



bushfire&natural
HAZARDSCRC

HIGHLIGHTS AND ACHIEVEMENTS

+ a year in review 2017-2018



Australian Government
Department of Industry,
Innovation and Science

Business

Cooperative Research
Centres Programme

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Bushfire and Natural Hazards CRC Report 2018:429
December 2018



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*Prof Vivienne Tippett, Queensland University of Technology,
speaking at Science at the Shine Dome 2018. Photo: Australian
Academy of Science*

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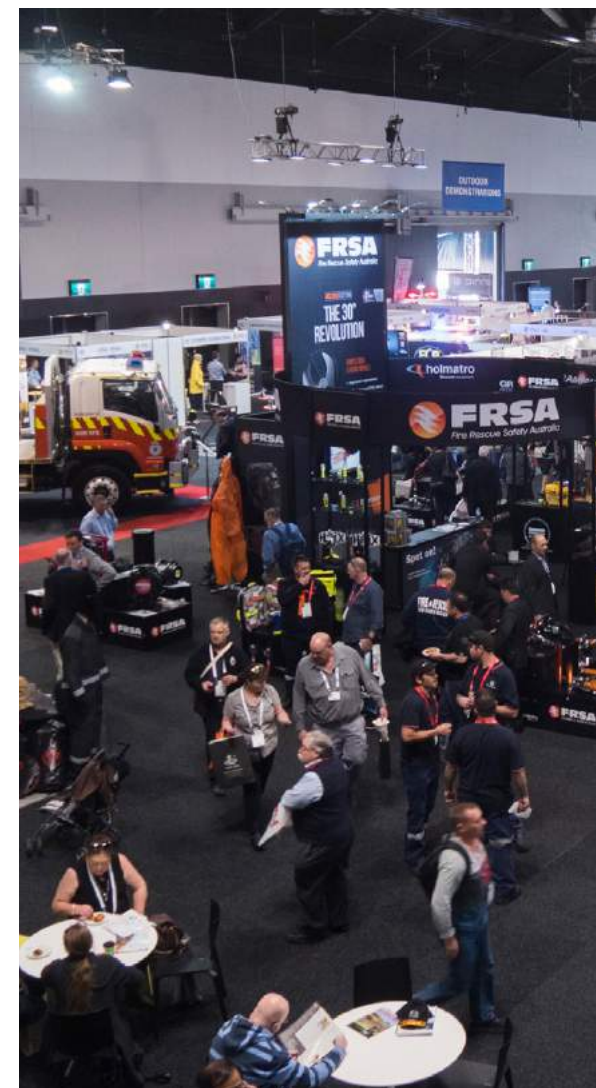


Dr Adam Leavesley, ACT Parks and Conservation Service, speaking at our annual conference.



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Our annual conference was attended by a record 189 exhibitors, a majority of which were small-to-medium enterprises.

BUSHFIRE AND NATURAL HAZARDS CRC: 2013-2018

A RESEARCH PROGRAM FOR BUSHFIRE AND NATURAL HAZARDS

In late 2013, the Bushfire and Natural Hazards Cooperative Research Centre was launched at Parliament House, Canberra, with high expectations and widespread support.

Then Minister for Justice, the Hon Michael Keenan declared that the new \$130 million research centre would draw together all of Australasia's fire and emergency service authorities with the nation's leading experts across a wide range of scientific fields to explore the causes, consequences and mitigation of natural disasters

In July 2017, the CRC and its partners gathered in Adelaide for Research Driving Change – Showcase 2017. That event celebrated the achievements of the first four years, and acknowledging the many practical uses of the research; by CRC partners and by others.

This publication captures the highlights and achievements of the CRC to date - as well as a review of 2017-2018 - activities that aim to save lives and reduce disaster-related costs.

Our vision is to be the preferred and trusted source of research and knowledge in bushfire and natural hazards.

National research

The CRC is conducting research to build a disaster-resilient Australia.

Across all natural hazards

The CRC coordinates a national research effort in hazards, including bushfires, flood, storm, cyclone, heatwave, earthquake and tsunamis.

Developed by members

The research program has been developed and delivered under the direction of the researchers and end-user agencies.



Field research after major hazards has led to new insights for partner agencies.

To be used by our members

Now in our fifth year of operation, researchers and end-user partners are working closely together to ensure that the research is embedded into the planning, policies and operations of partner organisations, and into the development of new research projects.

For the benefit of the Australian community

The centre draws together all of Australia and New Zealand's fire and emergency service authorities with the leading experts across a range of scientific fields to explore the causes, consequences and mitigation of natural disasters. This combined effort is helping to build disaster resilient communities.



2013-2018

ABOUT US

The CRC conducts a multi-disciplinary research program on the major national issues across the natural hazards spectrum. The CRC is a partnership of all Australian and New Zealand fire, land and emergency service agencies; more than 30 universities; plus many federal, state and local government departments; professional and volunteer associations; and, non-for-profit organisations.

From mid-2013 and backed with \$47 million over eight years from the Australian Government, plus contributions from its member organisations, the CRC has been undertaking research that supports the development of cohesive, evidence-based policies, strategies and programs to build a more disaster resilient Australia.

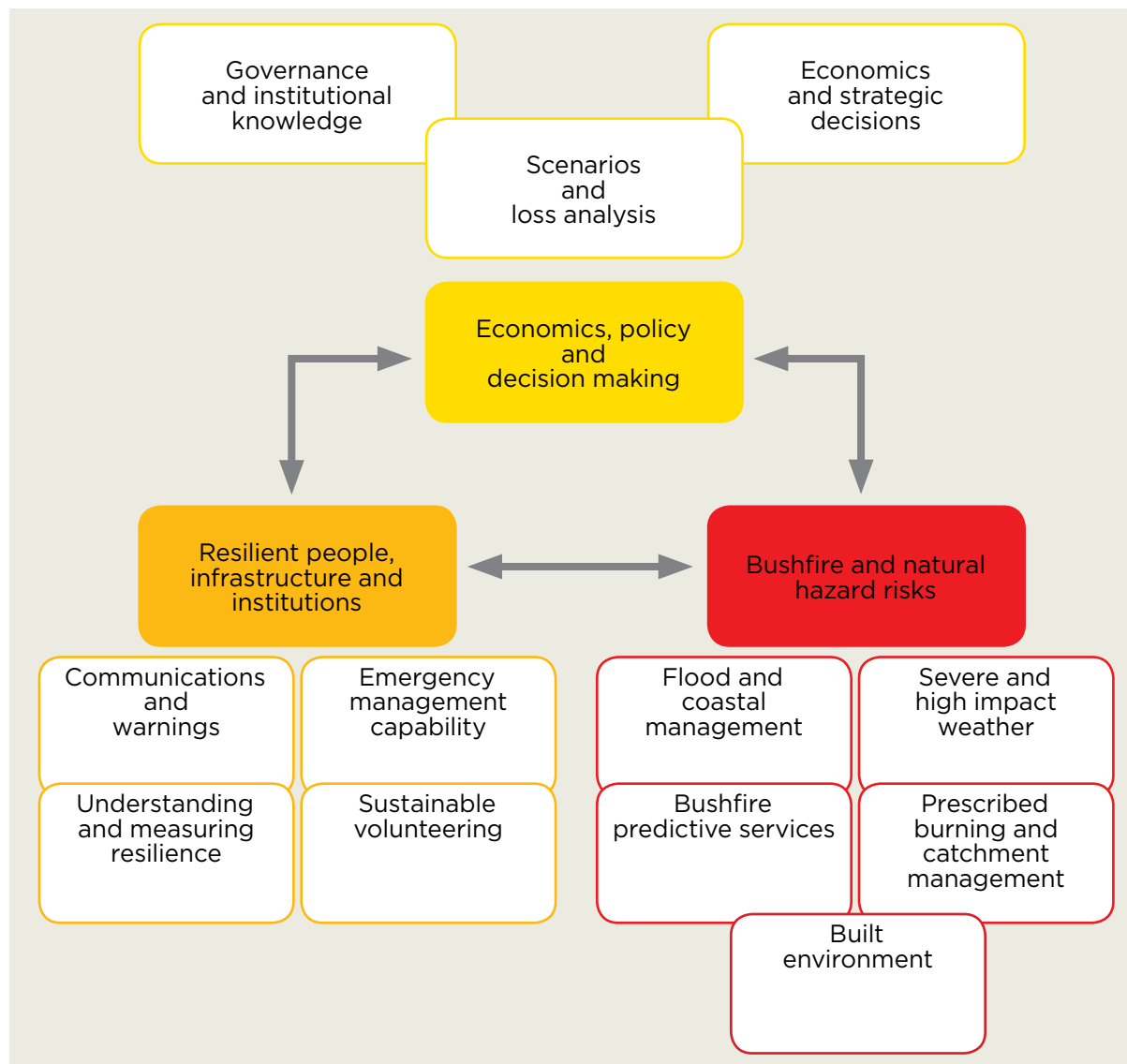
The CRC is providing a long-term knowledge base that directly supports emergency services and other government and non-government agencies protect their communities through work to prevent, prepare for, respond to and recover from natural disasters.

The CRC is end-user driven. This means that users of the knowledge define and are involved in the ongoing development of the research program so that the work is conducted with a clear end use in mind.

The utilisation of the research by the end-users to the benefit of the broader Australian community is critical to the whole process.

The research program comprises three broad themes, covering 12 clusters of projects, most of which span the priorities for those working in a multi-hazard environment. The themes are:

- Economics, policy and decision making.
- Resilient people, infrastructure and institutions.
- Bushfire and natural hazard risks.



A COLLECTIVE APPROACH



Dr Richard Thornton
Chief Executive Officer
Bushfire and Natural Hazards CRC

Research outcomes across the natural hazards have become vital to emergency services agencies, government departments and others within the sector. At the Bushfire and Natural Hazards CRC we have contributed strongly to this national demand by driving a collective approach to natural hazards science based on the requirements of our partners. In this publication the CRC looks back, forward and beyond to see how our research is making a difference for all to see.

We will continue to deliver our research benefits for the sector because the economic and social costs of disasters in Australia and New Zealand is continuing to increase. The need for an evidence base relevant to the challenges we face both now, and in the future, is constant. Collectively, we must all continue to ask the important questions. The future is not just a linear extension of what we know now.

Together with our partners, we are working towards a more disaster resilient Australia. This is your natural hazards research centre. We hope you will help us deliver for the community through your active involvement in the research.

On a sad note, our founding Chairman Dr Laurie Hammond passed away in November 2018 after a short battle with illness. Laurie was integral to the growth and development of the centre. His leadership at the Board level and his strategic advice to management was always insightful, timely and welcomed.

Laurie will be sadly missed by all of us here at the Bushfire and Natural Hazards CRC, and by his colleagues across the emergency services and management sector.



The CRC draws together all of Australasia's fire and emergency services with the nation's leading experts from a range of scientific fields. Photo: New South Wales State Emergency Service.



2013-2018



Twice-yearly Research Advisory Forums, such as this one in Hobart, are an opportunity for project teams to discuss progress and any issues.

A REVIEW OF THE FIRST FIVE YEARS

Research Driving Change - Showcase 2017 (Adelaide, July 2017) was an opportunity to listen, discuss and digest the learnings from the CRC. Case studies from those using the research highlighted how the findings are being put into practice.

CRC AIMS

The CRC was established to conduct end-user inspired, high-quality applied research.

The CRC was created with a mission to:

- Reduce the risks from bushfire and natural hazards.
- Reduce the social, economic and environmental costs of disasters.
- Contribute to the national disaster resilience agenda.

- Build internationally renowned Australian research capacity and capability.

CRC ACTIONS

This publication showcases the successes that demonstrate the CRC is delivering on the promises made.

The CRC has created:

Collective strength

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.

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 and activities, and publications.

Research loop

The business of the CRC is 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.

People capacity

With the creation of new knowledge through research, the CRC develops the skills and knowledge of partners, researchers, students, and the community.

Research in use

This is the final step - when the CRC harnesses its collective strength, creates a forum for knowledge, and manages the research loop, then it will have developed a capacity in its people (both researcher and agency personnel) to deliver research that is relevant, accessible and ready to be used.

COLLECTIVE STRENGTH

The strength of the CRC lays in its collective nature. As a cooperative research centre, the CRC is a collection of people and individual organisations, that bring a range of values to the whole. The CRC operates as a hub, creating bridges that link disparate and diverse groups together in a network focused on innovation.

With more than 250 researchers and 250 agency staff in Australia and internationally directly involved in the research projects - with many more indirectly involved - the collective strength is an efficient and effective way to advance the science of natural hazards.

The CRC provides a research capacity that is not feasible at the individual state or territory or agency level, nor with any one university or research organisation. Core funding through the Australian Government's CRC Programme combined with contributions from all partners (cash and in-kind) creates a pool of resources large enough to tackle research questions at the national scale.

With the resources pooled and the research outcomes shared, the return on the investment for any individual partner is significantly better than if it was to pursue the research aims alone.

This pooled investment in the CRC is also being leveraged in other 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 mostly conducted in collaboration with organisations that are major representative stakeholders, including AFAC groups and networks, the Bureau of Meteorology, and fire and emergency service agencies, plus other relevant community and industry groups.

The purpose of the workshops was to identify the



The priorities for national hazards research were presented to partners at the CRC Showcase in July 2017 in Adelaide.

critical national issues that could be addressed by research. Those issues will influence the future research program of the CRC and other research groups in the sector.

The outcome of the workshops was the publication of a national natural hazards emergency management research priorities statement *Issues, Priorities, Directions* (published in 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 the Attorney-General's Department. The new Institute was formed to deliver products and services around Australia that have been developed by, and for, the broad emergency management sector. The CRC has taken the lead role in the Institute's *Australian Journal of Emergency Management*.

United Nations International Strategy for Disaster Reduction

The CRC is 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



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sponsored by the United Nations International Strategy for Disaster Reduction, the International Council for Science and the International Social Science Council.

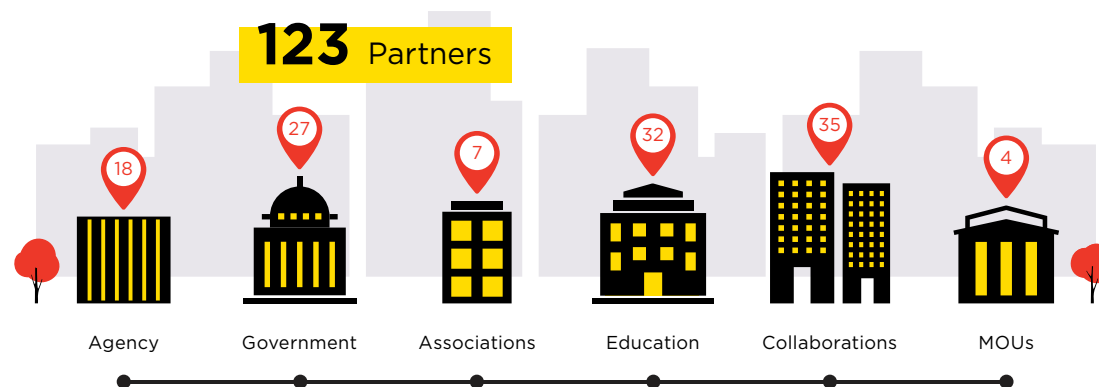
Through this arrangement there are many opportunities for the CRC to align its projects with the international disaster risk reduction strategy. Researcher Prof Kevin Ronan represented the CRC at several IRDR workshops and meetings on the implementation of the Sendai Framework for Disaster Risk Reduction. Researcher Prof John Handmer is on 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.

Since 2014, the CRC has observed the International Day for Disaster Reduction on 13 October, with public panel discussions supported by the Attorney-General's Department. These events have been in Canberra with the Australian National University (2014), in Perth with the University of Western Australia and the Office of Emergency Management (2015), in Melbourne with RMIT University (2016), and in Sydney with the NSW Rural Fire Service, Office of Emergency Management and Risk Frontiers (2017). The sessions featured panels of speakers from a range of partners who explored Australia's contribution to natural disaster risk reduction at home and in our region.

International research

Natural hazards research findings are exchanged between Australia and New Zealand under an agreement signed between the CRC and the New Zealand Natural Hazards Research Platform.

The CRC also has Memoranda of Understanding with the US Forest Service, Association for the Development of the Industrial Aerodynamics (ADAI, Portugal), and the Coastal Resilience Centre of Excellence, University of North Carolina.



Fire managers from across northern Australia gather each year to discuss regional issues - in June 2017 the CRC hosted the meeting in Kununurra.

A FORUM FOR KNOWLEDGE

The CRC is a forum to learn, and to share knowledge.

The national network of partners has created a lively forum for discussion, ideas, problems, issues, questions, answers and debate. The new knowledge is benchmarked, compared and measured.

The benefits are mutual. All partners have access to all research outputs and contribute to the development of new research projects based on their own needs.

Knowledge and learning is at the core of our 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, is a key part of advancing the research of the CRC.

The aim of all this activity is 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

The CRC and AFAC co-host the annual conference in a capital city each September, along with the partner organisations from that state. The CRC is prominent throughout the conference and in particular at the opening day Research Forum, which has attracted as many as 460 participants at a single event and more than 1500 combined. The full conference attracts up to 3200 people and the CRC has a prominent display in the exhibition hall. Annual conferences with the CRC have been in Wellington (2014), Adelaide (2015), Brisbane (2016), Sydney (2017) and Perth (2018).

Research Advisory Forum

Held in Queensland, New South Wales, the ACT, Victoria, Tasmania, South Australia and Western Australia over the last four years, these two-day events

11,794 followers on social media

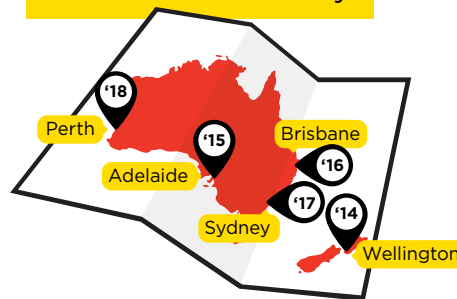


5,029 likes

4,629 tweets

2,136 followers

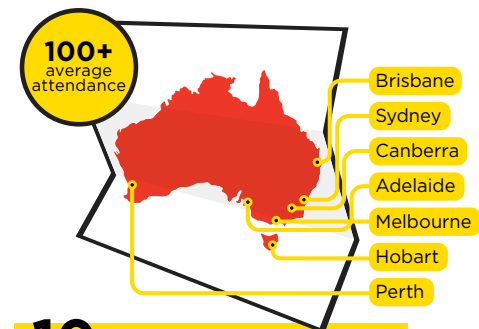
1953 Attendees @ Research Forum Day



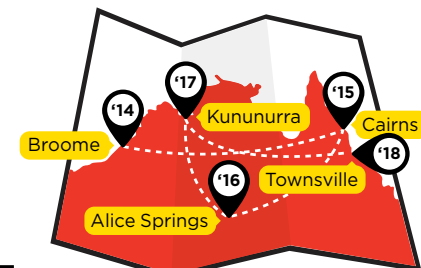
take place twice a year, providing the opportunity for CRC partners, project leaders and end-users to gain a complete overview of all the research activities within the CRC and participate in workshops to shape project research and utilisation directions.

Fire managers forums

These forums include participation from AFAC, the Bureau of Meteorology, many universities and all fire and land management agencies across the regions



10 Research Advisory Forums



5 North Australia Fire Managers Forums

to discuss issues of local and national relevance. The national Bushfire Seasonal Outlooks are formulated and released in conjunction with these forums. These outlooks are used by fire and emergency service agencies to work with state and federal governments to prepare resources for the bushfire season.

Disaster networks

The CRC is a key partner in the annual Australian and New Zealand Disaster and Emergency Management



2013-2018



conference in Queensland, the Emergency Management Conference in Victoria, and the biannual Australasian Natural Hazards Management conference. It takes 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 service regional conferences in NSW, Queensland, South Australia, Western Australia, Tasmania and Victoria.

Outputs for industry, community

A range of products has been developed to suit the needs of the CRC partners and the public

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 SES units, and regional councils. They are also shared more widely on social media. *Hazard Notes* are produced regularly with 57 currently available. The same email distribution list receives the monthly newsletter *Hazard News*.

The Australian Journal of Emergency Management is a CRC-led initiative out of the partnership in 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. The Journal follows a double-blind refereeing process for research articles undergoing peer review.

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.

Working with industry

The CRC has extensive engagement activities with the broader industry including small-to-medium enterprises and large corporations.

Industry engagement highlights include:

- The CRC annual conference with AFAC and Hannover Fairs Australia features a trade exhibition with up to 190 exhibitors from the fire and emergency services and related industries, the majority of which are small-to-medium enterprises active in both Australia and New Zealand. The conferences also attract significant corporate sponsorship, including long-term sponsor relationships with global vehicle manufacturers Scania, Hino and Isuzu, and fire equipment suppliers Dräger, Motorola and Gaam.
- The Fire Protection Association Australia (FPAA), which represents more than 6000 SMEs, is a contributing member of the CRC and actively promotes CRC research to its members through *Fire Australia*, the FPAA newsletter and social media, and conferences.
- Insurance and power industry representatives are regular attendees at CRC events, particularly at Research Advisory Forums and at the annual conference.

IN THE MEDIA

The CRC is frequently sought out for comment by a range of national, international and regional media. Through the CEO and through experts across many disciplines, the CRC is well positioned to provide media comment that supports our agency partners.

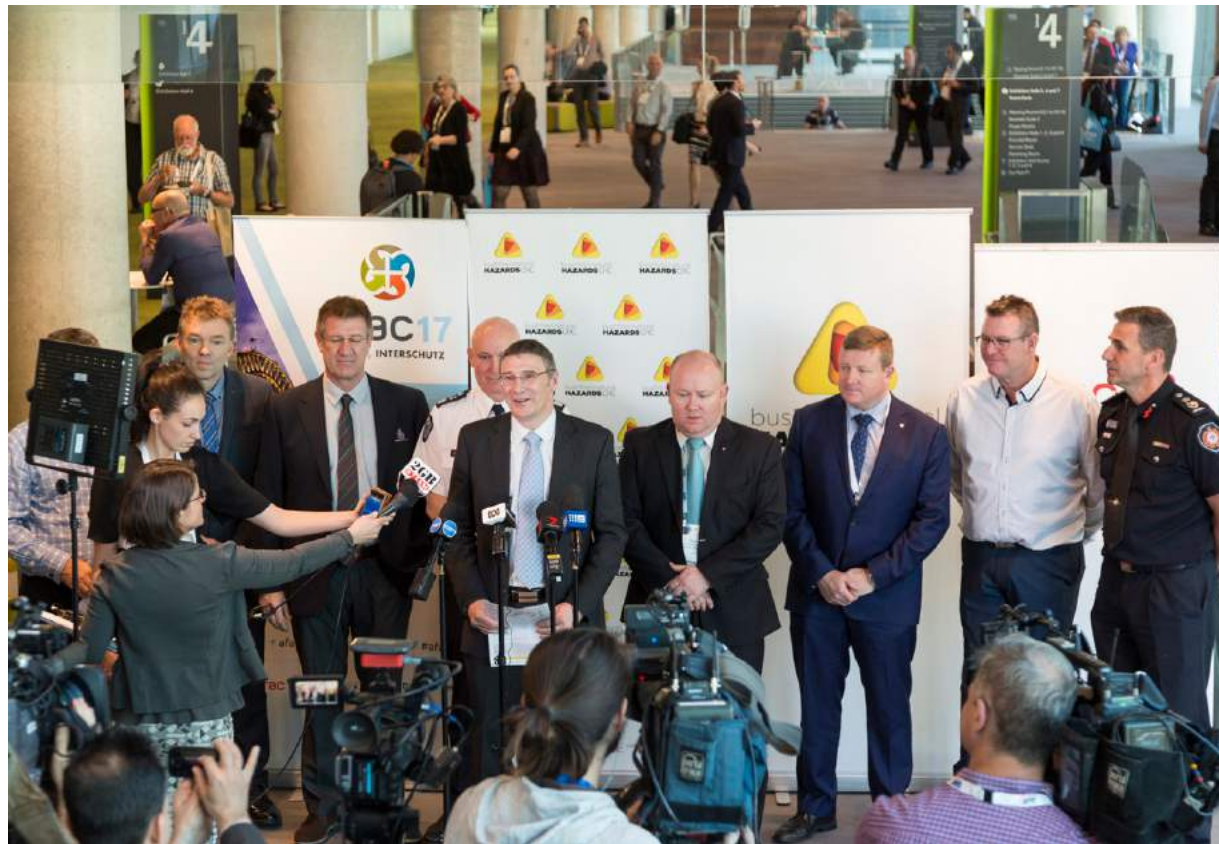
As an Affiliate Partner of the Australian Science Media Centre, the CRC is a key supporter of the promotion of Australian science. This partnership also places the CRC's natural hazard research in prominent view of science journalists around Australia and internationally. Many international media frequently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

Coverage in traditional media is amplified through the social media channels of the media, and the CRC and its partners. The CRC is active on Facebook, Twitter and LinkedIn, with a growing list of followers on each platform. Social media is an important channel to reach individuals and groups in addition to the regular CRC networks, including regional communities, volunteer brigades and units, local government, politicians, and international researchers.

Peak times centre around the CRC's *Seasonal Bushfire Outlooks* for southern and northern Australia, the Research Forum and annual conference, and major hazard events (prominently bushfires, floods and cyclones over summer).

Staff connections

The CEO is a member of the National Flood Risk Advisory Group, a sub-group of COAG's Australian and New Zealand Emergency Management Committee, which reports to the Law, Crime and Community Safety Ministerial Council. He is a member of the Forest Fire Management Group, a committee of Australian and New Zealand forest management agencies reporting to the Forest



The release of the annual Southern Australia Seasonal Bushfire Outlook each September is a peak time for media interest in the CRC.

Products Committee of COAG; a member of the International Science Advisory Group for the New Zealand Resilience to Nature's Challenges Centre; a member of the Victoria University Industry Advisory Board for the Centre for Environmental Safety and Risk Engineering (CESARE); a member of the CRC Association Board; and a member of the editorial advisory board of the *International Journal of*

Wildland Fire. He also reviews scientific papers for several international journals.

The Research Director is Editor-in-chief of the *Australian Journal of Emergency Management*.

The Communications Director is a Board member on the International Association of Wildland Fire and is Chair of the Editorial Advisory Committee for its magazine *Wildfire*.



2013-2018



Emergency service leaders talking about the future of natural hazards research at Research Driving Change - Showcase 2017.

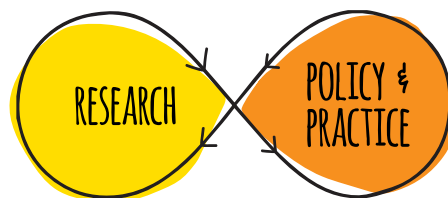
RESEARCH LOOP

The CRC ensures that the research both informs practice, and that the practice informs the ongoing and new research.

Integrated project teams of researchers and end-users are in place for every project to ensure the projects are informed by, and remain focused on, the needs of the partner organisations. Ongoing and active engagement between researchers and end-users is crucial to the success of each project.

End-user representatives on each project provide essential input:

- Framing and 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 are from across:

- All states and territories.
- All fire, land and emergency service agencies.
- All types of participants, including policy departments, operational agencies and non-government organisations.

The most visible example of this process is in the twice-yearly Research Advisory Forum. Research Advisory Forums were held in Perth and Melbourne in 2017, in Hobart and Canberra in 2016, Sydney and Brisbane in 2015, and Adelaide and Melbourne in 2014.

These two-day gatherings provide 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.

Many of the integrated project teams also held regular workshops and teleconferences and made use of opportunities to meet informally at conferences and other events to maintain ongoing project communication.

Science advice

The CRC International Science Advisory Panel, which provides strategic advice and review of the research program to the Board of the CRC, is chaired by Prof Carmen Lawrence of the University of Western Australia and includes 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.

CAPACITY OF PEOPLE

The CRC is building and maintaining 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 250 people across our 50 partner agencies have been involved in the concept development and ongoing engagement within the projects. The research has been in use right from the start with a seamless transition from the phase of data-gathering into utilisation.

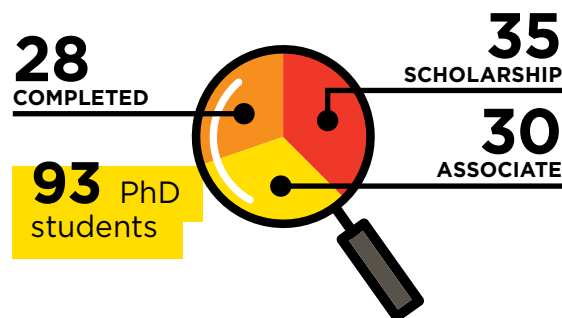
The integrated research project teams of end-users and researchers has created a capacity and capability in each group, and therefore within each partner agency, even as the individuals within these groups have changed over the four years of the CRC.

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

In addition, the CRC is building this capacity with a new cohort of researchers at the postgraduate level working on natural hazards science. Four years into the program, the CRC has 93 PhD students, (35 scholarship, 28 completed, 30 associate) more than doubling its initial target of providing support to 34 PhD students for the full life of the CRC.

FURTHER CAPACITY BUILDING

The CRC conducts research in addition to the science funded through the Cooperative Research Centres Programme. This complementary research is undertaken through consultancies and other programs.



Commissioned research

The CRC is conducting research on a consultancy basis, mainly with its existing partners.

The Victorian Department of Environment, Land, Water and Planning further extended its contract research program that began with the Bushfire CRC, across several 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. To date, community-focused research has been undertaken after major bushfires in New South Wales in 2013 and 2017, South Australia in 2014 and 2015, and Western Australia in 2014. Partners benefiting from this research are the NSW Rural Fire Service, Country Fire Service South Australia and the Department of Fire and Emergency Services Western Australia.

Fire and Rescue NSW also received additional insight into the effectiveness of equipment and training provided to their Community Fire Units during the Blue Mountains bushfires in 2013.

Queensland Fire and Emergency Services sought out the CRC to provide advice on how 2015's Severe Tropical Cyclone *Marcia* would impact vegetation for the following fire season and beyond. More recently, QFES asked the CRC to lead a review of incident management activities after Severe

Tropical Cyclone *Debbie* in March 2017. It is envisaged that this research could inform future operations and policy.

The Office of Bushfire Risk Management on behalf of State Emergency Management Committee (now Office of Emergency Management) for Western Australia requested a review into the 2015 Lower Hotham Block and O'Sullivan Block fires.

The CRC was also engaged to review traffic management policy in Western Australia for the Office of Emergency Management.

Tactical Research Fund

This fund began in 2017 to encourage the development of short duration research projects meeting near term needs of end-user partners. These short-term funded projects address strategic issues of national significance.

Research is being 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, and issues with building cladding and firefighting foam.

End-user partners benefiting from this work include AFAC, the Metropolitan Fire Brigade Melbourne and Emergency Management Victoria.

Funds for quick response

Support is provided for researchers to travel to areas affected by natural disasters, ensuring that the impacts and perishable data are captured in a timely manner. This can help to identify significant research questions arising from major natural hazards and provide a context for developing more extensive research proposals.

The impact of heatwaves in the NSW Northern Rivers region, as well as western Sydney, and how the June 2016 East Coast Low affected the homeless, are examples of how the funds have been used, with reports available on the CRC website.



2013-2018



Dr Marta Yebra, the Australian National University, in the field with the project on mapping bushfire hazards and impacts. Photo: Carolina Luiz

RESEARCH IN USE

ACHIEVEMENTS AND OUTCOMES

Over the first four 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 International Science Advisory Panel, the research program was mapped for progress of utilisation opportunities and to develop new projects for the coming years.

Major achievements for the research program so far include:

- 17 books/chapters.
- 237 journal papers.
- 284 conference papers.
- 225 reports.



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 following case studies.

EXECUTIVE SUMMARY 2017-2018





EXECUTIVE SUMMARY 2017-2018

ACHIEVEMENTS

The reporting period financial year 2017-2018 covers the fifth year, beyond the halfway point, of the Bushfire and Natural Hazards CRC's eight-year funding period. Accordingly, it marked an appropriate point to monitor ongoing progress and to plan future options for natural hazards research.

The primary activities of have been:

Reviewing centre operations, governance, and research quality and progress

Delivering utilisation opportunities

Bringing together researchers, partners and broader stakeholders through a calendar of events, conferences and workshops

Building the capacity of the sector through postgraduate research and mentoring

Establishing national research priorities for natural hazards emergency management

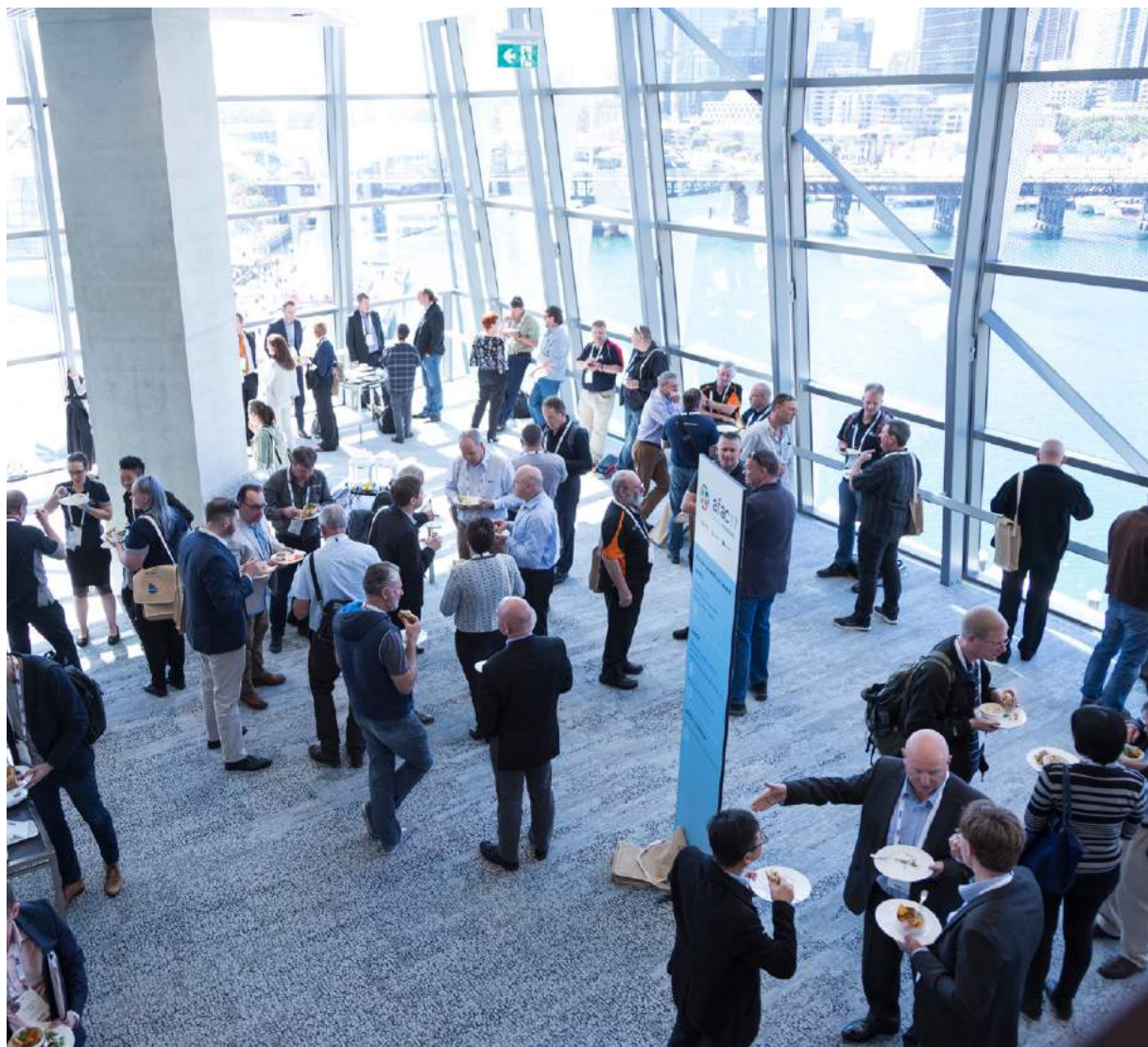
Developing options beyond this funding period to transition to an ongoing research centre.

These activities culminated in a visible display of progress, achievements and vision at the CRC's *Research Driving Change – Showcase 2017* event in the first week of July 2017.

In late 2017 the CRC released a publication that reviewed the activities of the first four years of the CRC. This was circulated to all senior stakeholders with an interactive version online: <https://www.bnhcrc.com.au/sites/default/files/managed/achievements/2017/>

The conduct of research and data gathering across all projects and postgraduate work was reinforced by outputs including:

- 4 book chapters
- 82 journal papers
- 47 refereed conference papers
- 34 reports for end-users



Delegates come from around the world to attend our annual conference every year.



North Australia Fire Managers Forum 2018 fieldtrip, Townsville.

REVIEWS

The International Science Advisory Panel conducted a review of the science quality of the suite of CRC projects at the request of the Research and Utilisation Committee in July 2017 and again in March 2018.

On each occasion the panel reviewed the quality of the current research teams with a view to ensuring that only good to high quality rated teams continued to be active. The panel's reports were considered by the independent review panel.

The panel concluded that there were some particularly outstanding projects in progress, specifically those led by:

- Prof Holger Maier (University of Adelaide) on mitigation decision support systems

- Prof Kevin Ronan (CQUniversity) on child centred disaster risk reduction
- Prof Vivienne Tippet (Queensland University of Technology) on effective multi-channel communication
- Dr Marta Yebra (Australian National University) on remote sensing.

It also found that approximately two-thirds of the projects were operating at very good or excellent standard, and that very few projects were operating at fair or poor standard.

In May 2018, an independent review of the achievements, the governance and management of the CRC over its first four and a half years was completed. Commissioned by the CRC Board, the review was carried out to ensure that the CRC

understands what it is doing well and not so well, to ensure that steps can be taken to improve the way the CRC operates. The review was also asked to consider plans for the CRC beyond the current funding period.

In general, the independent review panel confirmed that the CRC is progressing well with its research, utilisation and outreach activities and is on the right track to defining its longer-term future. [The Board formally responded in detail to the review report in September 2018.]

Led by Prof Mary O'Kane, AC and including Euan Ferguson, AFSM and Dr Tracey Arklay, the review panel heard from staff, researchers, end-users and PhD students on current work and on future directions.



EXECUTIVE SUMMARY 2017-2018

APPOINTMENTS

The Board of the CRC welcomed Mark Crosweller, AFSM, as a Director to replace Katherine Jones, PSM, who stepped down earlier in 2018. Mark heads the National Resilience Taskforce, in the Department of Home Affairs in the Commonwealth Government and has an extensive background in emergency management and emergency response at both a federal and state level.

CRC Research Director, Dr Michael Rumsewicz, left the CRC in October 2017. Michael was instrumental in the successes of the CRC since 2013, overseeing the development and implementation of the research program, and more recently the refresh process. Michael's energy, dedication, insight and advice will be missed around the CRC, and we all wish him well in his new endeavours.

Subsequently, Dr John Bates was appointed to the position of Research Director, leaving the role of Director of the Australian Institute for Disaster Resilience. John has had an extensive career in business development and research utilisation in academic organisations and is an active SES volunteer.

COLLABORATION OPPORTUNITIES

A multi-hazard focus presents opportunities for the CRC to continue to increase the scope of its collaborations and research links. This is evident in several ways, and includes:

National Research Priorities

The launch of *National research priorities for natural hazards emergency management* was the culmination of an extensive series of workshops with end-user stakeholders and other relevant groups to explore major issues across hazards, resilience and the community.

The workshops identified the critical issues that could be addressed by research. They were mostly conducted in collaboration with organisations that are major representative stakeholders, including AFAC and the Bureau of Meteorology. The priorities were considered and noted by the Council of Australian Governments' Australia-New Zealand Emergency Management Committee in June 2017. They are now being drawn upon to influence the future research program of the CRC.

National Institute

The Australian Institute for Disaster Resilience consolidated a partnership between the CRC, AFAC, the Australian Red Cross and the Department of Home Affairs during this reporting period. The Institute was formed to deliver products and services around Australia that have been developed by, and for, the emergency management sector. Knowledge is a core component of its role, with the CRC leading the drive through the *Australian Journal of Emergency Management*, the Knowledge Hub website and a series of events.

United Nations International Strategy for Disaster Reduction

The CRC is the national coordinator for a United Nations-backed committee that promotes and supports disaster risk reduction research programs and activities around the world. This Integrated Research on Disaster Risk 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.

Several researchers are in prominent roles, including Prof Kevin Ronan who represents the CRC at IRDR workshops and meetings, and Prof John Handmer who is on the Scientific Committee. The CRC hosted a public forum at Customs House in Sydney for the UN International Day for Disaster Reduction on 13 October 2017.



Research Driving Change - Showcase 2017.

EXECUTIVE SUMMARY 2017-2018

AWARDS

CRC excellence

The Bushfire and Natural Hazards CRC Outstanding Achievement in Research Award went to the CRCs *Economics and strategic decisions* cluster, led by Prof Holger Maier from the University of Adelaide and Ed Pikusa of the Department of Environment and Water SA.

With the support and guidance of a large group of end-users from a range of partner organisations, this cluster of four CRC projects is an outstanding example of the collaborative process that the CRC is all about. The research is based on the premise that to reduce both the risk and cost of natural disasters, an integrated approach is needed to consider multiple hazards and a range of mitigation options. Multiple CRC partners, along with local and state 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 cluster incorporates findings from several other CRC projects too - including work on the economic, social and environmental benefits of prescribed burning, the vulnerability of buildings to hazards, and research into improved warnings, community engagement, education, volunteering and community resilience.

CRC recognition

Our Special Recognition Award this year went to PhD student and project leader Steve Sutton. A great ambassador of the CRC, Steve's CRC PhD is being undertaken at Charles Darwin University. Steve has a long history with the Northern Territory, both in fire management and now as a researcher. Steve's PhD is looking at social and cultural aspects of the Indonesian island of Simeulue that led to remarkably low levels of casualties in the 2004 Indian Ocean Boxing Day tsunami.



Ed Pikusa, Department of Environment, Water and Natural Resources, and Prof Holger Maier, University of Adelaide, received the CRC's Outstanding Achievement in Research Award from Dr Richard Thornton on behalf of the Economics and strategic decisions cluster.

In addition to his PhD work, Steve has led a project that has developed training in bushfire and other hazards skills for Indigenous communities in northern Australia. The training units have been developed specifically for the needs of remote northern communities - they are sensitive to language and cultural variations and draw upon local knowledge and contexts.

Steve has also been prominent and engaging in his advocacy of the CRC and his research in various places including presentations at conferences, workshops, and across social media platforms.

Queens Birthday honour

Prof Vivienne Tippet was recognised for her efforts

and contributions to science with a Queen's Birthday Medal of the Order of Australia.

The OAM recognised Prof Tippet's contribution to medical education where she has worked for over 10 years as a researcher in the area of pre-hospital care.

Prof Tippet leads the *Communication and warnings* cluster for the CRC, which covers risk and warnings research for natural hazards. She leads the *Effective risk and warning communication during natural hazards* study.

Prof Tippet is the Head of the Discipline for Paramedicine in the Faculty of Health at Queensland University of Technology and the Director of Research for the School of Clinical Science.



EXECUTIVE SUMMARY 2017-2018

Australian honour

Former Bushfire CRC CEO Gary Morgan was recognised for his significant service to the community with an Australia Day honour. Becoming a member of the Order of Australia (AM), Gary was awarded for his significant service to the community through emergency response organisations, and to forest and fire research and management.

Gary was the CEO of the Bushfire CRC from 2007 until it wound up in 2014. Prior to this he was the Chief Fire Officer at Victoria's Department of Sustainability and Environment, from 1996 to 2005. He has continued with the CRC in short-term research consultancy, including conducting a review of traffic management strategies during emergencies.

Economics on ice

Project leader Dr Veronique Florec was one of 80 international scientists selected to join an all-female international expedition to Antarctica in early 2018. The expedition was part of the Homeward Bound program, which aims to heighten the impact of women with a science background.

Dr Florec leads the CRC's *Economics of natural hazards* project, focusing on applying economic analysis to the management of natural hazards such as bushfires and floods, to help decision makers get better value for money from public investments in hazard mitigation.

Animals prize

CRC research on how to best plan for animals in an emergency took out the inaugural Emergency Media and Public Affairs (EMPA) research award.

Led by Dr Mel Taylor from Macquarie University, the *Managing animals in disasters* project received the award at EMPA's annual conference, in June 2018. The project was recognised by EMPA as leading research that advances emergency communication

by improving community resilience, increasing the effectiveness of communication during emergency response and enabling agencies to better support communities recovering from an adverse event.

The research team has identified best practice approaches to animal emergency management, enabling emergency management agencies to obtain the data they need to make better informed decisions on planning and targeting of resources.

Emergency warnings high praise

Highly commended by EMPA was CRC research on emergency warnings and flood fatalities. Led by Prof Vivienne Tippet (Queensland University of Technology) and Dr Katharine Haynes (Macquarie University) this research is shaping public warnings and information campaigns that prepare and protect communities from flood, fire, heatwave and other natural hazards in Australia. Insights have combined to equip emergency service agencies around Australia with better-targeted long-term public safety campaigns, as well as urgent warning messages delivered to at-risk populations in the face of imminent natural hazards.

Blown away by research

CRC PhD student Korah Parackal was a finalist for an award that recognises both his research and his communication skills.

Korah, from James Cook University, was one of six finalists in the CRC Association's Showcasing Early Career Researchers competition, held in May at the CRC Association's annual conference in Sydney.

By making the finals, Korah demonstrated that he can convey the aims of his research clearly and effectively, with a 30 second video describing his research on strengthening rooves to withstand cyclones. He gave a five-minute presentation on his research at the conference.

Flood forecast project

CRC PhD student Ashley Wright was recognised for his excellent contributions to flood research by Monash University. Ashley won the Eric Laurenson Medal, which is awarded annually to a recent PhD graduate of Monash University who has written an excellent thesis, communicated their research findings to industry and has research utilisation potential in water science, engineering or management.

Ashley's project, *Improving flood forecast skill using remote sensing data* has used data gathered from historic rainfall to investigate how to reduce the damage caused by floods and improve flood forecasting.



Dr Mel Taylor, Macquarie University, with the EMPA Award.
Photo: EMPA.

RESEARCH

2017-2018

The reporting period 2017-2018 covers the fifth year of the CRC's eight-year funding period, where priorities for the research program were to consolidate ongoing progress, and to define pathways forward.

The conduct of active research and data gathering across all projects and postgraduate work was reinforced by outputs including:

- 4 book chapters
- 82 journal papers
- 47 refereed conference papers
- 34 reports for end-users

The research program (the full program is online www.bnhcrc.com.au/research) broadly takes in the policy objectives of the COAG-endorsed National Strategy for Disaster Resilience and is structured around three themes:

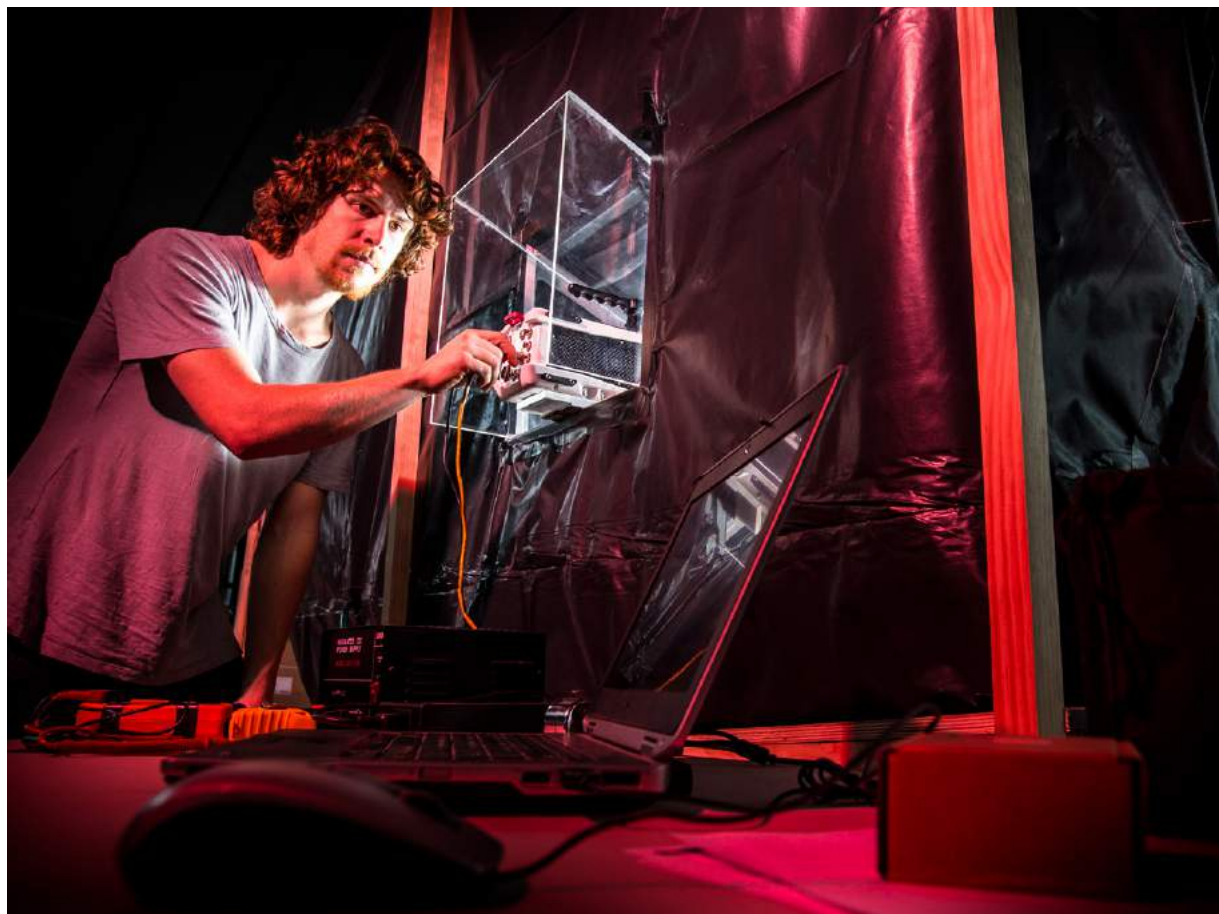
- Policy and economics of hazards
- Resilience to hazards
- Understanding and mitigating risks

Research outputs are increasingly appearing in peer-reviewed journals, and project team members present invited keynote speeches at international conferences. All reports are on the CRC website.

Consequently, the CRC remains on target to achieve its research outputs.

All 2016-17 Commonwealth Output Milestones have been completed. For the 2017-18 Commonwealth Output Milestones (59 in total), a total of 45 have been completed, 14 are in progress. The majority of these delayed milestones are for PhD student completions and these students are now in the final stages of their studies. The in-progress milestones are all expected to be complete by the end of June 2019.

The Centre also conducts research in addition to the science funded through the Cooperative Research Centres Programme.



Alan Green, University of Wollongong, testing water spray systems to protect buildings in bushfires. Photo: University of Wollongong.

This complementary research is undertaken through consultancies and other programs. This consultancy research is mainly with its existing partners, with a large program undertaken for the Department of Environment, Land, Water and

Planning Victoria. Short duration projects to meet the near-term needs of Centre partners are also funded through the Tactical Research Fund, while funding for quick response is made available to collect perishable data after a natural hazard.



RESEARCH 2017-2018

ACHIEVEMENTS

Research showcase

Emergency managers and policy makers from across Australia gathered in Adelaide in July for *Research Driving Change - Showcase 2017*. The event highlighted the practical research outcomes of the first four years of research through the CRC, with case studies and utilisation examples from across the research program presented by partners of the CRC.

The Showcase featured two days of learnings and case studies of how the emergency management industry is using the results of CRC research. How these findings are being put into practice across the sector was highlighted, with end-users also speaking about what works in directing research and how to make it easier to absorb the findings into operations and policy.

Topics covered included bushfire and severe weather modelling, emergency warnings and risk communication, teamwork in high pressure situations, the economics of mitigation, volunteering, engineering and the built environment, supporting Indigenous communities in northern Australia and disaster policy.

A series of panels featuring industry leaders shared their insights on how CRC research is influencing their business, how to get the best value from investment in research and where science will lead emergency management in Australia next.

Importantly, the next stage of the science was also discussed, with new projects pointing to exciting new directions in catastrophic event planning, land use planning, flood risk communication, predicting impacts on the built environment along the coast, diversity and wellbeing in emergency services, and mental health.

National research priorities

The CRC launched a set of priorities for national



Kate Brady, Australian Red Cross, speaking at Research Driving Change - Showcase 2017.

research into natural hazards. Now available online for broader discussion, the priorities arose from national workshops with the emergency management sector that led to their consideration by the peak Australia-New Zealand Emergency Management Committee.

This was the first time such a future-thinking exercise has been undertaken on natural hazards research in Australia. The CRC steered the extended process, which began with a review of its entire research agenda when it reached the halfway point in its

funding life in late 2016.

Four key themes were consistently raised by the sector at the workshops:

- shared responsibility and community engagement
- communicating risk and understanding the benefits of mitigation
- climate change
- predicting hazards more accurately, leading to better warnings.



Dr Katharine Haynes, Macquarie University, speaking at a joint Australian/NZ workshop in Wellington, 2018.

The National research priorities for natural hazards emergency management are online at www.bnhcrc.com.au/nationalpriorities.

PARTNER RESEARCH LINKS

Cyclone

Incident management research from the CRC helped the Queensland Fire and Emergency Services assess operations during Severe Tropical Cyclone *Debbie*, which occurred early in 2017.

QFES used findings and expertise from the *Improving decision-making in complex multi-team environments* project to inform future preparation, response and recovery. The research team of Dr Christine Owen (University of Tasmania) and A/Prof Chris Bearman (CQUniversity) supported QFES in an effective review of activities that took place across the seven QFES regions after *Debbie*, as well as facilitating debriefing workshops.

Flood

The CRC released a report that examined the cost-benefit of recent Launceston flood mitigation work. It was the first time the CRC had applied various parts of the research program to demonstrate how the CRC could pull together a solid synthesis highlighting the benefits of mitigation measures. The report was widely circulated and referenced nationally, and was well received by Tasmanian partners.

Fire

The CRC and the New South Wales Rural Fire Service released a joint report on community preparedness and responses to large fires in NSW in early 2017. This was widely promoted to the public by both organisations, with various media organisations picking up the key messages.

Hazard exercise

The CRC delivered an exercise for a severe cyclone for the NT Territory Emergency Management Committee. This committee is chaired by the Police Commissioner and Chief Minister's department and includes the CEOs of all major departments in the NT Government. The CRC developed, delivered and evaluated the exercise and assisted with the follow-up.

National fire danger

The CRC continues to take a leading role in the development of the science behind a new national Fire Danger Rating System, along with government and fire agency partners. Approximately 10 CRC projects are contributing to aspects of an enhanced Fire Danger Rating System. The Research Director is a member of the National Fire Danger Ratings Board, which reports to the Australia New Zealand Emergency Management Committee.

INTERNATIONAL RESEARCH LINKS

Fire and Emergency New Zealand agreed in January 2018 to contribute NZ\$300,000 to the CRC for further engagement with the research program. CRC and New Zealand researchers met in Wellington in May for a workshop on unpacking complexity, which discussed areas of mutual research interest currently underway and with future potential.

Following that workshop, two PhD scholarships targeting New Zealand fire issues were made available. Discussions are ongoing to ensure that New Zealand derives other benefits from its membership of the centre.

The CRC maintains other international links:

- A Memorandum of Understanding with the Coastal Resilience Centre of Excellence, University of North Carolina
- A Memorandum of Understanding with the US Forest Service, Department of Interior and Bureau of Land Management
- A Memorandum of Understanding with the Association for the Development of the Industrial Aerodynamics (Portugal)
- A Memorandum of Understanding with the Natural Hazards Research Platform (New Zealand)
- The National Committee for the Integrated Research on Disaster Risk program - a research program co-sponsored by the International Council for Science, the International Social Science Council, and the United Nations International Strategy for Disaster Reduction. This is a global, multi-disciplinary approach to dealing with the challenges brought by natural disasters, mitigating their impacts, and improving related policy-making mechanisms



RESEARCH 2017-2018

- The US National Fire Protection Association, including participation by the CRC in the NFPA annual meeting and project initiatives
- An International Science Advisory Panel
- Many of the CRC's core projects have links to international partners.

END-USER INVOLVEMENT

The CRC has active research projects with integrated project teams of researchers and end-users, established to ensure the projects continue to be informed by, and remain focused on, the needs of the partner organisations. Ongoing and active engagement between researchers and end-users is considered crucial to the success of each project.

In September 2017, the fourth Bushfire and Natural Hazards CRC - AFAC Conference was held in Sydney, New South Wales. The Research Forum of the conference, organised by the CRC, attracted 330 delegates from academia and emergency services agencies across Australia, New Zealand and internationally, including many project end-user representatives.

In October 2017, a Research Advisory Forum was held in Melbourne and in April 2018 another was held in Sydney. Around 120 people attended each forum, with roughly half being researchers and half end-user representatives. These two-day events provided the opportunity for CRC partners, project leaders and end-users to gain a complete overview of all the research activities within the CRC, and through workshop activities continue the process of reviewing project progress that shape the future direction of each project.

Many of the integrated project teams also held regular workshops and teleconferences and made use of opportunities to meet informally at conferences and other events to maintain ongoing project communication.



Dr Simon Heemstra, NSW Rural Fire Service, speaking at our annual conference.

UTILISATION AND COMMERCIALISATION 2017-2018

SETTING RESEARCH DIRECTIONS	<ul style="list-style-type: none"> Stakeholders identify needs Call for proposals from the research community Project review, selection, revision and approval
MAINTAINING AND REFINING RESEARCH FOCUS	<ul style="list-style-type: none"> End-users actively engaged on research projects Ongoing advice and access to partner organisations
IDENTIFYING MECHANISMS FOR KNOWLEDGE APPLICATION	<ul style="list-style-type: none"> End-user identification of potential application of research outputs Briefings via AFAC, ANZEMC sub-committees and direct access to end-user organisations to support appropriate planning timeframes in end-user organisations
TRANSLATING RESEARCH OUTPUT INTO PRODUCT	<ul style="list-style-type: none"> Identifying in detail how the knowledge developed should be translated into products such as training, methodologies, practices, systems CRC support for technology uptake activities

CORE BUSINESS

ORGANISATIONAL ACCEPTANCE OF RESEARCH PRODUCT	<ul style="list-style-type: none"> Ensuring that the receiving organisation has the skills to integrate the knowledge being delivered
ENHANCED ORGANISATIONAL CAPABILITY	<ul style="list-style-type: none"> Being able to consistently achieve something new or significantly better

The CRC is on target to achieve its utilisation outcomes. There were 19 utilisation milestones for the reporting period, of which 17 have been completed, and two are expected to be completed by the end of June 2019.

RESEARCH TO CAPABILITY

End-user engagement is central to the CRC's utilisation strategy. A model of a research to capability process is depicted at left, together with examples of how the strategy is being enacted within the Bushfire and Natural Hazards CRC. The core business of the CRC is focused on the top four boxes, but at the same time the CRC must be aware of the end-user environment towards which its research is directed (bottom two boxes).

The ideas underpinning the research to capability model have been incorporated into the CRC's research utilisation strategy. This strategy, which aligns with the CRC's overall organisational strategy, details the underlying principles for achieving research utilisation across the five major strategic objectives of:

- Partnership
- Outputs
- Research
- Capability and capacity
- Governance and management.

The strategy makes explicit the need to:

- develop and maintain an appropriate IP register
- develop high level measures to monitor the utilisation of the research
- develop utilisation roadmaps for each project to aid communication with all stakeholders that will potentially use the research.

In order to facilitate discussion and planning between researchers and end-users, the CRC has research utilisation roadmaps.



UTILISATION AND COMMERCIALISATION 2017-2018

A utilisation roadmap is a simple presentation of research utilisation objectives against a project timeline. They are high level and articulate a shared vision of utilisation, outlining opportunities and basic actions necessary for initiating more detailed business plans, including key stakeholders, further investment requirements and a communication strategy. The roadmaps are designed to benefit end-users by facilitating uptake of research outputs, as well as provide the CRC and all stakeholders a common understanding of the steps required for successful uptake.

The CRC is in the final stages of establishing a monitoring and evaluation framework for the utilisation program. This framework is using the utilisation register, quantitative and qualitative research tools and stakeholder analysis to evaluate utilisation. In addition, the CRC is working with project groups to demonstrate good practice in utilisation, providing models for the broader CRC research program.

Specific examples of research utilisation activity include:

- Engagement with multiple state-level organisations interested in implementing the principles developed through CRC research to improve their state and organisational risk framework by helping emergency managers understand their risk ownership and what can be done to reduce that risk. This framework enables risk practitioners and policy makers to act decisively and collaboratively in the present, whilst thinking and planning for the future. A major workshop for end-users was held at the 2017 annual conference.
- End-user refinement of a phone-based app for the rapid assessment of fuel levels in Australian forests, improving fire behaviour analysis.
- Utilisation of a decision support system to assist stakeholders evaluate disaster mitigation investment decisions that consider future

scenarios. The Western Australian government is co-investing the development of a model to understand natural hazard risk exposure for Perth. This will allow the government to assist in development and comparison of the costs and benefits of hazard mitigation. There has been interest from the Investor Group in Climate Change – as it grapples with risk management for major investments amid a changing climate and more extreme weather events.

- Development of an Emergency Management Breakdown Aide Memoire and a Team Process Checklist to strengthen teamwork before, during and after emergencies.
- Identification of four key forces reshaping volunteering in the 21st century, and the subsequent incorporation of research in the Communities Responding to Disasters: Planning for Spontaneous Volunteers - Handbook 12, of the Australian Institute for Disaster Resilience.
- Development of a prototype, high-resolution soil-moisture analysis system called JASMIN, and the closely linked Australian Flammability Monitoring System, which will result in improvements to the fire danger rating and warning systems, fire behaviour and flood prediction models, and will flow on to public emergency warnings.
- Incorporation of research into the national Handbook on Communications and Warnings, and the companion document, Choosing Your Words. This work aims to ensure everyone that receives information can understand what is being communicated and will know what actions to take.
- Development of an analytical toolkit for coastal managers to better understand beach response to clustered storms and to place this in the context of the geological and oceanographic setting, and land use, for a given part of the Australian coast.

- The Australian Nation Disaster Resilience Index prototype has been socialised with governments and emergency service organisations across Australia and New Zealand. The ANDRI provides a tool that will enable policymakers to understand at a national level, how resilience across 9 resilience characteristics vary across Australia and provide a means of tracking performance and change over time



EDUCATION AND TRAINING 2017-2018



CRC PhD students at a utilisation workshop in Brisbane.

The CRC is building a capacity and capability of highly skilled researchers to undertake high quality research in the sector. The CRC is building this capacity by developing a new cohort of researchers through an education program that has attracted postgraduate students to work across a range of natural hazards science projects.

Students are involved as either scholarship recipients or as associate students – both have the opportunity to engage with the industry and gain an understanding of the sector through their involvement with the CRC. All scholarship recipients have end-user sponsors who have indicated that the project has relevance to the industry and their organisation is interested in the outcomes.

At the end of this reporting period the CRC had 93 PhD students (37.2 FTE) – 35 scholarship, 28 completed, 30 associate, more than doubling its

target of providing support to 34 PhD students for the life of the CRC.

The CRC is also on track to meeting the target student completions with 28 students already completing their PhD studies.

To support the students, the CRC runs a variety of events centred on learning and networks. The annual conference and twice-yearly Research Advisory Forums and industry working groups (run by partner organisation AFAC) are key gatherings where students have the opportunity to present their findings. A number of students have also received CRC support to present their research at international conferences.

In 2017/18 students were again trained in presentation skills to promote their research using the Three-Minute Thesis format. This was incorporated into the above events and in the July

2017 Bushfire and Natural Hazards CRC Research Driving Change - Showcase 2017.

Eight CRC PhD students had the chance to present their research as part of a Three-Minute Thesis at the Research Advisory Forum either in Melbourne in November 2017 or in Sydney in April 2018, each in front of 120 partner representatives.

The students attended a workshop in the lead up to the forum where they were given expert advice on presentation skills and how to best present information in a short time.

“The workshop will change the way I undertake any presentation in the future.”
I Darryl Dixon, student



EDUCATION AND TRAINING 2017-2018

PHD GRADUATES

A round of PhD students graduated this year and shared their research outcomes with the fire and emergency services sector in several forums. They were joined by recent graduates who began their PhD studies with the Bushfire CRC. Some examples are listed below.

BUSHFIRE AND NATURAL HAZARDS CRC GRADUATES

■ Caroline Wenger

Caroline's PhD explored flood management in a

changing climate. Her research identified institutional barriers and investigated whether disaster resilience policies lead to adaptive outcomes. Caroline completed her PhD with the Australian National University.

■ Billy Haworth

Billy's PhD looked at volunteered geographic information (VGI), community engagement and bushfire preparation. VGI refers to the widespread engagement of citizens in the creation of geographic information, often through social media, smartphones and online mapping tools. Billy's

research was conducted through the University of Sydney. He is now a researcher and lecturer in geography and disaster management at the University of Manchester.

■ Yang Chen

Yang's research investigated the application of the Light Detection and Ranging (LiDAR) technique in quantifying forest fuel properties, including fuel structural characteristics and litter-bed fuel load at a landscape scale. Findings indicate that LiDAR allows a more efficient and accurate description of fuel structural characteristics and estimation of litter-bed fuel load. The results from her study can assist fire hazard assessment, fuel reduction treatment and fire behaviour prediction. Yang's PhD was through Monash University.

■ Melanie Baker-Jones

Melanie's thesis at the Queensland University of Technology examined government accountability for emergency warnings over social media. As well as this specific focus on legal accountability, Melanie's thesis examined the role of governance and regulatory components in the risk management process, investigating the extent to which responsibilities for warning and the use of social media are incorporated into the regulatory system.

■ Dolapo Fakude

Dolapo's research explored integrated response as a process for enhancing emergency management. Her research looked at existing functions within communities that can be utilised for preparedness and response functions with the goal of enhancing resilience. The result was the development of an integrated response framework that combines existing community functions that align with Incident Command System (ICS) structure and function domains of ICS. Dolapo completed her PhD as a CRC Associate Student with the University of Canterbury.



Dr Billy Haworth speaking at our annual conference.

EDUCATION AND TRAINING 2017-2018



Dr George Carayannopoulos, University of Sydney, speaking at our annual conference.

■ Rachel Quill

Rachel's PhD explored spatial-statistical characterisation of wind fields in complex terrains for bushfire modelling applications. Her research examined data to conclude that statistical approaches can be linked to current physics-based wind modelling methodology. Rachel hopes that the application of these statistical analyses will be used to evaluate the spectrum of wind prediction models used for bushfire modeling over rugged landscapes. Rachel completed her PhD with the University of New South Wales and is currently working as a researcher at the University of Adelaide.

■ Graham Dwyer

Graham's PhD at the University of Melbourne examined how organisations understand and learn from bushfires. His thesis showed how sense-making and learning occurred during public inquiries that followed major bushfires, and how learning has continued in emergency management organisations. Graham now lectures at the Swinburne University of Technology.

■ Philip Stewart

Investigating the changing fire regimes in the Great Sandy Region of south east Queensland, Associate Student Philip Stewart's PhD at the University of Queensland investigated at the past, present and future challenges in the area. Philip investigated the linkages between fire regimes and how they impact the environment, vegetation and population dynamics. His research offers a variety of regime management controls which can be implemented in the future.

BUSHFIRE CRC GRADUATES

■ Grahame Douglas

Grahame's PhD explored bushfire planning with climate change. Grahame's research, undertaken

through the Bushfire CRC at Western Sydney University, explored the application of extreme value analysis to extreme fire weather conditions. Historically, this approach had been restricted to floods, storms, temperature and wind.

■ David Barton

David's PhD investigated the aftermath of the Black Saturday bushfires and examined the notions of loss, grief and attachment. David drew on his own personal experiences as a resident of fire-ravaged Marysville, as well as the experiences of the Marysville community. David began his PhD with the Bushfire CRC and completed it as an Associate Student of the Bushfire and Natural Hazards CRC, based at RMIT University.

■ Mahfuz Sarwar

Mahfuz's PhD looked at reducing grid sensitivity of large eddy simulation based numerical fire model wildland-urban interface fire dynamics simulator. Mahfuz applied a fluid dynamics methodology to assess the performance of eddy viscosity models and their potential as forecasting tools. He found that the models were particularly grid sensitive, with variations in resolution changing the outcomes of the forecasts. Mahfuz completed his PhD at Victoria University.

GRADUATE DESTINATIONS

Many completed students from both the Bushfire CRC and the Bushfire and Natural Hazards CRC are now employed with either end-users or research organisations and are actively contributing to the current research program in their current roles.

These include:

- Dr George Carayannopoulos – University of Sydney
- Dr Steve Curnin – TasWater/University of Tasmania



EDUCATION AND TRAINING 2017-2018

- Dr Veronique Florec – University of Western Australia
- Dr Rachel Quill – University of Adelaide
- Dr Brianna Larsen – Griffith University
- Dr Rene Van der Sant – Melbourne Water
- Dr Grace Vincent – CQUniversity
- Dr Alex Wolkow – Monash University
- Dr Billy Haworth, University of Manchester, UK
- Dr Caroline Wenger, Australian National University
- Dr Graham Dwyer – Swinburne University of Technology
- Dr Douglas Brown – University of Western Sydney, Bushfire Architecture
- Dr Dolapo Fakuade – Otago Civil Defence and Emergency Management
- Dr Vaibhav Gupta – City of Casey
- Dr Josh Whittaker – University of Wollongong
- Dr Briony Towers – RMIT University
- Dr Claire Johnson – Emergency Management Victoria
- Dr Val Densmore – Department of Biodiversity, Conservation and Attractions, WA
- Dr Andrew Edwards – Charles Darwin University
- Dr Adam Leavesley – ACT Parks and Conservation Service
- Dr Felipe Aires – Office of Environment and Heritage NSW
- Dr Martijn van der Merwe – Department of Environment and Water, South Australia
- Dr Mika Peace – Bureau of Meteorology
- Dr Christine Eriksen – University of Wollongong
- Dr Phil Lacy – PF Olsen Australia Forestry
- Dr Karyn Bosomworth – RMIT University
- Dr Tim Prior – Centre for Security Studies, Switzerland
- Dr Lyndsey Vivian – Centre for Australian



PhD student Ashley Wright (right) receives the Monash University Eric Laurenson Medal from Prof Tony Wong. Photo: Monash University.

- National Biodiversity Research, CSIRO
- Dr Meaghan Jenkins – University of Wollongong
- Dr Peter Hayes – CQUniversity
- Dr Rowena Morris – Office of Environment and Heritage NSW

- Dr Phil Zylstra – University of Wollongong

» RESEARCH STUDENTS – SEE APPENDIX 6 FOR A LIST OF ALL POSTGRADUATE STUDENTS.

COMMUNICATIONS 2017-2018



Panel discussion on 'a changing world for emergency management research' at Research Driving Change - Showcase 2017.

With the CRC in its fifth year the communications priorities for the centre are well embedded. These include:

- Building public and industry knowledge of how to use the research, through targeted events, publications and in the general media
- Translating research findings into user friendly formats
- Providing training to researchers and postgraduate students to better communicate their work to varied audiences
- Creating and distributing branded publications and products to demonstrate the value of the CRC
- Refining the function and usability of a comprehensive website with access to publications and other research activities
- Expanding a social media presence to reach a wide range of audiences.

In late 2017 the CRC released a publication that reviewed the activities of the first four years of the CRC. This was circulated to all senior stakeholders with an interactive version online: www.bnhcrc.com.au/sites/default/files/managed/achievements/2017/

EVENTS

In addition to a Research Showcase and a high-profile annual conference, this reporting period saw a lot of activity around raising the profile of the centre, at conferences and other forums across a range of audiences including local government, public affairs, community safety and risk managers.

Showcase: Emergency managers and policy makers from across Australia gathered in Adelaide at the beginning of July to discuss how national research by the Bushfire and Natural Hazards CRC is making communities safer. *Research Driving*

Change - Showcase 2017 highlighted the practical research outcomes of the first four years of research through the CRC, with case studies and utilisation examples from across the research program presented by partners of the CRC. It was sponsored by the Attorney-General's Department, through its Emergency Management Australia section, and the University of Adelaide.

AFAC17

The CRC and AFAC co-hosted the annual conference in Sydney in September 2017, along with Hannover Fairs Australia. This was the biggest ever CRC annual conference in terms of delegates and trade exhibition. The CRC was prominent throughout the Sydney conference and in particular at the Research Forum, which attracted 330 participants. CRC researchers featured heavily on the program. The full conference attracted more than 3200 people and the CRC handed out many branded promotional



COMMUNICATIONS 2017-2018

items and corporate brochures, engaged with the media and was promoted heavily on social media. The CRC launched the *Season Bushfire Outlook for Southern Australia* at a media conference.

Disaster Reduction Day

Emergency management practitioners and researchers gathered in Sydney on 13 October 2017 for a public forum on reducing the impacts of disasters in Australia. The forum, held as part of the United Nations International Day for Disaster Reduction, saw nearly 50 people hear an expert panel discuss resilience and international, national, state and local perspectives on disaster reduction.

Speakers for the day were: Tony Jarrett, NSW Rural Fire Service; Feargus O'Connor, Office of Emergency Management NSW; Andrew Gissing, CRC and Risk Frontiers; Jessica Raine, Emergency Management Australia; and, Beck Dawson, Resilient Sydney. The forum for International Day for Disaster Reduction was held in conjunction with the Attorney-General's Department and the Australian Institute for Disaster Resilience, with the support of CRC partner Risk Frontiers.

Northern fire

The 20th Northern Australia Fire Managers Forum was held in Townsville on 26-27 June 2018. In what

was the largest annual meeting of this group, more than 65 fire managers and researchers from across the north of Australia discussed the history and future of the forum, plus topics of current interest in the tropical savannas. Among other issues, the meeting compared fire preparations and weather data to produce the annual *Northern Australia Seasonal Bushfire Outlook*. Speakers reflected that the original aims of the Forum 20 years ago were still relevant despite all the changes in the sector. Chaired by the CRC, the forum also included an overnight field trip that viewed fire management issues at a large solar park, defence land, a nature sanctuary, a wetlands forest, a eucalypt forest, and coastal woodlands.

Research Advisory Forums

These attracted more than 120 people to Melbourne in November 2017 in conjunction with RMIT University; and in April 2018 in Sydney hosted by the New South Wales Rural Fire Service. These two-day events provided the opportunity for CRC partners, project leaders and end-users to gain a complete overview of all the research activities within the CRC, and through workshop activities continue the process of reviewing project progress shaping the future direction of each project. The Sydney forum was preceded with a communications skills workshop for postgraduate students.

Connecting with NZ

The connections between Australian and New Zealand research in natural hazards were the focus of a workshop in Wellington in May 2018. CRC researchers discussed a range of current projects with colleagues from New Zealand along with agency partners and policy makers prior to the joint National Emergency Management and Australasian Natural Hazards Management Conference. The CRC hosted the strategic research workshop with the Joint Centre for Disaster Research at Massey University in collaboration with Fire and Emergency New Zealand and QuakeCORE. The unpacking



Dr Marta Yebra, the Australian National University, at our annual conference.

COMMUNICATIONS 2017-2018

complexity workshop included four panel sessions: disaster resilience education for young people; hazards, culture and Indigenous communities; planning and communicating messages and community understanding and response to warnings and alerts. The workshop allowed for networking and a broad discussion on the social science of emergencies, disasters and resilience, with a plan to follow up on the main issues over the coming year.

EM keynote

Research Director Dr John Bates was a keynote speaker at the Australia and New Zealand Disaster and Emergency Management conference on the Gold Coast in May 2018. Dr Bates spoke about the importance of perspective and how the CRC is driving change in research utilisation, as well as highlighting what the CRC has learned to date, alongside the challenges for conducting research into the future. The conference included presentations from CRC researcher Dr Darja Kragt (University of Western Australia), who presented on her project that is investigating how to sustain volunteering in emergency services. This is the seventh year of the conference and the fourth time the CRC has been directly affiliated with the event.

Shine Dome science

Predict, respond, recover: science and natural disasters - this was the theme for Science at the Shine Dome 2018, the flagship annual symposium for the Australian Academy of Science. The CRC was invited to be a partner for this prestigious event, which was held on 22 May 2018 at the Shine Dome in Canberra as part of a week of activities for Fellows of the Academy and the public. The day provided an opportunity to explore the critical role that science plays in predicting, mitigating, responding to and recovering from natural hazards and extreme weather events. The program featured many CRC speakers including CRC CEO Dr Richard Thornton, who spoke on the need to define the main

scientific questions. Other CRC speakers included Board member Mark Crossweller (National Resilience Taskforce), A/Prof Jason Sharples (University of NSW) and Prof Vivienne Tippet (QUT). The CRC supported two early career researchers to attend, Dr Daniel Smith (JCU) and Dr Rachael Quill (University of Adelaide).

Friends in Parliament

The Parliamentary Friends of Science held a breakfast briefing on natural hazards science at Parliament House Canberra, in May 2018. Several CRC researchers briefed MPs and parliamentary staff on the state of their projects and the potential impacts on local communities. The briefing was part of a regular informal meeting between scientists and MPs on current issues.

Showcase roadshow

Following the success of the *Research Driving Change - Showcase 2017*, smaller, more targeted research showcases were conducted at the request of partners. Key Commonwealth Government representatives and partners were briefed by CRC researchers in October 2017 and again in May 2018 in Canberra. With the aim of helping to embed research into planning, policies and operations, the forum was initiated by the Attorney-General's Department, through its Emergency Management Australia section, as part of its sponsorship agreement with the CRC for the successful *Research Driving Change - Showcase 2017* in July 2017. Similar showcases were conducted for Victorian partners in September 2017 and in the Northern Territory in October 2017. The forums provided an opportunity for people working across the several different areas of government and emergency service agencies to discuss how the research was relevant.

Community engagement

Community engagement was the focus in Coffs Harbour in May 2018 at the Australian Community



The CRC was a lead sponsor of Science at the Shine Dome 2018 with the Australian Academy of Science.



COMMUNICATIONS 2017-2018

Engagement and Fire Awareness Conference, run by the NSW Rural Fire Service. The CRC was a partner in this conference and shared a booth with AFAC and the Australian Institute for Disaster Resilience. The CRC was well represented on the program with Dr Josh Whittaker (University of Wollongong), Dr Melissa Parsons (University of New England), Dr Mel Taylor and Dr Katharine Haynes (both Macquarie University).

Sector issues

Senior management – Chairman Dr Laurie Hammond, CEO Dr Richard Thornton, and Communications Director David Bruce – attended the CRCA annual conference, this year held in Sydney in May. This event is an important one on the calendar each year to discuss key issues across the whole CRC program, and included a dinner where the CRC hosted a table with NSW-based CRC partners as guests.

US fire protection

Research Director Dr John Bates visited the US during June 2018 to attend the annual conference of the US National Fire Protection Association in Las Vegas. Dr Bates participated in a panel on leveraging data to engage at-risk communities around the world. While in the US Dr Bates also visited the US Forest Service fire research lab in Missoula and the Coastal Resilience Centre at the University of North Carolina. The CRC has Memoranda of Understanding with both organisations.

Justice workshop

A workshop in Newcastle in June 2018 wrapped up the *Policies, institutions and governance* project, led by Dr Michael Eburn. Thirty-six people attended to hear about the outcomes of the project on the role that restorative justice can play in policy and management of natural hazards, as an alternative to inquiries and royal commissions.

Media affairs

Members of the communications team represented the CRC in Melbourne at the annual Emergency Media and Public Affairs conference in June 2018. Attended by around 80 communications and community engagement practitioners, CRC research on community engagement with remote northern Australia communities was presented on by Steve Sutton (Charles Darwin University). The CRC sponsored the event and was represented on the organising committee by Communications Manager Nathan Maddock.

Flooding plains

More than 300 people gathered on the Gold Coast from 29 May to 1 June 2018 at the Floodplain Management Conference to discuss and analyse the latest developments in flood management. The CRC had a booth in the trade display, while several CRC projects presented. This included Dr Tariq Maqsood from RMIT University, who presented findings from his team on how different construction materials cope with being inundated with floodwater and the most cost effective way to mitigate different building types from floods, while Marcus Morgan from the NSW SES spoke on behalf of Dr Katharine Haynes and Dr Matalena Tofa (Macquarie University) on findings from interviews with people who sheltered in place during the floods after ex Tropical Cyclone *Debbie* in northern NSW in April 2017. End-user Andrew Richards also spoke about the work that NSW SES is doing to update its flood warnings, with support from research findings.

Burning questions

August 2017 saw a prescribed burning forum 'The Burning Question', take place in Busselton, Western Australia. The CEO was invited to be a keynote speaker and discussed CRC research on the topic. The CRC also had a booth, which was popular during the forum breaks.

Volunteers in the west



Steve Sutton, Charles Darwin University, at the EMPA conference. Photo: EMPA.

COMMUNICATIONS 2017-2018

For the fourth consecutive year, the CRC was invited to participate in the Department of Fire and Emergency Services WA Valuing Volunteers conference. The CRC, the Australian Institute for Disaster Resilience and AFAC shared a booth, which was busy all weekend, with volunteers keen to learn about new research and other activities under way at the national level. The conference was held in Perth in September 2017, with just over 700 volunteers in attendance.

Northern exercise

Northern Territory partners were briefed on the latest CRC research in Darwin in October 2017. Representatives from the NT Fire and Rescue Service, NT Emergency Service, Bushfires NT, Department of the Chief Minister and the Bureau of Meteorology attended.

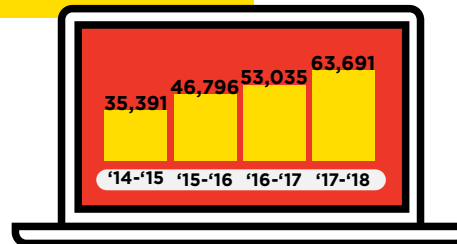
Weather research

The CRC supported the High Impact Weather Research stream of presentations at the 25th Australian Meteorological and Oceanographic Society and 12th International Conference for Southern Hemisphere Meteorology and Oceanography at the University of New South Wales in February 2018. CEO Dr Richard Thornton opened the session with a short presentation on the CRC research program.

Industry academia imacts

The CRC participated in the three-day *Engaging for Impact -Academia and Industry Co-Creating Our Future* event at RMIT University in February 2018. Along with several other RMIT-linked CRCs across a range of sectors (manufacturing, space technology, environmental remediation) the CRC spoke with industry representatives and other researchers about ongoing work and how they could be involved. The CRC featured RMIT-based research led by Dr Blythe McLennan on sustainable volunteering and by Dr Briony Towers on child centred disaster risk reduction.

63,691
Unique page visits



WEBSITE

The website is the central repository of all Bushfire and Natural Hazards CRC public documents and statements, with easy access to the outputs of the research program and the profiles of researchers.

It has links to all our partners, related research organisations and, importantly, the legacy website of the Bushfire CRC. Development is ongoing, with a major update of design and function released early in the current reporting period (18/19).

During the 12 month period the CRC's website had 63,691 site visits, for 242,617 page views. This represents increases of 21 per cent and 24 per cent respectively from the previous financial year.

HAZARD NEWS AND HAZARD NOTES

The email management tool Mailchimp is used to send CRC monthly newsletters, *Hazard News*, and plain language research updates, *Hazard Notes*. The subscriber list has grown steadily during the 12 months, from 1,612, to 2,055 an increase of 27 per cent.



Dr Blythe McLennan, RMIT University, speaking with her research project team at our annual conference.



COMMUNICATIONS 2017-2018

MEDIA

With experts across many disciplines, the CRC is well positioned to provide expert media comment that supports our agency partners.

Peak times centre around the CRC's *Southern Australia Seasonal Bushfire Outlook* and its update (September and November), the Research Forum and annual conference (August - September), major hazard events (mostly bushfires and cyclones over the summer months) and the *Northern Australia Seasonal Bushfire Outlook* (July).

Numerous television, radio and website interviews have focused on the science emerging from various projects. All media mentions are listed on the CRC website. Media coverage was generated through the efforts of the Communications Team and in conjunction with university and end-user partners in newspapers, TV, radio and web. *The Conversation* website has carried numerous pieces by CRC researchers on their science.

Industry and trade media are key media partners, with the CRC contributing regular articles on the latest research findings and developments in *The Australian Journal of Emergency Management*, *Asia Pacific Fire* (UK-based), *Wildfire* (US-based), and numerous partner agency publications including the biggest two, the New South Wales Rural Fire Service's *Bush Fire Bulletin* and the Victorian Country Fire Authority's *Brigade*. CRC research was also cited in numerous publications by the Climate Council, the Australian Academy of Science and the CRC Association.

Fire Australia, a quarterly magazine with a circulation of 6,000, is produced by the CRC jointly with the Fire Protection Association of Australia and AFAC.

The single biggest day for media conference was the annual launch the *Southern Australia Seasonal Bushfire Outlook 2017*, held on the first day of the annual conference. In 2017 in Sydney, the CEO hosted the media conference with speakers Dr

David Jones from the Bureau of Meteorology, Shane Fitzsimmons, Commissioner NSW Rural Fire Service, Dominic Lane, Commissioner ACT Emergency Services Agency, then Board member Craig Lapsley, Commissioner Emergency Management Victoria, Mike Wassing, Deputy Commissioner Queensland Fire and Emergency Services, Chris Arnol, Chief Fire Officer Tasmania Fire Service, Greg Nettleton, Chief Fire Officer South Australia Country Fire Service and Peter Norman, Superintendent Western Australia Department of Fire and Emergency Services.

The media conference was broadcast live on ABC 24 and Channel Seven, with Channel's Nine and Ten also attending and running stories on their nightly news. Other outlets to attend included the *Sydney Morning Herald*, *The Daily Telegraph*, ABC Radio, 2GB and AAP. With the assistance of the NSW Rural Fire Service, the media conference was livestreamed to communities on both the CRC and RFS Facebook pages.

SOCIAL MEDIA

The CRC regularly engages on social media and sees these channels as key communications tools. An active engagement strategy throughout the year has seen both the popularity and interactivity of the CRC's channels increase over the 12 month period. Collaborating closely with our partners, both research organisations and emergency services, has seen the reach of CRC posts on social media extend considerably.

The CRC uses Facebook, Twitter, YouTube, Linked In and SoundCloud. Our annual conference is a key time for engagement and generates the most activity and interest. Our seasonal bushfire outlooks for northern and southern Australia (July and September respectively) are also popular.

Combined through Facebook and Twitter for the 12 month period, the CRC achieved 20,832 Facebook shares, Twitter mentions and retweets (an increase

of 18 per cent from the previous 12 months). Total impressions across our Facebook and Twitter channels was over 2.1 million, a 40 per cent increase.



Dr Richard Thornton launches the Southern Australia Seasonal Bushfire Outlook 2017.

GOVERNANCE 2017-2018

The Bushfire and Natural Hazards CRC is 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 Governing Board met five times throughout the year, with each meeting held in a different capital city. Each meeting was held in conjunction with either a research showcase or an informal stakeholder partner event to enable the Board to meet with members, end-users, researchers, students and other key stakeholders.



Back row from left: Commissioner Craig Lapsley, Dr Richard Thornton, Prof Alistar Robertson, Mr Stuart Ellis, Mr Lee Johnson. Front row from left: Ms Kathy Gramp, Ms Naomi Stephens, Dr Laurie Hammond, Ms Katherine Jones, Mr Karl Sullivan.

GOVERNING BOARD MEMBERS

NAME	ROLE	KEY SKILLS	INDEPENDENT/ ORGANISATION	APPOINTMENTS/ RESIGNATIONS	ATTENDANCE
Dr Laurie Hammond	Former Chairman	Governance and strategy	Independent	Appointed August 2013, deceased November 2018	5 out of 5
Prof Alistar Robertson	Acting Chairman	Research	Independent	Appointed December 2013	5 out of 5
Stuart Ellis	Director	Industry based skills	AFAC	Appointed June 2013	5 out of 5
Kathy Gramp	Director	Finance and governance	Independent	Appointed December 2013	4 out of 5
Lee Johnson	Director	Industry based skills	Independent	Appointed December 2013	4 out of 5
Commissioner Craig Lapsley	Director	Industry based skills	Emergency Management Victoria	Appointed December 2013	4 out of 5
Katherine Jones	Director	Industry based skills	Dept of Home Affairs	Appointed November 2015, resigned May 2018	3 out of 3
Mark Crosweller	Director	Industry based skills	Dept of Home Affairs	Appointed May 2018	1 out of 2
Naomi Stephens	Director	Industry based skills	Office of Environment and Heritage, NSW	Appointed December 2013	5 out of 5
Karl Sullivan	Director	Industry based skills	Insurance Council of Australia	Appointed November 2015	5 out of 5
Doug Smith	Director	Industry based skills	Queensland Fire and Emergency Services	Appointed November 2016	5 out of 5



GOVERNANCE 2017-2018

COMMITTEE MEMBERS

The Board has two committees that each meet at least twice a year:

- **Audit Risk and Compliance Committee** - oversees corporate governance, audit responsibilities, finance, compliance and risk management.
- **Research and Utilisation Committee** - ensures research conducted meets the strategic aims of the CRC and the needs of end-users, and is responsible for providing strategic advice on the overall development of the CRC's postgraduate program and new educational initiatives. The committee also advises on the strategy for research adoption.

BOARD MEETINGS

DATE	CITY
July 2017	Darwin
September 2017	Melbourne
November 2017	Sydney
March 2018	Adelaide
May 2018	Canberra

NAME	ROLE	KEY SKILLS	INDEPENDENT/ ORGANISATION	COMMITTEES
Kathy Gramp	Chair	Finance and governance	Independent	Audit Risk and Compliance Committee
Lee Johnson	Member	Industry based skills	Independent	Audit Risk and Compliance Committee
Naomi Stephens	Member	Industry based skills	Office of Environment and Heritage, NSW	Audit Risk and Compliance Committee
Prof Alistar Robertson	Chair	Research	Independent	Research and Utilisation Committee
Lee Johnson	Member	Industry based skills	Independent	Research and Utilisation Committee
Stuart Ellis	Member	Industry based skills	AFAC	Research and Utilisation Committee
Dr Rob Webb	Member	Industry	Bureau of Meteorology	Research and Utilisation Committee
Heather Stuart	Member	Industry based skills	New South Wales State Emergency Service	Research and Utilisation Committee
Georgie Cornish	Member	Industry based skills	Country Fire Service, South Australia	Research and Utilisation Committee
Prof Liz Sonenberg	Member	Research	University of Melbourne	Research and Utilisation Committee
Jeremy Fewtrell	Member	Industry based skills	Fire and Rescue New South Wales	Research and Utilisation Committee

UTILISATION CASE STUDIES



Changing the focus of warnings messages is pivotal to successful action during an emergency. Photo: Dana Fairhead.



UTILISATION CASE STUDIES

BETTER WARNINGS TO ENSURE ACTION

With the multitude of warnings issued when an emergency hits, how can emergency services ensure their critical safety advice is heard and acted upon, rather than dismissed as noise?

Research undertaken through the *Effective risk and warnings communication* project at the Queensland University of Technology has helped emergency services warn communities by actively testing the wording and structure of warning messages to better understand how messages are understood and translated into direct action. The team, led by Prof Vivienne Tippet, 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 warning doctrine.

Changing the focus of warning messages has been the key, believes Anthony Clark, Director Corporate Communications at the New South Wales 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, 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 New South Wales State Emergency Service has also looked at how its warning messages are structured.

"We have seen some great outputs in the warnings space from this research," says the NSW SES' Andrew Richards.

"This will help us deliver our message to affected communities better so we can illicit the desired response during a disaster."

In Queensland, 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."

QFES have also drawn on the expertise of the team to inform its strategy development for the future.

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. Nationally, the research was used to support the Australian Institute for Disaster Resilience Handbook on public information and warnings and the companion document Choose Your Words, while the Emergency Media and Public Affairs conference recognised the research as having an impact on community safety, with a highly commended award in its 2018 research category.

SEQwater has also benefited from the science, and has sought input from the team on how to improve its messaging about releasing water from dams during a flood. Community surveys show that these revised messages are more trustworthy, and achieve more proactive action.

Further highlighting the wide-reaching implications of this research, ABC local radio in Wide Bay, Queensland, is also engaged with the research team, looking at ways it can improve its emergency broadcasting.

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 James Cook University, 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 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.



Research has informed a new grant scheme that is retrofitting homes in north Queensland to mitigate against a tropical cyclones. Photo: Michael Dawes (CC BY-NC 2.0.)

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 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 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.



UTILISATION CASE STUDIES

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 2017/2018 to better incorporate extreme fire behaviour. The revised system will be more comprehensive, providing provide 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.



Contemporary fire danger ratings will incorporate contemporary research for the first time since the system was devised. Photo: Carl Coleman, NSW Rural Fire Service.

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 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.

EMERGENCY PLANNING FOR ANIMALS



Two out of three Australian homes have a pet, but they are one of the most overlooked parts of preparing for an emergency. Photo: Jenny Bigelow.

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.

While the research phase of this work is complete, there is a strong utilisation focus, with the team actively engaged with emergency service

agencies, government departments and local community groups.

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 23 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. A community guide for establishing an animal ready community is now in development.

Building on this was Blue Mountains Animal Ready Community's first community seminar, held in October 2018. The project team was integral to the involvement of the seminar, which saw over 60 people attend to learn more about how to manage their small and large pets, livestock and wildlife during an emergency, as well as how to best be prepared beforehand. Resources developed by the project that identify local animal owners' planning and preparedness needs were distributed, and the day was MC'd by Dr Taylor.

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 matter and why they need 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 policies, while in Victoria, the Department of Environment, Land, Water and Planning has used the findings to inform its risk assessment processes.

HorseSA has also used the research to support its emergency planning and gain funding for appropriate equipment, explains the organisation's Executive Officer Julie Fielder.

"This research has provided evidence which we have used to advocate government around planning, and has helped us shape our messages to horse owners during emergencies," she says.

Nationally, the Australian Institute for Disaster Resilience has drawn on the research to develop a section on animal management in their updated evacuation planning 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 in recognition of its success, 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.



UTILISATION CASE STUDIES

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 vulnerability and risks* 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 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 will be 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.

The research has also been recognised internationally, taking out the best poster award at the 2017 European Climate Change Adaption conference in Glasgow, while the UK Climate Impacts Programme invited the project team to present at their adaption in practice series as part of their 20th anniversary celebrations.



Assessing risk ownership for managing natural hazards is complicated, particularly as natural hazard risks can resonate across long timeframes.

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. CRC research led by Prof Kevin Ronan (CQUniversity) and Dr Briony Towers (RMIT University) has 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.

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

New South Wales 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 New South Wales 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 RFS 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 Western Australia 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 represents stepped change in the first five years of this program of research, with the next steps geared towards enhancing and implementing disaster resilience education in schools, with the goal of 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.



UTILISATION CASE STUDIES



The NSW Rural Fire Service Schools Program is engaging primary school students in learning about effective action for house fire and bushfire safety. Photo: Ben Shepherd, NSW Rural Fire Service.

INTANGIBLE VALUE



Measuring the intangible benefits of prescribed burning is assisting agencies to better measure the impacts on ecosystems and peoples lives. Photo: Veronique Florec.

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?

With the 2015 Productivity Commission's report on natural disaster funding arrangements in Australia finding that there is an over-investment in post-disaster reconstruction and an under-investment in mitigation, the Economics of natural hazards project led by Associate Prof Atakelty Hailu and 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 a tool for generating estimates of non-financial benefits and undertaking integrated economic analysis of management options for floods in Adelaide and for prescribed burning in private land in South Australia's Mount Lofty Ranges. This value tool 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.

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.



UTILISATION CASE STUDIES

LOOKING BACK CAN PREVENT FUTURE FLOOD DEATHS



Research is informing who drives through floodwater and why they do it, which is assisting agencies to create better awareness campaigns. Photo: Rex Boggs (CC BY-ND 2.0).

CRC research is informing community flood warning campaigns, emergency services training and national policy initiatives, with the *Analysis of building losses and human fatalities from natural hazards* study led by Dr Katharine Haynes at Risk Frontiers, 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 NSW State Emergency Service has 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.

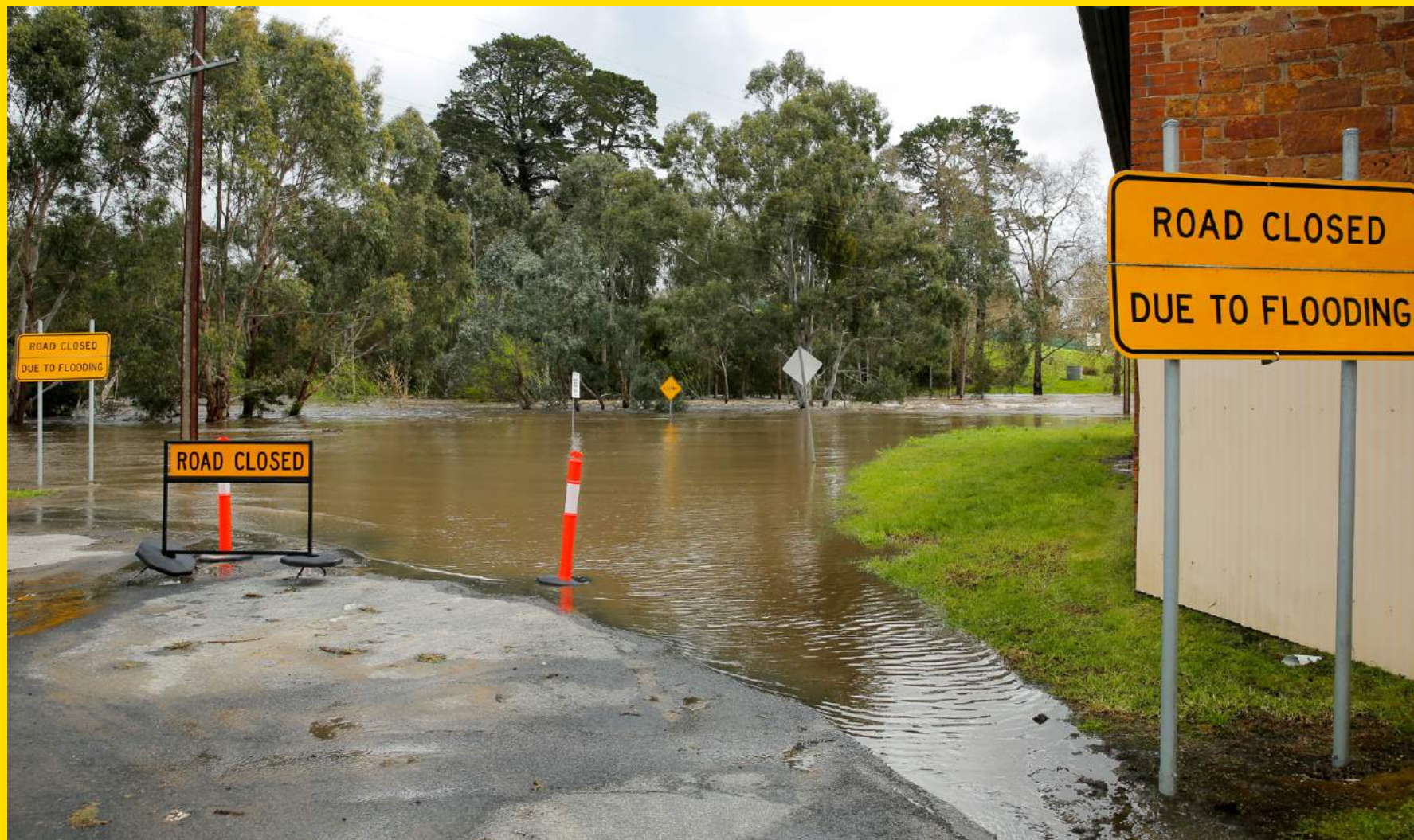
"As a consequence of risky behaviour, flood fatalities and rescues are a constant issue for emergency services. We are trying to increase public safety, to educate people to make the safe choice, and we think that the best way to achieve this is by highlighting true stories about what has happened to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

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.

UTILISATION CASE STUDIES



'What if?' scenario modelling creates a policy wind tunnel, allowing different policy ideas to be tested. Photo: South Australia State Emergency Service.



UTILISATION CASE STUDIES

“WHAT IF” QUESTIONS DRIVE FUTURE POLICY

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 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 disasters, we need an integrated approach 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 Graeme Riddell at the University of Adelaide, has completed case studies for Adelaide, Melbourne and the whole of Tasmania.

Based on the success of the research, further work began in Western Australia in 2017, funded through the National Disaster Mitigation Program.

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, Water.

“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.

Agencies will be able to use the system to help allocate budgets, demonstrating that they are

using the best available science to inform decision-making.

The science is drawing wider acclaim too, with the Investor Group on Climate Change highlighting the software modelling as a key tool to help navigate future climate risk.

This study is the only approach that compares different natural hazards and their mitigation options, while also taking into account long term planning. The ultimate aim is to develop a decision support framework and software system that is sufficiently flexible to be applied to large and small cities around Australia that will help planners from local councils through to state treasury departments answer the vital question on mitigation options that balance cost and impact: ‘what is the best we can be doing?’

This project is an outstanding example of the collaborative process that the CRC is all about, 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.

A MODEL FOR RELIEF AND RECOVERY



Understanding and enhancing disaster resilience in Australian communities will help to develop the capacities needed for adapting and coping with natural hazards. Photo: South Australia State Emergency Service.

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

Research led by Dr Melissa Parsons at the University of New England is developing the Australian Natural Disaster Resilience Index, which has already begun to improve 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 Natural Disaster 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.



UTILISATION CASE STUDIES

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 *Tools supporting fire 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 CO₂ emissions into the atmosphere than fires occurring early in the dry season. Although this calculation is based on years of data, CDU researchers are developing 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.

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 km², still only 40 per cent of the potential extent for these savanna burning projects. The fire severity mapping process developed by the research team 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.



This research is helping fire and land managers assess greenhouse gas emissions and develop carbon abatement plans.

UTILISATION CASE STUDIES



Clear thinking and effective communication will assist emergency managers to take better action before, during and after an emergency.



UTILISATION CASE STUDIES

COMPLEX DECISION MAKING AND TEAMWORK WHEN THE HEAT IS ON

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 Associate Professor Chris Bearman at CQUniversity.

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

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.

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.

“ They are invaluable not only during operational response, but also in debriefs and training. ”

The Tasmania Fire Service used the tools during the 2015-2016 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.

The project has also developed cognitive decision-tools and training materials to aide decision making in complex and high consequence scenarios. Fire and Rescue NSW’s Assistant Commissioner Rob McNeil has worked with the project team to understand his decision making as an incident controller deployed to Japan during the 2011 Fukushima earthquake and tsunami. The process has helped Assistant Commissioner McNeil better understand how he makes decisions, enabling him to teach this process to other incident controllers.

Findings from this research are also benefiting organisational resilience, with the federal Department of Home Affairs launching a practical guide to decision making based on research carried out in the project.

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.

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 from RMIT University, led by Prof Simon Jones and Dr Karin Reinke, will help 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.

This is being tested with a trial by the New South Wales Rural Fire Service over summer 2018/2019. Currently bushfires are primarily detected when



This research is testing new technology to help detect bushfires before they become too big to control. Photo: Mike Rowe (CC-BY-NC-2.0).

a member of the public calls Triple Zero, and occasionally from other satellites that may be passing over the area. Working with the research team, RFS will 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.



UTILISATION CASE STUDIES

SATELLITES TO HELP SHOW WHEN THE BUSH IS READY TO BURN



Fire managers are set to benefit from a new fire mapping tool that provides live information on soil and vegetation moisture. Photo: Marta Yebra.

Fire and land managers are set to benefit 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 will help 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 impact* project which has developed the web-based system. 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 prototype 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 data available through the system is invaluable to fire and land management agencies, explains Dr Adam Leavesley, the Research Utilisation Manager at the 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 is going to give us a really good guide across the whole country to how we expect fire to behave on any particular day. This will help agencies position resources during a bushfire, keeping our people safe, and 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 wenfo.org/afms/

UTILISATION CASE STUDIES



Mud Army and SES volunteers working as a team at the 2011 Queensland floods. Photo: Queensland Fire and Emergency Services.



UTILISATION CASE STUDIES

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.

Research from this project 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. 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 using the findings to shape how the organisation will recruit volunteers.

"Findings from the research really helped to shape our Volunteering Reimagined strategy, launched in 2017," says Andrew McCullough, Volunteering Strategist at the NSW SES.

“ We know that people want to volunteer in different ways, and that not everyone in the community is able to volunteer regularly or for extended periods of time. Flexible volunteering options are now essential to the way we operate.”

"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 policies 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.

"What is now crystal clear is that the old volunteering model is not sustainable," says John Schauble, Emergency Management Victoria's Director of Emergency Management Resilience.

“ We need to look at different ways of doing things, and this research has pointed us in the directions we need to head.”

Findings from this research are now informing a new CRC project on sustainable volunteering, focusing on how to best adapt emergency management agencies to these new ways of volunteering. This new research will centre around exploring the developments that are likely to occur over the next decade that will require adaption, as well as barriers to organisational change. The expectations and stereotypes about volunteering held by prospective volunteers will also be explored, investigating the effectiveness of recruitment materials and strategies, including for the attraction of more diversity amongst volunteers. What motivates people to volunteer will also be explored.

CHILD CENTRED HAZARDS STRATEGY

Dr Briony Towers was recognised as a prominent early career researcher for her excellent contributions to child-centred disaster risk reduction at the CRC's annual conference in Perth.

Briony has studied bushfire education programs that are implemented at primary schools to see how they enhance hazard reduction strategies and add to the resilience of the wider community.

She recently travelled to Portugal, Canada and the United States to share her research on empowering children in disaster risk reduction and received new interest from her European counterparts.

"There was a lot of interest in the child-led approach being employed at Strathewen and other schools in Victoria such as Anglesea Primary School, where the benefits of amplifying student voice and participation in disaster resilience education have been coming through really clearly," Briony said.

In Portugal, Briony presented at a conference on the importance of student voice and participation in disaster resilience education.

"There is currently nothing in place to support this kind of programming in disaster affected communities, and we need to address that," Briony said.

Briony's research at RMIT University in Melbourne was also a key focus during Red Cross Disaster Preparedness Week 2018, where she presented her findings at a workshop in Adelaide.



BRIONY TOWERS

“There is currently nothing in place to support this kind of programming in disaster affected communities, and we need to address that.”

| Briony Towers



CRC PEOPLE

PLANNING FOR YOUR PETS

Dr Mel Taylor's breakthrough research involving animals and emergency management has been praised in multiple forums, including the Emergency Media and Public Affairs conference (EMPA) in June 2018.

"It is a real honour for the project to be recognised by EMPA. The team has achieved a lot over the last four years, and we've worked with many organisations to not only undertake the research, but to help get the findings implemented into practice," Mel said.

Mel's CRC project leadership was recognised by EMPA as research that advances emergency communication by improving community resilience, increases the effectiveness of communication during an emergency response and enables agencies to better support communities recovering from an adverse event.

Her research with the Blue Mountains Animal Ready Community (Blue ARC) won a highly commended community award for the 2018 NSW Resilient Australia Awards. Blue ARC have worked with Mel to highlight the impacts of animals on the behaviours of people in natural hazards, and to reinforce the need of supporting communities to be prepared and better plan for their animals.

Mel also received an award at the CRC's annual conference, in recognition of her outstanding research and utilisation activities involving emergency advice and warnings now containing community reminders to consider pets and farm animals.



MEL TAYLOR

“ It is a real honour for the project to be recognised by EMPA. The team has achieved a lot over the last four years, and we’ve worked with many organisations to not only undertake the research, but to help get the findings implemented into practice. ”

I Mel Taylor

OUT IN THE COMMUNITIES

Dr Josh Whittaker leads a range of post-hazard studies for the CRC, where his expertise in geography and the vulnerability of communities to bushfires are called upon.

Over the past year, Josh has led multiple CRC research studies for the New South Wales Rural Fire Service, analysing community preparedness, warnings and responses in the aftermath of three catastrophic bushfires in 2017, as well as the Reedy Swamp bushfire in 2018.

Josh gathered insights into how people accessed and received warnings for the bushfires, as well as their understanding and perceptions of bushfire risk, and shared the findings at multiple forums including the CRC's annual conference and the NSW RFS-run Australian Community Engagement and Fire Awareness conference.

Josh began his career as a PhD student with the Bushfire CRC and has participated in multiple post-hazard analyses over the past decade, beginning with Black Saturday in 2009.



JOSH WHITTAKER



CRC PEOPLE

FORECASTING FOR FLOOD

Dr Ashley Wright received the Eric Laurenson Medal for his outstanding research on flood forecasting, soon after completing his PhD in September 2018.

The award recognises a recent PhD graduate of Monash University who has written an excellent thesis, communicated their research findings to industry, and has research utilisation potential in water science, engineering or management.

“The award gives me confidence that my work is meaningful and of high quality,” Ashley said.

Ashley’s PhD gathered data from historic rainfall to investigate how to reduce the damage caused by floods and improve flood forecasting.

Ashley’s supervisor and CRC researcher A/Prof Pauwels commended Ashley on the excellent quality of his innovative research.

Ashley worked with Monash University to investigate flood monitoring and modelling in Indonesia and Fiji, and is now working on A/Prof Pauwels CRC project, Improving flood forecast skill using remote sensing data as a research fellow.



ASHLEY WRIGHT

“The award gives me confidence that my work is meaningful and of high quality.”

■ Ashley Wright

AWARDED FOR WARNINGS

Professor Vivienne Tippet was recognised for her contributions to both warnings communications and to medical science in 2018.

Vivienne has worked as a researcher in medical education in the area of pre-hospital care for more than 10 years and rewarded this year with a Queen's Birthday Order of Australia Medal (OAM).

At the CRC Vivienne leads the *Effective risk and warning communication during natural hazards* project, which was highly commended as leading research at the Emergency Media and Public Affairs (EMPA) conference in June 2018.

The EMPA award acknowledged the contribution the project has made to public warnings and information campaigns that prepare and protect communities from natural hazards.

Insights from the project have equipped emergency service agencies from around Australia with better-targeted, long-term public safety campaigns, as well as urgent warning messages delivered to at-risk populations in the face of imminent natural hazards.

Vivienne is the Head of the Discipline for Paramedicine in the Faculty of Health at Queensland University of Technology and the Director of Research for the School of Clinical Science.



VIVIENNE TIPPETT



CRC PEOPLE

A HISTORY OF FLOOD FATALITIES

CRC researcher Dr Katharine Haynes from Macquarie University, has been recognised for how her research has helped shape public warning information campaigns that prepare and protect communities from floods.

Highly commended at the Emergency Media and Public Affairs (EMPA) conference, Katharine's work has informed community flood warning campaigns and emergency services training and national policy initiatives by investigating the circumstances of all flood fatalities in Australia from 1900 to 2015. It has also compared the impacts of disasters from more than 100 years ago with more recent events.

By exploring the socio-demographic and environmental factors surrounding the 1,859 flood fatalities over 115 years, the research found distinct trends in relation to gender, age, activity and the circumstances of the death that have been fundamental in shaping current policies.

Katharine is a key researcher on several CRC projects involving flood risk communication, building losses and human fatalities from natural disasters; preventable residential fire fatalities; disaster scenario analysis and planning and capability for catastrophic and cascading events.

Her research builds on her previous acknowledgements and awards including her selection as the Australian nomination for the prestigious Asia-Pacific Economic Cooperation (APEC) Science Prize for Innovation, Research and Education award in 2015, collaborating with academics and emergency management practitioners from a range of APEC economies including Indonesia, Japan, New Zealand, the Philippines and the United States.



KATHARINE HAYNES

BOUND FOR ANTARCTICA

Eighty female scientists travelled to Antarctica in March 2018, including CRC researcher Dr Veronique Florec.

Veronique joined The Homeward Bound Voyage, which aimed to heighten the impact of women with a science background who can influence policy and decision making. The Voyage focused on plastic pollution in the world's oceans for 22 days.

"We'll have more clarity, confidence and strategic capability to influence policy and decision-making to shape the future of our planet," Veronique said.

Veronique also leads the *Economics of natural hazards* CRC project out of the University of Western Australia and works closely with land management and fire agencies to quantify and assess the damages caused by natural hazards.

She has spent much of her academic career associated with the CRC, after completing her PhD on the economics of prescribed burning with the Bushfire CRC.



VERONIQUE FLOREC

“We’ll have more clarity, confidence and strategic capability to influence policy and decision-making to shape the future of our planet.”

| Veronique Florec



CRC PEOPLE

A STRONG ADVOCATE AND SUPPORTER

To acknowledge his significant contributions to the CRC over a number of years, John Schauble received the CRC's special recognition award at our annual conference.

Most recently John was the lead end-user for the *Governance and institutional knowledge* cluster of projects, but has a long history with the CRC as a key end-user and advocate since the early days of the Bushfire CRC.

Recently retired from Emergency Management Victoria, John has been a long time volunteer firefighter. Following an extensive career as a journalist, John's transition into emergency management saw him responsible for managing research and strategy projects for the Office of the Emergency Services Commissioner in Victoria, and more recently as the Director for Risk and Resilience at Emergency Management Victoria.



JOHN SCHUABLE

KEEPING THE ROOF OVER OUR HEADS

Korah Parackal was one of six finalists at the CRC Association Awards that showcased the innovation and communication skills shown by early career researchers at the association's annual conference in Sydney in May 2018.

Korah's entry focused on the dangers of losing fasteners on the roof of a home during a cyclone. Qualifying as a finalist by demonstrating he could communicate his research clearly and effectively in a 30 second video, Korah gave a five-minute presentation of his research at the Awards ceremony.

"I have used a wind tunnel, tested connections in the lab and surveyed damage from past cyclones to create a model where these progressive and cascading failures can be simulated," Korah said.

Korah has also engaged with local communities to show how cyclones can damage homes, and how CRC research will help to find the best and most cost-effective ways of retrofitting homes in cyclone-prone areas.

Korah recently completed his CRC PhD at James Cook University and has since joined the CRC project *Improving the resilience of existing housing to severe wind events*.



KORAH PARACKAL

“I have used a wind tunnel, tested connections in the lab and surveyed damage from past cyclones to create a model where these progressive and cascading failures can be simulated.”

I Korah Parackal



CRC PEOPLE

IN THE MOUTH OF THE FIRE

Volcanos and their disruption to critical infrastructure has taken Emma Singh around the world to talk about her recently completed her CRC PhD.

Her studies at Macquarie University drew on her early years growing up in New Zealand to focus on infrastructure failures over long periods including the exposure of roads to volcanic ash, road closures and evacuation plans.

She travelled to Naples in 2018 for the Cities on Volcanoes Conference at the foot of Mount Vesuvius.

“At this assembly I saw a growing interest and research into natural hazard risk to critical facilities, but there is still a lot work that needs to be done to improve our understanding and modelling of the impacts of critical infrastructure failure during and following future events,” Emma said.

Emma also attended 2017 International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) Scientific Assembly in the United States where she presented her PhD research on collecting volcanic ash at Mount Fuji and analysing its impacts on Japan's highways and evacuation planning.



EMMA SINGH

“ At this assembly I saw a growing interest and research into natural hazard risk to critical facilities, but there is still a lot work that needs to be done to improve our understanding and modelling of the impacts of critical infrastructure failure during and following future events. ”

Emma Singh

FIRE AND THE WAANYI-GARAWA WOMEN

The inclusion of women in fire management across remote Indigenous communities in northern Australia is the focus of Kate van Wezel's CRC PhD at Charles Darwin University. Her research follows women in the Waanyi and Garawa country in the remote south-west Gulf of Carpentaria and analyses their subordination in fire management practices.

Kate worked with these women in their communities to design a ranger program for women that includes a central role in fire management.

"The traditional owners are worried that although they've managed to reduce the extent of wildfires, that it's not happening in a way that's fulfilling their cultural goals," Kate said.

Collaborating with the women ranger groups, Kate compiled a booklet to help show the benefits of ranger groups. The *Waanyi-Garawa woman ranger program* intends to provide cultural guidance for women seeking to get back out on to country after being denied the opportunity to do so regularly. The program also allows women to build new skills and confidence through their ranger work to be able to participate fully in managing their Indigenous Protected Area.

Kate has spent long periods in the remote communities near the Queensland and Northern Territory border, and is now in the final stages of her PhD.



KATE VAN WEZEL

“The traditional owners are worried that although they’ve managed to reduce the extent of wildfires, that it’s not happening in a way that’s fulfilling their cultural goals.”

| Kate van Wezel

APPENDIX 1: RESEARCH PROGRAM LEADERS



RESEARCH PROGRAM LEADERS

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
Prof Holger Maier	University of Adelaide
Prof Roger Jones	Victoria University
Prof David Pannell	University of Western Australia
Dr Jessica Weir	Western Sydney University
Dr Timothy Neale	Deakin University
A/Prof Michael Eburn	Australian National University
Dr Katharine Haynes	Macquarie University
Dr Thomas Lorian	Macquarie University
Prof Kevin Ronan	CQUniversity
Dr Melanie Taylor	Macquarie University
Dr Ilona McNeill	University of Melbourne
Prof Vivienne Tippet	Queensland University of Technology
Prof David Johnston	Massey University
A/Prof Chris Bearman	CQUniversity
Dr Tariq Maqsood	RMIT University
Prof Michael Griffith	University of Adelaide
Dr Trent Penman	University of Melbourne

NAME	ORGANISATION
Dr Thomas Duff	University of Melbourne
Dr Melissa Parsons	University of New England
Dr Ross Bradstock	University of Wollongong
Dr Karin Reinke	RMIT University
Dr Matthew Mason	University of Queensland
Dr Krishna Nadimpalli	Geoscience Australia
A/Prof John Ginger	James Cook University
Prof Sujeeva Setunge	RMIT University
Prof John Handmer	RMIT University
Dr Michael Jones	University of Wollongong
Steve Sutton	Charles Darwin University
Adj Prof Jeremy Russell-Smith	Charles Darwin University
Dr Scott Nichol	Geoscience Australia
Prof Charitha Pattiaratchi	University of Western Australia
Dr Marta Yebra	Australian National University
Dr Jeff Kepert	Bureau of Meteorology

NAME	ORGANISATION
A/Prof Valentijn Pauwels	Monash University
Dr Imtiaz Dharssi	Bureau of Meteorology
Dr Khalid Moinudolin	Victoria University
Dr Tina Bell	University of Sydney
A/Prof Jason Sharples	University of New South Wales
Prof Alan March	University of Melbourne
Harald Richter	Bureau of Meteorology
Celeste Young	Victoria University
Prof Bruce Rasmussen	Victoria University
Andrew Gissing	Risk Frontiers
Lisa Gibbs	University of Melbourne
Dr Blythe McLennan	RMIT University
Dr Patrick Dunlop	University of Western Australia
Prof David Lawrence	University of Western Australia

APPENDIX 2: KEY STAFF

KEY STAFF

NAME	POSITION/ROLE	TIME
Dr Richard Thornton	Chief Executive Officer	1.0
Dr Michael Rumsewicz	Research Director - to October 2017	1.0
Dr John Bates	Research Director - from October 2017	1.0
David Bruce	Communications Director	1.0
Trevor Essex	Company Secretary/ Business Manager	0.3
Leanne Beattie	Executive Assistant	1.0
Dr Desiree Beekharry	Core Research Program Manager	1.0
Sarah Mizzi	Partnership Development Director	1.0
Nathan Maddock	Communications Manager	1.0
Vaia Smirneos	Communications Officer (Events) - on maternity leave from March 2018	1.0
Amy Mulder	Communications Officer (Events) - maternity leave position from February 2018	1.0

NAME	POSITION/ROLE	TIME
Dr Matthew Hayne	Research Utilisation Manager	0.5
Loriana Bethune	Research and DELWP Program Manager	1.0
David Boxshall	Research Program Support Officer	1.0

NAME	POSITION/ROLE	TIME
Kelsey Tarabini	Research Utilisation Program Support Officer	1.0
Kate Eagles	Financial Controller	0.3
Anna Nikitina	Finance Officer	0.3
Costa Haritos	Communications Assistant - Intern from February 2018	1.0



CRC staff from left: Costa Haritos, Kelsey Tarabini, Dr John Bates, Aleesha Hui, Amy Mulder, Leanne Beattie, Dr Matthew Hayne, Loriana Bethune, Dr Richard Thornton, David Boxshall, Sarah Mizzi, Nathan Maddock, David Bruce, Dr Desiree Beekharry.

APPENDIX 3: PARTICIPANTS



PARTICIPANTS

PARTICIPANT NAME	ORGANISATION TYPE
Attorney-General's Department, from January 2018 Department of Home Affairs	Australian Government
Bureau of Meteorology	Australian Government
Geoscience Australia	Australian Government
ACT Emergency Services Agency	State Government
ACT Territory and Municipal Services	State Government
Fire and Rescue NSW	State Government
Office of Environment and Heritage, NSW	State Government
NSW Rural Fire Service	State Government
NSW State Emergency service	State Government
NT Fire and Rescue Service	State Government
Queensland Fire and Emergency Services	State Government
SA Fire and Emergency Service Commission	State Government
Tasmania Fire Service	State Government
Country Fire Authority, VIC	State Government
Metropolitan Fire and Emergency Services Board	State Government
Department of Environment, Land, Water and Planning, VIC	State Government
Emergency Management Victoria	State Government

PARTICIPANT NAME	ORGANISATION TYPE
Victorian State Emergency Service	State Government
Department of Fire and Emergency Services, WA	State Government
Department of Parks and Wildlife, WA	State Government
Fire Emergency New Zealand	International
Australian National University	University
CQUniversity	University
Charles Darwin University	University
Deakin University	University
James Cook University	University
Macquarie University	University
Monash University	University
Queensland University of Technology	University
RMIT University	University
University of Adelaide	University
University of Melbourne	University
University of New England	University
University of Southern Queensland	University
University of Sydney	University
University of Tasmania	University
University of Western Australia	University

APPENDIX 3: PARTICIPANTS

PARTICIPANT NAME	ORGANISATION TYPE
University of Wollongong	University
Western Sydney University	University
Victoria University	University
AFAC	Industry
Australian Red Cross	Industry
Fire Protection Association Australia	Industry
RSPCA QLD	Industry
University of Canberra	University
Volunteering Queensland	Industry
Flinders University	University



Field trip at the North Australia Fire Managers Forum 2018, Townsville.

APPENDIX 4: ADDITIONAL RESEARCH



bushfire&natural
HAZARDSCRC

COMMISSIONED RESEARCH - 2017/18

TITLE	AGENCY
Develop a decision support system for Western Australia	Department of Fire and Emergency Services, Western Australia
Strategy 2030	Queensland Fire and Emergency Services
Post-bushfire research - Currandooley, Sir Ivan, Carwoola fires	New South Wales Rural Fire Service
Post bushfire research - Reedy Swamp fire	New South Wales Rural Fire Service
National research priorities for energy networks	Energy Networks Australia/S&C Electric
Quantifying catastrophic bushfire consequences	Energy Networks Australia
Community engagement: a framework and tools to support a flood warning system for New South Wales	New South Wales State Emergency Service

RESEARCH FOR THE DEPARTMENT OF ENVIRONMENT, LAND, WATER AND PLANNING, VICTORIA

TITLE
Smoke transportation modelling and smoke emissions modelling
Social values in bushfire management decision making (INFFER) project
Multi-platform analysis and remote sensing
Science based monitoring and reporting
Bushfire climatology project
2009 Black Saturday bushfires reconstruction
Framework for using and updating ecological models to inform bushfire management planning
Landscape fuel moisture forecasting for bushfire risk assessment
Dynamic smoke intelligence using remote sensing and fixed sensors
Community impacts of smoke
Severe fire behaviour characterisation - improved planning responses
Smoke impacts on community health and social perceptions
Science and policy impacts - establishing a MER framework
Risk communications
Provision of data inputs for INFFER
Estimating the social, economic and environmental cost and benefits
Bushfire and fires monitoring data validation and analysis

APPENDIX 4

TACTICAL RESEARCH FUND

TITLE	AGENCY
Re-imaging program evaluation for community resilience	Emergency Management Victoria and the University of New England
Classifying outcomes of inquiries and reviews: what can we learn?	AFAC
Analysis of preventable residential fire fatalities	Metropolitan Fire Brigade, Victoria
A guide to develop bushfire case studies - a case study of cropland fires	Country Fire Authority, Victoria
Risk assessments of non-compliant materials on buildings	Fire and Rescue New South Wales

FUNDS FOR QUICK RESPONSE

TITLE	RESEARCH ORGANISATION
Assessment of post-fire recovery of pencil pine forest after the 2016 World Heritage Area fires	University of Tasmania
Mapping the area of Tathra to study if Mechanical Fuel Load Reduction along with prescribed burning can save houses (in future) at Tathra, NSW	University of Technology Sydney
Disaster waste management in Darwin following Cyclone <i>Marcus</i>	Charles Darwin University

APPENDIX 5: INTERNATIONAL COLLABORATION



INTERNATIONAL COLLABORATION HIGHLIGHTS BY PROJECT

PROJECT	INTERNATIONAL COLLABORATIONS
<i>Economics of natural hazards</i>	Collaboration with US Forest Service on public perceptions of bushfire risk and the costs of suppression.
<i>Improved decision support systems for optimal natural hazard mitigation</i>	Collaboration with Karlsruhe Institute of Technology/Centre for Disaster Management and Risk Reduction Technology in Germany on earthquake modelling for the decision support system tool.
<i>Mapping and understanding bushfire and natural hazards vulnerability and risk at the institutional scale</i>	Collaboration with the UK Climate Impacts Programme.
<i>Optimising post-disaster recovery interventions in Australia</i>	Collaboration with the Asian Disaster Preparedness Center.
<i>Policies, institutions and governance</i>	Presentations at International Association of Wildland Fire Safety Summit, the UK Alliance for Disaster Research and at the Emergency Planning College, York, United Kingdom.
<i>Scientific diversity and uncertainty in risk mitigation policy and planning</i>	Case study with the Alberta Provincial Government exploring the use of science in risk mitigation decision making in the town of Lac La Biche, Alberta, Canada.
<i>Using realistic disaster scenario analysis to understand natural hazard impacts and emergency management</i>	Presentation at the 13th Americas Conference on Wind Engineering, Gainesville, Florida.
<i>An analysis of building losses and human fatalities from natural disasters</i>	Presentation at the American Association of State Floodplain Managers Conference.
<i>Catastrophic and cascading events – planning and capability</i>	Collaboration with University of North Carolina.

PROJECT	INTERNATIONAL COLLABORATIONS
<i>Child-centred disaster risk reduction</i>	Presentations to the International Congress of Applied Psychology, Paris; the UN World Conference on Disaster Risk Reduction in Sendai, Japan in 2015; a Research-Practice Workshop in Wellington in 2016; the UNISDR Global Platform on Disaster Risk Reduction in Cancun Mexico in 2017; and the XIX ISA World Congress of Sociology in Toronto, Canada, 2018.
<i>Effective risk and warning communication during natural hazards</i>	Collaboration with the Risk Communication and Resilience Research Program at the University of Maryland. Editorial board membership of the Journal of International Crisis and Risk Communication Research, based in the US.
<i>Enhancing remote north Australian community resilience</i>	Invitations from two Brazilian institutions to participate in international workshops on prescribed fire management in savanna environments.
<i>Community understanding of tsunami risk and warning system</i>	Collaboration with the University of Canterbury on the earthquake scenario workshop project. Presentation at the Building Individual and Organisational Capacity in the Asia-Pacific Region: 4th International Workshop on Psychological Intervention After Disasters 2015 in Taiwan.
<i>Factors affecting long term community recovery</i>	Presentation at the Global Risk Forum, IDRC in Switzerland. Collaboration with the University of Iowa in the field of indicators of disaster resilience.

APPENDIX 5: ADDITIONAL RESEARCH

PROJECT	INTERNATIONAL COLLABORATIONS
<i>Diversity and inclusion – building strength and capability</i>	<p>Presentation at the 6th International Conference on Building resilience, Auckland, New Zealand 2016 and at the European Climate Change Adaptation June 2017.</p> <p>Participation in advisory role in the Impressions Project, a multiparty collaboration across UK and European research institutes funded by the European Union. Collaboration with UKCIP at Oxford University.</p>
<i>Flood risk communication</i>	Presentation at the 4S and EASST joint conference, 'Science and Technology by Other Means,' 2016, Spain.
<i>Improving decision making in complex multi-team environments</i>	Presentations to the Forest and Rural Firefighters Association of New Zealand annual conference and the Society for Decision Making Under Deep Uncertainty annual workshop at the World Bank in Washington DC.
<i>Improving the retention and engagement of volunteers in emergency services agencies</i>	Erasmus + Exchange – EU Grant: To discuss inter alia Emergency Service Volunteering (Leadership; Diversity) in Greece.
<i>Improving hazard communications increasing residents' preparedness and response planning</i>	<p>Collaboration with Leeds University Business School, United Kingdom, testing interventions that increase intentions to perform behaviours.</p> <p>Collaboration with Columbia University, USA, looking at the relationship between different self-regulatory systems, including promotion and prevention focus, assessment and locomotion, and personality factors.</p>
<i>Managing animals in disasters</i>	Presentation at international conferences: the British Animal Rescue and Trauma Care Association in Prague and People in Disasters in Christchurch.
<i>Out of uniform – building community resilience non-traditional volunteering</i>	Presentations at the annual conference of the Royal Geographical Society UK and the Annual Conference of the American Association of Geographers.

PROJECT	INTERNATIONAL COLLABORATIONS
<i>Resilience of clustered disaster events on the coast- storm surge</i>	Collaboration with Japan Agency of Marine-Earth Science and Technology; and with Geoscience Australia on deep-sea geological research on the Lord Howe Rise, Coral Sea.
<i>The Australian Natural Disaster Resilience Index</i>	Presentation at the 5th International Disaster and Risk Conference, Davos, Switzerland in 2015. Presentation at the Binghamton Geomorphology Symposium on 'Resilience in bio-geomorphic systems' in San Marcos, Texas (2017) and at the International Society for River Science in Hamilton, New Zealand, 2017.
<i>Improving land dryness measures and forecast</i>	Collaboration with NASA Goddard to use the Land Information system to assimilate satellite derived soil moisture information.
<i>Improving the resilience of existing housing to severe wind events</i>	Invited speaker at the University of Florida sponsored workshop for the development of homeowner decision-support tools for mitigation, Tampa, Florida, 2016.
<i>Cost-effective mitigation strategy for building-related earthquake risk</i>	Collaboration with the University of Auckland in developing fragility curves for unreinforced masonry buildings with evidence from the recent Canterbury earthquakes.
<i>Improving flood forecast skill using remote sensing data</i>	Presentation at the KU Leuven in Belgium, 2016. Keynote at the 7th International Workshop on Catchment Hydrological Modeling and Data Assimilation in Xi'an, China, 2018.
<i>Cost-effective mitigation strategy for flood prone buildings</i>	Presentation at the 2016 International Conference on Flood Risk Management and Response Conference, Venice, Italy.
<i>Coupled fire-atmosphere modelling</i>	Collaboration on fire weather with the UK Met Office, Leeds University, the European Centre for Medium Range Weather Forecasting, and the South African Weather Service.
<i>Delivering effective prescribed burning across Australian ecosystem</i>	Collaboration with Landcare Research, New Zealand.



APPENDIX 5: ADDITIONAL RESEARCH

PROJECT	INTERNATIONAL COLLABORATIONS
<i>Mapping bushfire hazard and impacts</i>	Collaboration with the European Forest Fire Information System and the Global Wildfire Information System; the Council of Scientific and Industrial Research, South Africa, Meraka Institute and others.
<i>Enhancing resilience of critical road infrastructure</i>	Collaborated in the ANDROID disaster resilience network and with Huddersfield University, United Kingdom. Presentation at the 7th International Conference on Building Resilience, November 2017, Thailand.
<i>Fire spread prediction against fuel types</i>	Collaborating with Aix-Marseille University, France, Lebanese University, Lebanon; and the US Forest Service.
<i>Optimisation of fuel reduction burning regimes</i>	Keynote speaker at the International Congress on Prescribed Fires in Barcelona, Spain, 2017.
<i>Fire coalescence and mass spotfire dynamics</i>	Project X-Fire NZ: Preparing New Zealand for Extreme Fire. Collaboration with the Scion Forest Research (NZ), Missoula Fire Lab (USA), San Jose State University (USA), University of Canterbury (NZ), and UNSW (Australia). Funded by New Zealand Ministry for Business, Innovation and Employment. Project Firewhirl: Vorticity Effects in Wildfires. Collaboration with University of Coimbra (Portugal), University of Science and Technology of China, UNSW (Australia). Funded by European Commission.
<i>Fire surveillance and hazard mapping</i>	International conference presentations include: Asian Conference on Remote Sensing; World Engineering Conference on Disaster Risk Reduction; Congress for the International Society for Photogrammetry and Remote Sensing; EARSeL Forest Fire Special Interest Group Workshop; ForestSAT of the Remote Sensing and Photogrammetry Society.

PROJECT	INTERNATIONAL COLLABORATIONS
<i>Threshold conditions for extreme fire behaviour</i>	Collaboration University of Edinburgh and Tomsk State University.
<i>Improved predictions of severe weather to reduce community impact</i>	Collaboration on fire weather with the UK Met Office, Leeds University, the European Centre for Medium Range Weather Forecasting, and the South African Weather Service.
<i>Developing better predictions for extreme water levels</i>	Project leader is the science theme leader for natural hazards in the Indian Ocean region as part of the International Indian Ocean Expedition-II, University of Southampton. Collaborations on tsunami research with Civil and Coastal Engineering Department, University of Florida.

APPENDIX 6: STUDENTS

SCHOLARSHIP STUDENTS

NAME	UNIVERSITY	PHD COMMENCEMENT	PROJECT NAME
Avianto Amri	Macquarie	Jul-14	A cross cultural investigation of child-centred disaster risk reduction and climate change adaptation in Indonesia and Australia
Heather Bancroft	Melbourne	Jun-14	The impact of individual factors and operational organisational resources and demands on mental health outcomes
Shauntelle Benjamin	UNE	Jan-17	Why do people decide to drive through floodwater? Utilising virtual reality to assess motivations and behaviour associated with driving through floodwater
Bill Calcutt	Wollongong	Feb-14	Valuing volunteers – better understanding the primary motives for volunteering in Australian emergency services
Andrew Clarke	CQU	Oct-15	An evaluation of key fire safety messages and their efficacy when applied under varying degrees of stress
Miles Crawford	Massey	Jun-15	How risk informs natural hazard management: a study of the interface between risk modelling for tsunami inundation and local government policy and procedure
Amila Dissanayake	RMIT	Jul-15	Fire resilience of existing composite steel plate girder bridges
James Furlaud	UTas	Jul-15	How do wet eucalypt forests burn: managing Tasmania's most dangerous fuel type
Grigorijs Goldbergs	CDU	Dec-14	Remote sensing of tree structure and biomass in north Australian mesic savanna
Bryan Hally	RMIT	Mar-15	Attribution of active fire using simulated fire landscapes
Matthew Henry	CQU	Jan-16	Comprehensive school safety: developing a framework for the Australian school setting
Mitchell Humphreys	JCU	Feb-16	Wind induced internal pressures in industrial buildings
Sue Hunt	ANU	Feb-14	The National Strategy for Disaster Resilience: getting it right from top to bottom
Fiona Jennings	RMIT	Aug-14	Community volunteering and disaster recovery
Farook Kalendher	RMIT	Jul-13	Synthetic damage curves for concrete girder bridges under flood hazard
Thomas Kloetzke	Queensland	Jul-15	Analysis and simulation of surface wind fields during landfalling tropical cyclones
Roozbeh Hasanzadeh Nafari	Melbourne	Mar-15	Flood damage assessment in urban areas



APPENDIX 6: STUDENTS

NAME	UNIVERSITY	PHD COMMENCEMENT	PROJECT NAME
Maryam Nasim	RMIT	Jul-15	Investigation into the behaviour of a U-slab bridge due to flood
Mercy Ndalila	UTas	Feb-15	Pyrogeography of Tasmania: understanding how forest type and bushfire history influence smoke emissions
Korah Parackal	JCU	Mar-15	An analytical technique for determining the redistribution of structural load effects with increasing wind loads
Gabriela Raducan	RMIT	Mar-14	The impacts of bushfires on water quality
Timothy Ramm	UTas	Feb-15	Advancing long-term planning and decision analysis to improve the resilience of communities against changing coastal risk
Mayeda Rashid	CQU	Jul-15	Child-centred disaster risk reduction: achievements, challenges and scope
Graeme Riddell	Adelaide	Feb-14	Methods to develop long term, efficacious risk mitigation policies
Dario Rodriguez Cubillo	UTas	Dec-16	Landscape ecology of fire: lessons from Tasmanian wilderness.
Heather Simpson	Wollongong	Jul-15	Productivity and effectiveness of suppression resources and tactics on large fires
Emma Singh	Macquarie	Jan-14	Network disruptions during long-duration natural hazard events
Michael Storey	Wollongong	Mar-16	Empirical analysis of spot-fire and ember behaviour during extreme fire weather conditions
Steve Sutton	CDU	Jan-15	Cultural drivers of disaster response behaviour and their cross-cultural applicability
Christopher Thomas	UNSW	Sep-15	An investigation of the dynamics of fire-fire interactions using a coupled fire-atmosphere model
Kate van Wezel	CDU	Mar-15	Including women in fire management on Waanyi and Garawa lands
Rahul Wadhvani	Victoria	Nov-14	Refinement of the submodels of pyrolysis and firebrand transport and undertaking experiments to validate those for a physics-based bushfire prediction model
Houzhi Wang	Adelaide	Jan-15	Initiation of biomass smouldering combustion
Rachel Westcott	Western Sydney	Jul-14	The interactions between emergency responders and animal owners in bushfire: improving community preparedness and response outcomes
Mengran Yu	Sydney	Mar-15	Modelling the effect of fire on the hydrological cycle

APPENDIX 6: STUDENTS

COMPLETED 2014/15

NAME	UNIVERSITY	PHD COMMENCEMENT	COMPLETION DATE	PROJECT NAME
Steven Curnin	UTas	Jan-12	Jun-15	Spanning boundaries to support effective multi-agency coordination in emergency management
Grace Vincent	Deakin	Feb-12	May-15	Fighting fires and fatigue

COMPLETED 2015/16

NAME	UNIVERSITY	PHD COMMENCEMENT	COMPLETION DATE	PROJECT NAME
George Carayannopoulos	Sydney	Jun-11	Jul-16	Whole of government and crisis management, understanding coordination in a time of crisis
Veronique Florec	Western Australia	Jul-11	May-16	Economic analysis of prescribed burning for wildfire management in the south west of Western Australia
Brianna Larsen	Deakin	Jul-11	Oct-15	Simulated self-paced fire suppression
Phillip Stewart	Queensland	Apr-13	Jan-16	Changing fire regimes of the great sandy region of south eastern Queensland
Rene van der Sant	Melbourne	Jun-11	May-16	Aridity index as a predictor of the hydrogeomorphic response of burnt landscapes
Alex Walkow	Deakin	Jan-12	Dec-15	Sleep restriction across a simulated firefighting deployment: the impact on acute stress response



APPENDIX 6: STUDENTS

COMPLETED 2016/17

NAME	UNIVERSITY	PHD COMMENCEMENT	COMPLETION DATE	PROJECT NAME
Cathy Cao	Western Australia	Apr-11	Mar-17	Effective communication of household bushfire risk through web-based geovisualisation: considerations in content, representation and design
Yang Chen	Monash	Aug-13	Jun-17	Modelling forest fuel temporal change using LiDAR
Graham Dwyer	Melbourne	Mar-15	Jun-17	We have not lived long enough: sensemaking and learning from bushfire in Australia
Dolapo Fakuade	Canterbury	Oct-13	Apr-17	Integrated response as a process for enhancing emergency management
Vaibhav Gupta	RMIT	Jul-11	Dec-16	Remote sensing of fire severity in Australian dry sclerophyll forests
Billy Haworth	Sydney	Jan-14	Feb-17	Volunteered geographic information, community engagement and bushfire preparation
Rachel Quill	UNSW	Jul-14	Jan-17	Spatial-statistical characterisation of wind fields over complex terrain for bushfire modelling applications
Caroline Wenger	ANU	Jan-13	Jan-17	Flood management in a changing climate: integrating effective approaches

APPENDIX 6: STUDENTS

COMPLETED 2017/18

NAME	UNIVERSITY	PHD COMMENCEMENT	COMPLETION DATE	PROJECT NAME
Melanie Baker-Jones	QUT	Jul-14	Sep-17	Web 2.0 in disaster and emergency: a risk assessment of tortious liability
David Barton	RMIT	Jul-11	Dec-17	Disaster in relation to attachment, loss, grief and recovery: the Marysville experience
Douglas Brown	Sydney	Mar-10	Feb-18	Bushfire risk perception: a study of the perceived vulnerability of domestic architecture in Australian bushfire prone areas
Wasin Chaivarnont	UNSW	Mar-14	Aug-17	How does remotely sensed degree of curing and fuel load vary in grasslands and effect modelled fire spread?
Sarah Hall	Deakin	Mar-14	Sept-17	Sleep and stress in on-call fire and emergency service workers
Alex Holmes	Monash	Mar-15	Nov-17	Improving fire risk estimation through investigating fire intensity, moisture and temperature anomalies
Ryan Hoult	Melbourne	Oct-14	Sept-17	Seismic assessment and design philosophy of reinforced concrete walls in Australia
Charles Newland	Adelaide	Mar-14	May-18	Improved calibration of spatially distributed models to simulate disaster risk
Tetsuya Okada	Macquarie	Aug-12	Oct-17	Post-disaster recovery following recent natural hazard events and risk reduction measures in Australia and Japan
Kamarah Pooley	QUT	May-15	Jul-17	Preventing youth misuse of fire in New South Wales: an empirical evaluation
Sonja Maree van Nieuwenhoven	Melbourne	Mar-15	Jul-17	Planning for bushfires on the rural-urban interface: an analysis of the correlations between house setbacks and house loss as evidence of house-to-house fire spread in the 2009 Victorian bushfires
Ashley Wright	Monash	Mar-14	Dec-17	Improving flood forecast skill using remote sensing data



APPENDIX 6: STUDENTS

ASSOCIATE STUDENTS

NAME	UNIVERSITY	PHD COMMENCEMENT	PROJECT NAME
Joji Abraham	Federation	Jan-15	Fire and heavy metals: when wild and controlled fires transform un-rehabilitated mining waste
Anita Amirsardari	Melbourne	Feb-14	Assessing the seismic performance of reinforced concrete gravity moment resisting frames in Australia
Raven Marie Cretney	RMIT	Aug-13	The post-disaster city: Urban crisis, politics and social change in community-led earthquake recovery
Antara Dasgupta	Monash	Jul-15	Towards a comprehensive data assimilation framework for operational hydrodynamic flood forecasting
Darryl Dixon	Charles Sturt	Jun-12	Emergency service exposure to asbestos
Akvan Gajanayake	RMIT	Aug-16	Measuring social, environmental and economic consequences of road structure failure due to natural disasters
Angela Gormley	Sydney	Jan-16	Effects of surface litter by forest classification on fuels and fire behaviour in Hornby Shire
Lesley Gray	Otago	Sep-16	Preparing for the big one: disaster risk reduction for morbid obesity
Sam Hillman	RMIT	Mar-17	The utility of point clouds to estimate fuel hazard
Revathi Krishna	Monash	Mar-16	Coping with disasters by children and families who live in poverty
Diana Kuchinke	Federation	Dec-10	Effects of fire on the woodland birds of western Victoria.
Benjamin Martin	CQU	Mar-15	The role of the emergency management sector in the implementation of children's disaster education
Andrea Massetti	Monash	Mar-16	Remote sensing applied to bushfire
Daniel May	ANU	Mar-15	Taking fire: The political and cultural influence of Indigenous burning in settler societies
Sean Morling	RMIT	Jul-14	Using GIS to predict and mitigate erosion and sediment transfer following a bushfire
Prananda Navitas	QUT	Oct-15	The impact of prior disaster experience and disaster risk perception on adaptive behaviour
Liberty Pascua	Sydney	Jul-16	Precarious places, precarious knowledges: disaster risk reduction education in Australia, the Philippines, and Vanuatu

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NAME	UNIVERSITY	PHD COMMENCEMENT	PROJECT NAME
Grant Pearce	Canterbury	Mar-14	New Zealand fire climate severity: relationships between climate circulation, seasonal fire danger and fire occurrence
Nicholai Popov	Wollongong	Feb-13	The impact of leadership development on organisational citizenship behaviour and social capital: an intervention using self-determination theory
Kaitlyn Porter	QUT	Feb-16	What role could pharmacists play in optimising medicine management in humanitarian aid crises
Ismail Qeshta	RMIT	Aug-15	Strengthening of bridge superstructure to enhance resilience under exposure to flood loading
Shahriar Rahman	Macquarie	Apr-16	Development of a stochastic fire effect model in predicting the impacts of fire severity on vegetation
Nick Read	Melbourne	Jan-14	Models for lightning-caused wildfire ignition
Simone Ruane	Curtin	Mar-16	Planning for bushfire risk at the urban bushland interface: a local adaptive governance approach
Mitchell Scovell	JCU	Aug-16	An investigation of the psychosocial factors that influence cyclone mitigation behaviour in homeowners
Ken Strahan	RMIT	Aug-13	Household decision making in bushfire self evacuation
Mittul Vahanvati	RMIT	Jan-12	Post-disaster housing reconstruction as a means of enhancing disaster resilience
Sean Walsh	Melbourne	Jun-16	Combining fire, microclimate and vegetation models to predict the outcomes of hazard management practices at fine spatial resolution
Chathura Wickramasinghe	RMIT	May-15	Multi-resolution, high temporal fire monitoring and intensity mapping using AHI
Yang Zhang	UNSW	Sep-14	Understanding spatial patterns of wildfire occurrence in south-eastern Australia

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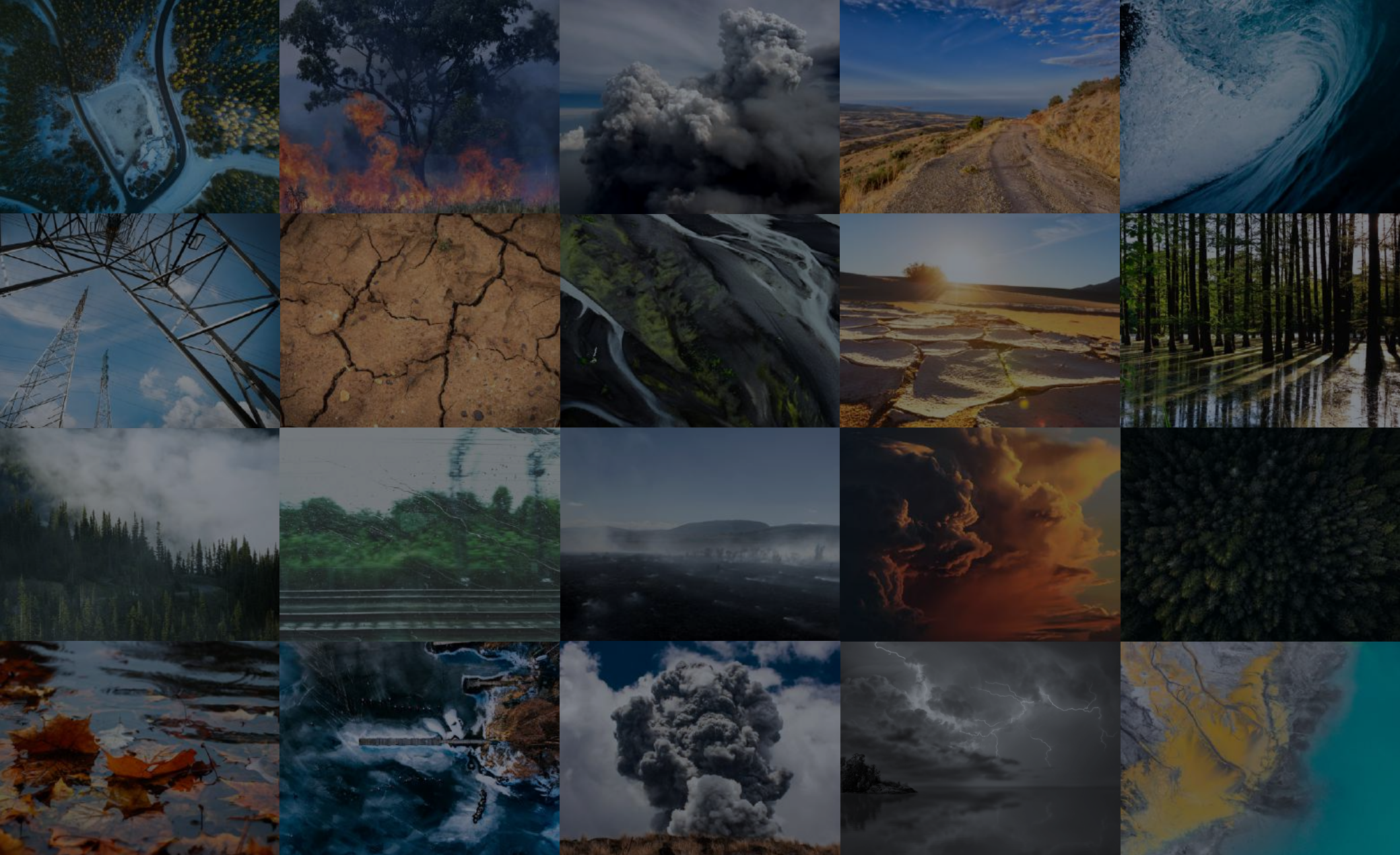
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