

Natural Hazards Research Australia

Australia's centre for research into natural hazard resilience and disaster risk reduction

RESEARCH THEMES

Draft prepared for research priorities and project identification workshops

21 July 2021

Natural Hazards Research Australia

The establishment of Natural Hazards Research Australia (the Centre) continues the coordinated national research effort of two Cooperative Research Centres – the Bushfire CRC and the Bushfire and Natural Hazards CRC - over the last 18 years and is addressing the major challenges arising from recent natural hazards, including the 2019-20 bushfire season.

The Centre:

- is focused on natural hazard resilience and disaster risk reduction to support the needs of a variety of critical stakeholders in preparing for, responding to and recovering from disasters caused by natural hazards.
- involves many partners drawn from governments, private and not-for-profit sectors across Australia and New Zealand.
- will provide new knowledge and evidence through the conduct of research and utilisation of that research to ensure that Australia and its nearest neighbours have greater capability and capacity to continuously develop resilience to the ongoing and increasing risks from natural hazards.
- will focus on natural hazard resilience and disaster risk reduction to support the needs of emergency service agencies, businesses, governments and communities in preparing for, responding to and recovering from future disasters caused by natural hazard.

The Centre has three overarching objectives to achieve:

- Protection of human life, minimising harm and suffering – towards zero preventable deaths,
- Supporting well-prepared and resilient communities, and
- Research that translates into action

To ensure the research of the new Centre remains focused on areas of identified need, the Centre will manage the research through a rolling 2-year research plan that will be reviewed annually, and be supported by a 10-year research strategy. The rolling research plan will also position the Centre to respond to emerging opportunities and changing natural hazard environment.

The Centre will:

- be a long-term national collaborative research organisation improving our understanding of approaches to minimising the impacts of and improving our response to natural hazards,
- be responsive to the needs of natural hazard and disaster resilience stakeholders, including local, state and territory governments, industry and the community,
- have an education and training program that includes, but is not limited to, a PhD program, technology development, developing skilled employees and research and development (R&D) capacity within organisations reducing natural hazard risks exposure or providing response and support during and following an emergency or disaster caused by natural hazards.

Factors influencing uptake and utilisation of natural hazards research

Significant broadscale risks will be considered in the framing of the Centre's research projects. These variable risks will influence the context in which the research outcomes are expected to deliver benefits. It is anticipated that many of the variables (for example, climate change, demographics, land use planning) will influence multiple hazard programs.

Climate change

Australia is facing more extremes in temperature, weather and other hazards resulting from climate change and this is influencing the way we live, work and play. Understanding the complexities and how the risk profiles are changing will influence:

- how emergency services will prepare and respond
- how communities will be living
- how plant and animal life will be affected.

The research will consider how this uncertainty can be understood and prepared for and will develop an understanding of the relevance of various outcomes in the changing environment.

This will include engaging with key complementary research groups focused on climate science including the newly formed Australian Climate Services as well as ARC Centre for Climate Extremes, the National Environmental Science program's Earth Systems and Climate Change Hub, and various university Centres of Excellence.

Demographics and demographic change

Understanding where and how populations will be living, what the structure of these communities will look like and how they will be working, exercising, travelling, recreating and holidaying will be a focus of the research.

The projects will develop an understanding of how the vulnerabilities and risk profiles change over time with changes in key demographic indicators, including age, ethnicity, employment and health. They will consider multiple perspectives, including cultural resilience, gender differences, migrant and Indigenous communities.

Building regulations

The Centre will address issues around living with risk in the current and future built environments, and how best to manage the impacts of current and future regulations. Issues to be considered include:

- Understanding what is required to bring in change – what evidence is required, what are the barriers, and when will those changes have an impact?
- Identifying how retrofitting options contribute to reducing the risk exposure of already built assets.
- Exploring assumptions behind building codes and the balance between protection of lives through building codes and avoidance of exposure through effective land-use planning.

Land use planning

Land use planning that considers the impacts of natural hazards is important for a range of organisations including government (local, State and national), emergency services, private land

developers, and other industries. The Centre will explore the impacts of current and emerging rules for land use planning, their likely interpretation, and lead times for achieving any benefits.

Community activities and behaviours

How will communities and community organisations change the way they prepare for and behave when threatened by natural hazards and what are the factors influencing their ability to do so successfully? The Centre will identify factors that influence community willingness (and unwillingness) and actions on mitigation and response.

Capacity, capability and resourcing in regional areas

Regional and remote locations in Australia bear the brunt of the impacts of natural hazards and have varying levels of capacity and capability to mitigate, respond and recover.

The Centre will help to evaluate the level of resources, information, services and other supports needed by various remote and regional at-risk communities with a view to increasing local capability and capacity. A particular focus will be working with traditional owner groups and remote Indigenous communities.

Catastrophic, cascading, concurrent and repeating events

Natural hazards need to be considered not as isolated events but as part of a linked chain of occurrences with cumulative impacts. Bushfires compound the effects of drought and previous fires. Sudden storms and cyclones in specific regions lead to prolonged floods across much larger areas. Each natural hazard event creates its own unique set of impacts on communities, resources, and government and private sector budgets – each with their own profile for vulnerability, exposure and risk.

Reliable access to critical infrastructure and services

Disruption to critical infrastructure and services, including power, water, transport, telecommunications, health and medical care, is a major parallel impact of a natural hazard.

Challenges include addressing the complexities in reliability of supply versus supporting the resilience of communities when supply is inevitably affected. Projects will also identify the components and practices that; assist critical infrastructure providers to improve risk communications; assist communities to better understand risk at a local or household level as it pertains to access to supply of essential services.

Political will

The nature of political decision making is complex, fluid and open to subjective influence across all levels of government and its supporting bureaucracies. Natural hazards managers can be assisted by research that examines the broader implications of changing intent and motivations to undertake actions and to support necessary changes. The research will provide evidence-based knowledge to help understand the varying influences of big business, international developments, and shifting community sentiments.

Financial influences

Major stresses and changes to the Australian economy have the potential to reduce the availability of funds directed to mitigation, preparedness, response and recovery at the national, State, local and personal level, while at other times, financial prosperity and changes to economic priorities can present opportunities that should be met with responses that are both strategic and financially sound. In addition, key initiatives such as the Task Force on Climate-Related Financial Disclosures

(TCFD) are working in parallel to assist businesses in improving how they report on climate related risks, how this risk is quantified financially and how that is communicated to customers and communities.

More broadly, funding to reduce the impacts of natural hazards is also influenced by:

- Corporate focus on profitability and sustainability as a key driver versus investment in public benefit outcomes,
- The level of adoption of insurance and the relative insurability of at-risk communities,
- The competing demands of corporatised and privatised essential services,
- Economic growth or decline, and the associated impacts on a national, regional and global scale.

Regulation

When considering natural hazards management, there are a myriad of rules and regulations that influence the operations and services of governments at all levels, emergency services, businesses, communities, families and individuals. Understanding their respective influence will be the subject of research in the Centre that will support the planning and decision-making needed to prepare, mitigate, respond and recover from natural hazards.

Technological evolution and revolution

As technologies continue to evolve and to challenge the current ways of doing business, organisations must learn how to evaluate efficacy, manage this accelerated rate of change and to prioritise the adoption of various innovations. In natural hazards management, new technology has the potential to be both a great aid and a wasteful distraction, and the Centre can support research that provides insight and knowledge to determine what is best for the sector. The Centre will also examine at the factors that influence the rate of adoption and penetration of these technologies across all parts of the country.

Capacity for organisational change

The ability for organisations to change and adapt will influence the uptake and effectiveness of research and of lessons learned. The success of the Centre in the translation and implementation of the research outcomes will require a strong commitment to organisational change from its stakeholders.

Research, and research translation capacity and capability

Research utilisation by partners is central to the mission of the Centre. The changing environment for national research programs and for research funding in the university sector will influence research capability and researcher retention and development. In end-user agencies, decisions on resources and priorities also influence the availability of research and research translation capabilities, capacities and expertise

Ecosystem services

The natural environment provides ecosystem services that can be costed into economic models to demonstrate the broader benefits of protecting and managing the environment, and to support investment and decision-making. The Centre's research program will consider the influence of ecosystem services including:

- Provisioning services: products obtained from ecosystems, such as food, fresh water, fuel and other materials
- Regulating services: benefits obtained from regulation of ecosystem processes, such as climate regulation, water purification, air quality regulation, flood protection and erosion control
- Cultural services: non-material benefits obtained from ecosystems, such as recreation, tourism, education, cultural heritage, health and wellbeing.

Research themes

The Commonwealth has confirmed that the initial scope of hazards for the new Centre will include:

- Bushfires
- Floods
- Cyclones
- Heatwaves
- Storms
- Inundation and erosion caused by sea level rise
- Earthquakes
- Tsunamis
- Landslides

This scope may be widened during the lifetime of the Centre as the needs of end-users change with time but is expected to remain focused on natural hazards research.

The following research themes capture the broad focus of the Centre and the influencing factors show the complexity of the challenges that need to be addressed for the research outcomes to be relevant and fit for use by the Centre's end users.

These research themes provide an initial framework for developing the Centre's research program. The themes and their associated descriptions will be used to:

- determine how individual projects fit into the research portfolio, and
- test how the outcomes, tools and deliverables as proposed will be relevant to delivering outcomes for the identified research theme end-users.

In developing these research themes, and the associated influencing factors, the Centre has:

- consulted with end-user stakeholders, and with research organisations,
- considered the commentary and recommendations from the Royal Commission into National Natural Disaster Arrangements,
- considered the needs outlined in the National Disaster Risk Reduction Framework
- considered the commentary and recommendations from current and past jurisdictional inquiries and reviews.¹

To develop the Centre's initial research priorities, a much broader consultation program ²will be undertaken to determine the research priorities for each of the themes, and for the Centre as a whole.

Sustainable, safe and healthy landscapes in a changing environment

Effective risk reduction and resilience-building across diverse landscapes can be measured in values of sustainability, safety and healthiness of those landscapes. Projects in this theme, whilst focusing on specific areas of interest will make a demonstrable contribution to the overall objective of sustainable, safe and healthy landscapes. This will include contributions from traditional knowledge holders, land management agencies and other relevant groups.

¹ <https://tools.bnhcrc.com.au/ddr/dataspace-home>

² Groups invited to participate in the consultations include: government departments (including infrastructure, resilience and recovery), transport, telecommunications, energy companies, private sector providers and philanthropist's, not-for-profit organisations, local governments, Insurance sector, banking and finance sector, police services and defence.

Research in this theme may explore many perspectives, including:

- Cultural land management
- All-hazard risk reduction
- Water availability
- Fuel management
- Understanding values and values trade-offs across the landscape
- Interfaces with settlements, infrastructure and agricultural production
- Biodiversity
- Environmental recovery
- Recreational land use
- Sustainable forestry
- Urban intrusion and changing land use
- The impact of climate change on local and regional landscapes

Projects from several research themes are also expected to produce outcomes that will contribute to sustainable, safe and healthy landscapes. These include:

- Operational response and innovation
- Evidence-informed policy and strategy
- Learning from disasters

Situational awareness

Situational awareness in its broadest sense is a continuum from the collection of data relevant to a range of natural hazards, through the transformation of that data into valuable and interpretable information and its effective communication to a diverse group of beneficiaries, each with their own needs:

- emergency services
- governments
- businesses
- not-for-profit organisations (e.g. Australian Red Cross)
- communities
- individuals

All of these beneficiaries share a common need for awareness of the environment in which they work, live or travel and current and emerging threats that may cause increased risk to their life or property.

Research in this theme may explore many perspectives, including:

Technological research:

- Exploring data from all sources, including terrestrial and earth observation
- Data and information visualisation
- Understanding, predicting, and modelling hazard behaviour
- Hazard simulations
- Analytical tools, including artificial intelligence and machine learning
- Impact forecasting
- Enhanced extreme weather forecasting
- Test and validation datasets

Social research:

- Public, business and government information and warnings
- Human factors and decision-making
- Motivators of action and inaction
- Community understanding and responses to emergency information
- The impact of stress and uncertainty on the effectiveness of communication

Projects from several research themes are also expected to produce outcomes that will contribute to situational awareness. These include:

- Operational response and innovation
- Learning from disasters
- Workforce and communities of the future

Operational response and innovation

The performance of response systems, capabilities and regulated industries will be informed and enabled by innovation and different ways of thinking and operating. This can provide opportunities to increase the safety of responses to emergencies and disasters at all levels – from single local incidents through to national response capabilities.

Research in this theme may explore many perspectives, including:

First responders

- Enhanced vehicle design and capability
- Improved safety
- Remote and autonomous response operations
- Data- and evidence-informed asset management and deployment
- Better use of real-time data feeds
- Enhanced automation of in-field data collection
- Testing and trialling capabilities
- Future operating environments

Essential services

- Critical infrastructure operation
 - Electricity supply
 - Communications services
- Impact forecasting
- Protection of business and community lifelines
- Transport & supply chains (food, etc)

Projects from several research themes are also expected to produce outcomes that will contribute to operational response and innovation. These include:

- Situational awareness
- Sustainable, safe and healthy landscapes in a changing environment
- Learning from disasters

Resilient and sustainable built environments

The built environment is a collection of all that has been built to support and connect our way of life. It includes critical infrastructure, transport and road infrastructure, business and private buildings, the provision of lifeline services and utilities including food, health, water, electricity, and communications. There are complex relationships between the many different contributors to an effective, safe and resilient built environment – with cross-dependencies that need to be understood, strengthened and managed.

Research in this theme can explore this area from many perspectives, including:

Physical built environment

- Understanding resilient built environments at local, regional and national scale
- Damage and reconstruction modelling of built assets affected by cascading hazard events
- Insurance and insurability of built assets
- Retrofitting and strengthening of built assets

Systems, regulations, and connections

- Hazard-risk-informed land use planning
- Building standards and designs for new constructions
- Operating environments and regulations for essential services

Projects from several research themes are also expected to produce outcomes that will contribute to resilient and sustainable built environments. These include:

- Sustainable, safe and healthy landscapes in a changing environment
- Resilient communities
- Learning from disasters

Resilient communities

Communities are an essential part of society. They also often bear the greatest short, medium and long-term impacts from disasters caused by natural hazards.

Disaster exposure, risk and impact is context-specific, being felt immediately and intensely at the local level. Enhancing resilience within and between communities to single and cascading hazards (and learning from past experiences) is an important goal in a world exposed to increasing natural hazard risk from a changing climate.

During the development of the Australian Disaster Resilience Index,³ it was apparent that the capacity for resilience has many facets that cannot simply be averaged across a country or region. Building capacity and capability for disaster resilience needs to reflect the understanding and engagement and capacity of all groups and sub-groups within any given community, including those experiencing any form of disadvantage and more transient groups such as tourists, new arrivals, and itinerant workers.

³ <https://adri.bnhcrc.com.au/#/>

Identifying factors that are likely to be broadly, or uniformly adoptable to increase resilience during and after a disaster is a significant contribution from research in this theme – to maximise the benefits across the many communities that make up Australia.

Research in this theme can explore this area from many perspectives, including:

- Disaster relief and recovery
- Risk understanding and communication
- Economic impacts of natural hazards on communities
- Resilience of essential lifelines
- Community mental health
- Individual and community behaviour under pressure
- Community participation in hazard risk identification and mitigation
- Roles and benefits of governments, businesses and community groups

Projects from several research themes are also expected to produce outcomes that will contribute to resilient communities. These include:

- Workforce and communities of the future
- Learning from disasters
- Evidence-informed policy and strategy
- Resilient and sustainable built environments

[Evidence-informed policy and strategy and strategic foresighting](#)

Developing robust, relevant, understandable and defensible evidence and thinking to support new and improved policy and strategy is a critical contribution to sustainable national disaster risk reduction and the strengthening of resilience to the impacts of disasters.

Foresight is about thinking systematically about the future to inform decision making today. Instead of attempting to provide solutions for challenges as they are currently manifested, strategic foresight encourages decision makers to explore the likely nature of the challenges in multiple futures. We cannot access hard data about what will happen in the future, but foresight processes help overcome this and can ensure thinking about the future is not based on ‘blue-skies’ or invented creative thinking, but is systematic, rigorous, explicit and evidence-based.

Strategic foresighting can be used to explore many perspectives including:

- application of future foresight theories, techniques and technologies to disaster risk reduction and community resilience
- application of future foresight practice as part of evidence-informed policy and strategy
- development of anticipatory processes for use in strategy development to identify systemic risks and vulnerabilities, including such issues as the complex, compounding and interdependent nature of essential and underpinning systems that support community resilience to disaster events
- where and when the underpinning systems required for disaster management become stressed and their interdependencies
- application of complex adaptive systems theories and models to inform approaches to adaptive and participatory policy development for disaster resilience and disaster risk reduction

- use of big data analytics to inform anticipatory strategy development and for modelling the effects of discontinuance

This research theme will provide a mechanism for relevant groups to discuss and create new policy and strategic approaches to seemingly intractable problems, and to determine the value of current and past policies and strategies.

Using that evidence through multiple engagement channels, the research will provide a greater understanding of:

- Short and long-term benefits of different investment options
- Understanding of new and emerging policy and strategy options
- Monitoring and evaluation of current policies and strategies
- Concept development and testing for new business models
- Modelling to understand the evolution of risk and compare mitigation options
- Understanding and communicating complexity and value of systems-based approaches
- Integrated decision support tools
- Analysis and evaluation of current and past policy initiatives

Projects from several research themes are also expected to produce outcomes that will contribute to evidence-informed policy and strategy. These include:

- Workforce and communities of the future
- Learning from disasters
- Resilient communities
- Resilient and sustainable built environments
- Situational awareness
- Operational response and innovation

Workforce and communities of the future

People are fundamental to the development, strengthening and effectiveness of risk reduction and disaster resilience across emergency services, through government agencies and not-for-profit organisations, and into communities. In different ways, each group will influence the development of resilience and the outcomes of emergencies and disasters.

Demographics are in a constant state of evolution, taking paths that are influenced by local, national and global factors, and by personal choices. Groups of people are intimately connected – the workforce lives in and is a part of the community.

Emerging technologies and new approaches to learning and working are just some of the factors to be considered in this theme.

The common link across this theme is people, and research in this theme can explore this area from many perspectives, including:

- Workforce management, health and wellbeing
- New models of volunteering
- Forecasting workforce dynamics and practices
- Effective participation, diversity and inclusion in the workforce and in community resilience-building
- Future workforce planning
- Understanding future population demographics and dynamics
- Preparing workforces and communities to use technological advancements at work and at home

Projects from several research themes are also expected to produce outcomes that will contribute to workforce and communities of the future. These include:

- Learning from disasters
- Resilient communities
- Evidence-informed policy and strategy

Learning from disasters

Utilising strategic foresight approaches, anticipatory modelling and lived experience from emergencies and disasters posed and caused by natural hazards provides important learning and research opportunities to help:

- Identify and understand the underlying risks and exposures and systemic vulnerabilities
- Identify and understand community behaviour and knowledge before during and after an event
- Explore (and test by modelling) the effectiveness of responses through all stages of the event
- collect data and information that can be used to predict, test (model) and trial new approaches.

Information captured before, during and after natural hazard emergencies and disasters represents a significant source of data for prediction, modelling monitoring and evaluation, and as a resource to support additional research, and inform the development and updating of policies and strategies.

Research in this theme can explore this area from many perspectives, including:

Social sciences and big data analytics

- Community development and resilience measures
- Community responses and behaviour
- Community mental health
- Measuring and evaluating resilience
- Information, communications and warnings
- Evacuation planning
- Social and community networks
- Impacts on vulnerable and at-risk groups – particularly in relation to age, gender, health or culture.

Physical sciences

- Predictive services
- Damage assessments
- Accessible and reliable natural hazard intelligence data collections
- Impact forecasting
- Data analytics
- Case studies and validation datasets

Projects from several research themes are also expected to produce outcomes that will contribute to learning from disasters. These include:

- Predictive services
- Workforce and communities of the future
- Evidence-informed policy and strategy

National critical systems, tools and capabilities priorities

Critical national systems, tools and capabilities required by end-users will need research support during the life of the Centre to ensure they remain current and beneficial. In many cases, there is currently no identified and functional research capability.

In most cases, these systems, tools and capabilities already have operational governance processes that are and will remain independent of the Centre. It is expected that through those governance arrangements, input will be provided into the Centre's research prioritisation with its end-users identifying needs, priorities and plans for research translation and implementation of outcomes into their systems.

Some current national systems, tools and capabilities include:

- Fire risk and exposure
 - The Australian Fire Danger Ratings System
 - Fire simulation capabilities (including Phoenix and Spark Operational)
- Aerial firefighting
 - National Aerial Firefighting Centre
- Risk, exposure and communication
 - National Warnings System
 - Australian Disaster Resilience Index
 - Australian Exposure Information Platform
 - AQFx smoke modelling.

Similarly, there are new national initiatives being developed that may likely also be beneficiaries of new and ongoing research undertaken by the Centre:

- Provision of research data and related information
 - Australian Climate Services (ACS)
 - The Australian Research Data Commons (ARDC)
 - The National Bushfire Information Capability (NBIC)
- Weather, climate, exposure and impact
 - The Bureau of Meteorology weather forecasting Model (ACCESS)
 - The Bureau of Meteorology prototype fire-weather modelling tool (ACCESS-Fire).

In addition, the Centre will explore with end users how to access and incorporate insights from data held by non-government stakeholders that play a critical role in disaster risk reduction and resilience, can inform better knowledge of the current state of play of communities and how best to increase their resilience to future shocks and stressors cause by natural events.

Investment by the Centre into these systems, tools and capabilities will be determined by the agreed research priorities of the Centre, and the views and expectations of its end-user stakeholders.

Opportunities will exist for the Centre to co-invest with the relevant governance groups,⁴ where they are able to jointly fund targeted projects to support these tools and systems.

⁴ For example, co-investment by the National Aerial Firefighting Centre with the Centre was foreshadowed in the Australian Government response to the Recommendations of the Royal Commission into National Natural Disaster Arrangements.