

# 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

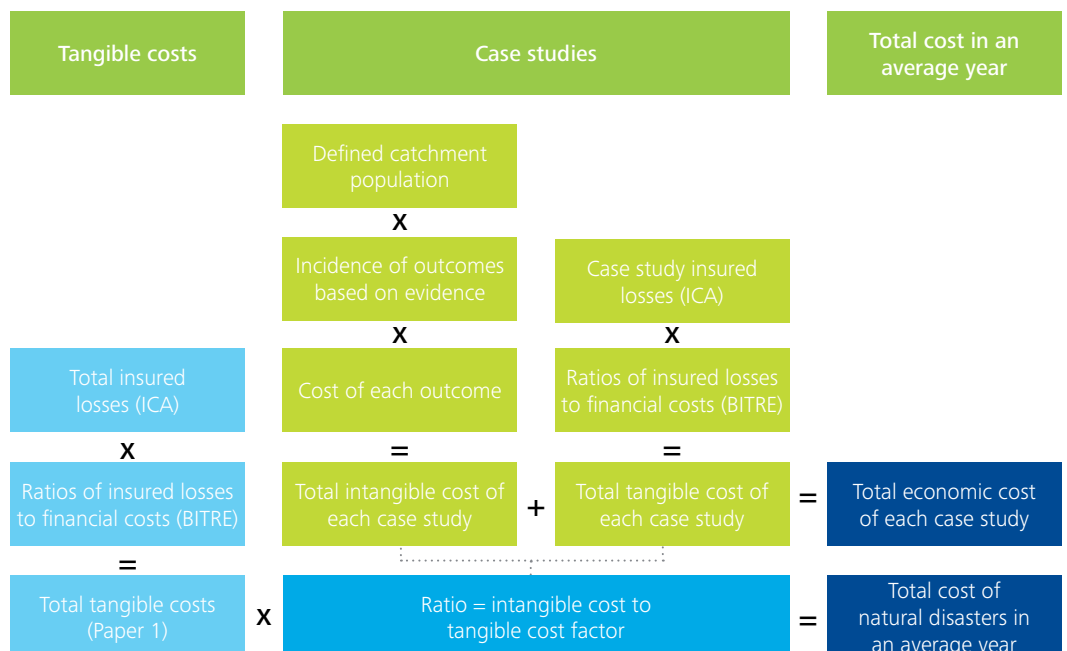
The overall approach to estimating costs is summarised in Figure D.1 and consists of three broad components:

- 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



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### 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.

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## 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
<b>Queensland floods</b>	Population	153,315	159,519	49,774	47,319	<b>409,927</b>
	Average age at time of disaster <sup>^</sup>	48	52	9	8	
	Average life expectancy	82	83	80	85	
<b>Black Saturday bushfires</b>	Population	73,016	78,434	28,303	26,611	<b>206,363</b>
	Average age at time of disaster <sup>^</sup>	55	56	11	9	
	Average life expectancy	83	83	80	85	

<sup>^</sup> 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.

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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% <sup>§</sup>
Mental health issues (female)	14.7%*	18.7% <sup>§</sup>
Alcohol misuse	1.1% <sup>†</sup>	19.0% <sup>§</sup>
Family violence (female and children)	2.7% <sup>‡</sup>	7.0% <sup>¶</sup>
Family violence (male)	1.1% <sup>‡</sup>	2.8% <sup>¶</sup>

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.

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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¶

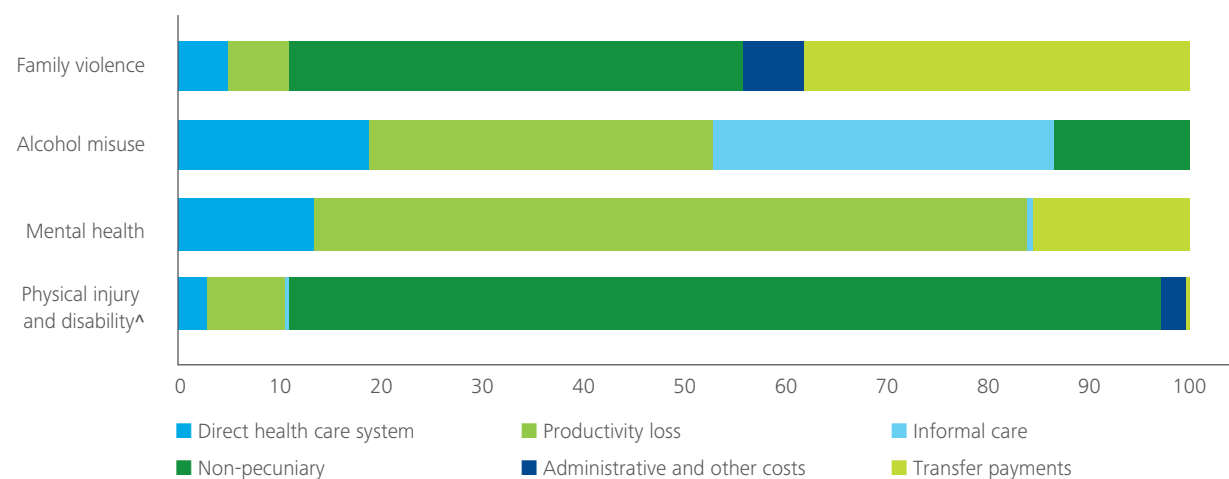
Source(s): Deloitte Access Economics using \* OBPR, † BTE (2001), ‡ Access Economics (2009), § Access Economics (2009), ¶ Access Economics (2004)

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

Outcome	Direct health care system	Productivity loss	Informal care	Non-pecuniary <sup>^</sup>	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.  
<sup>^</sup>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.  
<sup>^</sup>Non-pecuniary costs are associated with pain, suffering and premature mortality.

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### 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).

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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
<b>TOTAL</b>	<b>100</b>	<b>\$5,722</b>	<b>100</b>	<b>\$2,644</b>

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