resilience Australia National Schools Award.

Harkaway Primary School is learning from the the success of the Firestorm program at St Ives North Public School in NSW, and implementing a similar, project-based program, which is providing a valuable opportunity to study the processes and outcomes of this approach.

NSW Fire and Rescue have used the research to review their school-based Fire ED program. Based on this, firefighters now know the specific topics they need to educate children on to increase fire awareness and safety.

The NSW Rural Fire Service is also using the skills, knowledge and expertise of the research team in a number of ways. A change in NSW primary school curriculum now sees bushfire studied across the state by years 5 and 6 every two years. To assist in this educational change, the NSW Rural Fire Service has redeveloped their schools' education webpage to reflect inquiry-based learning principles, with information for teachers and students.

The NSW Rural Fire Service also drew on the expertise of the research team to inform the development of the 'Guide to Working with School Communities', which supports volunteers and staff to effectively engage primary school students in learning and action for house fire and bushfire safety. The Guide follows the earlier publication of a CRC ebook, based on the same

principles that if you educate children on fire safety, families and the wider community will also benefit.

The Bushfire Patrol program run by the Department of Fire and Emergency Services WA (DFES) has also been evaluated, with the refined program helping to ensure that children have the knowledge and skills they need to participate in bushfire planning and preparedness in their own homes. In the remote Kimberley region, DFES used the learnings to design a specific education program suitable to such a unique area. The North West Bushfire Patrol program was created to be geographically and culturally appropriate for the area, which has a large Indigenous population. The program covers all year levels of primary school and includes appropriate learning activities for each age group.

The benefits are flowing outside traditional emergency management agencies too. The Australian Red Cross is using findings of a mixed-methods, pre-post study to refine its disaster resilience education program, the Pillowcase Project.

Nationally, CRC researchers are actively engaged in the Disaster Resilience Education for Young People initiative, in partnership with the Australian Institute for Disaster Resilience. This initiative has allowed the project to actively engage with educators from across the country and to contribute to an online resource.

This overall set of evaluations represented stepped change in the first five years of this program of

research, while the last three years were geared towards enhancing and implementing disaster resilience education in schools, to providing additional benefits for children, schools, households and communities.

Further highlighting the international benefits of this research, emergency service agencies overseas have taken on board findings to develop their own child-centred disaster risk reduction programs.

EMERGENCY PLANNING FOR ANIMALS

Australians love their pets – and this influences how people behave during an emergency, with emergency services incorporating findings from research to influence their plans and policies during disasters.

Led by Dr Mel Taylor from Macquarie University, the *Managing animals in disasters* project identified best practice approaches to animal emergency management. This has given emergency management agencies the data they needed to make better informed decisions on planning and targeting of resources.

This project has had a strong utilisation focus, with the team actively engaged with emergency service agencies, government departments and local community groups.

Dr Taylor regularly attended community events to promote research outcomes, including the Sydney Dog Lovers show, Horse Owner Emergency Preparedness Open Day supporting NSW State Emergency Service and 'Giddy-up Get Ready Huon!' hosted by Tasmania Fire Service.

Working with the Blue Mountains Animal Ready Community, a range of emergency planning resources have been developed to highlight the importance of planning for animals during emergencies. The resources have been used by New South Wales Rural Fire Service brigades across the Blue Mountains, as well as by the Springwood Neighbourhood Centre and the Mountains Community Resource Network.

The resources have also been used to inform the NSW State Emergency Service's Get Ready Animals website, which launched in August 2020. The website features several targeted resources for different regions, including Blue Mountains and Hawkesbury-Nepean valley, and was awarded the 2020 New South Wales Resilient Australia Award. It is a major outcome from the NSW State Emergency Service's Ohana Project, funded by Resilience NSW.
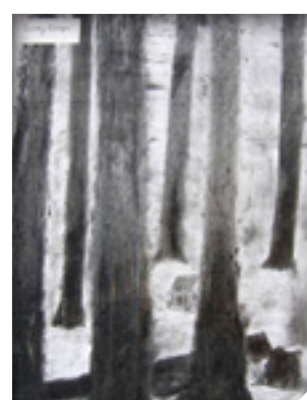
Dr Briony Towers, RMIT University, evaluated disaster risk reduction and resilience programs in Australian primary and secondary schools to find out how these programs contribute to the mitigation and prevention of disaster impacts on lives and property. Children's artwork: courtesy of 'Fire and Drought: Through the eyes of a child', Anglicare Victoria, Hume region.

NSW SES Commissioner Carlene York applauded the win at the Awards, encouraging animal owners to use the resources available on the Get Ready Animals website to ensure their readiness should a disaster hit.

"We need to make sure our communities are not only prepared themselves, but are preparing for their animals as well," she said.

"There are many resources available through the website including How to Build an Animal Ready Community, which is a great guide to help communities and animal groups become more prepared and self-reliant."

At the first Blue Mountains Animal Ready Community's community seminar, in 2018, the project team led discussion on how to manage small and large pets, livestock and wildlife during an emergency, as well as how to best be prepared beforehand.

Also in the Blue Mountains, the team partnered with the Winmalee Public School, with a student art competition developed into a book to reinforce why animals mattered and needed to be included in emergency plans.

In Tasmania, animal populations have been mapped in partnership with the Tasmania Fire Service and the Department of Primary Industries, Parks, Water and

Environment. This has informed evacuation planning, traffic management plans and capacity planning.

RSPCA Queensland has used the research to inform its polices, while in Victoria, the Department of Environment, Land, Water and Planning has used the findings to inform its risk assessment processes.

Nationally, the Australian Institute for Disaster Resilience has drawn on the research to develop a section on animal management in its updated 2020 Flood Emergency Planning for Disaster Resilience handbook.

State animal emergency management plans at three primary industry departments – the Victorian Department of Economic Development, Jobs, Transport and Resources, Western Australia Department of Primary Industries and Regional Development and South Australian Department of Primary Industries and Regions – have also been revised in consultation with the team.

The research has also received several awards, taking out the inaugural Emergency Media and Public Affairs conference research award as leading research making a difference in public safety in 2018, and as an integral part of Blue ARC's highly commended award in the NSW community category at the 2018 Resilient Australia Awards.

Dr Mel Taylor (fifth from right) with members of the Hawkesbury-Nepean Floodplain Strategy team and NSW SES at the Horse Owner Emergency Preparedness Open Day in July 2019. Photo: NSW SES.

EXTREME WEATHER

Photo: Andrew Xu (CC BY-SA 2.0).

"The Pyrocumulonimbus Firepower Threshold is a significant improvement in identifying fire-generated thunderstorm risk, including helping to flag other factors that should be looked at, such as mixed-layer windspeed. I review it every day that I am deployed as a fire behaviour analyst. It gives me a very quick heads-up on the potential, broad timing and location of fire-generated thunderstorms – if the chance of a storm is identified, it prompts further investigation of ignition potential, atmospheric instability and thus the likelihood of firestorms and community risk in those areas."

JAMIE MOLLOY, FIRE BEHAVIOUR ANALYST, DEPARTMENT OF ENVIRONMENT, LAND, WATER AND PLANNING VICTORIA

OVERVIEW

The ability to understand, predict, forecast and monitor extreme weather is fundamental to understanding the threat posed to communities and, in turn, our ability to provide appropriate warnings in the lead up to extreme weather. The Bushfire and Natural Hazards CRC sought to improve the scientific understanding of extreme weather in Australia and inform the development of numerical weather prediction systems specifically for severe weather.

The outcomes of the projects within this Extreme Weather theme have strengthened our national capability to understand and forecast extreme weather events, particularly through the Coastal Erosion Story Map, the Extreme Sea Levels in Australia website, the Pyrocumulonimbus Firepower Threshold and many other valuable resources.

TOOLS

COASTAL EROSION STORY MAP

sets out the key steps required to understand coastal erosion when storm clusters are a possible driver. It uses synthetic storm clusters to drive beach erosion and presents two case studies that model beach response for current sea level conditions. The map also helps evaluate impact of coastal erosion on infrastructure assets.

EXTREME SEA LEVELS IN AUSTRALIA

applies sea level data to predict Average Recurrence Intervals around the entire Australian coastline, including islands. These statistics, relevant plots and time series data can be used to provide a consistent, accessible and up-to-date dataset for use by coastal planners and emergency managers to protect life and property.

PYROCUMULONIMBUS FIREPOWER THRESHOLD

is diagnostic technology that measures the threshold required for fire-generated thunderstorms to form, by assessing the atmospheric potential to support the development of a fire sufficiently large and intense to create a storm. It helps predict when these storms might occur so that fire agencies can warn communities and firefighters.

SEVERE THUNDERSTORMS AND TORNADOS

On September 28, 2016 one of the most significant thunderstorm outbreaks recorded in South Australia impacted central and eastern parts of the state. Multiple supercell thunderstorms were embedded in a Quasi-Linear Convective System aligned with a strong cold front that was associated with an intense low-pressure system. The storms produced at least seven tornadoes, destructive wind gusts, large hail and intense rainfall. Transmission lines were brought down in four different locations, which contributed to a state-wide power outage.

Accurate prediction and understanding of tornadoes and other hazards associated with severe thunderstorms is very important, for timely preparation and announcement of warnings. By conducting high-resolution simulations, this study by the Bureau of Meteorology's Dr Dragana Zovko-Rajak, Dr Kevin Tory and Dr Jeff Kepert, offered a better understanding of the meteorology of the South Australian thunderstorm and tornados.

It also contributed to improving knowledge of how to best predict similar severe weather events, which in turn enables better risk management and preparedness for such events.

Updraft helicity, a severe storm surrogate that indicates the potential for updraft rotation in simulated storms, was used to investigate the ability of the model to predict the likelihood of a supercell and a tornado.

The ensemble simulations highlighted the uncertainty associated with timing, location and intensity of the convective systems that spawned the tornadoes. While each indicated some potential for tornado formation, this potential varied in magnitude, timing and location.

It may not be appropriate to assign a numerical probability to tornado formation in this case, since the ensemble has not been calibrated for this purpose. Nevertheless, such an ensemble would have strongly supported a forecast of a high risk of tornado formation.

This ensemble simulation presents a good example of an important advantage of ensembles over deterministic simulations. The control member of the ensemble provided a more modest indication of tornadoes, especially to the north of the region of interest, as

did two of the others. If any of these had been the sole deterministic member available, the forecasters would have not received as strong an indication of the potential for tornadoes. A single deterministic forecast can be regarded as a random choice from the set of all possible ensemble members. Although in this case the deterministic forecast happened to strongly indicate tornado risk, it could well have been weaker.

The most extreme forms of severe weather are, almost by definition, rare events. Thus, the use of an ensemble reduces the chances the numerical guidance will unluckily miss the true magnitude of the event.

The cost of extreme weather events

The implications of this extreme weather event were also discussed at public forum for the International Day for Disaster Risk Reduction in Adelaide in 2018, hosted by the Bushfire and Natural Hazards CRC.

Panelists for this session were:

- Malcolm Jackman, South Australian Fire and Emergency Services Commission
- Jillian Edwards, National Resilience Taskforce, Department of Home Affairs
- Prof Alan March, University of Melbourne and Bushfire and Natural Hazards CRC Project Leader
- Frank Crisci, SA Power Networks
- Peta O'Donohue, Country Fire Service, South Australia

Using this September 2016 extreme weather event as a real-world scenario, the panelists explored the real cost of disasters, efforts to build disaster resilient communities, and plans to reduce disaster risk.

FORECASTING FIRE-GENERATED THUNDERSTORMS

Pyrocumulonimbus (fire-induced thunderstorms; pyroCb) are associated with unpredictable changes in fire intensity, spread rates and direction, enhanced ember transport and lightning ignitions. Conventional thunderstorm threats such as downbursts, hail, lightning, and tornadoes may also be present.

In favourable atmospheric conditions, suitably large and hot fires can produce pyroCb cloud in the form of deep convective columns with many similarities to conventional thunderstorms. They may be accompanied

IMPROVED PREDICTIONS OF SEVERE WEATHER TO REDUCE COMMUNITY IMPACT

www.bnhcrc.com.au/research/predictingsevereweather

Dr Jeff Kepert

Australian Government
Bureau of Meteorology

DEVELOPING BETTER PREDICTIONS FOR EXTREME WATER LEVELS

www.bnhcrc.com.au/research/waterlevels

Prof Charitha Pattiaratchi

THE UNIVERSITY OF WESTERN AUSTRALIA

by strong inflow, dangerous downbursts and lightning strikes, which may enhance fire spread rates and fire intensity, cause sudden changes in fire spread direction, and the lightning may ignite additional fires. Dangerous pyroCb conditions are not well understood and can be very difficult to forecast.

CRC research has developed a method for determining how favourable the atmospheric environment is for pyroCb development. This method is combined with a plume-rise model (originally developed for pollutant dispersion prediction) to determine how much heat a fire must produce for pyroCb to develop in a given atmospheric environment. More specifically, this fire heat is the rate at which heat enters the fire plume (which has units of power), often termed the 'power of the fire' or 'firepower'. A theoretical minimum firepower required for pyroCb to develop in a given atmospheric environment is calculated, termed the Pyrocumulonimbus Firepower Threshold (PFT).

Forecast spatial plots of PFT are being trialled that provide an indication of how the favourability of the atmosphere for pyroCb development varies in space and time over typical weather forecast periods. It is anticipated that such plots will provide useful guidance for fire weather forecasters and fire agencies. Preliminary studies have shown that the PFT can vary substantially from day to day, and that days that favour pyroCb formation do not necessarily favour large-hot fires. A PFT-flag is also under development that identifies when both pyroCb and large-hot fires are favourable.

A series of CRC studies beginning with a little 'blue-sky' research into the thermodynamics of smoke plumes, led to the ability to identify potential condensation heights in plumes, and the minimum plume buoyancy required for plumes to freely convect to the electrification level. With this knowledge, equations for a theoretical minimum firepower required for pyroCb formation were derived using the Briggs plume model.

The work has culminated in the development of a diagnostic that seeks to determine when the atmosphere is conducive to both deep plume development and large, hot fires (PFT-flag). Originally designed as a flag to alert users when to examine the PFT, the PFT-flag may prove to be a more valuable prediction tool than the PFT itself.

It was developed and tuned to identify the atmospheric conditions corresponding to two pyroCb events at opposite ends of the pyroCb spectrum. The first (Sir Ivan fire, NSW 2017) occurred in catastrophic fire weather conditions when pyroCb formation conditions were not especially favourable. The second (Licola fire, Victoria 2019) occurred in much milder fire weather conditions when plume formation conditions were considerably more favourable.

The PFT-flag has now been applied to more than 20 cases covering multiple days and time periods. Rigorous performance testing is ongoing, but the tool appears to be working well. It not only identifies days of pyroCb occurrence, but also reproduces the diurnal variation in pyroCb threat, plus variations in threat associated with atmospheric features such as troughs, fronts and sea-breezes.

Both the PFT and PFT-flag are under continued development with real-time testing during southern Australian fire seasons.

In a training session recorded in November 2019, Dr Kevin Tory from the Bureau of Meteorology introduces the tool to aid in the forecasting of fire-generated thunderstorms.

The recording includes a presentation that introduces the PFT, explains how it works and gives examples of PFT usage. It provides valuable insight into plume dynamics, and a deeper understanding of the types of environments that support or suppress pyroCb formation. The video also includes instructions on how to calculate the PFT manually from atmospheric soundings on a thermodynamic diagram.

The PFT is now being used by fire agencies and BOM weather forecasters to predict when dangerous pyroCB storms might occur, so that fire agencies can warn communities and firefighters.

Research into extreme weather and hazard impacts has been led by researchers at the Bureau of Meteorology, including Dr Jeff Kepert, pictured presenting the keynote presentation at the Research Day of the AFAC/CRC annual conference in 2016 in Brisbane.

FIRE PREDICTIVE SERVICES

"As a way of accelerating this exciting research toward industry utilisation, the NSW RFS proposed to the research team a real-world 'live' trial of the experimental satellite fire detection algorithm under development. The RFS invested the time and expertise to incorporate RMIT's work into existing systems so it can run in parallel with currently operational satellite detection systems. Early industry utilisation has become a very important step in the research program itself. That is, using an incomplete product in a trial within an agency prior to the conclusion of the research project has enabled the research team to develop, troubleshoot, and refine their work."

BRAD DAVIES, NSW RURAL FIRE SERVICE, ON THE *FIRE SURVEILLANCE AND MAPPING* PROJECT

OVERVIEW

Fire modelling research improves our understanding of how and when fire propagates across different landscapes under different weather conditions. This understanding enables better warnings and more informed community safety, and a more precise allocation of resources for response.

The aim of the Bushfire and Natural Hazards CRC research in this Fire Predictive Services theme was to bridge the gap between fire danger prediction systems based on the science of the 1950's and 60's and a modern system that draws on current research, technology and conditions.

CRC research has created a base of solid scientific evidence that builds on a long history of fire danger ratings research in Australia. This has provided tools for CRC partners that enhance the way the Australian landscape is monitored with (near) real time fire-spread modelling, which improves their ability to predict and respond to fire.

The work in this theme is closely aligned with the research in the Extreme Weather and Managing the Landscape themes. Together, these themes provide the ability to understand, predict, forecast and monitor bushfires, which are the fundamental elements needed to improve resilience through better planning, preparedness, risk management and response.

TOOLS

SAVANNA MONITORING AND EVALUATION REPORTING FRAMEWORK

is a tool that evaluates the effects of fire where burnt area mapping is available across the Northern Territory, large parts of Western Australia and Northern Queensland. It assesses nearly twenty years of data to show where bushfires have burnt, at what time of year (early or late dry season) and when an area was last burnt.

CHARLES DARWIN UNIVERSITY

FIRE SIMULATION MODELLING

The PHOENIX RapidFire fire simulator places Australia as a world-leader in bushfire tools and analysis. It is used by land and fire managers to support fire management and land-use planning and to support decision-making during bushfires.

The major benefit of PHOENIX RapidFire is that the speed, accuracy and user-friendliness of its information allows quick, informed decisions to be made that save lives and properties. When combined with clear and timely warning messages, communities at risk can are able to informed actions while under the threat of a major fire.

By using PHOENIX RapidFire, fire and land management agencies can reduce natural hazards impacts on property and infrastructure both by ensuring appropriate measures are taken before the fire season begins and making more informed decisions about what areas are at risk when a fire has taken hold.

PHOENIX RapidFire is a model that simulates bushfires. It integrates fuel, terrain, weather conditions and suppression to simulate a fire's development and progression in the landscape. Its development was driven by the need to realistically describe bushfires across the Australian landscape.

In the late 1990s researchers at the University of Melbourne began to review the elements contributing to bushfire risk and the current state of knowledge. With the establishment of the Bushfire CRC in 2004, this research continued.

In 2005 Prof Kevin Tolhurst and programmer Derek Chong built and merged two models: PHOENIX, which described what a bushfire is like at any point in the landscape, and RapidFire, which analysed how a fire interacts with important assets, such as houses, powerlines, catchments and biodiversity. Since then, the use of PHOENIX RapidFire has resulted in a vast number of benefits for Australian communities, with many examples drawn from recent bushfires.

Queensland emergency services have credited PHOENIX RapidFire for enabling a quick responses to rapidly evolving fire threats that occurred across the entire state during the spring and summer of 2018.

On 28 November 2018, a small fire started outside Gracemere, Queensland, a town of 8000 people located just south of Rockhampton. The fire danger rating index that day had reached Catastrophic: the first time for such a level in Queensland.

Queensland Fire and Emergency Services' Inspector Andrew Sturgess said at the time that the PHOENIX RapidFire modelling allowed emergency responders to realise that the small fire west of Gracemere had the potential to turn into a blaze that could threaten the town.

The swift evacuation of the community with clear, direct warning messages has been hailed as an example of success of both the simulator and the CRC research into timely and effective warnings.

At the end of the Bushfire CRC in 2013, the IP for PHOENIX RapidFire was transferred to three joint parties: the University of Melbourne; the Victorian Department of Environment, Land, Water and Planning; and AFAC. The model's use is now licensed out commercially by Fire Prediction Services, which is owned by the three IP owners.

Phoenix RapidFire is an example of how investment and research made in the days of the Bushfire CRC is continuing to benefit the Australian community. The Bushfire and Natural Hazards CRC has developed updates and conducted research for inputs into the model, increasing its accuracy across different scenarios and landscapes. Recent CRC research projects that have informed the model include:

- fire coalescence research
- wind reduction in tree canopies
- research into soil moisture
- fire event spotting.

FINDING FIRES FASTER

The development of new and innovative algorithms are supporting near-continuous active fire surveillance from space unlike any other satellite hotspot products previously available.

Using the latest geostationary satellite-based earth observation systems and the Himawari satellite, the *Fire surveillance and hazard mapping* team

FIRE COALESCENCE AND MASS SPOTFIRE DYNAMICS

www.bnhcrc.com.au/research/firecoalescence

Prof Jason Sharples

UNSW

FIRE SPREAD PREDICTION ACROSS FUEL TYPES

www.bnhcrc.com.au/research/firespread

A/Prof Khalid Moinuddin

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

from RMIT University, led by Prof Simon Jones and Dr Karin Reinke, is helping fire managers with early fire detections to hone in on bushfires.

Most satellite-based fire detection algorithms are susceptible to the effects of clouds, as well as the accuracy of the land surface temperatures observed around a potential fire. But thanks to the research into an algorithm designed to take advantage of the 10-minute observations available from Himawari-8, and that is specifically tuned to Australian conditions and seasons, a robust and computationally rapid method for early fire detection across Australia has been developed.

Simeon Telfer is a fire manager from South Australia's Department of Environment and Water, and says the research can make a difference to operations.

"Due to the increased availability of the satellite data and faster processing, there is an opportunity for earlier detections, and for ongoing remote observations of fires to be made," Simeon says.

This means some fires could be detected hours earlier than was previously possible, leading to quicker deployment of firefighters and firefighting aircraft, as well as warnings to the public.

A trial with the NSW Rural Fire Service over summer 2018–19 helped to focus the research. Currently, bushfires are primarily detected when a member of the public calls Triple Zero, and occasionally from other satellites that may be passing over the area. The researchers worked with the NSW RFS to assess how much faster the new algorithm can detect fires compared to current methods.

The project is also improving the accuracy of vegetation monitoring for flammability, as well as saving critical personnel hours, through the development of a smartphone application. The Fuels3D app combines off-the-shelf digital cameras and/or smartphones with computer vision and photogrammetric techniques to calculate vegetation structure and fuel hazard metrics. This reduces individual bias in estimating bushfire risk and ensures more accurate and consistent data is collected as individual bias is completely removed. Fuels3D allows anyone to take a vegetation fuel sample; it has potential for pre- and post-burn mapping, and can provide inputs into fire behaviour modelling and risk assessment and planning.

BETTER FIRE DANGER RATINGS

The latest fire science, including Bushfire and Natural Hazards CRC research, has been used to develop the pilot National Fire Danger Rating System. The update currently underway is the first major update to the system since it was devised in the 1960s.

Initially developed as CRC research after a recommendation from the 2009 Victorian Bushfires Royal Commission, support from the Commonwealth government led to the successful transition from a collection of CRC managed research, to a fully owned and developed prototype system managed by the industry for the benefits of the community.

The new National Fire Danger Rating System prototype was trialled by the New South Wales Rural Fire Service over summer 2017–18 to better incorporate extreme fire behaviour. The revised system will be more comprehensive, providing a greater ability to understand and predict localised fire danger risk with greater scientific accuracy, rather than applying the same fire danger across large areas, as is currently the case. In coming years when the revised system is in operation around Australia, all fire agencies will be able to better predict bushfire danger, leading to better warnings, more efficient use and distribution of firefighting resources, improved community awareness of risk, and increased safety for both firefighters and the community.

The CRC has contributed contemporary science to the prototype system on fire weather, vegetation conditions, fire behaviour, ignition likelihood, fire suppression, fire impact, communicating risk, urban planning, decision making and mitigation.

The trial of the prototype is a significant demonstration of the successful utilisation of CRC research into the sector: CRC partners AFAC and the NSW Rural Fire Service now own the ongoing

COUPLED FIRE-ATMOSPHERE MODELLING

www.bnhcrc.com.au/research/coupledfire

Dr Mika Peace
Dr Jeff Kepert

Australian Government
Bureau of Meteorology

THRESHOLD CONDITIONS FOR EXTREME FIRE BEHAVIOUR

www.bnhcrc.com.au/research/extremefirebehaviour

A/Prof Trent Penman
Dr Thomas Duff

THE UNIVERSITY OF MELBOURNE

use of the research outputs. As the new system is piloted and integrated into the sector, the CRC will continue to play a critical role, providing vital science and evidence that underpins the new system.

A SEASONAL VIEW OF BUSHFIRE

Strategic decisions on resources, prescribed fire management and community warnings have, for the past 16 years, been underpinned by the Bushfire and Natural Hazards CRC's Seasonal Bushfire Outlook.

Governments and fire authorities are using the Outlook for planning purposes in the lead-up to their bushfire seasons, including refining their public messages that communicate bushfire risk and highlight areas with the highest potential for fire.

The CRC leads the preparation of the Outlook in close consultation with the Bureau of Meteorology, AFAC, and emergency service agencies in each state and territory.

The earlier Outlooks covered only the southern fire season and was released annually around September at the CRC and AFAC annual conference. Later, a northern outlook was added around June, and also an update to the southern outlook around November. In 2020, the Outlook shifted to a regular national quarterly release to better reflect the year-round nature of fire management and operations across Australia.

The Outlooks serve a range of purposes and are a critical component in raising community awareness about the coming fire season. A well-attended and widely broadcast media event with all of Australia's fire chiefs is held annually at the AFAC Conference as part of the statement's public release providing a timely opportunity to reach the community and other stakeholders. In recent years, as testament to the growing reliance on the Outlook, the launch has been livestreamed on ABC, Sky and other media channels, and followed up with extensive media coverage across print, radio, television and online.

The fire Outlooks began in 2003 under a Bushfire CRC project with Dr Graham Mills from the Bureau of Meteorology, drawing on experience from the US through Dr Tim Brown, of the Desert Research Institute. The primary information in the product consists of a map of seasonal bushfire potential, with extensive commentary and maps of climate conditions and forecasts. Areas where the fire potential is below normal, normal or above normal are shown in three colours.

The outlooks are prepared at workshops by integrating climate forecasts with extensive knowledge of the current fuel state and previous fire seasons to produce an overview for the upcoming fire season. The workshops consider the weather, landscape conditions and cross-border implications leading into the main fire season.

Fire season potential depends on many factors. Rainfall amount, location and timing of rainfall in the period leading up to the fire season are critically important, and contribute to fuel loads, dryness and fuel availability. The temperature and rainfall outlooks for the next few months are crucial factors for influencing the development of fire potential. The actual impact of fire within a season will depend on exposure to assets (such as houses and other infrastructure) and to people, community preparedness, the availability of firefighting resources and more random factors such as ignition sources. Fuel loads show much variability and are a product of past fire history, rainfall over one or more preceding seasons and land use, such as grazing and agriculture.

The Seasonal Bushfire Outlook is used by governments and fire authorities to make strategic decisions on resource planning and prescribed fire management for the upcoming fire season. How agencies and governments make use of the statement for planning, and its influence on decisions varies from jurisdiction to jurisdiction. One key use is as a tool to justify significant investment in resources such as additional firefighters, vehicles and aircraft. Another is to increase community preparedness campaigns in areas of high likelihood of fire.

The Outlook is widely distributed among related organisations and community groups for local use. The Australia Red Cross uses the Outlook to produce hazard and vulnerability data maps for its emergency services managers around Australia as part of its seasonal preparedness planning so resources can be shifted to areas with higher fire potential. ABC Emergency uses the Outlook to schedule training sessions for its journalists working in potentially hazardous areas around the country based on the priorities highlighted by the Outlook.

FUTURE WORKFORCE

Photo: Department of Fire and Emergency Services WA

> "Social and economic conditions are causing major changes in how people volunteer and what they are expecting out of their volunteering experience. This is particularly important knowledge, as understanding the challenges and opportunities that exist for volunteers will be pivotal to maintaining a sustainable volunteer base to provide essential emergency services to the community. This research has provided valuable findings, as well as practical and usable recommendations."

JENNIFER PIDGEON, STRATEGIC VOLUNTEER AND YOUTH PROGRAMS MANAGER, DEPARTMENT OF FIRE AND EMERGENCY SERVICES

OVERVIEW

The emergency services workforce of tomorrow needs to be highly adaptable to meet the challenges and opportunities presented by a future where natural hazards are more extreme, longer lasting, and a greater drain on resources, both human and economic.

The Bushfire and Natural Hazards CRC initiated a collaboration between researchers and emergency services agencies, as well as key partners and focus groups – such as the AFAC Workforce Management Group – to imagine what a future workforce might look like.

Research projects in this theme all explore the ways that contemporary research across Australia is influencing workforce and volunteer management strategies into the future, including issues of recruitment and retention, leadership and decision-making, mental health, capability and planning, and diversity and inclusion.

Key outcomes now being implemented in partner agencies include a mental health and wellbeing guide for young adult volunteers, a sustainable volunteering toolkit, a set of teamwork and strategic decision-making tools, a diversity and inclusion framework, and many other resources of value to the emergency managers in government, emergency services and community organisations. Research from the Future Workforce theme has been crucial in the development of important initiatives, such as Australia's first national handbook on planning for spontaneous volunteers.

TOOLS

CARE4GUIDE

and associated resources are a set of practical and usable evidence-based tools that promote positive mental health and wellbeing in young adult emergency service volunteers. Developed directly with young people, these can be used by team leaders, organisations and volunteers to guide the prevention and impact of traumatic experiences for young adults in emergency management.

RECRUITMENT AND RETENTION TOOLKIT FOR EMERGENCY VOLUNTEER LEADERS

supports emergency services leaders with their volunteer management practices. The Toolkit includes easy-to-use guides about recruiting volunteers for emergency services, supporting new volunteers, volunteer management, emergency volunteer recruitment messaging and volunteer succession planning.

TEAMWORK TOOLS

is a suite of six tools that enhance teamwork in emergency management. Teams and leaders can use these tools before, during and after emergencies to ensure the team is running as smoothly as possible under stress, including the enhancement of non-technical skills such as communication, leadership, coordination and strategic decision making.

COMPLEX DECISION MAKING

Effective decision making and teamwork are essential to ensure incident management teams function to the best of their ability in challenging and high stakes environments. To help improve these skills, practical tools have been developed by the *Improving decision-making in complex multi-team environments* project led by A/Prof Chris Bearman at CQUniversity and A/Prof Ben Brooks at the University of Tasmania.

Formally launched in 2018 and 2020, a set of teamwork tools (the Team Process Checklist, the Emergency Management Breakdown Aide Memoire, the Psychological Safety Checklist and the Cognitive Bias Aide Memoire) cover communication, coordination and cooperation and include helpful suggestions on how to identify and resolve teamwork problems during complex situations.

Two more tools launched in 2021: the Emergency Management Non-Technical Skills checklist, to help emergency managers and teams to enhance their cognitive, social and personal skills to complement technical skills and strengthen individual and team capabilities; and the Key Tasks Cognitive Aid, designed to prompt leaders during a crisis to ensure their teams are undertaking the tasks most important to effective performance.

Emergency services have been engaged throughout development, with information sought from 18 separate agencies ranging from state emergency services, urban fire, rural fire and local councils. Agencies allowed the research team to monitor both real and simulated emergency situations from within incident management centres, as well as providing feedback throughout the prototype stage. This has led to tools that are tailored specifically for emergency managers.

The tools are flexible and can be used as a health check to ensure the team is functioning effectively, to identify suspected problems, as a debrief tool and as a way to foster better teamwork. They have been used to better manage teams during incidents, to reflect on teamwork during periods of relative calm, and for assessment or debrief during training.

The South Australian Country Fire Service, Tasmania Fire Service and NSW State Emergency Service have adopted the tools and the Queensland Fire and Emergency Services sought out the expertise of the team in the aftermath of Severe Tropical Cyclone *Debbie* in 2017 to inform future preparation, response and recovery. Emergency Management Victoria has amended its operational doctrine and has provided the Team Process Checklist to all Real Time Monitoring and Evaluation personnel, and it was translated into Spanish by the Pau Costa Foundation for use in Spain. At the local government level, the Shire of Mundaring in WA has incorporated the Psychological Safety Checklist into its operations.

Those who work in Incident Management Teams, strike teams and at regional and state operations centres can see the most benefit, believes Mark Thomason, Manager Risk and Lessons Management at the South Australia Country Fire Service.

"The tools are straight-forward and practical, and adaptive to the needs of individual emergency managers to ensure their teams are functioning to the best of their ability," Mark says.

The Tasmania Fire Service used the tools during the 2015–16 fire season, which saw TFS responding to many major bushfires over two months. The tools helped to ensure communication between different teams was efficient and timely during a highly stressful time.

Jeremy Smith, the TFS Deputy Chief Officer during the fires, highly recommends the tools to other emergency managers.

"These tools have been validated and developed through a body of research. The support they provide for incident management is vital," Jeremy says.

More than 220 senior emergency management personnel have been trained to use the products developed in the decision-making stream of the research.

Findings from this research are also benefiting organisational resilience, with the federal Department of Home Affairs in 2018 launching a practical guide to decision making based on research carried out in the project. Researcher on the CRC project, Dr Steve Curnin, ran a masterclass and led the development of the guide as a member of the Resilience Expert Advisory Group. The guide, *Decision making during a crisis: a practical guide*, was an initiative of this Group.

IMPROVING DECISION-MAKING IN COMPLEX MULTI-TEAM ENVIRONMENTS

www.bnhcrc.com.au/research/multiteamenvironments

A/Prof Chris Bearman

ENABLING SUSTAINABLE EMERGENCY VOLUNTEERING

www.bnhcrc.com.au/research/resilience-hazards/3533

Dr Blythe McLennan
A/Prof Patrick Dunlop

Out west, workshops have been held with local government emergency managers through the Western Australia Local Government Association, as well as the Western Australia State Emergency Management Committee, to strengthen decision making in crisis situations.

The decision-making research is also benefiting those outside the traditional emergency management sector, with the research team conducting a workshop with the Queensland infrastructure sector.

Organisations such as the Australian Maritime Safety Authority and the Australia Antarctic Division have also used the tools in exercising and have incorporated them into operational use.

The project also engaged with the Joint Cyber Security Centre in Sydney, hosting a session 40 crisis management professionals who represented the banking and finance sector, energy sector, food and grocery sector, communications sector, and the water sector.

Working with AFAC through the Knowledge Innovation and Research Utilisation Network, a research utilisation maturity matrix has been developed to help guide emergency services and land management agencies in assessing how individual agencies implement research findings and where they grow their use. This element of the research has identified that agencies best placed to implement research findings have established governance processes to do so, embed utilisation into job roles, actively test outputs of research and are communities of practice.

A NEW MODEL FOR HELPING

How people volunteer to keep their community safe from natural hazards is changing. As our work and life commitments change, many people do not have the time to dedicate to traditional ways of volunteering with an emergency service, undergo the required training and develop the ability to respond to potentially dangerous situations. But they still want to help, and they still want to volunteer.

With research showing that the nature of volunteering and citizen involvement in disaster management is fundamentally changing, advice from the RMIT University team led by Prof John Handmer and Dr Blythe McLennan is regularly sought by individual agencies and organisations in the development of guides and policies around volunteering and spontaneous volunteering.

Dr McLennan was acknowledged for leadership and research in community resilience and disaster recovery, when presented with the 2018 Quiet Achiever Awards by Emergency Management Victoria Commissioner Andrew Crisp.

Research from the CRC project *Out of uniform: building community resilience through non-traditional emergency volunteering* has influenced key national initiatives, with findings from the study used extensively for the development of the National Spontaneous Volunteer Strategy by the Australia–New Zealand Emergency Management Committee.

The strategy provides advice to emergency service agencies on what they need to be aware of, and what they need to consider and plan for when working with spontaneous volunteers. Important issues such as legal obligations and social media are also covered, with the work of the project team integral to the Strategy's completion.

Building on this, the Australian Institute for Disaster Resilience has drawn directly on the research to develop a new handbook on spontaneous volunteer management. Released in 2018, the handbook provides important guidance for organisations on how to incorporate the principles of the National Spontaneous Volunteer Strategy, and the most recent research on spontaneous volunteering, into their own plans and procedures.

Emergency services are also using the research, with the New South Wales State Emergency Service (NSW SES) using the findings to shape how the organisation will recruit volunteers. Work on the development of this handbook was recognised by the CRC in 2019 with an Excellence in Research Utilisation Award given to Dr McLennan and the Australian Institute Disaster Resilience's Amanda Lamont.

Emergency services are also using the research, with the NSW SES using the findings to shape how the organisation will recruit volunteers.

"Findings from the research really helped to shape our Volunteering Reimagined strategy,

OUT OF UNIFORM: BUILDING COMMUNITY RESILIENCE THROUGH NON-TRADITIONAL EMERGENCY VOLUNTEERING

www.bnhcrc.com.au/research/communityresilience

Prof John Handmer

NATIONAL MENTAL HEALTH AND WELLBEING STUDY OF POLICE AND EMERGENCY SERVICES

www.bnhcrc.com.au/research/resilience-hazards/3403

Prof David Lawrence

launched in 2017," says Andrew McCullough, Volunteering Strategist at the NSW SES.

"The NSW SES is planning to lead in this space, and it is only with the help and the research of the CRC that this is possible," he says.

In Western Australia, the Department of Fire and Emergency Services has used the research to develop new directions in volunteering, while South Australia's Department of Communities and Social Inclusion, Volunteering ACT and Volunteering Victoria have also been influenced by the work in developing polices and guides to volunteer management, both during emergencies and in recovery. Be Ready Warrandyte, a community group in one of Melbourne's high bushfire risk suburbs, has drawn extensively on the research to help educate and support their local community.

ANSWERING THE CALL

Answering the Call, a product of the *National mental health and wellbeing study of police and emergency services* project, was the first national survey that investigated the factors that affect the mental health of employees, volunteers and former employees in the police and emergency services. Included in the research were personal and workplace factors, stigma and support seeking, workers compensation system experiences, and experiences after leaving the service.

Answering the Call began in 2018 and conducted as Phase 2 of the Beyond Blue National Mental Health and Wellbeing Study of Police and Emergency Services. The CRC played a vital role by providing part of the funding of Answering the Call and by partnering with Beyond Blue in conducting the research through the University of Western Australia and Roy Morgan Research.

The project received full support from all Australian emergency service organisations that operate with a volunteer workforce, including rural fire services, and state and territory emergency services. Of the 36 agencies in the industry, 33 of these agencies participated in the project. A random sample was selected and contacted to participate in an online survey. The total number of survey respondents – employees and volunteers – was 21,014.

The study found that, across the majority of the workforce in police and emergency services, there were good levels of positive mental wellbeing and resilience, and low levels of distress. However, compared with the general population, the levels of distress and mental health conditions in this sector were higher. One in three employees experienced high or very high psychological distress compared to just over one in eight of all Australian adults. The survey also showed that employees and volunteers are twice as likely to report having suicidal thoughts compared to the general population. The survey addressed areas of improvement to workplace culture, as the findings indicated that physical and verbal assault were fairly common.

Employees tend to stigmatise mental health more than the general population. The study found that reducing that stigma could promote behaviours positive to each individual's mental health. The majority of employees who made a workers compensation claim reported that the process hurt their recovery, and they found the system to be unsupportive and stressful more often than not. The survey also identified a number of gaps in mental health support, and recommended ways in which agencies can improve risk management and deliver support services. with many employees feeling there was insufficient help for their problems.

The results of Answering the Call include a national database that will be used for further research, both nationally as well as by individual agencies.

Answering the Call has also contributed towards further separate studies. The University of Western Australia was able to gain research funding to follow the ongoing wellbeing and resilience of Australia's first responders following the 2019-20 bushfires, and the CRC conducted research in partnership with the University of Adelaide, AFAC and the Hospital Research Foundation to develop a framework for protecting the mental health of young volunteers.

At this time of print, the findings from Answering the Call are still being implemented, but show great potential for volunteer welfare. The research has identified gaps in the existing framework for mental health service provision that will improve efficiency in managing mental health issues within the emergency services.

POSITIVE MENTAL HEALTH IN YOUNG ADULT EMERGENCY SERVICES PERSONNEL

www.bnhcrc.com.au/research/volunteermentalhealth

Dr Amanda Taylor

THE UNIVERSITY of ADELAIDE

DIVERSITY AND INCLUSION: BUILDING STRENGTH AND CAPABILITY

www.bnhcrc.com.au/research/diversityinclusion

Celeste Young
Prof Bruce Rasmussen

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

Photo: Bevlyne Sithole.

INDIGENOUS INITIATIVES

> "Family they saw what I was doing with all them projects, I bin go here and get that training and that training, this bin different from any other training workshop."
>
> ELDER, MALNYANGARNAK

OVERVIEW

While there may be differences in the ways that Aboriginal and non-Aboriginal people understand the world, these differences can create opportunities to build strong relationships and find mutual benefit in overlapping interests. The Bushfire and Natural Hazards CRC research in the Indigenous Initiatives theme has identified ways to make the most of those opportunities without losing sight of who we all are. This takes recognition, respect and trust.

CRC researchers have investigated Indigenous-driven interests and initiatives in building community resilience as a foundation for more effective relationships between communities and emergency management agencies.

The work was undertaken through Charles Darwin University in collaboration with the North Australian Land & Sea Management Alliance and the Aboriginal Research Practitioners Network – a collective of Indigenous community researchers..

The researchers identified the strengths and opportunities of Indigenous culture and society that are central to the future development of northern Australia, providing a basis for emergency management agencies to work with communities on respectful resilience measures in the face of fires, floods, cyclones and other hazards. A related project developed a training program that builds on the existing Indigenous ranger programs, with the added emphasis of increasing levels of competence and confidence and, in its turn, resilience.

Across southern Australia, researchers have identified areas for collaboration between Indigenous communities and the emergency management sector that reduce risk to natural hazards and increase social and ecological resilience.

TOOLS

NORTHERN AUSTRALIAN REMOTE BUSHFIRE AND NATURAL HAZARDS TRAINING

is a program of ten training units that provide practical support and reinforcement of capabilities in remote northern communities. The units interweave a set of philosophical and practical understandings of the management of landscapes for natural hazards in a changing climate, as well as the integration of Indigenous knowledge and experience with non-Indigenous approaches.

CHARLES DARWIN UNIVERSITY

Researchers Steve Sutton (back left) and Adj Prof Jeremy Russell-Smith (back right), Charles Darwin University, worked to build stronger relationships between communities and emergency management agencies.

DEVELOPING EFFECTIVE EMERGENCY MANAGEMENT PARTNERSHIPS IN REMOTE NORTHERN AUSTRALIAN COMMUNITIES

www.bnhcrc.com.au/research/remotecommunities

Adj Prof Jeremy Russell-Smith
Dr Bevlyne Sithole

CHARLES DARWIN UNIVERSITY

NORTHERN AUSTRALIAN BUSHFIRE AND NATURAL HAZARD TRAINING

www.bnhcrc.com.au/research/hazardtraining

Steve Sutton
Adj Prof Jeremy Russell-Smith

CHARLES DARWIN UNIVERSITY

HAZARDS, CULTURE AND INDIGENOUS COMMUNITIES

www.bnhcrc.com.au/research/indigenouscommunities

Dr Jessica Weir
Dr Timothy Neale

WESTERN SYDNEY UNIVERSITY

DEAKIN UNIVERSITY

TAKING FIRE: THE HISTORICAL AND CONTEMPORARY POLITICS OF INDIGENOUS BURNING IN AUSTRALIA AND THE WESTERN UNITED STATES

www.bnhcrc.com.au/research/policy-and-economics-hazards/2679

Daniel May

Australian National University

SAVANNA FIRE MANAGEMENT, RESOURCES, METHODS AND EFFECTIVENESS

www.bnhcrc.com.au/research/resilience-hazards/4155

Jay Evans

CHARLES DARWIN UNIVERSITY

WOMEN CARING FOR WAANYI AND GARAWA COUNTRY

www.bnhcrc.com.au/research/resilience-hazards/1669

Kate van Wezel

CHARLES DARWIN UNIVERSITY

INFRASTRUCTURE AND IMPACT

"The Australian Exposure Information Platform's (AEIP) Application Programming Interface (API) was integrated into the NSW RFS Cerberus Ensemble Fire Simulator workflow during the 2019–20 bushfire season. Cerberus is able to simulate where a fire is likely to move in the next 24 hours and the simulation polygon extent generated can now be automatically consumed by the AEIP API to generate an exposure report. This capability allows NSW RFS to quickly assess what is in the path if the fire is not controlled and therefore helps to plan and prioritise emergency responses.

STUART MATTHEWS, PRINCIPAL PROJECT OFFICER, OPERATIONAL SERVICES/PLANNING AND PREDICTIVE SERVICES, NSW RURAL FIRE SERVICE

OVERVIEW

The scale of the impacts of storms, cyclones, earthquakes and floods upon our houses, buildings, roads, bridges and other infrastructure is directly related to earlier decisions made to mitigate against potential disasters.

The Bushfire and Natural Hazards CRC has improved the way that vulnerability of buildings and key infrastructure is factored into planning decisions for communities at risk across a range of hazards.

The projects within the Infrastructure and Impact theme focused on high-risk components of the built environment and looked at how new construction can be undertaken as a risk reduction strategy for some hazards.

The outcomes of these projects have strengthened our understanding of how risk can be mitigated through interventions that will reduce damage, injury, community disruption and the future cost of natural hazards.

These outcomes are evident in the Coastal Erosion Story Map, Australian Exposure Information Platform, household resilience programs for cyclone and severe winds, and many other resources that are now in use.

TOOLS

AUSTRALIAN EXPOSURE INFORMATION PLATFORM

quickly and easily allows users to generate exposure reports of what is in the path of a hazard, for decision making before, during and after hazard events. The reports provide a detailed statistical summary of the number of people, dwellings, structures, businesses, and agricultural and environmental assets in any specified area across Australia.

Launch of the Australian Exposure Information Platform.

WEATHER THE STORM

is a website that informs builders and homeowners about how to improve an existing home's key structural connections against extreme winds. Based on CRC research at James Cook University's Cyclone Testing Station, it provides practical and economic options for upgrading existing houses to withstand cyclones and storms.

● UNCOVERING NATIONAL EXPOSURE

The Australian Exposure Information Platform (AEIP) was built on the CRC-funded Natural Hazard Exposure Information Modelling Framework and developed in partnership with Geoscience Australia. Using inputs from the Framework, its focus is to provide nationally consistent exposure information for emergency management by supplying key stakeholders with direct access to the information they need at the onset of a crisis through a web platform at aeip.ga.gov.au. The platform allows anyone to generate a report for any area of Australia at any time – before, during and after a hazard event has occurred.

The AEIP includes a complex model of how various assets are vulnerable to a number of hazards. The AEIP displays impacts on people, buildings, infrastructure, businesses, hazardous substances, agriculture and environmental assets, resulting from critical infrastructure failures, natural or human-induced hazards. For example, built environment exposure considers usage type, structural system, number of stories, size, age, etc. Business and economics exposure considers the type of business, assets and activities to assess the level of business continuity, disruption and recovery that might occur.

Users are able to rapidly gain a holistic understanding of what is exposed and at risk within an area. End-users enjoy the sense of empowerment through the AEIP – they can select the area of interest, the type of exposure data themes they require as well as other contextual information. The resulting report is generated automatically and delivered by email.

Geoscience Australia and research teams from the University of Canberra and the University of Melbourne collaborated to develop the AEIP. The software has extensive support from end-users who are involved in emergency management, risk assessment, impact analysis research and disaster management. These are stakeholders that are required to understand how severe a natural hazard might become and the associated exposure risks. These organisations include the Crisis Coordination Centre of Emergency Management Australia, the insurance sector and several Australian, state and local government agencies, industries and universities.

Previously, users faced delays while Geoscience Australia manually assembled exposure reports during emergencies. AEIP has sped up the process considerably by enabling users to quickly and easily create customised exposure reports. Organisations have access to on-the-fly scenario event assessments by either completing a simple form through AEIP's web mapping application or by connecting their applications directly via the API.

The beta version of AEIP was rolled out during the 2018-19 fire season. That season produced more than 1500 exposure reports by more than 200 users. Improvements were made based on feedback.

The platform was in demand during the Queensland flooding in December 2018 when 400 exposure reports were created in one week by government agencies. This assisted organisations with rapid and smarter decision-making, which saw a reduction in the loss of life and economic damage.

During Cyclone *Veronica* (March 2019), agencies were able to use the platform to understand exposures in the Pilbara in Western Australia that were under threat. The platform determined the vulnerabilities of structures and the population to tropical cyclones such as *Veronica* and other hazards. The Community Preparedness Branch within the WA Government used AEIP to identify vulnerable communities and to tailor community engagement based on demographic information.

During the 2019–20 bushfire season, the number of exposure reports produced from the AEIP was in excess of 14,500 by more than 200 individual users from more than 90 organisations (August 2019 to March 2020). Users such as NSW Rural Fire Service have integrated the API with their own applications and are producing thousands of valuable reports each month, with particularly high use during the 2019–20 bushfire season.

Western Power, a WA-based energy provider, has been regular user of the platform with more than 700,000 reports created.

During a crisis, when demand for information to inform decisions is extremely high, the AEIP is at its most valuable. By speeding up the delivery of

IMPROVING THE RESILIENCE OF EXISTING HOUSING TO SEVERE WIND EVENTS

www.bnhcrc.com.au/research/housingresilience

Prof John Ginger
Dr David Henderson

JAMES COOK UNIVERSITY AUSTRALIA

NATURAL HAZARD EXPOSURE INFORMATION MODELLING FRAMEWORK

www.bnhcrc.com.au/research/hazardexposure

Dr Krishna Nadimpalli
Russell Hay

Australian Government
Geoscience Australia

vital exposure information in an automated format, its nationally consistent and accessible approach to data ensures that information and decision making across jurisdictional borders can be done in a way that is comparable and quantifiable.

AEIP in use

The figure above represents the aggregated use of AEIP web mapping between December 2019 and March 2020. The lines on this map show the areas that exposure reports were generated for. Exposure reports were generated for both small and large areas, covering all states and territories. Dark-blue areas show multiple AEIP queries, correlating with extreme weather events, for example the 2019–20 bushfires.

STRENGTH IN THE FACE OF HIGH WINDS

Most of the damage from cyclones and severe storms occurs to older houses, but much can be done to reduce this damage. Research through the *Improving the resilience of existing housing to severe wind* project, led by Prof John Ginger, Dr David Henderson and Dr Daniel Smith at the Cyclone Testing Station at James Cook University (JCU), has shown that improvements can be made that can strengthen houses to reduce damage, as well as save money through the reduction of insurance premiums.

To help homeowners make these improvements, the Queensland Government has created the Household Resilience Program based on findings from the research. The Program, which is available to Queensland home owners who reside in recognised cyclone risk areas in a home built prior to 1984, will provide a grant of up to 75 per cent of the cost of improvements, with a maximum of $11,250, allowing for the upgrade of the roof structure, protection of windows and strengthening doors – key areas at risk of damage during strong cyclonic winds.

The Household Resilience Program by the Queensland Department of Housing and Public Works took out the Government category at the 2019 Get Ready Queensland Resilient Australia Awards.

The insurance industry is also benefiting from the research, with Suncorp Insurance learning more about the vulnerability of the houses in northern Queensland, explained Jon Harwood from Suncorp. The insurance company knew that some types of houses built before 1980 were the most vulnerable to cyclones, as they were constructed before the building code was developed for cyclones, but they were surprised by the other findings generated by the study.

"What we were surprised about was the water ingress failures across all ages of houses, whether they were built to code or not," Jon said.

A majority of claims – 60 per cent – were due to a lack a preparation. These were small claims that could have been easily avoided if the appropriate mitigation action was taken before a cyclone.

The research recommended a range of retrofitting options that reduced the chances of damage occurring.

"The research gave us a clear evidence base to show that retrofitting and strengthening homes really has a great cost-benefit analysis," he said.

Suncorp took these research findings and created the Cyclone Resilience Benefit, which rewards homeowners who have undertaken work to strengthen their homes and reduce the chances of damage. More than 30,000 people have accessed the benefit, with the average saving on premiums $100. Some have saved over $400.

Queensland Fire and Emergency Services (QFES) is also benefitting from the study, using findings to improve the work of its rapid damage assessment teams, which operate after major disasters to collect

COST-EFFECTIVE MITIGATION STRATEGY FOR FLOOD PRONE BUILDINGS

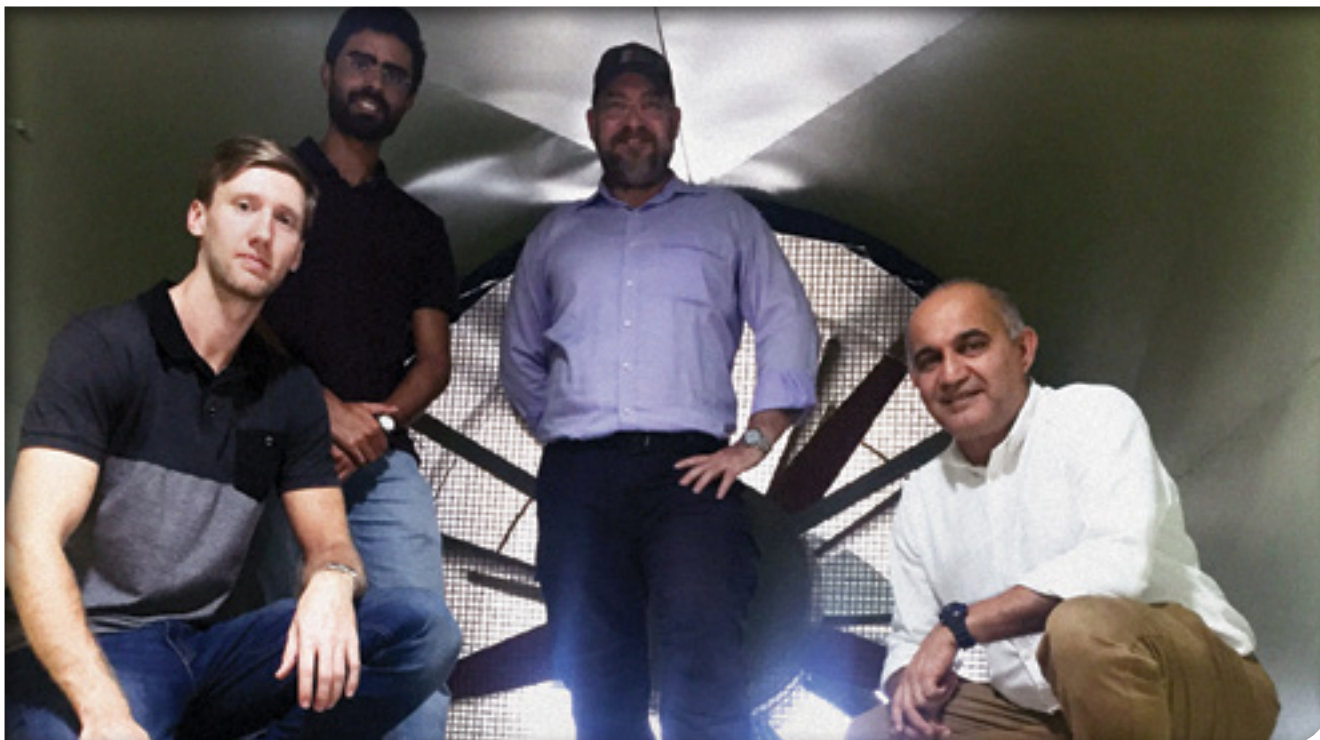www.bnhcrc.com.au/research/floodpronebuildings

Dr Ken Dale

ENHANCING RESILIENCE OF CRITICAL ROAD INFRASTRUCTURE

www.bnhcrc.com.au/research/roadinfrastructure

Prof Sujeeva Setunge

Wind tunnel tests at the Cyclone Testing Station at James Cook University has led to better advice on strengthening houses and other buildings in the face of high winds.

building damage data. This enables a focused and coordinated response, as well as better planning for event recovery. Specialist advice and lessons learnt are also provided by the team at pre-cyclone season briefings for emergency managers across Queensland to QFES, as well as other local, state and federal agencies.

Most recently, this research has contributed to a new website called Weather the Storm (www.weatherthestorm.com.au), based on the work of Dr Korah Parackal, one of the researchers for this project. Based at JCU's Cyclone Testing Station, Dr Parackal used his research on maintenance and retrofitting to develop the new website, which informs builders and homeowners about how to improve an existing home's key structural connections against extreme winds.

EARTHQUAKE – YORK CASE STUDY

By developing earthquake impact scenarios and an exposure database, the *Cost-effective mitigation strategy for building related earthquake risk* CRC project demonstrates the benefits in retrofitting a heritage listed town with buildings vulnerable to earthquake.

The project has informed the implementation of the retrofit activity in York, WA, through a succeeding project that is expected to refine a broader range of information to inform retrofit activity in other high risk communities across Australia.

Earthquake hazard was not fully recognised in Australian building design until the mid-1990s.

RESILIENCE TO CLUSTERED DISASTER EVENTS ON THE COAST – STORM SURGE

www.bnhcrc.com.au/research/stormsurge

Dr Scott Nichol

IMPROVING FLOOD FORECAST SKILL USING REMOTE SENSING DATA

www.bnhcrc.com.au/research/floodforecasting

A/Prof Valentijn Pauwels

MONASH University

CASE STUDIES

PROJECTS

This oversight has resulted in a legacy of vulnerable buildings that can be readily damaged in moderate to severe Australian earthquakes.

In particular, older unreinforced masonry buildings built with the architectural styles, materials and construction details used in the United Kingdom are particularly vulnerable. Australian earthquakes have highlighted the vulnerability of these building types. These include earthquakes in Adelaide 1954, Meckering 1968, Newcastle 1989 and Kalgoorlie 2010, all of which mostly damaged pre-WWII masonry buildings.

The proportion of the community building stock in this age and construction category can be quite significant in many low growth Australian regional towns and contribute disproportionately to the earthquake risk of a community. The damage to these buildings can also greatly add to emergency management logistics after a major earthquake and can impede the recovery of the community physically, economically and socially.

York is Western Australia's oldest inland town with many older masonry buildings that are particularly vulnerable to earthquakes. These legacy structures are greatly valued by the community and draw many visitors to the town, including those attending the large annual events hosted by York. They have great heritage value and many of the buildings are on the state and national heritage registers. The heritage precinct they create contributes significantly to York's economy, supporting the local businesses by the tourist spending they attract to the town. The risk posed by these buildings is exacerbated in York by the local seismic hazard, which is high compared to most other parts of Australia.

Understandably, improving the resilience of these buildings is of interest to property owners, the community, the Shire of York, the Western Australian Department of Fire and Emergency Services (DFES) and the WA Department of Planning, Lands and Heritage (DPLH).

This project developed a case study on the most effective means to address York's high risk buildings. It also sought to develop a better understanding of the logistics that would be faced by emergency services and the local shire council in a rare, but credible, earthquake event.

It also assessed the economic loss measures associated with human injury, contents losses, rental income, commercial property leasing, and business activity. It also included the application of the semi-intangible value placed on human life to society.

Benefits

Benefits have included reduced post event logistics for emergency management and the Shire, reducing financial losses to building owners, businesses, the Shire and the state, and reducing injuries and fatalities. It has also demonstrated that retrofitting reduces the long-term financial cost of earthquake hazard, thereby making risk transfer through insurance uptake more affordable.

The project developed a range of retrofit measures for a suite of six building types. These measures have been demonstrated to reduce the physical vulnerability of each building. The project also translated this vulnerability change into broader metrics that form an evidence base to inform decisions to retrofit.

The success of this project is greatly attributable to the alignment of six key factors. York has a high earthquake hazard by Australian standards, it has a high proportion of vulnerable masonry structures, the same structures are very valuable from a broader heritage perspective, the town's economy is highly dependent on the visitors attracted to York to enjoy the heritage appeal, the town hosts many large annual events centred in its heritage precinct and the local stakeholders have been highly engaged and motivated to understand and address this risk.

Denese Smythe, President of the Shire of York, noted these benefits. "The research from Geoscience Australia and the University of Adelaide in this Bushfire and Natural Hazards CRC earthquake mitigation study on six York building types is of immense benefit to the town. The results will not only be useful for York, they will enable the refinement and adaptation of the retrofit information for wider application to similar buildings elsewhere in the state and nation.

"It is a great example of what is possible when organisations work together for shared goals; to preserve life in natural disasters and preserve Australia's built heritage and the economies that depend on it."

IMPACT-BASED FORECASTING FOR THE COASTAL ZONE: EAST COAST LOWS

www.bnhcrc.com.au/research/coastalzoneforecasting

Dr Harald Richter

Australian Government
Bureau of Meteorology

COST-EFFECTIVE MITIGATION STRATEGY FOR BUILDING RELATED EARTHQUAKE RISK

www.bnhcrc.com.au/research/earthquakerisk

Prof Michael Griffith

THE UNIVERSITY of ADELAIDE

*Dr Alan Green conducting an experiment for his PhD on a sprinkler system to protect buildings from bushfire.
Photo: University of Wollongong*

FLOOD RISK MITIGATION ASSESSMENT FOR LAUNCESTON

www.bnhcrc.com.au/research/resilience-hazards/3289

Dr Tariq Maqsood

RMIT UNIVERSITY

QUANTIFYING CATASTROPHIC BUSHFIRE CONSEQUENCE

www.bnhcrc.com.au/research/resilience-hazards/4674

A/Prof Trent Penman

THE UNIVERSITY OF MELBOURNE

PROJECTS

MANAGING THE LANDSCAPE

> "The Prescribed Burning Atlas is a very significant accomplishment which will make a real contribution to the work of agencies and to the future safety of the community and its assets. It's a really great example of researchers responding to the needs of end-user fire management agencies to address a difficult problem.
>
> **NAOMI STEPHENS, PROGRAM DIRECTOR, FUTURE NPWS AT NATIONAL PARKS AND WILDLIFE SERVICE, BUSHFIRE AND NATURAL HAZARDS CRC DIRECTOR**

OVERVIEW

Landscape management uses prescribed burning and a range of other measures to mitigate the fire risk across different regions, not just in Australia but increasingly in fire-prone countries around the world. Bushfire and Natural Hazards CRC's research has built a firm quantitative basis for understanding and comparing the effectiveness of these measures.

Research shows that there is no one-size-fits-all solution to prescribed burning. This finding has major implications for fire managers who need to embrace tailored prescribed burning solutions, based on the unique risk mitigation profiles for their regions, including local fire regimes, climate zones, human settlements and land-use patterns.

Prescribed burning remains a critical component of contemporary fire management in Australia and elsewhere. Based on the research in this Managing the Landscape theme, we now have a quantitative basis for understanding and comparing the effectiveness of prescribed burning for mitigating risk across different landscapes.

Key project outputs have included tools now used by fire managers in the forest and grasslands of southern Australia as well as the tropical savanna landscapes across northern Australia.

TOOLS

AUSTRALIAN FLAMMABILITY MONITORING SYSTEM

is the first online mapping tool of its kind in Australia, using satellite data to provide a clear picture of dryness in the landscape. It collects near real-time information on moisture in vegetation and soil, and displays this information on an interactive map, which helps fire managers with prescribed burning efforts and prepositioning of resources.

PRESCRIBED BURNING ATLAS

assists and informs prescribed burning strategies so that land and fire managers can tailor their burning strategies to outcomes that will best reduce the risk in a target area within available budgets. It incorporates thousands of simulations to compare the level of risk reduction and cost of different prescribed burning techniques.

The Prescribed Burning Atlas showing the Blue Mountains area.

The Australian Flammability Monitoring System, showing flammability across Australia on 31 December 2019.

SATELLITES TO HELP SHOW WHEN THE BUSH IS READY TO BURN

Fire and land managers are benefiting from a new vegetation condition and flammability online mapping tool – the first of its kind to be introduced in Australia.

Effectively providing a clearer picture of immediate fire risks, the Australian Flammability Monitoring System uses satellite data to collect information on live moisture content in trees, shrubs and grass. It then displays this information on an interactive map, which helps fire managers in their prescribed burning efforts and prepositioning of firefighting resources.

Dr Marta Yebra at the Australian National University leads the *Mapping bushfire hazards and impacts* project, which has developed the Australian Flammability Monitoring System. As bushfires erupted along the east coast of Australia in November 2019, Marta was in the State Operations Centre at the New South Wales Rural Fire Service, working closely alongside fire behaviour analysts.

"Our research is being used here by the RFS to make informed decisions about where a fire may spread, and what areas should be prioritised when sending resources and equipment," Marta said while working at the operations centre.

NSW Rural Fire Service Senior Fire Behaviour Analyst Laurence McCoy said Dr Yebra had been important in validating their predictions. "From our perspective, statewide there has been recent patchy rainfall and it is sites like Marta's that help us to actually detect the risk, or give us more detailed analysis in terms of the effect of that rainfall," Mr McCoy said. He said satellite technology was important for their situational awareness and understanding of fire escalation. "In our unit in particular, we've got a significant appetite for the use of new technology and new research."

FIRE SURVEILLANCE AND HAZARD MAPPING

www.bnhcrc.com.au/research/firesurveillance

Prof Simon Jones
Dr Karin Reinke

RMIT UNIVERSITY

OPTIMISATION OF FUEL REDUCTION BURNING REGIMES

www.bnhcrc.com.au/research/fuelreduction

A/Prof Tina Bell

THE UNIVERSITY OF SYDNEY

MANAGING THE LANDSCAPE

Different filters and settings on the system give emergency services and land management agencies a new way to help evaluate the risk of a bushfire occurring in certain parts of the country, based on the dryness of soil and fuels and the flammability of vegetation. The system uses satellite data to provide a clear picture of the landscape where there are high levels of vegetation and soil dryness, which are the perfect conditions for a severe bushfire.

The cutting-edge technology was recognised with the Outstanding Achievement in Research Utilisation Award from the CRC in 2019.

The algorithm to calculate satellite-derived fuel moisture content has also been implemented in the emissions assessment and smoke-dispersion module of the European Commission's Forest Fire Information System, which provides the European Commission and the European Parliament with updated and reliable information about wildland fires on the continent.

The product has also been evaluated and used in South Africa, Argentina, Italy, the United States, and China.

The Australian Flammability Monitoring System is not only useful when bushfires are raging, but also in the cooler months to inform prescribed burning strategies. The data available through the system is invaluable to fire and land management agencies, explains Dr Adam Leavesley, the Bushfire Research Utilisation Manager at ACT Parks and Conservation Service.

"Fire managers across Australia need to understand when our landscape is in a position that is either not going to burn, burn in a way that will allow us to control a fire, or when conditions are so dry that if a fire starts it will be very dangerous and difficult to control," Dr Leavesley says.

"The Australian Flammability Monitoring System gives us a really good guide across the whole country to how we expect fire to behave on any particular day. This helps agencies position resources during a bushfire, keeping our people safe, and

Prescribed burning being conducted at Mount Dandenong, Victoria, in 2021. Photo: Zahlia Ligthart

SCENARIO PLANNING FOR REMOTE COMMUNITY RISK MANAGEMENT IN NORTHERN AUSTRALIA

www.bnhcrc.com.au/research/firemanagement

Adj Prof Jeremy Russell-Smith

CHARLES DARWIN UNIVERSITY

FROM HECTARES TO TAILOR MADE SOLUTIONS FOR RISK MITIGATION

www.bnhcrc.com.au/research/riskmitigationsolutions

Prof Ross Bradstock

UNIVERSITY OF WOLLONGONG AUSTRALIA

also with prescribed burn planning, particularly in mountainous locations where flammability changes depending on which side of a mountain you are on.

"It has been an amazing partnership with the research team. It is great quality science from a team that is driven by wanting to see their work make an impact – that has been the key to getting us to this stage."

Access the Australian Flammability Monitoring System at http://anuwald.science/afms

CARBON ABATEMENT THROUGH BETTER FIRE MAPPING

Australia's tropical savannas are extremely fire prone, with many millions of hectares burnt every year, contributing greatly to Australia's greenhouse gas emissions.

Sophisticated fire mapping and modelling of fire severity, undertaken by the *Scenario planning for remote community risk management in northern Australia* team, led by Adjunct Prof Jeremy Russell-Smith and Dr Andrew Edwards at Charles Darwin University, is helping fire and land managers assess greenhouse gas emissions and develop carbon abatement plans.

Previously, fire seasonality was used to calculate emissions, fires occurring in the latter part of the northern fire season (after 31 July) releasing double the CO_2 emissions into the atmosphere than fires occurring early in the dry season. Although this calculation is based on years of data, the research team developed a new greenhouse gas emissions abatement methodology, using actual fire effect, leading to improved accuracy of the calculations of greenhouse gas emissions.

Another important tool, the Savanna Monitoring and Evaluation Reporting Framework, provides users with the ability to monitor their fire management and evaluate its effects, providing a single standardised reporting system to assess and compare the outcomes of fire management across 70 per cent of the continent.

Information from the reports is used to apply local, ecological and traditional knowledge to improve biodiversity and landscape management. The savanna-wide web-based software enables land and fire managers to generate reports on all national parks, with plans to expand into all properties in northern Australia.

With the emergence of new industries such as carbon farming, which was officially recognised as an industry by the Northern Territory Government in October 2018, and the influence of climate change, bushfire management is rapidly changing in northern Australia, requiring decisions to be prioritised based on risk, and detailed mapping to support these decisions. With such large areas to cover, web-based mapping is fundamental to better improving these land management practices.

Andrew Turner, Director of Strategic Services at Bushfires NT, says the organisation uses the savanna mapping tools daily.

"They are crucial to all aspects of fire management – planning, mitigation, suppression, monitoring, and evaluation and reporting," Andrew says.

Currently northern Australia is generating over $30 million annually in this new carbon burning sector, on over 300,000 km^2, still only 40 per cent of the potential extent for these savanna burning projects. The fire severity mapping process developed by this research is an integral part of the process of improving the methodology, and has only been possible through the extensive collaboration process undertaken with other researchers from across Australia and around the world.

A firefighter undertakes prescribed burning to reduce flammable vegetation on the outskirts of Darwin.

POLICY, POLITICAL ENGAGEMENT AND INFLUENCE

> "Inquiry recommendations get lost or distorted over time, and so having a place where practitioners can find and search the actual text of inquiry recommendations will help with understanding the past in order to keep learning for the future. Post-event inquiries are only helpful if their recommendations are available and not forgotten. Bringing together the lessons from past events will help practitioners identify trends and recurring themes and ensure the lessons of the past are not forgotten."

A/PROF MICHAEL EBURN, AUSTRALIAN NATIONAL UNIVERSITY

OVERVIEW

Research that makes policy recommendations or provides data for decision makers is one voice in the cacophony of noise and information that has an actual influence on policy.

While some Bushfire and Natural Hazards CRC research has produced tangible useable items where impact and uptake are more straightforward, research utilisation in this theme of Policy, Political Engagement and Influence can be less tangible and, therefore, difficult to measure for success.

Many researchers and emergency managers may agree on priorities and outputs of research, but the decision to use this research is made by governments, ministers or appointed commissioners who create policy.

Policy affecting emergency management is made across a broad range of portfolios, from planning and land use, to building standards, infrastructure, transport, communications, justice and more. Research findings, although important, are only one consideration.

To support decision makers, this research theme has produced an index on national disaster resilience, a database of historical inquiries, modelling software for urban and infrastructure planners, disaster scenario planning, public information guides, a framework to understand risk ownership in the community, and legal and policy options for governments at all levels.

TOOLS

DIVERSITY AND INCLUSION FRAMEWORK FOR EMERGENCY MANAGEMENT POLICY AND PRACTICE

was designed to help the emergency management sector develop greater understanding of the implementation process and role of inclusion, identification of structures and practices to support that implementation, and possible mechanisms that address a lack of diversity and inclusion.

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PROJECTS

CATASTROPHIC AND CASCADING EVENTS: PLANNING AND CAPABILITY

www.bnhcrc.com.au/research/catastrophic

Andrew Gissing

RISK FRONTIERS

SHARING THE RISK

Assessing risk ownership for managing natural hazards is complicated, particularly as natural hazard risks can resonate across long timeframes and have multiple organisations responsible. But research is helping government and emergency management agencies identify and allocate ownership of risks, how risk owners are responsible, and what they can do to manage them.

Through the *Mapping and understanding bushfire and natural hazard vulnerability and risks at the institutional scale* project, led by Prof Roger Jones and Celeste Young at Victoria University, a framework has been developed to support better allocation of risk ownership as part of strategic planning and risk assessment activities.

Developed in consultation with CRC partners, the Risk Ownership Framework for Emergency Management Policy and Practice uses a values–based approach to provide a starting point for understanding and clarifying risk ownership as part of strategic risk planning and assessment activities.

Emergency Management Victoria (EMV) has incorporated key elements of the framework into the emergency risk assessment process that is used to assess emergency risks across the state, enhancing emergency risk management activities. Applicable to the all communities/all hazards model, the research has provided clarity for shared responsibility as an important element of managing risks, providing EMV with a method for identifying disparate risk owners at different stages, beyond the agencies that have traditional emergency management roles.

This means that the research is helping to guide priority projects and programs for risk mitigation.

The research is also being referenced at the federal level, informing disaster policy work for Emergency Management Australia, and changing the way that people think about risk ownership.

Key elements of the process have been mapped to the risk assessment process in the National Emergency Risk Assessment Guidelines. Greater application of the risk ownership process is expected if the key concepts of the research are integrated into the guidelines, or published as a companion document.

The team has also worked as part of a collaborative partnership with the National Resilience Task Force, part of the Commonwealth Department of Home Affairs, contributing to the Australian Vulnerability Profile, alongside conducting a policy briefing for the Commonwealth Department of Environment.

MAJOR POST-EVENT INQUIRIES AND REVIEWS: REVIEW OF RECOMMENDATIONS

www.bnhcrc.com.au/research/policy-and-economics-hazards/3928

Martijn Gough

AITHER

URBAN PLANNING FOR NATURAL HAZARD MITIGATION

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A/Prof Michael Eburn

Australian National University

MAPPING AND UNDERSTANDING BUSHFIRE AND NATURAL HAZARD VULNERABILITY AND RISKS AT THE INSTITUTIONAL SCALE

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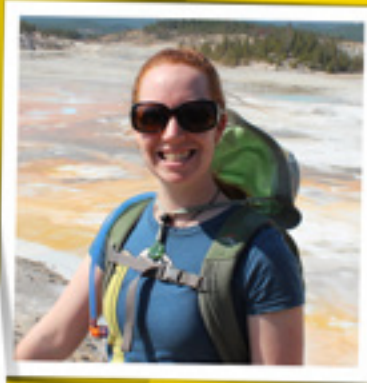
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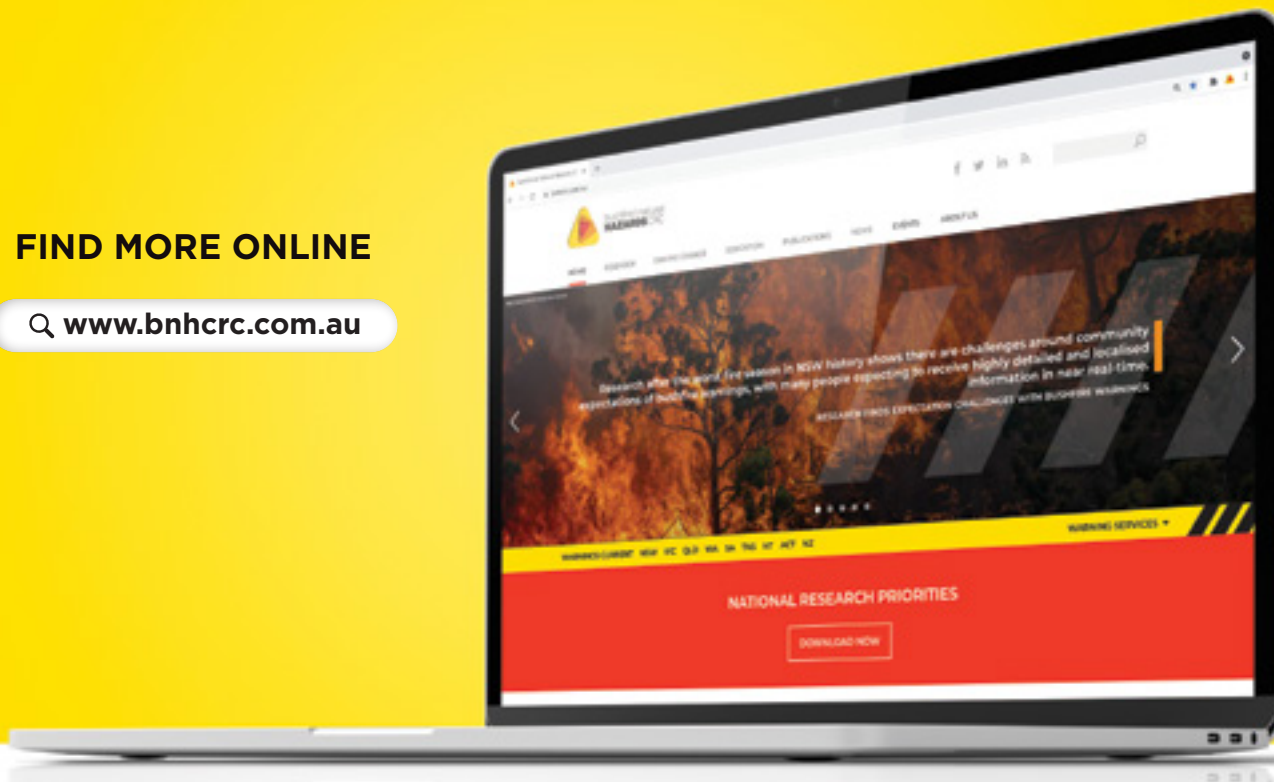
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Photo: Emma Singh

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