



The economic cost of the social impact of natural disasters



About the Australian Business Roundtable for Disaster Resilience & Safer Communities

The Australian Business Roundtable for Disaster Resilience & Safer Communities was formed in December 2012 by the chief executive officers (CEOs) of Australian Red Cross, Insurance Australia Group (IAG), Investa Property Group, Munich Re, Optus and Westpac Group.

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

In 2013, 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 2011 *National Strategy for Disaster Resilience* for greater collaboration between governments, businesses and communities to reduce the nation's vulnerability to natural disasters.

In 2014, the Roundtable released a second report, *Building an Open Platform for Natural Disaster Resilience Decisions*, which emphasised the need for communities, businesses and governments to have access to the latest research and accurate data to ensure safety from and resilience to natural disasters.

This new report, along with a second report, *Building Resilient Infrastructure*, builds on the reports from 2013 and 2014 by assessing the economic cost of the social impacts of Australia's natural disasters and the planning and approval process for new infrastructure.

* Current CEOs: Mr Noel Clement, (Director of Australian Services), Australian Red Cross; Mr Peter Harmer, IAG; Mr Jonathan Callaghan, Investa Property Group; Mr Heinrich Eder, Munich Re; Mr Paul O'Sullivan (Chairman), Optus; Mr Brian Hartzler, Westpac Group.



Cover image: A couple look at a house burnt out by bushfires in 2013 in Winmalee in Sydney's Blue Mountains. Residents faced scenes of devastation after bushfires ravaged communities and destroyed 'hundreds' of homes. (AFP PHOTO / Greg WOOD)

CEO statement

Many Australians know only too well the devastating consequences of natural disasters.

Having experienced the impact of natural disasters through our clients and customers, we came together in 2012 to form the *Australian Business Roundtable for Disaster Resilience & Safer Communities*. We wanted to understand the costs and long-term impacts of natural disasters in Australia and to make communities safer and more resilient.

This is the fourth report prepared for the Roundtable by Deloitte Access Economics and examines, for the first time, the economic cost of the social impacts following natural disasters. Our first report, *Building our Nation's Resilience to Natural Disasters*, outlined the costs of natural disasters and found that investment in resilience measures would reduce the costs of disaster relief and recovery by more than 50% by 2050.

This estimate did not, however, include the less visible and more intangible costs, such as increased mental health issues, family violence, alcohol consumption, chronic and non-communicable diseases and short-term unemployment.

This report examines, where data allows, these intangible costs and finds that:

- The social costs of natural disasters in 2015 were at least equal to the physical costs – if not greater
- The total economic cost of natural disasters in Australia exceeded \$9 billion in 2015, or about 0.6% of gross domestic product
- The total costs of disasters will rise to an average of \$33 billion per year by 2050 unless steps are taken to increase resilience.

These findings are conservative at best. We have therefore called for:

- Pre- and post-disaster policies and funding to further reflect the long-term and diverse social impact of disasters, together with a collective approach across government, business, not for profits and community groups to reduce these impacts
- Government, business and communities to further invest in prevention programs and education campaigns that drive behavior change
- More research and improved data access to ensure the costs of natural disasters, including the social impact, are better understood.



The Roundtable will keep calling for action and help to support the implementation of the recommendations in all of our reports.

The evidence in this report confirms what we expected through our work with disaster affected communities; that the magnitude of natural disasters is broad, manifests itself in a number of ways for individuals, families and communities, and is often long-lasting.

We have started a necessary conversation by commissioning this new and crucial research into the economic cost of the social impact of natural disasters. We now call on policy makers to join us in considering this evidence when planning for future natural disasters.

Together we can build a more resilient Australia.

Noel Clement
Director of Australian Services
Australian Red Cross

Peter Harmer
Managing Director and CEO
IAG

Jonathan Callaghan
CEO
Investa Property Group



Heinrich Eder
Managing Director
*Munich Holdings of
Australasia Pty Ltd*

Paul O'Sullivan
Chairman
Optus

Brian Hartzler
Managing Director and CEO
Westpac Group



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Glossary

Adaptation

The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (The United Nations Office for Disaster Risk Reduction, 2016).

Adaptive capacity

The factors that enable adjustment of responses and behaviours through learning, adaptation and transformation.

Coping capacity

The factors influencing the ability of a community to prepare for, absorb and recover from a natural disaster

Direct tangible costs

Those incurred as a result of the hazard event and have a market value such as damage to properties, infrastructure, vehicles and crops (Bureau of Transport Economics, 2001).

Disaster risk reduction

The practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including initiatives to reduce exposure to hazards and the vulnerability of people and property; judiciously manage land and the environment; and improve preparedness for adverse events (United Nations, 2009).

Economic cost

While there are varying definitions of the economic cost of a natural disaster (Hallegatte 2015), this report defines the total economic cost as including (direct and indirect) tangible and intangible costs.

Hard infrastructure

Hard infrastructure refers to physical structures or facilities that support the society and economy including roads, bridges, railways, ports, airports, school and hospitals as well as telecommunications, energy, water and sewage infrastructure.

Incidence of outcomes

The number of new cases of a condition, symptom, death or injury that develop during a specific time period, such as a year. It shows the likelihood that a person in that population will be affected by the condition.

Indirect tangible costs

The flow-on effects that are not directly caused by the natural disaster itself, but arise from the consequences of the damage and destruction such as business disruption, clean-up emergency relief and recovery costs, and network disruptions (Bureau of Transport Economics, 2001; Productivity Commission, 2015).

Intangible costs

Captures direct and indirect damages that cannot be easily priced such as death and injury, impacts on health and wellbeing, and community connectedness.

Intangible costs include the opportunity cost of expending resources: that is, the value of the next best alternative use of the resource that is foregone. For instance, if time is spent in hospital due to injury caused by a natural disaster, the opportunity cost could include lost leisure time or lost wages from not working.

Mitigation

Measures taken before a disaster aimed at decreasing or eliminating its impact on society and the environment (Council of Australian Governments (COAG), 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.]*

Preparedness

Disaster preparedness is the set of actions, knowledge and skills that people use to reduce the impacts of disasters (Australian Red Cross, 2015).

Prevention

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

Recovery

The coordinated process of supporting disaster-affected communities in rebuilding physical infrastructure and restoring emotional, social, economic and physical wellbeing (Emergency Management Australia, 2015).

Resilience

The ability of a system, community or society exposed to hazards to resist, absorb, adjust to and recover from the effects of a hazard in a timely and efficient manner, including initiatives to preserve and restore essential structures and functions (United Nations, 2009).

Response

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

Social capital

Social networks together with shared norms, values and understandings that facilitate co operation within or among groups (OECD, 2007).

Social impact

Social impact is the effect of natural disasters on the health and wellbeing of individuals and families, and/or the effect on the social fabric of affected communities. This report estimates the economic cost of social impacts.

Soft mitigation

Soft mitigation includes mitigation actions which modify behaviour or embed risk in decision-making such as information provision, land use planning and building regulations (Productivity Commission 2015).



Members of the Uranquinty community in NSW learn how to fill sandbags and build their own effective sandbag wall to help stop floodwater entering properties. (NSW SES)

Acronyms

ABS	Australian Bureau of Statistics
AEM	Australian Emergency Management
AUD	Australian dollar
BCR	Benefit-cost ratio
BDRCS	Bangladesh Red Crescent Society
BTE	Bureau of Transport Economics
CALD	Culturally and linguistically diverse
CBA	Commonwealth Bank of Australia
CCIQ	Chamber of Commerce and Industry Queensland
CDE	Chronic disease exacerbation
COAG	Council of Australian Governments
COPD	Chronic Obstructive Pulmonary Disease
CPES	Collaborative Psychiatric Epidemiology Surveys
CPP	Cyclone Preparedness Programme
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DATM	Disaster Assessment Training Manual
DALY	Disability-adjusted life year
DSCC	Dungog Shire Community Council
ECLAC	Economic Commission for Latin America and the Caribbean
EMA	Emergency Management Australia
FEMA	Federal Emergency Management Agency
GDP	Gross domestic product
GP	General practitioner
HILDA	Household, Income and Labour Dynamics in Australia
HR	Human resources
ICA	Insurance Council of Australia
JMA	Japan Meteorological Agency
LEMC	Local Emergency Management Committee
NDRP	Natural Disaster Resilience Program
NHTSA	National Highway Traffic Safety Administration
NDRRA	Natural Disaster Relief and Recovery Arrangements
NRMA	National Roads and Motorists' Association
NSDR	National Strategy for Disaster Resilience
NSW	New South Wales
OBPR	Office of Best Practice Regulation
OECD	Organisation for Economic Cooperation and Development

PCL	Post-Traumatic Stress Disorder Checklist
PFA	Psychological First Aid
PTSD	Post-traumatic stress disorder
QLD	Queensland
RACV	Royal Automobile Club of Victoria
RSPCA	Royal Society for the Prevention of Cruelty to Animals
SES	State Emergency Service
UNCRD	United Nations Centre for Regional Development
UNEP	United Nations Environment Programme
US	United States (of America)
USAID	United States Agency for International Development
VBAF	Victorian Bushfire Appeal Fund
VSLY	Value of statistical life year
WHO	World Health Organization

Companion reports

Companion reports commissioned by the Australian Business Roundtable for Disaster Resilience & Safer Communities

This report builds on **three companion reports** commissioned by the *Australian Business Roundtable for Disaster Resilience & Safer Communities*. A summary of key findings and recommendations from these reports is included in Appendix A. In brief:

- ***Building our Nation's Resilience to Natural Disasters*** (2013) reviewed the economics of mitigating disaster risks facing Australian communities. It identified opportunities for greater coordination between governments, businesses and communities in managing pre-disaster resilience, including carefully targeted mitigation investments. The report offered three key recommendations:
 - Improve coordination of pre-disaster resilience by appointing a National Resilience Advisor 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 activities that deliver a positive net impact on future budget outlays
- ***Building an Open Platform for Natural Disaster Resilience Decisions*** (2014) provided an overview of natural disaster data and research in Australia, and reinforced the need for better coordination and transparency of disaster risk and resilience information. The report recommended three outcomes:
 - Efficient and open – deliver a national platform for foundational data
 - Transparent and available – remove barriers to accessing data and research
 - Enable effective decision-making – establish a prioritisation framework
- ***Building Resilient Infrastructure*** (2016), was developed in parallel with this paper. It investigates the decision-making process for new 'hard' infrastructure assets in light of disaster risks, including the various Commonwealth and state guidelines for comparing project options through cost-benefit analysis. It also builds the case for embedding resilience considerations into this process, and offers practical steps to do so.

This body of work supports a growing national awareness of the need for disaster mitigation and resilience due to the increasing prevalence and cost of natural disasters. For example, following the release of *Building our Nation's Resilience to Natural Disasters*, the Australian Government asked the Productivity Commission to undertake a public inquiry into the efficacy of Australia's natural disaster funding arrangements. A summary of the inquiry's key findings and recommendations are included in Appendix B.

The Commission's inquiry made a number of key recommendations supporting those advocated by the Roundtable in the recommendations of *Building our Nation's Resilience to Natural Disasters* and *Building an Open Platform for Natural Disaster Resilience Decisions*.

In particular, the Commission recommended an increase in government funding and accountability for natural disaster risk management, and that natural hazard data and information be made publically available. To this end, the Australian Government Public Data Policy Statement [2015b], released in December, commits the Government to specific actions designed to optimise the use and reuse of public data; to release non-sensitive data as open by default; and to collaborate with the private and research sectors to extend the value of public data for the benefit of the Australian public.

The reports also support ongoing progress by the Australian Government towards improving infrastructure planning and prioritisation, including in response to the 2014 Productivity Commission inquiry into public infrastructure. Importantly, the report also calls for more focus on 'soft mitigation' measures such as community education and other preparedness measures that can yield significant benefits over time where it modifies behaviour and results in the avoidance of disaster risk.

A man comforts his daughter on their roof as they inspect damage to their neighbourhood as parts of southern Queensland experiences record flooding in the wake of Tropical Cyclone Oswald on January 29, 2013 in Bundaberg.
(Chris Hyde / Getty Images)



"A picture of my sister and me with a crew of army personnel who spent their 'day off' helping us at our house. They were happy to have time out from wading neck deep in water in the nearby Lockyer Creek, searching for bodies. We were forever grateful for their help." *Cathy Finch*

Cathy Finch is a photographer who grew up in Grantham and had friends and family impacted by the 2011 floods. She continued working in the impacted communities, interviewing people on their experiences and capturing these moments, while working for the Courier Mail.



Executive summary

Natural disasters affect all states and territories in Australia. They have an enormous impact on people, the environment and our communities

In Australia, natural disasters have incurred billions of dollars in tangible costs¹ to individuals, businesses and governments.

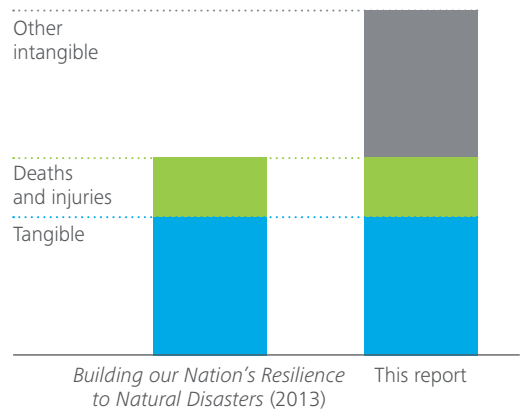
Beyond the known economic costs, it is well recognised that natural disasters have wide-ranging social impacts that are not only high in immediate impact, but often persist for the rest of people’s lives. While there is considerable evidence of social impacts, our knowledge of their economic cost is not well understood.

Where data permits, this report identifies and quantifies the social impacts of natural disasters, including those on health and wellbeing, education, employment and community networks. When considered alongside the tangible costs highlighted in *Building our Nation’s Resilience to Natural Disasters* (2013), a much richer picture emerges of the total economic cost of natural disasters to Australia.

This report finds that in 2015, the total economic cost of natural disasters in an average year– including tangible and intangible costs – exceeded \$9 billion, which is equivalent to about 0.6% of gross domestic product (GDP) in the same year. This is expected to almost double by 2030 and to average \$33 billion per year by 2050 in real terms (Chart ii), even without considering the potential impact of climate change.

Clearly comprehensive information on all costs of natural disasters is required to understand the full impact of natural disasters on our communities and economy and; to also understand the extent to which expenditure on mitigation and resilience measures is effective.

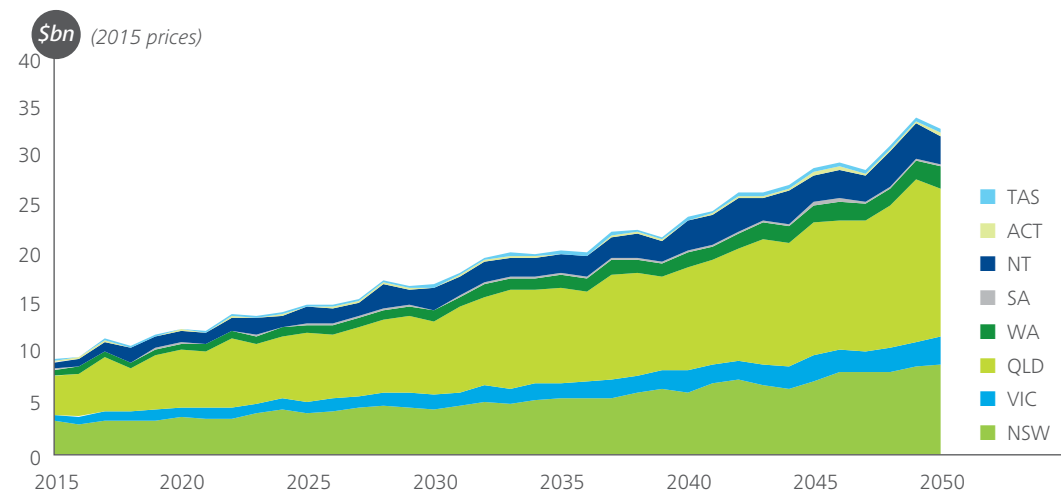
Chart i: Breakdown of costs between reports



1. In line with the Productivity Commission report, costs in this report are defined as:

- **Direct tangible costs:** those incurred as a result of the hazard event and have a market value such as damage to private properties and infrastructure
- **Indirect tangible costs:** the flow-on effects that are not directly caused by the natural disaster itself, but arise from the consequences of the damage and destruction such as business and network disruptions
- **Intangible costs:** capture direct and indirect damages that cannot be easily priced such as death and injury, impacts on health and wellbeing, and community connectedness.

Chart ii: 2015–50 forecast of the total economic cost of natural disasters, identifying costs for each state



Source: Deloitte Access Economics analysis

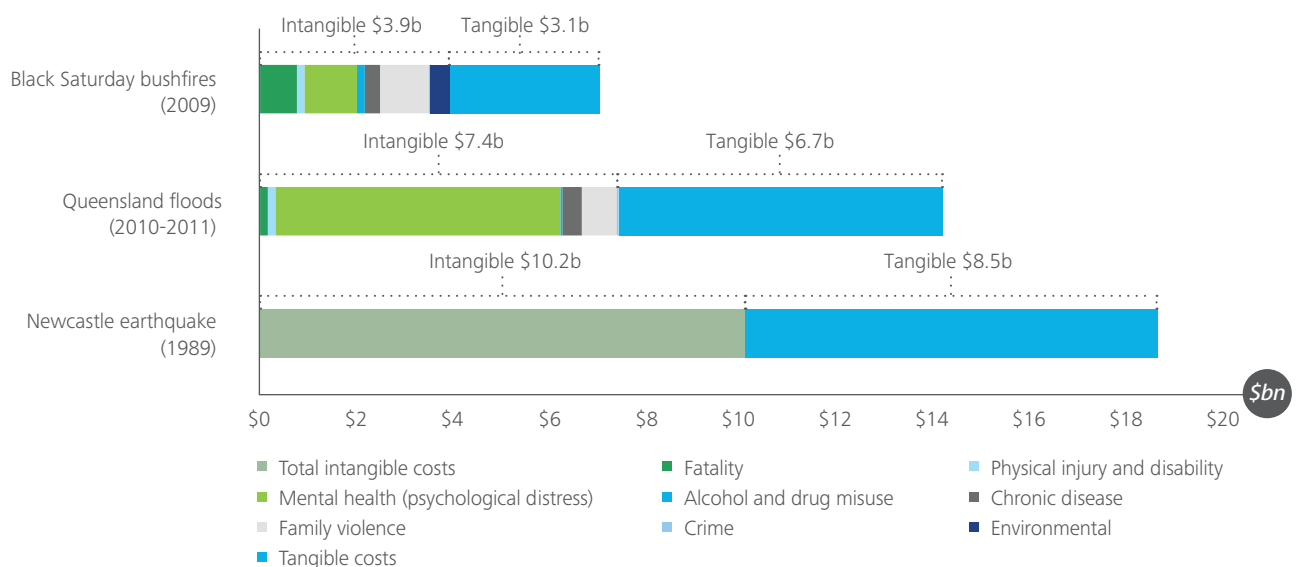
- Traditionally natural disaster costs have been a measure of tangible impacts. This paper identifies both tangible and intangible impacts and demonstrates that the economic cost of natural disasters may be underestimated by at least 50%
- Better understanding of the full costs of natural disasters further strengthens the case for increased mitigation measures and highlights the importance of coordinated, broad based recovery activities.

This report uses three case studies from different regions and periods – the 2010–2011 Queensland floods, the 2009 Victoria Black Saturday bushfires and the 1989 Newcastle earthquake – and assesses the tangible and intangible costs of the most recent two events. The report estimates the intangible costs to be as high as the tangible costs, and possibly higher. **In fact, the long term economic cost of natural disasters may be underestimated by more than 50%.**

This report only quantifies those intangible social impacts where there is sufficient data to do so, thus it provides a conservative estimate. Regardless of if they can be quantified, all identified outcomes are important and should be considered in any disaster mitigation decision-making process. Between 2009–10 and 2012–13, \$11.0 billion was spent on disaster recovery, while only \$225 million was spent on mitigation (Productivity Commission, 2015). The majority of relief and recovery assistance was provided through the Natural Disaster Relief and Recovery Arrangements (NDRRA), and in particular Category B payments which relate to essential public assets, financial support to small business and primary producers, and counter disaster operations.

The report demonstrates that the social costs of natural disasters equal the more traditionally defined economic costs – and are sometimes even higher. It is clear that a greater effort should be invested in the preparedness of individuals, in particular long-term psycho-social recovery. This would include community development programs and support for areas such as health and wellbeing, employment and education.

Chart iii: Total economic cost of Queensland floods, Black Saturday bushfires and Newcastle earthquake'



Source: Deloitte Access Economics analysis.

Note: Due to insufficient data, the total economic cost of the 1989 Newcastle earthquake was estimated using the tangible to intangible cost ratio of the 2010-11 Queensland floods and 2009 Black Saturday bushfires.

Executive summary

Our research leads to four recommendations to help reduce the long-term social impacts and economic costs of natural disasters.

1 Pre- and post-disaster funding should better reflect the long-term nature of social impacts

The analysis shows that the intangible costs of natural disasters are at least as high as the tangible costs. Significantly, they may persist over a person's lifetime and profoundly affect communities.

While building resilience into infrastructure is important, it should be accompanied by measures to ensure social and psychological wellbeing. **It is crucial that funding and policies** acknowledge the long-term social impacts of natural disasters.

As well as funding emergency services during disasters, infrastructure and recovery after disasters, government, business and the not-for-profit sector must also invest in services to support people, small businesses and communities well after the debris is cleared. These services are most effective when coordinated across sectors and when communities connect to foster a culture of resilience.

This report supports a national, long-term preventative approach to managing natural disasters and protecting our communities. This will require long-term commitment and multi-year funding to achieve. Critical to ensuring long-term impacts are minimised is "strengthening local capacity and capability, with greater emphasis on community engagement and a better understanding of the diversity, needs, strengths and vulnerabilities within communities" (COAG's *National Strategy for Disaster Resilience*, 2011).

A significant body of evidence shows that resilient and prepared communities are more likely to withstand the negative impacts of natural disasters. Likewise, strong social capital correlates to a more effective recovery.

2 A collaborative approach involving government, business, not-for-profits and community is needed to address the medium- and long-term economic costs of the social impacts of natural disasters.

Individuals, businesses, governments and communities all feel the social impacts of natural disasters. These impacts are complex and touch all levels of government and cross all portfolios, from infrastructure and planning to health and education.

This highlights the importance of a collaborative effort to build resilience, including coordinated approaches that consider all aspects of natural disasters: direct and indirect, tangible and intangible. This collaborative perspective should be considered within planning processes, to ensure disaster resilience is integrated across various portfolios in accordance with the National Strategy for Disaster Resilience (NSDR).

A coordinated approach with sustained resourcing makes community awareness education and engagement programs more effective. Such programs help communities to work together to better manage the risks they confront (NSDR). This promotes communities that are better able to withstand and recover from a crisis.

3 Governments, businesses and communities need to further invest in community resilience programs that drive learning and sustained behaviour change.

It is clear that funding of disaster mitigation measures should not only focus on building physical infrastructure such as flood levees, but include funding for social and psychological measures too. This would include community awareness, education and engagement programs that enhance social capital by building social networks and connections. While these preventative measures require up-front funding, they yield a return on investment by lessening the overall impact of a natural disaster on individuals, businesses, governments and communities.

Key considerations for program design include:

- Implementing appropriate incentives
- Programs that focus on learning and behaviour modification, in addition to general awareness
- The need for psychological preparedness
- Local solutions
- The need for solid data and evaluation
- Community connection to foster a culture of resilience.

Given how widespread the social impacts are after a natural disaster, it is important that communities, not-for-profits, emergency management agencies, businesses and governments collaborate to design and deliver preparedness programs and campaigns. These programs must educate communities as well as encourage and foster a culture of connectedness and resilience.

It is critical they be evidence-based to ensure cost-effective investment and continual improvement. It is important, too, to evaluate their effectiveness and draw out their key learnings.

4 Further research is needed into how to quantify the medium- and long-term costs of the social impacts of natural disasters.

While the complex social impacts of natural disasters are undisputed, there is currently a lack of consistent data to reliably quantify the cost. Direct and tangible impacts are usually considered as 'one-offs' but intangible social impacts tend to persist over time. Hence, data collection needs to better incorporate this temporal component to track and fully appreciate the long-term effects of natural disasters.

This report shows that the social impacts of natural disasters tend to be multiple and interrelated. Importantly, the experience of grief and trauma varies from person to person. It is therefore necessary to understand both the primary and secondary impacts of natural disasters on individuals and communities.

In *Building an Open Platform for Natural Disaster Resilience Decisions* we proposed a national platform to facilitate access to foundational data. In addition to this, there is a need to incorporate consistent longitudinal data to track social impacts. Areas that could benefit from better data collection include health and wellbeing, education, employment and communities. For example, datasets could incorporate information about people's experience of natural disasters such as timing and type.

Concluding remarks

This report highlights the significant economic costs of the social impacts of disasters. It provides four key recommendations in the form of strategies to help to reduce the long term impacts and costs of future natural disasters.

These recommendations reaffirm those made in *Building our Nation's Resilience to Natural Disasters* (2013) and *Building an Open Platform for Natural Disaster Resilience Decisions* (2014). Particularly, with regard to the need for national coordination and long-term, annual consolidated funding for pre disaster resilience, an open platform for foundational data, and for removing barriers to accessing data and research.

This report also supports the need to consider the social impacts of natural disasters when evaluating the benefits of resilient infrastructure in the investment decision-making process, as explored in *Building Resilient Infrastructure* (2016) and the need to build resilience before natural disasters happen.

“We will not be measured by the kilometres of road and pipes that we replace, we will be measured by how our people come through this”

Jim Palmer from Waimakiriri District Council after the Christchurch Earthquake, 2011



2009 Victorian Bushfires Relief Centre (Australian Red Cross)

"Grantham local, Derek Schulz, was known for his good humour and larrikin antics, always having a joke and looking on the bright side of life on the land. He had endured numerous major floods and droughts, suffered hail damage to his crops, empty water bores and devastating market prices. But like most farmers, he was bred tough and had a resilient spirit.

After the January 2011 floods that claimed the lives of friends and neighbours and destroyed almost everything he had ever known as 'home', Derek, on returning to his property, broke down in tears, his spirit was broken. The physical and emotional ramifications proved too hard to bear." *Cathy Finch, photographer, Queensland.*



January 10, 2012: Grantham, QLD. Local residents, friends and family attend the dawn unveiling of a memorial to victims killed in the floods in Grantham, Queensland on the morning of the first anniversary of the devastating 2011 Queensland floods (Lyndon Mechielsen / Newspix)



Total economic cost of natural disasters

Direct tangible costs

Costs incurred as a result of the hazard event and have a market value such as damage to private properties and infrastructure

Indirect tangible costs

The flow-on effects that are not directly caused by the natural disaster itself, but arise from the consequences of the damage and destruction such as business and network disruptions

Intangible costs

Capture direct and indirect damages that cannot be easily priced such as death and injury, impacts on health and wellbeing, and community connectedness

1. Introduction

Key points

- Natural disasters have a devastating impact on individuals, families, local communities, businesses and governments. In particular, the social impacts are complex, interrelated and difficult to quantify
- There is clear evidence social impacts account for a substantial part of the total economic cost of natural disasters
- This report focuses on placing a monetary value, where possible, on these social impacts to better understand the total economic cost of natural disasters and thereby strengthen the case for building individual and community resilience.

Natural disasters have devastating financial and social impacts on individuals, families, local communities, businesses and governments. The evidence shows that the social impacts are complex, interrelated and difficult to quantify; yet, it is clear they account for a substantial part of the total economic cost of natural disasters.

This report fills this recognised gap in the research by placing a monetary value on some of these broader social impacts. This enables a better understanding of the total economic cost of natural disasters in Australia, thereby strengthening the case for a national, long-term approach to managing natural disasters and protecting our communities.

Australia is vulnerable to a range of natural hazards including bushfires, severe storms, cyclones, floods and earthquakes. In recent years, natural disasters have included: the Black Saturday bushfires in Victoria; Cyclone Yasi in Northern Queensland; widespread flooding across Queensland, Victoria, Tasmania and New South Wales (NSW); and several damaging East Coast storms that, particularly in NSW, have claimed more than 200 lives and directly affected hundreds of thousands of people. These disasters have had long-lasting and far-reaching social impacts on the health and wellbeing of individuals and communities.

The findings from this report build on previous work commissioned by the *Australian Business Roundtable for Disaster Resilience & Safer Communities* in 2013, which estimated that financial losses, deaths and injuries in Australia cost more than \$6 billion in 2012 and was expected to average \$23 billion per year by 2050. The report noted that these disasters also had a wide range of social, psychological and community repercussions that were difficult to quantify but no less important – and could affect individuals, their communities and the broader society over a long period of time.

The 2014–15 Productivity Commission *Inquiry into Natural Disaster Funding Arrangements* noted that these social impacts can't be easily priced as they do not involve the purchase of products or services. The report recognised that these costs are difficult to quantify, can accrue over the long term and can have serious impacts. Data constraints and the complexity of estimating the social impact of natural disasters have made it difficult to estimate these costs.

It is important to note that this paper assumes natural hazards will be as frequent in the future as in the past; that is, the rate of natural disasters will be constant over time. Given the evidence for climate change, this is unlikely to be the case – extreme weather events will probably occur more regularly in the future than in the past (Box 1). Thus, since this paper does not factor in the impact of climate change, the estimations here are conservative, with future costs likely to be even bigger than anticipated.

1. Introduction

Box 1: The impact of climate change on natural disasters in Australia

There is virtually unanimous agreement among climate scientists that human activity is substantially contributing to climate change. The human impact on climate since the start of the industrial era greatly exceeds the impact due to known changes in natural processes (Intergovernmental Panel on Climate Change, 2007). The Intergovernmental Panel on Climate Change released its fifth *Assessment Report* into climate change in 2014. The second Working Group paper, *Climate Change 2014: Impacts, Adaptation, and Vulnerability*, states that climate change will generally (though not uniformly) increase the severity and rate of natural disasters in Australia. It states with 'high confidence' that there will be an 'increased frequency and intensity of flood damage to settlements and infrastructure in Australia', an increase in 'the number of days with... extreme fire weather' and 'greater frequency and intensity of droughts'.

The most recent report from Commonwealth Scientific and Industrial Research Organisation (CSIRO) into climate change, *Climate Change in Australia: Projections for Australia's Natural Resource Management Regions* (2015), likewise concludes that climate change will almost certainly increase the frequency and severity of natural disasters. As temperatures rise, the atmosphere is able to hold more water, increasing the possibility of extreme rainfall events and flash flooding. It is also projected that higher temperatures will increase the number of days with harsh fire weather.

Geographical shifts in the distribution of natural disasters are likely too, potentially affecting communities who are unfamiliar with preparing, responding to and recovering from natural disasters. The climatological distribution of rainfall will change, which translates to a change in catchment hydrology. Climate change will thus change the frequency and severity of river flood risks in Australia, but not in a uniform manner. Some rivers will flood more severely and frequently while others will not.

At the 21st Conference of Parties to the United Nations Framework Convention on Climate Change (COP21), member countries agreed by consensus in the Paris Agreement to 'reduce their carbon output as soon as possible and to do their best to keep global warming to well below two degrees Celsius'. The agreement, which comes into force in 2020, represents a turning point for multilateral action to limit climate change below dangerous levels. Despite the commitment to limit global warming to two degrees, sea levels are still expected to rise by around six metres, posing a great risk to coastal regions and small island nations (Dutton et al, 2015).

The COP 21 Agreement was a landmark commitment to focus on adaptation, resilience and response to climate impacts. All countries will need to submit adaptation priorities, support needs and action plans. Developing countries will receive increased support for adaptation actions and the adequacy of this support will be assessed through a transparent framework.

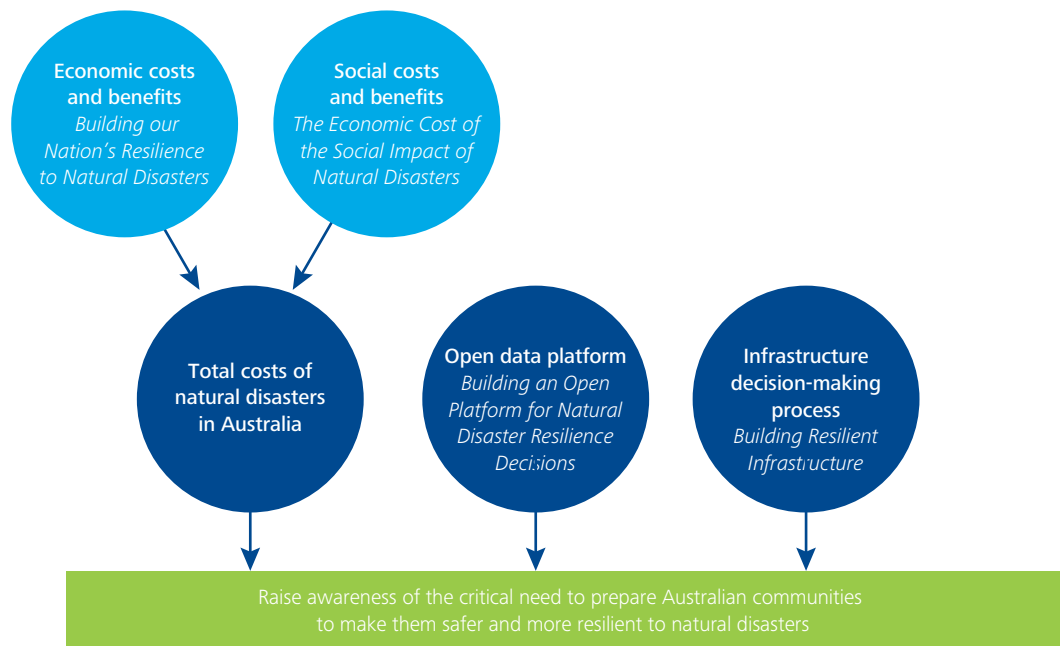
1. Introduction

Given the cost of extreme weather events is expected to continue increasing over time, as well as the large and long-term costs of social impacts associated with these events, there is an even greater need for emergency management across government, businesses and the not-for-profit sector. There has been a greater recognition of the need to build a more resilient Australia and some disaster recovery measures have recognised social impacts. For example, in 2007, the Australian Government Disaster Recovery Payment, which is intended to assist with short-term or emergency recovery needs, was extended to include those who were seriously injured in a disaster. In 2009, this was further extended to include those who experienced psychological trauma, who were unable to return to their home for 24 hours, or who experienced a utility failure for 48 hours. However, this extension of funding was removed in 2013.

This report supports the Roundtable's aim to raise awareness of the critical need for cost-effective resilient infrastructure, and to drive change in governments, businesses and communities. It directly supports the recommendations of *Building our Nation's Resilience to Natural Disasters* (2013) by demonstrating how important it is to consider the cost of social impacts in the disaster mitigation and infrastructure decision-making process. The report strengthens the case for a long-term approach to managing natural disasters, in line with the Roundtable's aim to build safer communities and generate broader economic and social benefits.

This paper has been developed in conjunction with a second paper, *Building Resilient Infrastructure*, which investigates the decision-making process for new 'hard' infrastructure in light of disaster risks. That report discusses the importance of taking a holistic view of economic costs when making investment decisions (Figure 1.1).

Figure 1.1: Summary of the Roundtable's work on natural disaster resilience



1. Introduction

1.1 The structure of this report

This report is set out as follows:

- **Chapter 2:** provides an overview of the complex web of tangible and intangible impacts that make up the total economic cost of natural disasters
- **Chapter 3:** quantifies the tangible and intangible cost of three case studies, and forecasts the total cost of an average year of natural disaster events in Australia
- **Chapter 4:** summarises the importance of building resilience at the individual and community level through community awareness, education and engagement programs that aim to strengthen social capital
- **Chapter 5:** provides recommendations for future action in pre-disaster resilience.

Supporting information is provided in five appendices:

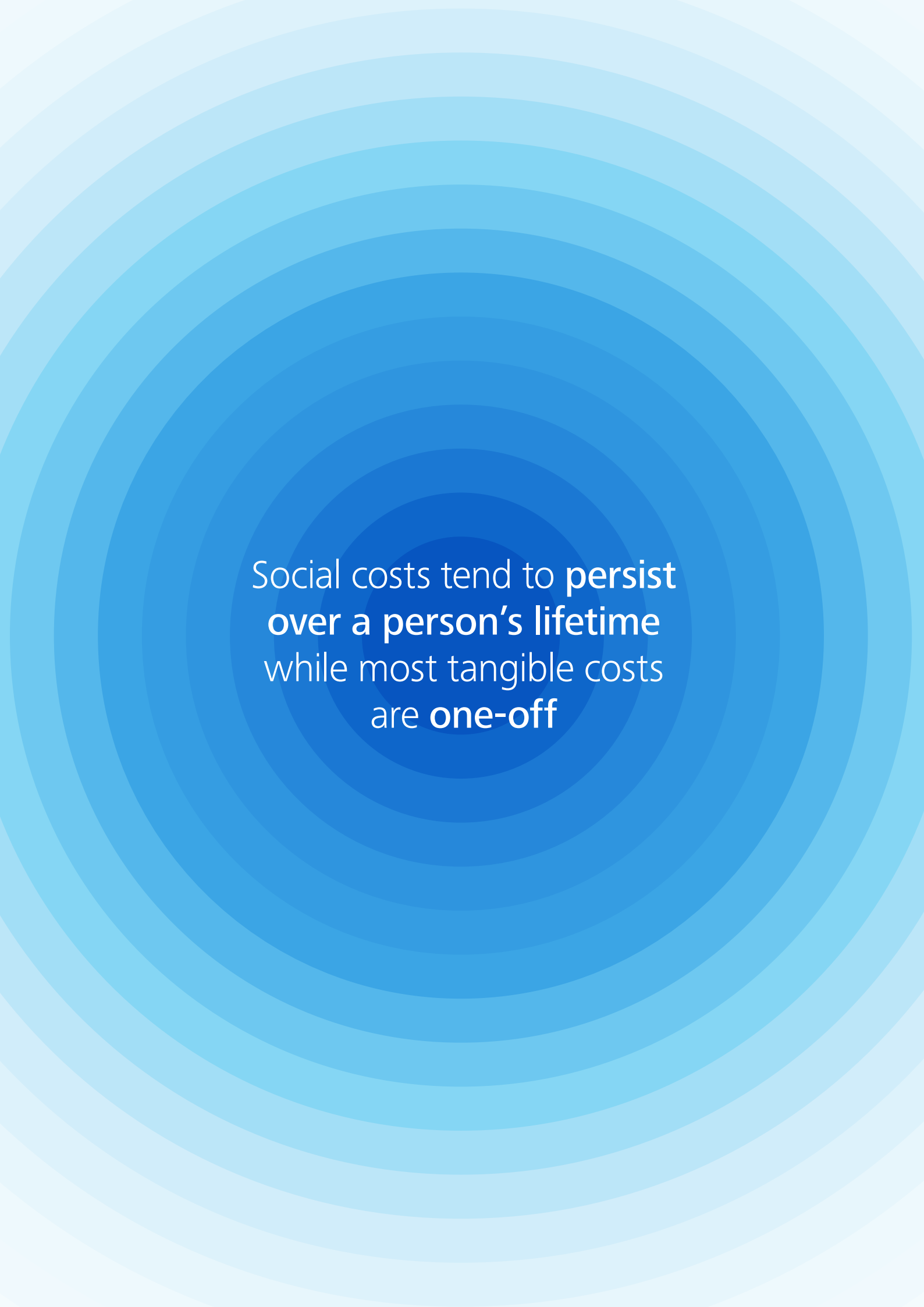
- **Appendix A:** provides a summary of the Roundtable's related companion papers and how this paper fits in overall
- **Appendix B:** provides an overview of the recent Productivity Commission inquiry into natural disaster funding arrangements
- **Appendix C:** looks at some key examples of natural disasters in other countries and the social impact of those disasters
- **Appendix D:** details the methodology for estimating natural disaster costs
- **Appendix E:** details the evidence on the social impacts of natural disasters.



People were left isolated by flooding in the Hunter region, NSW, 2007 (Guy Carpenter)



A local resident sits in his home surrounded by flood waters on January 6, 2011 in Rockhampton, Australia (Jonathan Wood / Getty Images)

The background consists of numerous concentric circles in various shades of blue, ranging from light to dark, creating a tunnel-like or ripple effect that draws the eye towards the center.

Social costs tend to **persist**
over a person's lifetime
while most tangible costs
are **one-off**

2. The social impact of natural disasters

Key points

- The total economic cost of natural disasters is a complex web of tangible and intangible costs
- Natural disasters have wide-ranging intangible impacts on health and wellbeing, education, community engagement and employment
- Intangible costs may be as high as, or higher than, tangible costs. Often intangible costs persist over a person's lifetime while most tangible costs are a one-off.

This report reviews evidence showing the range and significance of the social impacts of natural disasters in Australia and internationally. These impacts tend to be long term and incur considerable costs to individuals and their communities, governments and businesses. The research shows that the range and cost of social impacts are complex and difficult to measure, but there is clear evidence these costs form a substantial part of the total economic cost of natural disasters.

A review of the literature demonstrated the range and significance of the social impacts of natural disasters in Australia and internationally (see Appendix E).

The Productivity Commission *Inquiry Report on Natural Disaster Funding Arrangements* notes that economic costs are typically grouped into tangible costs (including direct and indirect) and intangible costs. These costs are defined as follows:

- **Direct tangible costs:** those incurred as a result of the hazard event and have a market value such as damage to private properties and infrastructure
- **Indirect tangible costs:** the flow-on effects that are not directly caused by the natural disaster itself, but arise from the consequences of the damage and destruction such as business and network disruptions
- **Intangible costs:** capture direct and indirect damages that cannot be easily priced such as death and injury, impacts on health and wellbeing, and community connectedness.

Figure 2.1 shows the complex web of tangible and intangible outcomes arising from natural disasters. The cost of intangible impacts may be as high as, or higher than, tangible costs. Importantly, in some cases, social impacts tend to persist over a person's lifetime while most tangible costs are a one-off. For example, a proportion of people will suffer from chronic disease or mental health problems post disaster, with negative impacts over their lifetime. These impacts may also be multiple and compounding (not necessarily linear).

2. The social impact of natural disasters

Figure 2.1: Impacts of natural disasters



2. The social impact of natural disasters

These outcomes can be quantified as human costs, general costs or economic efficiency losses (Table 2.1). This method of valuation adapts the World Health Organization's *WHO Guide to Identifying the Economic Consequences of Disease and Injury* (Box 2). The guide provides a framework for estimating the microeconomic and macroeconomic value of ill health based on market, non-market and economic welfare losses (WHO, 2009). For the purposes of this report, 'ill health' refers to the social impacts of natural disasters.

It is important to note that average costs have been used to estimate the cost of social impacts. In reality, anecdotal evidence shows that different people experience social impacts differently and their ability to recover depends on a range of other factors. For example, there were two women who both lost their husbands in the Black Saturday bushfires but only one also lost her house. As they reflected, the woman who lost her house found it more difficult to cope as she could not grieve in a familiar place where her husband had lived.

Figure 2.2 is an example of how each impact can be valued in monetary terms, and who bears the costs. For example, the rate of family violence has been shown to increase post-disaster. This leads to costs in the health system (including counselling services) and the justice system (if family violence is reported and/or proceeds to trial, or an intervention order is taken out). Businesses face costs due to absenteeism and the low productivity of physically and mentally affected employees. Costs are also associated with providing community support and services such as housing and relocation costs.

Box 2: Measuring the economic burden of disease and injury

There are a number of ways to measure disease burden. WHO provides a comprehensive guide to the methodology for measuring disease burden. Measurements of disease burden generally attempt to capture direct costs such as medical fees and travel time, and indirect cost such as reduced worker productivity.

A macroeconomic approach looks at the effects of disease on a societal level. 'Key channels through which disease or injury can impact on macroeconomic performance or output include increased health expenditures, labour and productivity losses, and reduced investment in human and physical capital formation' (WHO, 2009, p.4).

A microeconomic approach attempts to measure the burden at the level of an individual household, firm or government. Microeconomic models attempt to understand the trade-offs individuals make when affected by disease. Households, for instance, may shift consumption away from leisure and entertainment goods towards health expenditure. Education, which is important in human capital development, may be neglected, and savings may be run down to fund health costs.

However, these approaches can often fail to capture welfare loss from disease, focusing instead on market loss. To determine the welfare effects of disease on individuals' health, economists instead use models based on willingness to pay. Such models attempt to gauge how much individuals would be willing to forego to avoid or lessen the severity of a disease, taking into account a person's perception of medical care expenses, lost earnings, pain and suffering, and other subjective costs of illness. A greater willingness to pay to avoid a disease would indicate a greater welfare loss from the disease.

A common measure of overall disease burden is disability-adjusted life year (DALY). A loss of DALY can be conceptualised as the loss of a year from a 'healthy' life. The total DALY would capture the disease burden across the population. It is calculated using years of lives lost to a disease and years lost to disability. The weight of a disability is calculated from extensive survey data.

2. The social impact of natural disasters

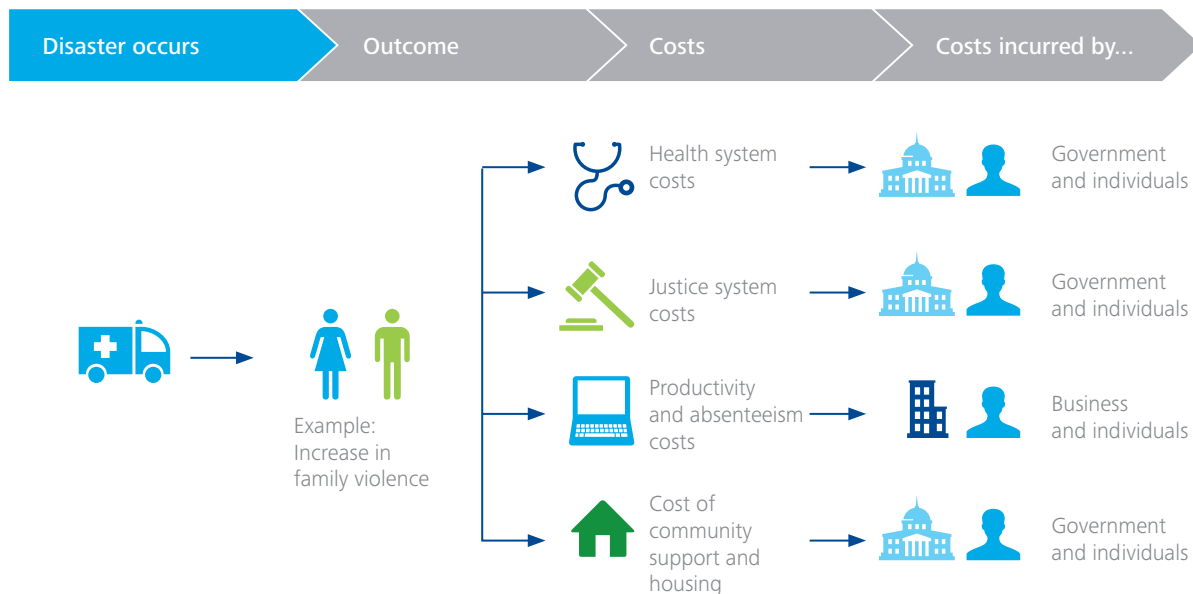
Table 2.1: Summary of the cost components of social outcomes

Level of government	Economic infrastructure
Direct health care system costs	Costs arising from services delivered within the health care system, including hospital, medical, paramedical and ambulance costs. Treatment may be provided by emergency services for those injured in a disaster, or someone with mental health problems or chronic disease may receive health care in hospital or by a general practitioner (GP).
Productivity loss	Poor health outcomes are likely to be associated with a reduced labour supply and lower productivity. This is valued as potential earnings lost as a result of disability, ill health or other outcomes. The human capital approach is used, which assumes that an employee cannot be easily replaced from the unemployment pool, and thus premature death or absence from work would result in a loss of productivity to the economy. Some productivity loss will be temporary and some over a person's lifetime.
Costs of informal care	Adverse health outcomes not only impose economic costs on individuals, but also on family and friends in caring for those who suffer from disability or ill health, or younger children who need care. These costs are estimated using the opportunity cost method, which measures the value in alternative use of time spent caring. This is typically valued by productivity losses (or value of leisure time) associated with caring.
Non-pecuniary costs	These put a value on the loss in quality of life as a result of premature death, disability or ill health, and on the pain and suffering of friends and families. This value is estimated using the value of statistical life year (VSLY) from the Office of Best Practice Regulation (OBPR, 2014).
Administrative and other costs	These include costs for legal services (associated with family violence, relationship breakdown and crime), temporary accommodation, paid care (as opposed to informal care), funerals and other publicly funded services.
Transfer payments	Transfer payments are not economic costs because they involve payments from one economic agent to another, but have been included to measure the allocative efficiency loss. These include social welfare payments from governments to individuals, victim compensation and accommodation subsidies.

Source: Deloitte Access Economics

2. The social impact of natural disasters

Figure 2.2: Example of how outcomes maps to costs



Source: Deloitte Access Economics

Table 2.2 (page 31) shows how each impact maps to the costs as found in the literature review (Appendix E), and categorises them into one of three groups:

- Those quantified as part of *Building our Nation's Resilience to Natural Disasters*
- Those quantified as part of this report, with a breakdown of costs as a proportion of the total cost of that outcome
- Those examined qualitatively but not quantified as part of this report due to insufficient information.

The methodology for estimating costs is described more fully in Appendix D. In brief, it was based on three broad components.

1. **Estimating the intangible costs of two natural disasters** (specifically the Queensland floods and the Black Saturday bushfires) using a bottom-up approach. Due to insufficient information on the intangible costs of the Newcastle earthquake, a top-down approach was used to calculate the earthquake's total average cost. A bottom-up approach estimates total cost by applying an incidence rate and average cost to the population affected by the natural disaster

2. **Estimating the tangible cost of two natural disasters** (specifically the Queensland floods and the Black Saturday bushfires) using the methodology from *Building our Nation's Resilience to Natural Disasters* (2013). This includes using updated data from the Insurance Council of Australia (ICA) as well as ratios of insured losses to uninsured losses from *Economic Costs of Natural Disasters in Australia* (2001) by the Bureau of Transport Economics (BTE) – now known as the Bureau of Infrastructure, Transport and Regional Economics. This method produced the intangible-cost-to-tangible-cost factor for each case study

3. **Applying the intangible-cost-to-tangible-cost factor** to the estimated average annual tangible cost to obtain the total cost of natural disasters in an average year of natural disaster events.

2. The social impact of natural disasters



January 15, 2011: Rosalie, QLD. Beth Waters is overcome with emotion as she helps residents and other volunteers with the clean-up operation in Fairfield in Brisbane, Queensland, after floodwaters receded leaving behind widespread property damage. (Robert MacColl / Newspix)

2. The social impact of natural disasters

Table 2.2: Outcomes of natural disasters and their associated costs as a proportion of total costs

Costs	Direct health care system	Productivity loss	Informal care	Non-pecuniary	Administrative and other costs	Transfer payments	Total costs
Tangible costs	Quantified in Building our Nation's Resilience to Natural Disasters						
Health and wellbeing*							
Fatality [^]	✓	✓		✓	✓		
Physical injury and disability [^]	2.9%	7.7%	0.3%	86.3%	2.4%	0.4%	100%
Mental health	13.4%	70.5%	0.6%			15.5%	100%
Alcohol misuse	18.8%	34.0%	33.6%	13.5%			100%
Ill health including chronic disease	✓	✓	✓	✓		✓	
Family violence	4.9%	6.2%		44.8%	6.1%	38.0%	100%
Relationship breakdown	Caruana (2010) notes there is 'a dearth of data on the rate of family breakdown following natural disasters' but 'anecdotal evidence, supported by a small number of studies, suggests that intimate partner violence, child abuse and sexual violence are more prevalent after disasters'. Hence, this has not been quantitatively measured in addition to family and domestic violence.						
Employment							
Short-term and long-term unemployment	Unemployment and loss of income has been measured as part of the cost of social outcomes (as above either through ill health, physical injury or disability or other social outcomes). To avoid double counting, unemployment has not been quantified separately.						
Impact on hiring and retaining qualified employees	Not quantified due to insufficient information on both the rate and value of this impact. However, it was found that Hurricane Katrina sparked difficulties for some local government human resources managers who, two years after the hurricane, were still struggling to retain workers and attract qualified people to fill positions (French, 2008).						
Education							
School enrolment and completion, and academic outcomes	Educational outcomes are difficult to value and attribute to natural disasters. They are largely a second order impact, influenced by trauma and mental health problems, relocation, physical injury and family violence post-disaster. Direct impacts are generally more immediate in nature, such as the inability for children to attend school due to disaster damage.						
Community							
Community dislocation	Not quantified due to insufficient information on the prevalence and long-term impact of community dislocation. Although it's acknowledged that natural disasters can dislocate communities, and examples have been documented (for example, in Arendt, 2014), the extent to which communities are affected is critically dependent on a number of factors that vary significantly in each setting.						
Crime	Only the cost of property crime post-disaster, such as looting and theft, has been quantified as part of this paper. Physical assault has been partly captured in the cost of family violence.						
Loss of animals	Costs associated with loss of livestock were estimated as part of <i>Building our Nation's Resilience to Natural Disasters</i> . Evidence shows that separation of pets and their owners in natural disasters may cause psychological distress. However, due to insufficient information on the rate and value of this impact, it has not been quantified.						
Environmental damage	Quantified as a one-off cost associated with damage to the environment as a result of natural disasters. This is based on the ecosystem service framework (Simpson, 2011), which values the environment in terms of ecosystem services it provides to humans, such as water supply, nutrient cycling, climate regulation and recreation.						
Social networks	Not quantified due to insufficient information on both the rate and value of the impact. The evidence is mixed on the impact of natural disasters on social networks. In some cases, natural disasters have had negative effects on social capital such as trust and social connection. In others, evidence shows positive impacts as volunteers work collectively in disaster recovery (Aldrich, 2012).						
Loss of heritage or culture	Not quantified due to insufficient information on both the rate and value of the impact. However, anecdotal evidence suggests these are important. An example is the loss of heritage-listed buildings and significant cultural objects in the Christchurch earthquakes.						

Source: Deloitte Access Economics

Note: A detailed literature review of each impact can be found in Appendix E

* Breakdown of cost components is based on existing studies that have quantified the economic cost of these outcomes. Refer to Table D.6 for more detailed information

[^] Quantified in *Building our Nation's Resilience to Natural Disasters* (Deloitte Access Economics, 2013) and refined in this paper.

Cost of Black Saturday bushfires

TANGIBLE \$3.1 bn

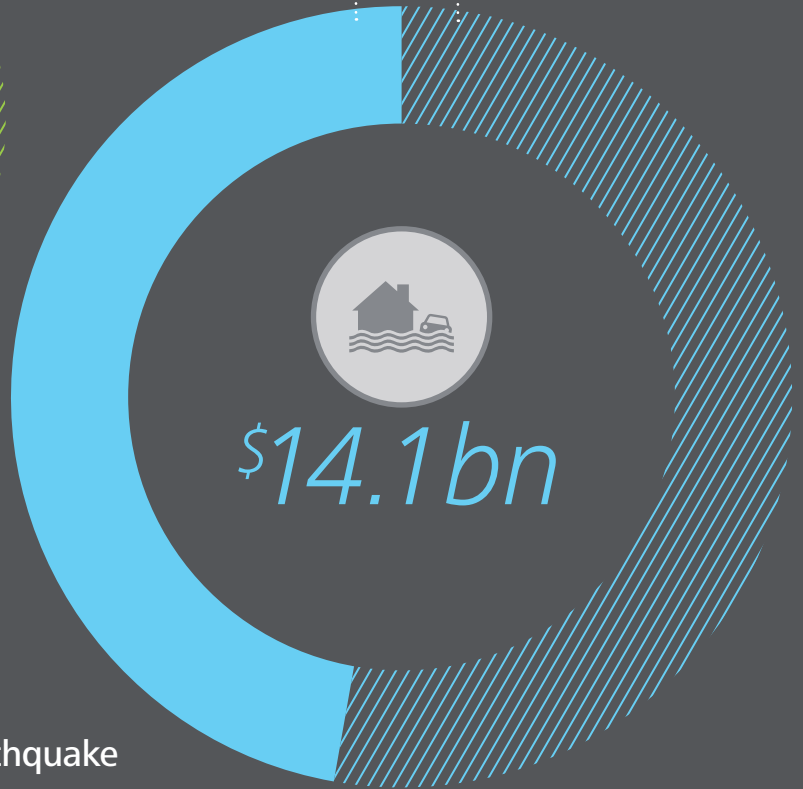
INTANGIBLE \$3.9 bn



Cost of Queensland floods

TANGIBLE \$6.7 bn

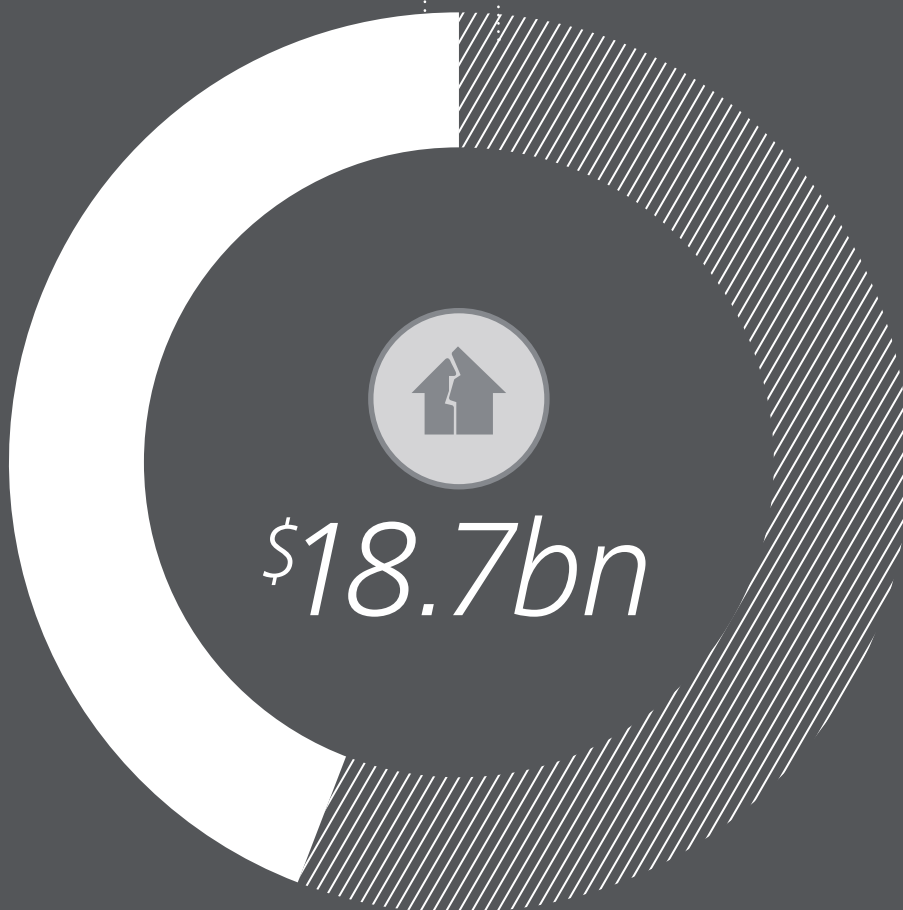
INTANGIBLE \$7.4 bn



Cost of Newcastle earthquake

TANGIBLE \$8.5 bn

INTANGIBLE \$10.2 bn



3. The cost of natural disasters: Australian experiences

Key points

- The case studies demonstrate that the total economic cost of natural disasters has been underestimated by at least 50%
- Accounting for the tangible and intangible costs, the forecast annual cost of natural disasters across government, business and communities in Australia is expected to reach about \$33 billion by 2050
- This estimate is likely to be conservative.

3.1 Case studies showing the cost of natural disasters in Australia

This section provides a detailed assessment of the tangible and intangible costs of two natural disasters: the 2010–11 Queensland floods and the 2009 Victoria Black Saturday bushfires. The costs have been estimated using a bottom-up methodology, which estimates the total economic cost by applying a disaster-specific incidence rate and average cost of each impact to the affected population. The methodology used to generate these estimates is explained in Appendix D. These case studies are illustrative of the magnitude of intangible costs, relative to tangible costs.

It is important to note that the ratio of tangible to intangible costs vary by the type, severity and geographic location of the natural disaster. For example, the incidence rate of psychological distress between the Queensland floods and the Black Saturday bushfires was broadly similar. However, the floods affected a vast area including highly populated centres of Brisbane and Ipswich, while the Victoria Black Saturday bushfires affected mostly regional and rural communities that are less densely populated.

3.1.1 Queensland floods

Cyclones and flooding have posed a serious threat to Queensland communities and industry in the past, particularly in the north. This section focuses on the impact of the cyclones and floods that occurred there in 2010–11, however Queensland has experienced multiple serious disaster events in the last decade (including Cyclone Larry in March 2006).

Prolonged and extensive rainfall from December 2010 to January 2011 led to extensive flooding in Queensland (Queensland Floods Commission of Inquiry, 2012). This was followed soon after by Cyclone Yasi on 3 February, 2011. Yasi made landfall as a category 5 cyclone in Far North Queensland, an area which had just recovered from Cyclone Larry.

In a Queensland survey on the effects of the floods, 47% of respondents reported that their own home, homes in their suburb, or their family home had been damaged or destroyed (Queensland Health, 2011). People from disadvantaged socioeconomic backgrounds and in outer regional and remote areas were affected more in a number of ways, such as distress and feeling terrified, helpless or hopeless, or having reduced incomes.

3.1.1.1 The economic cost of the 2010–11 Queensland floods

The 2010–11 floods were widespread and had devastating effects on communities. More than 78% of the state (an area bigger than France and Germany combined) was declared a disaster zone, and over 2.5 million people were affected (Queensland Floods Commission of Inquiry, 2012).

The intangible costs associated with the Queensland floods were estimated to be as large as the tangible costs, at an estimated \$7.4 billion dollars and \$6.7 billion dollars, respectively. This means the ratio of intangible costs to tangible costs is likely to be larger than 1.1.

3. The cost of natural disasters: Australian experiences

Deaths and injuries

Thirty-six people died in the floods, including three who were missing and later declared deceased. Major flooding occurred throughout most of the Brisbane River catchment, most severely in the catchments of Lockyer Creek, which caused the loss of 19 lives.

The number of people injured in the floods is not documented. However, based on a report by Van den Honert and McAneney (2011), these floods were very similar to the 1974 Australia Day floods in Queensland in which 300 people were injured. Applying a ratio defined by the Bureau of Transport Economics (2001), it is estimated the 2010–11 floods caused 100 severe injuries and 200 minor injuries.

Based on the average life expectancy in Queensland and the average age of people affected by the floods, **the lifetime cost of deaths and injuries is estimated at around \$320 million (net present value in 2015 dollars).**

Mental health issues

Adults of working age and residents of regional, remote and socioeconomically disadvantaged areas, were disproportionately more likely to report emotional impact caused by the floods. Of a sample of more than 6,000 Queensland residents exposed to the floods, 14.3% reported feeling 'terrified, helpless or hopeless', and 3.9% thought they might be 'badly injured or die'. Up to five months after the disasters, 7.1% were 'still distressed' and 8.6% were 'worried about how they might manage'.

Similarly, Alderman et al. (2013) found that residents whose homes were directly affected by the Brisbane flooding were more likely to report poorer physical and mental health. The affected residents were:

- 5.3 times more likely to report poorer health than those not affected by the floods
- 2.3 times more likely to report respiratory issues
- 1.9 times more likely to report psychological distress
- 2.3 times more likely to report poor sleep quality
- 2.3 times more likely to have probable post-traumatic stress disorder (PTSD) .

Mental health issues were the largest impact of the floods.

Using these surveys as proxies to estimate the number of people who had short- and long-term high to very high psychological distress, **the lifetime cost of mental health issues resulting from the floods is estimated at around \$5.9 billion (net present value in 2015 dollars).**

Risky or high-risk alcohol consumption

Mental health-related behaviours such as substance use (alcohol and smoking) have been documented following natural disasters. Turner et al. (2013) surveyed a sample of 3,000 residents (aged 18 years and over) in flood-affected areas in the greater Brisbane region. Of the 960 respondents, 10.6% reported some form of direct flood impact. The group affected directly by the floods were 5.2 times more likely to increase their alcohol use, and 4.5 times more likely to increase their tobacco use.

Using this to estimate the proportion of the affected population who had short- and long-term increases in risky and high-risk alcohol consumption, **the lifetime cost resulting from the floods was estimated at about \$20 million (net present value in 2015 dollars).**

Chronic and non-communicable diseases

Evidence shows that natural disasters exacerbate chronic disease, whether diagnosed or undiagnosed. The most common illnesses are cardiovascular disease, diabetes and respiratory conditions such as Chronic Obstructive Pulmonary Disease (COPD). Chronic disease exacerbation can be due to illness (for example, from increased susceptibility to injury or infection) or due to the disaster itself (such as by separation from medication or treatment, inhaled toxins, crush or blast injuries, or contamination of food and water) (Miller & Arquilla, 2008; Owens & Martsolf, 2014; Kobayashi et al., 2013).

Ryan et al. (2015) did focus groups and interviews with people with non-communicable diseases (NCDs), disaster responders and health specialists in the Cairns, Toowoomba and Townsville regions. They found a disaster can interrupt management and care for people with NCDs living in rural and remote areas of Queensland, which has the potential to exacerbate their condition or even result in death.

3. The cost of natural disasters: Australian experiences

There is also some anecdotal evidence that people affected by natural disasters may develop diseases such as cardiovascular disease from elevated stress and blood pressure. However, this is not quantified due to insufficient quantitative information and the complexities of attributing it to the natural disaster.

According to Alderman et al. (2013), people directly impacted by the floods were 5.3 times more likely to experience worse overall health and 2.3 times more likely to experience worse respiratory health.

Using a combination of these studies and the prevalence of diabetes, COPD and stroke in Queensland as a baseline, it is assumed that these conditions will be exacerbated in a proportion of people post-disaster. **From this, it is estimated that the cost of the exacerbation of diabetes and COPD, and the development of stroke resulting from the floods was around \$430 million (net present value in 2015 dollars).**

Family violence

Increased rates of family and gender violence after natural disasters is qualitatively well-documented. Stress is often cited as the key reason for increased violence against women post-disaster.

Anecdotal evidence from domestic violence service providers such as the Ipswich Women's Centre Against Domestic Violence reported a spike in cases of family violence after the 2010–11 floods. It was noted that the underlying problems many families were facing were heightened in the aftermath of the disaster. An additional exacerbating factor was the shortage of crisis accommodation due to the floods for people affected by domestic violence.

There has been no quantitative study of the impact of the floods on family violence levels. Hence, the Household Income and Labour Dynamics in Australia (HILDA) survey was used to estimate the difference in family violence rates between those who reported having their house or property damaged or destroyed by a natural disaster with those who did not. **It is estimated that family violence cost around \$720 million (net present value in 2015 dollars).**

Short-term unemployment

Natural disasters have negative effects on employment and disposable income, which in turn affects consumer

confidence. Because the value of unemployment and productivity loss is captured in several ways in the methodology (for example, productivity loss resulting from physical injury, mental health issues, chronic disease, alcohol misuse and family violence), this has not been separately costed, to avoid double counting.

In 2011, Commonwealth Bank of Australia analysed the effect of natural disasters on personal income and the disruption to living arrangements when disasters hit. The analysis used the Australian Government's Disaster Income Recovery Subsidy (equal to the Newstart Allowance) as a proxy for unemployment. It found the number of people applying for the Newstart Allowance rose dramatically following the floods. Importantly, repeated flooding events in North Queensland prior to the 2010–11 floods appeared to have made people vulnerable to loss of income. Between the North Queensland flood in 2009, the South West Queensland flooding in 2010 and the 2010–11 floods there was a consistent decline in the proportion of Queenslanders receiving a salary and an increase in the proportion relying on the Newstart Allowance as their only source of income.

This is consistent with Clemens et al. (2013), which found that 17% of respondents reported reduced incomes three to six months post-disaster.

Tangible costs

A breakdown of the tangible costs is included below. Many people reported disruption to businesses and displacement from homes after the Queensland floods and cyclones. Almost half of Queensland businesses were affected by the floods only, approximately 14% were affected by Cyclone Yasi, and almost 20% were affected by both, according to a survey done six months after the disaster by the Chamber of Commerce and Industry Queensland (CCIQ).

Approximately 29,000 homes and businesses were subject to some form of inundation during the Brisbane floods (Queensland Reconstruction Authority, 2011; CCIQ, 2011). The cost of rebuilding roads and other infrastructure, and supporting businesses and the community, totalled almost \$6.9 billion (Queensland Government, 2012). The cost incurred by housing-displaced people has not been quantified for the floods and cyclones (Queensland Reconstruction Authority, 2011).

3. The cost of natural disasters: Australian experiences

Transport was also severely disrupted, particularly following the Brisbane floods. Rail services between Darra and Ipswich were cancelled for more than one week, and Brisbane ferry services were suspended for more than six weeks (Brown, Bunker & Naiker, 2011). The bulk of recovery expenditure was spent on repairing roads, bridges and transport infrastructure (Queensland Government, 2012).

In total, the floods caused almost \$2.4 billion (2011 dollars) in insurance costs (Insurance Council of Australia, accessed 2015). Using the methodology shown in Appendix D for tangible costs, **the total tangible cost associated with the 2010–11 Queensland floods is estimated at around \$5.7 billion (2011 dollars) or \$6.7 billion (2015 dollars).** Table 3.1 summarises the breakdown of the tangible cost estimates.

Total economic cost

The total economic cost of the 2010–11 Queensland floods is estimated to be \$14.1 billion (in 2015 dollars), with \$7.4 billion in intangible social impacts and \$6.7 billion in tangible impacts (Chart 3.1). While mental health costs per person are low, the number of people who were psychologically distressed after the floods is extremely high, leading to by far the highest total intangible cost.

The methodology for this estimate is given in Appendix D. Because intangible cost estimates are conservative (due to the lack of information to quantify some social impacts) this suggests intangible costs are as high, if not higher, than tangible costs, with a ratio of around 1.1.

Table 3.1: Tangible cost estimates for 2010–11 Queensland floods

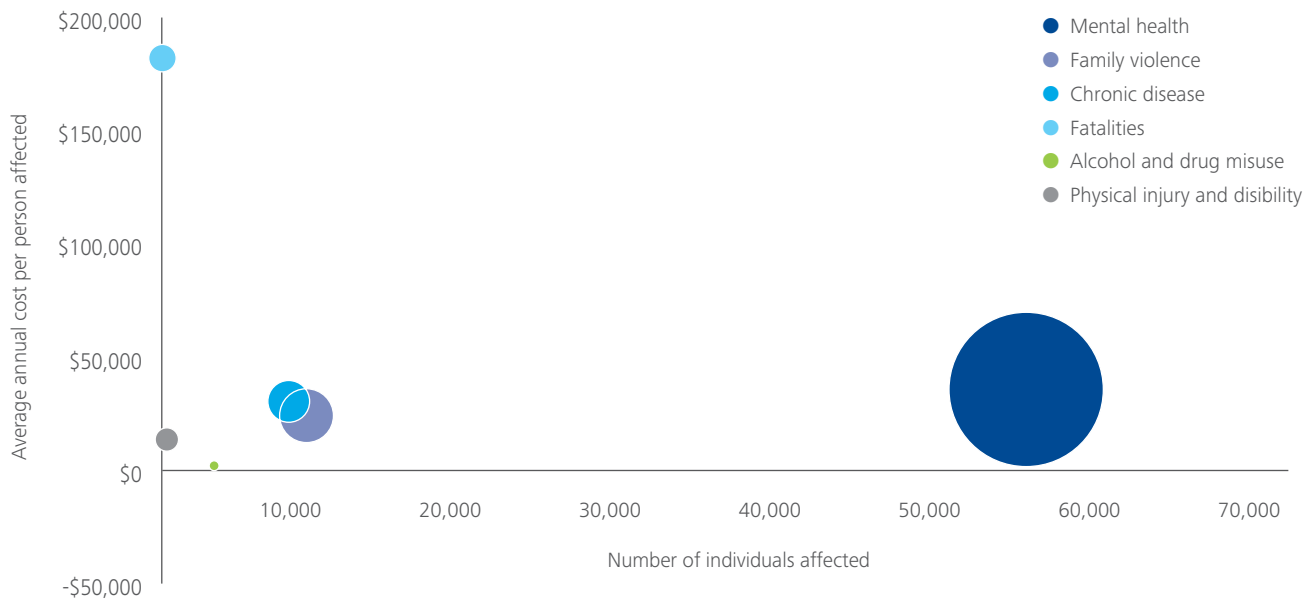
	Percentage of total	\$m (2011)
Insured	47.9	\$2,388
Uninsured	22.4	\$1,878
Category B	26.3	\$1,314
Agricultural production lost	0.0	\$0.57
Evacuated	0.0	\$0.31
Homeless	0.6	\$0.01
Homes – damaged	0.2	\$15
Commercial – damaged	0.0	\$3
Emergency response costs	2.5	\$123
Total	100	\$5,722

Source: Estimates using BTE (2011) and *Building our Nation's Resilience to Natural Disasters*.

Note: Category B refers to assistance to the state, and/or local governments for the restoration of essential public assets and certain counter-disaster operations through the National Disaster Relief and Recovery Arrangements. Category B assistance also covers assistance to small businesses, primary producers, not-for-profit organisations and needy individuals through concessional loans, subsidies or grants. Category B assistance is provided automatically by the states without requiring approval from the Australian Government.

3. The cost of natural disasters: Australian experiences

Chart 3.1: Total estimated economic cost for the 2010–11 Queensland floods



Note: Area of circle denotes the total cost of each social impact.

3.1.2 Black Saturday bushfires

The Black Saturday bushfires constituted one of the worst natural disasters in Australian history. On 7 February 2009, fires broke out across Victoria after a sustained and severe heatwave starting in the last week of January. The fires were further intensified by a wind change that moved across the state in the afternoon, with winds growing to storm force.

The Country Fire Authority and the Victorian Department of Sustainability and Environment (now the Department of Environment and Primary Industries) identified and/or attended 316 fires that had a devastating effect in terms of loss of life, injury, and damage to property and land (2009 Black Saturday Royal Commission, 2010). The Royal Commission investigated 15 of the most damaging fires. The greatest loss resulted from the Kilmore East fire where 119 lives were lost, followed by Murrindindi (40 lives), Churchill (11 lives), Beechworth-Mudgegonga (two lives) and Bendigo where one life was lost (2009 Black Saturday Royal Commission, 2010).

A total of 173 lives were lost and approximately 430,000 hectares were burnt. The total tangible cost was thought to have exceeded \$4 billion (2009 Black Saturday Royal Commission, 2010), with environmental and agricultural losses estimated at around \$366 million and \$733 million respectively, further underlining the impact of the bushfires (Stephenson, Handmer & Haywood, 2012).



February 7, 2011: Kinglake, VIC. A young couple comfort one another after attending a memorial service in Kinglake, Victoria, on the second anniversary of the Black Saturday bushfires, which were the deadliest in Australia’s history, claiming 173 lives. (Craig Borrow / Newspix)

3. The cost of natural disasters: Australian experiences

Figure 3.1: Map of areas affected by the 2009 Black Saturday bushfires



Source: 2009 Black Saturday Royal Commission (2010)

3.1.2.1 Economic cost of the 2009 Black Saturday bushfires

The Black Saturday bushfires on 7 February 2009 constituted one of the worst natural disasters in Australian history. More than 300 fires occurred across the state, killing 173 people and injuring 414 more.

The intangible costs associated with these bushfires were estimated to be significantly higher than the tangible costs, at \$3.9 billion dollars compared to \$3.1 billion dollars respectively. This means the ratio of intangible costs to tangible costs was around 1.3.

Deaths and injuries

The most serious consequence of the Black Saturday bushfires was the loss of 173 lives.

A total of 414 people presented to hospital emergency departments with bushfire-related injuries in the 72 hours after the fires. Twenty-four patients were subsequently treated at a burns referral centre. Of those, 50% required care in the intensive care unit, with three individuals ultimately passing away as a result of their burns. Of those presenting to the emergency department, 124 were primarily suffering from burns, 62 from physical trauma injuries and 42 from smoke inhalation. The bushfires were largely characterised by high mortality rates and relatively few survivors with serious injuries (Cameron et al., 2009).

Based on the average life expectancy in Victoria and the average age of people affected by the bushfires, **the lifetime cost of deaths and injuries was estimated at almost \$930 million (net present value in 2015 dollars).**

3. The cost of natural disasters: Australian experiences

Mental health

A large-scale traumatic event with a high mortality rate, such as the Black Saturday bushfires, inevitably has a large impact on the mental health and long-term psychological distress of those affected.

A significant minority of people reported persistent mental health problems after the fires. More participants in the highly affected communities (15.6%) reported probable Post Traumatic Stress Disorder (PTSD) linked to the bushfires than those in communities affected at medium (7.2%) and low levels (1.0%). Similar patterns were observed for depression (12.9%, 8.8% and 6.3% respectively) and severe psychological distress (9.8%, 5.0% and 4.9% respectively). All communities reported elevated rates of heavy drinking. One-third of people with severe psychological distress had not received mental health assistance in the month before the survey, indicating a need for more mental health support services.

However, the majority of people affected by the Black Saturday bushfires were able to recover from the trauma after a few years. Bryant et al. (2014) found that four years after the bushfires, the majority of respondents in communities affected at high (77.3%), medium (81.3%) and low (84.9%) levels reported no psychological distress on the Kessler-6 Psychological Distress Scale screening scale².

Mental health care, including the cost of caring for those drinking at high-risk levels, was the largest intangible cost resulting from the fires. The proportion of people suffering from PTSD in the first year was based on research by Bryant (2014), which estimated the weighted rate across areas affected at high, medium and low levels to be 11.2% for men and 18.7% for women. Over the long term, it is assumed the rate will fall to around 0.6% for men and 0.9% for women. **The lifetime cost of mental health issues are estimated at more than \$1 billion (net present value in 2015 dollars).** This cost is less than the cost associated with the Queensland floods because the bushfires happened in less populated areas.

High-risk alcohol consumption

Mental health-related behaviours such as substance use (alcohol and smoking) have been documented following disasters (Turner et al., 2014). Bryant et al. (2014) mapped the prevalence and predictors of psychological outcomes in communities 3–4 years after the Black Saturday bushfires in Victoria, split into communities affected at high, medium and low levels. The study found that while all communities reported an elevated rate of heavy drinking (24.7%, 18.7% and 19.7% respectively), the rate was around 1.4 times higher in the highly affected communities.

Using this to estimate the proportion of people with short- or long- term increases in risky and high-risk alcohol consumption, **the lifetime cost resulting from the bushfires is estimated at about \$190 million (net present value in 2015 dollars).**

Chronic and non-communicable diseases

As discussed in the floods case study, evidence shows that natural disasters exacerbate chronic disease. Given the lack of quantitative data on the incidence of chronic disease exacerbation as a result of the Black Saturday bushfires, the HILDA longitudinal survey was used in combination with prevalence rates of diabetes, COPD and stroke in Victoria as a baseline.

From this, it is estimated that the cost of the exacerbation of diabetes, COPD and the development of stroke resulting from the bushfires was around \$320 million (net present value in 2015 dollars).

Family violence

There is a well-documented increase in the incidence of family violence in populations impacted by disasters, predominantly physical abuse between partners and sexual abuse. However, these increases can be hard to quantify given the chaotic context and the difficulty of accurately observing family violence. A large-scale survey of those displaced by Hurricane Katrina showed that the incidence of family violence more than tripled after the disaster and remained elevated for two years (Anastario et al., 2009).

2. The Kessler Psychological Distress Scale is a questionnaire intended to yield a global measure of distress based on questions about anxiety and depressive symptoms that a person has experienced in the most recent 4 week period. The K-6 scale is a simplification of the K-10 scale, which measures a person's level of psychological distress based on their questionnaire score. The scale ranges from low distress to very high distress.

3. The cost of natural disasters: Australian experiences

A study of those affected by the Black Saturday bushfires identified increases in the incidence and severity of family violence (Walters & Mair, 2012). Parkinson (2014) interviewed 30 women in Victoria from two affected shires – 17 of whom reported family violence. Nine of the 17 relationships in the study reported no violence before the fires, and seven of these relationships were categorised as stable and non-violent. Seven reported the violence had escalated sharply or had been an isolated incident many years earlier.

Rates of family violence in areas severely impacted by the Black Saturday bushfires were compared against the rates in the rest of the state. **It is estimated that family violence cost around \$990 million (net present value in 2015 dollars).**

Environmental damage

The bushfires had a devastating impact on the environment and the natural resources in Victoria. Around 24,470 acres were damaged, 90% of which were in national parks. VicForests estimated the cost of the destroyed standing timber at approximately \$600 million. In addition, Melbourne Water estimated damage totalling \$5 million to its natural and built assets.

This paper has adopted the estimate formulated by Stephenson, Handmer and Haywood (2012) for the total cost of environmental damage. The impact of the fires on the environment was valued in terms of the benefits the environment provides humans, such as water supply, nutrient cycling, climate regulation and recreation, following the framework of Costanza et al. 1997, which provides a differential valuation based on the type of environment lost (for example, cropland or forest). Using this, **it is estimated that the cost of environmental damage was approximately \$410 million (net present value in 2015 dollars).**

Box 3: Intangible costs and gender

The social effects of natural disaster are significantly gendered, with women much more likely to experience adverse social impacts, such as family violence.

The incidence of violence against women increases following a natural disaster, and the effects of violence are longer-lasting for women than for men, suggesting a higher severity. Two studies, Clemens (2013) and Alderman (2013), also found that women were more likely to experience psychological distress up to 12 months after the Queensland floods. For example, Clemens (2013) found that after six months, the number of women experiencing distress was 8.8%, compared to 5.3% for men.

Not only does this demonstrate that the costs of social impacts are borne differently by women and men, but that responses to the adverse social impacts of a natural disaster may need to consider gender.

One example of how this has been achieved is the community-led group Firefoxes Australia, which provides a resilience program for women. Formed in the aftermath of the Black Saturday bushfires, the group provides a forum for women in the Kinglake region to connect and recover from the bushfires.

Firefoxes Australia uses feedback from women in the community to decide which services it will provide. These services include social activities, connecting people with health services, organising retreats, meal sharing, family fun days and providing information about disaster preparedness and recovery. The group has shared its grassroots disaster recovery and resilience model with other communities that have experienced a natural disaster.

Source: firefoxes.org.au

3. The cost of natural disasters: Australian experiences

Short-term unemployment

The Black Saturday bushfires caused significant short-term unemployment. A sample of transaction data from the Commonwealth Bank of Australia (2011) shows a 66% increase in the number of individuals receiving Newstart Allowance as their primary source of income. However, this proportion subsided relatively rapidly, returning to pre-bushfire levels after approximately 12 months.

As with the floods case study, this has not been separately costed, to avoid double counting.

Tangible costs

The tangible cost of the Black Saturday bushfires includes damage to private property and public infrastructure, and costs incurred due to disruptions in business activity. Over 3,500 structures were destroyed, including at least 200 houses, 50 commercial properties and 1000 farm structures.

The 2009 Victorian Bushfires Royal Commission estimated total general insurance payouts due to damage to private property at more than \$1.2 billion dollars, and the cost of the loss of and damage to infrastructure at more than \$77 million. In a survey of people affected by the fires, 59% of respondents had their house damaged or destroyed during the bushfires (Bushfire CRC, 2010).

The Royal Commission estimated the tangible cost of the fires at \$4.4 billion, including:

- Response costs, for which there was Victorian Government supplementary funding
- Damage costs, including insured losses; loss and damage to public infrastructure; the Victorian Bushfire Reconstruction and Recovery Authority costs; fatalities; destroyed timber and replanting; asset damage; costs incurred by Telstra and Melbourne Water; and the cost of the 2009 Victorian Bushfires Royal Commission.

The Victorian Bushfire Appeal Fund (VBAF) was established by the Australian Red Cross in partnership with the Victorian and Commonwealth governments to support the individuals and communities affected. The appeal officially closed around three months after the bushfires and raised \$379 million. Around 60% of VBAF funding went towards housing support, including over 6,677 payments to those whose homes were destroyed or damaged (Fire Recovery Unit, 2014). Other VBAF funding was distributed through initial emergency payments, personal support payments and support for communities.

Box 4: Social impacts and legal advice

Following the Black Saturday bushfires, individuals, their families and businesses faced legal issues which shed light on (but cannot be directly attributed to) some of the social effects of the fires.

People sought advice from Victoria Legal Aid about the following issues:

- Residential and commercial property damage and insurance claims (around 30%)
- Deceased estates (around 35%)
- Financial hardship and compensation issues (around 10%)
- Divorce (around 4%).

Other issues included tenant/landlord disputes, neighbour disputes (for example, fencing) and domestic/commercial planning.

Victoria Legal Aid provided legal advice on more than 750 occasions in the five years following the disaster, where clients expressly identified their legal problem was bushfire-related (many more may not have identified this).

Source: Victoria Legal Aid, 2015

3. The cost of natural disasters: Australian experiences

The impact on tourism in the Gippsland region, including subsequent loss of business revenue and productivity, was relatively minor (Walters & Clulow, 2010; Mair, Ritchies & Walters, 2014). The research found that, while it was implied that media coverage had a significant impact on tourist perceptions, the Gippsland tourism industry remained relatively stable (Walters & Clulow, 2010).

The bushfires generated almost \$1.3 billion (2011 dollars) in insurance costs (Insurance Council of Australia, accessed 2015). Using the methodology shown in Appendix D for tangible costs **the total estimated tangible cost associated with the 2009 Black Saturday bushfires is around \$2.6 billion (2011 dollars) or \$3.1 billion (in 2015 dollars)**. Table 3.2 gives a breakdown of the tangible cost estimates.

Total economic cost

The total cost of the 2009 Black Saturday bushfires is estimated at about \$7 billion at current prices, with \$3.9 billion in social impacts and \$3.1 billion in direct financial impacts (Chart 3.2). The methodology for this estimate is given in Appendix D. Again, the intangible cost estimate is conservative as some costs could not be quantified. This suggests the economic cost of the social impacts is as high, if not higher, than the tangible costs with a ratio of around 1.3.

Table 3.2: Tangible cost estimates for the 2009 Black Saturday bushfires

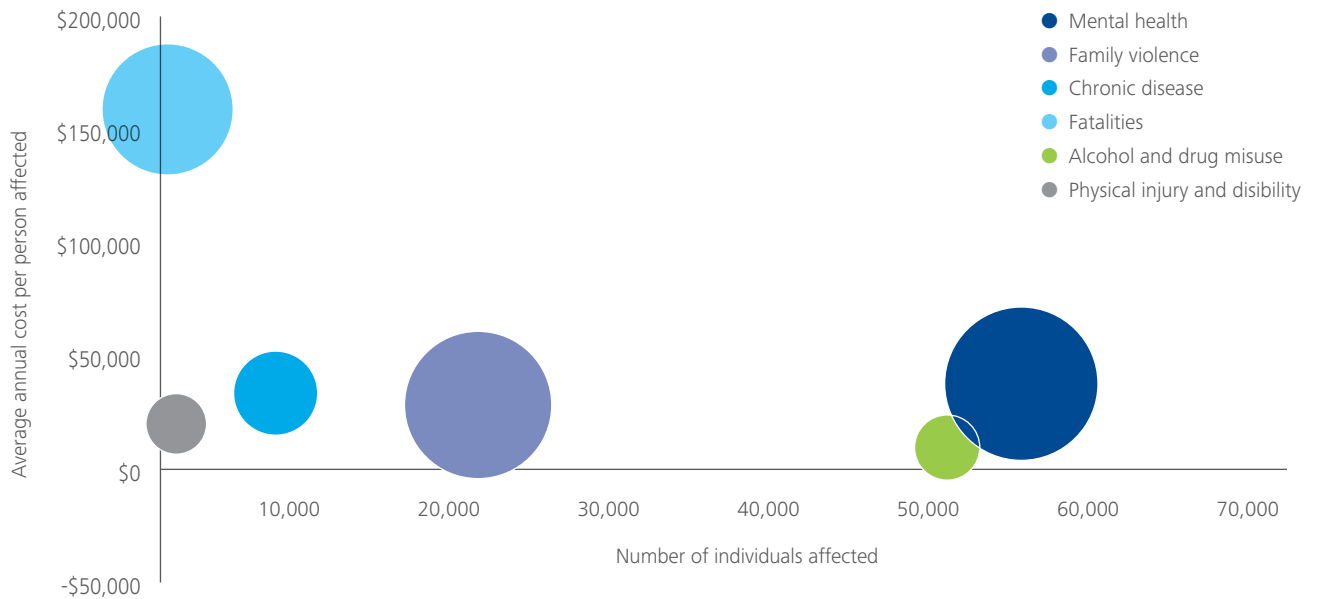
	Percentage of total	\$m (2011)
Insured	41.7	\$1,266
Uninsured	32.8	\$593
Category B	23.0	\$696
Agricultural production lost	0.0	\$0.04
Evacuated	0.0	\$0.09
Homeless	0.0	\$16
Homes – damaged	0.3	\$6
Commercial – damaged	0.1	\$1
Emergency response costs	2.1	\$65
Total	100	\$2,644

Source: Estimates use BTE (2011) and *Building our Nation's Resilience to Natural Disasters*.

Note: Category B refers to assistance to the state, and/or local governments for the restoration of essential public assets and certain counter-disaster operations through the National Disaster Relief and Recovery Arrangements. Category B assistance also covers assistance to small businesses, primary producers, not-for-profit organisations and needy individuals through concessional loans, subsidies or grants. Category B assistance is provided automatically by the states without requiring approval from the Australian Government.

3. The cost of natural disasters: Australian experiences

Chart 3.2: A breakdown of the tangible and intangible costs of the Black Saturday bushfires (\$ millions)



Note: Area of circle denotes the total cost of the category of intangible cost.



Queensland Fire and Rescue Service

3. The cost of natural disasters: Australian experiences

3.2 Total average cost of natural disasters in Australia

For two case studies considered in this report, a bottom-up approach was applied, where each outcome was derived from a base affected population and multiplied by the incidence and unit cost. Meanwhile, to estimate the total average cost of natural disasters in Australia (based on simulations of future disasters), a top-down approach was used (Appendix D). A conservative ratio of intangible to tangible cost reported in the two case studies was used to factor up the tangible cost estimated in *Building our Nation's Resilience to Natural Disasters*.

The top-down approach can then be applied to estimate the intangible costs of specific natural disasters which lack the data to build intangible costs up using a bottom-up approach. Section 3.2.1 estimates the intangible cost of the 1989 Newcastle Earthquake using this framework.

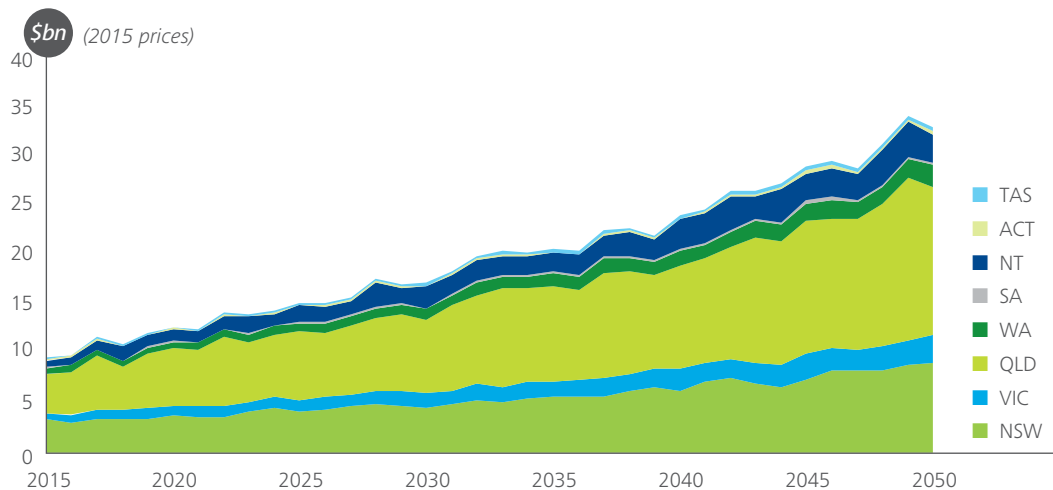
Using this methodology, the total economic cost of natural disasters in Australia, including tangible and intangible costs, was an estimated \$9.6 billion in 2015. By 2050, the total economic cost of natural disasters in Australia is expected to be around \$33 billion in real terms (Chart 3.3).

3.2.1 Newcastle earthquake

Though Australia is not located at the margins of tectonic plates, analysis by insurance group Munich Re (2015a) indicates an earthquake of magnitude 6.0 or greater on the Richter scale can be expected every five years on average, and is likely to occur in or around the capital cities of Perth, Adelaide, Melbourne and Sydney (Figure 3.2). Earthquakes have most recently occurred in Moe, Victoria, in 2012 (5.4 magnitude) and Bowen, Queensland, in 2011 (5.3 magnitude). As shown by the 2011 earthquake in Christchurch, New Zealand, an unexpected earthquake of even moderate magnitude near a heavily populated city can, and did, have a devastating impact.

On 28 December 1989, a 5.6 magnitude earthquake struck near the town of Boolaroo, 15 kilometres west of the Newcastle central business district, and 140 kilometres north of Sydney. Thirteen people lost their lives and more than 162 were injured, making the earthquake the deadliest in Australia. Nine deaths occurred when the Newcastle Workers Club collapsed. More than 35,000 homes, 147 schools and 3,000 other buildings were damaged (Australian Geographic, 2015).

Chart 3.3: Forecast total economic cost of natural disasters for 2015–50



Source: Deloitte Access Economics estimates

3. The cost of natural disasters: Australian experiences

3.2.1.1 The economic cost of the Newcastle earthquake

Despite the moderate magnitude of the Newcastle earthquake, the effects were widespread. Due to the paucity of data relating to the social impacts of the earthquake, a top-down approach has been adopted to estimate the economic cost.

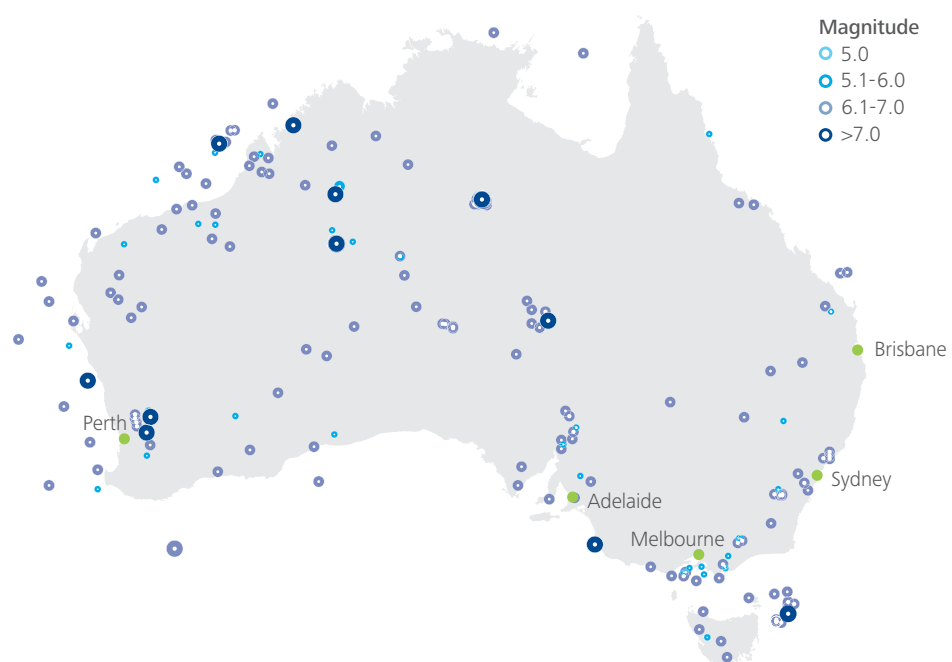
The Newcastle earthquake is estimated to have caused \$8.5 billion in tangible costs and \$10.2 billion in intangible costs, resulting in a total economic cost of \$18.7 billion in 2015 dollars.

The Newcastle earthquake had widespread effects. At the height of the crisis, between 300 and 400 people were placed in temporary accommodation. In the month following the earthquake, the Disaster Welfare Recovery Centre assisted almost 14,000 people (Geoscience Australia, 2015).

The most significant damage was around the shopping centre in Hamilton, which remained closed for six weeks. Entry was restricted to prevent looting and to safeguard the public from the hazards of damaged buildings. Carr et al. (1997) note that almost 70,000 insurance claims were made throughout the Hunter region after the earthquake, of which 10% were for damage to commercial properties.

Dobson et al. (1991) studied whether stress generated by the Newcastle earthquake led to an increased risk of heart attack and coronary death. There were six fatal heart attacks and coronary deaths among people aged less than 70 years in the four days following the earthquake – an unusually high number for that time of year. There was no evidence of increased risk of heart-related health issues during the following four months.

Figure 3.2: Earthquake epicentres in Australia since 1840



Source: Munich Re (2015a)

3. The cost of natural disasters: Australian experiences

In terms of mental health impacts, 21% of the adult Newcastle population was estimated to have used the general support and/or disaster-related services available to them, while medical services were used by 6% of adults (Carr et al., 1997). Though it was estimated that 1.5% of the adult population was injured in the earthquake, only 0.4% required medical treatment for their injuries. After adjusting for the level of psychological morbidity had there not been an earthquake, it was estimated that 28% of the people who were highly exposed to the earthquake (4,000 people) experienced moderate to severe psychological distress as a direct result. Furthermore, 18.3% of those exposed to high levels of threat (equivalent to 2% of the population) were likely to have suffered PTSD in the six months following the earthquake.

The earthquake only temporarily affected the electricity supply (Caldwell, 2013). Multiple failures occurred in the electricity substations closest to the earthquake epicentre and shut down supply to both industrial and domestic consumers. However, operational supply was restored to major industrial customers 1.5 hours after the incident, and all bulk supply points were restored after 2.5 hours.

The paucity of data on the effect of the earthquake led to the application of a top-down approach to estimate the intangible costs. According to the ICA database, the earthquake cost \$3.2 billion in insured losses (normalised to 2011 dollars). Based on an average tangible cost to insured losses multiplier of 2.2 and an average intangible cost to insured losses multiplier of 2.4, **the Newcastle earthquake generated an estimated \$8.5 billion in tangible costs and \$10.2 billion in intangible costs, resulting in a total economic cost of \$18.7 billion in 2015 dollars.**

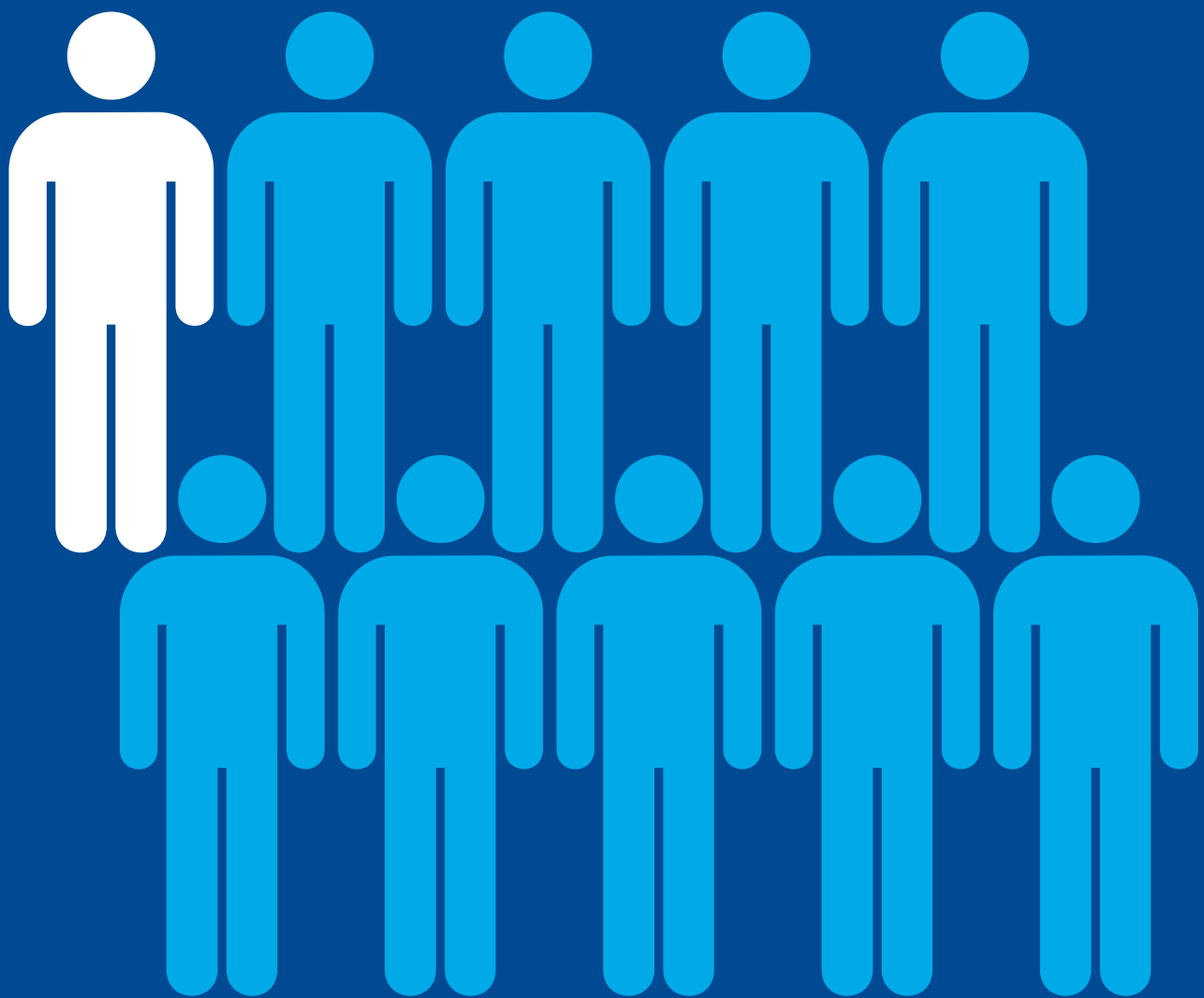


January 18, 2011: Brisbane, QLD. Army personnel help with the clean-up operation in Graceville, Brisbane in Queensland, after floodwaters receded leaving behind widespread property damage. (Anthony Reginato / Newspix)



Tributes: Flowers and messages on a fire-damaged tree on the one-year anniversary of Black Saturday (Richard Kendall AFP / Getty Images)

More than 1 in every 10 people exposed to natural disasters are reported to develop psychological distress with some persisting for the rest of their lives.



4. Building resilience: the case for community awareness, education and engagement programs

Key points

- The long-lasting impacts of natural disasters – sometimes lifetime impacts – means funding should also include resilience and mitigation measures for social and psychological impacts such as community awareness, education and engagement programs
- While data on the effectiveness of these programs is currently limited, there is significant evidence to show that strong social capital and community connectedness contributes to post-disaster recovery.

This report demonstrates the total economic cost of natural disasters in Australia is estimated at \$9.6 billion in 2015 and is expected to increase to about \$33 billion in 2050. Furthermore, these estimates are based on conservative assumptions, which suggest that actual costs could be even higher. The long-lasting impacts of natural disasters and the high lifetime costs of social impacts are motivation to consider measures to build the resilience of individuals and communities to disasters.

When government policy and funding has focused on resilience and mitigation, it has done so for physical infrastructure, such as building flood levees. However, the high economic cost of social impacts of natural disasters means funding should also include resilience and mitigation measures for social and psychological impacts such as community awareness, education and engagement programs.

Anne Leadbeater, who was awarded the Medal of the Order of Australia for her service to the community of Kinglake in the aftermath of the 2009 Black Saturday bushfires, wrote in the Australian Emergency Management Knowledge Hub blog::

“A major challenge for those working with impacted communities is that the ‘lights and sirens’ pace of response so often gets carried over into recovery. We forget (or don’t get the chance) to differentiate the ‘urgent’ – food, water, shelter, fuel, material aid, which need to happen quickly, from the ‘strategic’ – community infrastructure, rebuilding, community planning, psychosocial support – those things that need to be carefully considered and thought through and about which community members will want and need to have input when they are ready. Coupled with the well-intentioned desire to relieve peoples’ sadness by fixing stuff and building stuff, it’s not hard to get caught up in a ‘fast equals effective’ bricks and mortar view of recovery.”

This highlights that while it is important to invest in recovering physical infrastructure, there is also a need to consider community and social infrastructure and psychosocial support when making decisions about post-disaster funding.

4.1 Building community resilience

Resilience is related to the capacity of a system to withstand, absorb and recover from disturbances caused by natural disasters. Important in this view of resilience is the notion of adaptation, where adaptation and transformation can be proactive to help prepare for future events, or reactive in response to an event that has already occurred (Handmer & Dovers, 1996; Engle, 2011). Learning from experience and maintaining a focus on review and adjustment helps to build resilience to future events.

The resilience of a community is not a binary characteristic, but rather describes a process of linking a network of adaptive capacities in response to adversity or crisis (Norris et al 2008). The relationship between community resilience and individual resilience may also increase the complexity of the situation, with the resilience of the community impacting the individual’s ability to be resilient to stress and vice versa (Berkes and Ross 2013).

Community resilience to disaster describes two interrelated concepts:

- Coping capacity – the factors influencing the ability of a community to prepare for, absorb and recover from a natural disaster
- Adaptive capacity – the factors that enable adjustment of responses and behaviours through learning, adaptation and transformation.

4. Building resilience: the case for community awareness, education and engagement programs

As such, community awareness, education and engagement programs tend to be one of two types:

- Preparedness and mitigation strategies to reduce the exposure and vulnerability of individuals and communities to disasters by shifting the community mindset towards a culture of proactive preparedness and prevention
- Community recovery measures that encourage community and social connectedness to support individuals in times of need and empower them to adapt and improve post-disaster.

Individuals and communities display both coping and adaptive capacities during the four different phases of a disaster: that is, through preparedness, prevention, response and recovery (see Box 5).

Evidence shows that social capital – the networks and resources available to people through their connections to others – is critical in building resilience in communities following disasters. Aldrich (2012) studied four disasters: 1923 Tokyo earthquake, 1995 Kobe earthquake, 2004 Indian Ocean Tsunami and 2005 Hurricane Katrina. Quantitative and qualitative analysis showed that those areas with higher levels of social capital facilitated recovery and assisted survivors in coordinating more effective reconstruction post disaster. This effect was found to be larger than factors such as greater economic resources, assistance from the government or outside agencies and low levels of damage. The book notes:

‘Even highly damaged communities with low income and little outside aid benefit from denser social networks and tighter bonds with relatives, neighbors, and extralocal acquaintances. Alternatively, neighborhoods with lower levels of social resources can find themselves unable to organize collectively to deter looting and garbage dumping, to communicate necessary requests to the authorities, and to work together to rebuild their community. Deeper reservoirs of social capital serve as informal insurance and mutual assistance for survivors, help them overcome collective action constraints, and increase the likelihood that they will stay and work to rebuild (as opposed to moving elsewhere).’

Box 5: Measures to build community resilience

Resilience is the *‘ability of a system, community or society exposed to hazards to resist, absorb, adjust to and recover from the effects of a hazard in a timely and efficient manner, including initiatives to preserve and restore essential structures and functions’* (United Nations, 2009).

Measures to improve resilience can be broken into four categories:

1. **Preparedness:** including proactive physical, psychological and social preparation for a disaster, such as planning and undertaking property maintenance prior to a disaster
2. **Prevention:** including physical mitigation measures aimed to stop the disaster (or its consequences) from occurring, such as burying power lines in bushfire-prone areas to reduce the risk of the lines sparking a fire
3. **Response:** measures aimed at reducing the adverse impacts of disaster as they occur, for example, evacuating individuals from a flood risk area in the case of a flood
4. **Recovery:** where individuals and communities are offered help to recuperate from the physical and psychological damage of a disaster, for example, providing survivors with Psychological First Aid.

Community engagement programs are largely preparedness measures aimed at stopping the longer-term effects of disasters. However, it is important to note that response and recovery measures allow communities to continually improve and increase their resilience, thereby preparing them for future events.

4. Building resilience: the case for community awareness, education and engagement programs

4.1.1 Building community resilience in Australia

The need for disaster mitigation funding to include 'soft mitigation' such as community awareness, education and engagement programs was recognised and emphasised in the Productivity Commission's inquiry into current natural disaster funding arrangements (2015). The Commission noted:

"Soft mitigation, like community education and other preparedness measures, can yield significant benefits over time where it modifies behaviour and results in the avoidance of disaster risk."

In 2011, Australia adopted the National Strategy for Disaster Resilience (NSDR). The strategy provides high-level direction and guidance on how to achieve disaster-resilient communities for all levels of government, businesses, community leaders and the not-for-profit sector.

The NSDR recognises four characteristics of disaster-resilient communities:

1. Functioning well under stress
2. Successful adaptation
3. Self-reliance
4. Social capacity.

Following the NSDR, emergency management plans at the state-level are undergoing reform. In Victoria, work is underway to develop a Modern Emergency Management System focused on building resilience in the community in a way that is tailored to the community's unique networks, connections and structures (Emergency Management Victoria, 2015). This involves focusing on the strength and sustainability of a community's infrastructure and institutions, as well as building and strengthening the links between people and the services, systems and structures that support the functioning of the community. It will also work towards integrating emergency services to advance beyond the traditional categories of prevention, preparedness, response and recovery processes.

Additional research and data collection is required to fully understand the complexities of building resilience in communities and the best practice tools and pathways with which to facilitate this. Researchers funded by the Bushfire and Natural Hazards Co-operative Research Centre are currently working on developing an Australian Natural Disaster Resilience Index which measures the level of resilience in a community through a system of indicators based on the four NSDR characteristics. This index will facilitate assessment, evaluation, reporting and planning for natural hazard resilience under the NSDR.

Box 6: Community-based recovery

The benefits of community-based recovery services are demonstrated through those provided by the Dungog Shire Community Centre (DSCC) following the Dungog floods of April 2015. Dungog, a NSW town with a population of just over 2,000, was hit by a flash flood in April 2015. Three people died and 82 houses were destroyed or damaged. In the immediate aftermath, the DSCC provided assistance with housing, food and clothing, mental health services and coordinated volunteer operations. But recovery is a long journey and the DSCC recognised that people needed continued support and connections with the community. The DSCC initiated Project Bounce Forward to provide information, referrals, decision-making and emotional support.

Under the *State Emergency and Rescue Management Act 1989* (NSW), local governments are required to establish a Local Emergency Management Committee (LEMC). These include representatives from the local council, Police Service, Fire and Rescue, Ambulance Service and State Emergency Service (SES). Other states have similar provisions. While the plan advocates a principle of subsidiary where emergency management is conducted at the lowest effective level, in practice local community resources risk not being used effectively. There is no requirement for the LEMC to engage with community organisations and, frequently, they do not. An independent review of the Dungog floods found that the Dungog LEMC was largely unaware of the considerable capabilities of the DSCC.

Communication and coordination between existing community-based organisations and local government are essential in recovery efforts, as well as in preparedness and prevention activities.

Source: Consultation with Sarah U'Brien, DSCC Manager; ABC News (2015b).

4. Building resilience: the case for community awareness, education and engagement programs

4.2 Examples of community resilience programs

Building resilience is a shared responsibility between government, businesses, communities (including not-for-profit groups and agencies) and individuals.

“Disaster resilience is the collective responsibility of all sectors of society, including all levels of government, business, the non-government sector and individuals.” (COAG National Disaster Resilience Statement, 7 December 2009)

There is widespread acceptance of the need to work with members of the community in the emergency management process. Governments, community organisations and industry have made considerable efforts over the years to engage the public in this emerging area.

“Community engagement... is the process of stakeholders working together to build resilience through collaborative action, shared capacity building and the development of strong relationships built on mutual trust and respect.” (National Strategy for Disaster Resilience Community Engagement Framework, 2013)

4.2.1 Australian programs

A number of community awareness, education and engagement programs in Australia aim to foster individual and community resilience.

4.2.1.1 The Australian Red Cross's RediPlan

The Australian Red Cross's RediPlan is a general, all hazard preparedness guide to help individuals and the community to prepare, respond and recover from natural disasters. Resources are provided for seniors, people with a disability and their carers, people from culturally and linguistically diverse (CALD) backgrounds, and children. Emphasis is placed on both physical and psychological preparedness. The program costs \$990,000 per annum, with funds managed on a state-by-state basis.

In 2013 the Torrens Resilience Institute evaluated RediPlan. Key findings included:

- The RediPlan community education program accessed the more difficult-to-reach members of the community, who may not have attended other emergency service public education sessions.
- The findings from the surveys of those who attended RediPlan sessions showed that, immediately following the education session, there was an increase in knowledge about environmental risks, the sources of real-time emergency information and the need to have a plan. The findings from surveys two and nine months after the sessions showed a broader range of risks were identified and their knowledge appeared to have been retained over time.

A 2014 review of the program recommended greater face-to-face engagement, leading to the development of a Preparedness Engagement and Education framework, which will be finalised by June 2016.

4.2.1.2 Stormsafe NSW

StormSafe NSW is a program developed by the NSW SES and IAG, through the NRMA Insurance brand, to build awareness of storm risk and provide practical information to individuals to work together to prepare for and reduce the impact of storms. The program has three main components: a state-wide message campaign, including TV, radio, and social media content; education activities to teach people how to physically prepare their homes; and local community engagement.

Community education activities include workshops, NRMA Insurance in-store displays, and conversations about local risks with the public at key community events. Community engagement strategies include the identification of local champions as influencers in their own networks, establishing local reference groups to look at local hazards and promote learning through emergency planning.

The program costs almost \$990,000 per annum. This figure does not include the contribution of volunteer hours.

4. Building resilience: the case for community awareness, education and engagement programs

The StormSafe website is the program's main source of safety information. Website visitors increased by 70% during the 2014-15 campaign, compared to the previous year.

A survey of people exposed to StormSafe's 2014 campaign found that all had taken some kind of action in the previous three months to prepare for storms. The program also led to an 8% increase in the number of people in NSW who felt more prepared for storm activity than they did in 2012.

Other NSW SES community awareness, education and engagement programs include FloodSafe and TsunamiSafe. These programs also promote learning at a community and individual level.

Currently the NSW SES is investigating more effective strategies in community engagement for their FloodSafe program. Initiatives include:

- **Community-led planning:** Community members from Uki on the north coast of NSW asked how they could establish a local emergency management committee. The enquiry came from witnessing NSW SES processes in nearby Tumbulgum. In partnership with the SES, Uki residents established the Uki Emergency Management Committee to determine local impacts, preparation, response and recovery needs and solutions.

- **Agency-initiated but community-led planning:**

The NSW SES held gatherings at Uranquinty, south of Wagga Wagga, to look at the significant risk that they could not adequately respond to local floods. Discussions were held with community members about meeting this gap locally through identifying the risks as well as capacity issues. From these discussions, a group was formed to develop local response plans which included identifying high needs residents, establishing local phone trees and even determining a better evacuation centre for the town. A drill of the response plan was undertaken by the community of Uranquinty in 2015. Similar plans have also been implemented by caravan parks on the north coast of NSW and other communities in the NSW SES Murrumbidgee area.

- **Flood Reference Groups:** On the mid-north coast of NSW, flood reference groups were set up to help the NSW SES to identify and investigate local issues. They looked at flood impacts for a range of communities and provided linkages back to the community for information exchange and discussion. Local at-risk residents, business owners, rural property owners and other groups were involved.

Local children learn from NSW SES members how to safely rescue people from floodwater using a throw bag. This technique allows the rescuer to remain on the shore during the rescue, thereby reducing their exposure to risk (NSW SES)



4. Building resilience: the case for community awareness, education and engagement programs

- **Disaster scenario testing workshops:** These develop scenarios that realistically present information to community members about local impacts, through video, audio and mapping resources. Participants are run through a local flood progression and asked to provide actions and develop scenarios. Learning is based on group decision-making and discussions, while local social capital is built through connections and networking. An awareness of risk is established through the use of actual local flood risk information. Education is achieved through knowledge of warnings and discussions about appropriate actions. These workshops have been run in coastal NSW with diverse groups including local residents, business owners and aged care facilities. Participants could also expand to other high-risk groups, including Culturally and Linguistically Diverse (CALD) communities, newly arrived residents, caravan parks, flood prone housing estates, Indigenous communities and people living with a disability.
- **Community involvement in planning:** The NSW SES is investigating ways to involve community members in the review and development of Local Flood Plans (LFP). Part of this project is to research current best practice in community emergency management planning, establish local reference groups to develop processes and deliver engagement activities. A strategy is being developed which outlines a framework for including community members in these LFP reviews. The project will also map the current capacity of the NSW SES to achieve best practice in this area.

4.2.1.3 Business Roundtable EXTEND

Business Roundtable EXTEND was established in 2011 to help businesses prepare and connect to be more resilient in the face of disaster. The primary purpose was to assist small and medium-sized businesses to identify the risks a natural disaster might pose for a business, develop a preparedness plan, and encourage them to build networks to foster community resilience. Each roundtable is tailored to the issues and interests of local businesses.

4.2.1.4 Community Fireguard

The Community Fireguard program was established in the early 1990s by the Victorian Country Fire Authority (CFA) to promote fire safety and community resilience. The program seeks to build on the capacity of the local community, and to build resilience in residents whose lives may be directly impacted by a disaster.

Community Fireguard groups are encouraged to form themselves and usually comprise of 10-12 neighbouring households in high bushfire-risk areas. The groups are given information about living in a high risk environment, personal safety and resilience, and psychological preparedness. A CFA facilitator helps them develop bushfire behaviour and response strategies that suit their level of risk, lifestyle, environment and values. Implementation of preparation plans is led by local neighbourhood groups, with ongoing communication via meetings, newsletters, email (McGee, 2011).

A study of the program (Gibbs et al., 2015a) showed the average cost per Community Fireguard Group was \$10,884 (in 2012 Australian dollars). In the event of a major bushfire, each group was predicted to save \$732,747 by reducing property loss, and \$1.4 million by reducing fatalities. Based on a major bushfire event in the region of one in 100 years, the estimated cost savings in a 100-year period would be \$217,116 per group (not including psychosocial impacts).

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4.2.2 International programs

Quantitative evidence from international community awareness, education and engagement programs highlights the importance of initiatives that involve the entire community.

4.2.2.1 Earthquake safety education in Japan

In Japan, community education about earthquake safety and evacuation plans is routine. Awareness programs are ingrained in the school curriculum, beginning in kindergarten. Schools and businesses conduct regular earthquake evacuation drills, and emergency services, such as the police, practise the movement of emergency vehicles.³ Since 2011, annual national drills have been held on 1 September on Disaster Prevention Day with 2.3 million individuals taking part in 2014.

Repetition of emergency drills has been shown to encourage rote learning of emergency procedures. This can create challenges due to their inherent lack of flexibility when dealing with dynamic disaster scenarios. For example during an earthquake in Nepal, students who were taught to 'drop and cover' remained in buildings that were structurally unstable rather than moving outside to areas of less threat (Paci-Green et al. 2015).

While it is difficult to isolate the direct effects of these programs and exercises from those of broader resilience programs, it is likely they have affected the behaviour of the public response to disasters. It has been suggested that a result of these education programs is the notably calm and organised manner in which everyday citizens deal with earthquakes (Foster, 2011). Fraser, Matsuo and Leonard (2012) attributed this to improved survival rates in a study of the Great East Japan Earthquake and Tsunami in March 2011:

"Overall there was a 96% survival rate of those living in the inundated area of the municipalities visited. This can be attributed to mostly effective education and evacuation procedures."

3. <http://www.telegraph.co.uk/news/worldnews/asia/japan/8734690/Japan-holds-annual-earthquake-drill-first-since-March-disaster.html>

4.2.2.2 Bushfire mitigation and preparedness in Canada and the US

McGee (2011) examined bushfire (or 'wildfire') mitigation programs implemented at the neighbourhood level in North America and Australia. The study noted that interactive approaches involving two-way communication and partnerships between homeowners and organisations/government increased homeowners' knowledge and support of fire management. The study evaluated three wildfire mitigation programs that adopted a collaborative approach where residents were actively involved in their neighbourhoods: Firewise Communities/USA in the US, Firesmart-Forestwise in Canada, and Community Fireguard in Australia.

These programs join groups of residents to learn about the local bushfire risk, and collectively develop strategies for reducing the risk. The study found that participants demonstrated a willingness to engage in bushfire mitigation and preparedness activities at both the individual and neighbourhood level. There is evidence that these programs help build closer social ties between residents, which helps to engender a sense of community responsibility for fire safety.

"In addition to activities aimed at protecting themselves and their own property, residents spent time and considerable effort to help neighbours and to protect their neighbourhood." (McGee, 2011)

The study found that communication between neighbours and also between neighbours and government agencies was important in encouraging participation. It also noted that government support was crucial in all three programs to encourage resident involvement. Literature suggests that a strong relationship between the community and government motivates residents to attend information campaigns (Vaske et al., 2007) and support mitigation efforts (Olsen & Shindler, 2010).

McGee concluded that residents were interested in participating in neighbourhood-level bushfire mitigation programs when they had a desire to protect themselves and their families, have experienced hazard events, and where there was encouragement and support from government. However, it is important to note that these conclusions were drawn from a small sample of qualitative interviews with participants.

4. Building resilience: the case for community awareness, education and engagement programs

4.2.2.3 Organisational resilience in New Zealand after the Canterbury earthquakes

A report by Resilient New Zealand (2015) noted that the average cost to New Zealand of natural hazards is about NZ\$1.6 billion per year and large disasters such as the Canterbury earthquakes in 2010 and 2011 are estimated to cost over NZ\$40 billion.

The report, which focused on the role of business in improving resilience and recovery following the Canterbury earthquakes, found that:

'... local governments need to increase their focus on community resilience in their planning and work with businesses to unlock the contribution they can make. Businesses need to actively engage with local government in this.'

A National Public Education Programme is part of New Zealand's National Civil Defence and Emergency Management Strategy (CDEM, 2015). The program aims to 'effectively build public awareness and understanding by individuals and communities of hazards in New Zealand'. The program consists of a national media campaign with supporting resources – *Get Ready Get Thru* – and a school-based education program – *What's The Plan Stan?* – with ongoing monitoring and evaluation. 'Research in 2014 indicates that the preparedness messages are continuing to have an impact with increased awareness of hazards and growing numbers of people who are prepared.' (National Progress Report, 2015).

The *Get Ready Get Thru* program is evaluated each year. Approximately 60% of New Zealand residents are aware of the campaign. In 2014, 63% of individuals exposed to the ad campaign "took some action" because of the ad. However, the nature of these actions can vary significantly between respondents, and they do not indicate the level of risk mitigated.

4.2.2.4 Bangladesh's Cyclone Preparedness Programme

Bangladesh's Cyclone Preparedness Programme (CPP) draws strongly on community networks to help mitigate the impact of catastrophic cyclones that frequently hit Bangladesh's coast. It is comparable to Australian programs designed to promote community understanding and involvement in the dissemination of disaster information and warnings (such as community flood wardens), and to activities in other developed countries.

The CPP is a joint program of the Government of Bangladesh and Bangladesh Red Crescent Society (BDRCS). It ensures the rapid dissemination of official Bangladesh Meteorological Department cyclone warnings to communities, trained volunteers and officers. Warning messages are transmitted by radio then spread through local villages by volunteers using megaphones, signal flags and sirens.⁴

The United Nations Environment Programme (UNEP) report published in December 2015, *Collaborating for Resilience*, found that:

'The success of the CPP was demonstrated during the 1997 cyclone, an event of a similar scale to the 1970 cyclone, which killed 500,000 people. The effective response of volunteers and communities enabled the evacuation of one million people to cyclone shelters, reducing the death toll to 193.'

4. http://www.iawe.org/WRDRR_Bangladesh/Preprints/S4CPP.pdf

4. Building resilience: the case for community awareness, education and engagement programs

4.3 Key considerations for community resilience programs

The qualitative evidence shows there is a need to build the resilience of communities in order to cope and adapt after natural disasters. Australian and international experiences have shown a number of key factors in the effectiveness of community awareness, education and engagement programs.

4.3.1 Implementing appropriate incentives

Until recently, governments placed a heavy focus on recovery measures, often in the form of disaster assistance payments to assist rebuilding. The former Minister for Emergency Management, Robert McClelland (2013), argues this focus has led to a moral hazard: individuals have no incentive to undertake disaster preparedness measures since the cost of recovery will in part be borne by the government.

'Part of the problem is that governments have contributed to the development of a culture of entitlement rather than a culture of prevention. This has occurred because the emphasis of government has been on being seen to provide assistance to individuals after they fall victims to a natural disaster rather than on developing strategies and working with communities to prevent those communities from falling victim to disaster in the first place.'
(Robert McClelland, 2013)

The Productivity Commission (2015) noted that this current reimbursement model of recovery funding reduces incentives to implement appropriate and cost-effective options for disaster preparedness and recovery. Proper incentives need to be put in place to not only increase uptake of preventative measures, but also to encourage learning and modification of behaviour.

Research examining the types of incentives that could be used include:

- **Implementing targets on the social impacts of natural disasters** such as reducing the number of disaster-related deaths and reducing the economic cost of social impacts
- **Incorporating both the direct and indirect, tangible and intangible costs of natural disasters** when building the case for investment in community resilience programs
- **Linking the amount of disaster recovery funding to the level of hazard reduction or resilience measures adopted** by communities or individuals
- **Using insurance premiums as a financial incentive** to implement pre-disaster measures that reduce damage
- **Providing competition-based incentives to promote innovation and resilience.** For example, Rebuild by Design is a US Department of Housing and Urban Development competition that is intended to spur redevelopment of resilient communities affected by Hurricane Sandy. The competition brings together designers, businesses and policy makers to ensure the area's resilience and environmental sustainability.

4.3.2 Awareness versus learning and behaviour modification

Government, industry and community groups all have a role in developing individual and community resilience. Motivating individuals and communities to take preventative measures, however, has proven difficult, despite the relatively low effort required compared to the potential cost of natural disasters. This could be due to the moral hazard problem outlined by McClelland or possibly behavioural biases in individuals which distort personal risk assessments, as well as a number of other factors.

Mass market, broadly targeted awareness programs that seek to inform individuals of disaster prevention procedures do not by themselves effectively motivate learning and modification of behaviour.

4. Building resilience: the case for community awareness, education and engagement programs

“There is not a strong and causal link between receiving information and acting appropriately for hazards.” (Dufty, 2011)

These programs can be a necessary initial step in raising awareness and providing basic information on prevention practices, but must be followed by interactive community engagement (as opposed to merely delivering to communities) to fully motivate individuals to undertake prevention measures (Toman & Shindler, 2011).

There is a substantial amount of literature on effective education and communication measures on disasters and other risks (Miletti et al., 1999), but it is often assumed that simply providing information on hazards or risk will precipitate the adoption of preventive measures. The information–action link assumes that recipients automatically assimilate, comprehend and use information in forming and following action plans but, in practice, this is rarely the case.

Kieffer (1984), and Paton and Bishop (1996) describe community engagement strategies as enhancing both real and perceived control, facilitating community identification of problems, and developing strategies to solve or contain problems in ways consistent with local needs, systems and values. A consensus approach to decision-making is recommended to enhance community ownership of the plan. Participation in identifying shared problems, and developing and implementing solutions, creates a better sense of community. A focus on actively dealing with salient issues helps to foster individual and collective efficacy.

4.3.3 Need for emotional preparedness

Even where preparedness programs are effective in motivating learning and behaviour modification, there are indications they may not sufficiently prepare individuals for the emotional toll of disasters.

For example, research into preparedness for the Adelaide Hills bushfires of January 2015 (Every et al., 2016) found that concern about bushfires was high and a significant majority of people had undertaken pre-fire preparation actions (such as cleaning gutters and removing hazards and vegetation around their home). However, people were poorly emotionally prepared and struggled with the emotional strain the fire caused. Lack of emotional preparation led people to change their bushfire plans at the last minute. For example, as the fire approached, fear began to increase and people decided to leave their property although they had originally planned to stay. Some attempted to return to their property. Following the release of this report, the South Australia Country Fire Service acknowledged that more emphasis needed to be placed on emotional preparation in their community education programs (ABC 2015).

Given the high costs associated with the psychological impacts of natural disasters, it is important that community awareness, education and engagement programs adequately prepare individuals for the emotional toll that disasters may have on them.

Box 7: Targeted children and youth preparedness programs

Children, and households with children, are particularly vulnerable to both the physical and psychosocial risks of natural disasters. Research has shown that children can play a key role in promoting resilience in a household by encouraging their family to discuss and prepare for risks.

In 2014, Michelle Webb and Professor Kevin Ronan conducted a study of 20 youths from low socio-economic backgrounds who undertook interactive hazard education programs outside the school context. After the program, their parents reported carrying out an average of six additional home based activities to prepare for potential natural disasters.

A number of factors influence how effective these education programs are. According to Professor Ronan’s research, school based preparedness programs are most effective when repeated regularly, provide realistic perceptions of the risks, and encourage children to talk to their parents about disasters.

4. Building resilience: the case for community awareness, education and engagement programs

4.3.4 Localised solutions for local problems

It is essential that community awareness, education and engagement programs take into account the context affecting resilience. Just as individuals within communities may experience trauma and grief differently, no community is the same in how it experiences disasters.

'... disasters don't happen in a vacuum. Any group of people who identify as a community will have some shared values, common goals and aspirations, local leaders, networks and relationships, things about their community they are proud of, issues about which they disagree – all those ideas, opinions and connections that contribute to the fabric of community life. What's more, communities are generally autonomous and self-determining; they have the skills, experience and capacity to manage their facilities and infrastructure, govern their community organisations and to run their businesses and industries... Rather than taking a 'Ground Zero' approach and assuming that none of this capacity and resilience has survived the impact (or worse still, that it never existed in the first place), we can do our best work in recovery by listening, asking questions and trying to understand how the community functioned in the period before the disaster.' (Anne Leadbeater, on the Australian Emergency Management Knowledge Hub⁵ blog)

It is important that communities have consultation, collaboration and development processes in place to empower them to develop local solutions to local problems. There is no one program that meets all the needs of a community, so a suite of programs tailored to individual needs should be developed.

Importantly, such programs need to find ways to generate active and equitable participation of local residents in the full spectrum of planning, mitigation, preparation, and response and recovery activities. These approaches seek to utilise local knowledge and expertise and, frequently, existing formal and informal community networks. Through these strategies, programs and activities are anticipated to contribute to increased community resilience, community efficacy, local and cost-effective mitigation, and integrated, inclusive community preparation

and response. Notwithstanding these challenges, further consideration should be given to the design of community engagement, education and awareness programs at all levels but in particular the local level.

4.3.5 Better evaluation of community resilience programs

An examination of existing Australian disaster mitigation programs suggests that some may have had success in encouraging greater take-up of community resilience initiatives. However, limited quantitative analysis and robust evaluation means it is difficult to measure the degree to which these programs are effective and the factors that enable or hinder positive resilience outcomes.

Evidence from overseas jurisdictions suggests that effective programs are those that involve the community as a whole – from learning about the risks, to implementing mitigation strategies. However, these have been hampered by a lack of data and do not have evaluation embedded as part of their program design.

There is a need to design better measures as part of this monitoring and evaluation process to capture resilience. Traditional ways of measuring success focus on outputs such as number of people reached, or number of buildings restored. It is necessary to shift this focus towards outcomes such as improvement in community resilience, which is a key factor in how well a community recovers from, post-disaster trauma.

Robust evaluation is critical to continuous improvement, and with an issue as important as natural disaster resilience, we must continue to improve. Increasing both the soft and hard resilience of the community through these programs, and developing the infrastructure required to carefully evaluate which programs are having the largest impact and scaling them nationally, will be critical in reducing both the tangible and intangible costs of natural disasters.

5. <http://emknowledgeblog.com/2015/02/04/black-saturday-reflections-on-recovery/>

Total expected economic cost in real terms in 2050



\$33bn
2050

\$9bn
2015

5. Recommendations

This report offers four recommendations:

- Pre- and post-disaster funding should better reflect the long-term nature of social impacts
- A collaborative approach involving government, business, not-for-profits and community is needed to address the medium- and long-term economic costs of the social impacts of natural disasters
- Governments, businesses and communities need to further invest in community resilience programs that drive learning and sustained behaviour change
- Further research must be done into ways of quantifying the medium- and long-term costs of the social impacts of natural disasters.

This report estimates that the total economic cost of natural disasters is underestimated by more than 50% due to social impacts not being accounted for. It has also highlighted some of the gaps that exist in quantifying the complex web of direct and indirect, tangible and intangible outcomes and costs of natural disasters.

The four recommendations outline strategies to help reduce the trauma and long-term social impacts and economic costs of future natural disasters.

1 Pre-and post-disaster funding should better reflect the long-term nature of social impacts

The analysis has demonstrated that the intangible costs of natural disasters are at least as high as the tangible costs. Significantly, they may persist over a person's lifetime and have profound effects on communities. It is crucial that funding and policies better reflect the complexities and long-term nature of these impacts.

While recovering and building resilience into physical infrastructure is important, this needs to be balanced against measures to address the social and psychological trauma of natural disasters.

As well as funding emergency services during disasters, and infrastructure and physical recovery post-disaster, government, businesses and the not-for-profit sector must also invest in services that support people, small businesses and communities after the debris is cleared. These programs and services are most effective when coordinated across sectors, promoting community connection and a culture of resilience.

This report supports a national, long-term preventative approach to managing natural disasters and protecting communities, by building social capital. This will require long-term commitment and multi-year funding to achieve. A critical way to ensure long-term impacts are minimised is by 'strengthening local capacity and capability, with greater emphasis on community engagement and a better understanding of the diversity, needs, strengths and vulnerabilities within communities' (COAG's *National Strategy for Disaster Resilience* 2011).

There is significant evidence that resilient and prepared communities are more likely to withstand the negative impacts of natural disasters.

5. Recommendations

2 A collaborative approach involving government, business, not-for-profits and community is needed to address the medium- and long-term economic cost of the social impacts of natural disasters.

Individuals, businesses, governments and communities all feel the social impacts of natural disasters. These impacts are complex and multifaceted, but it is clear that they touch all levels of government and cross all portfolios, from infrastructure and planning to health and education.

This highlights the importance of a collective perspective on building resilience, including the need for coordinated approaches to ensure that disaster response and resilience measures consider all direct and indirect, tangible and intangible aspects of natural disasters. This collective perspective should be considered within strategic planning processes, to ensure that disaster resilience is integrated across the various portfolios, in accordance with the National Strategy for Disaster Resilience (NSDR).

A coordinated approach with sustained resourcing also enhances the consistency and effectiveness of community awareness, education and engagement programs. Evidence shows these programs can create communities that work together to understand and manage the risks they confront. This promotes communities that are better able to withstand a crisis and have a better ability to recover from them.

Several areas will need to adapt to ensure they encompass the social impacts of natural disasters. For instance, community education may grow to include information on other social issues related to disasters. Risk information could include the likelihood of social impacts occurring while adaptation research could encompass best practice methods for responding to the social and psychological impact of natural disasters.

Support from business and community advisory groups would help facilitate a more coordinated response. Businesses, not-for-profits and all government departments should be represented at the highest levels of policy development and decision-making.

Therefore, building on the Roundtable's previous recommendations, it is essential to consider measures to develop resilient and safer communities at the centre of government, as separate but connected policy issues. This can be achieved by establishing a national resilience advisor to effectively coordinate across departments and deliver faster progress on building a resilient Australia.

3 Governments, businesses and communities need to further invest in community resilience programs that drive learning and sustained behaviour change.

It is clear that funding of mitigation measures should not only focus on building physical infrastructure such as flood levees, but also on social and psychological measures such as community awareness, education, and engagement programs. To enhance social capital by building social networks and connections, these programs should include:

- Preparedness and mitigation strategies aimed at reducing the exposure and vulnerability of individuals and communities to disasters. Community awareness, education and engagement programs will be important in shifting community mindsets towards a culture of preparedness and prevention
- Community recovery and resilience measures that encourage social connectedness and ensure individuals have the support they need in their own communities.

While there are challenges in ensuring these programs lead to behaviour change – including appropriate program design and upfront multi-year funding – they can yield a positive return on investment by reducing the overall impacts on individuals, businesses, governments and communities after a natural disaster. Key considerations for the design of these programs include:

- Implementing appropriate incentives
- Multi-level programs that focus on learning and behaviour modification, in addition to general awareness campaigns
- The need for psychological preparedness
- Local solutions
- The need for solid data and evaluation
- Community connection to foster a culture of resilience.

5. Recommendations

Given the widespread nature of social impacts after a natural disaster, it is important that communities, not-for-profits, emergency management agencies, businesses and governments collaborate when designing and delivering preparedness programs and campaigns. These programs need to not only educate communities about disaster preparedness and mitigation, but also foster a culture of connectedness and resilience within communities.

It is critical that these programs are evidence-based to ensure investment is cost-effective and allows for continuous improvement. This means improving the ability to evaluate the effectiveness of programs, and draw out key learnings through better data and methodologies.

Evidence suggests that effective preparation programs involve the community as active and equal participants in learning about risks and implementing local mitigation strategies. More research is required to identify the best ways to plan, deliver and evaluate community awareness, education and engagement programs to maximise community participation and encourage learning and modification of behaviour.

Within the spectrum of community-focused activities it is important to balance investment across awareness and information programs, and education and engagement, because all contribute to holistic emergency management.

4 Further research is needed into how to quantify the medium- and long-term costs of the social impacts of natural disasters.

While the social impacts of natural disasters and their complexities are undisputed, there is currently a lack of consistent, outcomes-based data to quantify the costs. The detailed bottom-up analysis of two case studies – the 2010-11 Queensland floods and the 2009 Black Saturday bushfires – offered robust data due to their size and impact. Even then, the available information was based on discrete surveys of people affected up to six months post-disaster. A more consistent methodology for assessing social impacts and measuring their costs will allow for better planning of response services.

Direct and tangible impacts are usually considered as a 'one off' but intangible social impacts tend to persist over time. Hence, data collection needs to better incorporate this temporal component to fully appreciate the true long-term effects of natural disasters on people's lives.

'Dr Rob Gordon, Australia's pre-eminent disaster psychologist, describes recovery as a marathon. And considering the profound effect of a disaster on the lives of people and communities, that is as it should be. It takes time – sometimes a long time – for communities to re-group after a disaster, for people to grieve and take stock, and to try to make sense of what has happened and what the future might hold.' (Anne Leadbeater, on the AEM Knowledge Hub blog)

This report shows that the social impacts of natural disasters tend to be multiple and interrelated. Importantly, the experience of grief and trauma varies from person to person. It is therefore necessary to not only understand the 'primary' impacts of natural disasters, but also the secondary impacts on individuals and their communities.

5. Recommendations

In addition to the national platform proposed in *Building an Open Platform for Natural Disaster Resilience Decisions* to facilitate access to foundational data, there is a need to incorporate consistent longitudinal data to track social impacts. Figure 5.1 highlights some of the potential areas

that would benefit from better data collection and monitoring, for example by incorporating information about if people have experienced a natural disaster, when the disaster occurred, and the type of disaster.

Figure 5.1: Potential areas to improve data on the social impacts of natural disasters

Health and wellbeing	Education
<ul style="list-style-type: none"> • Health and wellbeing impacts are generally undisputed in the evidence, but quantification and attribution to natural disasters is still difficult • This area would benefit from data on service utilisation post-disaster over time including use of: <ul style="list-style-type: none"> – Hospital admissions data – Outpatient and community health services data – General Practice or Medicare data. 	<ul style="list-style-type: none"> • Education outcomes are largely a second order impact arising as a consequence of trauma and mental health outcomes for children, relocation, and physical injury or family violence outcomes that occur post-disaster. Hence, attribution of these outcomes to natural disasters is challenging. • This area would benefit from more data that links academic outcomes (for example children’s NAPLAN or year 12 results) to those who have been impacted by natural disasters, and the extent of that impact.
Employment	Community
<ul style="list-style-type: none"> • Unemployment and loss of income has been measured as part of the cost of other social outcomes (i.e. as a secondary effect). • This area would benefit from more research into other employment-related outcomes such as the impact of natural disasters on hiring and retaining qualified employees in the medium to long term and the impact on educational outcomes and consequently employment outcomes. 	<ul style="list-style-type: none"> • Community impacts were the most discussed in the evidence yet very little data exists to enable quantification of these outcomes. • The following areas would benefit from better data on the incidence and cost: <ul style="list-style-type: none"> – Community dislocation – Crime (apart from property crime) – Social networks – Loss of heritage/culture.

5. Recommendations

Conclusion

This report extends the research program of the *Australian Business Roundtable for Disaster Resilience & Safer Communities*, by providing a greater understanding of the economic costs of the social impacts of natural disasters and the importance of building community resilience.

The analysis has found that the intangible costs of natural disasters form a substantial part of the total economic costs. Costs such as those relating to health and wellbeing tend to have long lasting impacts over a person's lifetime. From this report, it is clear that the total economic cost of natural disasters is at least double that of existing estimates when intangible costs are included.

As natural disasters are expected to continue to affect Australia and our way of life, building resilience in the community will be critical. Pre- and post-disaster funding directed towards physical mitigation measures, but also social and psychological preparedness, has the potential to mitigate the devastating and costly impacts of disasters.

This report's recommendations outline strategies to help reduce some of the trauma and long-term impacts and costs of natural disasters. Evidence shows that communities with strong social capital are better able to recover from such disasters.

These recommendations reaffirm those made in *Building our Nation's Resilience to Natural Disasters* (2013) and *Building an Open Platform for Natural Disaster Resilience Decisions* (2014), particularly with regard to the need for national coordination and a commitment to long-term annual consolidated funding for pre-disaster resilience; an efficient and open platform for foundational data, and for the removal of barriers to data and research.

This report also supports the need to consider the social impacts of natural disasters when evaluating the benefits of resilient infrastructure in the investment decision-making process, as explored in *Building Resilient Infrastructure* (2016), and continues to highlight the need to invest in building resilience before natural disasters strike.

From this report, it is clear that the total economic cost of natural disasters is at least double that of existing estimates when intangible costs are included

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Appendix A: Companion papers

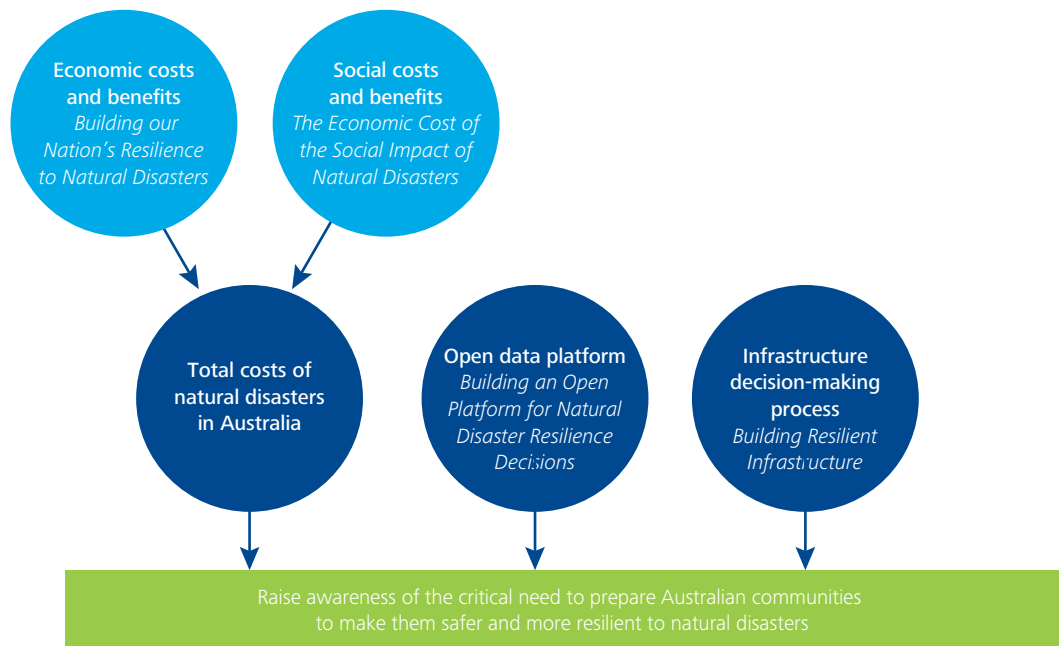
This appendix summarises the key findings and recommendations of three companion reports commissioned by the Roundtable:

- ***Building our Nation's Resilience to Natural Disasters*** (2013) reviewed the economics of mitigating disaster risks facing Australian communities.
- ***Building an Open Platform for Natural Disaster Resilience Decisions*** (2014) provided an overview of natural disaster data and research in Australia, and reinforced the need for better coordination and transparency of disaster risk and resilience information.

- ***Building Resilient Infrastructure*** (2016) was developed in parallel with this paper and investigates the decision-making process for new 'hard' infrastructure assets in light of disaster risks, including the various Commonwealth and state guidelines for comparing project options through cost-benefit analysis. It also builds the case for embedding resilience considerations into this process and offers the practical steps to do so.

The figure below summarises how these three reports relate to each other. Each of the companion reports is outlined in brief on the next pages.

Figure A.1: Summary of the Roundtable's work on natural disaster resilience



Source: Deloitte Access Economics (2016)

Appendix A: Companion papers

Building our Nation's Resilience to Natural Disasters (2013)

The report 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.

Quantifying natural disaster costs

Over the period from 1967 to 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 over the period from 1980 to 2012.

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

These costs are expected to rise as a result of continued population growth, concentrated infrastructure density and migration to particularly vulnerable regions. While the current annual total economic cost of natural disasters is around \$6.3 billion, on average this annual cost is expected to 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, which contribute to the cost of recovery, particularly through the Natural Disaster Relief and Recovery Arrangements. Using historical data, Deloitte Access Economics estimates that natural disasters cost the Australian and state governments an average annual real cost 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 the forecasts of total economic costs above, 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.

The expected future cost of natural disasters clearly highlights the need for governments to place a greater emphasis on improving Australia's resilience. Prioritising pre-disaster investments towards cost-effective resilience initiatives can substantially reduce government expenditure on response initiatives. Doing so will rely on access to accurate, consistent data, and findings from targeted research programs, which provide an essential evidence base for determining the cost-effectiveness of resilience measures.

The case for resilience

Deloitte conducted three cost-benefit analyses of different resilience activities, to illustrate how investing in resilience could generate net benefits for Australian communities.

Overall, it was found that:

- A program focused on building more resilient new houses in areas of southeast Queensland with a high cyclone risk would reduce cyclone-related damage by around two-thirds, and generate a benefit-cost ratio (BCR) of up to 3.0. It is a particular challenge to retrofit resilience into existing houses, 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 reduce 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

Appendix A: Companion papers

Chart A.2: Insured costs of natural disasters (\$bn), 1980 to 2012

Source: Insurance Council of Australia (2013)

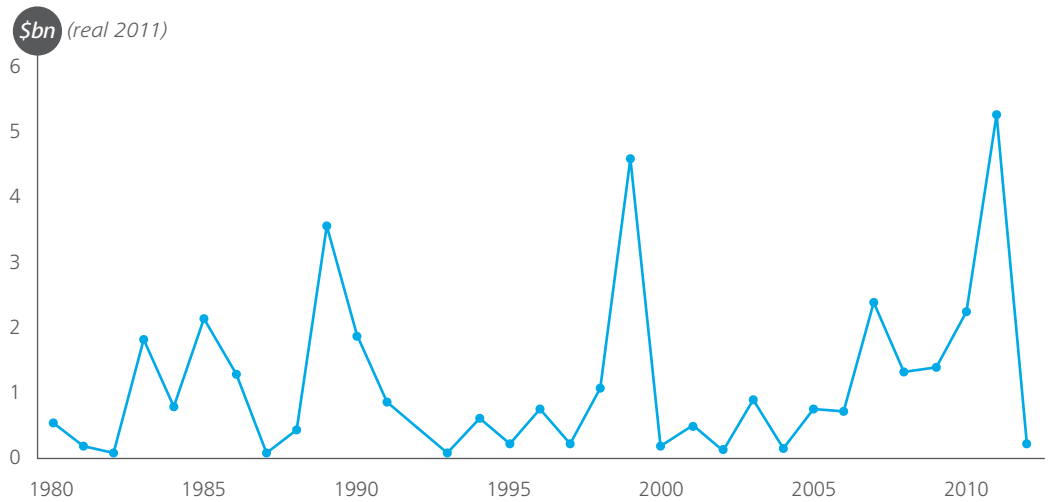


Chart A.3: Forecast total economic cost of natural disasters (\$bn), 2011 to 2050

Source: Deloitte Access Economics (2013)

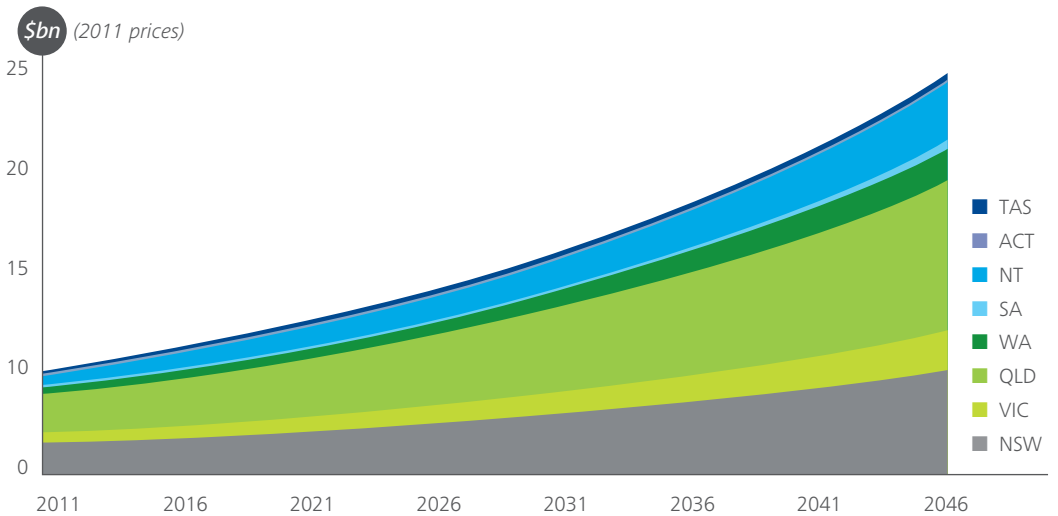
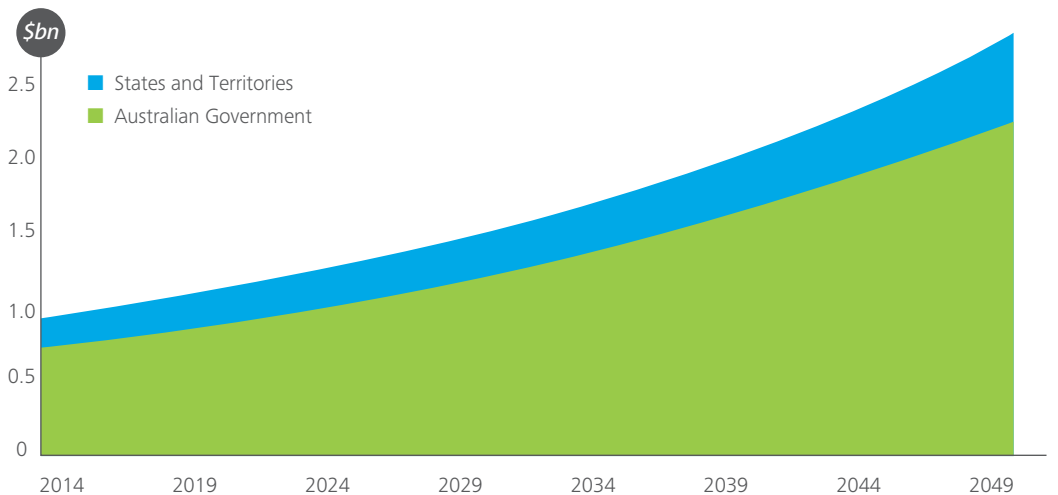


Chart A.4: Forecast annual cost to governments of natural disasters (\$bn), 2011 to 2050

Source: Deloitte Access Economics (2013)



Appendix A: Companion papers

- Building more resilient housing in high-risk bushfire areas generates a BCR of about 1.4; better vegetation management results in a BCR of about 1.3; and moving electricity wires underground results in a BCR of about 3.1.

These examples demonstrate that practical resilience measures – which target high-risk locations using an appropriate combination of infrastructure, policy and procedure – have the potential to generate economic benefits. The case studies also highlight the importance of having access to comprehensive information on disaster risk and the effectiveness of adaptation strategies as part of the cost-benefit analysis process.

Recommendations

This report put forward three key recommendations:

- **Improve coordination of pre-disaster resilience by appointing a National Resilience Advisor and establishing a Business and Community Advisory Group**

Developing resilient communities should be elevated to the centre of government decision-making, to support effective coordination across all levels of government, business, communities and individuals. This should be directly supported by a Business and Community Advisory Group, to facilitate a more coordinated response and ensure businesses and not-for-profits are represented at the highest levels of policy development and decision-making.

- **Commit to long-term annual consolidated funding for pre-disaster resilience**

All levels of government – led by the National Resilience Advisor – should commit to consolidating current outlays on mitigation measures, and to funding a long-term program that significantly boosts investment in mitigation infrastructure and activities. Critical to this success will be the consolidation of existing information and commissioning additional data where needed. This will help governments, businesses and the community develop and implement effective local responses.

- **Identify and prioritise pre-disaster investment activities that deliver a positive net impact on future budget outlays**

A program of mitigation activity should be developed, based on a cost-benefit analysis that demonstrates a clear positive outcome from investing in pre-disaster resilience measures. The prioritisation of these activities should be informed by analysis of research, information and data sets, allowing key investment decisions at all levels, including government incentives and price signals from the private sector.

Building an Open Platform for Natural Disaster Resilience Decisions (2014)

This report investigated the decision-making challenge, and identified the strengths and weaknesses of Australia's approach to natural disaster data and research. It made recommendations on how to support Australia to design a more sustainable and comprehensive national approach to safer and more resilient communities.

Accurate data and research is fundamental to better understanding natural disasters and their impact on communities, business and government. It is essential to supporting better decision-making and to prioritising mitigation investments needed to build a safer Australia. Optimal decisions on resilience investments requires access to high-quality data and research.

Providing wider access to accurate, relevant natural disaster data and research could increase government savings by between \$500 million and \$2.4 billion in present-value terms, over the period to 2050. Data and research that facilitates targeted and prioritised investment could deliver higher overall BCRs 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.

Appendix A: Companion papers

The decision-making challenge

Natural disaster resilience is an interdisciplinary issue. Multiple agencies are involved in collecting data and conducting research. This produces numerous platforms for accessing and using the necessary information; leads to increased search costs; and often creates complexity and disparity in understanding.

The key set of inputs required by end-users consists of:

- **Foundational data:** data that provides the basic standard layers of locational information. This includes the characteristics of assets at risk, community demographics, topography and weather details, which are also used for other purposes
- **Hazard data:** hazard-specific information on the risks of different disaster types, providing contextual details about the history of events and the risk profile of 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 future value at risk
- **Research activities:** actions that draw on data and seek to answer specific questions across a range of areas. There is often also feedback from research to data, because research outputs build on the existing stock of data that is available.

A broad range of end-users across communities, business and government are affected by this challenge, and their needs vary significantly. To realise the full potential of decisions aimed at increasing the safety, resilience and productivity of Australian communities, this data and research must be accessible in consistent formats that are fit for this variety of purposes.

Gaps and barriers to optimal decision making

The Australian approach to natural disaster research and data involves no comprehensive mechanisms to ensure inputs are available in a consistent and appropriate format.

Data

There is evidence of **gaps in the critical data inputs** required to inform resilience investments.

This significantly limits the ability of stakeholders to understand the exposure of communities and the extent of losses that might arise.

These issues are compounded by barriers that restrict end-users' access to critical data. Barriers include:

- **Reluctance to share data** – the potential legal implications of data sharing are of particular concern for local government
- **Restrictive licensing arrangements**, which prevent wider distribution and use of data
- **The high cost of data collection**, which encourages a piecemeal approach to developing critical data inputs
- **A lack of coordination and standardisation**, which prevents end-users from pooling data from different sources
- **The high cost of providing accessibility and transparency**, which weakens incentives for data sharing if the broader range of benefits are unclear.

These barriers lead to duplicated efforts in data collection, higher transaction costs when 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.

Appendix A: Companion papers

Research

The research 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, and the benefits that could be achieved through mitigation.

There are strong networks among Australian researchers but from an end-user perspective it is **difficult to identify what relevant research activities are happening**, and how to use research findings to better inform decisions about resilience. Although projects undertaken by the newly established Bushfire and Natural Hazards Cooperative Research Centre (launched in December 2013) explicitly involve end-users, this practice should be adopted more broadly. Increased transparency and better evaluation of the outcomes of research activities would support this change.

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. The business of developing resilient communities should be elevated to the centre of government decision-making efforts, enabling effective coordination of activities across all levels of government, business, communities and individuals.

This report makes three recommendations for an enhanced approach to natural disaster information, focusing on the potential benefits of making optimal end-user decisions around data and research.

• 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. Although the Bureau of Meteorology and the Australian Bureau of Statistics provide weather information and data on community demographics respectively, this would be improved by allocating responsibility for consistent topography and geocoded asset data at the national level. A national portal for this would support the prioritisation of resilience measures across local government and state borders, in the national interest.

• 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 include the full range of end-users and allow for the development of an access system that weighs up overall costs and benefits. There is a need to clearly delegate responsibility for hazard and impact data (such as hazard mapping) and develop a stronger approach to involving end-users in research. This should also address concerns with legal liability and unnecessarily restrictive licensing, and help ensure standardisation across jurisdictions.

• 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.⁶ This will support best-practice use of natural hazard data, allowing research to be collected and disseminated, and ensuring that investments in resilience produce optimal outcomes based on consistent, evidence-based cost-benefit analyses. This approach would build a common understanding of the nation's areas of highest risk, and the most effective measures for reducing that risk and prioritising the research agenda.

6. Infrastructure Australia's Priority List identifies projects of national significance and informs the Australian Government of the highest-priority projects. Infrastructure Australia provides guidelines for cost-benefit analyses, step-by-step methodologies for different investment types and links to standardised data sources, to assist in the preparation of submissions. Further details on this approach are provided in Chapter 2.

Appendix A: Companion papers

Building Resilient Infrastructure (2016)

Both the Productivity Commission and Infrastructure Australia have highlighted the need to prioritise investments that can limit the extent of disaster damage.

- The Productivity Commission's *Natural Disaster Funding Arrangements* inquiry report (2015) revealed that 'Governments overinvest in post-disaster reconstruction and underinvest in mitigation that would limit the impact of natural disasters in the first place. As such, natural disaster costs have become a growing, unfunded liability for governments'
- Infrastructure Australia's *Australian Infrastructure Audit* report (2015) called for increased focus on resilience and improving the maintenance of existing infrastructure, noting that 'The number and intensity of extreme weather events is increasingly likely to threaten certain infrastructure assets'.

In response to the Productivity Commission's *Public Infrastructure* inquiry report (2014), the Commonwealth (2014) has committed to improving the robustness of project selection processes, including favouring projects that deliver long-term priorities. To achieve this, Infrastructure Australia has been given a role to develop and implement a best practice framework for project evaluation. This includes 'determining a robust and consistent methodology for cost benefit analyses for all economic and social infrastructure'.

Planning for resilience has the potential to significantly reduce disaster costs. Most importantly, when considering a new project, there is a need to ensure risks associated with natural disasters are appropriately analysed and all options for resilience are considered during the decision-making process. The current reform agenda provides an invaluable opportunity to embed resilience in the planning process for significant infrastructure.

Investment decision-making and resilience

Infrastructure planning requirements typically make very little reference to resilience. Where references exist, there is a lack of supporting guidelines on how this should be achieved. There is an implicit assumption that land use planning, building codes and standards provide adequate requirements. Yet, for some assets, it is likely to be cost-effective to build to a higher level of resilience than these prerequisites mandate.

The decision-making process for building new infrastructure is often complex, requiring trade-offs between objectives within budget constraints. Cost-benefit analysis (CBA) is a key factor in the decision-making process and is used to prioritise the options with the greatest net benefits.

Yet a review of the CBA guidelines applicable to infrastructure appraisal reveals that, with the exception of Queensland's guideline to measure the benefits of flood-proofing transport infrastructure, there are no explicit guidelines for measuring the benefits of resilient infrastructure.

Appendix A: Companion papers

The economic case for change

Determining which resilience measures are appropriate before a natural disaster event or before infrastructure is built is challenging. It requires a detailed ex-ante assessment of the likelihood of a hazard affecting a proposed asset and a thorough analysis of the possible resilience options that could be implemented to mitigate disaster impacts.

Three ex-post case studies in this report demonstrate that investment decisions on infrastructure projects could be different if that infrastructure's resilience to disaster was evaluated before investments were approved.

- **The loss of electricity services** caused by the 2007 Victoria cost the national economy \$234 million bushfires. While it is expensive to build underground transmission lines (\$11 million per kilometre), evidence indicates there would be net benefits from this additional resilience measure in some high-risk areas, specifically where the risk of a similar event occurring is greater than 5% per year (a one-in-20-year event).

- **Flooding of a state highway bridge** in regional New South Wales has caused major traffic disruptions six times since its construction in 1987. The cost of future events is estimated at \$75 million totalling about \$92 million (in present value terms) over the projected life of the asset. This compares to an estimated replacement cost of \$7.4 million. The example highlights that the cost of minor disruptions to a local area can be significant over time
- **The loss of telecommunications services** as a result of the Brisbane floods in 2011 cost users about \$1 million per day and Optus around \$1 million overall. The total future cost of similar events is expected to be about \$9 million. In contrast, Optus has invested between \$3 and \$5 million to improve infrastructure resilience since 2011. The benefits exceed the costs of the measures implemented if the risk of a similar event occurring exceeds 4% (a one-in-25-year event).

In all three cases, greater investment in resilience would have more than paid off in terms of avoiding disaster costs.



A single loss-of-supply incident cost around **\$234 million**



Total bridge closure costs are estimated at **\$91.8 million**



Lost mobile services cost **\$1 million** a day during the Brisbane floods

Appendix A: Companion papers

Planning for resilient infrastructure

A number of limitations affect the capacity (and incentives) for government and industry decision-makers to invest in resilience for new and replacement infrastructure. These include complex cross-jurisdictional approval processes, intensive data requirements, limited technical capacity, a lack of specific guidelines for CBAs to include resilience benefits and inadequate references to resilience in appraisal processes.

To support the shift to a system in which options for resilience are considered at the planning and decision-making stages in major infrastructure projects, this report offers:

- **Practical guidance** for practitioners to integrate resilience into the CBA process for proposed infrastructure
- **Five principles** for decision-makers (at all levels of government and business) to facilitate comprehensive integration of disaster resilience into infrastructure planning, appraisal and approval processes.

Recommendations

This report offers three key recommendations:

- **Improve infrastructure planning processes:** Integrate resilience in government and industry decision-making by adopting the principles for resilience in infrastructure planning
- **Improve incentives:** Prioritise policy changes and funding arrangements that ensure resilience has been considered and incorporated where appropriate into infrastructure planning
- **Improve capacity:** Government and industry should work to strengthen the technical capacity of practitioners to identify, analyse and evaluate the costs and benefits of resilience options.

These recommendations will help to embed resilience in the decision-making process for new infrastructure. In turn, this will improve the cost-effectiveness of infrastructure spending and, more importantly, mitigate the devastating and costly impacts of disasters on businesses and communities.

People trapped on the Carpendale side of Lockyer Creek survey damage to the bridge after floodwaters from Toowoomba in Queensland caused flash flooding between Helidon and Grantham, after heavy rains caused widespread flooding across the region. (Aaron Francis / Newspix)



Appendix B:

Productivity Commission Inquiry into National Disaster Funding

Following the June 2013 release of the Roundtable's white paper, *Building our Nation's Resilience to Natural Disasters*, the Australian Government asked the Productivity Commission to inquire into the efficacy of national natural disaster funding arrangements and take into account the high priority of effective mitigation. The Commission received the terms of reference on 28 April 2014, and published the final report on 17 December 2014. This appendix provides a summary of the key findings and recommendations.

- The current funding arrangements for natural disasters are inefficient, inequitable and unsustainable, prone to cost-shifting, ad hoc responses and short-term political opportunism
- Expenditure on mitigation, across all levels of government, is likely to be below the optimal level, given the biased incentives towards recovery under current budget treatments and funding arrangements
- Governments make decisions about natural disaster risk management without full information on potential consequences, due to the budget treatment of natural disaster costs as an unquantified contingent liability
- While information on natural disaster hazards and exposure has improved significantly in recent years, there is scope for greater coordination and prioritisation of natural hazard research across government and research institutions.

The Productivity Commission made 22 recommendations to achieve a more sustainable balance of natural disaster mitigation, relief and recovery expenditure. This included calls for:

- Amendments to cost-sharing arrangements for natural disaster recovery, including the funding for the 'betterment' component of reconstruction costs after disasters
- Gradual increases in the amount of annual mitigation funding. Australian Government mitigation funding to states should increase to \$200 million a year and be matched by the states
 - This recommendation supports a recommendation from the Roundtable's report, *Building our Nation's Resilience to Natural Disasters*, which called for a commitment by all levels of government to long-term annual consolidated funding for pre-disaster resilience

- Improved recognition of natural disaster liabilities in government budgets
- Governments at all levels to make natural hazard data publicly available in accordance with open public sector information principles
- Exploration of partnerships and collaboration on natural hazard risk information, between state and territory governments, local governments and insurers
- Development of guidelines for the collection and dissemination of natural hazard mapping, modelling and metadata
 - This recommendation supports a recommendation from the Roundtable's report, *Building an Open Platform for Natural Disaster Resilience Decisions*, which called for the creation of a national data platform for foundational data, and the removal of barriers to accessing it
- Prioritising and accelerating the implementation of the *Enhancing Disaster Resilience in the Built Environment Roadmap* by state and territory governments
- Provision of statutory protection of local governments from liability for releasing natural hazard information and making changes to local planning schemes in good faith
- Best-practice institutional and governance arrangements for the provision of public infrastructure, including stronger processes for project selection that incorporate requirements for cost-benefit analyses that are independently scrutinised and publicly released, and consideration of natural disaster risk in project selection and asset management planning
- Development of a formula for allocating mitigation funding based on where such funding is likely to achieve the greatest net benefits.

The Australian Government has not yet formally responded to these recommendations.

Appendix C:

International experiences

Christchurch earthquakes

Christchurch and the wider Canterbury region in New Zealand were rocked by a magnitude 6.3 earthquake on 22 February 2011, causing the death of 185 people and significant damage to the central business district. The earthquake was an aftershock of a magnitude 7.1 earthquake that occurred on 4 September 2010. It was particularly destructive, occurring along a fault line and in close proximity to the city.

Both, however, were destructive in terms of human life and material costs (Table C.1). More than half of the fatalities were caused by the collapse of the Canterbury Television building. New Zealand Treasury (2013) estimated the capital costs to be \$40 billion, the equivalent of 20% of gross domestic product. In the immediate aftermath, about 60% of the city had no access to water while 80% did not have power (Pedroso, 2013).

Beyond the tangible costs, the social fabric of the local community changed. Mobile phone data indicates that about 55,000 people (or 15% of the population) may have relocated from Christchurch city in the immediate aftermath of the February 2011 earthquake (Canterbury Earthquake Recovery Authority, 2014). Although the overall population change may not seem substantial, this is mainly due to the influx of people working to rebuild the city over subsequent weeks and months. A month later, records indicate that most people had returned to Christchurch.

In the year to June 2011, 8,900 people (or 2.4% of the population) left Christchurch city, followed by another 1.2% over the next year (Canterbury Earthquake Recovery Authority, 2014). It is likely that most of these residents relocated within the wider Canterbury region. This population movement is consistent with that noted following the Queensland floods and the Kobe

earthquake in Japan, where displaced people relocated close to their previous homes to maintain links to their communities, jobs and schools (Love, 2011).

Academic literature strongly emphasises the psychological and mental health impacts of earthquakes on members of the community. The Christchurch Health and Development Study examined the extent of earthquake exposure on a well-studied birth cohort (Fergusson et al., 2014) and found that cohort members who were highly exposed to the earthquakes had mental disorder rates 1.4 times that of cohort members who were not exposed. The study showed a spike in major depression, post-traumatic stress disorder, nicotine dependence and other anxiety disorders.

Another longitudinal study of self-reported health found that since the earthquakes, middle-aged Christchurch residents had mean scores significantly lower than population norms in mental health, vitality and social functioning (Spittlehouse et al., 2014). Rates of major depressive disorders reached 7.5% in earthquake survivors compared to 5.1% and 3.7% in other historical, local and national surveys respectively. Similarly, bipolar disorder prevalence was 2.8% for earthquake survivors compared to 2.2% and 1.4% in other local and national studies respectively.

Similar to experiences in Australia after natural disasters and in the United States following Hurricane Katrina, reported domestic violence increased in the areas affected by the earthquakes, with New Zealand police seeing a 53% increase in domestic violence cases (Parkinson & Zara, 2013).

The literature also notes that invaluable items were removed from the New Zealand Heritage List. Some 195 heritage-listed buildings were destroyed, though the cost of this loss is not yet fully measured (Heritage New Zealand, n.d.).

Table C.1: Economic and social impacts, Canterbury earthquakes

Outcomes	Measure
Fatalities	185 fatalities
Capital costs ¹	\$40 billion
Mental health issues ²	Based on a well-studied birth cohort, those highly exposed to the earthquake had mental disorder rates 1.4 times higher than those who were not exposed.

Sources: 1. New Zealand Treasury (2013); 2. Fergusson et al. (2014).

Appendix C: International experiences

Hurricane Katrina

Hurricane Katrina struck the Gulf Coast of the United States (US) in August 2005. The storm initially travelled across southern Florida, leaving 100,000 houses without power, before entering the Gulf of Mexico. It then strengthened and passed directly over New Orleans, Louisiana, destroying many lighter buildings and causing extensive damage to other structures. Similar scenes of destruction occurred across Louisiana, as well as in Mississippi and Alabama. The storm surge which followed caused the levee system surrounding New Orleans to break, leading to the rapid and deep flooding of more than 80% of the city.

Hurricane Katrina and its catastrophic storm surge caused widespread damage and devastation. The most significant number of deaths occurred in New Orleans. The estimated death toll from Katrina exceeds 1,300, with approximately 1,067 of those deaths occurring in Louisiana and approximately 230 in Mississippi (FEMA, 2005) (Table C.2). Munich Re estimated the economic losses caused by the hurricane at \$125 billion (US 2005 dollars), of which almost \$62 billion were insured losses (Insurance Information Institute, 2010).

Residents were forced to leave New Orleans because Hurricane Katrina destroyed many workplaces and houses (Vigdor, 2008), causing a near-total evacuation of the city. Census estimates suggest that in the summer of 2006 the city's population was less than half the July 2005 (pre-Katrina) level of 453,000 people. The city was slow to recover, with population growth remaining sluggish for two years after the disaster.

With such large population disruptions, there were notable effects on the city's economy and labour markets. Based on Census data, the city economy suffered from 105,300 job losses in November 2005, compared to what it had been a year earlier (Dolfman et al., 2007). Ten months after the hurricane, job losses had diminished to 92,900 but were still significant. Lost wages over the 10-month period from September 2005 to June 2006 were estimated at \$2.9 billion, with 76% of the loss in the private sector. In addition to job losses, local governments continued to struggle with hiring and retaining qualified employees (French et al., 2008).

Ten years after Hurricane Katrina, there is a wealth of longitudinal data on the social impacts of the disaster, with a particular focus on mental health issues such as post-traumatic stress, psychological distress (Paxson, 2012) and serious emotional disturbance (McLaughlin et al., 2010). Based on a longitudinal survey of low income mothers from New Orleans, Paxson (2012) found that symptoms of post-traumatic stress declined after the hurricane, but still remained high 43–54 months later.

One of the most reported outcomes of Hurricane Katrina was an increase in crime rates, particularly looting and theft, as well as violence, murders and sexual assaults. However, some literature suggests that the incidence and severity of lawlessness was greatly exaggerated (Dwyer & Drew, 2005; Jacob, 2008; Constable, 2008). Jacob (2008), argues that in cases of severe social disruption such as the aftermath of Hurricane Katrina, there are some cases of antisocial behaviour but most people respond positively and generously. Looting did occur in the week following the storm, but the majority of looters were searching for essentials such as food, water and medicine (*The Guardian*, 2015).

Table C.2: Economic and social impacts, Hurricane Katrina

Outcomes	Measure
Fatalities ¹	1,300 fatalities (1,067 deaths in Louisiana)
Insured losses ²	\$61.9 billion (2005 US dollars)
Community dislocation ³	Loss of over half the population of New Orleans
Jobs lost ⁴	Over-the-year losses of 105,300 jobs in Nov 2005

Source(s): 1. FEMA 2005; 2. Insurance Information Institute (2010); 3. Vigdor 2008; 4. Dolfman et al., 2007

Appendix D: Methodology for estimating costs

Case studies

The three natural disasters used as case studies for this paper are:

- The Queensland floods (2010–11)
- The Black Saturday bushfires (Victoria, 2009)
- The Newcastle earthquake (New South Wales, 1989).

These were selected based on factors including:

- The geographical spread of the natural disaster
- The scale of the natural disaster
- The availability of data, particularly on social impacts and costs
- Where preventative measures and mitigation is possible.

Overview of the methodology

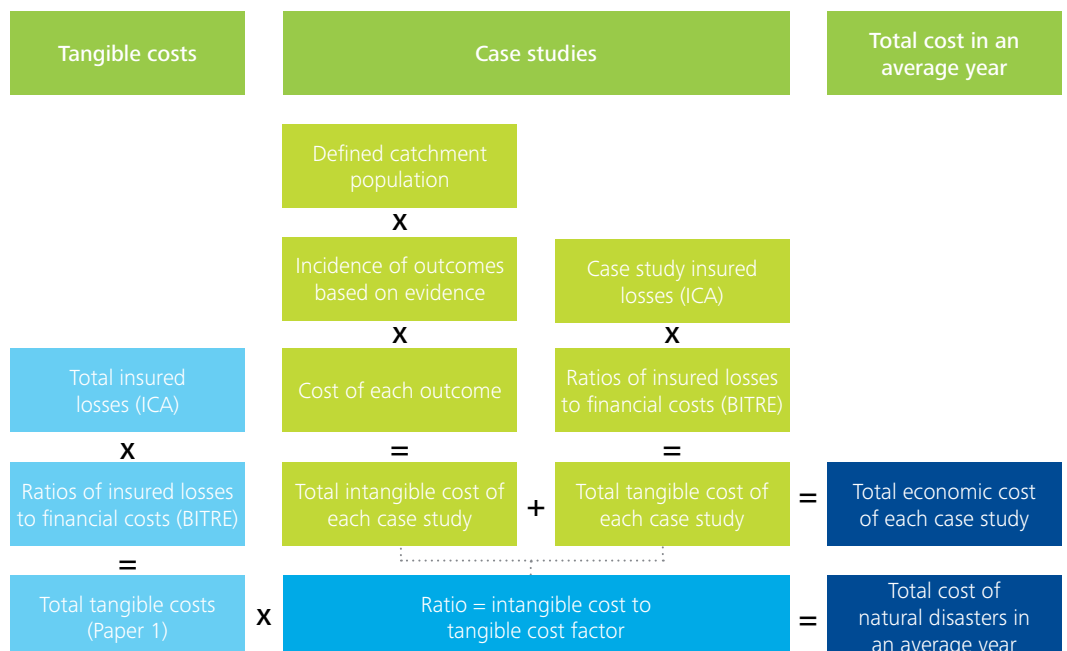
The overall approach to estimating costs is summarised in Figure D.1 and consists of three broad components:

- Estimating the intangible cost of two natural disasters (specifically the Queensland floods and the Black Saturday bushfires) using evidence from

studies, through a bottom-up approach. Note that due to insufficient information on the social impacts of the Newcastle earthquake, a top-down approach was used to calculate its total average cost

- Estimating the tangible cost of two natural disasters (the Queensland floods and the Black Saturday bushfires) using the methodology from *Building our Nation's Resilience to Natural Disasters* (2013). This includes using updated data from the Insurance Council of Australia (ICA) as well as ratios of insured losses to uninsured losses from *Economic Costs of Natural Disasters in Australia* (2001) by the Bureau of Transport Economics (now known as the Bureau of Infrastructure, Transport and Regional Economics). This produces the intangible-cost-to-tangible-cost factor for each case study
- Applying the intangible-cost-to-tangible-cost factor to the estimated average annual tangible cost in an average year to obtain the total cost of natural disasters in an average year, including tangible and intangible costs.

Figure D.1: Overall approach to estimating the total cost of natural disasters



Appendix D: Methodology for estimating costs

Estimating the intangible cost of the case studies

The methodology for estimating the intangible cost of the Queensland floods and Black Saturday bushfires is to:

- Define the catchment population: the number of people directly affected by the disasters through injury, damage to their property or loss of belongings
- Estimate the incidence of outcomes as a result of natural disasters by using an evidence base from studies to apply a rate to the catchment population
- Define the per case cost per annum of each outcome, including the tangible and intangible costs, by using existing economic cost studies
- Estimate the total intangible cost of the Queensland floods and Black Saturday bushfires by multiplying the incidence and per case cost per annum.

Due to insufficient information on the intangible impacts of the Newcastle earthquake, a top-down approach was used to calculate its total average cost – specifically, from insured losses to tangible costs to intangible costs.

The intangible costs estimated in this paper include only those for which there were sufficient data and, as such, they are a subset of total intangible costs. In addition, the intangible cost of natural disasters may be as high as or higher than tangible costs. In some cases they persist over the lifetime of affected people; such as for those who suffer from chronic disease and mental health problems that may be directly attributed to the natural disaster.

Estimating the total tangible cost of the case studies

To estimate the tangible cost of the Queensland floods and Black Saturday bushfires, the analysis draws from the methodology in *Building our Nation's Resilience to Natural Disasters* (2013).

The methodology includes:

- Using data from the Insurance Council of Australia (ICA) to identify the insured losses for each case study
- Using the *Economic Costs of Natural Disasters in Australia* (Bureau of Transport Economics, 2001) report to multiply a set of multipliers to the insured losses for each case study.

The tangible costs include:

- Uninsured losses
- Category B Natural Disaster Relief and Recovery Arrangements (NDRRA) payments
- Agricultural production lost
- Evacuation costs
- The cost of homelessness
- The cost of damaged homes
- The cost of damaged commercial properties
- Emergency response costs.

The total intangible cost divided by the total tangible cost produces the intangible-cost-to-tangible-cost factor.

Estimating the total average cost of natural disasters

Consistent with *Building our Nation's Resilience to Natural Disasters* (2013), forecasts of the total cost of natural disasters in Australia in an average year of natural disaster events is based on the historical frequency and severity of natural disasters in Australia. To obtain predictions of the total economic cost, the intangible-cost-to-tangible-cost factor was applied to the insured losses data.

Appendix D: Methodology for estimating costs

Detailed methodology for estimating costs

Estimating the intangible cost of case studies

An incidence-based approach was used to estimate the intangible cost of the case studies, examining the number of new cases of social impacts that can be attributed to the natural disaster. A prevalence approach estimates the overall cases of social impact (some of which are attributed to the natural disaster).

Population

For each case study, the base population in postcodes with at least four insurance claims in Queensland (provided by IAG) was estimated using Australian Bureau of Statistics (ABS) Census data. Surveys showed that 47% of respondents were directly affected by the Queensland floods – where their property or that of their friend, family or carer was damaged or destroyed – and 59% in the Black Saturday bushfires. This was used to estimate the population of people directly affected by the two disasters.

Estimating the incidence of social impacts

A literature review was conducted to determine the incidence of outcomes as a result of the Queensland floods and the Black Saturday bushfires. The main social impacts that had sufficient evidence to be quantified (Table D.3) include:

- Fatalities and physical injuries
- Mental health issues
- Alcohol misuse
- Family violence
- Property crime
- Environmental damage.

These incidence rates were assumed to be the rate in the first year of the disaster. That rate drops by one-third every year, to 5% of the rate by the fourth year post-disaster. The evidence (both published and anecdotally) shows that there is generally a spike in social impacts immediately after a disaster, but most people recover to an extent over the medium- to long-term. However, a small proportion of people never recover and continue to experience trauma. Hence, we assume that a small proportion have lifelong impacts.

Table D.2: Population by case study

		Adult (male)	Adult (female)	Children (male)	Children (female)	Total
Queensland floods	Population	153,315	159,519	49,774	47,319	409,927
	Average age at time of disaster [^]	48	52	9	8	
	Average life expectancy	82	83	80	85	
Black Saturday bushfires	Population	73,016	78,434	28,303	26,611	206,363
	Average age at time of disaster [^]	55	56	11	9	
	Average life expectancy	83	83	80	85	

[^] Based on the average age of fatalities in each case study

Sources: ABS Census (2013), IAG, Queensland Health (2011), Bushfire CRC (2010) and Royal Commissions.

Appendix D: Methodology for estimating costs

Where specific case study data was unavailable, additional data from the Household, Income and Labour Dynamics in Australia (HILDA) survey was used. This household study began in 2001 (wave 1), and data up to wave 13 was obtained for this analysis. Wave 9 (2009) included a question on if the household's dwelling was 'damaged or destroyed by a natural disaster'. This was used as a flag to identify people who had been impacted by a natural disaster between 2009 and 2013. The incidence rate of certain social impacts was compared between those who experienced a natural disaster and those who did not.

Table D.4 summarises the number of people by each social impact based on the incidence rate multiplied by the population (by sex and adult/child).

Estimating the unit cost of a social impact

The literature review also identified the unit cost of each of the social impacts. These were all indexed to 2015 dollars and multiplied by the incidence of social impacts as a result of each disaster.

The literature review also identified the proportion of the total costs for each outcome that could be attributed to each of the cost categories. In many instances, this involved identifying studies that had investigated a larger population level (for instance the cost of family violence for all of Australia). The cost by each category identified in the report was then divided by the total cost to determine the proportion. This proportion was subsequently applied to the total costs of each outcome.

Table D.3: Incidence of social outcomes resulting from the Queensland floods and Black Saturday bushfires

Outcome	Queensland floods	Black Saturday bushfires
Mental health issues (male)	12.2%*	11.2% [§]
Mental health issues (female)	14.7%*	18.7% [§]
Alcohol misuse	1.1% [†]	19.0% [§]
Family violence (female and children)	2.7% [‡]	7.0% [¶]
Family violence (male)	1.1% [‡]	2.8% [¶]

Source(s): *Alderman et al. (2013), † Turner et al. (2013), ‡ Average based on HILDA, § Bryant (2014), ¶ VicPol

Table D.4: Additional impact by case study

	Queensland floods	Black Saturday bushfires
Fatality	36	173
Injury	–	414
Mental health issues (number of people)	55,200	31,000
Family violence (incidents)	3,300	28,300
Property crime (incidents)	3,300	4,700
Risky alcohol consumption (number of people)	5,900	11,400

Source(s): Deloitte Access Economics estimates.

Appendix D: Methodology for estimating costs

Table D.5: Unit cost of social impacts (2015 dollars)

Outcome	Average unit cost per year
Death	\$189,200*
Physical injury (minor)	\$11,600†
Physical injury (serious)	\$325,000†
Mental health issue	\$36,500‡
Alcohol misuse	\$2,000§
Family violence	\$25,000¶

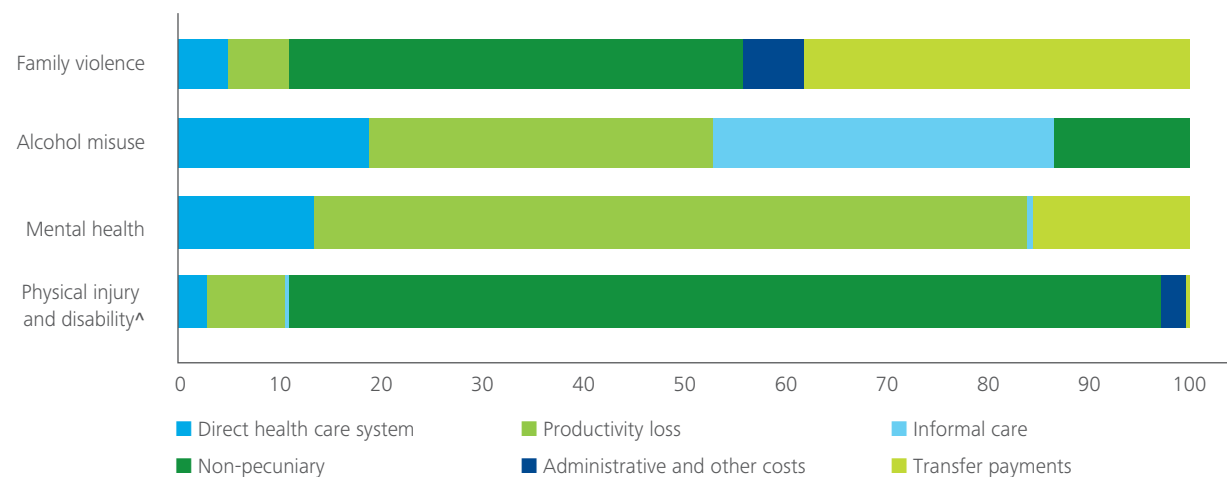
Source(s): Deloitte Access Economics using * OBPR, † BTE (2001), ‡ Access Economics (2009), § Access Economics (2009), ¶ Access Economics (2004)

Table D.6: Costs by category as a proportion of total costs (%)

Outcome	Direct health care system	Productivity loss	Informal care	Non-pecuniary [^]	Administrative and other costs	Transfer payments
Physical injury and disability	2.9%	7.7%	0.3%	86.3%	2.4%	0.4%
Mental health issue	13.4%	70.5%	0.6%	–	–	15.5%
Alcohol misuse	18.8%	34.0%	33.6%	13.5%	–	–
Family violence	4.9%	6.2%	–	44.8%	6.1%	38.0%

Source(s): Deloitte Access Economics using various sources.
[^]Non-pecuniary costs are associated with pain, suffering and premature mortality.

Table D.6: Costs by category as a proportion of total costs (%)



Source(s): Deloitte Access Economics using various sources.
[^]Non-pecuniary costs are associated with pain, suffering and premature mortality.

Appendix D: Methodology for estimating costs

Estimating the total tangible cost of case studies

The tangible cost of the case study disasters was estimated using the methodology from *Building our Nation's Resilience to Natural Disasters*, which calculated a number of costs to insured losses ratios. Table D.7 summarises the tangible cost for each of the disasters by cost category, using insured losses from the ICA normalised to 2011 dollars.

Estimating the total cost of natural disasters in an average year of natural disaster events in Australia

The national forecasting methodology from *Building our Nation's Resilience to Natural Disasters* was used to predict total insured losses. The steps were:

- Data on natural disasters was gathered up to 2015 from the ICA's database of natural disasters (ICA, 2015)
- For each state, the historical data was used to identify the distribution of the number of yearly natural disasters
- For the forecast period, the number of natural disasters per year was then simulated from this historical distribution. This gave a total number of events to be simulated for each state for each year of the forecast period
- Each natural disaster was then simulated using a bootstrapping procedure. This involved randomly selecting a historical event from the ICA database and incorporating some additional random variations in the severity of the event to represent tail risk not captured in historical data

- The bootstrapping procedure was carried out 1,000 times to provide a reliable estimate of both the distribution of natural disaster costs that could be expected as well as average annual natural disaster costs in each state
- The resulting simulated costs were then indexed to account for growth in the number of households and increases in the value of housing stock. This index was constructed from Australian Bureau of Statistics (ABS) population growth forecasts (ABS catalogue number 3236.0) as well as extrapolating trends in ABS data on housing value (ABS catalogue number 4102.0). It was assumed that growth rates for the value of housing in each state converged in the long run towards the national average.

In *Building our Nation's Resilience to Natural Disasters*, total economic costs (including deaths and injuries) were estimated by applying the multipliers for different natural disaster types reported by the Bureau of Transport Economics (2001) to the insured losses.

The case studies were used to calculate the total intangible cost in addition to deaths and injuries. The total economic cost to insured losses ratio was roughly 1.75 and 2.05 higher for the Black Saturday bushfires and Queensland floods respectively (between *Building our Nation's Resilience to Natural Disasters* than in this report). To be conservative, a factor of 1.75 was applied to the multipliers used in *Building our Nation's Resilience to Natural Disasters* (Table D.7).

Appendix D: Methodology for estimating costs

Table D.7: Share of amount of tangible costs

	Queensland floods		Black Saturday bushfires	
	% of total	\$m (2011)	% of total	\$m (2011)
Insured	47.9	\$2,388	41.7	\$1,266
Uninsured	22.4	\$1,878	32.8	\$593
Cat B	26.3	\$1,314	23.0	\$696
Agricultural production loss	0.0	\$0.57	0.0	\$0.04
Evacuated	0.0	\$0.31	0.0	\$0.09
Homeless	0.6	\$0.01	0.0	\$16
Homes – damaged	0.2	\$15	0.3	\$6
Commercial – damaged	0.0	\$3	0.1	\$1
Emergency response costs	2.5	\$123	2.1	\$65
TOTAL	100	\$5,722	100	\$2,644

Source(s): Deloitte Access Economics (2013).

Table D.8: Multipliers for total economic cost to insured losses by disaster type

	<i>Building our Nation's Resilience to Natural Disasters</i> (2013)	This report
Storm	3	5
Cyclone	5	9
Flood	10	18
Earthquake	4	7
Fire	3	5
Hail	3	5
Other	1	2

Appendix E: Literature review

The long-term effects of natural disasters

Australia is exposed to frequent and large natural disasters with the potential to destroy private property and essential infrastructure, causing problems for government, businesses and communities. A natural disaster may lead to fatalities and injuries, financial outcomes such as property infrastructure damage and emergency response costs, and costs associated with lost crops, pastures, fences and livestock.

These immediate outcomes combine to cause long term outcomes that include:

- Poorer health and wellbeing such as the development or exacerbation of chronic disease, disability or mental health issues
- Disruption to family life
- Community dislocation
- Loss of employment
- Business disruption
- Loss of public services and community assets
- Damage to the environment
- Clean-up costs including materials and labour
- Temporary accommodation
- Disruption to transport networks
- Disaster response and relief costs.

The effects on individuals can be multiple and compounding. Figure E.1 summarises the most common tangible and intangible costs discussed in studies on natural disasters. The focus of this chapter is on health and wellbeing, employment, education and community outcomes.

Research into the long-term outcomes of natural disasters has been drawn primarily from Australian literature, including studies of significant bushfires (Black Saturday 2009, Canberra 2003, Ash Wednesday 1983), floods and cyclones. The review also draws from international research, including that on the Kobe earthquake in Japan, the Christchurch earthquake in New Zealand and Hurricane Katrina in the United States (US).

Health and wellbeing

Injuries and fatalities

Estimating the exact number of fatalities from natural disasters worldwide is not simple: the worst affected regions often have poor data records and different criteria to define natural disasters. In 2014, approximately 7,700 fatalities were attributed to natural disasters worldwide – much lower than in the previous year which had over 20,000 fatalities, and well below the long-run average of 56,000 fatalities per year (Munich Re, 2015b; CRED, 2015). Over the past 15 years, the death and injury counts as a result of Australia's natural disasters have increased.

The Black Saturday bushfires directly resulted in the loss of 173 lives, affecting 51 townships (Cameron et al., 2009; Disaster Assist, 2015). Hospital emergency departments treated 414 patients affected by the bushfires. In the first 72 hours of the fires, adult burns patients spent a total of 48.7 hours in theatre at The Alfred hospital in Melbourne (Cameron et al., 2009). The fatality count does not include a further 374 deaths in Victoria during the first week of the heatwave before the Black Saturday bushfires (ABS, 2015).

The Queensland Floods Commission of Inquiry (2012) reported that 33 lives were lost as a direct result of the 2010–11 floods. No deaths occurred directly from far North Queensland tropical cyclones Larry in 2006 and Yasi in 2011.

Noy (2015) measured the direct human impact of the Christchurch earthquakes by aggregating the disaster's cost using an augmented disability-adjusted life year (DALY) approach which includes an estimate of financial loss. Using this technique, Noy estimated that New Zealand lost 180,000 life years as a result of the earthquakes. Sudaryo et al. (2012) found that physical injury as a direct result of natural disasters significantly correlates with both higher disability and lower quality of life (disability had a significant negative correlation with quality of life).

Appendix E: Literature review

Figure E.1: The complex web of tangible and intangible outcomes resulting from natural disasters



Source: Deloitte Access Economics, adapted from Productivity Commission (2015)

Appendix E: Literature review

Natural disasters also lead to deaths indirectly, including suicides and stress-induced deaths and those caused by motor accidents during relocation, accidents during the recovery phase and health system disruptions (Lawry, 2008). Studies exploring how to measure natural disasters' indirect death tolls are emerging. In the US, Stephens et al. (2007) found the mortality rate five to 11 months after Katrina was 0.5 deaths per day per 10,000 people, compared to the pre-disaster rate of 0.3 deaths per day per 10,000 people. Lawry (2008) suggested indirect deaths could be measured up to a year after a natural disaster.

Qualitative research by Osman (2012) showed that natural disaster refugees in close-knit communities experienced high levels of anxiety over the deaths and injuries of their loved ones, greatly affecting their personal resilience and coping mechanisms.

Mental health

Natural disasters are often followed by grief, post traumatic stress disorder (PTSD), anxiety, depression and substance abuse. Prevalence estimates for these types of mental health conditions depend heavily on when the assessment is made and the person's level of exposure to the natural disaster. Post-traumatic mental health problems often occur together – particularly PTSD, depression and substance abuse – which can present treatment sequencing dilemmas for practitioners (Australian Psychological Society, 2011).

More recently, research has begun to focus on achieving a broader understanding of loss and grief experiences to better inform post-disaster recovery understandings and interventions (Harms et al., 2014). For example, in-depth interviews with people affected by the Black Saturday bushfires found that many people grieved the loss of not only family and friends but other community members who they may not have been closely attached to, but whose deaths also impact profoundly.

Alderman, Turner and Tong (2013) used multi-variable logistic regression to examine the association between flooding and perceived health outcome variables (adjusted for current health status and sociodemographic factors). The analysis concluded that residents whose households were directly affected by flooding were more likely to report experiencing poor respiratory health, psychological distress, reduced sleep quality and PTSD.

McLaughlin et al. (2010) completed baseline and follow-up telephone surveys 18–27 months after Hurricane Katrina and 12–18 months after the first survey to assess serious emotional disturbances. Serious emotional distress decreased from 15.1% prevalence during the first round of interviews to 11.5% during the second, but was still significantly above pre-hurricane rates estimated at 4.2%.

Camilleri et al. (2010) completed a study of the experiences of people directly affected by the 2003 Canberra bushfires. Almost one-fifth (19.5%) of survey respondents reported high to very high levels of psychological distress approximately 3 years after the bushfires. This proportion is high when compared to the statewide rate of psychological distress of 13% shown in the ABS 2004–05 National Health Survey (ACT).

PTSD is the most commonly identified disorder that occurs after exposure to a traumatic event. Like mood disorders, PTSD rates often depend on how soon after the disaster the assessment is made as rates decrease quickly. Generally, PTSD rates are high in the initial months after a disaster but symptoms usually disappear in subsequent months (Bryant, 2009; Bryant, 2011). Bryant et al. (2014) found that while the majority of respondents reported no psychological distress on the Kessler-6 screening scale (a standardised measure of psychological distress), those in communities highly affected by the disaster (such as extensive property loss or injuries) reported higher rates of PTSD, depression and severe psychological distress than less-affected communities.

Most people will eventually adapt after a natural disaster. However, a significant minority of survivors will experience psychological and social difficulties over the medium- to long-term (Bryant, 2011). Bryant et al. found that a significant minority of people in communities highly affected by the Black Saturday bushfires reported persistent PTSD, depression and psychological distress four years after the fires. Strong predictors of psychological distress were fear for one's life in the bushfires, death of someone close to them, and subsequent stressors. Separation from close family members during and in the hours following the bushfires were found to be an important component of the trauma experience, impacting on mental health outcomes (Gallagher HC, in press). The 2011 Christchurch earthquakes led to a 7% increase in Canterbury residents accessing mental health support services in 2011–12 (Deloitte Access Economics, 2015).

Box 9: Trauma in survivors of disasters

Professor Rob Gordon is a clinical psychologist specialising in disaster trauma who has worked with survivors of disasters since the 1983 Ash Wednesday bushfires. He explains how disasters can disrupt everyday life.

Everyday life is marked by habits and routines that provide structure to individuals. Survivors lose their routine and structure and are thrown into a world without past experiences to draw upon. Cognitive and physical effort is often overwhelmingly directed towards first survival then immediate recovery. Long-term planning and leisure activities are neglected, while abstract thinking becomes difficult. Such a state can continue for many months and can be stressful and fatiguing.

Professor Gordon has seen many individuals suffering from a breakdown in their ability to make decisions.

'After floods occurred in New Zealand a sheep farmer asked to borrow his neighbour's gun. The neighbour inquired as to the reason, and the farmer told him that he intended to kill his sheep: they were stranded on his property and were dying of starvation. The neighbour thought for a minute and instead offered to take down the fences on his property so that the farmer could move the sheep to some adjacent properties that had been provided by the rescue services for just this purpose. Under the state of stress caused by the floods, the farmer's thinking had narrowed but ensuring connectivity with the community and communication of the support and resources that had been made available allowed the farmer to save his sheep.'

'After the 1983 Ash Wednesday Bushfires a family, whose house had burnt down, were invited to stay in their neighbour's house until their house was rebuilt. After some time they expressed interest in moving out of their neighbour's house into a caravan, but the neighbours protested such a move and insisted that they stay. Without privacy of their own home, the marriage lost its intimacy and resulted in divorce while the parent's relationships with their children also suffered.'

Source: Consultation with Professor Rob Gordon.

PTSD also affects first responders such as emergency workers. In studies that examined PTSD among first responders to natural disasters, particularly firefighters and police officers (Everly & Perrin, 2008; McFarlane, 1987a, 1988; Spurrell & McFarlane, 1993) a high prevalence of PTSD was estimated. For example, 21% of firefighters responding to the 1999 Chi-Chi earthquake in Taiwan (Chang et al., 2005) had PTSD at five months after the disaster; likewise, 22% of firefighters responding to Hurricane Katrina in 2005 (Centers for Disease Control and Prevention, 2006) experienced PTSD 2–3 months after the disaster (Neria et al., 2008).

These patterns have implications for the timing of treatments after disasters because most survivors recover unaided by formal mental health intervention (Bryant, 2011). One-third of those with severe psychological distress did not receive mental health assistance in the month before they were surveyed.

However, there is a need to promote the use of health and complementary services, community-based initiatives, and family and other informal supports to target the minority of people who experience significant and persistent psychological distress, mood disorders or PTSD (Bryant et al., 2014; McFarlane and Raphael, 1984).

Approaches to treatment and support should be unique to each circumstance. Two critical measures can be used to decide the appropriateness of an intervention:

- The extent to which the threat to the survivor still exists
- The extent to which the survivor has sufficient resources to manage the intervention (Bryant et al., 2014).

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For example, the survivors of the Victorian fires who lost their homes and their sense of belonging were expected to experience persistent upheaval for months after the event (Bryant, 2011; Proudley 2010). In less than 10 years, Victoria has experienced three devastating fires, in 2003, 2007 and 2009. The stories of fire-community members, whose lives were fundamentally altered by the 2009 Black Saturday fires, reveal the complexity of identity and belonging in the post-bushfire landscape. Many were displaced from their homes and found themselves faced with the decision of whether to rebuild or relocate. For some participants, the losses and consequent decisions were extensive and overwhelming.

Exposure to natural disasters can also lead to an increase in alcohol and tobacco consumption. International studies have identified the relationship between natural disasters and alcohol consumption (North et al., 2004; Adams & Adams, 1984; Shimizu et al., 2000; Cerda et al., 2011; Kohn et al., 2005). A review by Keyes et al. (2012) found that studies covering a timeframe of a year or less after a natural disaster indicate post-disaster increases in alcohol consumption (Kohn et al., 2005). In comparison, longitudinal studies have found attenuation of this relationship over time (Keyes et al., 2012). Nordløyken et al. (2013) finds that people affected by natural disasters self-reported increased alcohol consumption. Parslow and Jorm (2006) looked at young adults following the 2003–04 Canberra bushfires and found their experience was associated with an increase in their consumption of tobacco (odds ratio of 1.12).

Box 10: Impact of natural disasters on children

Children and young people are particularly vulnerable to the psychological impact of natural disasters, with indications of more serious mental health impacts on biological, psychological and emotional development (King 2006; McDermott & Palmer, 2002; Wooding & Raphael, 2004).

McDermott and Palmer (2002) found a range of psychological responses across the developmental spectrum. A study of primary school children six months after a bushfire showed a greater prevalence of self-reported depression symptoms among children aged 9–11 compared to adolescents. The study found relationships between depression, emotional distress and school grade.

Following the 2003 Canberra bushfires, McDermott et al. (2005) found that of 222 child respondents from school grades 4–12, 9% reported severe or very severe PTSD, while 22.6% showed symptoms of emotional distress. Younger children and individuals with greater exposure to and perception of threat experienced higher levels of PTSD and general psychopathology.

However, the impact of the disaster was found to be minimal on long-term mental health outcomes in adulthood. MacFarlane and Van Hooff (2009) examined the impact of childhood exposure to the 1983 Ash Wednesday bushfire on their pathology in a 20-year longitudinal study. The study found that the disaster had a minor long-term effect on anxiety (rather than causing depressive disorders) but showed no significant differences in current or lifetime prevalence of PTSD between survivors and the control group. The authors note that a lack of differences in some outcomes does not mean that the impact of disasters was small. Rather, lifetime exposures to other traumatic events can be just as significant and, over time, people tend to respond to trauma in similar ways.

Following the Black Saturday 2009 bushfires, the Smouldering Stump Association was established to help relieve the suffering and distress of children and young people affected by the fires. It provides support to schools for educational and health-related programs for children and young people suffering from post-traumatic disorders, and emotional, learning and development issues. It also raises money for school- and community-based resources, therapy programs, group activities and campaigns to raise awareness of the impacts of PTSD, particularly for young people.

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Chronic disease and non-communicable diseases

According to Miller and Arquilla (2008) chronic disease exacerbations (CDE) account for one of the largest patient populations during disasters. Other studies consistently support this, showing that individuals with chronic disease are at increased risk of suffering from natural disasters (Miller & Arquilla, 2008; Owens & Martsolf, 2014; Guha-Sapir et al., 2007; Cherry, 2009; Hobson, Bacon, & Cameron, 2014).

Outcomes appear to be influenced by either illness (for example, increased susceptibility to injury or infection) or the disaster itself (such as separation from medication or treatment, inhaled toxins, crush or blast injuries, or contamination of food and water) (Miller & Arquilla, 2008; Owens & Martsolf, 2014; Kobayashi et al., 2013).

Furthermore, adverse outcomes can present immediately or be delayed (Guha-Sapir et al., 2007). Studies highlight the importance of medical teams being prepared to address chronic disease as well as acute conditions. Guha-Sapir et al. (2007) found that a delay in the presentation of many acute conditions has long-term implications after disasters. Longitudinal studies found that autonomic reactivity and development of new vascular problems were sensitive to disaster exposure, even years later (Hobson, Bacon, & Cameron, 2014).

Ryan et al. (2015) reviewed of the impact of cyclone, flood and storm-related disasters on those susceptible to, or experiencing, non-communicable diseases (NCDs). The review included the following findings:

- **Cancer:** There is no evidence that natural disasters exacerbate illness for people with cancer. However, it does reduce access to cancer treatment and care in some instances (which can last for up to one year based on Hurricane Katrina research)
- **Cardiovascular diseases:** People with cardiovascular disease are at risk of severe exacerbation or complications of their illness such as high blood pressure, heart attack and preventable death. Based on Hurricane Katrina research, this risk can continue for weeks or years

- **Chronic respiratory disease:** People with chronic respiratory diseases are at increased risk of experiencing acute exacerbations of their conditions after a disaster due to disruption in care and increases in the amount of mould and other allergens present after a disaster
- **Diabetes:** There is an increased risk of severe exacerbations or even preventable death due to disrupted diabetes management, as well as factors such as physical activity and nutrition.

There is also evidence that natural disasters contribute to cardiovascular disease and chronic disease risk factors, due to their stressful nature. Kario et al. (2003) studied the effects of the Kobe earthquake on the population's cardiovascular systems. The earthquake resulted in a threefold increase in heart attacks in people living close to the epicentre in the four weeks following the disaster, and a near doubling in the frequency of strokes.

Clayer, Bookless-Pratz and Harris (1984) conducted a survey of health and psychosocial problems in victims of the 1983 Ash Wednesday bushfires. The study found a significant increase in stress-related conditions 12 months after the disaster, including hypertension, gastrointestinal disorders, diabetes and mental illness, while the prevalence of cancer and urological diseases did not increase significantly.

Box 11: The impact of cyclones, floods and storm-related disasters in rural areas on non-communicable disease (NCDs) and public health infrastructure

Ryan et al. discussed the impact of natural disasters on people with NCDs or chronic diseases – mainly cardiovascular diseases, cancers, chronic respiratory diseases and diabetes.

The study interviewed patients and health providers in Queensland and found that disasters can disrupt treatment for people with NCDs because public health infrastructure is damaged. This in turn exacerbates their illness and sometimes causes death.

Mitigation strategies might be strengthening public health infrastructure; improving communication and education across the health system; basing disaster plans on community priorities; and ensuring general practitioners are present at evacuation centres.

Many studies on illness after a natural disaster focus on the short-term implications. There is anecdotal evidence that such disasters can have long-term psychological impacts for some survivors, however there is less research on the development of chronic physical conditions after a disaster. Galea (2007) examined the electronic medical records of rescue workers involved in the 2000 Enschede fireworks explosion in the Netherlands which killed 23 people including four firefighters, and injured 947. Though the workers were a relatively young and fit, they disproportionately experienced physical health concerns well after the disaster.

Armenian et al. (1998) found some evidence of increased morbidity from heart disease, hypertension, diabetes and arthritis in the six months after a 1988 earthquake in Armenia (though not necessarily new development of these diseases).

Zaetta et al. (2011) examined survivors of the 1963 Vajont Dam disaster in northern Italy in which a wave of water swept over the dam, causing a landslide that wiped out downstream villages. Sixty survivors were compared against 48 control subjects of similar gender, education and age. According to Zaetta, the 'Vajont disaster reported a higher number of gastrointestinal diseases, dermatological problems, respiratory diseases, and a miscellanea group, including neurological, rheumatological, and ophthalmological problems.' Even 40 years after the disaster, survivors were still having negative physical and mental health effects.

Family violence

In the 1990s, researchers began to identify links between natural disasters and increased violence against women (Sety, 2012). Research has continued showing an increasing awareness of women's vulnerability to, and experiences of, domestic and family violence after disasters (Anastario, Lawry & Shehab, 2009).

A substantial increase in gender-based violence is reported to occur following disasters (WHO, 2005). Studies have found that such violence often persists at very high levels for years past the event (Sety, 2012; Anastario, Lawry & Shehab, 2009; Clemens et al., 1999). Of the limited studies that explore the patterns of domestic and family violence following a natural disaster, all suggest that the crime is becoming more prevalent and even accepted (Gutman, 2012; Sety, 2012; Anastario, Lawry & Shehab, 2009; Parkinson, 2013). In the majority of studies, this increase has not been established by an increased number of domestic violence police reports, but an increase in the number of women seeking help and support (Sety, 2012).

In Australia, Parkinson and Zara (2013) conducted research to identify the link between women and violence after natural disasters. Out of 30 interviews conducted after the Black Saturday bushfires, 17 women spoke of violence in their own relationship – nine of whom experienced this type of violence for the first time.

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Gutman (2012) produced strong anecdotal evidence of the increased incidence of elder abuse after disasters. WHO (2005) supports this, although there is a lack of formal evidence. True et al. (2013) found that violence against women increased after the Christchurch earthquakes and suggested this had important implications for post-disaster interventions.

The majority of such studies have taken a qualitative approach to measurement, although police reports provide occasional, valuable quantitative data for support (Parkinson and Zara, 2013). New Zealand police reported a 53% rise in domestic violence after the 2011 Christchurch earthquake (Parkinson & Zara, 2013). Another study found a fourfold increase in domestic violence following two disasters and a 98% increase in the physical victimisation of women after Hurricane Katrina (Schumacher, et al., 2010).

Increased stress is commonly cited to explain the increase in violence against women during and after disasters. In Parkinson's qualitative study (2013), the community, family and service providers 'often denied or minimised women's disclosures of violence after the Victoria bushfires, citing the stress experienced by men as an excuse for their behaviour'. Similarly, workers in Houghton's study (2009) cited the primary reason for increased violence as financial stress, noting loss of earnings, possessions and housing, and a lack of insurance. However, both studies suggest that stress is not a cause. They theorise that it is the perpetrators' sense of losing control over other aspects of their life (such as housing, employment, food, shelter, communication and social support) that causes them to seek more intense control over their family – domination through violence.

Fortunately, research in this area is increasing and recent studies are accompanied by insights into opportunities to ensure the safety, wellbeing and empowerment of women who experience domestic violence during or after disasters (for example, see the Gender and Disaster Pod at www.genderanddisaster.com.au). The fact that more women are coming forward to seek help is evidence of the increased help available to them.

Relationship breakdowns

Studies suggest that natural disasters can have a negative impact on relationships, particularly between spouses and families (Caruana, 2010). The majority of research on responses to natural disasters focuses on children and adolescents rather than families (Caruana, 2010; Davidson & McFarlane, 2006). Impacts in the family are therefore derived by pairing child responses and 'what is known about the impact of stress on individual functioning and marital outcomes' (Caruana, 2010; Landau, Mittal, & Wieling, 2008).

Natural disasters affect family relationships in several ways. The effect depends on if the disaster was endured by the entire family, some family members or a single family member (Caruana, 2010; Davidson & McFarlane, 2006; Figley, 2002). For example, partners dealing with trauma-impaired spouses may experience compassion fatigue or secondary traumatic stress disorder. This can lead to escalating conflict and relationship breakdown (Figley, 2002).

The makeup of families can also influence a family's risk of breakdown. For example, Solomon and Smith (1994) found that single-parent families are at a higher risk of impairment and breakdown after disasters due to the likelihood that they had fewer resources before the disaster and thus feel more strongly the loss of social supports.

Earlier studies found a more positive impact of disasters on the functioning of families. Silber, Perry & Bloch (1958) indicated there may be increased closeness and familial cohesion immediately following a disaster. McFarlane and Raphael (1984) also noted increased family closeness, but this occurred 26 months after the event rather than immediately after. This increased familial closeness did not necessarily lead to closer community-wide bonds.

Surprisingly, the Rural and Regional Families Survey concluded that drought has not resulted in higher rates of family conflict and separation, nor is it attributed to a diminished quality of couple relationships or family functioning (Edwards et al., 2008). Studies suggest that this may be due to the characteristically resilient attitudes of rural and regional communities (Caruana, 2010).

The impact of natural disasters and trauma on families and relationships is increasingly being explored and due to the family being recognised as an important part of recovery for individuals (Landau et al., 2008).

Appendix E: Literature review

Employment outcomes

Natural disasters can affect employment due to ill health, injury and death, as well as damages to businesses, agricultural crops and infrastructure.

Infrastructure damage and crop loss has led to reduced productivity in the agricultural sector of Far North Queensland more than once. Cyclone Larry devastated the banana industry in Far North Queensland, leaving an estimated 4,000 people out of work (*Sydney Morning Herald*, 2006). A similar banana shortage occurred after Cyclone Yasi (Carey, 2011).

Attracting and retaining staff are key problems arising from natural disasters. Hurricane Katrina sparked employment difficulties for local government human resources management positions. Two years after the hurricane, some local governments were still struggling to attract and retain qualified people to fill positions (French, 2008).

The National Highway Traffic Safety Administration (NHTSA) in the US looked at the costs associated with loss of worker productivity due to natural disasters. They estimated the extent of costs associated with loss of worker productivity for fatalities (three months wages), severe injuries (four months wages) and minor injuries (two days wages).

In 2011, the Commonwealth Bank of Australia (CBA) published a report focusing on the short- and long-term effects of natural disasters on income, salary levels and salary recipients. Using salary payments into CBA accounts as a proxy for employment and income trends, the report found large downturns during and immediately after the Black Saturday bushfires and the Queensland floods in 2009, 2010 and 2011. However, the report also found that in most cases, income levels bounced back to pre-disaster levels over a period of 4–8 months.

Education outcomes

Natural disasters have both direct and indirect effects on the education of students. The direct or immediate impact is the damage of educational infrastructure and the costs of demolition and clearing (ECLAC Subregional Headquarters for the Caribbean – Disaster Assessment Training Manual, 2009; USAID, 2014; Chang et al., 2013). In addition, educational or sporting facilities may be used as shelters and relief centres, and costs are incurred accommodating students elsewhere as well as lost school fees, loss of income to teachers and disruption to education (Kambon, 2009; Cuaresma, 2010; ECLAC, 2009).

Box 12: Effects on swimming pool use in Christchurch

Janine Gainsford and Roslyn Kerr (2013) outline how sports facilities were affected by the 2011 Christchurch earthquake in their report *Swimming in Christchurch*. The closure of the QEII swimming complex after the disaster included the facility's Olympic-standard pools. Furthermore, 24 of the 45 school pools in the city were damaged. This meant that public access to swimming facilities was severely reduced, including for school children. Competitive swimming clubs reported dramatic drops in memberships: '... on average there was a 17% drop in the number of Canterbury swimmers competing' in the New Zealand short course swimming competition after the earthquakes.

Empirical evidence also suggests that natural disasters have a negative effect on secondary school enrolment (Cuaresma, 2010; Vreyer, Guilbert & Mesple Soms, 2015). Data from Statistics New Zealand (2011) shows that 9,534 school students who were enrolled in Christchurch, Selwyn and Waimakariri before 22 February 2011 then re-enrolled in other schools. This comprises 12.5% of all school students enrolled in those three districts.

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Natural disasters affect social and educational outcomes in a variety of ways, including through damaged infrastructure, dysfunctional family situations, socio-economic difficulties, discouraged students, disrupted living conditions and students suffering psychosocial trauma (Kambon, 2009; Fuller, 2013). Following the Black Saturday bushfires, Gibbs et al. (2015b) found many children were dealing with disruptions after their school burnt down. Students of all ages struggled to cope with schooling and tertiary education. Participants reported children and young people had problems coping with key transitional stages such as the start of school or the final year of secondary school.

The social repercussions of natural disasters and how they influence education have received limited attention. Kambon (2009), Fuller (2013) and Hermida (2009) however, found that disasters negatively impact education outcomes. Studies suggest the post-traumatic stress symptoms and disorders experienced by students affected by natural disasters can reduce their educational achievement (Sims et al., 2015; Kronenberg et al., 2010; Weems et al., 2013). Conversely, Smilde-van den Doel et al. (2006) compared the academic achievement of students exposed to natural disasters with those not exposed and found they did not influence academic achievement.

Sims et al. (2015) found an association with direct exposure to disasters and student dissatisfaction with school, although its impact on educational outcomes is less clear. Overall, the impact of natural disasters on schooling and educational attainment is ambiguous due to the varying nature of the effects involved (Baez et al., 2009).

Furthermore, there is limited research exploring the long-term impact and costs of lost or disrupted education. Schools play a central role as 'banks' and facilitators of educational human capital (Baah-Boateng, 2013; Baez et al., 2009), so it is expected that disrupted or lost education would impact future employment prospects.

Most studies highlight the opportunity for government policies and initiatives to help disaster-exposed students (Sims et al., 2015; Weems et al., 2013). Sims et al. (2015) suggests identifying successful school-based interventions to reduce anxiety symptoms after natural disasters and exploring how these could be applied to minimise education disruptions and reduce dissatisfaction with school. The strong influence teachers have on students' post-disaster recovery is acknowledged as having important implications for school-based interventions (Seyle, 2015; Smilde-van den Doel, 2006).

Porche et al. (2011) examines data from Collaborative Psychiatric Epidemiology Surveys (CPES), finding that American students who experienced a natural disaster had a dropout rate of 22.43%, compared to the national average of 16%.

Similarly, a report from Broberg et al. (2005) on the educational success of survivors of the Göteborg discotheque disaster, where a fire killed 63 people and physically injured 213 showed that 18 months after the disaster 23% had dropped out of school or repeated a class. Meanwhile 43% reported the disaster had negatively affected their schooling.

Pietro (2015) examines the impact of the Italian 2009 L'Aquila earthquake on University of L'Aquila education outcomes. While in the very short term there was no effect on dropouts, 'empirical results suggest that this natural disaster has reduced students' probability of graduating on time by 6.6 percentage points'. The effect was even larger for female students.

An OECD (2003) report found that every high school graduate is worth US \$127,000 to American taxpayers. A 1999 estimation found that leaving high school early in Australia results in \$15,000 of lost income each year to an individual (Te Riele, 2013).

However, more research is needed to further explain the direct and indirect impacts of natural disasters on short- and long-term educational outcomes.

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Community outcomes

Social networks

The traditional focus of emergency management activities in Australia is on preserving life, hazard management and mitigation, and replacing infrastructure including roads, buildings and equipment. Losses are measured in monetary and tangible terms such as costs and infrastructure damage. This neglects the impact that natural disasters have on social capital.

Social capital refers to networks of formal and informal organisations, and strong community leadership. It can save lives, encourage the sharing of information and resources, provide a basis for the planning and implementation of tasks, and ensure appropriate self-advocacy (Australian Red Cross, 2013). Studies show that natural disasters can result in a loss of social capital in the form of trust and community networks (Toya, 2014). Qualitative research by Miller (2006) on the impact of Hurricane Katrina found 'a new social reality marked by a culture of distrust and a decline in social capital among residents'.

Aldrich (2012) studied four disasters: 1923 Tokyo earthquake, 1995 Kobe earthquake, 2004 Indian Ocean Tsunami and 2005 Hurricane Katrina. Quantitative and qualitative analysis showed those areas with higher levels of social capital facilitated recovery and helped survivors to coordinate more effectively after the disaster. High social capital was found to be a larger factor than greater economic resources, assistance from government or outside agencies. The book notes:

"Even highly damaged communities with low income and little outside aid benefit from denser social networks and tighter bonds with relatives, neighbors, and extralocal acquaintances. Alternatively, neighborhoods with lower levels of social resources can find themselves unable to organize collectively to deter looting and garbage dumping, to communicate necessary requests to the authorities, and to work together to rebuild their community. Deeper reservoirs of social capital serve as informal insurance and mutual assistance for survivors, help them overcome collective action constraints, and increase the likelihood that they will stay and work to rebuild (as opposed to moving elsewhere)."

Social capital can serve three critical functions:

- **Informal insurance:** Social ties can provide people with guarantees of financial help, physical assistance and other forms of support including housing, child-care and short-term loans. (Beggs, Haines and Hurlbert 1996)
- **Mobilisation and collective action:** Social capital enables a greater ability to organise, share information and put in place effective processes. Communities with higher levels of social capital are able to more effectively use public space and curb anti-social behaviours (Dow 1999)
- **Increase social cohesion:** Social capital increases the cost of leaving the community, which leads to more people staying to help the community recover, rather than strike off on their own. Individuals with a long-term stake in the community are the most motivated to rebuild and possess the greatest capacity to do so (Chamlee-Wright and Rothschild 2007). Social cohesion also helps information more easily diffuse throughout the community (Aldrich 2012).

Higher social capital leads to a greater capacity to recover following a disaster. More trust and engagement allows individuals to better mobilise and be more resilient to the impacts of disaster (Aldrich 2012).

There is evidence to suggest that social capital can be increased by policies that create local institutions and make it easier to participate in them (Krishna 2007). There is also evidence that natural disasters can have a positive effect on social capital. After Cyclone Larry, more than 150 people from around Australia joined in the clean-up, helped to re-open damaged schools and shops, and to make homes habitable again. More than 6,000 hours of community service was completed as a part of the clean-up after Cyclone Larry (Queensland Corrective Services, 2006).

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Environmental damage and loss of animal lives

Natural disasters cause extensive environmental damage that cannot be restored. Many assessments describe the damage to the environment rather than quantifying the economic loss incurred by it. Hurricane Katrina is described as having caused extensive damage to trees in the urban environment and forests, and the Black Saturday bushfires burnt private and public land (McCallum & Heming, 2006; The Wilderness Society, 2015). A qualitative study by Falco Mammone et al. (2006) found that up to 73 parks and forests in north Queensland were affected by Cyclone Larry, with an estimated cost of \$10 million in damage to infrastructure and resources. Bushfires in 2003 in Australia destroyed more than three million hectares of vegetation (Sivakumar, 2005).

The impact of environmental loss is not just tangible costs. After the Black Saturday bushfires, it was estimated that more than one million animals perished (RSPCA, 2015; The Wilderness Society, 2009). After three fires in less than 10 years, experts are concerned the fires may have devastated some of Victoria's most endangered animals and plants, raising major concerns for their survival (The Wilderness Society, 2009). The five species considered most threatened include the Leadbeater's Possum, Sooty Owl, Barred Galaxias, Ground Parrot and Spotted Tree Frog. In addition, people in the Kinglake Ranges and the Blue Mountains described how seeing burnt out bushland made them feel depressed (Australian Red Cross).

Natural disasters cause pet loss which can have profound psychological impacts on their owners. There are substantial anecdotal reports of pet owners risking their lives to protect their pets, demonstrating the strong bond owners can forge with their animals (Thompson, 2013). There are also reports of households only partially evacuating so that somebody could stay to care for pets (Taylor et al., 2015). A survey of Taranaki and Wellington regions in New Zealand found 56% of pet owners would be unwilling to evacuate if it required abandoning pets (MerCALLI, 2010). Many, however are forced to abandon their pets, causing psychological distress to owners and emergency workers. A survey of Australian pet owners found 15% of owners who evacuated left at least one pet behind. A survey after Hurricane Katrina found pet loss was significantly correlated with psychological distress (measured using the Kessler-6 Psychological Distress Scale).

Crime

Few studies discuss the impact of natural disaster on crime. Some do consider post-disaster police data and reports to determine whether crime levels increase.

The *Annual Statistical Review* by Queensland Police (2012) reported an increase in crime in the year following the 2011 floods. It noted a 2% increase in the rate of total offences against people, a 6% increase in the rate of total offences against property and a 6% increase in the rate of other offences. This contrasted with a long-term trend of decreasing crime.

Shortly after Hurricane Katrina hit, crime levels were reported to be increasing (Filosa, 2005; Dwyer & Drew, 2005). Filosa (2005) describes that state officials had to set up a temporary booking and detention centre in New Orleans to deal with the increased number of people accused of crimes against people who were trapped in the aftermath of the hurricane and awaiting evacuation.

Other studies (Dwyer & Drew, 2005; Jacob, 2008; Constable, 2008) suggest that antisocial behaviour such following natural disasters is a myth. Jacob (2008) argued that after Hurricane Katrina there was only isolated cases of antisocial behaviour, which were exaggerated by the media, and most people respond positively and generously after natural disasters. Dwyer and Drew (2005) agree that many 'reports of rape and murder were the produce of frightened imaginations, chaotic circumstances and unreliable communication'. However, they concede that genuine acts of violence, looting and theft did occur for a week after Hurricane Katrina at a greater rate than normal.

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Community dislocation

Dislocation refers to individuals and populations who experience displacement, both physically and culturally (Alexander, 2008). It is increasingly acknowledged that climatic changes have substantial effects on people's sense of displacement (Fritze et al., 2008; Sartore et al., 2007). Peek and Fothergill (2008) point out that moving permanently from a disaster area can mean leaving extensive social networks and jobs. In this way, relocating can carry significant social and economic cost for individuals. However, parents often chose to shoulder this cost to protect their children from further disasters.

In 2013, natural disasters displaced three times more people than war, with 22 million people driven out of their homes by floods, hurricanes and other hazards (Goldenburg, 2014). There is limited data to measure the impact of a natural disaster on dislocation and population flows, however studies show that earthquakes and hurricanes are the disasters most commonly associated with dislocation (Smith & McCarty, 1996; Lu, 2007).

Smith and McCarty (1996) found that two years after Hurricane Andrew in Florida, a tiny proportion (0.2%) of the North Dade population had moved and remained outside the area, while a much larger proportion of the South Dade population (6.5%) had moved and stayed outside the area. Another study found that recovery after Hurricane Andrew was slower for households in apartments than houses, that recovery tended to exacerbate patterns of social inequality in housing status, and that rented housing showed a slower rate of recovery (Lu, 2007). The population of Christchurch fell from 348,456 in 2006 to 341,469 in 2013 (Bayer, 2013) while the population of wider Canterbury region grew as residents moved out of the earthquake-affected city. The net population figures, however, undervalue the extent of dislocation because the outward migration was offset by the inward migration of people there to help rebuild. An estimated 55,000 people left Christchurch city in the immediate aftermath of the earthquake (Canterbury Earthquake Recovery Authority, 2014).

Less research has looked into the relationship between dislocation and bushfires. Approximately 2,000 homes, along with businesses and schools, were destroyed in the 2009 Black Saturday bushfires, resulting in the dislocation of many people. The 2009 Victorian Bushfires Royal Commission reported that 7,562 people were displaced as a result of the fires. Of those, 116 sold their fire-affected properties to the Victorian Government under a buy-back scheme, rather than rebuilding their homes (Fire Recovery Unit, 2014). Three years after the fires, 13% were still in temporary accommodation. Proudley (2013) explored the complexity of identity and belonging after the bushfires, demonstrating the effect dislocation has on mental health and wellbeing. Individuals and families rendered homeless often felt overwhelmed by major decisions about their medium- and long-term futures.

As Gibbs et al. (in press) notes, little attention has been paid to the impact of post disaster relocation on personal wellbeing. Based on in-depth interviews and a survey of respondents following the Black Saturday bushfires, Gibbs et al. (in press) explores the experiences of those who stayed and those who relocated, and the impact on wellbeing. The current wellbeing of those who stayed was more likely to be tied to subsequent life stressors, indicating they may have benefited from support to alleviate the financial and relationship stressors after the fires. In contrast, individuals who left the community reported greater exposure to the disaster, and less sense of community in their new location, both of which had a negative influence on their wellbeing. This indicates services need to be more accessible to those who relocate.

Appendix E: Literature review

Loss of heritage and culture

Natural disasters can result in the loss of irreplaceable artistic and cultural assets (Taboroff, n.d.). It is argued that cultural factors such as social values, traditions and attachment to a location influence how communities respond to natural disasters. However, few studies have measured the effects of loss of culture and heritage after natural disasters.

The most commonly reported loss in this category is that of heritage. In Canterbury, 195 heritage buildings were destroyed (Heritage New Zealand, 2015) by the earthquakes.

According to Jogia (2014), affected communities frequently give priority to factors such as social values, religious beliefs, traditions and attachment to a location, rather than the danger posed by a natural disaster. Jogia (2014) used community responses to volcanic eruptions to support this. During the eruption of the Merapi volcano in Indonesia in 2006, many communities refused to evacuate at-risk areas, following their traditional community leaders rather than government instructions (Lavigne et al., 2008).

Since it is likely that the frequency of natural disasters will rise due to climate change, preventive measures become more important, particularly for protecting cultural heritage and immovable cultural property (Meier, Petzet & Will, 2007). As such, Jogia (2014) highlights the importance of disaster mental health services that are tailored to people with different cultural backgrounds.

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February 28, 2011: Christchurch, NZL. Australian search and rescue teams from Queensland and New South Wales search the rubble of destroyed buildings in Christchurch, New Zealand, looking for victims of the 6.3 magnitude earthquake which struck on 22/02/2011, 20km southeast of Christchurch, New Zealand. (David Caird / Newspix)

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