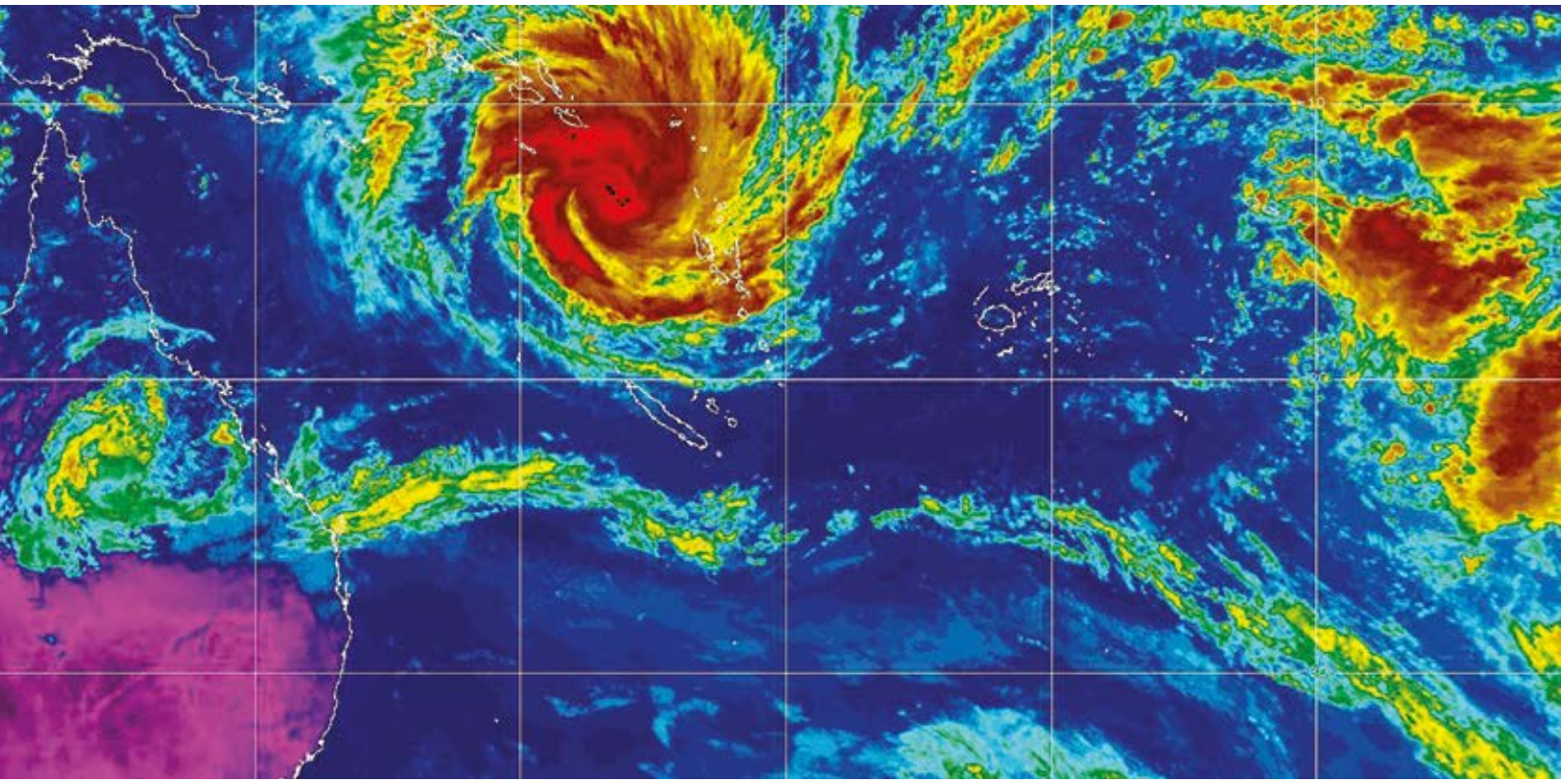
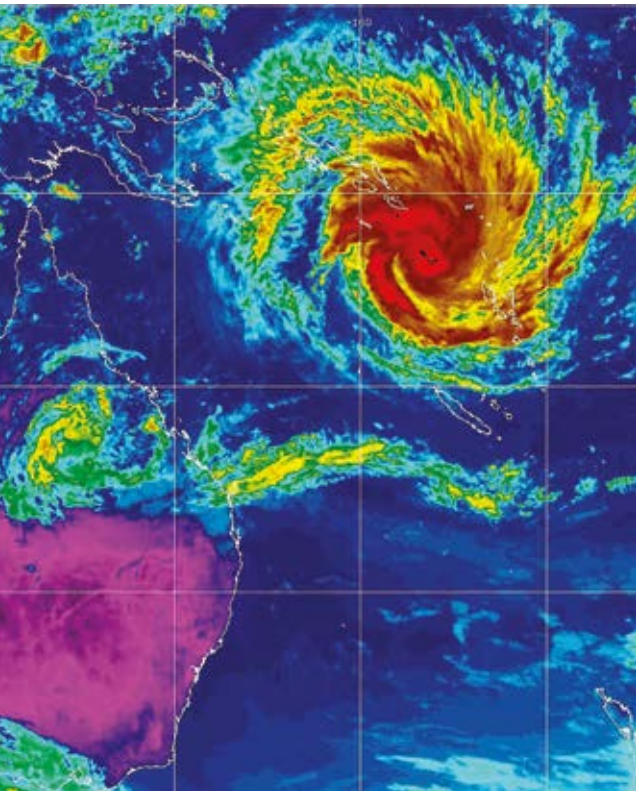
Deloitte Access Economics



Building an open platform for natural disaster resilience decisions

Australian Business Roundtable for Disaster Resilience and Safer Communities

Deloitte.



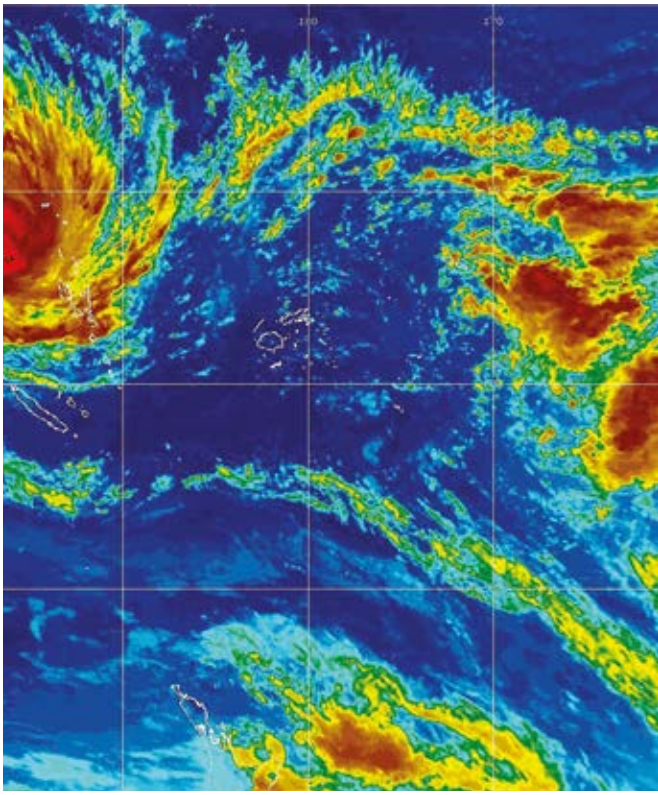
About the Australian Business Roundtable for Disaster Resilience and Safer Communities

The Australian Business Roundtable for Disaster Resilience and Safer Communities was formed in December 2012 by the Chief Executive Officers of Australian Red Cross, Insurance Australia Group, Investa Property Group, Munich Re, Optus and Westpac Group.

Following an unprecedented number of floods, storms and bushfires that devastated life and property across Australia in recent years, Chief Executive Officers Mr Robert Tickner, Mr Mike Wilkins, Mr Scott MacDonald, Mr Heinrich Eder, Mr Kevin Russell and Mrs Gail Kelly created the Roundtable, believing it is of national importance to build resilient communities able to adapt to extreme weather events.*

Deloitte Access Economics was commissioned to prepare the report *'Building our Nation's Resilience to Natural Disasters'* in response to the call in the Australian Government's 'National Strategy for Disaster Resilience' for greater collaboration between governments, businesses and communities to reduce Australia's vulnerability to natural disasters. This paper extends that work and provides an overview of natural disaster data and research in Australia.

* Current CEO's: Mr Campbell Hanan, Investa Office, Investa Property Group. Mr Paul O'Sullivan, Optus



Satellite Image: Cyclone Yasi, Category Five storm with winds of approximately 250km/hour approaching Queensland, January 14, 2011.

Australia's worst cyclone in a century devastated towns and left 175,000 people without power. Miraculously no deaths were recorded.

Future Proofing Our Nation

Quality data leads to better analysis; analysis drives insight and greater insight changes behaviour

Increasing Australians' understanding of their exposure to natural perils is vital to improving the resilience of our communities.

Natural disasters are by their nature infrequent and difficult to predict. When they do occur their effects are devastating. We can't expect Australians to be able to adequately protect themselves against these risks without critical information that helps them safeguard life and property. Natural perils mitigation is and will remain a problem shared between communities, businesses and governments. We need to work together to make Australia safer.

Key to better understanding the impacts of natural perils is the availability of accurate, current data and relevant research. Yet, crucial natural disaster information is difficult and costly to access, often incomplete or out of date and frequently duplicated across sources. It is often single purpose and the needs of multiple stakeholders have not been considered.

Through the research set out in *'Building an Open Platform for Natural Disaster Resilience Decisions'* we show that a fresh approach to the collation, co-ordination and analysis of natural disaster information and research is fundamental to the prioritisation of mitigation decisions that will help strengthen and safeguard our communities.

In this paper, the Roundtable calls for:

- The centralisation of key natural perils data through the development of a national open source platform which provides more timely, relevant information;
- Focused research attention through the removal of barriers to research and greater collaboration and engagement between stakeholders; and
- The establishment of a national prioritisation framework for funding resilience initiatives and research.

As business leaders representing a large and diverse cross section of the Australian economy, along with the Australian Red Cross, an auxiliary to government, we formed the *Australian Business Roundtable for Disaster Resilience and Safer Communities* and commissioned a White Paper *'Building our Nation's Resilience to Natural Disasters'*.

This Paper estimated that natural disasters cost the Australian economy $6.3 billion per year and forecast costs to rise to $23 billion annually by 2050. The research also demonstrated that carefully targeted resilience investments of $250 million per annum have the potential to generate budget savings of $12.2 billion for all levels of government and would reduce natural disaster costs by more than 50% by 2050.

We have encouraged the Australian Government to:

- Promote resilience to the centre of government decision-making;
- Consider a comprehensive, national co-ordinated approach; and
- Commit to a long-term annual pre-disaster resilience fund.

Our recommendations highlighted that natural perils information is fundamentally important to decision making.

'Building an Open Platform for Natural Disaster Resilience Decisions' expands on these recommendations and proposes an open platform framework for the consolidation of existing information and the commissioning of additional research to address gaps and disparities in natural disaster understanding. Core to achieving this are the principles of openness, collaboration, transparency and effective prioritisation as committed to by the Australian Government in 2010. It is only when decision making is co-ordinated and supported by reliable data and research that awareness and action can increase.

The research shows that governments have allocated an estimated $280 million to natural disaster research over the period from 2009 to 2021. Consistent with the trend identified in our first Paper, the majority of research funds are allocated to disaster response and recovery rather than mitigation solutions that will help save lives and property.

All natural disasters have the potential to cause loss of life and property, however the report reveals disproportionate research spend on some disaster types with little to no spend on others. For example, despite the expected annualised cost of bushfires being relatively low when compared to other perils, it has the highest research spend. Significantly, only a small amount of research has been conducted into the effectiveness of mitigation and into the social and psychological impacts of disasters.

We demonstrate that through the provision of wider access to accurate, relevant natural disaster data and research, better local responses from governments, businesses and communities would generate additional potential savings for Government of between $500 million and $2.4 billion over the period to 2050.

Both of the Roundtable's commissioned research papers outline a new approach to pre-disaster investments in Australia. They highlight the importance of integrated information and activity across governments, businesses and communities. By centralising decision-making and funding, and establishing a national research agenda, Government will be better able to co-ordinate and prioritise resilience activities across relevant departments and levels of government.

Adopting the key recommendations of these Papers will materially reduce economic costs and relieve long term pressures on budgets.

Governments, businesses and our communities need to be aware of the risks they face. We believe that access to timely relevant data will enable communities to better prepare for natural disasters and to build a safer and more productive society.

Together, we can build a more resilient Australia.

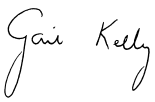
Robert Tickner
CEO
Australian Red Cross

Mike Wilkins
Managing Director and CEO
Insurance Australia Group

Campbell Hanan
CEO, Investa Office
Investa Property Group

Heinrich Eder
Managing Director
Munich Holdings of Australasia Pty Ltd

Paul O'Sullivan
CEO, Group Consumer
Optus



Gail Kelly
Managing Director and CEO
Westpac Group

Contents

Glossary

Adaptation

Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects. Adaptation can be carried out in response to (post-disaster) or in anticipation of (pre-disaster) changes in weather risks. It entails a process by which measures and behaviours to prevent, moderate, cope with and take advantage of the consequences of climate events are planned, enhanced, developed and implemented (The World Bank, 2012).

Bathymetry

The study of the depths and shapes of the underwater terrain of oceans, seas and lakes.

Benefit-cost ratio

A benefit-cost ratio (BCR) is an indicator that attempts to summarise the overall value for money of a project or proposal. A BCR is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. All benefits and costs should be expressed in discounted present values.

Disaster risk reduction

The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events (United Nations, 2009).

Emergency management

Emergency management has four areas of focus: prevention, preparedness, response and recovery (Attorney-General's Department, 2011).

Foundational data

Base layers of locational information used for assessment of natural disaster risks, as well as a range of other broader purposes. This encompasses exposure data (assets at risk, population and community demographics), as well as fundamental geographic data (geological, topography and weather information).

Geocoding

The process of assigning geographic co-ordinates to sites or regions of interest.

Hazard data

Hazard specific information on the risks of different disaster types, providing contextual data about the history of events and the risk profile for Australian locations.

Impact data

Data on the potential and actual impacts associated with natural disasters, including information on historical costs and damage, and the current and predicted future value at risk.

LiDAR (light detection and ranging)

A high quality form of elevation data which uses high speed laser pulses to generate three-dimensional structural data for terrain and landscape features (CSIRO, 2013).

Mitigation

Measures taken in advance of a disaster aimed at decreasing or eliminating its impact on society and environment (Council of Australian Governments, 2011).

In climate change terminology, mitigation refers to actions to address the causes of climate change. This generally involves actions to reduce anthropogenic emissions of greenhouse gases that may contribute to the warming of the atmosphere. This is not the definition of mitigation used in this report.

Natural disasters

A natural disaster is a naturally occurring rapid onset event that causes a serious disruption to a community or region (Productivity Commission, 2014).

For the purpose of this report we define natural disasters as bushfires, cyclones, earthquakes, floods or storm surges.

Preparedness

To protect our people, assets, infrastructure and institutions from disaster events and to establish, train and exercise arrangements to respond to, and recover from a disaster event (Prosser & Peters, 2010).

Prevention

To hinder, deter and mitigate disasters, while maintaining readiness to deal with disaster events (Prosser & Peters, 2010).

Recovery

To return national and community life to normal as quickly as possible after a disaster event, through the restoration of social, economic, physical and environmental wellbeing (Prosser & Peters, 2010).

Resilience

The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions (United Nations, 2009).

Response

To respond rapidly and decisively to a disaster event and manage its immediate consequences (Prosser & Peters, 2010).

Flooded Bruce Highway bordered by banana plantations devastated when Cyclone Yasi tore through Tully on February 3, 2011.

Acronyms

ABCB	Australian Building Codes Board
ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
ANDS	Australian National Data Service
ANHMRC	Australian National Health and Medical Research Council
ANZLIC	Australian and New Zealand Land Information Council
APEC	Asia-Pacific Economic Co-operation
ARC	Australian Research Council
ARCom	Australian Research Committee
ASBEC	Australian Sustainable Built Environment Council
BCR	Benefit-cost ratio
BITRE	Bureau of Infrastructure, Transport and Regional Economics
BNHCRC	Bushfire and Natural Hazards Cooperative Research Centre
BoM	Bureau of Meteorology
BTE	Bureau of Transport Economics
CAWRC	Centre for Australian Weather and Climate Research
CDEM	Civil Defence Emergency Management
CIPMA	Critical Infrastructure Program for Modelling and Analysis
COAG	Council of Australian Governments
CRC	Cooperative Research Centre
CSIRO	Commonwealth Science and Industrial Research Organisation
CTS	Cyclone Testing Station
DHS	Department of Human Services
DIISRTE	Department of Industry, Innovation, Science, Research and Tertiary Education
EMA	Emergency Management Australia
EM-DAT	Emergency Events Database
FEMA	Federal Emergency Management Agency
FMA	Floodplain Management Authority
GFDRR	Global Facility for Disaster Reduction and Recovery
GRID	Global Resource Information Database
GRIP	Global Risk Information Platform
IAG	Insurance Australian Group
ICA	Insurance Council of Australia
IP	Intellectual property
LA RED	Network of Social Studies on Disaster Prevention
LiDAR	Light detection and ranging
MCDEM	Ministry of Civil Defence and Emergency Management
NCCARF	National Climate Change Adaptation Research Facility

NDRP	Natural Disaster Resilience Program
NEHRP	National Earthquake Hazards Reduction Program
NEMP	National Emergency Management Projects
NFID	National Flood Information Database
NGO	Non-Government Organisation
NHRP	Natural Hazards Research Platform
NIWA	National Institute of Water and Atmospheric Research
NSDR	National Strategy for Disaster Resilience
NSW	New South Wales
NZ	New Zealand
OAIC	Office of the Australian Information Commissioner
OECD	Organisation for Economic Co-operation and Development
ONRN	National Observatory for Natural Hazards
OpenDRI	Open Data for Resilience Initiative
PC	Productivity Commission
PDF	Portable Document Format
PPD	Presidential Policy Directive
PREP	Property Resilience and Exposure Program
PSI	Principles for Sustainable Insurance
PSMA	Public Sector Mapping Agencies
QLD	Queensland
QRA	Queensland Reconstruction Authority
SA	South Australia
SCCC	Select Council on Climate Change
SRTM	Shuttle Radar Topography Mission
TERN	Terrestrial Ecosystem Research Network
TISN	Trusted Information Sharing Network
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
UNEP FI	UNEP Financing Initiative
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNISDR	United Nations Office for Disaster Risk Reduction
UNU	United Nations University
US	United States
VIC	Victoria
WHO	World Health Organisation

Executive Summary

The financial and emotional burden of natural disasters in Australia has been great and the costs of extreme weather events continue to rise.

To help make better, more informed decisions regarding safety from and resilience to natural disasters, it is imperative that communities, businesses and governments can access the latest research founded on accurate data.

The stakes are high

This report builds on previous work commissioned by the *Australian Business Roundtable for Disaster Resilience and Safer Communities*, which analysed the opportunities for Australia to design a more sustainable and comprehensive national approach to making communities safer and more resilient.

'Building our Nation's Resilience to Natural Disasters' demonstrated that the economic cost of natural disasters to Australian communities amounts to an average of $6.3 billion per year, with $700 million of that borne by all levels of government, the majority of which is spent on post disaster relief and recovery. By 2050, this is forecast to rise to $23 billion per year, with a total government budget impact of around $2.3 billion annually in present value terms.

Carefully targeted disaster mitigation investments can reduce these costs. For example, an annual investment of $250 million over the period to 2050 could generate government savings of around $12.2 billion, in present value terms, if carefully targeted to achieve an overall benefit-cost ratio of 1.25.

Providing wider access to accurate, relevant natural disaster data and research could increase government savings by between $500m and $2.4 billion in present value terms, over the period to 2050. Data and research which facilitates targeted and prioritised investment has the potential to deliver higher overall benefit-cost ratios of between 1.3 and 1.5. Based on this, total savings to government could rise to anywhere between $12.7 and $14.6 billion in present value terms, over the period to 2050.

However, without access to critical data and research, communities, businesses and governments cannot make informed decisions on how to target these investments to achieve the greatest impact.

This report investigates the decision-making challenge and identifies the strengths and weaknesses of Australia's approach to natural disaster data and research. It recommends a way forward to support Australia as it designs a more sustainable and comprehensive national approach to making communities safer and more resilient.

Notably, the effectiveness and sustainability of Australia's natural disaster funding arrangements is currently the subject of a Productivity Commission Inquiry. The purpose of the Inquiry is to identify reforms to achieve a balance between recovery and mitigation to help communities better prepare for disasters.

The decision-making challenge

Accurate data and research is fundamental to better understanding natural disasters and their impact on communities, businesses and governments. It is essential to supporting better decision-making and prioritising mitigation investments to build a safer Australia.

Optimal decisions on resilience investments require access to high quality data and research.

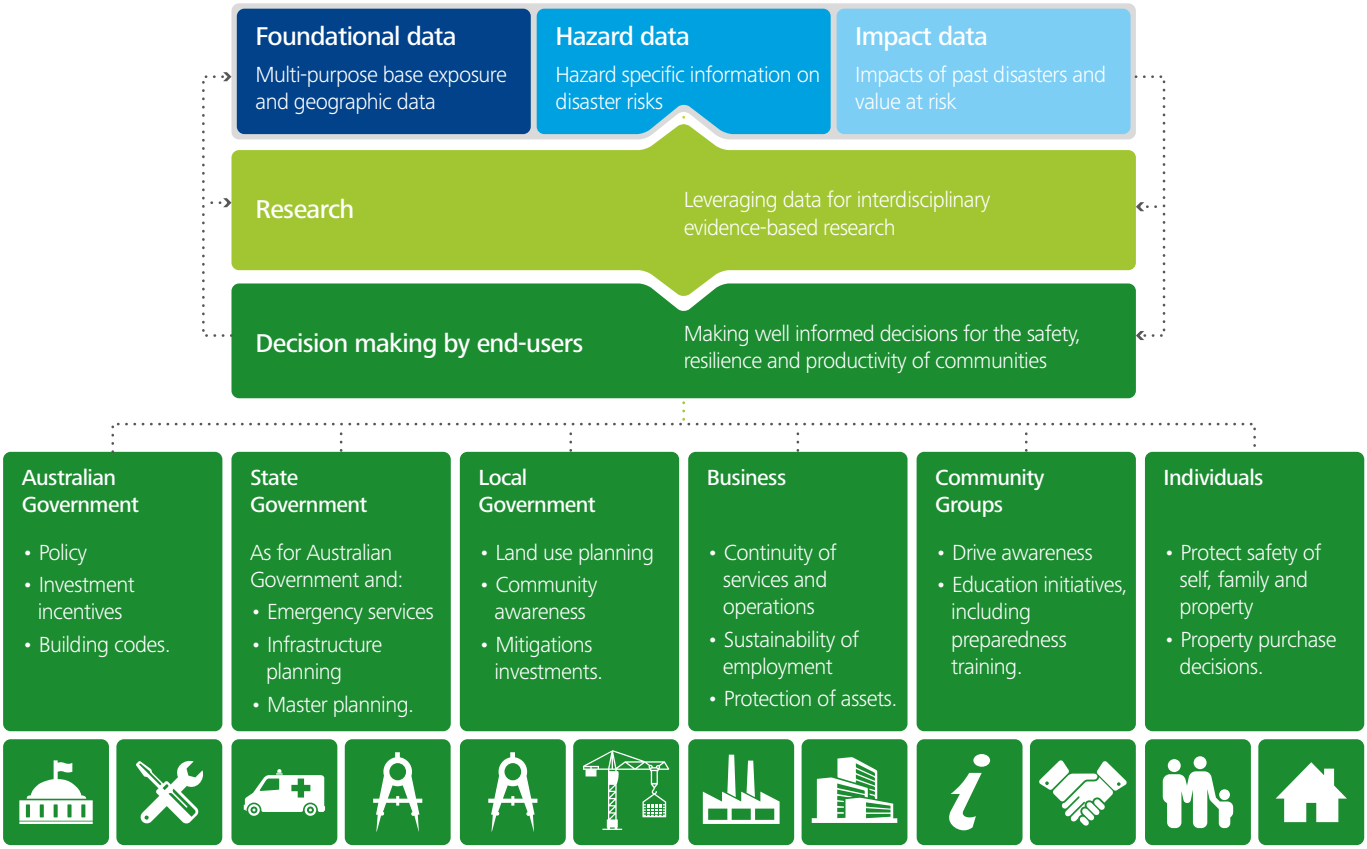
However, the process of linking data and research to end users for optimal decision-making is a challenge faced by many countries. Natural disaster resilience is an interdisciplinary issue. Multiple agencies are involved in collecting data and undertaking research. This results in numerous platforms to access and utilise the range of necessary information, increased search costs and complexity and disparity in understanding.

As illustrated in Figure i below, the key set of inputs required by end users consists of:

- **Foundational data –** data that provides the basic layers of locational information. This includes information on the characteristics of assets at risk, community demographics, topography and weather, and is also used for a range of other purposes.
- **Hazard data –** hazard specific information on the risks of different disaster types, providing contextual data about the history of events and the risk profile for Australian locations.
- **Impact data –** data on the potential and actual impacts associated with natural disasters, including information on historical costs and damage, and the current and predicted future value at risk.
- **Research activities –** activities that draw on data and seek to answer specific research questions across a range of areas. There is often also feedback from research to data, where research outputs build on the existing stock of data that is available.

The information needs of end users across communities, businesses and governments vary significantly. In order to increase the safety, resilience and productivity of Australian communities, it is imperative that data and research is accessible in consistent formats and is fit for a variety of purposes.

Figure i: Data and research inputs for optimal decision-making on resilience investments



Source: Deloitte Access Economics, *Australian Business Roundtable for Disaster Resilience and Safer Communities* (2014)

Current activities

Australian and state government policies recognise the importance of providing access to information and in supporting research activities to drive resilience and productivity. For instance, through the 2010 Declaration of Open Government, the Australian Government publically committed to providing public sector information that is useable and accessible (Department of Finance, 2010).

This is consistent with experiences in international jurisdictions and other sectors in Australia, such as the US Open Government Initiative, the National Observatory for Natural Hazards in France, and the approach to the curation and supply of financial data undertaken by the Australian not-for-profit company, Sirca.

In practice, a large number of stakeholders across Australia are making valuable contributions to the body of knowledge on natural disasters and resilience, combining expertise from numerous disciplines, including earth science, psychology, health, engineering, construction, economics and information technology. This encompasses at least seven Australian Government departments and agencies, all eight state and territory governments, many local councils, six major research institutions, 24 universities and numerous private sector firms and agencies.

While the total costs of data collection are uncertain, this review has identified over $283 million in public funding for natural disaster research activities in Australia between 2009 to 2021. Over 40% of this investment is directed towards disaster risk reduction research efforts, with the remaining 60% allocated to research on disaster response and recovery.

Notably, significant barriers remain that restrict optimal decision-making that is dependent on and informed by data and research. This limits our progress towards a more resilient Australia.

Gaps and barriers to optimal decision-making

The approach to data and research into natural disasters in Australia has no comprehensive mechanisms to ensure that these inputs are available in a consistent and appropriate format for the spectrum of end users involved in decision-making. This review highlights some of the key barriers and gaps in the data and research systems, respectively.

Data

There is evidence of gaps in the critical data inputs required to inform resilience investments. This significantly limits the ability of various stakeholders to understand the exposure of different communities and the true extent of losses that might arise should a natural disaster occur.

These issues are compounded by barriers which restrict access by end users to critical data. These barriers include:

- **Reluctance to share data –** for example, the potential legal implications from data sharing are an issue of particular concern for local government
- **Restrictive licensing arrangements** which prevent wider distribution and use of data
- **High costs of collection** which encourages a piecemeal approach to the development of critical data inputs
- **A lack of co-ordination and standardisation**, which impedes the ability of end users to pull together data from different sources on a consistent basis
- **High cost of providing accessibility and transparency** which weakens incentives for data sharing where the broader range of benefits are unclear.

These barriers lead to duplication of data collection, higher transaction costs of using data and restricted access for end users. To the extent that the benefits for the full range of end users exceed the costs of providing data, the current arrangement is inefficient, and fails to deliver the best outcome for Australian communities and taxpayers.

Research

From the evidence of research activities **identified** by this review, it has been found that **less funding** is directed towards understanding the **effect of mitigation, value at risk** and the **process of coping with natural disasters** compared with other areas of research such as risk management, vulnerability, hazard detection, policy and decision support. This limits the ability of decision-makers to understand the baseline costs associated with exposure to natural disasters, as well as the benefits that could be achieved through mitigation.

Furthermore, while it is evident that there are strong networks among Australian researchers, from an end user perspective it is difficult to identify what relevant research activities are being undertaken, and to leverage research findings to better inform decision-making on resilience investments. While projects undertaken by the newly established Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC) explicitly involve end users, this practice should be adopted more broadly. This could be supported through better transparency and evaluation of the outcomes of research activities.

Recommendations

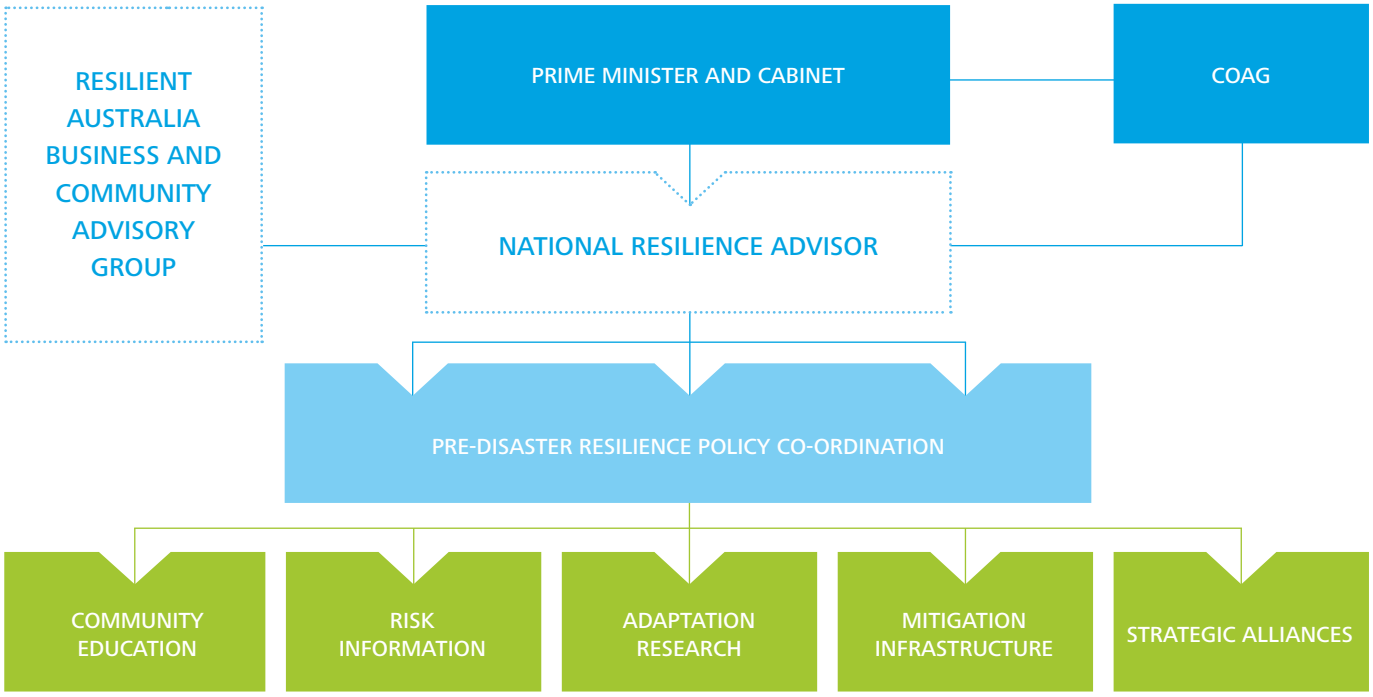
Consistent with the recommendation of *'Building our Nation's Resilience to Natural Disasters'*, a National Resilience Advisor within the Department of Prime Minister and Cabinet would be well placed to address these issues. Developing resilient communities should be elevated to the centre of government decision-making to deliver effective and efficient co-ordination of activities across all levels of government, business and communities.

Specifically, there is a need for continuous involvement of the full spectrum of end users in the development and application of natural disaster data and research, to unlock the full potential of Australia's data and research capabilities.

This should be directly supported by a Business and Community Advisory Group to facilitate a more co-ordinated response and ensure that business and the not-for-profit sector are represented at the highest levels of policy development and decision-making.

This approach is described in Figure ii below.

Figure ii: Building a more resilient Australia



PRINCIPLE: CENTRAL GOVERNMENT FOCUS WITH STRONG SUPPORT FROM BUSINESS TO ADDRESS THE CO-ORDINATION CHALLENGE

Source: Deloitte Access Economics, *Australian Business Roundtable for Disaster Resilience and Safer Communities* (2013)

This report makes three recommendations for an enhanced approach to natural disaster information. The recommendations focus on the benefits possible through optimal end user decisions around data and research:

1 **Efficient and open - deliver a national platform for foundational data**

Given that foundational data is used for a broad range of purposes, beyond the scope of natural disaster issues, the Australian Government should provide a single point of access for all Australians. While weather information and data on community demographics is consistently provided by the Bureau of Meteorology and the Australian Bureau of Statistics respectively, allocation of responsibility for consistent topography and geocoded asset data at the national level is required. A national platform for this broader key data would facilitate prioritisation across local government and state borders in the national interest.

2 **Transparent and available - remove barriers to accessibility of data and research**

Access to data and research is restricted. Greater transparency across the system is required to identify the full range of end users and allow for the development of a system of optimal access which weighs up overall costs and benefits. There is a need for clear delegation of responsibility for hazard and impact data (such as hazard mapping) and a stronger approach for involving end users in research. This should also address concerns with legal liability, unnecessarily restrictive licensing and ensure standardisation across jurisdictions.

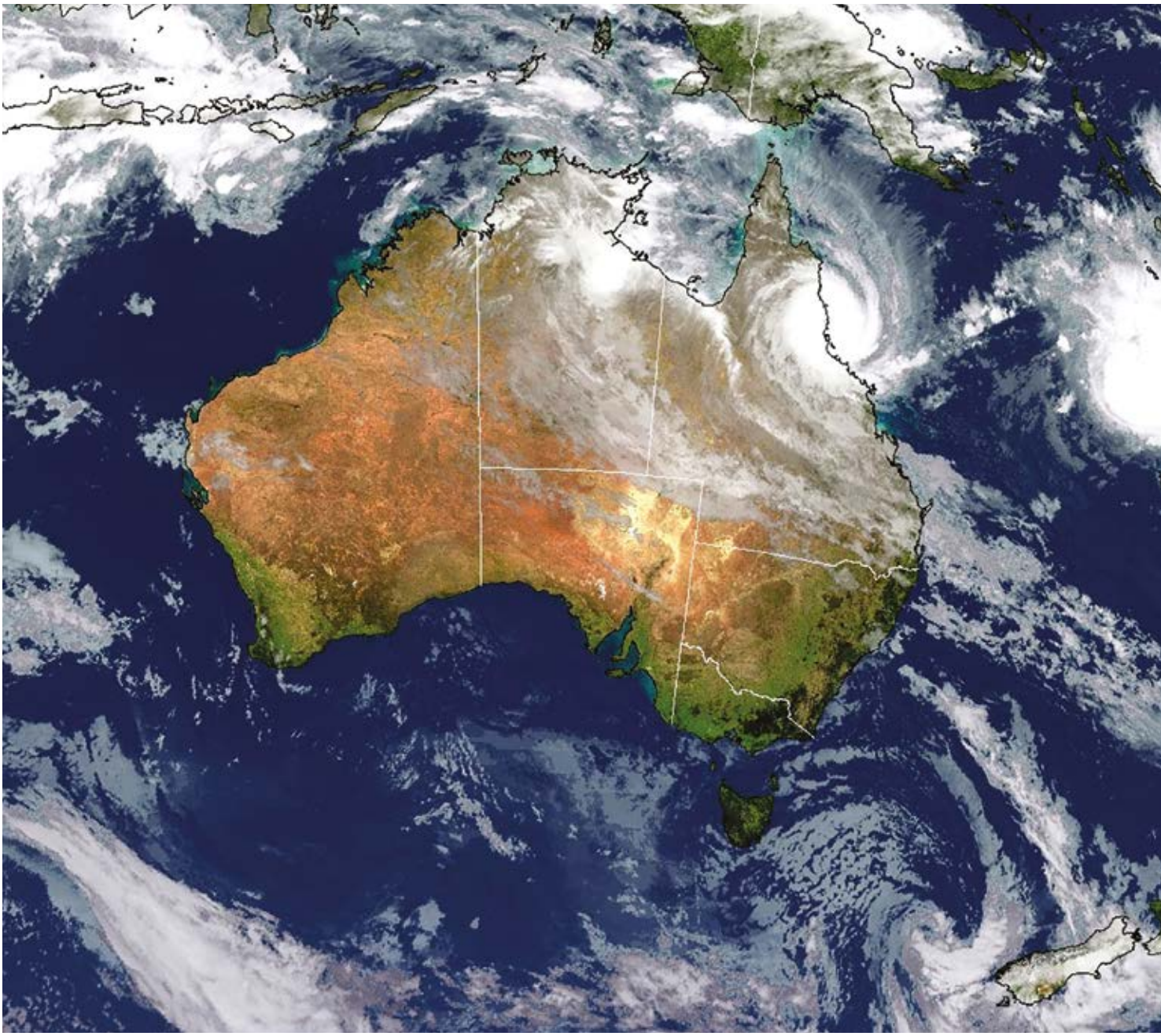
3 **Enabling effective decision-making - establish a prioritisation framework**

A national prioritisation framework for investment in resilience should be established, consistent with the approach adopted by Infrastructure Australia[1]. This will enable best practice use of natural hazard data and research to be collected and disseminated and ensure an optimal outcome from investment in resilience for Australia, through focus on consistent, evidence-based cost-benefit analyses. This approach would build a common understanding of the nation's areas of highest risk and also the most effective measures to reduce that risk and assist in prioritising the research agenda.

Conclusion

These recommendations will help to unlock the full potential of data and research, and reduce the burden of natural disasters on the Australian economy and our communities, however they can only be achieved through a shared effort by governments, businesses and communities.

1 Infrastructure Australia's Priority List identifies projects of national significance and informs the government of the highest priority projects. Guidelines for cost-benefit analysis, step-by step methodologies for different investment types and links to standardised data sources are provided by Infrastructure Australia to assist in the preparation of submissions. Further details on this approach are provided in Chapter 6.



Bureau of Meteorology: Satellite image showing a cloud/surface composite over Australia as Cyclone Ita moves toward the Far North Queensland coast, April 2014.

Over 50 stakeholders involved in providing natural disaster data and research

- Government
- Emergency services
- Research organisations
- Universities
- Community organisations
- Private sector
- Industry associations

1. Introduction

Key points

This paper builds on 'Building our Nation's Resilience to Natural Disasters', providing an analysis of data and research associated with natural disasters in Australia.

The recommendations of this report seek to contribute towards the Productivity Commission's Inquiry into Australia's natural disaster funding arrangements and the growing recognition by stakeholders of the need for better co-ordination and transparency of disaster risk and resilience information.

Deloitte Access Economics was commissioned by the *Australian Business Roundtable for Disaster Resilience and Safer Communities* to provide an analysis of data and research associated with natural disasters in Australia.

This report investigates the decision-making challenge and identifies the strengths and weaknesses of Australia's approach to natural disaster data and research. It makes recommendations for a more efficient, transparent approach to enable effective decision-making.

1.1 Background

This report builds on previous work commissioned by the *Australian Business Roundtable for Disaster Resilience and Safer Communities*, which analysed the opportunities for Australia to design a more sustainable and comprehensive national approach to making communities safer and more resilient. The paper, *'Building our Nation's Resilience to Natural Disasters'*, launched in June 2013, offered three key recommendations as outlined in Box 1 below.

Box 1: 'Building our Nation's Resilience to Natural Disasters' – Recommendations for a fresh, sustainable approach to pre-disaster resilience:

- Improve co-ordination of pre-disaster resilience by appointing a National Resilience Advisor within Prime Minister and Cabinet and establishing a Business and Community Advisory Group.
- Commit to long-term annual consolidated funding for pre-disaster resilience.
- Identify and prioritise pre-disaster investment in resilience that delivers a positive net impact on future budget outlays.

The implementation of these recommendations, particularly in relation to the consolidation of long-term funding for pre-disaster resilience, requires a best practice approach to the collection and provision of information. As noted in the paper:

"A national strategy to improve resilience needs to find ways to better co-ordinate relevant data held by all parts of government and business so that decisions can be made on the best available information" (2013:51)

Awareness of these issues across stakeholders is high.

For example, in November 2013, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) hosted a workshop with over 35 representatives from government, private companies and emergency service organisations to discuss the need to develop a 'system of systems' for disaster management. While the workshop was focused on disaster response and recovery, the key challenges raised are also relevant to information sharing on resilience[2]:

- Constraints related to data interoperability and standards
- Inconsistencies in the methods, channels and terminology used to communicate risk
- A lack of governance around data and information
- Uncertainty around the quality of data
- Unclear linkages and provenance between data, models and other information (CSIRO, 2014).

More recently, the Attorney General's Department and CSIRO hosted another workshop focused on disaster mitigation. Attended by more than 50 representatives from government, emergency services, research agencies, universities and the private sector, the objectives of the workshop were to:

- Consider a vision for disaster mitigation in Australia in 2030
- Develop a shared understanding of a model of the disaster mitigation value chain and the range of information, tools and methods required to inform disaster mitigation investment decisions
- Compile a stocktake of recent, current and planned work that contributes to mitigation investment decisions in the context of the value chain
- Consider stakeholder needs and identify gaps
- Identify priorities for future work across the value chain to address gaps towards the 2030 vision.

The workshop helped inform the ongoing work program of the Australia-New Zealand Emergency Management Committee with respect to natural disaster mitigation as well as informing the Productivity Commission Inquiry referred to below.

The effectiveness and sustainability of Australia's natural disaster funding arrangements is currently the subject of a Productivity Commission Inquiry. The purpose of the Inquiry is to identify reforms to achieve a balance between recovery and mitigation to help communities better prepare for disasters. The Issues Paper notes that:

"Identifying the optimal level of disaster mitigation, resilience and recovery at an aggregate level is arguably elusive… However, it is possible… to identify reforms to governance, institutional arrangements and decision-making processes that make it more likely that decision-makers will face the appropriate incentives and make appropriate risk management decisions. Benefit-cost assessment is integral to such decision-making and will inform actions that will tend to lead to outcomes that are closer to the optimum."

Source: Productivity Commission 2014:5-6

This report seeks to contribute to these activities by assessing Australia's approach to natural disaster data and research and by making recommendations to ensure that critical information is efficient, open, transparent and available to enable effective decision-making by the spectrum of end users.

The accessibility and consistency of data and research for decision-makers is an important determinant of the effectiveness of resilience investments and, hence, the ability for Australia to achieve outcomes that are closer to the optimum.

2 CSIRO 2014, 'Building a system of systems for disaster management workshop: joint issues statement'

1.2 Approach

The analysis presented in this paper relies on an evidence base developed through:

- A consideration of the **end users** of research and data in the context of the **Australian policy framework**, developed through consultations with representatives from major research institutions and representatives from the *Australian Business Roundtable for Disaster Resilience and Safer Communities*
- A review of the current **data** holdings relevant to natural disaster risk and exposure in Australia, based on detailed discussions with relevant stakeholders
- An evaluation of the key **research** activities that have occurred or are planned to occur between 2009 to 2021, based on desktop research, quantitative analysis and consultations
- An evaluation of different models for the organisation of data and research, considering **international examples** in the context of natural disasters, as well as the organisation of research in other sectors of Australia.

This approach has allowed us to develop recommendations for improved co-ordination of natural disaster research and data to address the decision-making challenge.

1.3 Report structure

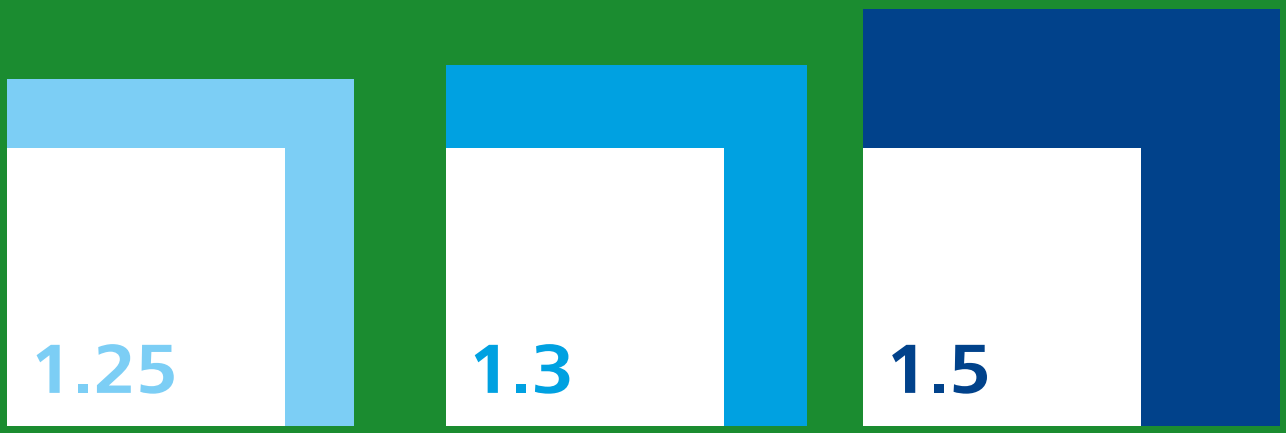
The remainder of this report is structured as follows:

- **Chapter 2** establishes the framework used for assessing natural disaster data and research, describes the current policy context in this area and highlights the economic justification of access to information
- **Chapter 3** presents a summary of current data relating to natural disasters that underlie the research activities on resilience and highlights examples where this does not align with key policy principles
- **Chapter 4** provides an overview of natural disaster research activities in Australia
- **Chapter 5** highlights lessons for the organisation of data and research in Australia, drawing on the approaches taken internationally and in other sectors
- **Chapter 6** makes recommendations for improved co-ordination of natural disaster information in Australia and provides concluding remarks.

Supporting information is provided in the following Appendices:

- **Appendix A** provides context around natural disasters and resilience in Australia by summarising the key findings of the paper *'Building our Nation's Resilience to Natural Disasters'*, highlighting key areas of relevance for this report
- **Appendix B** provides additional international evidence on natural disaster data and research
- **Appendix C** provides additional description of the role of different stakeholders in natural disaster research in Australia.

Carefully targeted investment



can deliver additional savings

2014 — 2050

$500 million – $2.4 billion

2. The decision-making challenge

Key points

As natural disaster resilience is an interdisciplinary issue, there are multiple agencies involved in collecting data and undertaking research – imposing **high search costs** to accessing information.

This challenge is faced by a **broad range of end users** across communities, businesses and governments, whose roles, responsibilities and objectives vary significantly.

The importance of data and research is well recognised in Australian policy. The Government **has committed to providing useable and accessible information** and has recognised resilience as an Australian Strategic Research Priority.

However, there is greater scope to **improve practical implementation** of these policies.

Additional savings for government of between **$500 million and $2.4 billion** over the period to 2050 could be achieved through improvements in the efficiency, transparency and effectiveness of data and research.

A broad range of data and research inputs are required to understand the best way to build the resilience of a community against natural disasters. This chapter describes the framework used to assess these information inputs, reviews current government policy positions and highlights the economic justification for promoting efficient, transparent, and effective data and research.

2.1 Data and research as inputs for optimal decisions

Optimal decision-making on resilience investments, by communities, businesses and governments, depends on a range of factors. For instance, decision-makers must have the appropriate incentives within governance and legal frameworks to conduct thorough, accurate cost-benefit analysis before investing funds.

The focus of this report, however, is the ability of decision-makers to leverage natural disaster data and research to make informed decisions for the creation of safer, resilient, and productive communities.

As illustrated in Figure 2.1 on page 24, the key set of inputs required by end users consists of:

- **Foundational data** – data that provides standard layers of locational information. This includes information on the characteristics of assets at risk, community demographics, geology, topography and weather and is also used for a range of other purposes
- **Hazard data** – hazard specific information on the risks of different disaster types, providing contextual data about the history of events and the risk profile for Australian locations
- **Impact data** – data on the potential and actual impacts associated with natural disasters, including information on historical costs and damage and the current and predicted future value at risk
- **Research activities** – activities that draw on data and seek to answer specific research questions across a range of areas. This includes questions on approaches to risk management, value at risk, vulnerability, the effect of mitigation, hazard detection, disaster impacts and recovery, decision support tools and strategy issues. There is often also feedback from research to data, where research outputs build on the existing stock of data that is available.

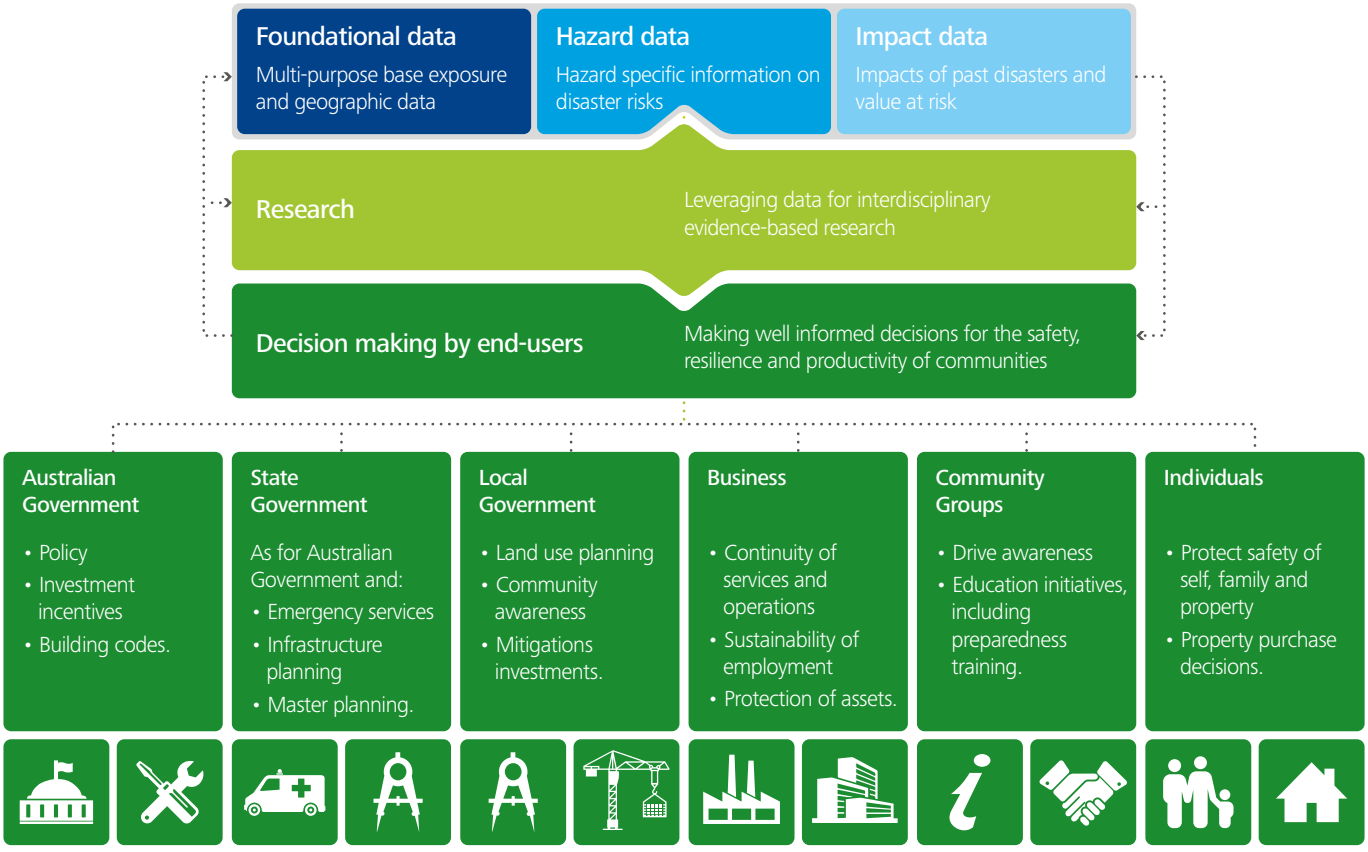
The process of linking data and research to end users for optimal decision-making is, however, practically very difficult. Natural disaster resilience is an interdisciplinary issue and multiple agencies collect data and undertake research – across governments, businesses and the community. This has resulted in many platforms to access the range of necessary information, imposing high search costs and disparate information sets.

The information needs of a broad range of end users across communities, businesses and governments vary significantly, increasing the challenge.

For example:

- The Australian Government requires information to ensure that policy and strategy supports incentives for best practice investments and to help shape building codes and disaster risk management
- State governments require information to develop and implement policy within their jurisdictions to improve disaster risk management, including through emergency management services, and to help guide infrastructure and master planning
- Local governments require information to guide land use planning decisions, community awareness and mitigation investments within their jurisdictions

Figure 2.1: Data and research inputs for optimal decision-making on resilience investments



Source: Deloitte Access Economics, *Australian Business Roundtable for Disaster Resilience and Safer Communities* (2014)

- Businesses require information to ensure sustainability of employment and to protect their assets, including critical infrastructure to enable business continuity and delivery of services to the public during and post natural disaster events and to improve business continuity management for future events
- Community groups require information to drive awareness, undertake education initiatives – such as preparedness training – implement risk management activities and to support their clients where appropriate
- Individuals require information to take action that protects the safety of their families, property, livelihoods, neighbourhoods and communities.

In order to realise the full potential of decisions to increase the safety, resilience and productivity of Australian communities, it is imperative that data and research is efficient, open, transparent and available in consistent formats that are fit for this variety of purposes.

To the extent that the benefits for the full range of end users exceed the costs of providing data and research, the current arrangement is inefficient and fails to deliver the best outcome for Australian communities and taxpayers.

2.2 Policy positions

All levels of government in Australia recognise the importance of building open information sets to aid decision-making around resilience. This section describes the current policy in relation to responsibilities for information in the context of natural disasters and resilience, as well as policy for data and research more generally in Australia.

2.2.1 Responsibilities for natural disaster information

The National Strategy for Disaster Resilience, the core Australian Government policy on natural disaster management, has called for a whole-of-nation approach to disaster resilience and management (COAG, 2009). It is widely accepted that governments, businesses, community organisations and individuals need to work together to successfully build resilience against natural disasters in Australia.

The responsibility for efficient, open and transparent provision of risk information lies primarily with government. This is outlined explicitly in the 'statement of common understanding' produced by the COAG Select Council on Climate Change (SCCC), as shown in Box 2.

Box 2: Guiding principles for allocation of roles and responsibilities for climate change risk

The COAG Select Council on Climate Change 'statement of common understanding' highlights the need for different stakeholders to share responsibility for climate change risks. In particular, the statement notes that:

"Governments should respond to market failures and regulatory failures that prevent effective and efficient natural disaster risk management, focusing on… providing best available information about risks to facilitate adaptation by the private sector and making information accessible and useable."

The statement also highlights that decision-making should:

- Be based on the best available research
- Be cost-effective
- Be regularly reviewed to meet changing circumstances
- Enhance social inclusion.

Source: SCCC (2012)

As holders of valuable data sets, supporters of research activities and end users of information, the private sector is capable and willing to support government in this role. For example, the Australian Sustainable Built Environment Council (ASBEC) has called for engagement between government and industry to co-sponsor research into the impacts of climate change and appropriate adaptation strategies (ASBEC 2013).

The following two sections describe current Australian government policy in relation to data and research more broadly, highlighting the key principles that apply to natural disaster information.

2.2.2 Data policy

Through the 2010 Declaration of Open Government, the Australian Government publically committed to providing public sector information that is open and transparent (Department of Finance, 2010). This is consistent with the increasing international recognition of open access to information for public accountability and engagement. Through the international Open Government Partnership, 64 countries have committed to making their governments more open, accountable and responsive to citizens through open government reforms (Open Government Partnership, 2014).

Table 2.1: Principles on open public sector information

Principle	Summary
1. **Open access to information – a default position**	Providing open access to information using information technology, where there is no legal need to protect that information.
2. **Engaging the community**	Engaging the community on decisions around what information to publish, the method and format of publication, and welcoming feedback on quality, completeness, usefulness and accuracy.
3. **Effective information governance**	A senior executive 'information champion' or knowledge officer in the agency should be responsible for information management and governance. The senior officer should be supported by an information governance body that may include people from outside the agency.
4. **Robust information asset management**	Maintaining asset inventories / information registers, which identify information custodians and their responsibilities, known limitations on quality, legislative and legal requirements. Establishing clear procedures for decisions on publication and release of information, to begin at the time of creation. Protecting against inappropriate, unauthorised use, access or disclosure.
5. **Discoverable and useable information**	Publishing up to date information asset registers. Publishing information in open and standards-based formats which are machine readable with high quality metadata attached.
6. **Clear reuse rights**	Making information available for reuse on open licensing terms, with the Creative Commons BY standard[3] as the default.
7. **Appropriate charging for access**	Facilitating public access to information at the lowest reasonable cost. Charges that may be imposed by an agency for providing access should be clearly explained in an agency policy that is published and regularly reviewed.
8. **Transparent enquiry and complaints process**	Agencies should have a transparent enquiry and complaints procedure for the public to raise issues about agency publication and access decisions.

Source: Adapted from Office of the Australian Information Commissioner (2011)

3 Creative Commons Australia provide simple, standardised licensing arrangements to allow the sharing of information. The Creative Commons BY standard allows users to distribute, remix and build upon a work, and create derivative works – even for commercial use – provided they credit the original creator/s.

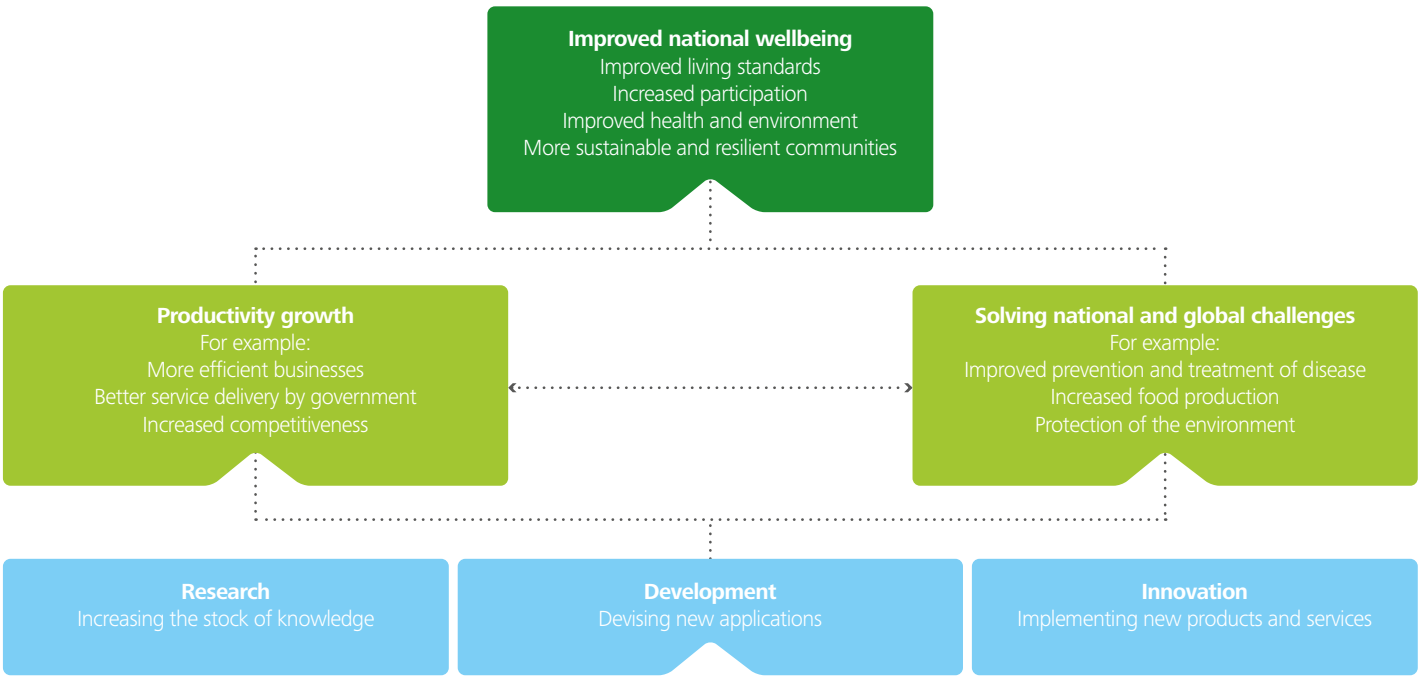
Following this declaration, the Office of the Australian Information Commissioner (OAIC) developed a set of principles to promote best practice information management in 2011, drawing from both Australian and international literature and a public consultation process. These principles are described in Table 2.1. The principles sit alongside legal requirements for information management, including the *Freedom of Information Act 1982, Privacy Act 1988 and Archives Act 1983*.

Currently, NSW, QLD, SA VIC and the ACT governments have reflected these principles through their own open data policies, strategies or declarations (Department of Finance, 2013). Some local governments, such as the City of Gold Coast, are also involved in open data projects and planning for their jurisdictions (City of Gold Coast, 2013).

Data.gov.au is one of the key initiatives focused on implementation of this policy at the national level. This website provides free access to almost 3,500 government data sets, primarily under a Creative Commons licence, and allows users to publically submit requests for additional information. The data sets are drawn from over 100 government departments and agencies, encompassing a very broad range of topics, from the location of Medicare offices through to energy ratings for household appliances.

These policy principles are particularly relevant in the context of natural disaster information in Australia. Data and research on natural disaster risks and the effectiveness of resilience options should be, in principle, publically available to maximise the positive externalities achieved through informed decision-making. That said, there remains a challenge for compliance with privacy and confidentiality requirements. The extent to which current foundational, hazard and impact data sets comply with these principles is examined in Chapter 3.

Figure 2.2: Australian Government framework for the benefits of research



Source: DIISRTE (2012:5)

2.2.3 Research policy

In 2012, the Australian Government released a National Research Investment Plan to guide a co-ordinated, whole-of-government approach to research investment (Department of Industry, 2012). As illustrated in Figure 2.2 on page 27, the plan highlighted the importance of research for improving the wellbeing of Australia by driving productivity growth and addressing national and global challenges.

This plan was prepared by the Australian Research Committee (ARCom), consisting of officials from government departments and representatives from the Australian Research Council, the National Health and Medical Research Council, CSIRO, the Defence Science and Technology Organisation, the Innovation Australia Board and Universities Australia.

ARCom was established in response to the 2011 *'Focusing Australia's Publicly Funded Research Review'*.

Some of the key findings of that review were that while there are no significant shortfalls or duplication across the spectrum of publically funded research activities, the system would benefit from:

- A more co-ordinated, coherent approach to maximise returns from investment
- A revision of the national research priorities
- Development of a rigorous, transparent, system-wide research impact assessment mechanism, to evaluate the wider benefits of research
- Stronger incentives for universities to engage more effectively with industry and other end users, so that businesses are driven by leading edge thinking to achieve productivity gains (Department of Innovation, Industry, Science and Research, 2011).

To assist with the implementation of the National Research Investment Plan, ARCom developed a set of Strategic Research Priorities to replace the National Research Priorities, which were first released in 2002. The fifteen Strategic Research Priorities are categorised into five societal challenges, the first of which has a clear focus on resilience. The three priorities to respond to the challenge of 'living in a changing environment' are outlined in Box 3. These Strategic Research Priorities were announced by the Australian Government in June 2013.

Box 3: Living in a changing environment – strategic research priorities

In response to the challenge of living in a changing environment, research should:

Identify vulnerabilities and boundaries to the adaptability of changing natural and human systems

Research will identify the level of environmental change human and natural systems can tolerate before fundamental ecological processes are irreversibly changed. This includes understanding complex systems, especially human–natural linked systems, and interpreting and predicting their behaviour.

Manage risk and capture opportunities for sustainable natural and human systems

Research will identify behavioural, economic, technological, institutional and design options for managing change in the linked human and natural environment including climate change, extreme events, population growth, consumption and biodiversity.

Enable societal transformation to enhance sustainability and wellbeing

Research will identify the areas of highest risk and develop options for the change required to mitigate and/or adapt to environmental change. This priority will focus on urban design, governance systems, decision frameworks and industry policies.

Source: Australian Government (2013)

Table 2.2: National research policy co-ordination responsibilities

Department of Education	Department of Industry
• Co-ordination of research policy in relation to universities • Creation and development of research infrastructure • Policy, co-ordination and support for international education and research engagement • Research grants and fellowships	• Co-ordination of science research policy • Collaborative research in science and technology • Commercialisation and utilisation of public sector research • Geoscience research and information services including geodesy, mapping, remote sensing, groundwater and spatial data co-ordination. • Industrial research and development, and commercialisation • Science engagement and awareness • Science policy

Source: Department of the Prime Minister and Cabinet (2013)

The transition process from the National Research Priorities to the Strategic Research Priorities has been taking place over the 2013-14 financial year. While the objectives of the Strategic Research Priorities and the National Research Investment Plan have been clearly stated, it is not currently evident how they will be implemented in practice. For example, while research activities are undertaken by a range of government departments and agencies, the core responsibilities for the co-ordination of research policy have been split between the Department of Education and the Department of Industry, as illustrated in Table 2.2.

Nevertheless, government policy clearly recognises the importance of research to help respond to the national challenge of building resilience. However, as identified in Chapter 4, beyond the Bushfire and Natural Hazards Cooperative Research Centre, links between research and the end user for practical implementation are limited.

2.3 Benefits of access to information

Getting the approach to natural disaster data and research right in Australia has significant financial consequences. *'Building our Nation's Resilience to Natural Disasters'* demonstrated that the economic cost of natural disasters borne by Australian communities is around $6.3 billion per year, on average, including $700 million in costs for government. By 2050, this is forecast to rise to $23 billion per year, with a government budget impact of around $2.3 billion in real terms.

It is well established that investments in resilience can reduce these costs. Furthermore, these investments will have the largest impacts where they are informed by the latest research and accurate, consistent data on disaster risks and exposure. For example, research undertaken by the Cyclone Testing Station played a key role in revising building codes in the early 1980s, leading to significant reductions in damage caused by future cyclones, as described in Box 4 on page 30.

By making information on disaster risks and resilience options more accessible, decision-making around resilience investments can be optimised and deliver additional savings for government, as well as reducing the impact of disasters on communities.

For example, *'Building our Nation's Resilience to Natural Disasters'* illustrated how an increase in pre-disaster resilience investments could generate long-term savings for government through gradual reductions in post-disaster response and recovery expenditure. Specifically, it showed how carefully targeted resilience investments of around $250 million per annum – achieving an overall benefit-cost ratio of around 1.25 – would generate savings for government of around $12.2 billion over the period to 2050, in present value terms.

Providing wider access to accurate, relevant natural disaster data and research can generate further savings by supporting governments, businesses and the community to prioritise these investments.

This will manifest through the achievement of higher benefit-cost ratios. Conservatively assuming that better informed investments could achieve an overall cost-benefit ratio of between 1.3 and 1.5, the total savings to government could rise to anywhere between $12.7 and $14.6 billion in present value terms, with additional savings of between $500 million and $2.4 billion over the period to 2050.

While the additional administrative costs associated with this national co-ordination would need to be deducted to estimate the net benefit of the improved approach, it is unlikely that the scale of the savings would be insufficient to offset those costs.

In any case, these figures illustrate the approximate scale of benefits that could be achieved from a more co-ordinated approach to natural disaster data and research that makes these critical information inputs open, transparent and available for governments, businesses and communities.

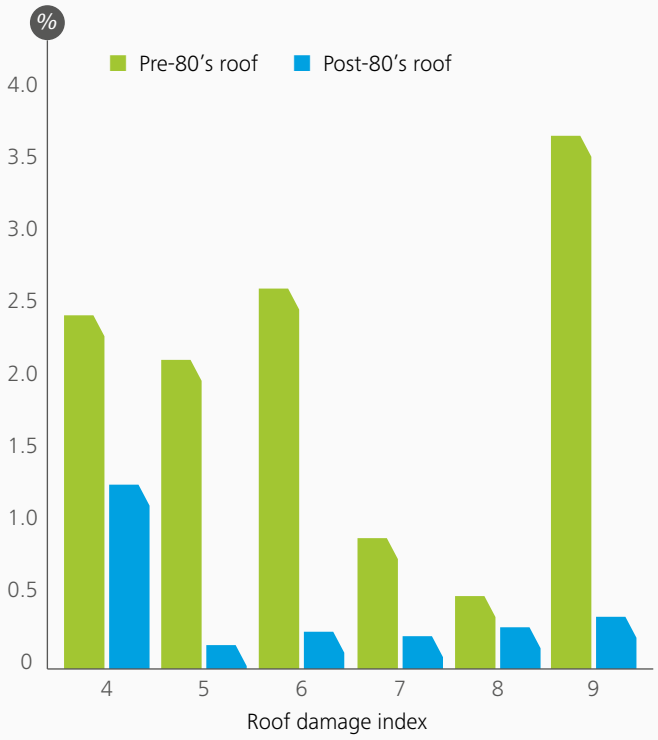
Box 4: James Cook University, Cyclone Testing Station – facilitating safer housing

The Cyclone Testing Station at James Cook University was established in 1977 in response to the devastating impact of Tropical Cyclone Tracy on Darwin in 1974. Cyclone Tracy resulted in 71 deaths, the evacuation of over 35,000 people and the destruction of 80% residential buildings (Geoscience Australia, 2011). Following the cyclone, it was recognised there was a gap in the availability of information on the effect of severe wind on low rise housing and the testing station was established.

Partly as a result of the work of the testing station, building standards in Queensland's cyclone prone areas were significantly strengthened in the 1980s. A post event analysis of Tropical Cyclone Yasi showed that 70% of post-1980s buildings sustained no roof damage compared with just 50% for pre-1980s buildings (Cyclone Testing Station, 2011). As illustrated in Chart 2.1, the examination revealed that pre-1980s buildings sustained a consistently greater frequency of serious roof damage.

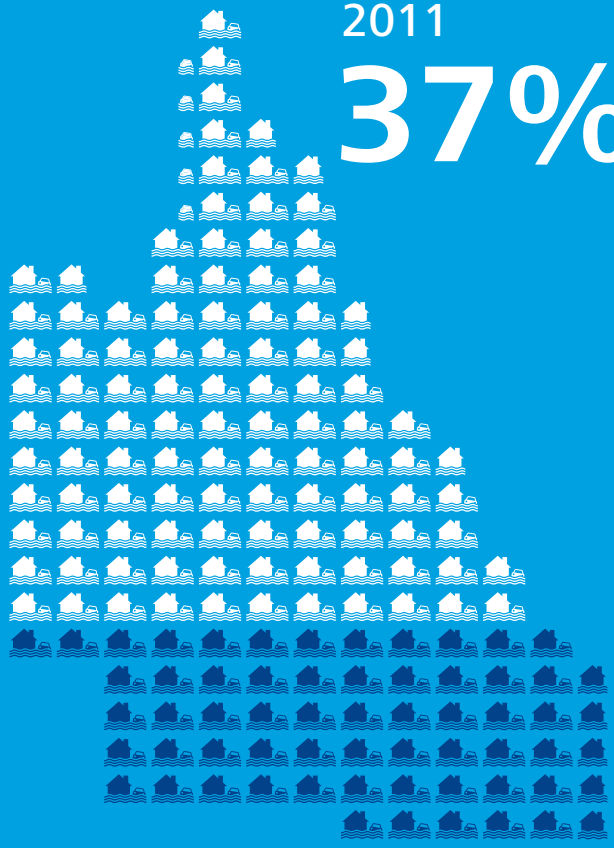
Source: Cyclone Testing Station (2011)

Chart 2.1: Percentage by roof damage index



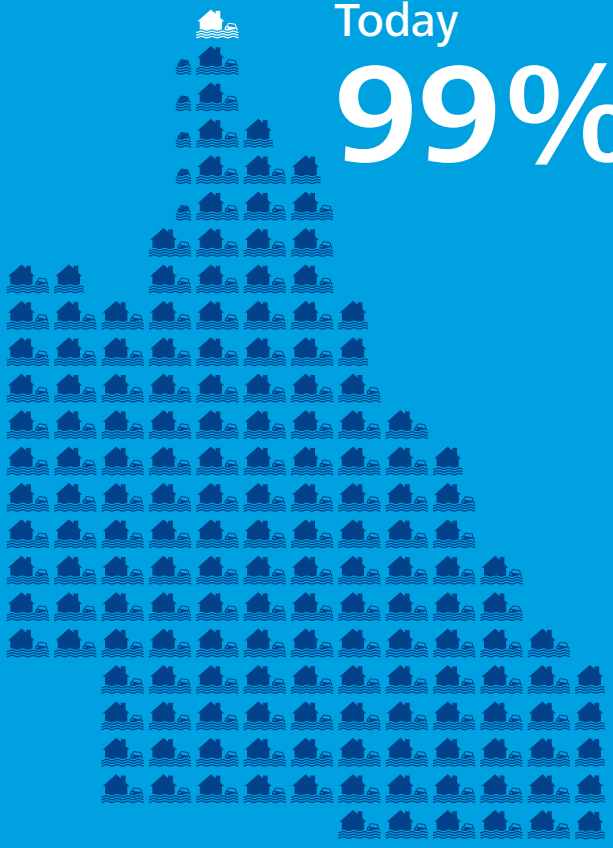
Cyclone Testing Station SWIRLNet anemometer, Cooktown: Portable wind station measuring wind speeds against Cyclone Ita 2014.

It can be done... Baseline floodplain maps in Queensland



2011

37%



Today

99%

3. Natural disaster data

Key points

The key categories of data inputs used in natural disaster research include:

- **Foundational data:** Base layers of locational information relevant to all hazards, including exposure data and fundamental geographic data. Used for a broad range of purposes, including but not limited to analysis of natural disasters
- **Hazard data:** Hazard specific information on the risks of different disaster types, providing contextual data about the history of events and the risk profile for Australian locations
- **Impact data:** Data on the potential and actual impacts associated with natural disasters, including information on historical costs and damage, and the current and predicted future value at risk.

Gaps exist across all three categories of data.

Significant barriers exist to the better provision, sharing and quality of natural disaster data sets.

There are two key elements to natural disaster information: underlying data inputs and the findings of research activities. This chapter focuses on the first element, setting out a high level summary of the current data holdings relevant to natural disaster risk and exposure in Australia.

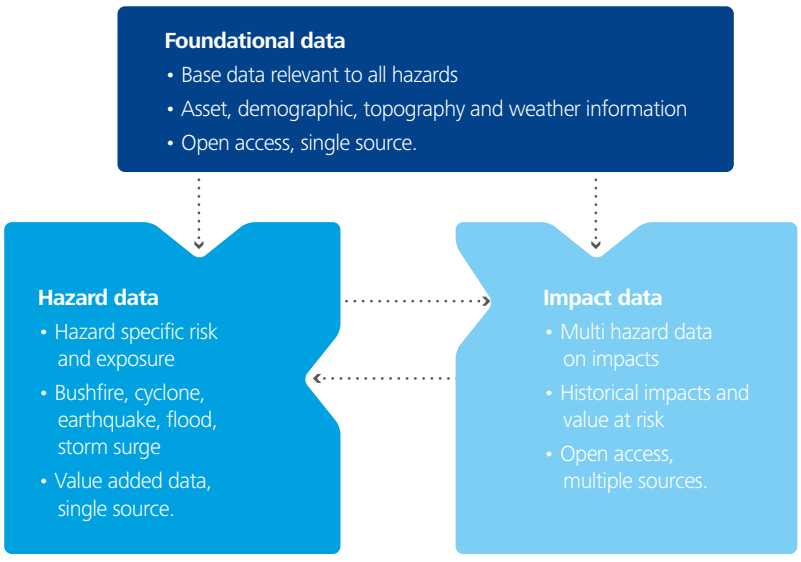
A summary of the key data sets and their custodians broken down by category is provided in tables in Section 3.1. Best practice data management is then explored using Australian Government principles for open data and examples of successful data sharing. This is followed by an analysis of the major barriers to the effective provision of data.

The models used to assess risk are only as good as the data used in their development. It is therefore vital that accurate data is open, transparent and available to end users. Importantly, improved collection and sharing of data will better inform research and decision-making around resilience options.

3.1 Current data holdings

To fully assess the risks associated with natural disasters, a comprehensive spectrum of data inputs from multiple disciplines is required. This encompasses foundational data, hazard data and impact data. Where such data is open, accurate and available, it provides a critical platform for evidence-based research activities and decisions that build resilience across Australian communities. Figure 3.1 outlines the main categories of data sets relevant to bushfires, flooding, earthquakes, cyclones and storm surges.

Figure 3.1: Data categories



Source: Deloitte Access Economics (2014)

Foundational data

Foundational data, which can be used across multiple hazards, forms the base for further peril analysis. Foundational data is also essential as an input to ensure effective decision-making for land planning, building codes and mitigation investment.

As this data can be used for a wide range of purposes, by many users, it should be made open access from a single source.

Table 3.1: Foundational data summary

Category	Data requirements	Data custodian/s
Assets	Location of housing	Australian Bureau of Statistics (ABS), Australia Post, Public Sector Mapping Agencies (PSMA), local governments, private firms
	Location of other infrastructure	ABS, local governments, private firms
	Asset construction data	ABS, local governments, private firms
Demographics	Local population, socio-economic status data	ABS
Topography and geological	Bathymetry	Geoscience Australia
	Elevation data	State governments, local governments, private firms
	Land surface	Terrestrial Ecosystem Research Network (TERN), Geoscience Australia
	Geological	Geoscience Australia
	Vegetation	TERN
Weather	Humidity	Bureau of Meteorology (BoM)
	Rainfall	BoM
	Temperature	BoM
	Satellite and radar data	BoM
	Tide gauge	BoM, local governments
	Wind speeds	BoM, Cyclone Testing Station

Source: Deloitte Access Economics (2014)

Hazard data

Hazard data is specific to a hazard type and relates to risk and exposure. This type of data is generally value-added in nature, providing another layer of information on top of foundational data.

Depending on the circumstances, this data may or may not be made freely available. For example, some data developed by private organisations may be a source of revenue or a competitive advantage and they may be unwilling to share it.

Table 3.2: Hazard data summary

Category	Data requirements	Data custodian/s
Bushfire	Mapping of fire breaks	Emergency services, state governments, local governments, private firms
	Mapping of control burns	Emergency services, state governments, local governments, private firms
	Hazard zones	BoM, local governments, local fire authorities
Cyclone	Historical cyclone tracks and characteristics	BoM
	Wind hazard maps	Australian Building Codes Board
Earthquake	Historical earthquake characteristics	Geoscience Australia
	Interruption contingencies	Private firms, researchers
	Seismic characteristics	Geoscience Australia
	Event shake maps	Geoscience Australia
	Hazard maps	Geoscience Australia
Flood	Mapping of levees / retention basins	Local governments, private firms, researchers
	Mapping of water depth and velocity	Local governments, private firms, researchers
	Hazard flood maps	Local governments, Geoscience Australia, state governments, Insurance Council of Australia (ICA)
Storm surge	Mapping of water depth and velocity	Local governments, BoM, private firms, researchers
	Storm tide analyses	BoM, private firms, researchers
	Hazard maps	Local governments, private firms, researchers

Source: Deloitte Access Economics (2014)

Impact data

Impact data measures the potential and actual impacts associated with a disaster. This includes the costs of damage to assets, emergency response, and human costs in the form of fatalities, injury and longer term social and psychological impacts.

Generally, impact data should be made open to facilitate multiple uses. However in some instances where private organisations have spent considerable resources developing value at risk models, commercial considerations may impede open access.

Table 3.3: Impact data summary

Category	Data requirements	Data custodian/s
Economic costs	Insured losses	Industry bodies, re-insurers and insurers
	Residential, commercial and industrial buildings damaged and destroyed	Emergency Management Australia (EMA), ICA
	Motor vehicles, water vessels, trains and aircraft damage	EMA, ICA
	Farms, crops and livestock damaged and destroyed	EMA, ICA
	Infrastructure damage	EMA, local governments
	Fatalities and injuries	EMA
	Post-disaster health data	Department of Health, Health Insurance Commission, Department of Human Services (DHS)
	Number of people evacuated	EMA
	Number of displaced	EMA
	Social and psychological impacts	Research organisations, state community service agencies
	Impact on employment / livelihoods	Centrelink, DHS
	Impact on public lands	State public land management agencies/departments, research organisations
	Impact on essential services	Private firms, state infrastructure departments, research organisations
	Government relief payments / financial assistance	Commonwealth budget papers, Department of Finance, DHS, EMA
	Costs of response and recovery programs	Commonwealth budget papers, Department of Finance, DHS, EMA, state budget papers, state community service agencies
	Total economic cost	Bureau of Infrastructure, Transport and Regional Economics
Risk models	Value at risk	Local councils, insurance companies, ABS
	Probability or frequency of losses occuring	State governments, local councils, specific researchers, insurance companies, private firms

Source: Deloitte Access Economics (2014)

3.2 Best practice data management

A co-ordinated approach to improved data dissemination and access has multiple benefits for multiple users. In order to achieve better outcomes, best practice principles need to be followed.

As noted in Chapter 2, in 2011 the Office of the Australian Information Commissioner (OAIC) developed a set of principles, listed here, on open public sector information. According to the OAIC, the principles rest on the democratic premise that public sector information is a national resource that should be available for community access and use.

1. Open access to information – a default position
2. Engaging the community
3. Effective information governance
4. Robust information asset management
5. Discoverable and useable information
6. Clear reuse rights
7. Appropriate charging for access
8. Transparent enquiry and complaints process

The principles form the basis of best practice data management. There is a strong case for foundational data, in particular, to adhere to these principles. As foundational data informs research, modelling and decision-making it is important that accurate data is widely available. By providing open access to foundational data through a national platform based on the OAIC principles, decision-making by end users of the data will be improved.

There is also an argument that any data that underpins where a house is built and how it is built (e.g. planning and building codes) should be open access. If not, it may lead to inconsistent or incorrect views of risk and mixed messages to the community, poor decisions around resilience and unnecessary duplication.

Table 3.4 outlines some of the potential benefits of moving towards best practice.

Table 3.4: Benefits of better data

Benefits	Application
Reduced search costs	Researchers can access data without having to devote time and resources to searching for and collating data
Improved research outcomes	Improved research outputs
Better decision-making	Better land planning decisions
	Better emergency response decisions
	Better building decisions
Informed communities	Individuals and homeowners can assess hazard risk easily through central online platforms
Reduced duplication	Transparency and access to available data will reduce the need for re-production
Effective mitigation	Improved building standards
	Informed mitigation investment
Accurate pricing of risk	Consistent insurance pricing
	Availability of mortgages

Source: Deloitte Access Economics (2014)

A current example of best practice data management in the Australian research community is the Terrestrial Ecosystem Research Network (TERN) as outlined in Box 5. TERN demonstrates what can be achieved with adequate infrastructure investment, a concerted effort across organisations and flexible licensing arrangements.

The Bureau of Meteorology is also very well regarded amongst the research community. Some issues exist such as the sparse nature of the wind measuring networks and the time taken to make historical river flow information available, however the overall availability and quality of data is high. Compared to equivalent agencies globally, the Bureau is considered one of the leaders in data provision.

3.3 Gaps in data

Gaps exist across all three types of data. Gaps may occur both where data is non-existent and where it is inaccessible to end users. While this review is not exhaustive, specific examples have been provided to demonstrate areas where gaps can be filled and improvements made.

Elevation data: LiDAR

Elevation data provides information on the land surface such as the bare earth digital elevation models (DEMs) and other land surface objects such as vegetation and buildings often referred to as a land surface model. This data is used across a wide range of perils such as flood, wind and bushfire and can be used for addressing issues relating to urban planning, infrastructure design, water security, environmental management and climate change.

Most elevation data is captured via remote sensing equipment on air craft, satellites or other space craft such as the Shuttle Radar Topography Mission (SRTM). The coverage, accuracy, resolution and costs of different methods vary significantly. Light Detection and Ranging (LiDAR) is typically the most accurate and expensive while coarser national or global scale methods such as SRTM may be freely available. Appropriate quality of data is required to understand the natural hazard risk in some areas. Figure 3.2 illustrates that to understand the flood risk in this geographic area, more accurate methods such as LiDAR would be necessary. Flood modelling undertaken using the SRTM data would produce a significantly different and inaccurate outcome as the watercourse features are not properly defined.

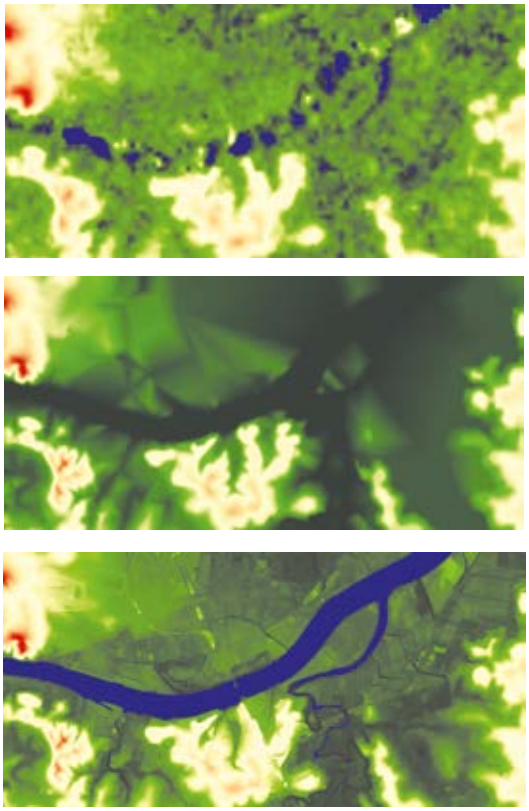
Box 5: Terrestrial Ecosystem Research Network (TERN) – connecting ecosystem scientists

TERN provides the infrastructure to enable the sharing and storage of ecosystem data across disciplines. TERN was created through a $20m grant as part of the National Collaborative Research Infrastructure Strategy in 2009 and $4.1 million from the Queensland State Government. An additional $25.6 million was provided through the Super Science Initiative in 2011.

The TERN Data Discovery Platform delivers open access to Australia's ecosystem data. Researchers in the natural disaster area can access vegetation data through the platform for bushfire modelling. A flexible licensing arrangement allows data sharing by a range of research organisations to make data as openly accessible as possible. TERN's philosophy is 'collect data once – make it discoverable – use it many times'.

Source: TERN (2014)

Figure 3.2: Differences in accuracy of elevation data



SRTM

Cost: Free

Coverage: Global

Quality: Poor in many areas – cannot be used in some areas

Contour

Cost: Low – moderate

Coverage: Many areas

Quality: Medium

LiDAR

Cost: High

Coverage: Limited

Quality: High

Source: Insurance Australia Group (2014)

There are gaps, however, in the coverage of LiDAR data available in Australia. In areas that are covered, the data may be held by different custodians in different formats with different licensing arrangements. Differences in the quality, and thus the accuracy of elevation data is another important issue, relevant to all types of natural disasters in Australia.

Geoscience Australia holds approximately 200,000km^2 of LiDAR data predominantly over and around built-up and coastal areas. The largest strip of contiguous LiDAR data extends along the coastline from north Queensland around the south-east to Adelaide. Other data sets represent the coastal regions of Tasmania (northern and south east coasts), Darwin, Kakadu and the Perth region south to Busselton.

New data set acquisitions exceeding 50,000km^2 are currently underway along floodplains of the Darling River, to be completed in 2014. Co-ordination of LiDAR acquisition exists through the Intergovernmental Committee on Surveying and Mapping through the Elevation and Depth Working Group currently chaired by Geoscience Australia with representation from all states and territories.

Currently the only LiDAR surveys that are licensed for non-government (Creative Commons) use are the most recent acquisitions over the Darling River floodplains. All other projects have been licensed for internal government use only and are available to all levels of government. Therefore there is very limited LiDAR data currently available to the general public through Geoscience Australia over the populated parts of Australia.

Since the inception of the National Elevation Data Framework, new LiDAR acquired by government (mostly states) has shifted significantly towards state ownership. The culture of suppliers retaining intellectual property is now largely a relic of the earlier acquisitions.

Although all states are moving to open data, or already have open data policies in place, most have exemptions in place for imagery and LiDAR until they can resolve issues around stewardship and custodianship relating, for example, to management of large data volumes and maintaining data currency. Therefore for the more recent acquisitions, the key barriers for open access to high resolution elevation data across Australia are the lack of a robust governance framework and a national investment plan.

Flood hazard information

While good coverage of flood modelling data is available across Queensland (see Box 7), there are significant gaps in the coverage across other states and territories. There are national and state guidelines for best practice preparation of flood hazard information, however these are often applied inconsistently as floodplain management entities and local councils are often small organisations with limited budgets and technical expertise.

Where inadequate flood mapping exists, incorrect land planning decisions may result. It is important to have a detailed understanding of the flood hazard of a local area in order to allocate land safely to avoid devastation. The inability to accurately model flood hazard and risk also impacts the ability of all levels of government to make mitigation investment decisions.

Even where quality flood related data exists, it may not be accessible. For example, an environmental services firm undertook a pilot investigation for a major insurer in 2013 to determine how easy it was to gather flood related data, as well as useability of format for 20 local government areas in NSW. The investigation found significant differences among the councils as to the availability of flood studies and data. And of those that were available some flood studies were considered to be out of date.

Differences in the availability and quality of flood risk information can lead to data disparity or inequality amongst local councils. This can result in some communities unable to make informed decisions while others are able to implement effective, preventative measures to increase resilience.

A lack of access to flood hazard mapping may also affect insurance and mortgage availability, create inconsistent and inaccurate views of risk and cause unnecessary duplication of data capture and analysis. Smaller insurers with limited risk measurement capabilities may choose not to offer insurance or mortgages in areas where flood modelling is unavailable. Larger insurers and banks need to factor in the additional costs in forming a view of risk in order to provide these financial products.

An important additional benefit to the availability of flood hazard maps is that they enable communities to be informed about the hazard of flood posed to their families and homes. An interactive flood check map covering all floodplains in Queensland is now available online.

Wind observations

Measurements of the wind speeds of tropical cyclones that cross Australia's coastline are often inaccurate as a result of issues with the distribution and quality of wind sensors within the automatic weather station network predominately operated by the Bureau of Meteorology. In fact, it is estimated that the peak gusts generated by tropical cyclones are captured by these wind stations in less than 2% of cases (Harper et al, 2008).

These inaccuracies in the severity of cyclone wind speeds and gaps in the capture of data lead to greater uncertainty around the risks borne by coastal communities and the extent of resilience investments required to minimise cyclone impacts. This data is also a very important input into the development of building codes which can significantly enhance the resilience of new housing stock.

An initiative from the Cyclone Testing Station (CTS), at James Cook University in Townsville is trying to address this issue but it requires a significant boost in funding to be sustainable. The station has developed mobile towers with wind sensors which it can deploy into the predicted path of an approaching tropical cyclone. This initiative demonstrated its value in 2014 for Tropical Cyclone Ita when three mobile towers where set up in Cooktown in the main populated areas impacted by the cyclone.* This enabled the CTS to know more precisely the wind speeds and loads that caused failure to these buildings so that building performance can be accurately assessed. This real time transmitted data also informs emergency services, local councils and the community.

Coastal bathymetry

There is limited risk information and research on storm surge activity around Australia. To date, progress has been made through the storm tide mapping in local council areas in Queensland and Western Australia, however there are known issues with quality of these outputs for decision-making. For example, Geoscience Australia has stated that a recent storm surge and inundation modelling study undertaken in Busselton for Planning WA, "is not suited to inform day to day planning determinations", due to the modelling process and the data underpinning the project (Planning WA, 2014).

Coastal bathymetry data is essential for accurate modelling of storm surge inundation. The availability of this data is sparse and often out-dated and may also be in different formats depending on why it was collected. This has a direct flow-on effect on the quality of storm surge mapping.

Social and psychological impacts

There is a lack of available data on the social and psychological impacts of natural disasters. Information regarding the effects on a community after the response and recovery phase is sparse. Social and psychological research is largely ignored on natural disaster research agendas.

Some researchers are seeking to address the limited amount of data by conducting surveys for individual research projects in particular areas however there is no broad collection of data. Information on business disruption, employment and availability of essential services are important to understand the long-term impacts on a community.

Economic impacts

The empirical information on the past or future economic impacts of natural disasters in Australia is unavailable, fragmented or out of date. This is one of the key inputs for prioritisation of research and data activities.

'Building our Nation's Resilience to Natural Disasters' provided overall estimates on the total economic costs of natural disasters in Australia and the forecast growth rate of these costs. As the focus of the paper was to provide a high level view on the budgetary impact of building Australia's resilience, more granular economic cost data was not included in the analysis.

The most recent available source of detailed estimates on economic impacts is the *'Economic Costs of Natural Disasters in Australia'* report developed by the Bureau of Transport Economics in 2001, which is based on historical events only. It does not provide information on potential impacts that are possible but have not occurred. While the information in this report is currently being updated, there is no holistic collation of economic impact data available for users to make economic impact or cost estimates.

3.4 Barriers to efficient, open, transparent and available data

Significant barriers exist to the better provision, sharing and quality of natural disaster data. The removal or reduction of these barriers would help Australia to move closer to optimal decision-making. While the list here is not exhaustive, it covers the key obstacles to a more transparent and open data environment.

* Refer to image of SWIRLNet anemometer mobile tower p.31

Reluctance to share data

Local councils are custodians of a large amount of data used in land planning and emergency response planning. A key barrier regarding the willingness of local councils to share the data is the threat of legal action from citizens due to a potential fall in land and property prices. Even if it is known there will be no legal ramifications, the legal costs involved in defending the release of data can be a deterrent for councils.

The inconsistency among councils in providing flood information is a common area of frustration raised by stakeholders. A submission by the Floodplain Management Association (FMA) summarises the issue well:

"There is variance between how freely Councils share flood databases. Many place all flood studies and maps on their public websites, and make the above data sets available to consultants, the insurance industry and government agencies. Others are more reticent to allow public access, citing misuse / misinterpretation, and instead rely on systems such as s149 property certificates to inform property owners of flood risk on request. Local politics often plays a part, with community members often raising concerns that the publishing of flood data may affect land values and insurance premiums (although these concerns are usually unfounded)." (FMA, 2014)

With gaps existing in flood data due to the variability of sharing arrangements, researchers and users of flood mapping information are required to either source their own information from private organisations or use incomplete data sets. This creates unnecessary costs and can directly impact the quality of research outputs. Inconsistent views of risk, mixed messages to the community, poor decisions around resilience and unnecessary duplication may also result.

This is just one example of a reluctance to share data. Another example is when a researcher has spent considerable resources developing a data set to create original research outputs which can generate future research grants. Where commercial advantages arise from investing in better quality data to accurately model risk, private firms may be unwilling to release information to competitors.

Restrictive licensing arrangements

In some circumstances, councils will receive subsidised elevation data whereby private contractors retain the intellectual property rights of the data. Given the limited financial resources available to some councils, there may be little incentive to pay the additional cost for full rights to the data. This unco-ordinated approach to elevation data creates considerable search costs for the end users and limits accessibility. Box 6 illustrates how limited licensing arrangements can lead to excessive costs in obtaining data.

Another example of licensing arrangements inhibiting usage is the Geoscience Australia LiDAR data holdings. The restrictions imposed on Geoscience Australia's use of LiDAR data mean that the vast majority of the data is only available for internal government use. This is due to the intellectual property ownership resting with the original suppliers, or contracted acquisition companies. A key barrier to opening up access to the data holdings is the cost of implementing new intellectual property arrangements for approximately 200 previous LiDAR acquisitions so their intellectual property is vested in the Commonwealth and Creative Commons licensing can be applied. As noted earlier, the key barriers for open access to high resolution elevation data across Australia are the lack of a robust governance framework and a national investment plan. To complicate this further, end users requiring data now may not be able to access it via other private firms. This is because of the lack of commerciality in building and maintaining such data sets due to government potentially agreeing to release this data in the future.

Cost of collection

The cost of collecting data consistently across regions is in some instances, a primary reason for the piecemeal approach to data collection.

A key barrier to the wide collection of bathymetry data used to model storm surge risk is the substantial costs involved. The Queensland Government has estimated that gathering bathymetric LiDAR data across the entire Queensland coast would cost more than $70 million (Queensland Government, 2013). The implication of not collecting this data is that the awareness of the risk as well as the ability to forecast storm surge is impaired.

Box 6: Restrictive flood map licensing inhibiting decision-making

In late 2012 a company specialising in extreme weather risk analysis, Climate Risk, contacted a local council to request flood and coastal inundation maps. The data was needed as part of a national project to help identify risks to water utility assets from extreme weather and to assess the most cost effective solutions.

Climate Risk knew that high quality flood modelling had been commissioned by the council and had been paid for using a $325,000 grant from the State Government. A PDF of the flood maps could be seen on the internet.

Climate Risk needed to check the hazards for nearly 100,000 water assets from large machinery down to individual sections of pipe. Because the task was too big to do manually, they had developed a software system to check the digital version of the flood maps for the depth and probability of a flood at each asset location and then calculate the annual financial risk.

Climate Risk asked for the original digital version of the files. They were initially directed to use the PDF files on the internet but they explained these were low resolution and did not contain the information within the council's digital flood files. Unfortunately, the council refused to provide a digital copy.

Climate Risk appealed the decision under freedom of information laws. This went to an internal appeal within the council, but the independent assessor confirmed the refusal of access. Their reasoning was based on a clause in the act that allowed the council to refuse to provide information, including digital documents, if the information was available for a fee.

The fee was $2,000 per 'tile' of data, with 150 tiles to cover the required area. The irony is that Climate Risk would have to pay the council $300,000 for a project designed to help protect the water services of residents who had already paid for as tax payers. Furthermore, the data license was for single use, which could be interpreted as requiring multiple such payments.

Climate Risk refused to pay the fees and the request for data was not pursued. But two major consequences flow from the obstruction of access to publicly funded hazard information.

Firstly, prudent risk reduction decisions cannot be made by asset managers. If an asset was found to be at risk, asset managers could take preventative action as part of routine asset upgrades. For example, a machine that is found to be at risk of flooding can be moved or raised to higher ground. This is much cheaper than replacing damaged equipment when an unanticipated flood occurs.

Secondly, there are consequences for the community. No flooding risks can be identified, so the actions to protect water supplies and public health are severely hindered.

Source: Climate Risk, 2014

Land based LiDAR data is one of the more expensive methods of collecting elevation data, compared to methods such as Shuttle Radar Topography Mission (SRTM). However, the bulk purchase of data can have a significant effect on the overall price paid.

The barrier of cost could potentially be reduced through a co-ordinated effort at a state or national level. During consultations, Queensland was put forth as a state that used a well-regarded private firm for the wide collection of LiDAR data and achieved significant cost efficiencies.

While the cost of collecting data is a key barrier, it must be noted that as technology improves it is anticipated that the price of data collection will fall. As an example, satellite derived bathymetry is much cheaper than bathymetric LiDAR, however it is still in the experimental stage. Once improved, this method may enable co-ordinated, consistent data collection at a reasonable cost.

Lack of co-ordination and standardisation

In many cases, data is held in different formats and is subject to different methodologies. Inconsistent assumptions, data management and approaches present big challenges to end users who rely on broad data coverage and need to integrate multiple sources. The co-ordination and standardisation of data collection, storage and provision can help alleviate these problems.

In consultations with stakeholders, it was noted that LiDAR information is being collected multiple times through various levels of government and private firms. Across the state and territory governments, agencies have different data standards, cost structures and licence terms.

There could be significant benefits from the national co-ordination of LiDAR data. A national approach to collecting and disseminating LiDAR data would avoid the current duplication that exists by providing a central source for use in land planning, emergency services, property development and other end users.

There may be a need for additional flyovers for specific purposes but there are known advantages in having a base availability.

Accurate information on building attributes is required to assess asset exposure to particular perils. This includes geocoded address data to identify the position of an asset in relation to a peril and details on the construction materials and building design. The main index for geographic co-ordinates of a property is the Geocoded National Address File (G-NAF) data set from the Public Sector Mapping Agency (PSMA). However, in this data set the location of a particular property is mapped in different ways across the states, depending on the methodology used. Victoria and ACT assign the property to the midpoint of the front boundary of the block, whereas all other states use the centre of the block.

In the absence of a consistent standard for geographical positioning of an asset or parcel of land, use of different information can lead to substantial differences in the outcome of risk modelling, research and policy decisions related to natural disasters. This is particularly the case for large or sloping properties. Similarly, differences in information around the floor height of a building or its construction material can greatly vary its assessed vulnerability.

Box 7: Queensland flood mapping – from poor coverage to complete coverage

Queensland provides an example of what can potentially be achieved through a concerted effort. Following the 2010/2011 floods, the Queensland Floods Commission of Inquiry found there was an inadequate level of flood mapping in Queensland, given that maps were included in only 37% of Queensland's planning schemes. Of those planning schemes with maps, only 23.6% were completed in accordance with state planning policy (2012:62). The inquiry recommended that:

"A recent flood study should be available for use in floodplain management for every urban area in Queensland. Where no recent study exists, one should be initiated." (2012:13)

Since the inquiry, 99% of Queensland was assessed for floodplains and 27% of the state was identified as floodplain (QRA, 2012). A partnership between the Queensland Reconstruction Authority and the Department of Environment and Resource Management led to the development of statewide floodplain maps. All main areas now have at least a basic view of the risk and a more consistent form of data, making Queensland the only state with a statewide understanding of its floodplains.

This is not to say that co-ordination is easy. The Australia and New Zealand Land Information Council (ANZLIC) was established in 1986 to co-ordinate the collection and transfer of land-related information between the different levels of government. ANZLIC provide standards and frameworks for data used in natural disaster research such as elevation and geocoding information. Given the existing issues with elevation data, and that ANZLIC has existed since 1986, shows the problems are not easily solved and require concerted effort by many stakeholders. Obstacles around co-ordination can be overcome, as illustrated in Box 7.

Cost of providing accessibility and transparency

A prevalent issue among researchers is that data exists but is not accessible or is too costly to be used broadly. Limited sharing of data can impede research from occurring and lead to inefficiencies due to overlaps in data gathering. Similarly, another major barrier that creates considerable search costs and further duplication is the lack of transparency around what data is available. The costs involved may inhibit the data collector from providing accessibility and transparency.

Some progress has been made in this area. For example, before the 2010/2011 Queensland floods, flood hazard maps were held by many local councils, but were often not accessible to the public. After the floods, the State Government decided to release this information, providing public access to flood maps through an interactive website. This decision was made in recognition of the value of this information for decision-making to reduce community exposure to flood hazards in the future.

Similarly, in response to the findings of the 2011 National Disaster Insurance Review, the Australian Government committed $12m over four years for Geoscience Australia to develop a national flood risk information platform. The platform aims to provide a public access point for flood risk information. While it is still in progress, it is important that, when complete, the information is up-to-date, thorough and the underlying data is made available for the benefit of all users. The Productivity Commission has recommended the platform be expanded over time to encompass other natural hazards (PC, 2012).

3.5 Conclusions

This chapter has provided a high level summary of the current data holdings relevant to natural disaster risk and exposure in Australia and has highlighted best practice and key barriers. It is clear that a more co-ordinated approach to natural disaster data would not only reduce administrative costs but also support the quality of research activities and decision-making around resilience investments for the benefit of Australian communities. It would also have the added benefit of reducing the unnecessary duplication of data capture and analysis and ensuring assessments of risk were accurate.

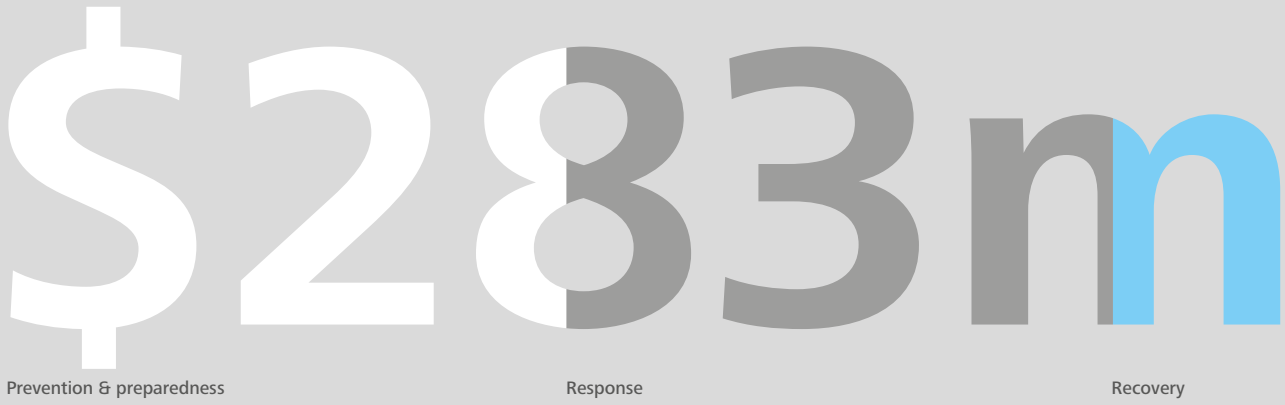
While key areas for improvements in data are outlined, a detailed analysis of the cost-effectiveness of resolving gaps or improving access is necessary to ensure the best use of limited resources. It needs to be clear that the benefits of better data provision outweigh the costs.

It is also important to recognise that awareness of these issues is not new. For example, Webb has highlighted that one of the strategies to assist with the adaptation process should involve better co-ordination of key data inputs, as described in a recent paper:

"There needs to be a more systematic identification and coverage of, provenance over, and access to, key adaptation-related data sets and data bases, especially those that are identified as high priority for national support. This includes the next wave of climate and socio-economic information and scenarios; hazard, exposure and impact data; and risk, vulnerability and adaptation options information" (Webb 2013:3)

Collaborative efforts between government agencies to improve the transparency and availability of data is an important first step. There is also potential for greater business involvement in the sharing of data as part of a nationwide strategic shift to greater data co-ordination.

Research funding identified from 2009 – 2021



4. Natural disaster research

Key points

From 2009 to 2014 most of the funding for natural disaster research was allocated to **bushfire research**.

There has been relatively little research on the **effect of mitigation** and the **social and psychological impacts** of disasters relative to other areas.

Funding comes from a variety of different sources, but needs to be **co-ordinated** to support long-term research (e.g. rationalisation of building codes, nationwide elevation data) rather than individual short term projects.

This chapter is an overview of the key natural disaster research activities that have happened or are planned to happen in Australia between 2009 and 2021. This analysis covers:

- The range of stakeholders involved in research activities
- The distribution of research activities by type of natural peril
- The distribution of research activities by research theme
- The sources of funding for the research activities identified.

Potential research gaps and areas where research could be restructured or better organised are also identified.

4.1 Research organisations

Natural disaster research is conducted across all levels of government and across a range of research institutions, universities and other organisations. The following section provides a brief summary of the research undertaken by key organisations. More detail on each organisation and the research programs can be found in Appendix C.

Australian Government

Various Australian Government departments and agencies have different roles and responsibilities related to natural disasters and conduct research accordingly. The Australian Government is the main funder of natural disaster related research, providing direct funding to CSIRO, the Attorney-General's Department, Geoscience Australia and the Bureau of Meteorology. The Government provides indirect funding to universities through the Australian Research Council (ARC) grants and Cooperative Research Centres (CRCs).

This central funding role creates an opportunity for the prioritisation of the research agenda, which would enable effective decision-making to address the nation's highest risk areas through investments in resilience.

CSIRO is Australia's national science agency and conducts a range of research into natural disasters, making a substantial contribution to the field. CSIRO explores all hazards, with links to other research organisations such as the BoM through the Centre for Australian Weather and Climate Research (CAWCR). The significant scaling back of the research activities of the Climate Adaptation Flagship, where much peril related research was conducted, is part of a major restructure to streamline the organisation and shift the focus to present day challenges in the natural disaster area.

The Federal Minister for Justice is responsible for national emergency management and disaster resilience. As a result, the Attorney-General's Department is responsible for the national co-ordination of emergency management. Within the department, the National Security Resilience Policy division and the Emergency Management Australia (EMA) division have natural disaster related responsibilities. The department provides the National Emergency Management Projects (NEMP) grant program to fund programs of work that contribute to the National Disaster Resilience Strategy.

Geoscience Australia is a prescribed agency within the Industry portfolio and plays an important role in natural disaster research through the provision of data and direct involvement in undertaking research. The main areas of direct research are programs in vulnerability, resilience and information. Geoscience Australia also engages with other research institutions to produce collaborative outputs such as the BoM, CSIRO and the Bushfire and Natural Hazards CRC.

The BoM is Australia's national weather, climate and water agency. The Bureau plays a key role in disseminating data and information related to natural disasters. The development of natural hazard warning systems and associated knowledge also plays a significant role in the research community. The provision of historical weather and peril data by the BoM is vital for a lot of researchers. The Australian Tropical Cyclone Database and the Southern Hemisphere Tropical Cyclone Data Platform are inputs for many models developed by academics as well as insurers. The Australian Daily Rainfall Gridded Data and Intensity-Frequency Duration curves are widely used for flood modelling.

Other government departments and agencies involved in research include the Department of Human Services and the Department of Defence.

The Department of Human Services has collaborated with the CSIRO in the past on the Emergency Response Intelligence Capability and is responsible for intelligence gathering and situation reporting during emergency events. The Department of Defence provides support to other federal and state agencies in geospatial intelligence including unclassified imagery, tailored mapping and geospatial data.

State and Territory Governments

State and territory governments are involved in natural peril related research through a variety of channels. The delivery of services is a key role of the states and territories and thus they are the end users of much of the applied research. Individual state emergency service organisations conduct varying degrees of research as do peak bodies such as the Australian Fire and Emergency Service Authorities Council and the Australian Council of State Emergency Services. State and territory governments also contribute to research by participating in the Bushfire and Natural Hazards CRC and by funding specific resilience and mitigation projects through the Natural Disaster Resilience Program (NDRP). State and territory governments also assist local councils to build their capabilities in assessing approaches to natural disaster risk management[4].

Local Governments

Local governments play an important role in natural disaster research through the provision of flood mapping and related data, participation in post-disaster assessment and analysis and being central to land use planning. Local governments have the best knowledge of local circumstances and are closely in contact with the community and the devastation that can occur as a result of a natural disaster. The research conducted by local governments varies considerably depending on their financial capacity and the relevance of research to their specific geographical area. More information on local government involvement in research is included in Appendix C.

4 For example, the NSW Office of Environment and Heritage currently provides decision-making support to local government through grants for preparation of coastal studies, coastal zone management plans, and the investigation, design and implementation of management actions to reduce coastal erosion risks.

Bushfire and Natural Hazards Cooperative Research Centre

The Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC) is the largest funder of natural disaster related research in Australia. Launched in December 2013 with $130 million in funding over eight years, the BNHCRC is an important contributor to the research landscape. The Australian Government contributed $47 million to the centre with the remainder coming from more than 45 program partners. CRCs are funded through the Department of Industry.

National Climate Change Adaptation Research Facility

The National Climate Change Adaptation Research Facility (NCCARF) was established in 2008 to direct national research into the risks associated with climate change. NCCARF commissioned approximately $40 million across more than 100 projects during the operational phase between 2008 and 2013 (NCCARF, 2012). A portion of the research related directly to natural disasters with one of the research priorities focused on emergency management.

Terrestrial Ecosystem Research Network

The Terrestrial Ecosystem Research Network (TERN) was created in 2009 to provide the infrastructure and networks to allow ecosystem scientists to collect, store and share data across disciplines. TERN enables wide access to ecosystem science data for research through the TERN Data Discovery Platform. The data licensing policy maintains open access under different licensing arrangements through a suite of appropriate licenses. TERN data is used in the natural disaster research community including coastal data sets for understanding floods and cyclones and vegetation data to model bushfire risk.

Universities

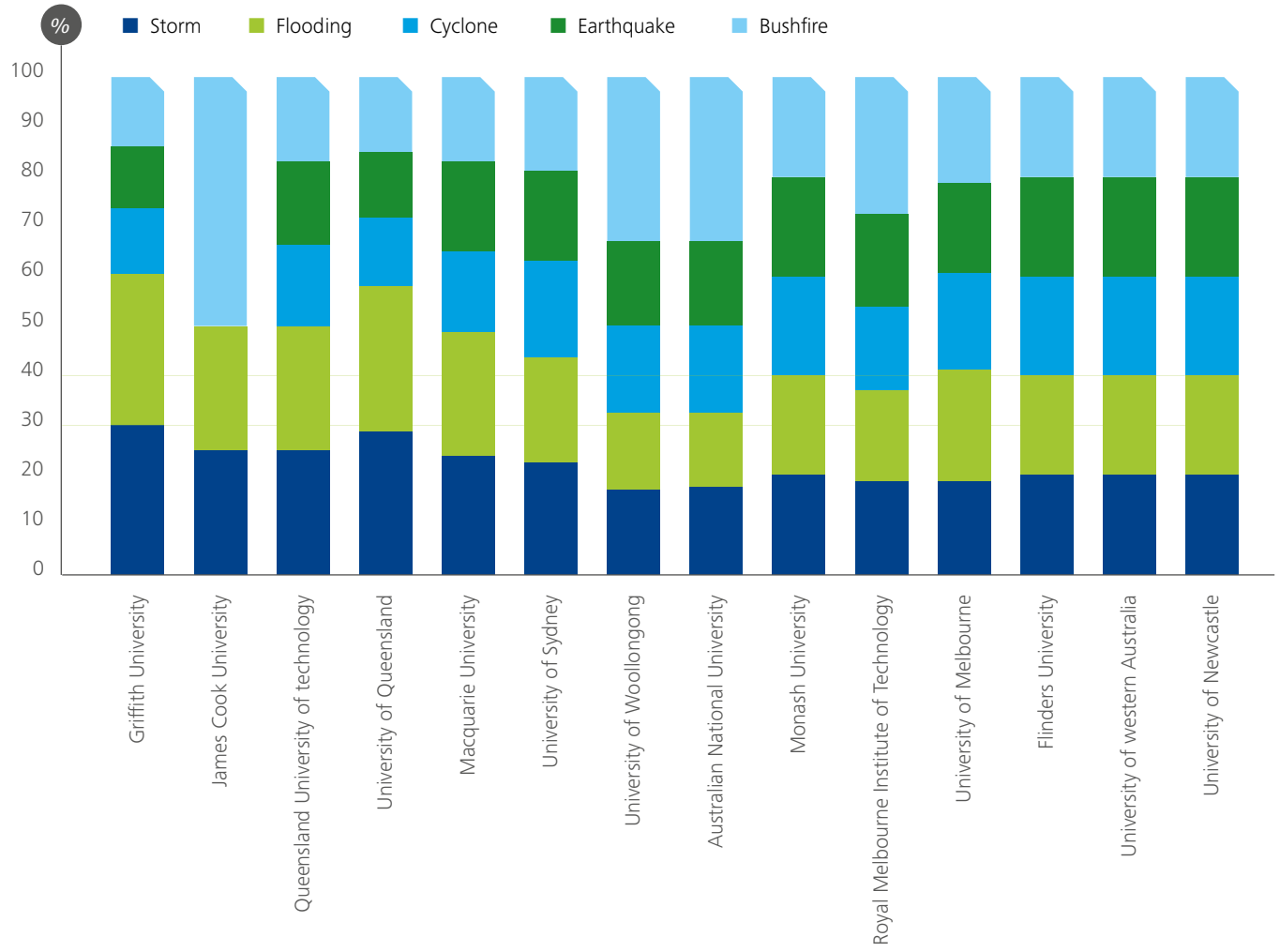
The primary source of funding for university research is through the Australian Research Council (ARC) National Competitive Grants Program. There is approximately $19.8 million in university funding for the 2009-2021 period related to storm surge, flooding, cyclones, earthquakes and bushfires. Universities conduct a broad range of research with multiple specialist platforms and networks across the natural disaster field. The researchers within universities also conduct much of the research funded through research organisations such as the BNHCRC and NCCARF. Universities also collaborate with government organisations such as CSIRO, Geoscience Australia and the BoM.

Table 4.1: Research areas within the Bushfire and Natural Hazards CRC

Economics, policy and decision-making	Resilient people, infrastructure and institutions	Bushfire and natural hazard risks
Governance and institutional knowledge	Communication and warnings	Monitoring and prediction
Economics and strategic decisions	Emergency management capability	Next generation fire modelling
Scenario and loss analysis	Sustainable volunteering	Prescribed burning and catchment management
	Understanding and measuring social resilience	Coastal management
	Hardening buildings and infrastructure	

Source: BNHCRC (2014)

Chart 4.1: University research by type of natural disaster



Source: Deloitte Access Economics (2014)

Chart 4.1 summarises the distribution of research activities across the range of natural hazards within select universities in Australia. Where research has been conducted on natural disasters in general and not a specific peril, this has been allocated across all peril types.

The data suggests certain universities are focused on a particular type of disaster. For example, the University of Wollongong and the Australian National University are more focused on bushfire; the University of Queensland and Griffith University are focused on floods; while James Cook University is primarily focused on cyclones. Unsurprisingly, the data reveals that universities tend to focus on the natural hazard more common to their geographic location. For example, South East Queensland with flooding, the ACT with bushfires and Northern Queensland with cyclones.

Private organisations

Private organisations engage in research for their own purposes, for other organisations on a user-pays basis, or for the benefit of the community. Some examples of private organisations conducting or funding research in the natural disaster area include the Insurance Council of Australia (ICA), Risk Frontiers and the Australian Disaster Management Platform which is a collaboration between IBM and the University of Melbourne.

Box 8: Insurance Council of Australia – pragmatic data provision

The Insurance Council of Australia (ICA) is the representative body for the insurance industry in Australia. The ICA relies on hazard data supplied by state and local governments to provide guidance to the community and governments on insurance availability and affordability as well as the need for mitigation. Insurers and reinsurers also rely substantially on natural hazard data to price policies effectively, particularly in hazard prone areas. As some of the fundamental data inputs are common across the industry, the ICA plays a role in creating a central source of information helping to avoid some overlap. This central role arose due to the immediate practical need to have flood data for use in the underwriting process.

ICA Data Globe

The ICA Data Globe provides data on a wide range of perils including flood, earthquake, bushfire, storm surge and cyclone. Its main function is to provide the ICA with a mechanism to demonstrate to governments the linkages between hazards in an area and the pricing or availability of insurance products, as well as areas that are suffering from a lack of hazard mapping. The data collected is also made available to insurers to supplement their own data sets for underwriting purposes. The data is collected from government agencies and other stakeholders that are typically the statutory authority responsible for that data.

The Data Globe is a central source of multi hazard data at a national level and is presently shared with the Queensland Government, while several other governments are in the process of executing the required licenses to join.

National Flood Information Database

The National Flood Information Database (NFID) provides an address level flood exposure data set. The ICA commissioned Risk Frontiers and Willis Re in 2008 to develop the database using existing government flood mapping as a result of a project to increase the availability of flood insurance cover. The NFID provides participating insurers with flood depth information on approximately 10 million addresses and is used by the majority of insurers as an input to the pricing of flood risks.

The NFID has been expanded continually since its inception, as additional local government flood studies have been acquired, and is planned to continue until 2017. The NFID is made available through the ICA Data Globe, enabling flood frequency and depth to be visualised at individual addresses, where raw flood data has been supplied by a local or state government.

Property Resilience and Exposure Program

The Property Resilience and Exposure Program (PREP) is intended to operate as a formal mechanism to assist industry and government to reduce information asymmetry regarding hazards and the built environment. Under the PREP, local governments are encouraged to share data with the ICA in return for resilience mapping to be used as an input to local development control decisions and mitigation measures. By providing the ICA with available hazard mapping as well as building control data, councils are able to engage with the ICA regarding perceived affordability issues in their community.

This program has been piloted and is being prepared for general release in 2014.

The research conducted by private organisations is wide, varied and can be commercially sensitive. This means it can be difficult to ascertain what research is being conducted or already exists. Notably, private sector involvement has not been included in the quantitative analysis presented in the remainder of this chapter due to difficulties in ascertaining the magnitude of funding.

Box 8 on page 51 does, however, outline some of the activities currently offered to insurers and reinsurers or being developed by the ICA.

There are situations whereby the private sector has specialised skills and expertise that could be better leveraged as part of a co-ordinated effort to improve natural disaster research in Australia. For example, a partnership between the Property Council of Australia and the Investment Property Databank. The partners are currently reviewing the applicability of the UK Eco-Portfolio Analysis Service for Australia. This is a benchmarking service that identifies and highlights the potential environmental risks in a real estate investment portfolio. The service aims to provide a transparent assessment of the vulnerability of a particular property.

Other organisations

Other organisations such as the Australian Building Codes Board (ABCB), the Australian Red Cross and the Regional Australia Institute also conduct or fund research.

The ABCB is responsible for the National Construction Code and conducts research to ensure building standards reflect the latest evidence captured on the effects of extreme weather events on new buildings.

The Australian Red Cross commissions individual research projects on the social and psychological effects of natural disasters on individuals and communities and participates in the BNHCRC. The Red Cross is also a partner in the five-year University of Melbourne ARC Linkage Grant Beyond Bushfires project, as well as working closely with a number of other research institutions.

The Regional Australia Institute conducts a research agenda that focuses on issues affecting regional areas including natural disasters.

4.2 Research by natural peril type

From 2009 to 2014 most of the funding for natural disaster research was allocated to **bushfire research** despite the annualised cost of this disaster being relatively low when compared to the other main perils.

Based on available data, our findings suggest that the amount of research into **flooding and cyclones,** relative to their average cost of damage, is **small**.

These findings are based on the current fund allocation by natural disaster and comparing it to the average annual costs of natural disaster from 1967 to 1999.

Australia experiences a range of natural disasters including bushfires, floods, storm surges, earthquakes and cyclones. These events cause great financial hardship for individuals and communities, disrupt lives and can also result in loss of life. As outlined in *'Building our Nation's Resilience to Natural Disasters'*, the costs of these disasters can be measured to some extent through the insured value of property but should extend to broader costs that include the loss of life and the social and psychological impacts on individuals and communities.

Theoretically, the cost of research into natural disasters should be easier to identify. However, in practice it is difficult to accurately collate data on the magnitude of the funding for research in this field. Australian Government organisations tend to have the most available information on funding arrangements for data. However, even then it was difficult to categorise the funding into the type of disaster and research and the profile of expenditure. In some cases, it was unclear how total funding for a particular project was allocated to different disasters. In these cases it was assumed to be equally funded across bushfires, storm surges, earthquakes and cyclones.

Consequently, the analysis of allocation of funding across disasters and types of research presented here has some weaknesses and should be treated with caution. More transparent data on funding and allocation across natural disasters would assist with better co-ordination of the research and identify where there may be gaps in the research agenda.

With these caveats in mind, our analysis identified a total of $283 million in public funding over the period from 2009-2021. Chart 4.2 shows how this funding has been allocated to each of the natural disasters over that period. The shape of the funding over time most likely reflects the typical four-year cycle of budget allocations and does not necessarily represent a policy decision to reduce funding into natural disasters in the future. Research that has been conducted on natural disasters in general, and not a specific peril, has been allocated across all disaster types.

In the *'Building our Nation's Resilience to Natural Disasters'* paper it was estimated that consistent Australian Government pre-disaster funding was approximately $50 million per annum. This figure included all spending on pre-disaster resilience and included the total spending and investment on mitigation measures. While the figure varies year to year, it is estimated that approximately $32 million was funded in 2012/13 on natural disaster research. As research only makes up a portion of the total spending on pre-disaster programs, such as the National Emergency Management Projects and the National Partnership Agreement on Natural Disaster Resilience, the lower figure is to be expected.

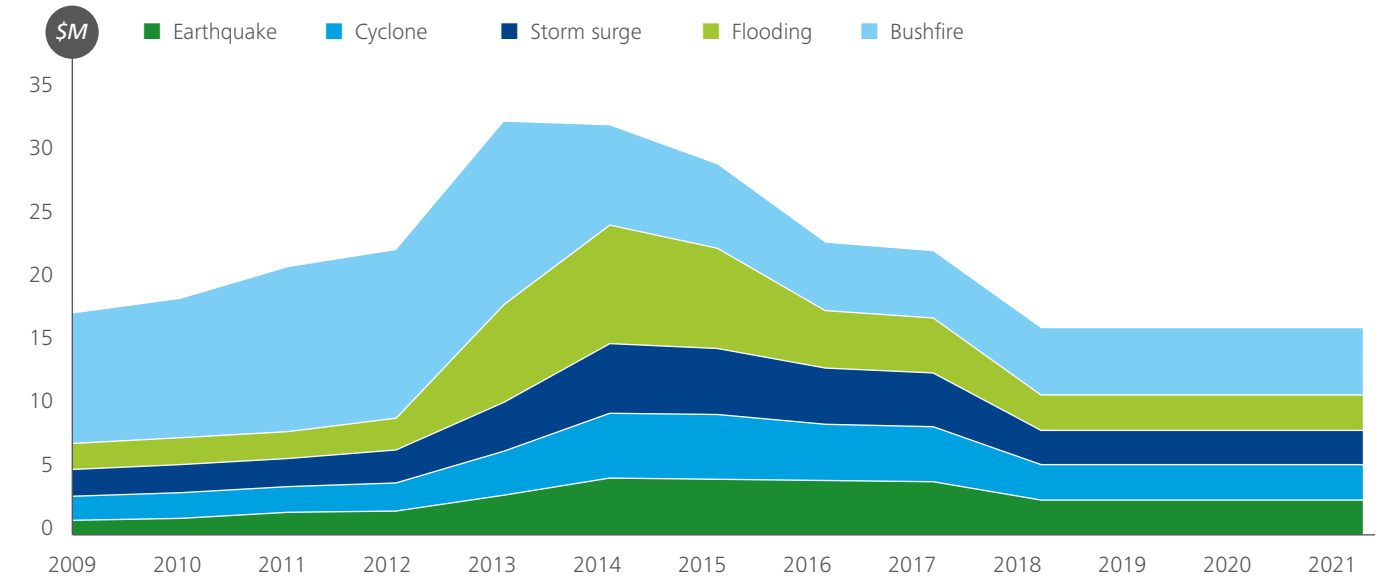
It is useful to consider if funds are allocated appropriately. As a starting point, we examine the average cost of disaster relative to the total annual costs and compare it to the current funding arrangements. Table 4.2 highlights the average annual cost of disasters and associated proportion by type of disaster.

Table 4.2: Average annual cost of natural disasters

Disaster	Average annual cost (1967-1999)	Proportion of total
Earthquake	267.4	7.06%
Cyclone	1,439.4	38.01%
Flooding	1,745.2	46.09%
Bushfire	334.9	8.84%

Source: BITRE

Chart 4.2: Current funding by disaster types ($m), 2009-2021



Source: Deloitte Access Economics research of publicly available funding information (2014) and consultations

A summary of funding by disaster types relative to these costs is presented below. Storm surge has been omitted from this analysis as no data relating to annual costs was available.

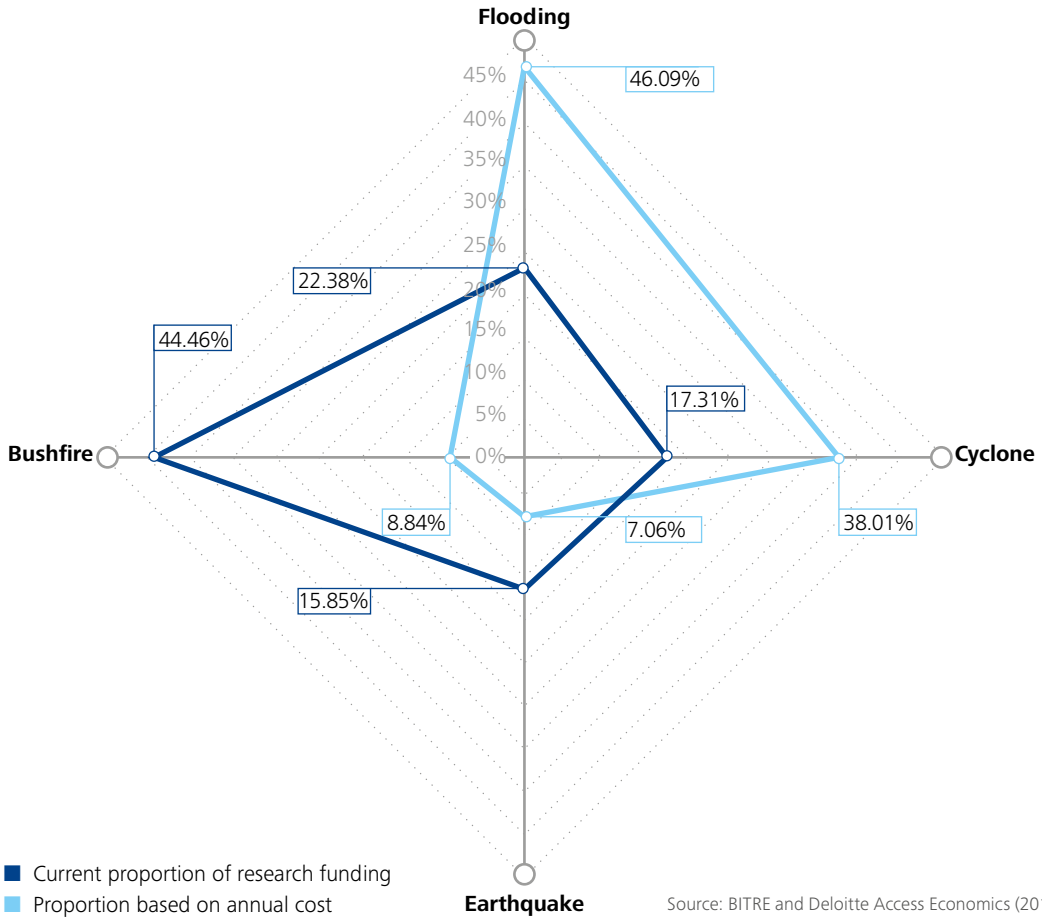
At face value, the data in Table 4.2 on page 53 suggests that, based on the annual costs of the disaster, research undertaken for **flooding and cyclones,** relative to the average cost of damage by these disasters, is **small**.

It is important to acknowledge that the annual costs listed in Table 4.2 are based on the available quantifiable value and may not fully reflect aspects such as loss of life. This should be accounted for in terms of funding and may explain some of the discrepancies between the average annual costs and the current funding arrangements.

Average annual costs may also be skewed by large, single year events such as the 1989 earthquake in Newcastle and Cyclone Tracy in 1974. There is a need to have a better long-term view of risk so that research and data capture can be properly prioritised.

More importantly, however, this is not necessarily the appropriate way to consider the optimal prioritisation of research funding. As discussed in Chapter 6, the allocation of funding for research should be informed by the opportunities for the greatest impact on communities, balancing the need for competitive funding, to incentivise innovative research ideas, alongside targeted funding that responds to known issues and challenges.

Chart 4.3: Proportion of current funding by disaster types



Source: BITRE and Deloitte Access Economics (2014)

4.3 Categories of natural disaster research

There has been relatively little research on the **effect of mitigation** and the **social and psychological impacts** of disasters relative to other areas.

Some types of research sit well with the private sector, some sit well with the public sector, while others could benefit from greater **co-operation**.

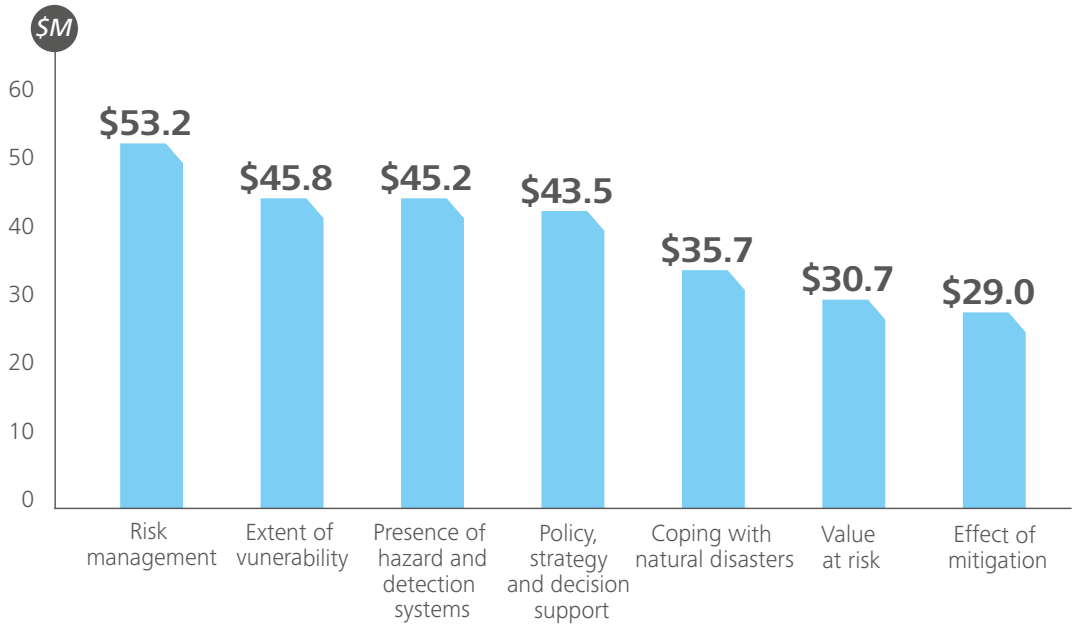
In addition to the types of disaster, consideration must also be given to the types of research that should be undertaken, for example mitigation, coping with disaster or value at risk.

Some natural disasters may yield more benefits from mitigation measures, where others may benefit more from research on coping after the event. The appropriate mix of research depends on the nature of the disaster but also on the current stock of research.

In examining the funding allocated to types of natural disaster research, in cases where uncertainty existed, the estimated funding was allocated equally across the seven types of natural disaster research. These are: risk management; presence of hazard and detection system; value at risk; extent of vulnerability; effect of mitigation; coping with natural disasters; and policy, strategy and decision support. A summary of the funding by research type from 2009-2021 is presented in Chart 4.4.

The category of coping with natural disasters includes the social and psychological impacts research referred to later in this chapter as well as other research on community preparedness, resilience and recovery.

Chart 4.4: Funding by research types ($m), 2009-2021



Source: Deloitte Access Economics (2014)

The data in Chart 4.4 suggests that the **three areas** which received the **least funding** are: **the effect of mitigation, value at risk and coping with natural disasters**. In *'Building our Nation's Resilience to Natural Disasters'*, the potential benefits of mitigation were highlighted. The data suggests that mitigation remains an underfunded area of research.

Research into the effect of mitigation is important in guiding resilience activities on the ground. Effective resilience measures mean fewer people and communities are affected by natural disasters. Targeted investment in risk reduction, while having a large up-front cost, provides a large return over the long-term. Adequate research in this area can help ensure taxpayer funds are utilised more effectively.

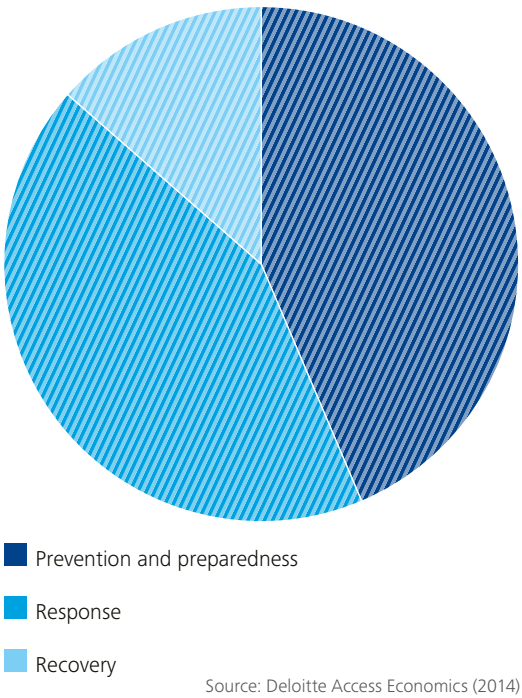
Research activity by the stage of disaster, being: prevention and preparedness (pre-disaster); response; and recovery (post-disaster) was analysed. It showed that the majority of funding is allocated to projects focused on the prevention and preparedness and response stages (Chart 4.5).

It is estimated that the total national budget for Fire and Emergency Services exceeds $4 billion. This budget includes the capturing of data and the contribution to research. While we have captured the emergency service organisations contributions to the Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC) and research undertaken through the National Emergency Management Projects, we were not able to quantify all of the direct research and data capture undertaken. This research is predominantly focused on response and recovery and would alter the allocation of funding towards these stages.

Just looking at university research activity, there is a greater focus on the response stage as outlined in Chart 4.6. The focus on emergency services and disaster response in some research activities leads to a greater funding proportion.

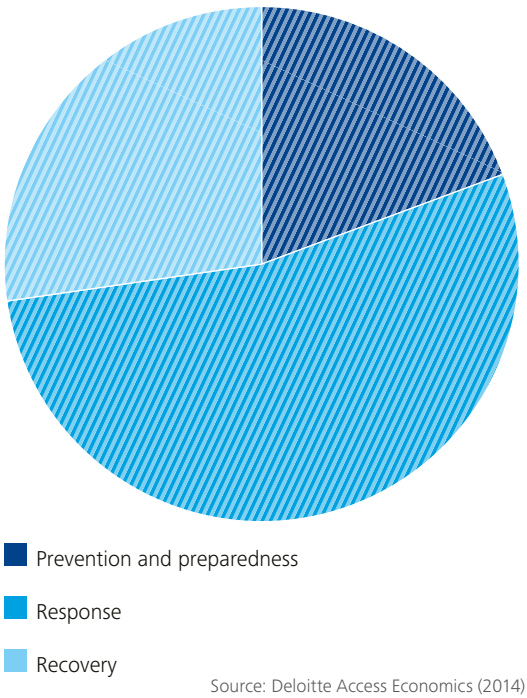
It is difficult to ascertain whether the proportions of current funding are adequate in addressing the current needs for natural disasters since the appropriate mix will depend on the nature of the disaster and potential benefits of the research.

Chart 4.5: Allocation of funding



Source: Deloitte Access Economics (2014)

Chart 4.6: Allocation of funding – university research



Source: Deloitte Access Economics (2014)

It is important to acknowledge that the data behind these proportions are from public institutions. Thus the current data may not be an accurate representation of the population of the actual research since private enterprises such as insurance firms have undertaken research in areas such as value at risk which is not reflected in the data.

The social and psychological impacts of natural disasters is an area where there is limited Australian research. The Beyond Bushfires study, a partnership between the University of Melbourne and industry partners including the Australian Red Cross (Box 9), as well as work on community wellbeing by Victoria University and the University of South Australia, illustrates some research is being conducted but more needs to be done.

Outside of these institutions, there appears to be minimal research into the social and psychological impacts of natural disasters.

Current research tends to focus specifically on Post-Traumatic Stress Disorder with little focus on other social and psychological impacts. Research conducted on how to assist emergency services to inform communities on psychological preparedness for a disaster is limited. A major gap in this area is a formal analysis of the costs and benefits associated with the soft measures of mitigation such as preparedness programs and community education. Such research could potentially inform the effectiveness of soft measures relative to physical measures.

Box 9: Beyond Bushfires: a study into community resilience and recovery

Beyond Bushfires is a five-year study into the medium to long-term impact of the 2009 Victorian bushfires on mental health, wellbeing and the social relationships of individuals and their communities. The study is a partnership between the University of Melbourne, the Australian Red Cross and a variety of organisations with a concern for mental health in the community. The study was launched in response to a need for evidence-based research into the patterns of impact and recovery over time.

The study will conduct surveys, interviews, focus groups and community visits. Approximately 3,000 children, adolescents and adults will be surveyed from 16 different communities that suffered varying impacts from the bushfires. A small group of study participants will participate in detailed interviews, while all participants will take part in three 30-minute phone or online surveys.

A key differentiator of the research is the investigation into the connection between individual impacts and community recovery over a long time frame. The study has been funded by a five-year grant from the Australian Research Council. According to Dr Lisa Gibbs of the University of Melbourne's School of Population Health, "We hope to establish some mental health and wellbeing strategies that individuals, communities and agencies can rely on if they ever face future natural disasters again" (University of Melbourne, 2011).

Residents battle a fast moving grassfire while several fires are burning throughout Victoria. February 2014.

The New South Wales Rural Fire Service conducting a controlled back-burn in the Blue Mountains West of Sydney, 2014

4.4 Funding sources

Funding comes from a variety of sources but needs to be **co-ordinated** to support long-term research rather than individual short term projects. For example, rationalisation of building codes and nationwide elevation data.

Competition is beneficial for the quality of research and to support innovation.

However, there is a need to co-ordinate research completed by the **public and private sector**, with appropriate data confidentiality protocols in place.

Co-ordination within government **could be improved**, encompassing the research activities of the Australian Government, state and territory governments as well as emergency management authorities.

Research is relatively well co-ordinated (especially now with the CRC and CSIRO 'system of systems' initiative) but **data co-ordination is lacking.***

Historically, research into natural disasters has been fragmented with many different organisations looking into different peril types under different funding arrangements. The establishment of key organisations such as the BNHCRC and NCCARF, has helped to co-ordinate the research across perils to some extent. Co-ordination ensures available funds are efficiently utilised and can reduce duplication. The issue of co-ordination not only stems from within and across governments but also from the government to the private sector.

However, better co-ordination does not necessarily imply that research should not overlap, in fact, overlapping research can be beneficial i.e. researchers should leverage the works of other researchers to improve their knowledge. Research outcomes derived from different methods can also improve the reliability of the conclusions. Thus, while co-ordinating funds is important, from the government's perspective there is also a need to make them competitive to ensure researchers can build on the work of others and have a strong incentive to produce quality research.

The issue of co-ordination between governments and the private sector is more difficult due to possible competitive advantages derived by private firms from research and data. Protocols for sharing information need to be considered so that private sector research can benefit the wider community without eroding its competitive advantage.

* Refer to the CSIRO 'system of systems' initiative p.20

4.4.1 Government funding

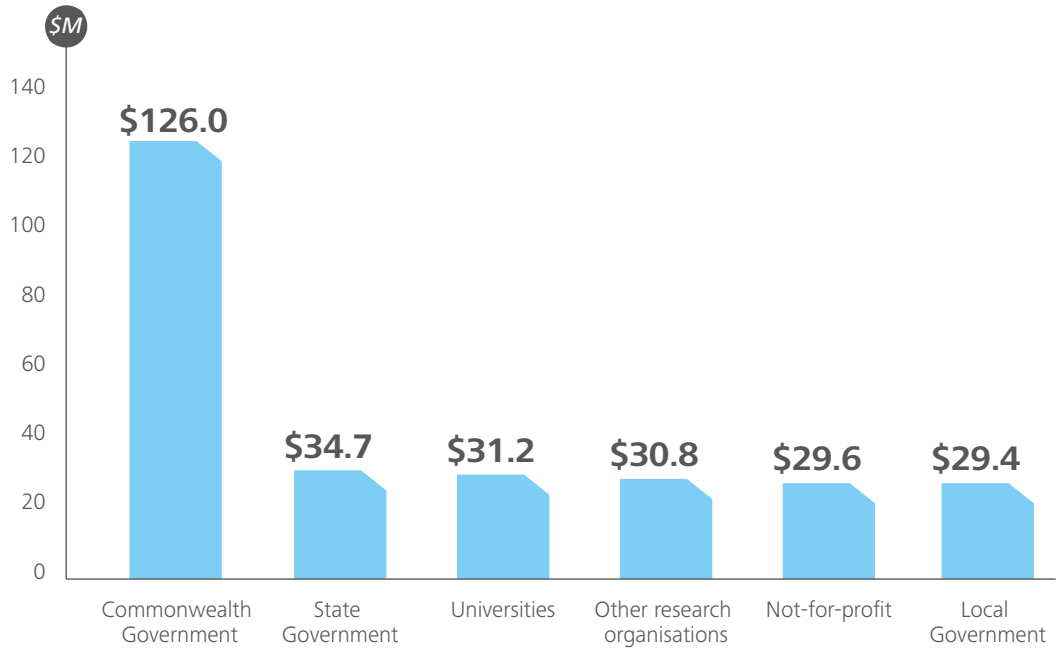
Our analysis has found that from 2009 to 2021 around 45% of research is directly financed by the Australian Government. If we include university funding our figures suggest the Government contributes around 56% of total funding. The state governments fund around 12% of the total amount. Chart 4.7 summarises the funding provided by various entities from 2009 to 2021 and suggests the Australian Government is the primary financier of natural disaster research.

It is important to acknowledge that the funding outlined above is based only on publicly available data. It does not capture investments made by the private sector into natural disaster research.

4.4.2 Private sector funding

The main organisations represented in our analysis are government funded institutions. While consultations revealed some private sector research, there is limited visibility of what research is being conducted or the cost involved. Due to much of the research and its cost being commercially sensitive, without an expansive survey it was not possible to obtain estimates of current funding levels.

Chart 4.7: Funding by source ($m), 2009-2021



Source: Deloitte Access Economics (2014)

Gaining momentum: open data

5. Lessons from international jurisdictions and other sectors

Key points

Evidence from international jurisdictions and other sectors in Australia highlights three key principles for better organisation of data and research:

- **Access to information** through data sharing platforms
- **Facilitating collaboration to** leverage diversity of skills and experience across multiple disciplines
- **Prioritising investments** to meet the practical needs of end users.

There is significant scope to embed these principles in Australian data and research, through a greater focus on the needs of end users in response to the decision-making challenge.

Dealing with the risk of natural disasters is a global challenge. In 2013, a total of 890 loss events occurred throughout the world, causing 20,500 fatalities, insured losses of $US35 billion and overall losses of $US135 billion (Munich Re, 2014).

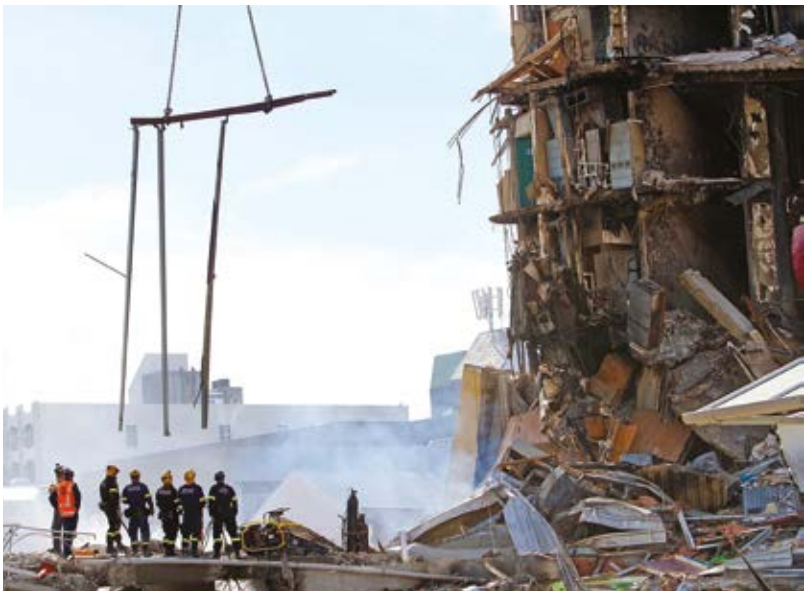
At the 2005 World Conference on Disaster Reduction, 168 countries adopted the Hyogo Framework for Action, a 10-year plan focused on strengthening the resilience of communities to natural disasters. Two of the five priority actions set out in the framework highlight the importance of collecting and utilising data and research on disaster risk exposure and mitigation. Meanwhile, data and research is also critical for driving improvements in other sectors, such as health and finance.

Accordingly, the organisation of data and research in Australia should be informed by evidence from international jurisdictions and these other sectors. This chapter outlines the importance of:

- Access to information
- Facilitating collaboration
- Prioritising investments.

These principles have been identified based on a review of the activities of the United Nations, World Bank and Organisation for Economic Co-operation and Development (OECD), national co-ordination of natural disaster information within New Zealand and the United States and approaches to building and sharing information in the finance and medical sectors in Australia.

Christchurch, New Zealand: Following three major earthquakes since September 2010, geotechnical experts divided Christchurch into four zones – red, orange, green and white. Residents in the worst-affected red zone received a formal offer from Government to buy their homes.



Christchurch, New Zealand February 2011: the collapsed CTV building where 110 people died. Much of the downtown area was destroyed and remained sealed off one year later following the 6.3 quake which killed 185 people as it flattened office blocks, buckled roads and brought historic buildings crashing down.

5.1 Access to information

Access to information is critical for practical application of data and research by end users. In addition, the accessibility of information helps to avoid duplication of effort and facilitates learning from the experiences of others. Both internationally and in Australia, there are numerous initiatives which support access to information for these purposes.

At the international level, an online platform administered by the United Nations Office for Disaster Risk Reduction (UNISDR), PreventionWeb, has established itself as the 'go to' information repository for disaster risk reduction (Gregorowski et al 2012). Designed as a participatory platform, PreventionWeb allows users to search for information and upload content according to country or region, theme or issue, and hazard type. The types of information on the platform include academic and training programs, educational materials, links to specialist networks and organisations, documents and publications, policies, maps and statistics. The target audience of PreventionWeb includes national and local governments, NGOs, community-based organisations and risk reduction experts and practitioners (Gregorowski et al 2012:25).

Access to information on natural disasters across multiple countries is also facilitated through a number of international risk and loss databases. These have been developed by a mix of stakeholders, including international organisations, research institutions, government agencies and the private sector. Some examples are presented in Table 5.1.

Global reinsurers, Munich Re and Swiss Re also maintain databases, NatCatSERVICE and Sigma respectively, on the losses associated with natural disasters across the world, in terms of lives lost, insured losses and total losses. NatCatSERVICE provides free access to basic data and mapping online, as well as free access to raw data for non-commercial purposes.

Links to these databases, and others, are provided on the United Nations Development Programme's (UNDP) Global Risk Information Platform (GRIP). This sits alongside a 'Methodologies Platform' which provides documents on concepts, standards, frameworks and techniques for disaster risk assessments (GRIP, 2014).

The World Bank's Global Facility for Disaster Risk Reduction (GFDRR) also supports access to disaster risk information in 25 developing countries through its Open Data for Resilience Initiative (OpenDRI) (GFDRR, 2014e).

Table 5.1: Selected natural disaster risk and loss databases

Database	Developer	Content	Extent of access
DesInventar	LA RED (the Network of Social Studies on Disaster Prevention in Latin America). UNISDR is the host and main sponsor. Also involves UN, NGOs, Government agencies, universities and private sector.	• Disaster events, causes, human impacts and economic losses • 29 countries across North, Central and South America, the Caribbean, Asia and the South Pacific.	Free, open source access to tables, graphics and thematic maps.
EM-DAT: The International Disaster Database	Centre for Research on the Epidemiology of Disasters – University of Louvain, Belgium. Partnerships with the International Federation of Red Cross and Red Crescent Societies, UNISDR and US Agency for International Development, among others.	• Human impacts, economic damage, international aid contributions • Data compiled from various sources.	Free, open source access to data.
PREVIEW Global Risk Data Platform	Created and hosted by UNEP/GRID-Geneva. Supported by UNISDR.	• Spatial data on global risk from natural hazards.	Free for non-commercial purposes.

Source: Centre for Research on the Epidemiology of Disasters (CRED) 2014; Corporación OSSO 2013; United Nations Environment Programme (UNEP) 2013; UNISDR (n.d.)

The purpose of this project is to make the information necessary to inform resilience investments available to decision-makers. It has led to the development of open source software and data platforms, such as haitidata.org, and the Indonesian Scenario Assessment for Emergencies (InaSAFE).

Individual countries are also increasingly recognising the importance of providing citizens with access to information on natural disasters. For example, a recent OECD report into disaster risk financing in Asia-Pacific Economic Co-operation (APEC) economies found that one of the top priorities for strengthening financial resilience in the region is the 'improvement of the availability and quality of data on hazards, exposures, vulnerabilities and losses' (OECD, 2013).

Government responsibilities in this area are consistent with the principles of the broader 'open government' movement. The United States has been at the forefront of such policy development, with President Barack Obama releasing a Memorandum on Transparency and Open Government on his first day in office in 2009. This highlighted the importance of transparency, participation and collaboration between government and citizens. This was followed by an Open Government Directive, which set actions and deadlines for government departments and agencies in relation to publishing information online, improving the quality of information and establishing an open government culture and policy framework (US Government, 2009a). In May 2013, the US Government released a new open data policy and executive order, focused on the accessibility and usefulness of information. Through this process, the US Government seeks to provide open data that is public, accessible, described, reusable, complete, timely and managed post-release (Project Open Data, n.d.).

In 2011, an Open Government Partnership was established in recognition of these principles (Open Government Partnership, 2014). There are currently 64 countries commited to developing and implementing an action plan, undertaking annual self-assessments, participating in an independent reporting mechanism process and contributing to peer learning. Australia is set to join the partnership in May 2015.

Similar ideals have been highlighted in the context of natural disasters more specifically. For example, The Rockefeller Foundation, in conjunction with PopTech, developed a set of principles for big data and resilience projects at a workshop in 2013. The principles call for:

- Open source tools for data analytics and manipulation
- Transparent data infrastructure
- Developing and maintaining local skills in using data
- Local data ownership
- Ethical data sharing
- The right not to be sensed
- Learning from mistakes (PopTech & The Rockefeller Foundation Bellagio Fellows, 2013).

While policies are recognising open access to information as an essential first step, implementing these principles is challenging. The Open Knowledge Foundation's Open Data Index measures the openness of 10 key national data sets in terms of whether the data exists, is in digital form, is publically available free of charge, is online, is machine readable, is available in bulk, openly licensed and up to date (Open Knowledge Foundation, n.d.). Australia is currently ranked 9th out of the 70 countries listed, although there remains opportunities for improvement in the openness of seven of the 10 Australian data sets considered. This is in addition to the multiple barriers to open natural disaster data in Australia, demonstrated in Chapter 3.

In an interview with McKinsey & Company, former chief analytics officer for New York City, Mike Flowers, noted that open data involves breaking down technological, cultural, legal and political barriers (McKinsey & Company, 2014). Furthermore, it is critical to address these challenges from an end user perspective:

"I think we need to do a much better job of helping people understand that data, which means being much more transparent from a process-and-people standpoint and not just a data standpoint. Open data is a start. It's not the end. (Mike Flowers, in McKinsey & Company, 2014)

Nevertheless, there are numerous examples of successful national open data initiatives. For instance, in 2008 the United States National Science Foundation initiated the DataNet program to establish a set of best practice data research infrastructure organisations. The program's first round of funding helped to establish the following two key initiatives:

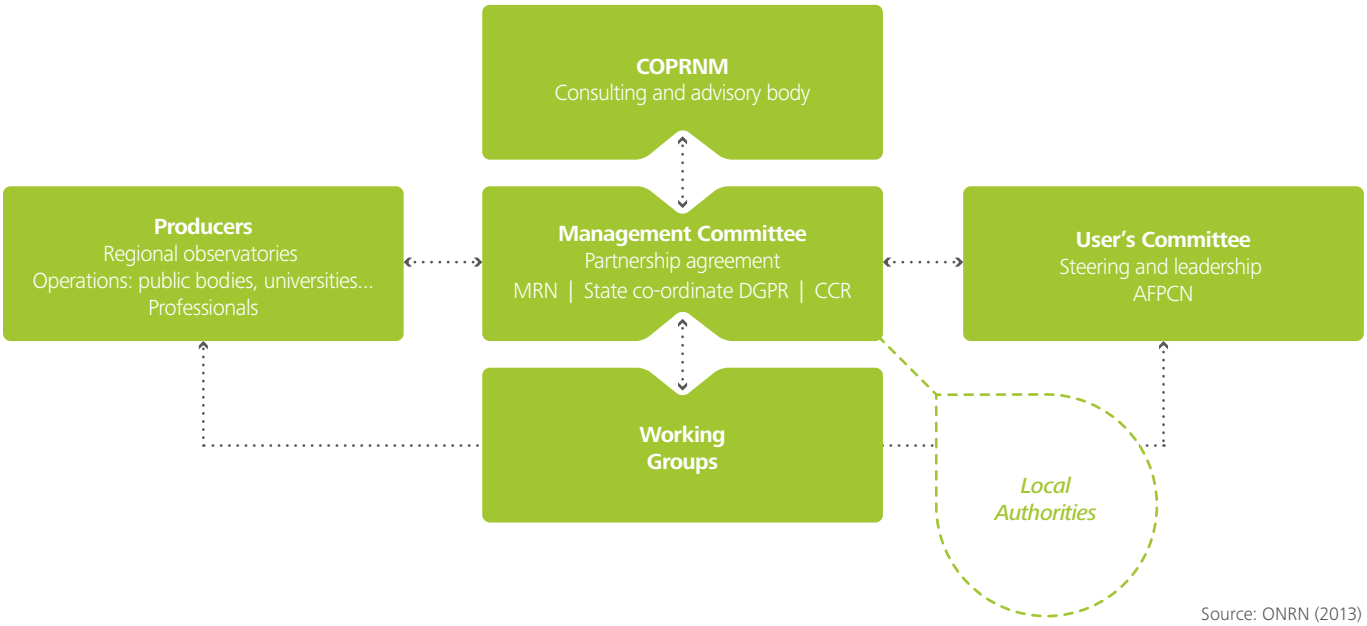
- **DataONE** – a central platform of earth observational data, provided through an open network of member nodes and co-ordinating nodes (DataONE, 2014)
- **Data Conservancy** – a community of university libraries, data centres, research labs and information science research and education programs, involved in the development of data repositories, such as the National Snow and Ice Data Center, and research on best practice data frameworks (Data Conservancy, n.d.).

Another highly regarded international initiative for data sharing and access is the National Observatory for Natural Hazards (ONRN) in France.

The ONRN was established in 2012 as a partnership between the Ministry of Sustainable Development, the Central Reinsurance Company (CCR) and the Association of French Insurance Undertakings for Natural Risk Knowledge and Reduction (OECD, 2013). The purpose of the ONRN, a not-for-profit company, is to facilitate the sharing of data from different stakeholders, at both central and local levels, in a reliable, updated and consistent manner. Insurers provide detailed frequency and cost-of-claim information and the public sector provides hazard information. While the achievement of reliable and updated data sharing is a work in progress, the ONRN's governance arrangements provide for input from both data producers and data users, as illustrated in Figure 5.1.

A recent report into Disaster Risk Financing in APEC Economies published by the OECD describes ONRN as a noteworthy collaborative effort "focusing on the improvement of consistency and interoperability of data on natural hazards for a full range of different applications, including risk assessment, risk mitigation, emergency preparedness and financial planning" (2013:43). There may be scope to use this as a model for greater access to natural disaster data in Australia.

Figure 5.1: National Observatory for Natural Hazards governance structure



Source: ONRN (2013)

There are also successful Australian initiatives that support access to information in other sectors. For example, Sirca is a leader in the collection, storage and provision of financial data to enable research. A brief description of Sirca's activities is provided in Box 10. This example demonstrates a potential mechanism for centralised collection and provision of data between end users that seek the same data for different purposes. Just as the approach to financial data management is being applied to the Sense-T project, Sirca's experience can also provide insights for better access to natural disaster data in Australia.

Another relevant example of data sharing is the Critical Infrastructure Program for Modelling and Analysis (CIPMA).

The CIPMA was established in 2007 by the Attorney General's Department to facilitate modelling and simulations of the behaviour and dependency of relationships between critical Australian infrastructure, encompassing banking and finance, communications, energy, water services and transport (TISN, n.d.).

The program involves the provision of underlying data by the owners and operators of critical infrastructure, including private sector stakeholders, state and territory governments, and Australian Government agencies. As a technical partner, Geoscience Australia is responsible for developing the computer capabilities to analyse the data, combining infrastructure sector simulation models, databases, geospatial information systems and economic models. This enables businesses and governments to identify, under different scenarios, how a disruption to a critical infrastructure service will flow-on through, within and across sectors (Scott, 2007; TISN, n.d.).

Box 10: Sirca

Sirca was established in 1997 by a group of academics in Australia and New Zealand, who were seeking to reduce the time spent by PhD students collecting and preparing financial data for their studies. Sirca currently operates as a not-for-profit company, limited by guarantee, directly accountable to its membership of 39 universities across Australia and New Zealand.

Sirca's philosophy is to enable financial research by providing access to data from a wide range of sources. Financial trade and news data is stored in raw format in Sirca's data centres, through partnerships with Thomson Reuters and the Australian Securities Exchange. This data can be accessed by users through online, self-service interfaces, including an Application Programming Interface which is compatible with external software tools and a variety of programming languages.

Data use licences are provided to members and commercial customers on an enterprise wide basis. Users are then able to submit one-off or scheduled data requests through the online interface, or make a request via code through programs such as Matlab, SAS and R, among others. Overall, Sirca's database is around 2PB in size, growing by 35TB per month. In turn, Sirca provides around 100TB of data to consumers each month, in response to around two million data requests.

Sirca has played a key role in establishing a number of financial research initiatives, including the Capital Markets Cooperative Research Centre and Centre for International Finance and Regulation. Its flexible approach to data curation seeks to ensure that the potential of data for research is maximised.

Leveraging this approach, Sirca's involvement in data storage and provision has extended beyond the finance sector. In December 2013, Sirca announced a partnership with the University of Tasmania to establish a big data platform in Hobart for the Sense-T initiative. The Sense-T projects use sensor and communication technologies to collect real-time data for agriculture, aquaculture, viticulture and water management, with the objective of creating the world's first economy-wide intelligent sensor network.

Ultimately, this aids operational and strategic decision-making around resilience measures, for all hazards, including but not limited to natural disasters. To ensure the security of the program's sensitive information, data confidentiality arrangements are in place, consistent with the Australian Government's Protective Security Manual (TISN, n.d.). As part of these arrangements, there is a 'tasking' process through which stakeholders nominate research questions for analysis. Based on the strategic priorities, finalised each year by the CIPMA Executive Committee, analysis may be funded through the program's budget, or be undertaken on a cost-recovery basis (Attorney General's Department, n.d.).

Importantly, the program supports the broader Trusted Information Sharing Network (TISN), the mechanism that facilitates collaboration between government and the private sector to ensure the resilience of Australia's critical infrastructure, consistent with the national Critical Infrastructure Resilience Strategy[5].

Given the strong links between the critical infrastructure resilience agenda and the notion of building resilience against natural disasters, an evaluation of this program should provide useful guidance for structuring broader sources of natural disaster information.

5.2 Facilitating collaboration

Given that the challenge of responding to natural disaster risks encompasses multiple disciplines, international evidence suggests that the development and analysis of information inputs is best shared between stakeholders. This allows for specialisation and responsiveness to local issues, which would be difficult to achieve if responsibilities were consolidated within a single institution. At the same time, it is important for collaborative partnerships between governments, industries and communities to leverage academic expertise to tackle pressing societal issues.

At the international level, organisations such as the United Nations, The World Bank and the OECD naturally focus on co-ordination and facilitating collaboration and information between stakeholders from different countries and disciplines. A summary of collaborative initiatives is provided in Box 11.

Box 11: International collaborations on natural disaster data and research

A small sample of international projects relating to natural disaster data and research:

- **UNEP FI Principles for Sustainable Insurance (PSI) Initiative Global Resilience Project** – The PSI Initiative is a global sustainability framework and initiative of the United Nations Environment Programme Finance Initiative. The PSI Initiative is undertaking the Global Resilience Project to deepen understanding of disaster risk reduction globally, identify the social and economic cost of disasters and use this information to help governments and communities mitigate their risk.
- **Future Earth** – a collaborative research platform on global sustainability, launched in 2012, by the Science and Technology Alliance for Global Sustainability. Members of the alliance include the UN Educational, Scientific and Cultural Organisation (UNESCO), UN University (UNU) and the UNEP. Through the platform, research projects are undertaken in relation to sustainability issues, including natural disasters (Future Earth, n.d.).
- **OECD International Network on the Financial Management of Large-scale Catastrophes** – was established to lead a proactive, co-ordinated approach to natural disasters, involving both the public and private sector (OECD, 2014b). The network is guided by a High Level Advisory Board, consisting of 18 representatives from governments, academia and the private sector. The role of the Board is to provide intellectual leadership through advice on the content of the network and priorities for research, analysis and public initiatives.

5 Further details on the Critical Infrastructure Resilience Strategy are provided in Appendix A.

While these initiatives demonstrate some of the ways in which collaboration on data and research is facilitated internationally, in this report it is more useful to examine how collaboration is achieved within countries, while balancing the need for specialisation. In New Zealand and the United States, there are many stakeholders involved in the development and analysis of natural disaster data and research.

For example, in New Zealand there is a range of government departments and agencies working with research institutions and the private sector in the context of natural disaster data and research. This includes GNS Science, the National Institute of Water and Atmospheric Research and a number of universities and other private sector initiatives, such as Opus Research.

The distribution of activities in the United States is also quite broad, with participation of at least seven government bodies, both within departments and as independent agencies. This is also evident from the organisation of data and research activities around finance and medicine in Australia, which involves a mix of government, research and industry participants.

Yet, at the same time, it is important that there are mechanisms to facilitate collaboration between these stakeholders. Some key examples of collaborative partnerships for natural disaster data and research in these countries are described in Box 12.

Box 12: National collaborations on natural disaster data and research

This review has uncovered many examples of collaborative partnerships for natural disaster data and research. A small sample of these initiatives from New Zealand and the United States include:

- **Joint Centre for Disaster Research, NZ** – is a partnership between Massey University and GNS Science. The Centre, hosted by the University's School of Psychology, undertakes applied teaching and research aimed at improving community resilience, emergency management planning, hazard education strategies and public responses to warning systems (Massey University, 2014b).
- **Resilient Organisations, NZ** – is a partnership of over 20 researchers from a number of New Zealand universities, including the University of Canterbury and the University of Auckland, with backgrounds across a range of disciplines. The partnership undertakes research projects within five streams, and has provided input into practical applications, such as the Construction Sector Workforce Plan for Greater Christchurch (Resilient Organisations Research Programme, 2012).
- **Natural Hazards Center at the University of Colorado, US** – is funded by a consortium of US Federal Government Agencies. The Center administers three core programs, related to information dissemination, research and quick response. Since 1975, the Center has hosted an Annual Natural Hazards Research and Applications Workshop, attended by federal, state and local emergency officials, NGOs, researchers and consultants (Natural Hazards Center, 2014).
- **National Earthquake Hazards Reduction Program, US** – is a partnership between the Federal Emergency Management Agency, National Institute of Standards and Technology, National Science Foundation and US Geological Survey. The program is focused on research and implementation, aiming to improve earthquake resilience in public safety, economic strength and national security (NEHRP, 2009).
- **Insurance Institute for Business & Home Safety Research Center, US** – was established by a group of 60 companies within the property insurance industry in 2010. The research facility is designed to test the resilience of one and two story residential and commercial buildings against the effects of simulated 'storms'. The Center co-ordinates and works in partnership with manufacturers, trade groups, government agencies, academic institutions and other research organisations (Insurance Institute for Business & Home Safety, 2013).

Similarly, there is an abundance of examples of collaborative research partnerships across Australia. Through the Cooperative Research Centre (CRC) Program, the Australian Government provides funding to research partnerships between businesses, researchers and community stakeholders, such as the BNHCRC. However, many collaborative partnerships have also been established outside of this program.

In the finance sector, three of the major collaborative research partnerships are listed here:

- **Capital Markets CRC** – facilitates links between industry and over 40 senior researchers in the fields of securities market design, wealth management, language technology and data mining. The CMCRC is also a developer of commercial products (Capital Markets CRC Limited, 2013)
- **Australian Centre for Financial Studies** – a not-for-profit consortium between Monash University, RMIT University and the Financial Services Institute of Australasia, which aims to "to engage industry, academia, regulators and government in knowledge creation, transfer and thought leadership related to the financial sector" (Australian Centre for Financial Studies, 2014)
- **Centre for International Finance and Regulation** – a partnership between Sirca, the Capital Markets CRC, six universities and four industry bodies, sponsored by the Australian and NSW Governments, with the aim of linking academia with policy makers, regulators and industry. The Centre provides funding for research projects (Centre for International Finance and Regulation, 2011).

As a final example, there are many agencies also involved in collaborative research for the medical sector in Australia. For example, there are 43 World Health Organisation (WHO) Collaborating Centres in Australian academic and scientific institutions. These centres lead the implementation of WHO programs as part of an international collaborative network (WHO, 2014).

Overall, these examples highlight the importance of establishing opportunities for stakeholders to leverage the diversity of skills and experience in identifying and addressing key research questions.

5.3 Prioritising investments

The last clear lesson highlighted by international evidence and other sectors of Australia is that mechanisms for prioritising and evaluating research investments can be an effective means of fostering links between researchers and end users.

For example, the New Zealand Natural Hazards Research Platform was established in 2009 to provide secure, long-term funding for natural hazard research and to help research providers and end users work more closely together (NHRP, 2013).

The NHRP is led by GNS Science, and is co-anchored by the National Institute of Water and Atmospheric Research (NIWA), both government-owned companies classified as Crown research institutes. Other partners of the NHRP include the University of Canterbury, Massey University, University of Auckland and Opus Research, an independent research facility. Additional research groups from academia, consultancies and international bodies are also involved as NHRP sub-contractors. The core partners to the Platform form a Management Group, which is also supported by a Strategic Advisory Group consisting of end users, and a Technical Advisory Group of international scientists.

Each year, the Ministry of Business, Innovation and Employment invests approximately NZ$17 million through the platform (NHRP, 2013). The prioritisation of funding to research projects is guided by a research strategy, last published in 2010. While a revised strategy for 2014-2018 is in development, the current strategy identifies six guiding principles, stipulating that the platform should support research that:

- Meets national needs
- Is responsive
- Is of the highest quality
- Has enduring capability
- Is connected and co-ordinated
- Is communicated (NHRP, 2010).

The 2010 Research Strategy also outlines five themes for organising of the research activities supported by the platform. These are:

- Geological hazard models
- Predicting weather, flood and coastal hazards
- Developing regional and national risk evaluation models
- Societal resilience such as social, cultural, economic and planning factors
- Resilient building and infrastructure (NHRP, 2010).

Accordingly, this mechanism helps to ensure that research effort is directed towards key areas of national importance and supports links with end users through governance arrangements. While the platform also helps to increase transparency on the range of research activities being undertaken, there appears to be scope for further improvement by providing online access to research publications.

In Australia, funding for research activities is provided by a range of sources. However, the Australian National Health and Medical Research Council (ANHMRC) demonstrates that national co-ordination of funding can be an effective means for ensuring continued investment in valuable research activities, on both an individual and collaborative basis.

The NHMRC was established in 1936 and became an independent statutory agency on 1 July 2006, within the Australian Government's Health and Ageing portfolio (NHMRC, 2014a). It is Australia's peak body for supporting health and medical research, and is also responsible for developing health advice for the Australian community, health professionals and governments and for providing advice on ethical behaviour in health care and in the conduct of health and medical research.

At the end of January 2014, NHMRC was involved in facilitating or providing support for 2,216 project grants, 68 program grants, 43 development grants, 69 NHMRC partnerships for better health – partnership projects, two partnership centres and the administration of grants at 88 research institutions (NHMRC, 2014b).

Similar bodies have been established to allocate research funding at the state level, such as the State Health Research Advisory Council in Western Australia (Department of Health, n.d.).

The success of health and medical research is also monitored by government at the national level. In 2013, the McKeon Review into health and medical research acknowledged the benefits generated as a result of research and argued for research to be better leveraged to deliver improvements in healthcare delivery. The review outlined a vision for 'better health through research', and made recommendations to:

- Embed research in the health system
- Support priority-driven research
- Maintain research excellence
- Enhance commercial and non-commercial pathways to impact
- Attract philanthropy and new funding sources
- Invest and implement (Department of Health and Ageing, 2013).

Bushfire, Gippsland, Victoria, January 2012

Some of these recommendations could also act as guiding principles for the organisation of natural disaster research, particularly in relation to stronger application of research in practice. Furthermore, this highlights the importance of review processes and evaluations of the impact of research investments, to drive accountability for the outcomes achieved by publically funded research.

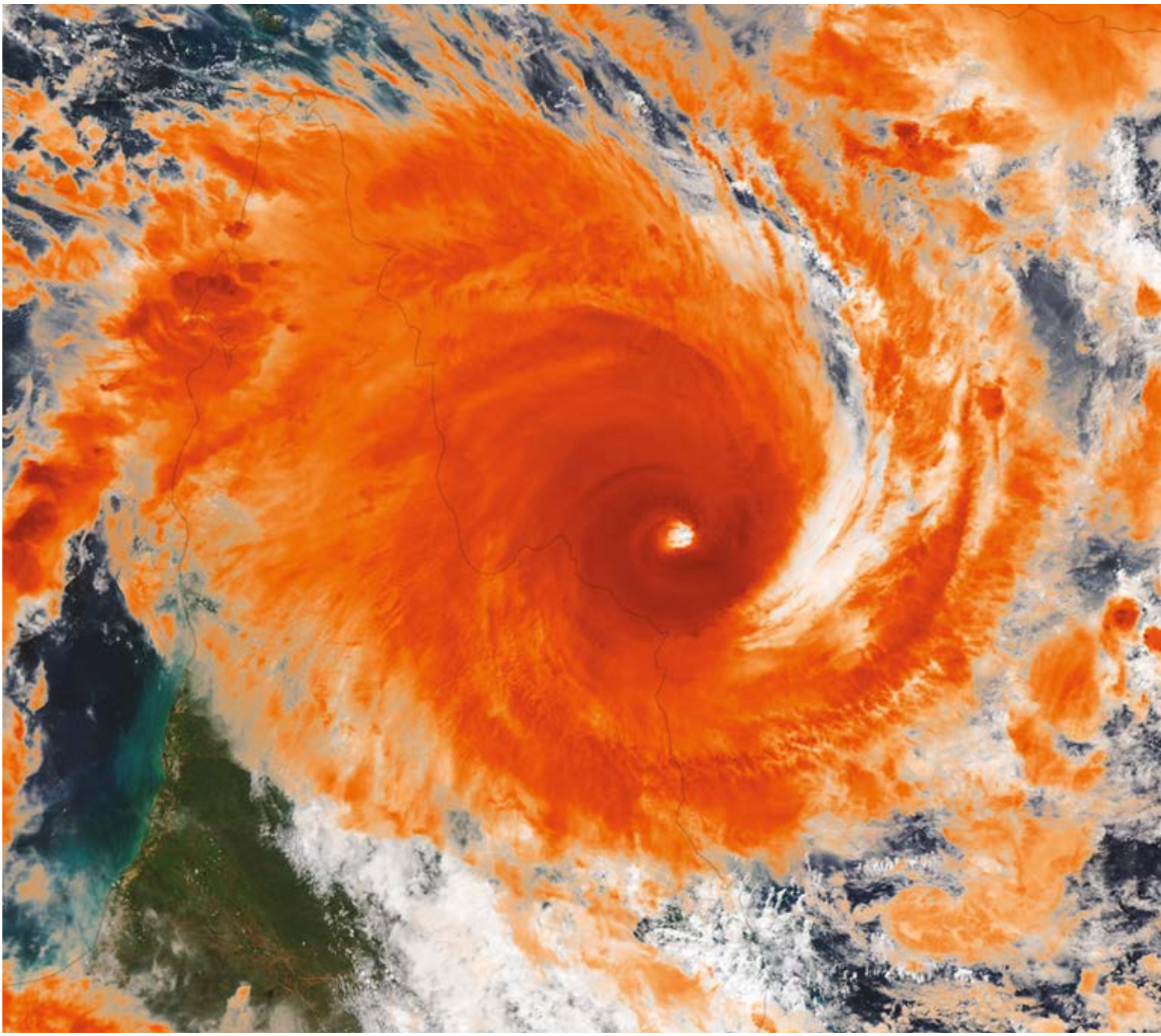
Finally, when establishing frameworks for the prioritisation of research funding, it is important to consider the appropriate balance between competitive funding, which typically seeks to foster innovative ideas, and targeted funding, which is more prescriptive regarding its topics and research questions.

For example, in October 2013, the Board of the Centre for International Finance and Regulation made the decision to switch from a competitive funding model based on broad themes to a more targeted funding model (2013). This switch was intended to allow industry end users to play a greater role in shaping the research agenda. In the context of natural disasters, it is likely that some aspects of a targeted approach would help to improve the practical application of research findings by end users.

5.4 Conclusions

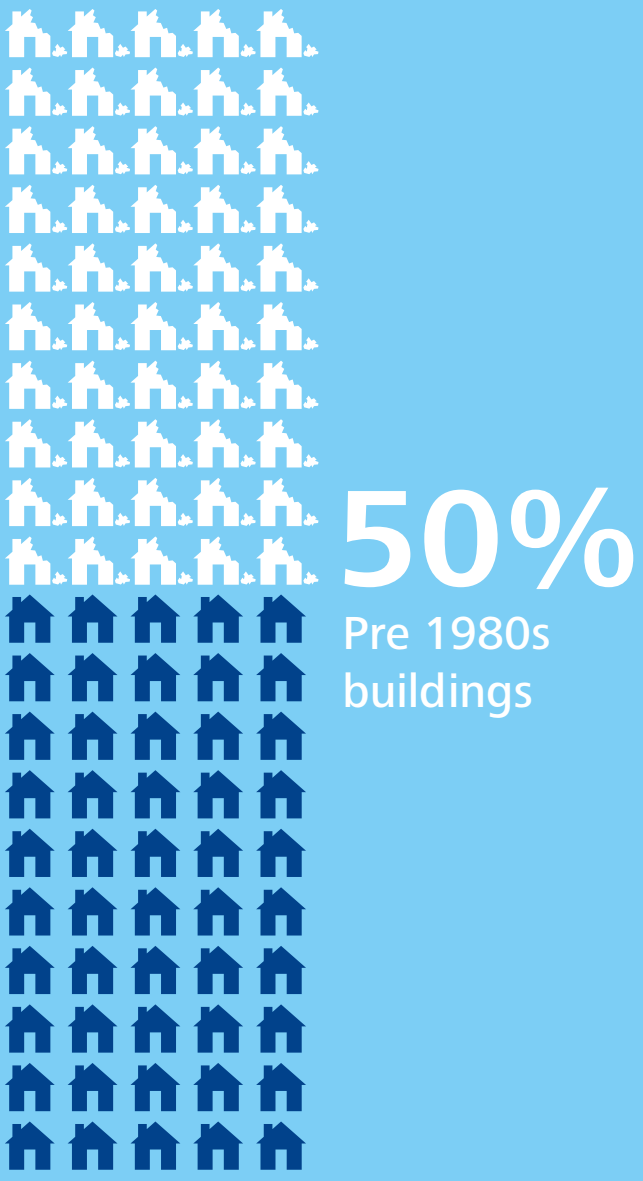
International approaches to the organisation of natural disaster data and research, as well as Australian initiatives for data and research in the financial and medical sectors, clearly demonstrate the value of access to information, collaboration and prioritisation of investments.

To an extent, these principles are reflected in areas of Australia's natural disaster data and research spectrum. However, there is significant scope to embed these principles across the overall system through a greater focus on end user needs. The following chapter outlines recommendations that will implement these learnings.

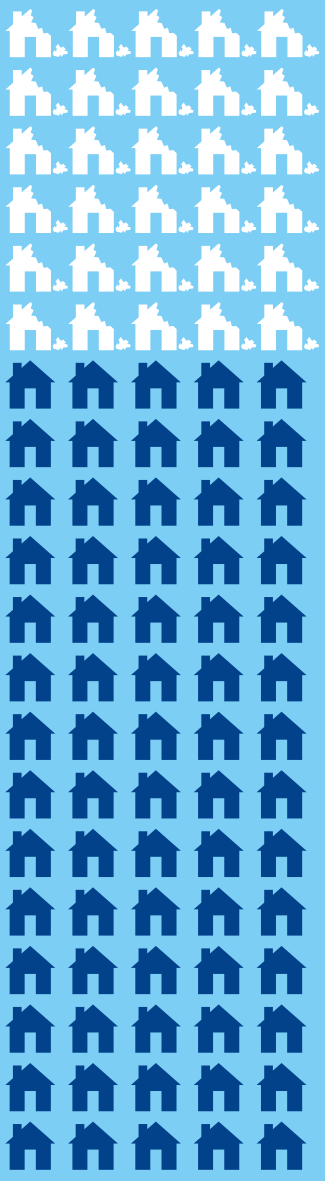


A satellite photo made available by Australian Bureau of Meteorology 20 March 2006 shows Cyclone Larry over the coast of North Queensland. The category five storm slammed into the coast south of Cairns carrying winds of 290 kph and left a trail of destruction in its wake.

Cyclone Testing Station post event analysis of Tropical Cyclone Yasi – no roof damage



50%
Pre 1980s buildings



70%
Post 1980s buildings

6. Recommendations

Key points

This report makes three recommendations for natural disaster data and research to address the decision-making challenge:

1. Efficient and open – deliver a national platform for foundational data
2. Transparent and available – remove barriers to accessibility of data and research
3. Enabling effective decision-making – establish a prioritisation framework

This report has highlighted the gaps and disparities that exist in Australia's approach to data and research on natural disasters, along with barriers that prevent full use of information by end users for optimal resilience investments. The following recommendations outline the steps required to address the decision-making challenge.

1. Efficient and open – deliver a national platform for foundational data

Given that foundational data is used for a broad range of purposes beyond the scope of natural disaster issues, it is critical that the Australian Government provide a single point of access for all Australians. This would provide a valuable, base level of information upon which research and decisions around disaster resilience could be made on a consistent basis, while reducing search costs for a range of other broader uses.

This platform should facilitate access to data on community demographics and weather currently produced and published by the Australian Bureau of Statistics and the BoM.

Responsibility for consistent topography and geocoded asset data is required at the national level. Currently, this data is held by a mix of agencies across the public and private sector, with limited public access. This has generated high search costs and duplication of activity.

This action must overcome the barriers encountered in past, similar efforts, such as the Australian and New Zealand Land Information Council's development of a Foundation Spatial Data Framework. The Terrestrial Ecosystem Research Network Data Discovery Platform provides an example of how this foundational data platform might be designed and implemented.

2. Transparent and available – remove barriers to accessibility of data and research

This report has highlighted key examples of where access to data and research is restricted. Greater transparency across the system is required to identify the full range of end users and allow for development of a system of optimal access which weighs up overall costs and benefits.

Data

There is a need for clear delegation of responsibility for hazard and impact data, such as hazard mapping. This should address concerns with legal liability, unnecessarily restrictive licensing and ensure standardisation across jurisdictions. While data provision may continue to be undertaken by a range of stakeholders across government agencies, academia and businesses to allow for specialisation, it is important these activities are transparent and the data is accessible.

There is also potential for more involvement by the private sector in data sharing. For example, due to a lack of government centralisation of flood data, the Insurance Council of Australia has co-ordinated central flood risk information in the National Flood Information Database. It is recognised that while commercial interests need to be protected to encourage the continued development of such information sources, there are benefits from promoting a level of access to researchers and local decision-makers. The National Observatory for Natural Hazards in France[6] provides a model for a partnership between the insurance industry and government, which could be replicated in Australia.

In doing so, it might be useful to explore the opportunities to leverage the existing data.gov.au and the Australian National Data Service infrastructure (ANDS). The ANDS is currently funded by the Australian Government and administered by Monash University, Australian National University and the CSIRO (ANDS, n.d.).

Research

There is a need to establish better opportunities for end users to be involved in natural disaster research.

This analysis highlights that greater transparency is required around past and present research activities related to natural disaster resilience. This would foster valuable links between groups with common interests and motivate new streams of research responsive to the needs of Australian communities. This is consistent with the 2011 'Focusing Australia's Publically Funded Research Review', which called for greater co-ordination to maximise returns from investment and also builds on the Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC) approach of linking with end users.

Ideally, a complete stocktake of natural disaster information would encompass the dimensions identified in Table 6.1. This stocktake could be easily maintained as part of a co-ordinated funding process for research projects. The recent stocktake of mitigation investment decision work for the disaster mitigation workshop hosted by the Attorney-General's Department and CSIRO could be included. In the interests of transparency, as much of the stocktake as possible should be made publically available, accompanied by an easy-to-use search capability. However, database or project files could be held internally by the National Resilience Advisor in cases where private information was provided in confidence.

Table 6.1: Elements of a complete natural disaster information stocktake

Elements for databases	Elements for research projects
• Data category (see Chapter 3)	• Research theme
• Data format (time series, maps etc.)	• Research objective and outputs
• Time period collected	• Relevant time period
• Location collected for	• Relevant geographic location
• Relevant type/s of disaster	• Relevant type/s of disaster
• Agencies involved in collecting data	• Agencies involved in project
• Contact details for data set manager	• Contact details for project manager

6 The National Observatory for Natural Hazards in France facilitates data sharing and pools information and studies produced by different stakeholders. Access is provided to hazard maps, assets at risk, vulnerability and resilience at a local level, loss records and lessons learnt, and public risk prevention programmes and procedures. Insurers provide detailed frequency and cost-of-claim information to the observatory while the public sector provides the rest of the information (ONRN, 2013).

A national resilience research agenda should be established to promote greater application of research in decision-making. A national agenda would identify the key issues that need to be resolved to assist decision-makers with the prioritisation of research investments. The mechanisms used by the Natural Hazards Research Platform in New Zealand and the National Health and Medical Research Council in Australia provide examples of how this agenda might be implemented.

In setting the agenda, it would be important to balance the need for competitive funding, to incentivise high quality, innovative research ideas, and targeted funding, in relation to known issues and challenges.

To allow for greater accountability of research and to help shape this agenda, completion of an impact evaluation framework could be established as a condition for research grants. The nature of this evaluation is described in Box 13.

Box 13: Research impact evaluation

To ensure funds are allocated efficiently, effectively and in a manner consistent with the achievement of policy objectives the outcomes of research programs require monitoring, evaluation and reporting.

The monitoring and evaluation process typically starts with a program logic map outlining the conceptual framework for a research program and detailing the hypothesised cause and effect relationships between inputs, outputs and outcomes, and the overarching program objectives. The logic map then guides the development of a monitoring and evaluation plan and aids effective program implementation, enabling stakeholders to reach clarity and consensus as to the links between program inputs, activities, outputs and outcomes.

The development of a monitoring and evaluation plan early in the research process helps to ensure that research outcomes can be fully evaluated later, and interim assessments can be made, e.g. to assess whether the research is on track to delivering a longer-term outcome. A good evaluation plan is structured, systematic and coherent and ensures the right questions are asked, the right information is collected and an evidence-base is established for ongoing evaluation.

Finally, following research completion, research outcomes need to be evaluated. In an environment of limited resources, rigorous ex post impact evaluation gives research organisations firm evidence of the effects of research on the economy, environment and society. Ex post impact evaluation is an important mechanism to assess the effects of a program of work, including the fulfilment of its goals and objectives and possibly its unintended outcomes.

It can provide evidence to inform funders, policy makers, research teams and other stakeholders for reasons of accountability, allocation of future funds, analysis to inform investment decision-making and to build advocacy with funders and the general public. To ensure the evaluation is consistent across different works, an evaluation framework is required. Steps would include identification, measurement and aggregation of research outcomes, so that outcomes can be compared across a range of research programs.

In an environment where there is an increasing requirement for accountability, most research organisations have implemented, or are implementing, structured approaches to monitoring and evaluation to improve transparency, ensure more efficient use of resources and drive better research outcomes.

3. Enabling effective decision-making – establish a prioritisation framework

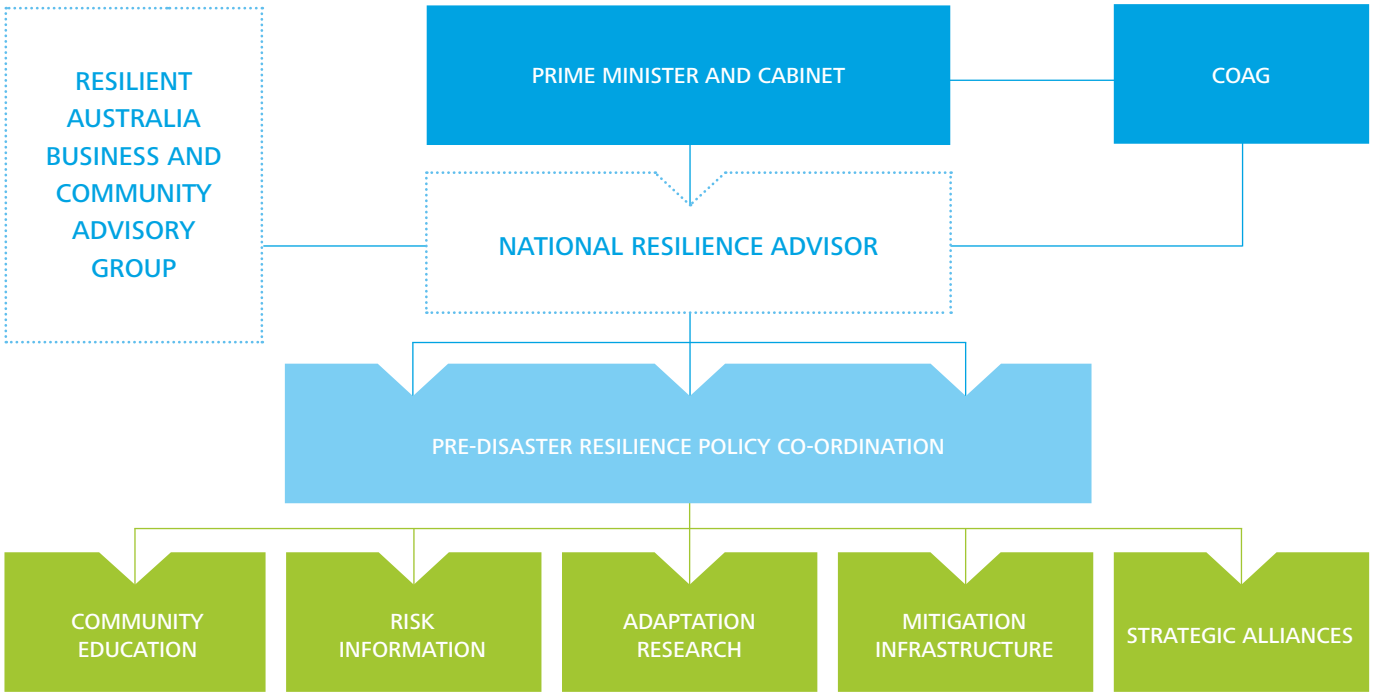
Finally, to support the broader, consistent application of data and research in decision-making, a national prioritisation framework for investment in resilience should be established. This framework would be similar to Infrastructure Australia's Priority List, by providing guidelines for cost-benefit analysis of resilience investment options, including links to standardised data sources and step-by-step methodologies for different investment types. This would allow comparison of different projects on a consistent basis and enable transparent, evidence based decision-making through prioritisation of funding based on benefit-cost ratios.

This approach would enable best practice use of natural hazard data and research to be collected and disseminated and ensure an optimal outcome on resilience investment decisions in Australia.

Through the collation of analysis, the framework would also build the common understanding of the nation's areas of highest risk and the most effective measures to reduce that risk and assist in prioritising the research agenda.

Consistent with the recommendation of *'Building our Nation's Resilience to Natural Disasters'*, a National Resilience Advisor within the Department of Prime Minister and Cabinet would be well placed to address these issues. Developing resilient communities should be elevated to the centre of government decision-making to deliver effective and efficient co-ordination of activities across all levels of government, business, communities and individuals. This should be directly supported by a Business and Community Advisory Group to help facilitate a more co-ordinated response and ensure that business and the not-for-profit sector are represented at the highest levels of policy development and decision-making.

Figure 6.1: Building a more resilient Australia



PRINCIPLE: CENTRAL GOVERNMENT FOCUS WITH STRONG SUPPORT FROM BUSINESS TO ADDRESS THE CO-ORDINATION CHALLENGE

Source: Deloitte Access Economics, *Australian Business Roundtable for Disaster Resilience and Safer Communities* (2013)

Concluding remarks

Many stakeholders across Australia are making valuable contributions to knowledge about natural disasters and resilience, across governments, businesses and communities. However, significant barriers remain to optimal decision-making that is informed by data and research, and this is limiting our progress towards a resilient Australia.

The three recommendations we offer will help to unlock the full potential of data and research and to reduce the burden of natural disasters on the Australian economy and our communities. This can only be achieved if there is a shared effort between governments, businesses and communities.

A prop plane dropping fire retardant material over bushfires in the Grampians, Victoria. January, 2014.

References

Attorney-General's Department 2011 *Emergency Management Approaches* http://www.em.gov.au/Emergencymanagement/Pages/EmergencyManagementApproaches.aspx#CA

2012*, National Guidelines for the National Flood Risk Information Program.* Retrieved from http://www.em.gov.au/Publications/Program%20publications/Pages/National-Guidelines-for-the-National-Flood-Risk-Information-Program.aspx.

2014*, National Partnership Agreement on Natural Disaster Resilience.* Retrieved from *http://www.em.gov.au/npa*

(n.d.), *Critical Infrastructure Program for Modelling and Analysis*, http://www.ag.gov.au/NationalSecurity/InfrastructureResilience/Pages/CriticalInfrastructureProgramforModellingandAnalysisCIPMA.aspx

Australian Centre for Financial Studies 2014, *About ACFS*, http://www.Australiancentre.com.au/AboutACFS

Australian Government 2010, *Declaration of open government*, http://www.finance.gov.au/blog/2010/07/16/declaration-open-government/

2013, *Strategic Research Priorities*, http://www.industry.gov.au/research/Documents/SRP_fact_sheet_web.PDF

Australian Institute of Health and Welfare (AIHW) 2013, *About*, https://www.aihw.gov.au/about/#prod

Australian National Data Service (n.d.), *Australian National Data Service*, http://www.ands.org.au/index.html

Australian Sustainable Built Environment Council (ASBEC) 2013, *A framework for improve resilience*, http://www.asbec.asn.au/asbecs-policy-platform/#Resilience

Bureau of Meteorology (BoM) 2013, *Water Information Research and Development Alliance*. Retrieved from http://www.BoM.gov.au/water/about/waterResearch/wirada.shtml (accessed on 02/04/2014)

Bureau of Transport Economics 2001, *Economic Costs of Natural Disasters in Australia*, Report 103, Canberra.

Capital Markets CRC Limited 2013, *About CMCRC*, http://www.cmcrc.com/index.php/home/about

Centre for International Finance and Regulation 2011, *Who We Are*, http://www.cifr.edu.au/site/About/Who_We_Are.aspx

2013, *Introduction of Targeted Research Funding Model*, http://www.cifr.edu.au/site/Latest_news/CIFR_Introduces_a_Targeted_Research_Funding_Model.aspx

Centre for Research on the Epidemiology of Disasters (CRED) 2014, *EM-DAT: The International Disaster Database*, http://www.emdat.be/

City of Gold Coast 2013, *Gold Coast Open Data Project*, http://www.businessgc.com.au/businessgc-opportunities-7

Corporación OSSO 2013, *DesInventar: inventory system of the effects of disasters*, http://www.desinventar.org/en/

Council of Australian Governments (COAG) 2011, *National Strategy for Disaster Resilience*, Barton, http://www.em.gov.au/Documents/1National%20Strategy%20for%20Disaster%20Resilience%20-%20pdf.PDF

CSIRO 2013, *Light detection and ranging (lidar),* http://www.csiro.au/Outcomes/Food-and-Agriculture/LightDetectionLidar.aspx

2014, *Building a system of systems for disaster management workshop: joint issues statement*, http://www.csiro.au/~/media/CSIROau/Flagships/Digital%20Productivity%20and%20Services%20Flagship/GCS_images/SOSDMd/SOSDMd01-14%20Issues%20Statement.pdf

Cyclone Testing Station 2011, *Tropical Cyclone Yasi: Structural damage to buildings*, CTS Technical Report No 57, http://www.parliament.qld.gov.au/Documents/TableOffice/TabledPapers/2011/5311T4542.pdf

DataONE 2014, *Data Observation Network for Earth*, http://www.dataone.org/

Data Conservancy (n.d.) *About us*, http://dataconservancy.org/about/

Deloitte Access Economics 2013, *Building our Nation's Resilience to Natural Disasters*, report commissioned by the Australian Business Roundtable for Disaster Resilience and Safer Communities.

Department of Finance 2013, *The Government Data Landscape in Australia*, http://www.finance.gov.au/blog/2013/10/26/government-data-landscape-Australia/

Department of Health (n.d.), *State Health Research Advisory Council (SHRAC),* http://www.health.wa.gov.au/researchdevelopment/home/about_shrac.cfm

Department of Health and Ageing 2013, *Strategic Review of Health and Medical Research*, http://www.mckeonreview.org.au/downloads/Strategic_Review_of_Health_and_Medical_Research_Feb_2013-Final_Report.pdf

Department of Homeland Security (DHS) 2011a, *National Preparedness Goal: First edition September 2011*, http://www.fema.gov/media-library-data/20130726-1828-25045-9470/national_preparedness_goal_2011.pdf

2011b, *Presidential Policy Directive/PPD-8*, http://www.dhs.gov/xlibrary/assets/presidential-policy-directive-8-national-preparedness.pdf

2013, *National Mitigation Framework*, http://www.fema.gov/media-library-data/20130726-1914-25045-9956/final_national_mitigation_framework_20130501.pdf

(n.d.), *Science and Technology Directorate*, http://www.dhs.gov/science-and-technology-directorate

Department of Industry 2012, *National Research Investment Plan*, http://www.industry.gov.au/research/Pages/NationalResearchInvestmentPlan.aspx

Department of Industry, Innovation, Science and Research 2011, *Focusing Australia's Publically Funded Research Review: Maximising the Innovation Dividend, Review Key Findings and Future Directions*, http://www.innovation.gov.au/research/Documents/ReviewAdvicePaper.pdf

Department of Industry, Innovation, Science, Research and Tertiary Education (DIISRTE) 2012, *2012 National Research Investment Plan*, http://www.innovation.gov.au/research/Documents/NationalResearchInvestmentPlan.pdf

Department of the Prime Minister and Cabinet (DPMC) 2013, *Administrative Arrangements Order made on 12 December 2013*, http://www.dpmc.gov.au/parliamentary/docs/aao_20131212_signed.pdf

Federal Emergency Management Agency (FEMA) 2013, *National Flood Insurance Program: Flood Hazard Mapping*, http://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping

2014a, *Hazus*, http://www.fema.gov/hazus

2014b, *Learn about Presidential Policy Directive-8*, https://www.fema.gov/learn-about-presidential-policy-directive-8

Future Earth (n.d.), *Future Earth*: research for global sustainability, http://www.futureearth.info/

Geoscience Australia 2011, *Open Source Hydrodynamic Modelling*. GA 11-5346. Available from https://anuga.anu.edu.au/ (accessed on 03/04/2014)

2011, *What Would Happen If Cyclone Tracy Hit Darwin in 2008?.* Retrieved from http://www.ga.gov.au/hazards/our-capabilities/case-studies/what-would-happen-if-cyclone-tracy-hit-darwin-in-2008.html

2014, *Hazards*. Retrieved from http://www.ga.gov.au/hazards.html (accessed on 03/04/2014)

Global Facility for Disaster Reduction and Recovery (GFDRR) 2014a, *About GFDRR*, https://www.gfdrr.org/about_gfdrr

2014b, *Disaster risk assessment and monitoring*, https://www.gfdrr.org/dra_monitoring

2014c, *Knowledge and capacity enhancement*, https://www.gfdrr.org/node/67

2014d, *Knowledge center*, https://www.gfdrr.org/KnowledgeCenter

2014e, *Open Data for Resilience Initiative*, https://www.gfdrr.org/opendri

2014f, *Services and business lines*, https://www.gfdrr.org/node/43

2014g, *The GFDRR labs*, https://www.gfdrr.org/labs

Global Risk Information Platform (GRIP) 2014, *GRIP Global Risk Information Platform*, http://www.gripweb.org/gripweb/

GNS Science 2014, *Welcome to GNS Science*, http://www.gns.cri.nz/

Gregorowski R, MacDonald D, Flatters G, Spaven P, Pulgar D, Volgel I & Barr J 2012, *Evaluation of PreventionWeb and related UNISDR Information Services for Disaster Risk Reduction Final Report*, commissioned by UNISDR and prepared by ITAD Ltd., United Kingdom, http://www.preventionweb.net/files/27624_pwevalfinalreportwithannexes.pdf

Houghton J 2011, *Costs and benefits of data provision: report to the Australian National Data Service*, http://www.ands.org.au/resource/houghton-cost-benefit-study.pdf

Insurance Council of Australia (ICA) 2013, *Historical Disaster Statistics.*

Insurance Institute for Business & Home Safety 2013, *Research Center*, https://www.disastersafety.org/research-center/

Integrated Research on Disaster Risk (IRDR) 2013, *Integrated Research on Disaster Risk*, http://www.irdrinternational.org/

International Council for Science 2014, *Disaster Risk (IRDR),* http://www.icsu.org/what-we-do/interdisciplinary-bodies/irdr/

James Cook University, Cyclone Testing Station 2011, *Tropical Cyclone Yasi Structural Damage to Buildings, CTS Technical Report 57.* Retrieved from https://www.jcu.edu.au/cts/publications/content/technical-reports/jcu-078421.pdf/view

KC, Shyam 2013, *Cost benefit studies on disaster risk reduction in developing countries*, East Asia and the Pacific (EAP) Disaster Risk Management (DRM) knowledge notes working paper series; no. 27, World Bank, Washington DC, http://documents.worldbank.org/curated/en/2013/08/18136412/cost-benefit-studies-disaster-risk-reduction-developing-countries

Massey University 2014a, *International Centre of Excellence in Community Resilience*, http://www.massey.ac.nz/massey/learning/departments/school-of-psychology/research/disaster-research/research-projects/icoc/icoc_home.cfm

2014b, *Joint Centre for Disaster Research*, http://www.massey.ac.nz/massey/learning/departments/school-of-psychology/research/disaster-research/disaster-research_home.cfm

McKinsey & Company 2014, *Learning from New York City's open-data effort*, http://www.mckinsey.com/insights/public_sector/learning_from_new_york_citys_open_data_effort

Ministry of Civil Defence and Emergency Management 2007, *National Civil Defence Emergency Management Strategy*, http://www.civildefence.govt.nz/memwebsite.NSF/Files/National_CDEM_Strategy/$file/National-CDEM-strategy-2008.pdf

2014, *CDEM Research*, http://www.civildefence.govt.nz/memwebsite.nsf/wpg_url/for-the-cdem-sector-cdem-research-index?opendocument

Munich Re 2014, *Loss events worldwide 2013*, Geo Risks Research, NatCatSERVICE.

National Aeronautics and Space Administration (NASA) 2011, *GRIP Hurricane Mission*, http://www.nasa.gov/mission_pages/hurricanes/missions/grip/main/index.html

2014a, *Earth Observatory*, http://earthobservatory.nasa.gov/?eocn=topnav&eoci=home

2014b, *Hurricanes/Tropical* Cyclones: latest storm images and data from NASA, http://www.nasa.gov/mission_pages/hurricanes/main/index.html

National Climate Change Adaptation Research Facility (NCCARF) 2012, *Climate change adaptation research in Australia: An overview of research funded by the National Climate Change Adaptation Research Facility*. Retrieved from: http://www.nccarf.edu.au/sites/default/files/attached_files_publications/Portfolio_small.pdf (accessed on 07/04/2014)

National Earthquake Hazards Reduction Program (NEHRP) 2009, *About Us*, http://www.nehrp.gov/about/history.htm

National Health and Medical Research Council (NHMRC) 2014a, NHMRC's role, https://www.nhmrc.gov.au/about/organisation-overview/nhmrcs-role

2014b, *Presentation by Professor Warwick Anderson AM, CEO, Perth, 26 March 2014*, https://www.nhmrc.gov.au/_files_nhmrc/file/about/senior_staff/articles/prof_warwick_anderson_presentation_perth_140326.pdf

National Institute of Standards and Technology (NIST) 2014, *Building and Fire Research Platform*, http://www.nist.gov/building-and-fire-research-platform.cfm

National Oceanic and Atmospheric Administration (NOAA) 2013, *NOAA National Severe Storms Laboratory CI-FLOW: Coastal and Inland Flooding Observation and Warning Project*, http://www.nssl.noaa.gov/projects/ciflow/

2014a, *About NESDIS*, http://www.nesdis.noaa.gov/about_nesdis.html

2014b, *NOAA Center for Tsunami Research*, http://nctr.pmel.noaa.gov/

National Science Foundation (NSF) 2014, *About the National Science Foundation*, http://www.nsf.gov/about/

Natural Hazards Center 2014, *Our History and Mission*, http://www.colorado.edu/hazards/about/

Natural Hazards Research Platform (NHRP) 2010, *Natural Hazards Platform – Research Strategy 2010-2011*, http://www.naturalhazards.org.nz/NHRP/Publications/Establishment-Strategy

2013, *About us*, http://www.naturalhazards.org.nz/NHRP/About-Us

NSW Government 2013, *NSW Government Open Data Policy*, http://finance.nsw.gov.au/ict/sites/default/files/NSW%20Government%20Open%20Data%20Policy%201.0.pdf

Observatoire National des Risques Naturels (ONRN) 2013, *The National Observatory for Natural Hazards (ONRN),* http://www.onrn.fr/site/binaries/content/assets/documents/onrn/brochure_ang_web.pdf

Office of the Australian Information Commissioner (OAIC) 2011, *Principles on open public sector information*, http://www.oaic.gov.au/images/documents/information-policy/information-policy-agency-resources/principles_on_psi_short.pdf

Open Government Partnership 2014, *What is the Open Government Partnership?,* http://www.opengovpartnership.org/

Open Knowledge Foundation (n.d.), *Open Data Index*, https://index.okfn.org/country/

Opus International Consultants 2014, *Community Resilience About Us*, http://www.resilience.org.nz/index.php/pages/about#funding

Organisation for Economic Co-operation and Development (OECD) 2014a, *OECD iLibrary*, http://www.oecd-ilibrary.org/

2014b, *OECD International Network on the Financial Management of Large-scale Catastrophes*, http://www.oecd.org/finance/insurance/oecdinternationalnetworkonthefinancialmanagementoflarge-scalecatastrophes.htm

2014c, *What we do and how*, http://www.oecd.org/about/whatwedoandhow/

2013, *Disaster Risk Financing in APEC Economies: Practices and Challenges*, http://www.oecd.org/daf/fin/insurance/OECD_APEC_DisasterRiskFinancing.pdf

PopTech & Rockefeller Foundation Bellagio Fellows 2013, *Seven Principles for Big Data and Resilience Projects*, http://100resilientcities.rockefellerfoundation.org/blog/entry/seven-principles-for-big-data-and-resilience-projects

Productivity Commission (PC) 2012, *Barriers to Effective Climate Change Adaptation*, Report No. 59, Final Inquiry Report, Canberra.

2014, *Natural Disaster Funding Arrangements*, Issues Paper, Canberra.

Project Open Data (n.d.), *Principles*, http://project-open-data.github.io/principles/

Prosser B & Peters C, 2010, 'Directions in disaster resilience policy', *The Australian Journal of Emergency Management*, 25:3.

Queensland Floods Commission, 2012, *Queensland Floods Commission of Inquiry, Final Report*. Retrieved from http://www.floodcommission.qld.gov.au/__data/assets/pdf_file/0007/11698/QFCI-Final-Report-March-2012.pdf (accessed on 04/04/2014)

Queensland Government, 2013, *Seabed mapping*. Retrieved from http://www.qld.gov.au/environment/coasts-waterways/beach/studies-seabed/ (accessed on 23/05/2014)

Queensland Reconstruction Authority, 2012, *Operation Queenslander Update 2011-2013*. Retrieved from http://www.qldreconstruction.org.au/u/lib/cms2/operation-qlder-update-2011-2013-4.pdf (accessed on 23/05/2014)

Regional Australia Institute 2013, *From Disaster to Renewal: The Centrality of Business Recovery to Community Resilience*. Retrieved from http://www.regionalAustralia.org.au/wp-content/uploads/2013/08/From-Disaster-to-Renewal.pdf (accessed on 07/04/2014)

Resilient Organisations Research Programme 2012, *Our funders*, http://www.resorgs.org.nz/our-funders.html

Risk Frontiers 2013, *Capability Statement*. Retrieved from http://www.riskfrontiers.com/capability.htm (accessed on 02/04/2014)

Scott G 2007, *CIPMA – Critical Infrastructure Protection Modelling & Analysis*, Geoscience Australia, http://www.polymtl.ca/crp/doc/GREGSCOTT-CIPMABriefingforCanada.pdf

Select Council on Climate Change (SCCC) 2012, *Roles and responsibilities for climate change adaptation in Australia*, http://www.coag.gov.au/sites/default/files/Roles%20and%20Responsibilities%20for%20Climate%20Change%20Adaptation.pdf

Sirca 2014, *About Sirca*, http://www.sirca.org.au/about-sirca/

Southgate RJ, Roth C, Schneider J, Shi P, Onishi T, Wenger D, Amman W, Ogallo L, Beddington J & Murray V 2013, *Using science for disaster risk reduction: report of the UNISDR Scientific and Technical Advisory Group*, http://www.unisdr.org/files/32609_stagreport2013assembled.pdf

Terrestrial Ecosystem Research Network, 2014, *About TERN*, http://www.tern.org.au/What-is-TERN-pg22570.html

The World Bank 2012, *Adaptation Guidance Notes – Key Words and Definitions*.

The World Bank Group 2013, *Partnership Charter, Global Facility for Disaster Reduction and Recovery*, https://www.gfdrr.org/sites/gfdrr.org/files/publication/GFDRR_Partnership_Charter_2013.pdf

Trusted Information Sharing Network (TISN) (n.d.), *Critical Infrastructure Program for Modelling and Analysis*, http://www.tisn.gov.au/Documents/CIPMA+-+Fact+Sheet.PDF

United Nations (UN) 1999, *Press Release SG/SM/7060: Secretary-General to Decade for Natural Disaster Reduction*, http://www.un.org/News/Press/docs/1999/19990706.SGSM7060.html

2005, *United Nations General Assembly A/RES/60/195*, http://www.unisdr.org/files/resolutions/N0549930.pdf

2009, *UNISDR Terminology on Disaster Risk Reduction*, http://www.unisdr.org/we/inform/terminology

United Nations Environment Programme (UNEP) 2013, *Global Risk Data Platform*, http://preview.grid.unep.ch/

United Nations Office for Disaster Risk Reduction (UNISDR) 2001, *Establishment of an Advisory Scientific and Technical Group for the ISDR*, http://www.unisdr.org/files/8152_EstablishmentofASTG2001.pdf

2007, *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*, http://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf

2013a, *Global Assessment Report*, http://www.unisdr.org/we/inform/gar

2013b, *Members of the UNISDR Scientific and Technical Advisory Group (STAG),* http://www.preventionweb.net/files/workspace/7935_scientifictechnicaladvisorygrouplis[1].pdf

2014a, *PreventionWeb*, http://www.preventionweb.net/english/themes/

2014b, *What we do*, http://www.unisdr.org/we

(n.d.), *DesInventar*, http://www.desinventar.net/index_www.html

United States Government 2009a, *Memorandum of the Heads of Executive Departments and Agencies: Open Government Directive*, http://www.whitehouse.gov/open/documents/open-government-directive

2009b, *Memorandum for the Heads of Executive Departments and Agencies: Transparency and Open Government*, http://www.whitehouse.gov/the_press_office/TransparencyandOpenGovernment/

University of Melbourne 2011, *Beyond Bushfires, a study into community resilience and recovery*. Retrieved from http://newsroom.melbourne.edu/news/n-696

U.S. Geological Survey (USGS) 2014, *About USGS*, http://www.usgs.gov/aboutusgs/

Webb RJ & Beh J 2013, *Leading adaptation practices and support strategies for Australia: an international and Australian review of products and tools*, National Climate Change Adaptation Research Facility, Gold Coast.

World Health Organisation (WHO) 2014, *Collaborating centres*, http://www.who.int/collaboratingcentres/en/

The feedback and information provided during consultations has been an invaluable resource in putting together this report. We would like to sincerely thank the following organisations and the individuals representing them for sharing their insights and knowledge throughout the consultation process:

- Attorney-General's Department
- Australian Red Cross
- Australian Building Codes Board
- BT Financial Group
- Bushfire and Natural Hazards CRC
- Climate Risk
- CSIRO (Digital Productivity Flagship and the Climate Change Adaptation Flagship)
- Deloitte Analytics
- Deloitte Actuaries & Consultants
- Deloitte Local Government
- Deloitte Sustainability
- Floodplain Management Association
- Geoscience Australia
- Green Cross
- Insurance Australia Group
- Insurance Council of Australia
- Investa Property Group
- James Cook University, Cyclone Testing Centre
- Land and Property Information, NSW
- Lend Lease
- Munich Re
- National Climate Change Adaptation Research Facility
- Optus
- Property Council of Australia
- Regional Australia Institute
- Risk Frontiers
- Sirca
- University of NSW (ADFA)
- University of Technology Sydney
- Westpac.

Appendix A: Building our nation's resilience to natural disasters

In June 2013, the paper, *'Building our Nation's Resilience to Natural Disasters'*, was released by Deloitte Access Economics in conjunction with the *Australian Business Roundtable for Disaster Resilience and Safer Communities*.

The paper highlighted the need for a new approach to investment in pre-disaster resilience across Australia to reduce the economic costs, relieve long-term pressures on government budgets and, most importantly, minimise the longer-term social and psychological impacts of natural disasters.

This appendix summarises the findings of the paper, focusing on particular areas of relevance for this report.

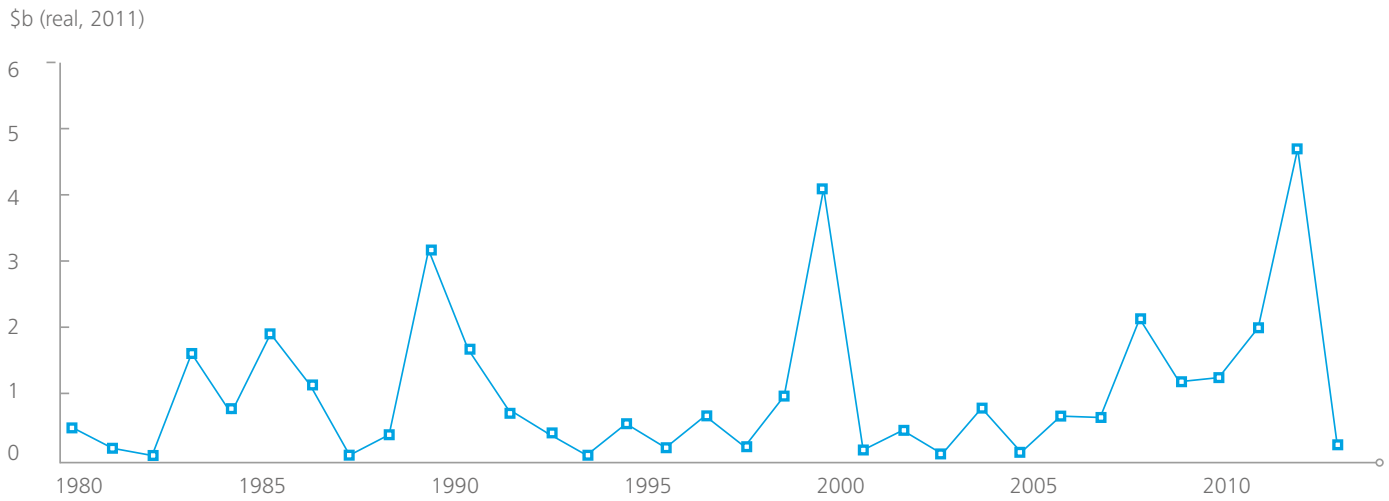
Disaster risks in Australia

Australian communities are exposed to a wide range of natural disasters, including storms, cyclones, floods, bushfires and earthquakes. These disasters have devastating impacts including damage to homes, critical infrastructure and the natural environment, the loss of human life, injury and longer-term social, community and psychological costs.

Between 1967 and 2012, Australia experienced an average of at least four major natural disasters per year where the insured loss exceeded $10 million (Insurance Council of Australia, 2013). In addition, there have been numerous smaller-scale disasters with equally devastating local consequences. Chart A.1 illustrates the extent of insured losses from natural disasters in Australia between 1980 and 2012.

It is important to recognise that these losses only represent a proportion of the total economic costs of natural disasters. In addition to insured losses, total economic costs incorporate the cost of damage to uninsured property and infrastructure, costs of emergency response and intangible costs such as death, injury, relocation and stress. Historically, it has been estimated that total costs are between two and five times greater than insured costs alone for most types of disaster (BTE, 2001).

Chart A.1: Insured costs of natural disasters ($bn), 1980-2012



Source: Insurance Council of Australia (2013)

Furthermore, these costs are expected to rise as a result of continued population growth, concentrated infrastructure density and migration to vulnerable regions. While the current annual total economic cost of natural disasters is around $6.3 billion, on average, it is expected that this annual cost will double by 2030 and reach $23 billion in real terms by 2050, as illustrated in Chart A.2. These forecasts do not reflect any expected increase or shift in the currently observed level and severity of disasters that might be caused by climate change.

These rising costs have significant financial implications for all levels of government, regarding the cost of recovery, particularly through the Natural Disaster Relief and Recovery Arrangements. Using historical data, Deloitte Access Economics estimates that the Australian and state governments currently face average annual real costs of natural disasters of $700 million per year, around 11% of total economic costs. It is estimated that 80% of government expenditure is outlaid by the Australian Government.

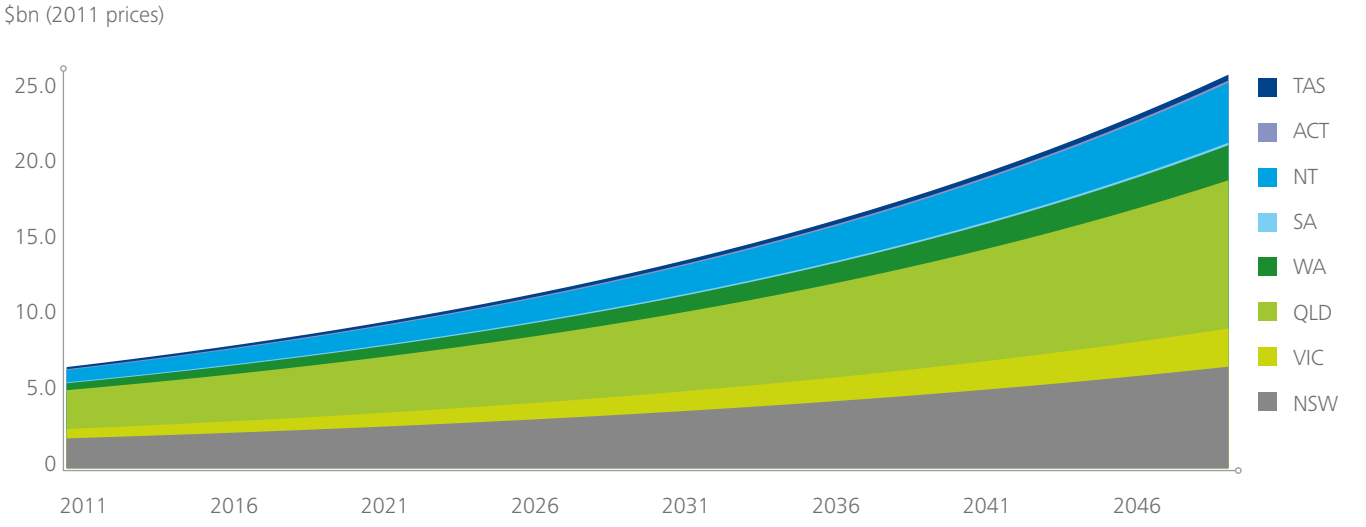
Based on this forecast of total economic costs, it is expected that governments will eventually face an annual cost of around $2.3 billion in real terms, as illustrated in Chart A.3 on page 86.

Overall, the expected future cost of natural disasters clearly highlights the need for governments to place a greater emphasis on improving Australia's resilience. Where pre-disaster investments are prioritised towards cost-effective resilience initiatives, substantial reductions in government expenditure on response initiatives can be achieved. This will rely on access to accurate, consistent data and on findings from targeted research programs, which provide essential evidence for determining the cost effectiveness of resilience options.

Adaptation and mitigation in Australia

Having quantified ongoing expenditure on natural disaster response efforts in Australia, the next component of the analysis reviewed the policy framework and allocation of roles and responsibilities in disaster management.

Chart A.2: Forecast total economic cost of natural disasters ($bn), 2011 – 2050



Source: Deloitte Access Economins (2013)

The core Australian Government policy on natural disaster management is the National Strategy for Disaster Resilience (NSDR) (Council of Australian Governments (COAG), 2011). The strategy builds on the COAG agreement in 2009 to adopt a whole-of-nation approach to disaster resilience and management. Recognising the importance of co-ordination and cooperation between stakeholders, the NSDR clearly acknowledges the roles of businesses, community organisations and individuals, as well as government.

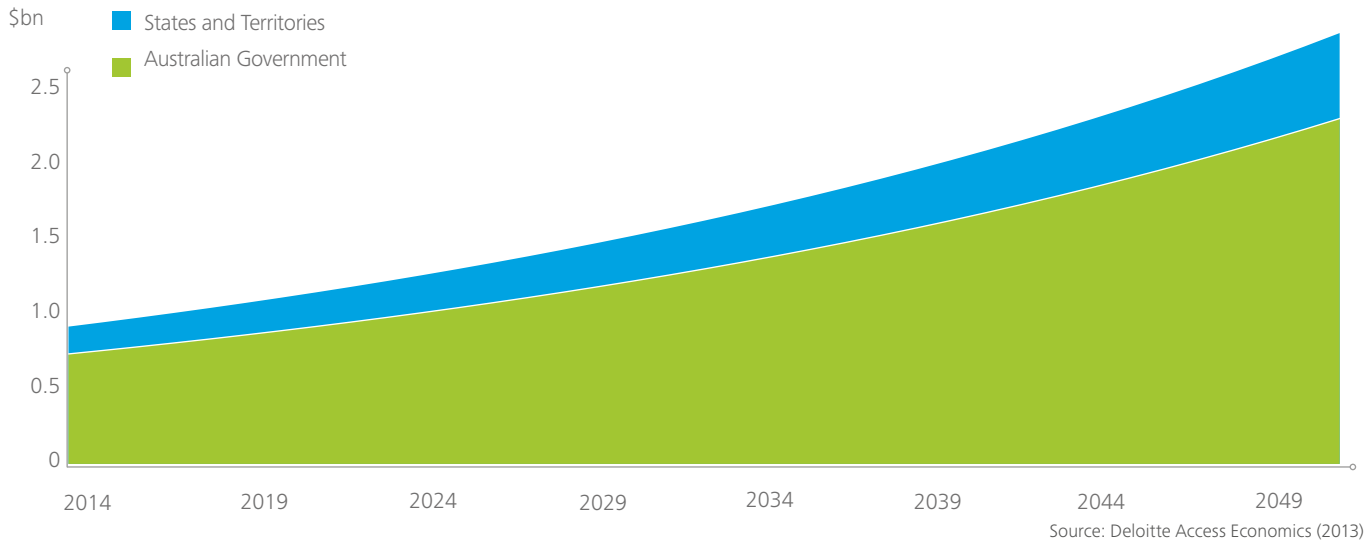
Similarly, the notion of shared responsibility for building resilience against natural disasters was recognised in a 'statement of common understanding' adopted by the COAG Select Council on Climate Change (SCCC) in 2012 (SCCC, 2012). The key roles and responsibilities from this document are outlined in Box A1 on page 87.

Notably, the document highlights the importance of best practice research as a foundation for decision-making, and the role of government in providing the best available risk information, in an accessible and useable way, in order to facilitate adaptation by the private sector.

Flowing from these roles and responsibilities, governments, businesses, communities and individuals are all involved in natural disaster adaptation and mitigation activities. Interactions between all levels of government take place through the COAG Responding to Disasters agenda, through the Standing Council on Policy and Emergency Management and the Australia New Zealand Emergency Management Committee. That said, there are also elements of pre-disaster resilience that reside within the remaining COAG reform agendas.

For example, the Critical Infrastructure Resilience Strategy, published in 2010, provides an example of how businesses, governments and communities have successfully worked together to reduce the exposure of Australian communities to risks posed by natural disasters. The strategy focuses on developing a process to improve resilience for physical facilities, supply chains, information technologies and communications networks, the loss of which would have significant impacts on the wellbeing of Australian communities (Australian Government – Attorney General's Department, 2010). This approach is targeting ways to improve resilience, allowing for greater operational sustainability and business continuity in the aftermath of future disasters. A comprehensive review of the effectiveness of the strategy is due in 2015.

Chart A.3: Forecast annual cost to governments of natural disasters ($bn), 2011 - 2050



Source: Deloitte Access Economics (2013)

Box A1: Guiding principles for allocation of roles and responsibilities for climate change risk

The COAG Select Council on Climate Change 'statement of common understanding' highlights the need for different stakeholders to share responsibility for climate change risks. In particular:

- Building resilience should be assigned to those most appropriate to respond to local conditions. This will favour local initiatives and private responsibility where resilience has no external effects on third parties. That is, private parties will continue to take responsibility for their own actions, assets, investments and risks.
- Governments should respond to market failures and regulatory failures that prevent effective and efficient natural disaster risk management, focusing on:
  - Providing best available information about risks to facilitate adaptation by the private sector and making information accessible and useable
  - Ensuring that regulations, markets and institutions promote effective private risk management
  - Managing risks to public goods/assets and government service delivery
  - Taking account of disaster risk in policy and planning
  - Helping build capacity and resilience, where required, particularly to assist vulnerable individuals, groups, regions and communities.
- Decision-making should:
  - Be based on the best available research
  - Be cost-effective
  - Be regularly reviewed to meet changing circumstances
  - Enhance social inclusion.

Source: SCCC (2012)

The core responsibility for driving the implementation of the NSDR sits within the Attorney General's Department. Resilience activities are spread across a range of government departments and bodies, reflecting the importance of resilience within the broader policies. The activities of the Australian Government are supported by the states and territories, local governments, businesses, communities and individuals. Collectively, there is a great deal of valuable activity being undertaken in Australia to increase resilience against disasters.

However, there is a lack of co-ordination across these sectors, with the resilience agenda primarily resting within a traditional emergency management policy focus. Accordingly, the majority of funding for the management of natural disasters in Australia is concentrated on post-disaster relief and recovery activities, with much less allocated to pre-disaster resilience efforts. As described by the Productivity Commission:

"Broader emergency management arrangements may not be achieving the right balance between government expenditure on disaster prevention and expenditure on recovery. There appears to be an inadequate focus on preventing damages from natural disasters." (Productivity Commission, 2012:241)

This issue has now been made the focus of a new Productivity Commission Inquiry. The inquiry is examining the full scope of national expenditure on disasters, and the effectiveness of current mitigation support arrangements.

Deloitte Access Economics estimates that the Australian Government consistently spends around $50 million per annum on pre-disaster resilience, and around $560 million on relief and recovery – a 1:10 ratio. If no action is taken to reduce this disparity, this gap will widen as the costs of natural disasters increase.

This paper considers the opportunity for co-ordinating data provision and research to increase the efficiency of resilience investments, directing funds towards mitigation activities that will achieve the greatest returns. This will reduce the substantial costs associated with disaster relief and recovery, in terms of asset re-construction, the loss of human life and long-term physical and psychological trauma.

The case for resilience

In order to illustrate how investments in resilience could generate net benefits for Australian communities, indicative cost-benefit analyses for different types of resilience activities were undertaken through three case studies.

Overall, it was found that:

- A program focusing on building more resilient new houses in high cyclone-risk areas of South-East Queensland would reduce the risk of cyclone-related damage for these houses by around two thirds, and generate a benefit-cost ratio (BCR) of up to 3.0. Existing houses are particularly challenging to retrofit but the BCR of retrofits approaches 1.0 in high-risk areas.
- Raising the Warragamba Dam wall by 23 metres would reduce annualised average flood costs by around three quarters and generate a BCR of between 2.2 and 8.5. This would result in a reduction in the present value of flood costs between 2013 and 2050 from $4.1 billion to $1.1 billion, a saving of some $3.0 billion.
- Building more resilient housing in high-risk bushfire areas generates a BCR of around 1.4; improved vegetation management results in a BCR of around 1.3; and undergrounding electricity wires results in a BCR of around 3.1.

These examples demonstrate that practical resilience measures, which target high-risk locations using appropriate combinations of infrastructure, policy and procedure, have the potential to generate economic benefits. Furthermore, the case studies highlight the importance of access to comprehensive information on disaster risk and the effectiveness of adaptation strategies as part of the cost-benefit analysis process. As noted in the report:

"A national strategy to improve resilience needs to find ways to better co-ordinate relevant data held by all parts of government and business so that decisions can be made on the best available information." (2013:51)

Accordingly, the *Australian Business Roundtable for Disaster Resilience and Safer Communities* commissioned Deloitte Access Economics to prepare this report on natural data and research in Australia.

Brisbane River Flood Map, Queensland 2012

Appendix B: International approaches to natural disaster data and research

To inform the assessment of the Australian approach to natural disaster research, this appendix:

- Describes international involvement in natural disaster data and research, focusing on the roles of the United Nations (UN), The World Bank and the Organisation for Economic Co-operation and Development (OECD)
- Reviews examples of research co-ordination at the national level, considering natural disaster research in New Zealand and the United States.

International approaches

It is useful to understand the international policy frameworks that deal with natural disasters, the role that different international organisations play in natural disaster research and mitigation, and how they interact.

While there are many initiatives operating on a global scale, in this section focuses on the UN, The World Bank and the OECD, taking into consideration their policy frameworks and the nature of their involvement in natural disaster data and research.

United Nations

Policy framework

In December 1999, the UN General Assembly adopted the International Strategy for Disaster Reduction, and established the UN Office for Disaster Risk Reduction (UNISDR) to ensure its implementation. This policy embodied an important shift in management of natural disaster risks, promoting a transition away from 'response' to 'reduction'. As described by the then UN Secretary-General, Kofi Annan at the International Conference Centre of Geneva,

"We must, above all, shift from a culture of reaction to a culture of prevention. Prevention is not only more humane than cure; it is also much cheaper... Above all, let us not forget that disaster prevention is a moral imperative, no less than reducing the risks of war." (UN, 1999)

Since then, the UNISDR has played a lead role in co-ordinating international efforts to improve the level of resilience to natural disasters globally. Reflecting its mandate for collective action that recognises local needs, the UNISDR has established global, regional and national platforms for disaster risk reduction.

At the 2nd World Conference on Disaster Reduction in 2005, arranged by the UNISDR, the current primary international agreement for disaster reduction, the Hyogo Framework for Action 2005-2015, was adopted by 168 countries.

The Framework, which was endorsed by the UN General Assembly later in 2005 (UN, 2005), sets out a 10-year plan for strengthening resilience to natural disasters and highlighting five priority actions, one of which relates to the identification and monitoring of disaster risks and the role for both ongoing research and accurate underlying data.

This may include the collection and exchange of statistical information on disaster occurrence, impact and losses, the development of common methodologies and research capabilities to analyse natural disasters, assess risk (including the development of risk maps) and forecast natural disasters and the improvement of monitoring and early warning.

This reinforces the argument that successful mitigation action relies on high quality data and research. The continued need for science to form a key part of the post-2015 Hyogo Framework for Action has been highlighted by the UN (Southgate et al., 2013).

Involvement in natural disaster data and research

The critical need for science and technology as an input to implementing the International Strategy for Disaster Reduction has been long recognised by the UNISDR (UNISDR, 2001). In order to facilitate greater involvement of the scientific, technical and academic communities in the formulation and implementation of disaster reduction strategies, the UNISDR established a Scientific and Technical Advisory Group. The group currently consists of representatives from national agencies, including Dr John Schneider from Geoscience Australia, and international organisations such as the World Health Organisation (UNISDR, 2013b).

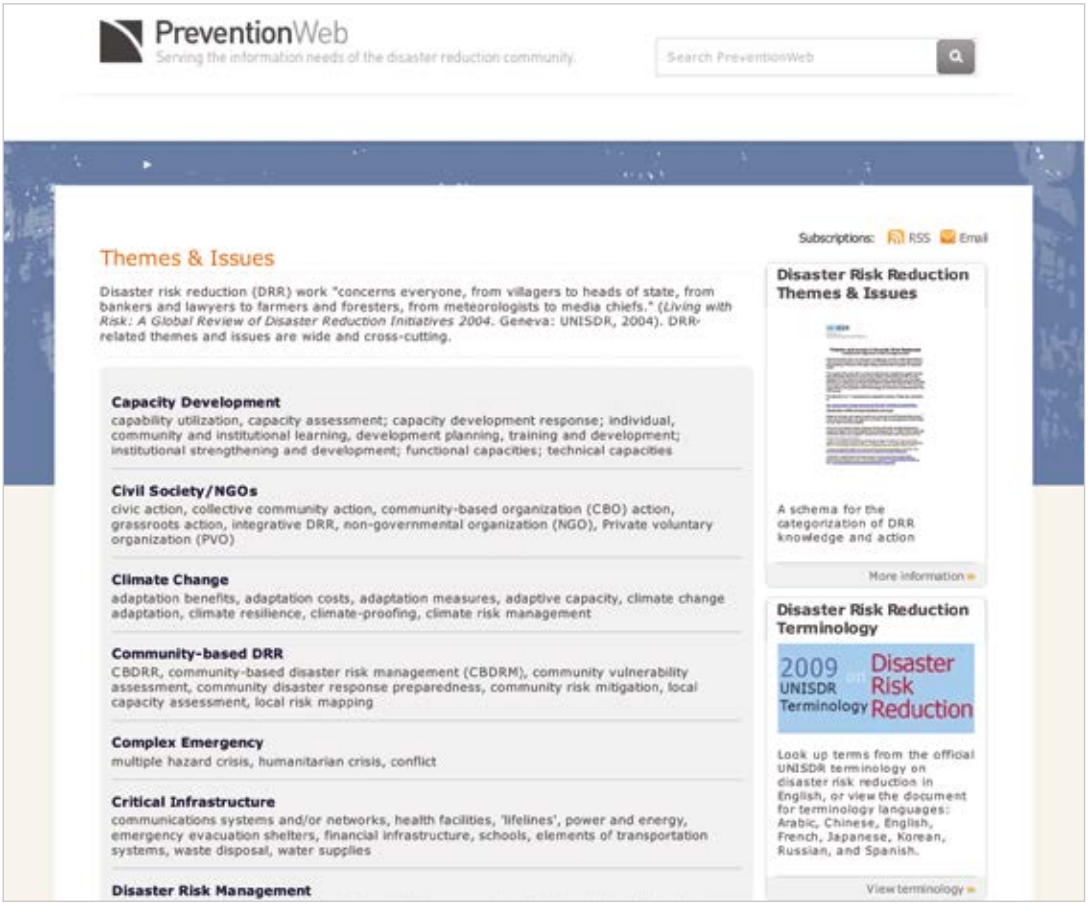
Given its broad mandate to support disaster risk reduction, the activities that UNISDR undertakes are broad, encompassing roles in co-ordination, campaigning, advocacy and the provision of information (UNISDR, 2014b).

Focusing on data and research, the main areas of involvement for UNISDR, outlined in Table B.2 include:

- **Disaster risk and loss databases:** UNISDR provides support to countries to assist with the development of disaster loss databases, and works with a number of partners to promote data sharing
- **Administration of online platform:** UNISDR administers PreventionWeb, a platform for disaster reduction knowledge management (see Figure B.1)
- **Global Assessment Report:** biennial global assessment of disaster risk reduction; analysis of natural hazards affecting humanity
- **Support for research partnerships and programs:** e.g. through the Integrated Research on Disaster Risk Programme.

These activities largely reflect the responsibilities of international organisations as envisaged in the Hyogo Framework. In particular, the Framework highlights the need for international co-ordination to support globally consistent data collection and forecasting on natural hazards, vulnerabilities, risks and disaster impacts at all scales, leveraging off existing networks and platforms.

Figure B.1: UNISDR's PreventionWeb



Source: UNISDR (2014a)

Table B.2: UNISDR natural disaster data and research initiatives

Areas of UNISDR involvement	Initiative	Organisations involved	Description of initiative & intended outputs	Format of outputs	Level of information sharing
Disaster risk and loss databases	DesInventar	Project of LA RED (the Network of Social Studies on Disaster Prevention in Latin America). UNISDR is the host and main sponsor. Also involves UN, NGOs, Government agencies, universities and private sector.	Database with information on disaster losses in 29 countries across North, Central and South America, the Caribbean, Asia and the South Pacific. Provides access to time series data on types of disaster events, causes, human impacts and economic losses, across geographies.	Data; outputs include tables, graphics, thematic maps	Free, open source
	EM-DAT: The International Disaster Database	Centre for Research on the Epidemiology of Disasters – University of Louvain, Belgium, International Federation of Red Cross and Red Crescent Societies and US Agency for International Development.	Independent database with information on the human impact of disasters, disaster-related economic damage estimates and disaster-specific international aid contributions. Data compiled from various sources, including UN agencies, non-governmental organisations, insurance companies, research institutes and press agencies.	Data	Free, open source
	PREVIEW Global Risk Data Platform	Created and hosted by UNEP/GRID-Geneva. Supported by UNISDR.	Share spatial data on global risk from natural hazards. Users can visualise, download or extract data on past hazardous events, human & economical hazard exposure and risk from natural hazards.	Data	Free, for non-commercial purposes
Online platform	PreventionWeb	UNISDR project, supported by technical and design advisory group consisting of representatives from UNISDR and strategic/visual designers and advisors.	Participatory web platform online platform for disaster reduction knowledge management. Users include representatives from NGOs, government departments, education and research institutions, private sector businesses, independent experts.	Online platform with access to data, research reports, policy documents	Free to access and upload content
Reports	Global Assessment Report	UN agencies, governments, academic and research institutions, donors, technical organisations/specialists. Advisory Board acts as an independent and strategic advisory body.	Biennial global assessment of disaster risk reduction; analysis of natural hazards affecting humanity. Monitors risk patterns/trends and progress in disaster risk reduction and provides strategic policy guidance.	Report on risks and strategic approaches for government	Free to download, including links to data
Support for research partnerships and programs	Integrated Research on Disaster Risk Programme	Sponsored by International Council of Science in partnership with the International Social Science Council and UNISDR. Governed by Working Groups, Scientific Committee.	Interdisciplinary research program seeking to address the challenges brought by natural hazard events, mitigate their impacts, and improve related policy-making mechanisms. Information provision: characterisation of hazards/risk, understanding decision-making in complex and changing risk contexts and reducing risk and curbing losses.	Research projects, annual conference	Somewhat restricted

Source: BNHCRC (2014)

The examples in Table B.2 on page 91 also illustrate the ways in which UNISDR works with a range of stakeholders to support data provision and research. As described at the establishment of the UNISDR Scientific and Technical Advisory Group,

"Successful longer-term prevention strategies must be based on cross-sectoral and interdisciplinary co-operation involving the scientific community, national and local governments, NGO's, the private sector, as well as the organisations and agencies of the UN system" (UNISDR, 2001).

This notion is reflected in the activities of other UN agencies, such as the UN Environment Programme (UNEP). For example, the Principles for Sustainable Insurance Initiative (part of the United Nations Environment Programme Finance Initiative) is conducting the Global Resilience Project. Including a broad range of insurers across many markets, its aim is to deepen understanding of disaster risk reduction globally, identify the social and economic cost of disasters and use this information to help governments and communities mitigate their risk.

As part of the first phase, the project researched over 300 sources to assess the effectiveness of behavioural, structural and ecosystem risk reduction measures for the hazards of cyclone, earthquake and flood.

Alongside the UNEP, the UN Educational, Scientific and Cultural Organisation (UNESCO) and the UN University (UNU) are involved in the broader Science and Technology Alliance for Global Sustainability. Among other roles, this partnership of international organisation sponsors Future Earth, a collaborative research platform on global sustainability, launched in 2012. Through the platform, research projects are undertaken in relation to sustainability issues, including natural disasters. The platform reflects an international call for an integrative, international and solutions-oriented approach to research that involves a range of stakeholders (Future Earth, n.d.).

The World Bank

Policy framework

As part of its role in providing financial and technical assistance to developing countries, The World Bank supports the International Strategy for Disaster Reduction and participates in the implementation of the Hyogo Framework for Action (The World Bank, 2013).

The Bank's efforts in this regard are primarily directed through the Global Facility for Disaster Reduction and Recovery (GFDRR), a partnership of 41 countries and eight international organisations, established in 2006. The GFDRR's mission is to incorporate disaster risk reduction and climate change adaptation within development strategies, by supporting the implementation of the Hyogo Framework for Action at the national level (GFDRR, 2014a).

Involvement in natural disaster data and research

The activities of the GFDRR are categorised into one of three business lines, relating to the development of global and regional partnerships, mainstreaming risk reduction in development and assisting with sustainable recovery (GFDRR, 2014e). Accordingly, the GFDRR has a natural involvement in the development of research inputs necessary for those activities.

Since 2010, the GFDRR has also administered the GFDRR Labs, in order to encourage the use of science, technology and innovation to empower decision-makers in developing countries to improve their resilience (GFDRR, 2014f). The work of the Labs supports the use of open data and open source technology at the local level to improve decision-making. The Labs engage with developing countries through:

- The Open Data for Resilience Initiative (OpenDRI) – facilitating the development of free, open source data and software
- Real-time disaster mapping support and damage assessment validation
- The Understanding Risk Community
- Participation in open development partnerships
- Provision of regional technical assistance.

Beyond these activities, the GFDRR provides free access to documents and details of projects, experts and knowledge events through its online Knowledge Center (GFDRR, 2014b). The GFDRR also supports research activities related to disaster risk management by Bank staff. For example, the GFDRR supported a cost-benefit analysis on disaster risk reduction in developing countries, undertaken by the Bank's East Asia and Pacific Disaster Risk Management Team (KC, 2013).

Organisation for Economic Co-operation and Development (OECD)

Policy framework

The OECD is a partnership of 34 countries, focused on promoting policies to improve global economic and social well-being. Established in 1961, the activities of the OECD are focused on data collection, analysis, discussions, decision-making, implementation and evaluation, across the full spectrum of economic and social policy (OECD, 2014c).

Involvement in natural disaster data and research

While the OECD is involved in the provision of data and analysis to aid policy development, only a small proportion of its research activities relate to natural disasters. Nevertheless, the online iLibrary database provides access to copies of articles, working papers, chapters and books published by the OECD related to natural disasters (OECD, 2014a).

Perhaps the most significant contribution of the OECD towards natural disaster research is in facilitating discussions between global stakeholders, through its International Network on the Financial Management of Large-scale Catastrophes. This network was established by the OECD in recognition of the substantial costs of natural disasters and the need for a proactive, co-ordinated approach involving both the public and private sector (2014b). It is guided by a High Level Advisory Board of 18 representatives from governments, academia and the private sector. The role of the Board is to provide intellectual leadership through advice on the content of the Network and priorities for research, analysis and public initiatives.

This example again highlights the importance of information sharing and co-ordination among policy makers, researchers and business, and illustrates that forums can be a useful means through which the establishment and prioritisation of research initiatives can take place.

National approaches

In addition to the international initiatives, it is also useful to consider how research models are employed at the national level, to help identify arrangements that might be replicated for the context of natural disaster information in Australia.

This section reviews:

- Natural disaster research in New Zealand
- Natural disaster research in the United States.

Acknowledging the different political structures in place in New Zealand and the United States, these examples begin with a description of the policy framework within which the agenda for greater resilience against natural disasters sits.

Natural disaster research in New Zealand

Policy framework

The guiding policy for improving resilience against natural disasters in New Zealand is the National Civil Defence Emergency Management (CDEM) Strategy. Forming part of a broader CDEM Framework, the National CDEM Strategy requires a comprehensive approach to hazards, encompassing the four key elements of Reduction, Readiness, Response and Recovery (Ministry of Civil Defence and Emergency Management (MCDEM), 2007).

The vision of the strategy is to achieve a 'Resilient New Zealand', in which communities are able to understand and manage their exposure to hazards (2007:1). The responsibility for carrying out the strategy is shared among all New Zealanders, including central government agencies, local authorities, emergency services, lifeline utilities, infrastructure providers, businesses and individuals. Responsibility for CDEM lies with the relevant Ministry, MCDEM.

Approach to data and research

The importance of research is clearly acknowledged within the New Zealand policy framework, with the MCDEM noting that "developing effective CDEM arrangements requires a robust evidence base, derived from sound research" (MCDEM, 2014). Accordingly, MCDEM is involved in clarifying research priorities, encouraging integrated research and improving the accessibility and delivery of research outputs.

To guide and deliver the prioritisation of funding for research into natural disasters, the Natural Hazards Research Platform (NHRP) was established in 2009. Approximately NZ$17 million in funding each year is invested through the platform by the Ministry of Business, Innovation and Employment (NHRP, 2013). The main objectives of the platform are to provide secure, long-term funding for natural hazard research and to help research providers and end users work more closely together (NHRP, 2013).

The NHRP is led by GNS Science, and is co-anchored by the National Institute of Water and Atmospheric Research (NIWA), both government-owned companies classified as Crown research institutes. Other partners of the NHRP include the University of Canterbury, Massey University, University of Auckland and Opus Research, an independent research facility. Additional research groups from academia, consultancies and overseas bodies are also involved in the NHRP as sub-contractors. The core partners to the Platform form a Management Group, which is also supported by a Strategic Advisory Group consisting of end users, and a Technical Advisory Group comprising of international scientists.

The prioritisation of funding to research projects is guided by a research strategy, the latest of which was published in 2010. While a revised strategy for 2014-2018 is under development, the current strategy identifies six guiding principles, and five themes for research activities, as described in Section 5.3.

While a large proportion of NHRP funding is distributed to its anchor companies and partners for individual research projects, one example of a collaboration that has been funded is Resilient Organisations (Resilient Organisations Research Programme, 2012). This is a research and industry collaboration, involving the University of Canterbury and University of Auckland, among other institutions.

Beyond the Natural Hazards Research Platform, a number of institutions are also involved in collaborative research activities. For example, GNS Science earns 15-20% of its revenue from monitoring geological hazards for the New Zealand Earthquake Commission, and has partnerships with research institutes in Australia, Europe, Asia and the US (GNS Science, 2014). Furthermore, through the Joint Centre for Disaster Research GNS Science has a partnership with Massey University.

The Centre has recently become involved in the Integrated Research on Disaster Risk Programme described in Table B.2 on page 91, co-ordinating the International Centre of Excellence in Community Resilience (Massey University, 2014a).

Natural disaster research in the United States

Policy framework

The US approach to the management of hazards, including natural disasters, is guided by Presidential Policy Directive / PPD-8: National Preparedness, released by President Obama in March 2011 (Department of Homeland Security (DHS), 2011b). The policy sets out a 'whole of community' approach to building resilience, calling for the development of a National Preparedness Goal, and a series of implementation frameworks and plans (Federal Emergency Management Agency (FEMA), 2014b). While there are roles for numerous government agencies in facilitating broader community involvement in the delivery of the policy directive, overall co-ordination is undertaken by the DHS, through FEMA.

The main components of the policy framework developed out of PPD-8 are the:

- National Preparedness Goal – specifies the primary objective of preparedness activities and the core capabilities required to achieve it
- National Preparedness System – outlines a six-part process for achieving the National Preparedness Goal
- National Planning Frameworks – describes the process for whole of community involvement in prevention, protection, mitigation, response and recovery.

This framework recognises the importance of research and information sharing for improved resilience to hazards. In particular, 'research and development' is identified as one of the four ongoing requirements to build and sustain preparedness (FEMA, 2014). In addition, 'intelligence and information sharing', 'risk and disaster resilience assessment' and 'threats and hazard identification' are listed among the 31 core capabilities necessary to achieve the National Preparedness Goal, encompassing the mission areas of prevention, protection and mitigation (DHS, 2011a).

As described in the National Mitigation Framework:

"All levels of public and private entities have a role in community resilience and sustainability … This is complemented by research, development, and investment—the basis of new and improved long-term vulnerability reduction capabilities—making these investments an increasingly effective, cost-efficient, and sustainable approach to building resilience." (DHS, 2013)

Approach to data and research

The organisation of natural disaster data and research in the US embodies the principle of shared responsibility for preparedness across the community that is central to the policy context described above. Government agencies, academia and the private sector each participate in the collection of data and research activities, on both an individual and collaborative basis.

Within Government, involvement in natural disaster data and research is distributed broadly across bodies within the Department of Homeland Security, Department of Commerce and the Department of the Interior, as well as independent agencies such as the National Science Foundation and the National Aeronautics and Space Administration. Many of these agencies are involved in the collection and provision of data, undertake research projects, and participate in collaborative partnerships, as summarised in Table B.3.

In addition, academia and, to a lesser extent, businesses in the private sector make a critical contribution to the collection of data and analysis of issues related to natural disasters in the US. While it is not practical to list all of those institutions, a few examples include the Natural Hazards Center hosted by the University of Colorado, the National Earthquake Hazards Reduction Program and the Insurance Institute for Business & Home Safety Research Center.

Table B.3: US Government involvement in natural disaster data and research

Government body	Examples of roles
Department of Homeland Security – Science and Technology Directorate	• Manages science and technology research for the operational components of the DHS • Undertakes research projects through the Resilient Systems Division of the Homeland Security Advanced Research Projects Agency • Facilitates research partnerships, e.g. Coastal Hazards Center of Excellence.
Department of Homeland Security – Federal Emergency Management Agency	• Provision of data – Flood Insurance Rate Maps and Hazus tool for estimating the potential losses. (Hazus is a geographic information system based natural hazard loss estimation software package developed and freely distributed by the FEMA) • Involvement in research partnerships, e.g. National Earthquake Hazards Reduction Program.
Department of Commerce – National Institute of Standards and Technology	• Undertaking and reporting on research projects through the Building and Fire Research Platform • Involvement in research partnerships, e.g. Lead agency of the National Earthquake Hazards Reduction Program.
Department of Commerce – National Oceanic and Atmospheric Administration	• Provision of data – National Environmental Satellite, Data and Information Service • Undertaking research, e.g. NOAA Centre for Tsunami Research • Involvement in research partnerships, e.g. Coastal and Inland Flooding Observation and Warning Project.
Department of the Interior – US Geological Survey	• Provision of data and maps • Undertaking research, e.g. Landslides Hazards Program • Involvement in research partnerships, e.g. National Earthquake Hazards Reduction Program.
Independent agency – National Science Foundation	• Provision of data and maps • Facilitation of research – accounting for around 25% of federal support to academic institutions for basic research • Involvement in research partnerships, e.g. National Earthquake Hazards Reduction Program, and support for data infrastructure e.g. DataNet program.
Independent agency – National Aeronautics and Space Administration	• Provision of data, e.g. Earth Observatory, images and data on hurricanes and tropical cyclones • Undertaking research, e.g. Genesis and Rapid Intensification Processes experiment.

Appendix C: Natural disaster research in Australia

Natural disaster research is conducted across all levels of government and across a range of research institutions and universities.

Australian Government

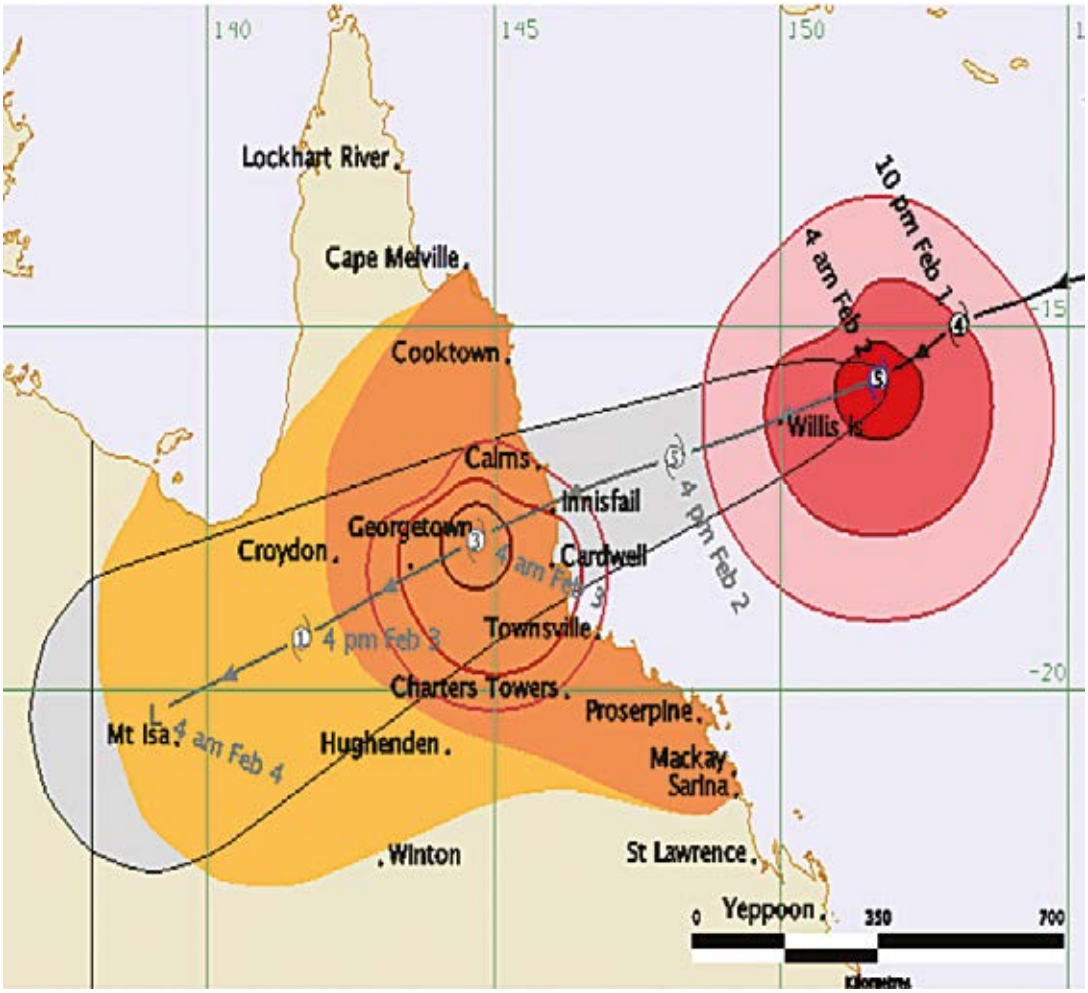
CSIRO

The Centre for Australian Weather and Climate Research (CAWCR) is a partnership between CSIRO and the Bureau of Meteorology to conduct research into areas including weather prediction, hazard prediction and warnings and responses to weather and climate related health hazards.

Research within CAWCR has helped develop a weather forecasting system, ACCESS, which has delivered a ten-fold improvement in weather forecasting over the past five years. ACCESS accurately predicted the path and intensity of Tropical Cyclone Yasi in 2011, five days before the cyclone hit the Queensland coast, which enabled detailed emergency response planning.

Within the Ecosystem Sciences division, a national bushfire research testing system has been developed, CSIRO Pyroton. The facility is open to researchers from around Australia and overseas and features a 25 metre long fire-proof wind tunnel. The division also conducts research into understanding the causes and impacts of flooding.

Figure C.1: Prediction of Tropical Cyclone Yasi



Source: CSIRO, BoM

The Digital Productivity and Services Flagship, launched in 2012-13 conducts research on digital technology and services for disaster management. Examples of its research are the development of computational modelling including floods and the Emergency Situation Awareness software which analyses Twitter messages to detect disaster events. The flagship is also developing a Disaster Management Decision Support Platform to equip emergency planners with information to aid their decision-making process.

The Climate Change Adaptation Flagship conducted research into a variety of topics related to natural perils, including understanding tropical cyclones, the causes and impacts of extreme heatwaves and climate vulnerability assessments. The work previously being undertaken in the Climate Change Adaptation Flagship related to natural disasters was moved to other areas within CSIRO following a significant scaling back of research activities.

Attorney-General's Department

The Attorney-General's Department provides the National Emergency Management Projects (NEMP) grant program to fund programs of work that contribute to the National Disaster Resilience Strategy. The program is a competitive process and approximately $3.6 million per year is allocated across a wide range of projects with research projects making up approximately 38% of this. Each project is reviewed by an Australia-New Zealand Emergency Management sub-committee and the Minister for Justice makes the final decision on successful applications. Research projects generally have shorter timeframes compared to other natural disaster research funding arrangements.

Under the National Partnership Agreement on Natural Disaster Resilience, funding is provided to the state and territory governments to enhance the resilience of communities against the impact of natural disasters. The agreement was established to consolidate the Bushfire Mitigation Program, Natural Disaster Mitigation Program and the National Emergency Volunteer Support Fund. Under the agreement, the state and territories then have the freedom to fund their own measures which include research projects.

The Australian Emergency Management Institute within the EMA division hosts the Australian Emergency Management Knowledge Hub which provides a clearing house of research and information useful to the emergency management sector. The institute also produces the Australian Journal of Emergency Management, which is a quarterly publication to facilitate scholarly debate in the area.

The Attorney-General's department also contributes to research by participating in the Bushfire and Natural Hazards CRC and commissioning specific natural disaster related research. Where a gap is identified, funding is procured as part of the government procurement process to fund research. The Critical Infrastructure Protection Modelling and Analysis (CIPMA) Program was also initiated and is managed by the department with Geoscience Australia and CSIRO working to construct the technical components. CIPMA identifies areas of highest risk in Australia's infrastructure and where strengthening is needed if a disaster occurred.

Geoscience Australia

Geoscience Australia produces earthquake hazard maps which are used as inputs for research as well as by insurance companies in developing risk models. A number of applications for use by researchers are also made available including a landslide search, earthquake mapping tool, Australian flood studies database and the Sentinel bushfire mapping application.

The government committed $12 million over four years for Geoscience Australia to establish the National Flood Risk Information Project as part of its response to the Natural Disaster Insurance Review in November 2011. According to the National Guidelines for the National Flood Risk Information Program, "the 4-year Project will aim to improve the quality, availability and accessibility of flood information in Australia, enhancing community awareness of the flood risks they face and creating opportunities to improve and better inform decision-making in a wide range of areas including emergency management, land use planning and insurance" (Attorney-General's Department, 2012).

The Australian National University (ANU) and Geoscience Australia collaboratively developed ANUGA, a free and open source software package capable of modelling the impact of hydrological disasters such as dam breaks, riverine flooding, storm surge and tsunamis. The modelling results can be used to guide land use planning and the development of evacuation plans by local councils. The software has been used in Western Australia to understand tsunami risk with the results being utilised by emergency managers.

Geoscience Australia has also developed computational models in the earthquake and tropical cyclone areas to analyse risks and impacts. The Earthquake Risk Model was developed to estimate the impacts on communities from earthquakes and formed the basis for reports on earthquake risk in the Newcastle and Perth regions. The Tropical Cyclone Risk Model simulates the impact of tropical cyclone events on a community and can determine the annual probability of cyclonic winds. The Earthquake Risk and Tropical Cyclone Risk Models are open-source software applications allowing the results to be tested or modified independently.

Bureau of Meteorology

The Bureau of Meteorology (BoM) is Australia's lead agency for providing flood forecasting and warning systems. The Water Information Research and Development Alliance is a joint research project between BoM and CSIRO to improve water forecasting and information systems. The research has led to the development of Short-Term Water Information Forecasting Tools, which generate continuous short-term forecasts seven to 10 days ahead. The alliance was funded with a total investment of $50 million over the five years from 2008 to 2013, with further investment planned between 2013 to 2016 (Bureau of Meteorology, 2013).

In 2013, the government announced $58.5 million to improve the Bureau's capacity to respond to extreme weather events and natural disasters. As part of this, a new National Centre for Extreme Weather will be established to conduct research and enhance the dissemination of information about severe weather events. A new flood forecasting system, heavy rainfall risk guidance, enhanced storm surge prediction and an integrated all-hazards decision system are to be developed as part of the centre.

The Bureau collaborates with CSIRO on the Centre for Australian Weather and Climate Research (CAWCR). The Weather and Environmental Prediction group within CAWCR is responsible for the development warning systems for severe weather with the application of the research improving emergency response for floods, bushfires and tropical cyclones. The Bureau is also a participant of the Bushfire and Natural Hazards CRC and collaborates with Geoscience Australia on the Joint Australian Tsunami Warning System.

State and Territory Governments

State and territory governments support the BNHCRC by providing funding, participating in board meetings and by engaging as end users. All states and territories contribute to the BNHCRC and are key stakeholders given their responsibility for the provision of emergency management services. Representatives are engaged as end users within the BNHCRC to refine the research focus of BNHCRC projects and allow direct access to research outputs.

The Natural Disaster Resilience Program, as part of the National Partnership Agreement on Natural Disaster Resilience, provides approximately $27 million per year to states and territories to enhance the resilience of communities against the impact of natural disasters (Attorney-General's Department, 2014). State and territory governments then use this funding to provide their own grant programs with research funding making up a portion of this. Research projects funded under this arrangement are typically smaller than ARC, CRC or NEMP funded research.

The state and territory organisations participating in the BNHCRC include:

- Department for Communities and Social Inclusion, South Australia
- Department of Environment and Primary Industries, Victoria
- Department of Environment, Water and Natural Resources, South Australia
- Department of Parks and Wildlife, Western Australia
- Department of Planning, Transport and Infrastructure, South Australia
- Department of Premier and Cabinet, South Australia
- Department of Premier and Cabinet, Tasmania

- Department of Primary Industries, Parks, Water and Environment, Tasmania
- Department of Science, Information Technology, Innovation and the Arts, Queensland
- Fire Services Commissioner, Victoria
- Office of Environment and Heritage, New South Wales
- SA Water
- Fire and Emergency Services Commission, South Australia
- Territory and Municipal Services, Australian Capital Territory
- Department of Land Resource Management, Northern Territory (through Bushfires NT).

The state and territory organisations responsible for funding NDRP projects comprise:

- ACT Emergency Services Agency
- Ministry for Police & Emergency Services, New South Wales
- Northern Territory Police, Fire and Emergency Services
- Department of Community Safety, Queensland
- SA Fire and Emergency Services Commission
- Department of Police and Emergency Management, Tasmania
- Office of the Emergency Services Commissioner, Victoria
- Department of Fire and Emergency Services, Western Australia.

As part of the National Emergency Management Projects administered by the Attorney-General's Department funds, research is funded to address problems faced by states and territories. Having a centralised funding source helps to avoid potential overlaps of research topics being funded by individual state and territory agencies separately.

State and territory governments, sometimes in combination with local councils, also directly fund research. The Queensland Floods Commission of Inquiry, for example, recommended that the Queensland Government and local councils should ensure that flood studies are conducted on areas which do not have access to flood information (Queensland Floods Commission, 2012). The Queensland Government's Statistician's office also conducted a community preparedness survey in 2013 to create a data set to be used by disaster management researchers.

Local Government

Local governments commonly fund local engineering and consulting firms to conduct flood research and mapping for their geographical area. The research is a key phase in the planning process and can have a significant bearing on the costs incurred should a flood occur. The availability and quality of flood maps is variable across different councils. Local governments also fund the research and development of hazard management plans.

Organisations such as the Floodplain Management Association (FMA) pool local council resources to conduct research and share knowledge in a more efficient way. The FMA membership is made up of 84 local councils, 14 organisations with links to flooding, as well as professional and individual members. An annual flood plain conference is held each year by the FMA with flood related researchers presenting their findings to attendees. The Australian Local Government Association (ALGA) also conducts research into natural disaster related areas for the benefit of the 560 councils it represents. The ALGA has commissioned research including a national local government emergency management survey and a report on the contribution of land use planning to natural disaster risk management.

Other organisations with local government involvement, such as the South East Queensland Fire & Biodiversity Authority Consortium, aim to conduct applied fire ecology research. The research investigates gaps in fire management and assists land managers with information. The consortium is funded by 12 separate councils as well as other stakeholders.

Research organisations

Bushfire and Natural Hazards CRC

The Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC) is focused on the following three overarching themes of research:

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

The CRC plays a matching role within the research community by assigning end user partners from across emergency management, government departments and non-government organisations. This allows relationships to be built and for the scope of research to be defined in a way that is useful for the organisations involved on the ground as well as the prioritisation of research areas.

National Climate Change Adaptation Research Facility

A portion of the research undertaken is related directly to natural disasters, with one of the thematic research priorities focused on emergency management. The emergency management research focused on the adaptation to an increased frequency and intensity of natural disasters. NCCARF also funded historical case studies of extreme events looking at the lessons learned from the management of past disasters including Cyclone Tracy and the 2008 Queensland floods.

Under phase two of the facility NCCARF will be provided with $9 million in funding over three years. The emphasis of phase two will be on developing support for local governments in the coastal zone to incorporate sea-level rise into decision-making.

Other research organisations

The CRC for Spatial Information conducts research in the natural hazard area such as a joint initiative between Geoscience Australia and the Space Policy Unit reviewing how spatial information products were used in response to the 2009 Victorian bushfires, the 2011 floods and the recent New Zealand earthquakes. The CRC has also conducted research into the relationship between the extent of physical damage from natural disasters and stress related health outcomes.

Private organisations

The Insurance Council of Australia (ICA) provides historical disaster statistics for use by insurers, reinsurers, researchers and government agencies. The ICA also funds Risk Frontiers, within Macquarie University, and Willis Re to build and maintain the National Flood Information Database (NFID). The NFID combines available government flood mapping into a format that can be analysed at an address level.

The ICA is currently developing a Data Globe database of natural hazard information and has started facilitating the Property Resilience and Exposure Program which will provide information on the resilience of housing stock as well as commission direct research in the area.

Insurance companies devote considerable resources to building natural hazard models to determine the risks associated with a specific address and the pricing of particular policies. Insurance companies also commission and sponsor research to be undertaken by organisations such as Risk Frontiers and the Cyclone Testing Station. Reinsurers regularly release studies and information relating to the global insured losses from natural catastrophes which is commonly cited in natural disaster related research.

Risk Frontiers is an independent research centre based at Macquarie University and sponsored by the insurance industry. The centre is self-funded and undertakes risk assessment and research into natural hazards, develops databases of natural hazards, as well as loss models to improve the pricing of natural hazard catastrophe risks (Risk Frontiers, 2013). Key databases enabling research include the PerilAus database, which provides a historical source of data on natural hazard impacts in Australia from European settlement.

Private consultancies and engineering firms conduct research for local governments to map hazards and assist in the land planning process. Councils regularly engage specialist hydrology engineers to conduct flood and floodplain risk management studies. Geotechnical engineers are also employed to conduct landslide hazard maps and develop models to allocate hazard ratings. Councils also fund Light Detection and Ranging (LIDAR) surveys and other satellite imagery for use in hydrologic models.

The Australian Disaster Management Platform is a collaboration between IBM and the University of Melbourne to develop new IT technologies to help manage disasters. The platform takes a multi-hazard approach to developing prediction frameworks and informing decisions. Geospatial and infrastructure information from multiple data sets are used to develop simulations of natural disasters for communication to decision-makers in the emergency management field.

Other organisations

The Australian Building Codes Board (ABCB) is responsible for the National Construction Code, which details on-site construction requirements across Australia. The Code prescribes how new buildings are currently designed and constructed to withstand extreme weather events such as cyclones, bushfires and floods. As part of these responsibilities, the ABCB conducts research to ensure building standards reflect the latest evidence in the area.

The Australian Red Cross focuses on the humanitarian aspect of natural disaster research. One of the seven priority areas identified is Emergency Services in Australia. The research conducted within the area is based on three main themes: preparedness, response and recovery. The Red Cross undertakes research by commissioning projects and engaging in research partnerships and participates in the BNHCRC as an end user.

The Regional Australia Institute conducts a research agenda that focuses on issues, including natural disasters, that affect regional areas. The institute commissioned Griffith University to undertake a series of case studies examining the economic recovery of rural communities following natural disasters in 2013 (Regional Australia Institute, 2013). The case studies led to the release of a report on the centrality of business recovery to community resilience.

A woman, evicted from her condemned home, walks along a badly-rutted road after a 6.3-magnitude earthquake devastated Christchurch, February 2011.

Limitation of our work

General use restriction

This report should not be relied on by any party other than our client. We accept no duty of care to any other person or entity for the use of this report.

Contact us

Deloitte Access Economics
ACN: 149 633 116

Level 7
225 George Street
Sydney NSW 2000
PO Box N250
Grosvenor Place NSW 1220 Australia

Tel: +61 2 9322 7110
Fax: +61 2 9322 7001

www.deloitteaccesseconomics.com.au

Deloitte Access Economics is Australia's pre-eminent economics advisory practice and a member of Deloitte's global economics group. The Directors and staff of Access Economics joined Deloitte in early 2011.

About Deloitte

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited, a UK private company limited by guarantee, and its network of member firms, each of which is a legally separate and independent entity. Please see www.deloitte.com/au/about for a detailed description of the legal structure of Deloitte Touche Tohmatsu Limited and its member firms.

Deloitte provides audit, tax, consulting, and financial advisory services to public and private clients spanning multiple industries. With a globally connected network of member firms in more than 150 countries, Deloitte brings world-class capabilities and deep local expertise to help clients succeed wherever they operate. Deloitte's approximately 200,000 professionals are committed to becoming the standard of excellence.

About Deloitte Australia

In Australia, the member firm is the Australian partnership of Deloitte Touche Tohmatsu. As one of Australia's leading professional services firms. Deloitte Touche Tohmatsu and its affiliates provide audit, tax, consulting, and financial advisory services through approximately 6,000 people across the country. Focused on the creation of value and growth, and known as an employer of choice for innovative human resources programs, we are dedicated to helping our clients and our people excel. For more information, please visit our web site at www.deloitte.com.au.

MCBD_SYD_07/14_050329