bushfire&natural HAZARDS CRC

RESEARCH PROJECTS

THE RESEARCH CHALLENGE

In the last decade, we have seen natural disasters cause more damage and destruction across Australasia and our neighbouring region than ever before.

Fire, flood, cyclone, earthquake, tsunami and heatwave cause injury, death and widespread damage. The full impacts of these disasters often remain poorly quantified, but continue to be felt through their long-term consequences for individuals, communities, infrastructure, the landscape, and the economy.

Population growth and changing demographics feature highly among the factors that have increased exposure and vulnerability to natural disasters. A growing, ageing and more multi-cultural population places significant pressure on government policy, particularly around risk communication, land-use planning and infrastructure development.

The policies and settlement patterns of the past are proving inadequate for the challenges of the future and in many instances are intensifying the exposure to risk.

These issues are a challenge for the Bushfire and Natural Hazards CRC.

The national research capacity is driving our ability to think differently about how to deal with natural disasters into the future.

– Dr Richard Thornton,
Chief Executive Officer,
Bushfire and Natural Hazards CRC

A RESEARCH PROGRAM FOR BUSHFIRE AND NATURAL HAZARDS

The Bushfire and Natural Hazard CRC is conducting research to build a disaster-resilient Australia.

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.

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

From July 2013, $47 million over eight years in Australian Government funds under the Cooperative Research Centres Program have been matched by support from state and territory government organisations, research institutions and NGOs.

Research partners include universities, Bureau of Meteorology and Geoscience Australia, and several international research organisations.

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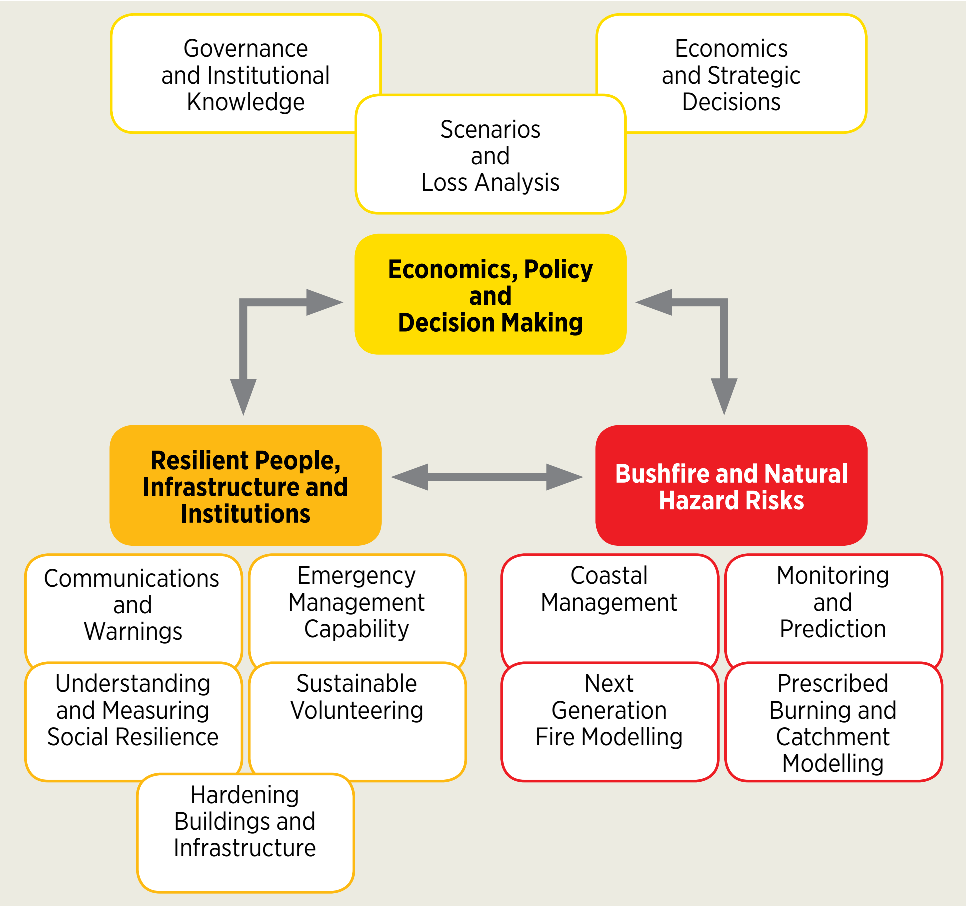
The research program has developed under the direction of the researchers and end-user agencies. The research has three major themes covering 12 clusters of projects, most of which span the priorities of those working in a multi-hazard environment.



PEOPLE AT THE CRC

Governance

The Bushfire and Natural Hazards CRC is an incorporated not-for-profit public company limited by guarantee. It is managed through a central office co-located with the Australasian Fire and Emergency Service Authorities Council in Melbourne. It has a skills-based Board of Directors elected by its members. The Board is chaired by an independent Director, Dr Laurie Hammond. The Chief Executive Officer is Dr Richard Thornton.

Name	Organisation
Dr Laurie Hammond	Independent
Mr Stuart Ellis	AFAC
Ms Kathy Gramp	Independent
Commissioner Lee Johnson	Queensland Fire and Emergency Services
Commissioner Craig Lapsley	Emergency Management Victoria
Mr David Place	South Australian Fire and Emergency Services Commission
Prof Alistar Robertson	Independent
Mr Tony Sheehan	Attorney-General's Department
Ms Naomi Stephens	Office of Environment and Heritage, NSW

From left: Ms Naomi Stephens, Prof Alistar Robertson, Commissioner Lee Johnson, Dr Laurie Hammond, Ms Kathy Gramp, Mr Stuart Ellis, Mr David Place and Mr Tony Sheehan (Absent: Commissioner Craig Lapsley).

Staff

Name	Position/Role
Dr Richard Thornton	CEO
Dr Michael Rumsewicz	Research Manager
David Bruce	Communications Manager
Leanne Beattie	Executive Assistant
Trevor Essex	Business Manager
Desiree Beekharry	Projects Officer
Lyndsey Wright	Contract Research and Education Manager
Vaia Smirneos	Communications Officer (Events)
Nathan Maddock	Communications Officer
Brenda Leahy	Research Utilisation (AFAC)

From left: Vaia Smirneos, Nathan Maddock, Brenda Leahy, Dr Michael Rumsewicz, Leanne Beattie, Lyndsey Wright, Dr Richard Thornton and David Bruce (Absent: Trevor Essex and Desiree Beekharry).

Participants

Government and Agencies

Attorney-General's Department

Bureau of Meteorology

Geoscience Australia

ACT Emergency Services Agency

ACT Territory and Municipal Services

Fire and Rescue NSW

Office of Environment and Heritage, NSW

NSW Rural Fire Service

NSW State Emergency Service

NT Fire and Rescue Service

Queensland Fire and Emergency Services

SA Fire and Emergency Service Commission

Tasmania Fire Service

Country Fire Authority, VIC

Metropolitan Fire and Emergency Services Board

Department of Environment, Land, Water and Planning, VIC

Emergency Management Victoria

Victorian State Emergency Service

Department of Fire and Emergency Services, WA

Department of Parks and Wildlife, WA

New Zealand Fire Service Commission

Academic and Research

Australian National University

Central Queensland University

Charles Darwin University

Deakin University

James Cook University

Macquarie University

Monash University

Queensland University of Technology

RMIT University

University of Adelaide

University of Canberra

University of Melbourne

University of New England

University of Southern Queensland

University of Sydney

University of Tasmania

University of Western Australia

University of Western Sydney

University of Wollongong

Victoria University

Associations

AFAC

Australian Red Cross

Fire Protection Association Australia

RSPCA QLD

Volunteering Queensland

Collaborations

Australian Local Government Association

Department of Community Safety and Emergency Services, Queensland

Department of Transport and Main Roads

DLR - German Aerospace Centre

Lockyer Valley Regional Council

Los Alamos National Laboratory

Massey University

NAILSMA

Queensland Department of Housing and Public Works

Queensland Reconstruction Authority

Roads and Maritime Services, NSW

Save the Children

Southern Rural Fire Authority, New Zealand

United Nations University

University of Alberta, Canada

University of Canterbury, New Zealand

University of Gothenburg, Sweden

University of Twente, Netherlands

Education

A postgraduate student program supports and extends the broader research activities of the CRC.

Scholarships provide funds for up to three and a half years in addition to industry expertise and mentoring, conference travel support, research promotion and professional development opportunities.

An associate student program is open to students conducting research in relevant areas but not already directly involved with the CRC. This research is of significant interest to CRC stakeholders, including research partners and end-users.

Outreach

The Bushfire and Natural Hazards CRC makes a coordinated effort to promote the research program in as many relevant forums as possible.

A program of interactive and engaging events and publications for the natural hazards sector and for the research community as well as the general public is a key part of promoting the research of the CRC.

The annual conference, held jointly with the Australasian Fire and Emergency Service Authorities Council, attracts more than 1000 people from the emergency services sector and from research organisations, and increasingly, from fields including government, fire protection, health, and utilities. The week of activities includes presentations, professional development sessions and field tours around a multi-hazard theme.

Research is featured in the quarterly magazine, *Fire Australia*, and in regular research briefing papers, *Hazard Notes*, and promoted to communities across Australia and internationally through the media, online media and industry publications.

ECONOMICS, POLICY AND DECISION MAKING

This theme deals with economics and the interface between risk-based priorities and the decisions that allocate resources for the greatest benefit.

Governance and institutional knowledge

Lead End User: John Schauble, Emergency Management Victoria

Research Leader: Dr Stephen Dovers, Australian National University

Policies, institutions and governance of natural hazards

Lead Research Organisation: The Australian National University

Project Leader: Associate Professor Michael Eburn

This research project is shedding light on policy, institutional and governance arrangements to develop new approaches on shared responsibility to increase community resilience across all natural hazards.

The research is building on important issues exposed in recent Bushfire CRC and NCCARF projects by the researchers. Over three related themes it is considering issues of policies, institutions and governance across the entire "Prevent, Prepare, Respond and Recover" spectrum.

Theme 1: Legal and policy barriers to effective community engagement. This research is identifying the barriers to more active community involvement in emergency management. It will identify solutions, either in reform of policy and governance structures and processes, or their practical applications.

Theme 2: Perverse incentives for active involvement in emergency management. The project is exposing the incentives hidden in policies, institutions and governance arrangements that may inhibit the rebuilding of communities after disasters.

Theme 3: The use of Royal Commissions and other post event inquiries. Post-event reviews such as Royal Commissions and coronial inquests and inquiries do not adequately identify and respond to future threats, challenges and vulnerabilities. This project is looking at how best to review the impact of natural hazard events to help communities prepare for the next impact, rather than focus on the last one.

Scientific diversity, scientific uncertainty and risk mitigation policy and planning

Lead Research Organisation: University of Western Sydney

Project Leader: Dr Jessica Weir

A better understanding of the role of science in decision-making will help industry articulate and defend decisions to the community, media, inquiries and elsewhere, and, better frame information and advice on how scientists and professionals communicate.

The project has four components:

1. Exploring how people have different understandings of the science of flood and bushfire risk.
2. A focus on flood and bushfire mitigation activities in urban, peri-urban and rural locales in southeast Australia. This will include sites where flood and fire risk are combined, such as catchment and riparian vegetation management upstream and downstream of large metropolitan water storages.
3. Considering bushfire and flood risk across the spectrum of Prevent, Prepare, Respond and Recover, with an emphasis on mitigation activities.
4. Informing bushfire and flood mitigation practice, policy and planning, and engaging with the experiences of practitioners.

Economics and strategic decisions

Lead End User: Ed Pikusa, SAFECOM

Research Leader: Professor Holger Maier, University of Adelaide

Economics of natural hazards

Lead Research Organisation: University of Western Australia

Project Leader: Professor David Pannell

Decision makers require information about: risks of fire occurrence, risks of fire spread, frequencies of fires of different severities, impacts of weather conditions on these things, losses associated with bushfires of different severities, reductions in those losses under different prescribed burning regimes, and costs of different prescribed burning regimes. This information must be combined to illuminate the merits of different decision options.

For hazards such as earthquakes, floods, cyclones and tsunamis, similar observations apply. This project aims to fill key knowledge gaps in these areas. It spans issues related to values, risks, and decision making to deliver value for money from public investments in natural hazard management.

The project is considering these questions:

1. Which strategies for managing natural hazards offer the best value for money?

2. How can we value the social and environmental benefits of management?
3. How should emergency budgets be set, recognising the variability of need?
4. What are the requirements for sound economic analysis of natural hazard management?

Pre-disaster multi-hazard damage and economic loss estimation model

Lead Research Organisation: The University of Melbourne

Project Leader: Professor Abbas Rajabifard

The emergency response system in Australia has proven to be effective in saving lives but the mitigation and preparedness phases in disaster risk reduction appears to be less successful in minimising the adverse economic impacts of natural disasters.

This project is investigating, at the national level, the economic impact of natural disasters on sectoral growth of the Australian economy. At the state level, it is assessing the multi-hazard risks and estimating potential damages and economic losses. This will be followed by identifying the optimum economic policy option to recover or minimise such adverse effects. This project is focussing on Victoria, with emphasis on three types of natural disasters – bushfires, flood and earthquakes.

The specific sectors for which economic growth impact of natural disasters are being considered include 19 sectors in the National Accounting System of Australia – agriculture, forestry and fishing; mining; manufacturing; food, beverage and tobacco products; electricity, gas, water and waste services; construction; wholesale trade; retail trade; accommodation and food services; transport, postal and warehousing; information media and telecommunications; financial and insurance services; rental, hiring and real estate services; professional, scientific and technical services; administrative and support services; public administration and safety; education and training; health care and social assistance; arts and recreation services; and other services.

Decision support system for assessment of policy and planning investment options for optimal natural hazard mitigation

Lead Research Organisation: The University of Adelaide

Project Leader: Professor Holger Maier

The project is developing decision support tools that enable the impact of different policy and planning options on various economic, environmental and/or social objectives to be assessed. This will enable the best possible disaster mitigation options to be identified, thereby increasing disaster preparedness, as well as reducing disaster impact and the cost of disaster response and rehabilitation.

Previous research has not taken into account the use of optimisation and taking a multi-hazard approach, when assessing mitigation options. Land use is a critical component of this risk, and land use planning measures are the main means of minimising this risk. However, research to date has not considered how land use will change into the future. Furthermore, research has not considered the impacts of climate change. This research is considering optimisation with a multi-hazard approach.

Better information based on this approach should lead to more strategic and less responsive decisions for mitigating the impact of disasters and natural hazards.

Mapping and understanding bushfire and natural hazard vulnerability and risks at the institutional scale

Lead Research Organisation: Victoria University

Project leader: Professor Roger Jones

Current government spending on natural disaster response is more than 20 times spending on preparedness. Many climate-related natural hazards are increasing and the number of people living in hazard prone areas is also increasing. Large natural disasters can also cross domains, moving from the private to the public realm, and shifting from a local, to a state or national concern. This raises the potential of future, unmanaged risks.

The spending mismatch is well understood, but we also face potential deficits in important social and environmental values that may not be adequately compensated. If a risk is owned then we can assess the balance between preparedness and response. If the risk is un-owned, these values may be damaged and degraded, or lost.

The project is mapping a broad range of economic, social and environmental values and relating these to natural hazards across several case studies. The project is exploring who owns these values and what happens when they cross domains. It will then explore how a range of alternative strategies may contribute to improved resilience by sustaining economic, social and environmental values in a changing environment. A governance framework illustrating such strategies will be created.

Scenarios and loss analysis

Lead End User: Corey Shackleton, NSW Rural Fire Service

Research Leader: Dr Katharine Haynes, Macquarie University

An analysis of building losses and human fatalities from natural disasters

Lead Research Organisation: Macquarie University

Project Leaders: Dr Rob van den Honert and Dr Katharine Haynes

This project is analysing building losses and human fatalities from natural disasters in Australia. It is measuring the impacts of natural disasters in order to provide an evidence base for emergency management policy and practice.

The foundation for this work is the Risk Frontiers data base *PerilAUS*. This is an authoritative database of Australian natural hazard events that have resulted in either loss of life or damage to property. The database contains historical data dating back to European settlement on the incidence and consequences of such events.

This project is providing an analysis of building damage by hazard and by state and territory due to natural hazards since 1900, and a longitudinal analysis of the social and environmental circumstances in respect to fatalities, injuries and near misses. These trends will be interpreted in the context of emerging issues such as an ageing population, population shifts and climate change, and how these issues might influence vulnerability and exposure trends in the future.

Using realistic disaster scenario analysis to understand natural hazard impacts and emergency management requirements

Lead Research Organisation: Macquarie University

Project Leaders: Dr Matthew Mason (University of Queensland), and Dr Felipe Dimer de Oliviera (Macquarie University)

Realistic disaster scenarios help us better understand disasters. They allow end-users to visualise potential impacts before disasters happen and proactively plan for these events. In this project, realistic disaster scenarios are being developed using catastrophe loss models so that vulnerable areas, utilities and assets within our major cities can be identified.

The scenarios will quantify the impacts on society, critical infrastructure, lifelines and buildings, and the natural environment. This information will allow end-users to understand the implications of these events for their agencies and their industries so they can better prepare for, or mitigate the impacts of events that are beyond their experience.

The hazards being considered are earthquake, tropical cyclone, flood, tsunami and bushfire.

The project will develop a modelling framework so the impacts of hazard events can be quantified.

RESILIENT PEOPLE, INFRASTRUCTURE AND INSTITUTIONS

This theme aims to improve the conceptualisation of resilience and the factors that both promote and inhibit its development. Improved understanding of these factors will optimise the development of a capability to identify vulnerability, manage the risk and enable resilience.

Communications and warnings

Lead End User: Andrew Richards, NSW State Emergency Service

Research Leader: Professor Vivienne Tippett, Queensland University of Technology

Child-centred disaster risk reduction

Lead Research Organisation: Central Queensland University

Project Leader: Professor Kevin Ronan

Children represent the most vulnerable demographic group in disasters – with estimates of 30-50% of fatalities being children. They are also most vulnerable to psychosocial impacts. Early research indicates that they are a resource for reducing current disaster risks and can also mitigate future risks.

The role of children's disaster education in managing risk has been recognised as a major priority in the National Strategy for Disaster Resilience by the Australian Government. Yet, despite a recent surge in child-centred disaster research, the social, psychological, economic and political mechanisms that enable children to both understand and take action to reduce disaster risk remain largely unexplored and the evidence-base for best-practice remains limited.

A promising approach to supporting children's active engagement in disaster risk reduction is referred to as Child-Centred Disaster Risk Reduction. Its aim is to strengthen children's skills so that they understand the disaster risk in their communities and are able to take a lead role in reducing that risk. While it is becoming increasingly popular amongst government and non-government agencies and organisations around the world, rigorous empirical research on the efficacy of the approach is scarce.

This project is conducting a nationwide evaluation of programs and strategies based on a Child Centred-Disaster Risk Reduction framework.

Managing animals in disasters: Improving preparedness, response, and resilience through individual and organisational collaboration

Lead Research Organisation: University of Western Sydney

Project Leader: Dr Melanie Taylor

Consideration of animals can impact on people's decision making and behaviour during natural disasters, which may cause issues for the safety of both the public and emergency responders.

The aim of this project is to identify best practice approaches to the management of animals in disasters that result in improved outcomes for public safety, longer term mental and physical health of emergency services responders, those with animal-related businesses, community members and their communities.

The project is developing prototype support tools to assist operational response, communication and professional development. These include training resources, guidelines, or engagement materials.

In this project animals include domestic pets, commercial animals, livestock, and wildlife. Animal owners may include pet owners, small-scale animal related business owners, livestock producers, and those concerned with and interested in wildlife (for example, wildlife carers, rural dwellers). Similarly, responders will be drawn from a broad range of groups, such as emergency services, Local Government, RSPCA officers, Parks and Wildlife rangers, NGOs, general practitioners, veterinarians, and volunteer organisations.

Improving the role of hazard communications in increasing residents' preparedness and response planning

Lead Research Organisation: University of Melbourne

Project Leaders: Associate Professor Jennifer Boldero and Dr Illona McNeill.

The increasing frequency and complexity of natural hazards poses a challenge for community resilience. Communication and education of risk mitigation strategies play an essential role in building and maintaining resilience through preparation and planning by residents.

However, little is known about the relative effectiveness of existing hazard communications and education strategies (i.e. the extent to which they influence the amount and quality of residents' preparedness and planning behaviours for natural hazards). Also, to improve the current effectiveness of these strategies, we need to determine what are some of the key barriers and enablers to preparedness and planning.

This project is identifying barriers and enablers in residents' decision making, preparing, and planning with regard to natural hazards. It is examining residents' intended use of different types of triggers for action during hazards; for example when to start evacuating and what information source to use. It is investigating why some residents form a better quality household plan with safer intended triggers than other residents.

This will provide recommendations for end-users regarding the communication of action triggers to residents during actual hazards. This project is focussing on aspects that will lead to safer responses during disasters, and on aspects that will facilitate recovery post-disaster, for recurring hazards such as bushfires, floods, and cyclones/storms

Connecting communities and resilience: A multi–hazard study of preparedness, response and recovery communications

Lead Research Organisation: Queensland University of Technology

Project Leader: Professor Vivienne Tippett

This project is examining strategies that motivate appropriate action and informed decision-making during the response and recovery phases of natural disasters.

It is combining expertise in communication, consumer psychology and marketing, disaster and emergency management, and law. The project adopts a multi-hazards approach to examine the effectiveness of response and recovery communication in communities (made up of individuals, groups, and businesses) affected by floods, cyclones, fires, and earthquakes

This research is:

- Examining the content and delivery strategies of official emergency messages.
- Developing evidence-based advice to guide trigger communications during hazards.
- Analysing the effectiveness and efficiency of official emergency messages in the response and recovery phases.
- Promoting both community and end-user understanding of the psychological and legal motivators for maximising engagement with response plans and emergency instructions.
- Examining opportunities for application of new technology and communication systems maximise the comprehension and compliance of communities at risk.

Community understanding of the tsunami risk and warnings systems in Australian communities

Lead Research Organisation: University of Tasmania

Project Leader: Professor Douglas Paton

This project aims to better understand the factors that shape community resilience to tsunami in Australia, and effective tsunami warning risk communication.

Public understanding of the limitations of Australia's official tsunami warning systems has been found to be limited in many communities. Reliance on actual and perceived siren systems for public notification during tsunami events has been found to increase the risk to citizens and may increase the risk of fatalities and injuries. Public inability to interpret natural warnings for tsunami, and make decisions about appropriate actions, also places increased responsibility upon emergency management practitioners and other hazard education and public safety agencies to educate the public.

This research is evaluating the gaps in public understanding of risk and intended response to official and natural warnings for tsunami and to explore why the push for siren-based systems continues throughout many Australian communities. The outputs of the research will enable us to recommend more effective use of resources and methods to engage with and educate the public about tsunami, natural warnings, and the limitations of technology-based systems such as sirens.

Emergency management capability

Lead End User: Keith Fitzgerald, NSW State Emergency Service

Research Leaders: Dr Paul Barnes, Queensland University of Technology; Dr Chris Bearman, Central Queensland University.

Capability needs for emergency and disaster management organisations

Lead Research Organisation: Queensland University of Technology

Project Leader: Dr Paul Barnes

This study is examining the in-depth lessons from historical emergencies and disasters by engaging with state and federal response agencies, as well as those supporting response and recovery, and local government. The project is examining options for defining agile and sustained skills sets across the full cycle of disaster management.

This study is also enhancing planning mechanisms for the delivery of effective disaster response and efficient recovery strategies for future emergencies. The combination of capability gap analysis and scenario-based futures-based thinking will allow the formation of scaled descriptions of capability along a continuum of increasing effectiveness, adaptability and sophistication to contribute to strengthening community resilience.

This knowledge is critical because within the context of modern disaster situations, institutions would be unlikely to face single incidents but rather a series of systemic failures, often appearing concurrently. Emergent complexities in linked systems make crises difficult to anticipate and consequences difficult to plan for. Furthermore, under emergency conditions the pressure on senior decision-makers to 'make sense' of multiple lines of information (for both crisis and consequence modes) is significant.

Practical decision tools for improved decision-making in complex time-constrained and multi-team environments

Lead Research Organisation: Central Queensland University

Project Leader: Dr Chris Bearman

Agencies are facing growing pressures from larger-scale natural hazards, financial constraints and from declining volunteer numbers. Conversely, there is a decreasing tolerance in the community and political spheres to failures in emergency management coordination.

One consequence of response and recovery becoming more complex is that people are more likely to become overwhelmed. If people are overwhelmed they are more prone to errors and breakdowns, which impair the operational response.

This project is developing ways to help people cope in these more complex situations and providing strategies to facilitate operational recovery following breakdowns or errors.

The researchers are working with agencies to develop practical ways to help people cope in complex situations and better recover from breakdowns and errors.

The outcomes will include:

- Cognitive decision strategies: These can help people at strategic levels to better deal with complex situations.
- Team monitoring strategies: For strategic level supervisors to better monitor the performance of their teams.
- Process based performance metrics: These can be used to better examine the effectiveness of the response.

Hardened infrastructure projects

Lead End User: Leesa Carson, Geoscience Australia and Ralph Smith, DFES

Research Leader: Professor Mike Griffith, University of Adelaide

Cost-effective mitigation strategy development for flood prone buildings

Lead Research Organisation: Geoscience Australia

Project Leader: Dr Tariq Maqsood

The project is developing cost-effective strategies to mitigate damage to residential buildings from riverine floods. The research is providing evidence-based retrofit strategies for decisions concerning buildings with the greatest vulnerability in Australia.

Floods impact many Australian communities, while some communities are inundated repeatedly due to inappropriate urban development in flood plain areas. This results in significant logistical issues for emergency management, disruption to communities and considerable cost to all levels of government to repair damages and to enable communities to recovery. There is a need for supporting information on the cost effectiveness of mitigating the risk posed by existing buildings either through retrofit, reconstruction on the site or relocation.

This project will build on existing research to broaden the knowledge of the vulnerability of Australian building stock to flood hazard and will identify suitable retrofitting strategies.

Natural Hazard Exposure Information Modelling Framework

Lead Research Organisation: Geoscience Australia

Project Leader: Dr Krishna Nadimpalli

Exposure is defined as the elements at risk that have been, or could be, subject to the impact of natural hazards. The Natural Hazard Exposure Information Modelling Framework will address the data and knowledge gaps and requirements for disaster resilience, resource assessment, emergency management, risk mitigation policy and planning.

A disaster's severity depends on how much impact a hazard has on exposure. The scale of impact in turn depends on the decisions made as a part of disaster mitigation. Therefore, exposure information is a fundamental requirement for decision making in disaster mitigation.

This project will identify the fundamental data requirements and modelling framework to derive exposure information to enable a better understanding of the vulnerability of people, buildings and infrastructure.

The project is a significant step towards developing national exposure information capabilities in Australia. The framework will support impact assessments on people, economy, infrastructure and the environment, caused by natural hazards such as bushfires, floods, cyclones and earthquakes.

Improving the resilience of existing housing to severe wind events

Lead Research Organisation: James Cook University

Project Leader: Associate Professor John Ginger

Typically older Australian houses built prior to the mid-1980s do not offer the same level of performance and protection during windstorms as houses constructed to contemporary building standards. Given that existing houses will represent the bulk of the housing stock for many decades, practical structural upgrading solutions based on the latest research will make a significant improvement to housing performance and to the economic and social wellbeing of the community.

This project is developing the evidence base for risk mitigation by devising simple practical and economic upgrading options for existing houses. The outcomes will promote retrofit investment by home owners and provide a basis for incentives to encourage this action through insurance and government initiatives.

The primary objective is to develop cost-effective strategies for mitigating damage to housing from severe windstorms across Australia. Outputs from this project will target a range of users from policy development through to homeowners and builders on recommended actions to improve resilience of existing housing. The uptake of the research will reduce the cost of natural disasters in Australia.

Enhancing resilience of critical road infrastructure: bridges, culverts and floodways

Lead Research Organisation: RMIT University

Project Leader: Associate Professor Sujeeva Setunge

Road networks and critical road structures such as bridges, culverts and flood ways have a vital role before, during and after extreme events to reduce the vulnerability of the community being served.

A major gap in the current research is the lack of assessment techniques and tools to reduce the vulnerability of road structures to enhance both community and structural resilience. This project will develop innovative tools and techniques for implementing strategies to enhance resilience of road infrastructure to multi-hazards of floods, fire and climate change and earthquakes.

The research has commenced with close assessment of two case study regions: in Victoria and in Queensland. It will later be expanded and validated.

The outcomes of this project will include

1. Quantitative evaluation of vulnerability of road structures under multi hazards of fire, flood, earthquake and climate change: a web based tool for design and maintenance optimisation of bridges, culverts, floodways to flood, bushfire, climate change and earthquake.
2. Quantifying social, environmental and economic consequences of failure: community, emergency services staff and road/local government authorities: Community adaptation options to enhance resilience as an alternative to hardening of structures when critical road structures are damaged.
3. Input for decision support at local government and state road authorities: a new design guide for floodways, plus recommended changes to other standards.
4. A generic research methodology that can be applied to other infrastructure such as transmission towers, and water infrastructure.

Cost-effective mitigation strategy development for building related earthquake risk

Lead Research Organisation: The University of Adelaide

Project Leader: Professor Michael Griffith

The primary objective of this research is to develop cost-effective strategies to mitigate damage, injury and business disruption associated with the earthquakes in the most vulnerable buildings in Australian business districts.

Earthquake hazard has only been recognised in the design of Australian buildings since 1995. This failure has resulted in the presence of many buildings that represent a high risk to property, life and economic activity. These buildings also contribute to most of the post-disaster emergency management logistics and community recovery needs following major earthquakes. This vulnerability was in evidence in the Newcastle earthquake of 1989, the Kalgoorlie earthquake of 2010 and with similar building types in the Christchurch earthquakes. With an overall building replacement rate of two percent nationally, the legacy of vulnerable building persists in all cities and predominates in most business districts of lower growth regional centres.

This research project is drawing upon and extending existing research and capability within both academia and government to develop information that will inform policy, business and private individuals on their decisions concerning reducing vulnerability. It is also drawing upon New Zealand initiatives that make use of local planning as an instrument for effecting mitigation.

The project's scope includes all typical building construction types in Australia as specified in Australian Standard for Earthquake Loading AS 1170.4. It excludes special construction such as power plants, offshore structures, and other industrial/manufacturing structures.

While the focus of this project is on buildings, many of the project outputs will also be relevant for other Australian infrastructure such as bridges, roads and ports, while at the same time complementing other CRC project proposals for severe wind and flood.

Understanding and measuring social resilience

Lead End User: Suellen Flint, Department of Fire and Emergency Services, Western Australia

Research Leader: Dr Phil Morley, University of New England.

Scoping remote north Australian community resilience and developing governance models through action research

Lead Organisation: Charles Darwin University

Project Leader: Professor Jeremy Russell-Smith

Almost half of the north Australian community are Indigenous and the majority live in remote communities ill-served by existing emergency services.

While these communities have significant Indigenous and local knowledge allowing them to understand and interact with their traditional estate, poor health, under-investment in infrastructure, restricted communication services and flawed governance models heighten vulnerability to the increasing array of natural hazards across the region.

This project is addressing the complexities inherent in this problem by identifying and building on the existing knowledge of bushfire and natural hazards. It is developing a fine-grained understanding of how local knowledge and other capacity underpins existing risk management and post-event responses and what changes would be most effective and valued. It is also documenting how community proposed changes could best be implemented.

Two linked projects are employing a highly participatory, applied and action-oriented approach to engage many residents of remote communities and relevant stakeholders.

Northern Australian bushfire and natural hazard training

Lead Organisation: Charles Darwin University

Project Leaders: Steve Sutton and Professor Jeremy Russell-Smith

The project focusses on the development and implementation of training for the communities and habitats of all the jurisdictions of northern Australia. It is using existing or emerging community organisations as a scaffold for growing leadership and resilience.

There are few examples of advancing capacity in remote north Australia, but two are the indigenous land, fire and sea management rangers and NORFORCE. These two groups identify, encourage and employ talented and motivated community members to achieve specific land management and defence/intelligence duties. The organisations are also accumulating technical resources that may be adapted to manage natural hazards. These resources, both the human capital and infrastructure provide a foundation to significantly enhance remote community resilience in the face of bushfire and natural hazards.

The Australian Natural Disaster Resilience Index: A system for assessing the resilience of Australian communities to natural hazards

Lead Research Organisation: University of New England

Project Leaders: Dr Phil Morley and Dr Melissa Parsons

The relationship between natural hazards and communities has traditionally been viewed from a vulnerability perspective. Australia's recently adopted National Strategy for Disaster Resilience (NSDR) takes an internationally progressive approach in the application of a disaster resilience paradigm. This strategy gives communities greater options and diversity in managing natural hazards, and places natural hazard preparation, prevention, response and recovery in the context of societies learning from and adapting to change.

The NSDR recognises four characteristics of disaster resilient communities: 1) they function well while under stress; 2) they adapt successfully; 3) they are self-reliant; and 4) they have strong social capacity. Building these characteristics of disaster resilient communities is seen as a shared responsibility among individuals, households, businesses, governments and communities. Yet how could progress towards the development of these characteristics be assessed? Where are the areas of high and low disaster resilience in Australia? How could investments to develop disaster resilience be prioritised, evaluated and reported?

This project is developing an index of the current state of disaster resilience in Australian communities – the Australian Natural Disaster Resilience Index. The index will facilitate assessment, evaluation, reporting and planning for natural hazard resilience under the NSDR. Deliverables will include development of disaster resilience indicators, maps of disaster resilience at multiples scales, a state of disaster resilience report, and examples that use the index in a natural hazard resilience planning context.

Sustainable volunteering

Lead End User: David Rae, NSW State Emergency Service

Research Leader: Professor John Handmer, RMIT University.

Out of uniform: Building community resilience through non-traditional emergency volunteering

Lead Research Organisation: RMIT University

Project Leader: Professor John Handmer

Despite highly specialised and capable emergency management systems, members of the public are usually first on the scene in an emergency or disaster and remain long after official services have ceased. Citizens may play vital roles in helping those affected to respond and recover, and can provide invaluable assistance to official agencies.

Citizen participation is a key principle of disaster risk reduction and resilience building.

However, emergency management relies largely on a workforce of professionals and, to varying degrees, volunteers affiliated with official agencies. Individuals and groups working outside of this system have often been seen as a nuisance or liability, and their efforts are largely undervalued.

Given increasing disaster risk worldwide due to population growth, urban development and climate change, it is likely that 'informal' volunteers will provide much of the surge capacity required to respond to more frequent emergencies and disasters in the future.

This project has three key objectives:

- Identifying how non-traditional emergency volunteering contributes to building community resilience to disasters throughout different phases of emergency management.
- Identifying ways the emergency management sector in Australia and New Zealand can promote community resilience through support of non-traditional emergency volunteering.
- Developing and evaluating alternative models for emergency volunteering in Australia and New Zealand that are inclusive of non-traditional volunteering and volunteering organisations.

The project will deliver a range of outcomes including practical guidance for end users on how to engage with non-traditional volunteers; the development of new approaches and models for engaging non-traditional volunteers; and an assessment of possible risks and liabilities associated with the involvement of non-traditional volunteers.

Improving the retention and engagement of volunteers in emergency service agencies

Lead Research Organisation: University of Wollongong

Project Leader: Dr Michael Jones

The Australian emergency service landscape is on the cusp of change. On the one hand the frequency and impact of natural disasters is on the increase, while on the other hand the volunteer workforce who are available and able to assist communities during these crises is reducing.

A large part of the problem in retaining volunteers has been attributed to poor volunteer leadership. Volunteers are far less tolerant of poor leadership than they would be in paid occupations. Therefore effective leadership skills need to be developed to maintain effective volunteer capacity.

This project is developing a program to prepare brigade leaders and unit controllers to create more effective leadership environments. Using leading edge concepts of leadership (Self-Determination Theory and Emotional Intelligence) leaders will be able to foster volunteer environments and relationships that will empower volunteers, increase their connectedness and unlock individual competencies. Participants in the program will learn what a leader can do to improve the quality of the volunteer experience and increase the motivation, wellbeing, and retention of volunteers.

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BUSHFIRE AND NATURAL HAZARDS RISKS

This theme seeks better forecasts of likely events and precursor conditions; greater accuracy of forecast tools and more timely forecasts. This leads to increased preparedness for the impacts of natural hazards, improved communications and warnings and enhanced ability to predict and mitigate the risk.

Coastal management

Lead End User: Martine Woolf, Geoscience Australia

Research Leaders: Dr Scott Nichol, (Geoscience Australia) and Professor Charitha Pattiaratchi (University of Western Australia)

Develop better predictions for extreme water levels

Lead Research Organisation: University of Western Australia

Project Leader: Professor Charitha Pattiaratchi

The occurrence of extreme water levels can lead to loss of life and damage to coastal infrastructure. To better prepare, coastal engineers, emergency managers and planners require accurate estimates of extreme water levels

Extreme water levels result from the combination of different physical processes including tides, storm surges, tsunamis, seasonal and inter-annual mean sea level variations.

Potential impacts and hazards of extreme water level events along our coasts are significantly increasing as populations grow and mean sea levels rise. To better prepare, coastal engineers, managers and planners need accurate estimates of average exceedance probabilities for extreme water levels. The occurrence of extreme water levels along low-lying, highly populated or developed coastlines can lead to considerable loss of life and billions of dollars of damage to coastal infrastructure.

It is vitally important that the exceedance probabilities of extreme water levels are accurately evaluated to inform risk-based flood management, engineering and future land-use planning. This ensures the risk of catastrophic structural failures due to under-design or expense due to over-design are minimised.

This project is developing better predictions and forecasts for extreme water levels arising from storm surges, surface waves, continental shelf waves, meteorological tsunamis, mean sea level rise and the transition from tropical to extra-tropical cyclones.

Resilience to clustered disaster events on the coast – storm surge

Lead Research Organisation: Geoscience Australia

Project Leader: Dr Scott Nichol

Coastal communities in Australia are particularly exposed to clustered disasters, due to the impact of cyclones and tropical storms when there can be coincidence of severe wind damage, storm surge, coastal flooding and shoreline erosion. Because the climatic drivers of cyclones and severe storms are stronger during specific times these events often repeatedly impact the coast over periods of weeks, months or up to a few years. The consequences of individual events are therefore exacerbated with little or no opportunity for recovery of natural systems or communities.

The processes that drive the coincidence or clustering of natural disasters are reasonably well understood. However there is as yet no clear methodology in use to quantify the elevated risk to communities from clustered or coincident events. Typically, risk assessments are based on individual hazards against a long-term frequency baseline. This is misleading as it underestimates the true impacts of coincident or clustered events on the resources and resilience of communities.

Coastal communities are particularly sensitive to clustering because of the dynamic nature of the coast. Coastal landforms provide the physical foundation of coastal communities, as well as potentially forming natural protection to those communities. Inadequate techniques that do not take a holistic approach to the dynamic response of coastal landforms and communities to clustered events can lead to inappropriate decision-making or funding allocation.

This project is developing a methodology to quantify the impact and risk of coincident and clustered disasters on the coast, with an initial focus on storm surge, associated erosion and reshaping of the coastline and the resulting inundation and damage to buildings and infrastructure.

Monitoring and predictions

Lead End User: John Bally, Bureau of Meteorology

Research Leader: Dr Jeff Kepert, Bureau of Meteorology

Mapping bushfire hazard and impacts

Lead Research Organisation: Australian National University

Project Leader: Professor Albert Van Dijk

Government agencies, individuals and businesses need accurate spatial information on fire hazard to prevent, avoid and manage impacts. Bushfire hazard depends not only on weather but also on landscape conditions.

In Australia, fire hazard monitoring involves fire danger indices that consider mainly meteorological conditions, although a simple algorithm is used in the MacArthur Forest Fire Danger Index to calculate the 'Drought Factor Value' from antecedent weather data, intended as a rough estimate of litter moisture content.

To date, there has not been much emphasis on routinely providing and using spatial information on landscape-related hazard factors in determining fire risk. Partly, this is because of a lack of reliable, consistent, accurate and long-term information. This situation is changing, however. Several relevant satellite, airborne and mapping derived products and prediction models are now readily available to estimate important landscape variables that determine fire hazard.

This project is developing methods to produce the spatial information on critical aspects of fire hazard including fuel load and flammability. This is needed by planners, land managers and emergency services. The relevance and added value represented by these new information sources will be compared to the practical feasibility and costs of their use.

Disaster landscape attribution: Thermal anomaly surveillance and hazard mapping, data scaling and validation

Lead Research Organisation: RMIT University

Project Leaders: Professor Simon Jones and Dr Karin Reinke

This project seeks to optimise the use of earth observing systems for active fire monitoring by exploring issues of scale, accuracy and reliability, and to improve the mapping and estimation of post-fire severity and fuel change through empirical remote sensing observations. Understanding the trade-offs between sensors and their ability to map and measure fire related attributes over a range of different landscapes and fire scenarios is important.

Researchers are developing approaches that provide new information to assist fire agencies in responding to fire management tasks and future proof their practices to parallel developments in remote sensing.

The project is systematically addressing the provision of rapid, timely and high quality information from multi-scale remote sensing systems. It is developing enhanced metrics on active fire extent, intensity and configuration as well as bushfire landscape attributes.

The study aims to bridge significant information and knowledge gaps that currently prevent optimal use of earth observing technology. These include


Photo: CFS Promotions Unit

accuracy and reliability issues in active fire surveillance, quantitative estimates of post-fire severity, a lack of product validation, and out-of-date approaches to collecting information on landscape condition.

This work is leading Australian contributions to GEO / GEOSS / CEOS in this area and integrate and enhance Australian led existing disaster monitoring (e.g. the CSIRO/GA Sentinel Asia / Sentinel hotspots) and reporting systems with next generation earth observation technology and systems from the German Aerospace Center and other agencies.

Improved predictions of severe weather to reduce community Impact

Lead Research Organisation: Bureau of Meteorology

Project Leader: Dr Jeff Kepert

This project is using high-resolution modelling, together with a range of meteorological data, to better understand and predict important meteorological natural hazards, including fire weather, tropical cyclones, severe thunderstorms, and heavy rainfall. The outcomes from the project will contribute to reducing the impact and cost of these hazards on people, infrastructure, the economy and the environment.

Specific areas within the project include studies on the Blue Mountains fires of 2013; ember transport by fire plumes; pyrocumulus simulation and prediction, and heavy rain and tropical cyclone formation.

This project will to extend our successful high-resolution fire weather modelling work with the Bushfire CRC in the following directions:

1. Other weather phenomena, particularly tropical cyclones, severe thunderstorms and intense extratropical cyclones.
2. Begin to move from "deterministic" prediction of the most likely outcome, to a pilot demonstration of probabilistic prediction of the range of plausible scenarios, together with the estimation of their relative likelihood.
3. Contribute to the development, and eventual operational implementation, of a run-on-demand severe weather version of the Bureau's ACCESS NWP system.

Improving flood forecast skill using remote sensing data

Lead Research Organisation: Monash University

Project Leader: Dr Valentijn Pauwels

Flood forecasting systems aim at predicting the arrival time, water depth and velocity of the flood wave in each point of the downstream valley. As such they are an essential tool for emergency management.

Significant progress has been made in the improvement of these models, but they are prone to a significant error, due to errors and uncertainties in the rainfall data and the model structure and parameters.

Remote sensing can be a helpful tool for operational water management, and particularly for flood forecasting. In this project, remote sensing data is being used in two ways. First, estimated soil moisture profiles from hydrologic models will be improved through the merging of these model predictions with remotely sensed surface soil moisture values. This is expected to have a beneficial impact on modelled hydrographs.

Second, estimated flood inundations and water levels from hydraulic models will be improved through merging these model results with remotely sensed observations of flood inundations or water levels. This is expected to improve the predictive capability of the hydraulic model. Overall, using remote sensing data in flood forecasting is expected to lead to better early warning systems, management of floods, and post-processing of flood damages.

The research is expected to lead to improved flood peak estimates, better mapping of flood extents, and improved flood warnings.

Mitigating the effects of severe fires, floods and heatwaves through the improvements of land dryness measures and forecasts

Lead Research Organisation:
Bureau of Meteorology

Project Leader: Dr Imtiaz Dharssi

Good estimates of landscape dryness underpin fire danger rating, fire behaviour models and flood prediction. Soil dryness also strongly influences heatwave development by driving the transfer of solar heating from the soil surface into air temperature rise.

Fire intensity, spread rate and ignition are sensitive to the fuel dryness which is strongly linked to soil moisture content. Estimates and forecasts of fuel and soil moisture are the foundation of the fire danger calculations used to rate and manage wildfires and to warn of developing fire danger. Similarly estimates and forecasts of soil moisture are essential ingredients to be able to forecast with accuracy river flows on a seasonal scales (one to three months), which is much in demand by water managers and reservoir operators.

This project is improving the ability to manage extreme events by developing a soil moisture analysis that makes use of many different sources of observations and cutting edge land surface modelling and data assimilation. The new information is being calibrated with the old scheme so that it can be used within existing fire and flood forecasting prediction systems.

Next generation fire modelling

Lead End Users: Dr Simon Heemstra (NSW Rural Fire Service) and Andrew Stark (ACT Rural Fire Service)

Research Leader: Professor Graham Thorpe, Victoria University.

Fire spread prediction across fuel types

Lead Research Organisation:
Victoria University

Project Leader: Professor Graham Thorpe

Bushfires occur on a scale that may be measured in kilometres. However, a challenge faced in developing next generation bushfire models is to capture the significant contributions that small scale phenomena make to the propagation of bushfires.

This project is using spatial averaging to accurately describe the interactions between the wind and vegetative canopies. Averaging methods are being used to quantify the rate of thermal radiation in bushfires.

In this project these length scales will be spanned by making use of a computational technique known as large eddy simulation, which accurately resolves phenomena that occur on the length scales of tens of centimetres, and which relies on approximations of the small scale phenomena.

The project aims to obtain more accurate fuel data, develop a bushfire model based on Australian vegetation, model airflow through tree canopies, and provide a detailed description of the generation and spread of embers.

Coupled fire-atmosphere modelling

Lead Research Organisation: Bureau of Meteorology

Project Leaders: Dr Jeff Kepert and Dr Mika Peace

Bushfires affect the surrounding atmosphere because of the large amount of heat and moisture released to the atmosphere as a result of combustion. The atmospheric response to this energy input includes changes to the local winds, modification of the boundary layer, and the development of pyroconvective clouds. These changes can profoundly modify the evolution of the fire.

This project is:

- Developing an Australian coupled fire-atmosphere modelling capability based upon the national numerical weather prediction infrastructure.
- Providing a better understanding the contribution of fire-atmosphere interaction and three-dimensional atmospheric structure to fire behaviour, including spread, intensification, and "blow-up" behaviour.
- Providing a better understanding of the impact of fire on the atmosphere, including fire-generated winds and their damage potential, ember transport and plume development.
- Progressing towards an eventual operational capability for coupled fire-atmosphere modelling within Australia.
- Improving operational fire prediction services by efficiently transferring the knowledge gained in this project and others to Bureau of Meteorology fire weather forecasters and to fire agency fire behaviour analysts.
- Exploring the development of computationally efficient methods for robustly accounting for fire-atmosphere coupling in fire prediction.

Fire coalescence and mass spot fire dynamics: experimentation, modelling and simulation

Lead Research Organisation: University of New South Wales

Lead Researcher: Associate Professor Jason Sharples

Fire behaviour in dry eucalypt forests in Australia is characterised by the occurrence of spotfires – new fires ignited by the transport of burning debris such as bark ahead of an existing fire. Under most burning conditions, spotfires play little role in the overall propagation of a fire, except where spread is impeded by breaks in fuel or topography. Spotfires allow these impediments to be overcome.

However, under conditions of severe bushfire behaviour spotfire occurrence can be so prevalent that spotting becomes the dominant propagation mechanism and the fire spreads as a cascade of spotfires forming a 'pseudo' front.

It has long been recognised that the presence of multiple individual fires affects the behaviour and spread of all fires present. The converging of separate individual fires into larger fires is called coalescence and can lead to rapid increases in fire intensity and spread rate leading to the phenomenon of a 'fire storm'. This coalescence effect is frequently used in prescribed burning, with multiple point ignitions used to rapidly burn out large areas.

This project is focussing on:

- Fire coalescence to provide better predictions of fire propagation.
- The intrinsic dynamics of flame front propagation as a contributor to fire spread across different spatial and temporal scales.
- Within a simulation framework an end-to-end model of the behaviour of mass spotfires, from firebrand/ember launch to fire coalescence.

Determining threshold conditions for extreme fire behaviour

Lead Research Organisation: University of Melbourne

Project Leader: Dr Trent Penman

While a number of advances have been made in understanding bushfire development under extreme conditions, these have not been quantified in a manner that is suitable for inclusion in fire behaviour modelling frameworks. One of the main aims of this project is to develop statistical models that allow for the inclusion of dynamic effects when they are important – that is, when fires grow sufficiently large and complex.

This project is identifying the thresholds beyond which dynamic fire behaviour becomes a dominant factor, the effects that these dynamic effects have on the overall power output of a fire, and the effects that such dynamic effects have on fire impacts (fire severity). This will necessarily include consideration of other factors, such as how fine fuel moisture varies across a landscape.

The project is investigating the conditions and processes under which bushfire behaviour undergoes major transitions, including fire convection and plume dynamics, evaluating the consequences of eruptive fire behaviour (spotting events, convection driven wind damage, rapid fire spread) and determining the combination of conditions for such behaviours to occur (unstable atmosphere, fuel properties and weather conditions).

Prescribed burning and catchment management

Lead End User: Belinda Kenny, Office of Environment and Heritage, NSW

Research Leader: Dr Tina Bell, University of Sydney

Savanna Fire Management

Lead Research Organisation: Charles Darwin University

Project Leader: Professor Jeremy Russell-Smith

This project has three major components:

- Savanna burning.
- Management of high biomass weeds.
- Spinifex and mulga landscapes.

Savanna burning:

The Savanna Burning project builds on the substantial work previously undertaken within the Bushfire CRC's North Australian Fire Mapping project.

The project developed a comprehensive algorithm for mapping fire effects on tropical savanna vegetation. These data and the annual fire history mapping data were then applied in preliminary analyses to assess the risk to biodiversity, greenhouse gas emissions and ecosystem services in general under various climate scenarios.

The Savanna Burning project will build on this work by gathering finer scaled data and undertaking more detailed assessments of these and other criteria in regions defined as being at greatest risk.

The preliminary analyses suggested that the most deleterious effects to ecosystem services occur predominantly on indigenous owned and/or managed lands. Therefore, the project will involve consultation with lead Indigenous groups such as the North Australia Indigenous Land and Sea Management Alliance and the Land Councils to determine those areas where it would be most feasible to undertake the detailed analyses through the collation of fine scale spatial data leading to research determining community resilience to those risks.

This project is expanding upon broad-scale bushfire risk assessments in previously determined high risk regions using higher resolution spatial analyses. Current risk assessments include impacts on greenhouse gas emissions abatement, biosequestration, soil erosion, biodiversity, communities, and enterprises – under different management and climate scenarios.

Managing flammable high biomass grassy weeds:

A range of invasive grasses have spread rapidly in tropical Australia over the past two decades, substantially altering the savanna, riparian and wetland ecosystems.

These grasses include: gamba grass, mission grass, annual mission grass, grader grass, para grass, olive hymenachne and alemann grass.

The ecological, economic and social

consequences of these grasses are so significant that many are now declared at the Territory and State level, have been listed as Weeds of National Significance, and listed as a Key Threatening Process under the EPBC Act. The impacts are primarily due to the substantial change in fire regime, with more frequent fires occurring at intensities higher than ever recorded previously in north Australian tropical ecosystems.

In the NT, special fire zones have already been declared based on the increased fuel loads and fire risk resulting from high-biomass grasses. There is a lack of decision support tools or models to effectively inform the longer-term consequences of grass invasion or the optimal decisions regarding the allocation of resources to manage this fire risk. The lack of these tools directly affects determinations about where to invest scarce resources to have the greatest impact on reducing risk and improving community resilience. This project is assessing the likelihood and magnitude of risk of high biomass invasive grasses to fire regimes in the tropical savanna region and provide critical information for Government policy and planning, particularly prioritisation of weed risk for fire-regime changing species, and for fire management planning

Central Australian spinifex and mulga landscapes:

Substantial R&D has been undertaken over the past 15 years into the development of savanna burning greenhouse gas emissions abatement and sequestration methodologies, and associated project applications.

There may also be considerable potential for the development of complementary methodologies focusing on improved fire management of extensive central Australian mulga- and spinifex-dominated rangelands. Most prospective is a biosequestration methodology focusing both on mulga (Acacia aneura) and spinifex (Triodia spp). Unlike tussock grasses, Triodia continues to accumulate biomass at decadal scales similar to woody shrubs.

Available national mapping sources indicate that such landscapes cover at least a quarter of the continental landmass. These landscapes are very sparsely settled (mostly by Aboriginal people in small isolated communities), and support no economically significant agricultural or pastoral enterprises.

Despite the extreme aridity (with highly annually variable mean annual rainfall conditions <250 mm/yr) of mulga-spinifex landscapes, very extensive fires occur in the contemporary era particularly after intermittent rainfall events.

These contemporary ‘boom and bust’ patterns contrast strongly with the well-documented patchwork fire mosaics maintained under Aboriginal fire management until as recently as the late 1950s in some regions.

This project is contributing to the development of an approved Carbon Faring Initiative (or related) biosequestration methodology addressing improved fire management under central Australian conditions.

In the longer term, the project provides an economic and employment foundation for remote central Australian communities to develop land management enterprises/undertakings so as to provide a sustainable basis for developing stronger and more resilient communities.

Optimisation of fuel reduction burning regimes for fuel reduction, carbon, water and vegetation outcomes

Lead Research Organisation: University of Sydney

Project Leader: Dr Tina Bell

Fuel reduction burning is often patchy as a result of fuel and climatic conditions and inherent landscape-related features such as topography and soils. A strong sampling design is required to capture this variation. In addition, it is becoming increasingly obvious that as wildfires become larger they become more intense and thus have greater influence on soils and vegetation. It is unknown if the same situation arises with fuel reduction fires (FRFs).

The relationships between burn size and soil, water, vegetation and fuel outcomes has yet to be quantified. The ability to predict the effects of FRFs of different size across landscapes is currently negligible.

To design an a priori sampling scheme of FRFs with appropriate statistical power, it is important to define what a 'small' fire is compared to a 'big' fire. Logically, larger fires will need to be sampled at a different scale and frequency than smaller fires – but what range of burn area might we be talking about?

To determine historical fire size, land and fire management agencies in NSW, Victoria, South Australia, Western Australia and Tasmania have been approached for access to data relating to fire size, location and timing for the last 10 years. Patterns in fire size and timing that will provide valuable information for our sampling design are already emerging.

Ultimately, this project will move research and management capabilities to its next logical focus – building a predictive model and framework for planning of FRFs.

This will help predict the effects of fuel reduction burning on fuel loads, broad vegetation types and carbon and water potential (for example, capacity for carbon sequestration, water yield) of forests at a manageable spatial scale.

From hectares to tailor-made solutions for risk mitigation: Systems to deliver effective prescribed burning across Australian ecosystems

Lead Research Organisation: University of Wollongong

Project Leader: Professor Ross Bradstock

Prescribed burning in Australia, currently stands at a cross roads. The 2009 Victorian Bushfires Royal Commission recommended an annual treatment target of 5% of public land in Victoria. Subsequently, concerns have been formally raised (for example in the Bushfires Royal Commission Implementation Monitor 2013 Annual Report) that such an area-based target may not deliver the most effective levels of risk reduction for people and property in Victoria. Concurrently, some other states have adopted such a prescribed burning target, but formal attempts to evaluate its effects on risk to people, property and environmental values across different jurisdictions are lacking. Such extrapolation of the 2009 Royal Commission recommendation pre-supposes that there is a “one-size-fits-all” solution to the problem. While many agencies are moving toward planning systems supposedly based on risk assessment, knowledge of the best way to use prescribed fire to reduce risk to key values is generally lacking.

The project aims to deliver:

1. A Prescribed Burning Atlas to guide implementation of ‘tailor-made’ prescribed burning strategies to suit the biophysical, climatic and human context of all bioregions across southern Australia. The Atlas will define the quantitative trajectory of risk reduction (including resultant residual risk) for multiple values (such as property, water, carbon, vegetation structure) in response to differing prescribed burning strategies (including spatial configurations and rates of treatment), across different Australian environments based on their unique climatic, biophysical and human characteristics.
2. Continental-scale, biophysically-based models of ignition and fuel accumulation for Australian ecosystems, for use in dynamic risk management planning and operational decision-making about prescribed burning at seasonal and inter-annual time scales, accessible via the Atlas.
3. Detailed scenarios of future change in risk mitigation effectiveness of prescribed burning strategies in response to integrated scenarios of changes to climate, fuel (including elevated CO_2 effects) and ignitions. These will also be accessible through the Atlas.

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HAZARDS CRC

Level 1, 340 Albert Street
East Melbourne VIC 3002
tel: +61 3 9412 9600
email: office@bnhcrc.com.au

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