**Senate Standing Committee on Environment and Communications**

**Inquiry into Recent Trends in and Preparedness for Extreme Events**

# Submission from:

# Centre for Risk and Community Safety

# RMIT University

RMIT's Risk and Community Safety Research Centre started eleven years ago as a joint initiative between RMIT University, Emergency Management Australia and ANU. It has established itself as one of Australia's leading publically funded research groups in fire and emergency management, and over the last few years also in that component of climate change adaptation covered by emergency management. The group led the Bushfire CRC's research program on self sufficient communities and the post-Black Saturday human impacts research effort. We also worked closely with the Royal Commission into the fires and assisted the Queensland Chief Scientist with the Queensland flood inquiry. We lead the NCCARF (National Climate Change Adaptation Research Facility) Emergency Management Network, are active in VCCCAR (Victorian Climate Change Centre for Adaptation Research) through research on extremes, and serve on a number of national and international committees including the National Flood Risk Advisory Group the UN University's Expert Working Group on Vulnerability, and IPCC. We continue to play a leading role in fire research and are actively involved with the 2013 bushfire research effort. Our most recent book is "Handbook of disaster policies and institutions" (Handmer and Dovers 2013).

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## ***Recommendations to the Committee***

- That the Committee is aware of the imprecision associated with disaster cost assessment, and considers the need for fuller and more consistent data collection for research, policy and specific decision-making. Full estimates would include more indirect and intangible costs, and would consider the impacts of heatwave and droughts.
- That the Committee consider that even very conservative estimates of disaster costs under climate change are significant and likely warrant investment in disaster risk reduction and climate change adaptation.
- That the use of economic tools to investigate and recommend policy initiatives acknowledge and explore, via sensitivity analysis, the underlying assumptions, value judgements and uncertainties that are inherent in their analysis.
- Community safety activities within the emergency services sector are not crowded out in preference for operational response; both are vital.
- Resources spent on whole of society vulnerability reduction, continuity planning and household and community preparedness, are likely to have a much bigger payoff than further investment in fire and emergency services alone.
- That the Committee extend the scope of its inquiry in this area to consider the roles and responsibilities of communities and other sectors of society with respect to managing extreme weather events, in addition to those of governments. We suggest this is done in a way that reflects the current focus in emergency management on building resilience to disasters and engages actively with communities rather than prescriptively defining their roles.
- That the Committee consider the underlying causes of vulnerability, for example socio-economic factors inhibiting household preparedness, and holistic approaches to building community resilience.
- That the Committee include within the scope of its inquiry assessment of the major gaps in the existing research that informs our knowledge of extreme weather events and approaches to adapt to the impacts of climate change in the emergency services sector.

## *Economic estimates*

- With no adaptive change, by 2050 increases in bushfire damage to the agricultural industry due to climate change will have cost the Victorian economy an additional $1.4 billion (or $47.9 million per annum by 2050) over and above the no climate change scenario. (High mk3 climate change scenario, 5% discount rate, 2011AUD).

- With no adaptive change, by 2050 increases in bushfire damage to the timber industry due to climate change will have cost the Victorian economy an additional $2.85 billion (or $96.2 million per annum by 2050) over and above the no climate change scenario. (High mk3 climate change scenario, 5% discount rate, 2011AUD).

- With no adaptive change, by 2050 increases in bushfire damage in Southeastern Australia to ecosystems due to climate change will have cost an additional $1.5 billion, over and above the costs if no climate change took place. . (High mk3 climate change scenario, 5% discount rate, 2011AUD).

- With no adaptive change, by 2050 increases in heatwaves due to climate change will have caused **an additional 6214 deaths** (or 402 deaths annually by 2050) over and above the no climate change scenario. These figures translate to an additional $6.5 billion (or $225 million per annum by 2050) loss over and above the no climate change scenario. (CSIRO3.5 climate model, 5% discount rate, 2011AUD).

## *Contents*

## *Regarding TOR b.ii*

### Estimating the cost of disasters

### Use of insurance industry data for assessing cost has numerous problems

Disaster cost estimates in Australia are largely drawn from insurance claims data or insurance data with some augmentation. Insurance data only account for insured losses, and these represent only a fraction of the total cost of a disaster. In particular they do not include many indirect costs, valuations for loss of life, nor intangibles such as ecosystem services which can have significant impacts on cost estimates. The use of insurance data biases conclusions according to which hazards and assets are or are not insured (Keating and Handmer 2011b).

### Total cost of disasters to Australia

The aggregate cost of disasters to Australia is investigated in three works – BTE (2001), Blong (2004) and Crompton & McAneney (2008). Each report utilises different data and comes to different conclusions. The reports differ in ways too significant to allow for their results to be directly weighed against each other, however a cautious comparison highlights systemic issues with this type of analysis, and the way in which data and methodology can influence conclusions drawn (see Keating and Handmer 2011b).

**Summary of three reports and their key findings:**

| **Analysis name** | **Data source and analysis time frame** | **Key Australian findings** | **Distinguishing factors** |
|---|---|---|---|
| Economic Costs of Natural Disasters in Australia – BTE, 2001 | EMA database (insured losses from Insurance Council of Australia, plus broader cost estimates, newspaper reports). *Includes earthquakes. 1967-1999* | Average annual cost of disasters to Australia 1967 – 1999: ***$1.68 billion (2011AUD)*** | Most comprehensive and frequently cited Australian analysis. |
| Natural Hazards Risk assessment: An Australian Perspective – Blong, 2004 | Risk Frontiers database (Scientific and government reports, other databases, BoM, Geoscience Australia, newspaper reports). *Meteorological hazards only. 1900-1998* | 1788 – 2003: tropical cyclones and floods account for 70%+ fatalities. 1900 – 2003: tropical cyclones, floods, thunderstorms and bushfires caused 93.6% of building damage. | Looks at deaths and building damage, rather than dollar value economic cost estimates. |
| Normalised Australian insured losses from | Insurance Council of Australia Natural Disaster Event List. | Australian average annual weather-related (normalised) | Normalises damage estimates to 2006 conditions by |

| | | | |
|---|---|---|---|
| meteorological hazards: 1967- 2006 – Crompton & McAneney, 2008 | *Meteorological disasters only. 1967-2006* | damage, 1967 – 2006: ***$947 million (2011AUD)*** | adjusting for population, wealth, inflation and building standards. |

*Source: Adapted from Keating and Handmer 2011b*

BTE (2001) and Crompton & McAneney (2008) estimate average annual cost of disasters to Australia to be $1.68 billion and $947 million respectively. Several factors contribute to this significant difference:

- BTE's (2001) figures are normalised for inflation only, whereas Crompton & McAneney (2008) normalise for inflation, population, wealth and building standards as they were in 2006.[1]
- Crompton & McAneney (2008) utilise only data on insurance claims in their analysis, whereas BTE's (2001) estimates include other data sources as well as insurance data, and inflations of insurance data used in an effort to capture more costs.
- BTE's (2001) analysis included the significant costs of the 1989 Newcastle Earthquake, which was not included in Crompton & McAneney (2008).
- Crompton & McAneney's (2008) analysis included disasters up until 2006 whereas BTE's (2001) data set ended in 1999, there were significant disasters during this period.

We can conclude that estimating the cost of extreme weather in Australia is not straightforward. Data and methodology can lead to significantly different estimates.

## Cost of individual disasters

The 1983 Ash Wednesday bushfires were one of the most devastating disasters in Australia's history. A comparison of several analyses of this event further highlights how data and methodology impact outcomes (Keating and Handmer 2011b). Six cost/loss/impact estimates are compared below and demonstrate just how profoundly different estimates of the same event can vary.

[1] Crompton & McAneney's (2008) 'normalisation' procedure estimated what historical events would have cost under societal conditions in 2006.

**Table 4: Six reported estimates of the cost of the 1983 Ash Wednesday bushfires**

| Source | Cost estimate, 2009AUD millions | Source/make-up of estimate |
|---|---|---|
| ICA database (2010) (VIC & SA) | 465 | ICA database. Insurance claims only. |
| Legislative Assembly Ministerial Statement (1983) [cited in VBRC, 2009, Appendix C] (VIC only) | 502 | State agency asset loss, other public sector losses, lost assets to the private sector (majority of the $190 million) and State agency operating costs. |
| Stephenson (2010) (VIC only) | 807 (net) | Economic analysis from various sources. Contains direct, indirect and intangible, as well as losses and benefits – insurance is a benefit. |
| Munich Re (2010) (VIC & SA) | 885 | 463 insured cost (52%) from ICA database. |
| EMA database (2010) (VIC & SA) | 1057 + | Insurance data from ICA database, plus a wider estimate.[12] |
| BTE (2001, pg. 109) (VIC & SA) | 1320 | Economic analysis from various sources. Includes some indirect and intangible costs including fatalities. |

*Source: Keating and Handmer 2011, table 4, page 10.*

The estimates of the cost of the Ash Wednesday bushfires listed above range from $465 - $1320 million (2009AUD). This variation is due to the fact that the lower estimates are insurance claims only, whereas the higher estimates are full economic assessments.

## Heatwave and drought are often not recorded as disasters

Both heatwave and drought are expected to increase under climate change. Some analysts have suggested that heat waves have killed approximately 70% as many people, often the elderly, as all other hazards combined. Heatwaves are not included in most disaster impact data (Keating and Handmer 2011b).

Similarly drought, because it is slower onset and does not directly result in death, injury or much building damage, is not often considered in the same class of disasters as bushfires or floods. Despite this it is considered to be the most economically costly extreme weather event Australians face (Keating and Handmer 2011b).

## Intangible costs are significant and often omitted from economic impact assessmnets

Intangible costs refer to disaster impacts for which there is not an observable market price because they are not traded in the market place. Intangibles include assets such as fatalities and injuries, health effects, environmental damage, memorabilia and cultural heritage. Research by the Centre estimates that:

***Between 1983 and 2009 the average annual environmental costs (in AUD2011) due to severe bushfires in Southeast Australia was approximately $118 million. This accounts for 31% of total economic cost of bushfire. These have not been factored into any national estimates.***

Environmental and other intangible costs are rarely captured in disaster impact assessments.

***Recommendation:***
That the Committee is aware of the imprecision associated with disaster cost assessment, and considers the need for fuller and more consistent data collection for research, policy and specific decision-making. Full estimates would include more indirect and intangible costs, and would consider the impacts of heatwave and droughts.

## Costs of disasters under climate change

Work by the Centre (Keating and Handmer, *in press*) estimates the current and future costs of bushfire to the Victorian agricultural and timber industries, ecosystem services and heatwave mortality under climate change.[2]

## Costs of bushfire to the Victorian agricultural industry under climate change

We estimate the current total cost to the Victorian economy due to bushfire damage to the agricultural industry (including business disruption costs) to be $92 million per annum, then extrapolate future losses. The baseline scenario accounts for increases in exposure only.

***Total damage costs to Vic agricultural industry under baseline and climate change scenarios by 2020 and 2050, $millions AUD2011:***

| Scenario for change in number of days where FFDI>50 | 2020 No climate change | 2020 low mk2 – 11% | 2020 high mk3 – 40% | 2050 No climate change | 2050 low mk2 – 19% | 2050 high mk3 – 138% |
|---|---|---|---|---|---|---|
| **Present Value (discount rate = 5%)** | $922.2 | $972.0 | $1,090.8 | $2,457.3 | $2,801.6 | $3,874.5 |

***With no adaptive change, by 2050 increases in bushfire damage to the agricultural industry due to climate change will have cost the Victorian economy an additional $1.4 billion (or $47.9 million per annum by 2050) over and above the no climate change scenario. (High mk3 climate change scenario, 5% discount rate, 2011AUD).***

## Costs of bushfire to the Victorian timber industry under climate change

We estimate the current total cost to the Victorian economy due to bushfire damage to the timber industry (including business disruption costs) to be $185 million per annum, then extrapolate future losses. The baseline scenario accounts for increases in exposure only.

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[2] The estimates of current bushfire damage costs associated to the Victorian agricultural and timber industries, and ecosystem services are developed from Stephenson's (2010) estimates of the cost of five major bushfires from 1983-2009, complemented by data from three further fires. Two scenarios for future fire weather are taken from Lucas et al 's (2007) models of predicted increases in days when FFDI (forest fire danger index) exceeds 50. See Keating and Handmer (*in press*).

***Total bushfire damage costs to Vic timber industry under baseline and climate scenarios by 2020 and 2050, $millions AUD2011.***

| **Scenario for change in number of days where FFDI>50** | **2020 No climate change** | **2020 low mk2 – 11%** | **2020 high mk3 – 40%** | **2050 No climate change** | **2050 low mk2 – 19%** | **2050 high mk3 – 138%** |
|---|---|---|---|---|---|---|
| **Present Value (discount rate = 5%)** | $1,850.9 | $1,950.8 | $2,189.4 | $4,931.9 | $5,622.9 | $7,776.3 |

***With no adaptive change, by 2050 increases in bushfire damage to the timber industry due to climate change will have cost the Victorian economy an additional $2.85 billion (or $96.2 million per annum by 2050) over and above the no climate change scenario. (High mk3 climate change scenario, 5% discount rate, 2011AUD).***

## Costs of bushfire impacts to Victorian ecosystem services under climate change

Between 1983 and 2009 the average annual environmental costs (in AUD2011) due to severe bushfires in Southeast Australia was approximately $118 million. The following calculations assume that exposure of environmental assets does not increase or decrease in the future.

***Total bushfire damage costs to ecosystem services in southeast Australia by 2020 and 2050, $millions 2011AUD***

| **Scenario for change in number of days where FFDI>50** | **2020 No climate change** | **2020 low mk2 – 11%** | **2020 high mk3 – 40%** | **2050 No climate change** | **2050 low mk2 – 19%** | **2050 high mk3 – 138%** |
|---|---|---|---|---|---|---|
| **Present Value (discount rate = 5%)** | $1,027 | $1,079 | $1,214 | $2,138 | $2,348 | $3,634 |
| **Present Value (discount rate = 0.1%)** | $1,288 | $1,360 | $1,549 | $4,731 | $5,326 | $9,817 |

***Based on these estimates, by 2050 increases in bushfire damage in Southeastern Australia to ecosystems due to climate change will have cost an additional $1.5 billion, over and above the costs if no climate change took place. . (High mk3 climate change scenario, 5% discount rate, 2011AUD).***

## Cost of heatwaves in Melbourne under climate change

We estimate increased heatwave deaths in Melbourne due to climate change and increasing population aged 65+.[3]

***Total number of deaths and valuation by 2020 and 2050 due to heatwaves under baseline and climate change scenarios***

| **Climate change scenario** | **2020 Exposure only** | **2020 Miroc3.2 model** | **2020 Csiro3.5 model** | **2050 Exposure only** | **2050 Miroc3.2 model** | **2050 Csiro3.5 model** |
|---|---|---|---|---|---|---|
| **Number of deaths** | 4287 | 4436 | 4522 | 23222 | 27161 | 29436 |
| **Valuation, $millions AUD2011, 5% discount rate** | $13,162.9 | $13,568.1 | $13,801.7 | $35,057.6 | $39,197.6 | $41,608.9 |

***With no adaptive change, by 2050 increases in heatwaves due to climate change will have caused an additional 6214 deaths (or 402 deaths annually by 2050) over and above the no climate change scenario. These figures translate to an additional $6.5 billion (or $225 million per annum by 2050) loss over and above the no climate change scenario. (CSIRO3.5 climate model, 5% discount rate, 2011AUD).***

***Recommendation:***
That the Committee consider that even very conservative estimates of disaster costs under climate change are significant and likely warrant investment in disaster risk reduction and climate change adaptation.

## Challenges for impact assessment under climate change

## Intergenerational equity and discounting

*(See Keating and Handmer 2011a)*

The selection of the discount rate is a contentious issue in climate change policy because it is the primary way in which costs and benefits to future generations are weighted against costs and benefits to the current generation. Discounting is used in economics to convert

[3] We utilised McMichael's (2003) estimate that in 2003 heatwaves caused approximately 289 deaths annually in Melbourne, predicted increase in population aged 65+ and estimates of projected changes in the annual number of days over 35 degrees, under baseline (exposure increases only) and two climate change scenarios (adapted from Climate Change in Australia 2012). Valuations based on statistical value of life using figures from Department of Finance and Deregulation (2008). These estimates are considered conservative as highlighted by the mortality rate seen in the heatwave of 2009.

future costs (and benefits) into present day values. Discount rates are generally positive because they reflect a preference for consumption today over consumption tomorrow, or the rate of return on capital investment. If a discount rate is zero this indicates that costs in each time period are valued equally; the higher the discount rate, the less future costs are valued. Small changes in the discount rate can have enormous impacts on net present value.

The Garnaut Report 2011 states that discount rate can be determined in a positive or a normative way. Positive approaches to economic analysis involve observation, description and explanation of economic phenomena, while a normative approach aims to consider values and ethics. A normative approach to determining the discount rate is derived from judgements about how to value the wellbeing of future generations compared to those of today. Reflecting Stern (2007) Garnaut suggested that a normative approach is more appropriate for climate change where issues of equity and sustainability are important.

Some theorists argue that since a society, unlike an individual, does not have a finite life the concept of a time preference is not applicable. The fact that climate change impacts may be irreversible is another argument for a lower discount rate than the rate of return on capital.

## Uncertainty compounds under climate change

There are various sites of uncertainty pertinent to decision-making for extreme events under climate change (Keating and Handmer, *in press*):

- Uncertainty about the extent of future emissions. This depends on future scenarios of global mitigation agreements, global population growth and technological advances.
- Uncertainty about the effect of emissions on mean climate variables. Climate models can predict some of these variables better than others.
- Uncertainty about the effect of emissions on extremes. Predicting this is more difficult than for mean changes.
- Uncertainty is higher for local level predictions than global predictions, yet many specific decisions are made at the local level.
- Uncertainty about future socio-demographic conditions and future vulnerabilities.
- Uncertainty increases with time.

When these long time spans are coupled with the uncertainty regarding the impacts of climate change there is a very real risk of maladaptation.[4] Dominant economic methods have a difficult time calculating net present value when the probabilities of outcomes in the future are not know.

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[4] The IPCC defines maladaptation as: "Any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead."

## Cost-benefit analysis and catastrophes

Events that have a low probability but high impacts ie catastrophes, are an issue for preparedness for extremes under climate change. Policy and investment in climate change adaptation has tended to focus on gradual change scenarios while ignoring extremes and rapid change. Research currently being conducted for NCCARF by the Centre for Risk and Community Safety in conjunction with Victoria University identifies several alarming trends regarding the use of orthodox economic approaches namely cost-benefit analysis (CBA).

Firstly, CBA may appear objective and unbiased, but may in fact be fostering increased disaster risk by omitting the significant flow-on costs from catastrophes. In other words a catastrophic event is more than the sum of its parts, yet this is not captured in the standard approach.

Secondly, the issue of the 'levee effect' is pertinent. The levee effect occurs when a levee is built and people assume that it will provide protection against floods and as such build on the lands "protected" by the levee, thereby increasing future damages. Short time frames, limited scope and complex socioeconomic outcomes have led to the incidence of the 'levee effect' because CBA does not typically capture this possibility. The need for a consideration of risk, the levee effect and how factors can compound overtime to facilitate catastrophe is also seen in the example of Hurricane Katrina and the flooding of New Orleans. Burby (2006) states:

> *In summary, federal policies have sought to make areas at risk from natural hazards safe places for urban development by reducing the degree of hazard and by shielding hazard-area occupants from financial risks of loss. Over time, these policies have facilitated the development of these areas, as illustrated by urban growth in New Orleans, but they have increased the potential for catastrophic losses in large disasters. In this sense,* ***Hurricane Katrina and the flooding of New Orleans could be viewed as an expected consequence of federal policy rather than an aberration that is unlikely to be repeated****.* (Emphasis added)

Each individual aspect of the New Orleans levee system very likely would have passed a CBA in its own right, yet the compounding impact was catastrophic. This is a sobering lesson that Australia should heed in its approach to preparedness to extremes and climate change adaptation.

***Recommendation:***
That the use of economic tools to investigate and recommend policy initiatives acknowledge and explore, via sensitivity analysis, the underlying assumptions, value judgements and uncertainties that are inherent in their analysis.

# *Regarding TOR (d)*

## Community safety and 'whole of society'

We suggest that the Committee specifically consider the adequacy of resources available for community safety activities in the emergency services sector, including community engagement, communication and warnings. A focus on community safety is needed to reduce the human impacts of extreme weather events and improve the level of preparedness of communities and households to face these events under uncertain future conditions (Handmer and Haynes 2008; O'Neill and Handmer 2012). Community safety activities were central to the recommendations of the 2009 Victorian Bushfires Royal Commission, the 2010-11 Victorian Flood Warnings and Response Review, and the special inquiry into the 2011 Perth Hills bushfires. Given current budgetary constraints, there is a danger that resources allocated to community safety activities by emergency services may decline in preference to maintaining resources for operational response.

Community safety activities encompass more than information provision and awareness-raising activities. Full community safety initiatives include an integrated range of approaches that engage communities in partnership and collaboration with authorities. Elsworth et al's (2009) study of community safety programs for bushfire found that genuine engagement to be most likely to be effective, as opposed to a stand-alone initiative such as information-provision.

***Recommendation:***
Community safety activities within the emergency services sector are not crowded out in preference for operational response; both are vital.

The NSDR (National Strategy for Disaster Resilience) emphasises curtailing dependence on government for emergency management and recognises that emergency management is a "whole of society" activity. However governments are in the position to lead the emergency management task and the Productivity Commission's draft report on climate change adaptation identified emergency preparedness as a key role for government. Ensuring engagement of "whole of society" in emergency management is a significant obstacle to achieving the goals of the NSDR and as such should be a priority.

Currently all emergency management funding are directed at official emergency management groups. We suggest that a) these groups should be equipped to take the lead on emergency management within a "whole of society" approach, not remain the only players; and b) further funds be directed towards broader "whole of society" preparedness.

***Recommendation:***
Resources spent on whole of society vulnerability reduction, continuity planning and household and community preparedness, are likely to have a much bigger payoff than further investment in fire and emergency services alone.

## *Regarding TOR (e)*

### Communities, resilience and 'shared responsibility'

We suggest that the Committee extend the scope of its inquiry in this area to consider and possibly more clearly define the roles and responsibilities of communities and other sectors of society with respect to managing extreme weather events, in addition to those of governments. We suggest this is done in a way that reflects the current focus in emergency management on building resilience to disasters. The current terms of reference for this inquiry do not refer to the roles of communities in preparedness and response to extreme weather events, nor do they reflect the current emphasis in the emergency management sector on promoting community resilience and 'shared responsibility' for disaster management. The National Strategy for Disaster Resilience (NSDR) emphasises the need for a "whole of nation, resilience-based" approach to disaster management in which "governments, businesses, not-for-profit, communities and individuals" share responsibility. This was also a central theme underpinning the recommendations of the 2009 Victorian Bushfires Royal Commission (see McLennan and Handmer 2012a).

Realising the objectives laid out in the NSDR will require significant changes in the way that emergency services and governments relate to and work with communities in preparing for and responding to extreme weather events and reducing disaster risk (McLennan et al. 2012; McLennan and Handmer 2012b). However, the existing rules and institutions that shape how responsibilities are allocated and shared between governments and communities are often ambiguous, in conflict, contested and may also be inappropriate for unfamiliar and extreme conditions (McLennan and Handmer 2012a; 2012b). To increase preparedness for extreme weather events into the future under the impacts of climate change, we must therefore confront challenges related to building community resilience and sharing responsibility between governments and communities.

***Recommendation:***
That the Committee extend the scope of its inquiry in this area to consider the roles and responsibilities of communities and other sectors of society with respect to managing extreme weather events, in addition to those of governments. We suggest this is done in a way that reflects the current focus in emergency management on building resilience to disasters and engages actively with communities rather than prescriptively defining their roles.

## *Regarding TOR (h)*

### A focus on resilience

Building community resilience will require innovative and holistic approaches that increase people's capacities to anticipate, prepare for, respond to and recover from extremes and disasters. Research has shown that vulnerability arises from the circumstances of people's everyday lives, with pressures such as financial hardship, social isolation and limited access to essential services reducing people's capacities to protect themselves (Whittaker et al., 2012). Community engagement and education is a necessary and important part of any attempt to build resilience; however, such measures are unlikely to be effective if the underlying causes of vulnerability are not addressed. We suggest that the Committee consider the underlying causes of vulnerability, for example socio-economic factors inhibiting household preparedness, and holistic approaches to building community resilience.

***Recommendation:***
That the Committee consider the underlying causes of vulnerability, for example socio-economic factors inhibiting household preparedness, and holistic approaches to building community resilience.

## Research priorities

We suggest that the Committee include within the scope of its inquiry assessment of the major gaps in the existing research that informs our knowledge of extreme weather events and approaches to adapt to the impacts of climate change in the emergency services sector. The National Climate Change Adaptation Research Facility's Emergency Management network released a revised adaptation research plan in 2012 (Handmer et al. 2012). The plan identifies a number of key areas where greater research is needed. The review that informed the development of the plan found that "Whilst there is a large body of research to assist the emergency management sector to adapt to the current climate, research that considers future conditions is not as well developed" (p.6).

Major gaps also exist in examining the implications of long-term climatic changes that will shift 'baselines' of food security, land-use capacity, and infrastructure requirements that underpin both the vulnerabilities and resilience of communities. Research should also inform management and long-term policy and program options to address these changes.

***Recommendation:***
That the Committee include within the scope of its inquiry assessment of the major gaps in the existing research that informs our knowledge of extreme weather events and approaches to adapt to the impacts of climate change in the emergency services sector.

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