

The Senate

Environment and Communications
References Committee

Recent trends in and preparedness for extreme
weather events

August 2013

© Commonwealth of Australia 2013

ISBN 978-1-74229-899-3

Committee membership

Committee members

Senator Simon Birmingham (LP, SA) (Chair)
Senator Doug Cameron (ALP, NSW) (Deputy Chair)
Senator Catryna Bilyk (ALP, TAS)
Senator the Hon Ron Boswell (NATS, QLD)
Senator Anne Ruston (LP, SA)
Senator Larissa Waters (AG, QLD)

Participating members

Senator Richard Di Natale (AG, VIC)
Senator Christine Milne (AG, TAS)
Senator Lee Rhiannon (AG, NSW)

Committee secretariat

Ms Sophie Dunstone, Committee Secretary
Ms Toni Matulick, Committee Secretary
Mr Tim Watling, Committee Secretary
Ms Sophie Power, Principal Research Officer
Mr Chris Lawley, Senior Research Officer
Ms Nerissa Stewart, Research Officer
Mrs Dianne Warhurst, Administrative Officer
Dr Ruth Edwards, Administrative Officer

Committee address

PO Box 6100
Parliament House
Canberra ACT 2600
Tel: 02 6277 3526
Fax: 02 6277 5818
Email: ec.sen@aph.gov.au
Internet: www.aph.gov.au/senate_ec

Table of Contents

Committee membership	iii
Recommendations	vii
Abbreviations and acronyms	ix
Chapter 1 - Introduction and background	1
Conduct of the inquiry	1
Acknowledgement	2
Structure of report.....	2
Background.....	3
Chapter 2 - Recent trends and projections on the frequency of extreme weather events	27
What is 'extreme weather'?	27
Trends and projections on the frequency of extreme weather events	29
Uncertainties in future projections	49
Chapter 3 - Costs and impacts of extreme weather events	61
Financial costs of extreme weather events	61
Impacts on industry	78
Impacts on infrastructure	80
Health impacts of extreme weather events	81
Social impacts of extreme weather events	86
Impacts on natural ecosystems	90
Chapter 4 - Preparing for extreme weather events	95
Introduction	95
General preparedness.....	96
Infrastructure	104
The health sector.....	118
Emergency services	124
Chapter 5 - Developing a national response to extreme weather: coordination, roles and responsibilities	135
Introduction	135

The division of responsibilities between different levels of government	135
Developing effective coordination between governments	143
Australian Greens' Additional Comments	169
Appendix 1 - Submissions, form letters, tabled documents, additional information, correspondence and answers to questions taken on notice ..	173
Appendix 2 - Public hearings	189
Appendix 3 - Recommendations from Productivity Commission Inquiry Report on Barriers to Effective Climate Change Adaptation	193

Recommendations

Recommendation 1

2.115 The committee recommends that the Commonwealth government, through the Bureau of Meteorology and CSIRO, continues to support data collection and research to improve forecasting of extreme weather events, especially early warning capabilities.

Recommendation 2

2.117 The committee recommends that the Bureau of Meteorology and CSIRO continue to improve projections and forecasts of extreme weather events at a more local level.

Recommendation 3

2.119 The committee notes the linkage between climate change and extreme weather events and recommends that the Bureau of Meteorology and CSIRO conduct further research to increase understanding in the areas of:

- the interaction between large-scale natural variations, climate change and extreme weather events;
- the impacts of climate change on rainfall patterns and tropical cyclones; and
- that Australia cooperatively engage, where appropriate, with international research initiatives in these areas.

Recommendation 4

3.60 The committee recommends that disincentives to insurance, such as taxes and levies applied by the states and territories, should be removed as part of a national reform process.

Recommendation 5

3.109 The committee recommends relevant authorities work with community service organisations in both planning responses to and responding to extreme weather events, in particular those organisations that provide vital services to vulnerable groups.

Recommendation 6

4.104 The committee recommends that credible and reliable flood mapping activities and the development of other information that would best inform landowners or prospective landowners of potential risks from extreme weather events are prioritised and used to inform land use planning laws.

Recommendation 7

4.106 The committee recommends that building codes incorporate mitigation measures that take into account foreseeable risks from extreme weather events.

Recommendation 8

4.171 The committee recommends that Commonwealth, state and territory governments ensure that all facilities caring for vulnerable groups, in particular hospitals, schools, childcare and aged care facilities, have emergency management plans, relevant to their geographic settings, in place and regularly revised.

Recommendation 9

5.61 The committee recommends that Australian governments specifically address issues of compatibility and capacity to facilitate the most effective interoperability of emergency service organisations and their key personnel, especially for fire services.

Recommendation 10

5.136 The committee recommends that the Commonwealth government works with state and territory governments to continue to implement the recommendations of the Productivity Commission report, where possible, to improve coordination in relation to climate change adaptation.

Abbreviations and acronyms

ACOSS	Australian Council of Social Service
ABC	Australian Broadcasting Corporation
ACF	Australian Conservation Foundation
ACT	Australian Capital Territory
Adaptation Framework	<i>National Climate Change Adaptation Framework</i>
Adaptation Position Paper	<i>Adapting to Climate Change: An Australian Government Position Paper</i>
AFAC	Australasian Fire and Emergency Services Authorities Council
AFPA	Australian Forest Products Association
AGD	Attorney-General's Department
AGDRP	Australian Government Disaster Recovery Payment
AHPPC	Australian Health Protection Principal Committee
ALGA	Australian Local Government Association
AMA	Australian Medical Association
AMSTECI	Association for Mitigation Studies for Top End Cyclones Inc.
AMTA	Australian Mobile Telecommunications Association
ANEDO	Australian Network of Environmental Defender's Offices
ANRA	Australian National Retailers Association
APS	Australian Psychological Society
ARC	Australian Research Council
AusMATs	Australian Medical Assistance Teams
BITRE	Bureau of Infrastructure, Transport and Regional Economics
BTE	Bureau of Transport Economics

BoM	Bureau of Meteorology
Bushfire CRC	Bushfire Cooperative Research Centre
CAHA	The Climate and Health Alliance
CCWA	Conservation Council of Western Australia
CFA	Country Fire Authority
COAG	Council of Australian Governments
CRCS	The Centre for Risk and Community Safety
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSO	community service organisations
DBCDE	Department of Broadband, Communications and the Digital Economy
DCCEE	Department of Climate Change and Energy Efficiency
DEA	Doctors for the Environment Australia
DIICSRTE	Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education
DIRS	Disaster Income Recovery Subsidy
DoHA	Department of Health and Ageing
DSE	Department of Sustainability and Environment (Victoria)
EMA	Emergency Management Australia
FFDI	Forest Fire Danger Index
GDP	gross domestic product
GHG	global greenhouse gas
IAG	Insurance Australia Group
ICA	Insurance Council of Australia
IPCC	Intergovernmental Panel on Climate Change
LGAQ	Local Government Association of Queensland

NCCARF	National Climate Change Adaptation Research Facility
NDRRA	Natural Disaster Relief and Recovery Arrangements
NECCSC	National Emergency Call Centre Surge Capability
NIAC	National Insurance Affordability Council
NSW	New South Wales
SA	South Australia
SEMC	State Emergency Management Committee (South Australia)
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
SREX	Special Report of the IPCC: Managing the risks of extreme events and disasters to advance climate change adaption
UNEP	United Nations Environment Programme
WA	Western Australia
WMO	World Meteorological Organisation
WALGA	Western Australian Local Government Association
WSSA	Water Services Association of Australia

Chapter 1

Introduction and background

Conduct of the inquiry

1.1 On 28 November 2012, the Senate referred the following matter to the Environment and Communications References Committee (the committee) for inquiry and report by 20 March 2013:

- (a) recent trends on the frequency of extreme weather events, including but not limited to drought, bushfires, heatwaves, floods and storm surges;
- (b) based on global warming scenarios outlined by the Intergovernmental Panel on Climate Change and the Commonwealth Scientific and Industrial Research Organisation of 1 to 5 degrees by 2070:
 - (i) projections on the frequency of extreme weather events, including but not limited to drought, bushfires, heatwaves, floods and storm surges,
 - (ii) the costs of extreme weather events and impacts on natural ecosystems, social and economic infrastructure and human health, and
 - (iii) the availability and affordability of private insurance, impacts on availability and affordability under different global warming scenarios, and regional social and economic impacts;
- (c) an assessment of the preparedness of key sectors for extreme weather events, including major infrastructure (electricity, water, transport, telecommunications), health, construction and property, and agriculture and forestry;
- (d) an assessment of the preparedness and the adequacy of resources in the emergency services sector to prevent and respond to extreme weather events;
- (e) the current roles and effectiveness of the division of responsibilities between different levels of government (federal, state and local) to manage extreme weather events;
- (f) progress in developing effective national coordination of climate change response and risk management, including legislative and regulatory reform, standards and codes, taxation arrangements and economic instruments;
- (g) any gaps in Australia's Climate Change Adaptation Framework and the steps required for effective national coordination of climate change response and risk management; and
- (h) any related matter.

1.2 On 26 February 2013 the reporting date was extended to 26 June 2013. On 25 June 2013, the Senate granted a further extension to 10 July 2013. On 10 July 2013 an interim report was tabled, stating that the committee intended to table a final report on 24 July 2013. On 23 July 2013, a second interim report was tabled, stating that the committee intended to table a final report on 7 August 2013.

1.3 In accordance with usual practice, the inquiry was advertised in *The Australian* and on the internet. The committee also wrote to relevant organisations inviting submissions by 18 January 2013. The committee received 344 submissions, listed at Appendix 1.

1.4 The committee held 6 public hearings in the following cities:

- Melbourne on 20 February;
- Brisbane on 22 February;
- Perth on 7 March;
- Sydney on 10 April; and
- Canberra on 11 April and 7 June 2013.

1.5 A list of stakeholders who appeared at these hearings can be found at Appendix 2.

Acknowledgement

1.6 The committee thanks those individuals, organisations and government departments who contributed to the inquiry. The committee also thanks the secretariat for its work, coordination and drafting assistance.

Structure of report

1.7 This chapter examines recent extreme weather events in Australia and also summarises a number of recent reports relevant to extreme weather events and climate change in Australia.

1.8 Chapter 2 outlines trends and projections on the frequency and magnitude of extreme weather events. It also briefly considers the gaps and uncertainties in relation to those trends and projections, and areas where further research might be needed.

1.9 Chapter 3 discusses the financial and social costs of extreme weather events, and their impacts on key sectors, including industry, infrastructure and health.

1.10 Chapter 4 looks at the preparedness of key sectors for extreme weather events, including preparedness in emergency situations.

1.11 Chapter 5 considers the roles and responsibilities of the Commonwealth, state, territory and local governments in Australia, as well as coordination between these different levels of government in managing and responding to extreme weather events.

Background

1.12 Australia has long been a land of weather extremes, 'a sunburnt country...of droughts and flooding rains'.¹ However, recent extreme weather events have raised questions about whether the patterns and nature of these events are changing.

Recent extreme weather events in Australia

1.13 During the summer of 2012–2013, Australia experienced numerous extreme weather events: a heatwave, bushfires, and flooding associated with heavy rain and storm tides. Various other extreme weather events have also occurred during the last decade, including Cyclone Yasi in February 2011, the Queensland floods during 2010–2011, the Black Saturday bushfires in Victoria in 2009 and the Canberra bushfires in 2003. These are outlined in further detail below. Note that further information about the costs and impacts of some of these events are set out in Chapter 3 of this report.

Heatwave

1.14 During December 2012 and January 2013, large areas of central and southern Australia experienced 'a persistent and widespread heatwave event'² (see Figure 1.1). During the heatwave, temperatures regularly exceeded 48°C with the highest recorded maximum of 49.6°C at Moomba in South Australia.³

1.15 On 7 and 8 January, the Australian-averaged maximum daily temperature rose to over 40°C. The temperature of 40.30°C on 7 January set a new record, beating the previous highest Australian daily maximum of 40.17°C set in 1972. The temperature on 8 January came in as the third highest on record at 40.11°C.⁴

1.16 More unusually, the Australian mean temperature (representing the average of the daytime maximum and night-time minimum) set record high values on both days at 32.22°C (7 January) and 32.32°C (8 January), well above the previous high of 31.86°C also set in 1972.⁵

1.17 However, it was the duration of the extreme heatwave that was its most unusual feature: while some Australian towns regularly experience extended runs of hot temperatures, the limited geographical extent of those events distinguishes them

1 Dorothea Mackellar, 'My Country', 1908.

2 Bureau of Meteorology (BOM), *Special Climate Statement 43: Extreme January heat*, p. 1.

3 The Conversation, *What's causing Australia's heatwave?*, <http://theconversation.edu.au/whats-causing-australias-heat-wave-11628> (accessed 21 February 2013).

4 The Conversation, *What's causing Australia's heatwave?*, <http://theconversation.edu.au/whats-causing-australias-heat-wave-11628> (accessed 21 February 2013).

5 The Conversation, *What's causing Australia's heatwave?*, <http://theconversation.edu.au/whats-causing-australias-heat-wave-11628> (accessed 21 February 2013).

from the January heatwave.⁶ Multiple days of extreme heat covering most of the continent are both rare and isolated; the January heatwave saw a sequence of Australian temperatures above 39°C for seven days and above 38°C for 11 days straight.⁷ To put this into context, a run of three days above 39°C has occurred on only three occasions, and a run of four days just once, in 1972.⁸

The 2013 bushfires

1.18 Associated with the extreme heatwave during January 2013, numerous Australian states suffered damaging bushfires. The most notable of these were those in Tasmania, New South Wales (NSW) and Victoria.

1.19 On 3 and 4 January 2013, several large bushfires burnt out of control in Tasmania. Numerous communities were impacted by the fires; the worst affected were the towns of Dunalley, Boomer Bay, Connellys Marsh, Murdunna, Bicheno and Sommers Bay.⁹ Approximately 30 per cent of the buildings in Dunalley were destroyed, including the police station, primary school and bakery.¹⁰

1.20 Some 2600 people were evacuated during the bushfires.¹¹ As a result of the Tasmanian bushfires, more than 20 000 hectares was burnt and around 170 properties were badly damaged or destroyed.¹²

6 The Conversation, *What's causing Australia's heatwave?*, <http://theconversation.edu.au/whats-causing-australias-heat-wave-11628> (accessed 21 February 2013).

7 The Conversation, *What's causing Australia's heatwave?*, <http://theconversation.edu.au/whats-causing-australias-heat-wave-11628> (accessed 21 February 2013); see also Climate Commission, *The Angry Summer*, March 2013, p. 5.

8 The Conversation, *What's causing Australia's heatwave?*, <http://theconversation.edu.au/whats-causing-australias-heat-wave-11628> (accessed 21 February 2013).

9 Tasmania Police, 'Fires update 0800', Media release, 5 January 2013, <http://www.police.tas.gov.au/news/posts/view/3768/fires-update-0800/> (accessed 21 February 2013); Tasmania Police, 'Fires update at 10am', Media release, 7 January 2013, <http://www.police.tas.gov.au/news/posts/view/3778/fires-update-at-10am/> (accessed 21 February 2013); Anne Mather, Dave Killick and Zara Dawtrey, 'Thousand flee fire storms', *The Mercury*, 5 January 2013; ABC News, 'Thousands stranded as fires devastate Tasmania', 5 January 2013, <http://www.abc.net.au/news/2013-01-05/conditions-cool-as-fires-devastate-tasmania/4453532> (accessed 21 February 2013).

10 Tasmania Police, 'Fires update 0800', Media release, 5 January 2013.

11 Jill Stark, 'Mass rescue as thousands flee Tasmania fires', *Brisbane Times*, 6 January 2013.

12 David Killick, 'Police search burnt premises', *The Mercury*, 6 January 2013; Tasmania Police, 'Fires update at 10am', Media release, 7 January 2013; ABC News, 'Thousands stranded as fires devastate Tasmania', 5 January 2013; and ABC News, 'Homes destroyed in NSW bushfire', 14 January 2013, <http://www.abc.net.au/news/2013-01-14/homes-destroyed-in-nsw-bushfire/4463136> (accessed 21 February 2013).

The fires were finally extinguished on 24 March 2013. See ABC News, 'Destructive Tasmanian fires finally extinguished', 24 March 2013, <http://www.abc.net.au/news/2013-03-24/destructive-tasmanian-fires-finally-extinguished/4590762> (accessed 5 August 2013).

1.21 At around the same time as the Tasmanian bushfires, bushfires started burning in NSW. During early January, 'catastrophic' fire conditions were declared in the Shoalhaven, Illawarra, Southern Ranges, Northern and Eastern Riverina and parts of the Lower Central West Plains;¹³ on 8 January, NSW fire services were battling 135 fires in temperatures above 40°C.¹⁴ The worst fires were in the south of the state near Cooma, Nowra, Bega and Wagga Wagga, as well as in the state's central west.

1.22 The most devastating of these was a bushfire ignited by lightning strike that started in the Warrumbungle Ranges near Coonabarabran.¹⁵ This fire resulted in around 55 000 hectares being burnt¹⁶ and the destruction of 53 homes,¹⁷ 100 sheds¹⁸ and five buildings at the Siding Spring Observatory.¹⁹ There were no human fatalities.²⁰

1.23 Victoria also experienced numerous bushfires across the state during early 2013, some of which destroyed property. On 8 January 2013, a fast-moving fire in the Chepstowe area destroyed a number of homes including an historic homestead.²¹

1.24 Bushfires continued to burn in Victoria throughout January and February. A fire in the alpine region of Victoria threatened properties in the Harrietville, Mount

13 Climate Commission, *The Angry Summer*, March 2013, p. 1.

14 AAP, 'Fast-moving fire takes properties in central Victoria as NSW battles 135 blazes', *The Australian*, <http://www.theaustralian.com.au/news/fast-moving-fire-takes-properties-in-central-victoria-as-nsw-battles-135-blazes/story-e6frg6n6-1226549351466> (accessed 4 March 2013).

15 Robyn Herron, 'Fire continues to burn near Coonabarabran', *ABC News*, 25 January 2013, <http://www.abc.net.au/news/2013-01-25/fire-continues-to-burn-near-coonabarabran/4483636> (accessed 21 February 2013).

16 Robyn Herron, 'Fire continues to burn near Coonabarabran', *ABC News*, 25 January 2013, <http://www.abc.net.au/news/2013-01-25/fire-continues-to-burn-near-coonabarabran/4483636> (accessed 21 February 2013).

17 Robyn Herron, 'Fire continues to burn near Coonabarabran', *ABC News*, 25 January 2013, <http://www.abc.net.au/news/2013-01-25/fire-continues-to-burn-near-coonabarabran/4483636> (accessed 21 February 2013).

18 Ambulance Service of NSW, *State on Fire*, February 2013, <http://www.ambulance.nsw.gov.au/Media-And-Publications/Ambulance-Newsletter.html> (accessed 21 February 2013).

19 ABC News, 'Homes destroyed in NSW bushfire', 14 January 2013, <http://www.abc.net.au/news/2013-01-14/homes-destroyed-in-nsw-bushfire/4463136> (accessed 21 February 2013).

20 Ambulance Service of NSW, *State on Fire*, February 2013, <http://www.ambulance.nsw.gov.au/Media-And-Publications/Ambulance-Newsletter.html> (accessed 21 February 2013).

21 AAP, 'Blaze destroys up to 20 homes near Ballarat', 9 January 2013, <http://news.ninemsn.com.au/national/2013/01/08/03/00/fire-threat-worsens-in-victoria> (accessed 4 March 2013).

Hotham, Hotham Heights and Dinner Plain areas during late January²² and resulted in the death of two firefighters on 13 February.²³ On 18 February, a fire forced the evacuation of some of Melbourne's northern suburbs.²⁴ Bushfires also burned through the Gippsland²⁵ and Grampians areas.²⁶

1.25 Bushfires were not confined to the eastern states: during February and March 2013, several bushfires were ablaze in Western Australia (WA). During mid-February, various fires burned through Southampton, Greenbushes, western Bridgetown, Wandillup and Maranup, threatening homes and destroying historic Southampton Homestead.²⁷

1.26 In early March, fire crews battled a bushfire burning through Perth's semirural northeast where homes in Shady Hills and Bullsbrook were threatened.²⁸ The source of the fire was suspected to be sparks from a freight train.²⁹ While approximately 1200 hectares were burned, property losses were limited.³⁰

-
- 22 Stuart Rintoul, 'Mouth Hotham at risk as Harrietteville bushfire leaps containment lines', *The Australian*, 31 January 2013, <http://www.theaustralian.com.au/in-depth/bushfires/mount-hotham-at-risk-as-harrietteville-bushfire-leaps-containment-lines/story-fngw0i02-1226566185695> (accessed 4 March 2013).
 - 23 Stuart Rintoul, 'Tribute to firey and "farm girl"', *The Australian*, 15 February 2013, <http://www.theaustralian.com.au/in-depth/bushfires/tribute-to-firey-and-farm-girl/story-fngw0i02-1226578255416> (accessed 4 March 2013).
 - 24 Chip Le Grand and Rachel Baxendale, 'Fire licks at Melbourne's northern fringes', *The Australian*, 19 February 2013, <http://www.theaustralian.com.au/news/nation/fire-licks-at-citys-northern-fringes/story-e6frg6nf-1226580673790> (accessed 4 March 2013).
 - 25 Pia Akerman, 'Fears that blaze could break through containment lines', *The Australian*, 24 January 2013, <http://www.theaustralian.com.au/in-depth/bushfires/fears-that-blaze-could-break-through-containment-lines/story-fngw0i02-1226560413709> (accessed 4 March 2013).
 - 26 Rachel Baxendale, 'Blaze races towards farms', *The Australian*, 22 February 2013, <http://www.theaustralian.com.au/in-depth/bushfires/blaze-races-towards-farms/story-fngw0i02-1226583068361> (accessed 4 March 2013).
 - 27 9News, 'Homestead lost as bushfires torch WA', 14 February 2013, <http://news.ninemsn.com.au/national/2013/02/14/03/00/five-wa-towns-under-bushfire-threat> (accessed 4 March 2013).
 - 28 AAP, 'WA bushfires out of control', *The Weekly Times*, 1 March 2013, http://www.weeklytimesnow.com.au/article/2013/03/01/561841_national-news.html (accessed 4 March 2013) and Sky News, 'WA bushfire under control', 2 March 2013, <http://www.skynews.com.au/local/article.aspx?id=850660> (accessed 4 March 2013).
 - 29 Sky News, 'WA bushfire under control', 2 March 2013, <http://www.skynews.com.au/local/article.aspx?id=850660> (accessed 4 March 2013).
 - 30 AAP, 'WA bushfires out of control', *The Weekly Times*, 1 March 2013, http://www.weeklytimesnow.com.au/article/2013/03/01/561841_national-news.html (accessed 4 March 2013) and Sky News, 'WA bushfire under control', 2 March 2013, <http://www.skynews.com.au/local/article.aspx?id=850660> (accessed 4 March 2013).

Flooding

1.27 During late January 2013, heavy rainfall in Queensland and northern NSW associated with ex-Tropical Cyclone Oswald caused areas of flooding. Early on 28 January, the Bureau of Meteorology issued numerous flood warnings for rivers including the Condamine River, Burnett River, Mary River and Laidley and Lockyer Creeks in the Lockyer Valley.³¹ BOM predicted that the Burnett River would reach a peak of 9 metres, exceeding the peak of 7.02 metres during the 2010–2011 Queensland floods and the previous record of 8.59 metres in 1942.³² The most serious flood threat was for the town of Bundaberg (on the Burnett River) where authorities expected the worst flood ever recorded: on 28 January, Bundaberg residents were evacuated as the river rose.³³

1.28 During late February and early March 2013, some parts of northern NSW experienced heavy rainfall and flooding.³⁴ Residents in towns such as Kempsey, Port Macquarie and Bellingen were evacuated, two deaths were recorded and some 16 000 homes were without power.³⁵

Cyclone Yasi³⁶

1.29 Severe Tropical Cyclone Yasi began developing as a tropical low northwest of Fiji on 29 January 2011. The system quickly intensified to a cyclone and on 1 February was upgraded to a Category 4. At the same time, Yasi started to take a

31 ABC News, 'Live: Flood disaster unfolds as weather wreaks havoc', 29 January 2013, <http://www.abc.net.au/news/2013-01-28/qld-flooding-alert-moves-south/4486666> (accessed 12 March 2013).

32 ABC News, 'Live: Flood disaster unfolds as weather wreaks havoc', 29 January 2013, <http://www.abc.net.au/news/2013-01-28/qld-flooding-alert-moves-south/4486666> (accessed 12 March 2013).

33 ABC News, 'Live: Flood disaster unfolds as weather wreaks havoc', 29 January 2013, <http://www.abc.net.au/news/2013-01-28/qld-flooding-alert-moves-south/4486666> (accessed 12 March 2013).

34 AB News, 'Northern NSW on flood alert', 22 February 2013, <http://www.abc.net.au/news/2013-02-22/northern-nsw-on-flood-alert/4533398> (accessed 19 June 2013); ABC News, 'Flooding death toll rises as NSW towns evacuated', 23 February 2013, <http://www.abc.net.au/news/2013-02-23/teenage-boy-drowns-in-stormwater-drain-in-nsw-storms/4535548> (accessed 19 June 2013); ABC News, 'Hunter braces for more flooding', 2 March 2013, <http://www.abc.net.au/news/2013-03-02/hunter-braces-for-more-flooding/4549272> (accessed 19 June 2013); and ABC News, 'Flooding isolates parts of northern NSW', 4 March 2013, <http://www.abc.net.au/news/2013-03-03/flooding-isolates-parts-of-northern-nsw/4549938> (accessed 19 June 2013).

35 ABC News, 'Flooding death toll rises as NSW towns evacuated', 23 February 2013, <http://www.abc.net.au/news/2013-02-23/teenage-boy-drowns-in-stormwater-drain-in-nsw-storms/4535548> (accessed 19 June 2013).

36 Information in this section is taken from the BOM, *Severe Tropical Cyclone Yasi*, <http://www.BoM.gov.au/cyclone/history/yasi.shtml> (accessed 18 February 2013).

more west-southwestward movement and began to accelerate towards the tropical Queensland coast. On 2 February, Yasi was upgraded to a marginal Category 5 system. Yasi maintained this intensity and its west-southwest movement, making landfall on the southern tropical coast near Mission Beach in the early hours of Thursday, 3 February. The cyclone maintained a strong core with damaging winds and heavy rain, tracking westwards across northern Queensland and finally weakened to a tropical low near Mount Isa around 10.00 pm on 3 February.

1.30 Cyclone Yasi was one of the most powerful cyclones to have affected Queensland since records commenced. Previous cyclones of a comparable measured intensity include the 1899 Cyclone Mahina in Princess Charlotte Bay, and the two cyclones of 1918 at Mackay (January) and Innisfail (March).

*Queensland floods 2010–2011*³⁷

1.31 During the summer of 2010–2011, prolonged and extensive rainfall over large areas of Queensland, coupled with already saturated catchments, led to flooding of historic proportions in that state.

1.32 In total, 25 people died in the 2010–2011 floods.³⁸ More than 78 per cent of the state (an area bigger than France and Germany combined) was declared a disaster zone, with over 2.5 million people affected. Approximately 29 000 homes and businesses suffered some form of inundation: the Queensland Reconstruction Authority estimated that the cost of the flooding events was in excess of \$5 billion.

*Black Saturday bushfires*³⁹

1.33 Victoria endured one of its most severe and prolonged heatwaves during the final week of January 2009. The temperature in Melbourne was above 43°C for three consecutive days for the first time since records had been kept. Saturday, 7 February was forecast to reach temperatures in the low 40s, accompanied by strong winds. The Country Fire Authority (CFA) and the Victorian Department of Sustainability and Environment (DSE) warned that forests and grasslands were the driest they had been since the Ash Wednesday fires in 1983.

1.34 The conditions forecast for 7 February were realised and fires broke out across the state. Temperatures were nearing 40°C by 11.00 am in many parts of the state and later climbed to the mid-40s. Numerous areas endured record-breaking maximums—including Melbourne, which reached 46.4°C. Strong winds in the morning grew to storm force as the day progressed, and a wind change moved across

37 Information in this section is taken from the Queensland Floods Commission of Inquiry, *Final Report*, March 2012, p. 32.

38 Office of the State Coroner (Queensland), *Inquest into the deaths caused by the south-east Queensland floods of January 2011*, 5 June 2012, p.1.

39 Information in this section is taken from 2009 Victorian Bushfires Royal Commission, *Final Report*, July 2012, p. 1.

the state during the afternoon, greatly intensifying the fires. The CFA and DSE attended or patrolled 316 grass, scrub or forest fires on that day.

1.35 The most serious consequence of the fires was the death of 173 people. Accompanying this loss of life was the fires' impact on property, infrastructure and the environment. The Royal Commission estimated the cost of the Black Saturday bushfires to be more than \$4 billion.

*Canberra bushfires*⁴⁰

1.36 On 8 January 2003, lightning strikes in the Australian Capital Territory (ACT) and surrounding areas of NSW caused four fires known as the McIntyres Hut fire, the Bendora fire, the Stockyard Spur fire and the Mount Gingera fire. The McIntyres Hut fire in NSW gathered momentum, crossed the border and joined the fires burning in the ACT, resulting in a firestorm that firefighters had no way of controlling.

1.37 The firestorm resulted in the deaths of four people, injury to 435 others, the destruction of 487 homes and 33 commercial/government premises, the destruction of Mount Stromlo Observatory and the death or injury of 'an inestimable number of animals'.⁴¹ Almost 70 per cent (157 170 hectares) of the ACT was burnt. Financial losses arising from the firestorm were estimated at \$610 million.

The Millennium Drought, 1997–2009

1.38 The drought across southeastern Australia between 1997-2009, known as the 'Millennium Drought', was one of Australia's most severe droughts. Annual rainfall during the period was 12% below the long-term average (1900-2010). It has been described as the most severe hydrological drought since accurate records began in 1865, because the rainfall deficiencies were most prominent in autumn and early winter and therefore greatly decreased the runoff into catchments.⁴² The Bureau of Meteorology stated that the Millennium Drought was also remarkable for its absence of significantly wetter than average months that might have otherwise replenished water storages.⁴³

1.39 The Millennium Drought had major ecological, agricultural, social and economic impacts particularly in southeastern Australia and the Murray-Darling Basin. For example, irrigated rice and cotton production in the Murray-Darling Basin

40 Information in this section is taken from the ACT Coroner, *The Canberra Firestorm: Inquests and Inquiry into Four Deaths and Four Fires between 8 and 18 January 2003, Volume I*, December 2006, pp viii and 3.

41 ACT Coroner, *The Canberra Firestorm: Inquests and Inquiry into Four Deaths and Four Fires between 8 and 18 January 2003, Volume I*, December 2006, p. 3.

42 Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 32.

43 BOM, *Submission 65*, p. 17.

fell by 99% and 84% between 2002 and 2009, respectively.⁴⁴ In terms of social impacts, reports showed that rural communities suffered losses of employment, household income, local businesses, services and social cohesion. In 2002 it was estimated that employment was reduced by 3% in the Murray River region and from 2006 to 2009, 6000 jobs were lost.⁴⁵

Summary of recent reports relevant to the inquiry

1.40 The following sections summarise a number of recent reports relevant to extreme weather events and climate change in Australia, including by the Climate Commission, the Productivity Commission, Bureau of Meteorology, Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Intergovernmental Panel on Climate Change (IPCC).

The Critical Decade 2013: climate change science, risks and responses

1.41 On 17 June 2013, the Climate Commission released a report titled *The Critical Decade 2013: Climate science, risks and responses*.⁴⁶

1.42 In summary, the report found that, a quarter of the way through the 'critical decade', many consequences of climate change are already evident and the risks of climate change are better understood. The report further stated that:

- social, economic and environmental consequences of climate change are already being seen;
- the changing climate poses substantial risks for health, property, infrastructure, agriculture and natural ecosystems;
- some progress is being made globally to reduce carbon emissions but far more needs to be done; and
- most of the available fossil fuels cannot be burned if the climate is to be stabilised this century.⁴⁷

The Critical Decade: Extreme weather

1.43 During April 2013, the Climate Commission released a report titled *The Critical Decade: Extreme weather*.⁴⁸ The report examined the definition and

44 Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 32.

45 Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 32.

46 Climate Commission, *The Critical Decade 2013: Climate change science, risks and responses*, June 2013, <http://climatecommission.gov.au/report/the-critical-decade> (accessed 3 July 2013).

47 Climate Commission, *The Critical Decade 2013: Climate change science, risks and responses*, June 2013, pp 4–5.

48 Climate Commission, *The Critical Decade: Extreme weather*, April 2013, <http://climatecommission.gov.au/report/extreme-weather> (accessed 3 July 2013).

consequences of extreme weather events, the influence of climate change on extreme weather events and how such events are expected to change through the rest of the century.⁴⁹

1.44 Briefly, the report's key findings were:

- climate change is increasing the intensity and frequency of many extreme weather events;
- climate change is worsening the impact of extreme weather events on people, property, communities and the environment;
- the climate system is shifting, thus changing the conditions for all weather including extreme events;
- there is a high risk that extreme weather events will become even more intense in Australia over coming decades; and
- only strong preventive action now and in coming years can stabilise the climate and halt the trend of increasing extreme weather.⁵⁰

Barriers to effective climate change adaptation

1.45 On 14 March 2013, the Productivity Commission released its report examining *Barriers to effective climate change adaptation*.⁵¹ Of relevance to this inquiry, the Productivity Commission found that:

- Changes in the frequency, intensity, location and timing of extreme weather events are likely to be how most Australians experience climate change.
- ...
- A range of policy reforms would help households, businesses and governments deal with *current climate* variability and extreme weather events. These reforms would also build capacity to respond to *future climate* impacts. Examples include:
 - reducing perverse incentives in tax, transfer and regulatory arrangements that impeded the mobility of labour and capital
 - increasing the quality and availability of natural hazard mapping
 - clarifying the roles, responsibilities and legal liability of local governments, and improving their capacity to manage climate risks

49 Climate Commission, *The Critical Decade: Extreme weather*, April 2013, p. 3.

50 Climate Commission, *The Critical Decade: Extreme weather*, April 2013, pp 4–5.

51 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, <http://www.pc.gov.au/projects/inquiry/climate-change-adaptation/report> (accessed 19 June 2013).

- reviewing emergency management arrangements in a public and consultative manner, to better prepare for natural disasters and limit resultant losses
- reducing tax and regulatory distortions in insurance markets.
- Further actions are required to reduce barriers to adaptation to future climate trends and to strengthen the climate change adaptation policy framework. These include:
 - designing more flexible land-use planning regulation
 - aligning land-use planning with building regulation
 - developing a work program to consider climate change in the building code
 - conducting a public review, sponsored by the Council of Australian Governments to develop appropriate adaptive responses for existing settlements that face significant climate change risks.
- Some measures should not be implemented, as the costs would exceed the benefits.
 - Household insurance subsidies, or insurance regulations that impose net costs.
 - Systematically reviewing all regulation to identify impediments to adaptation.
 - Mandatory reporting of adaptation actions.⁵²

1.46 The Productivity Commission made a number of recommendations for reforms to address barriers to effective climate change adaptation, including in the areas of information provision, local government, land-use planning, building regulation, emergency management and insurance. Some of these recommendations are considered where relevant in subsequent chapters of this report.⁵³ Recommendations made by the Productivity Commission are set out in Appendix 3.

The Angry Summer

1.47 On 4 March 2013, the Climate Commission released a report on the extreme weather events experienced in Australia during the 2012–2013 summer entitled *The Angry Summer*.⁵⁴

52 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, p. 2.

53 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, pp 27–31.

54 Climate Commission, *The Angry Summer*, March 2013, <http://climatecommission.gov.au/report/the-angry-summer> (accessed 3 July 2013).

1.48 The 'key facts' in the report were:

- extreme weather events, including record-breaking heat, severe bushfires, extreme rainfall and flooding, dominated the 2012–2013 Australian summer;
- all weather is influenced by climate change, including the nature, impact and intensity of extreme weather events;
- the significant impacts of extreme weather on people, property, communities and the environment highlight the serious consequences of failing to adequately address climate change;
- it is highly likely that extreme hot weather will become even more frequent and severe in Australia and around the globe over coming decades; and
- it is critical to be aware of the influence of climate change on many types of extreme weather so that communities, emergency services and governments prepare for the risk of increasingly severe and frequent extreme weather.⁵⁵

Off the charts: Extreme Australian summer heat

1.49 In January 2013, the Climate Commission released a report titled *Off the charts: Extreme Australian summer heat*.⁵⁶ In summary, the report found:

- the length, extent and severity of the January heatwave were unprecedented in the measurement record;
- climate change is increasing the risk of more frequent and longer heatwaves and more extreme hot days, as well as exacerbating bushfire conditions;
- climate change has contributed to making the current extreme weather conditions and bushfires worse; and
- understanding climate change risks is critical to ensure appropriate action is taken to reduce greenhouse gas emissions and put in place measures to prepare for and respond to extreme weather.

1.50 The Climate Commission stated that, while hot weather has always been a feature of the Australian climate, 'there has been a significant increase in the frequency of hot days and hot nights over the last 50 years.'⁵⁷ Consistent with global trends, Australia's average temperature has risen by 0.9 degrees Celsius since 1910.⁵⁸ It further noted:

55 Climate Commission, *The Angry Summer*, March 2013, p. 1.

56 Climate Commission, *Off the charts: Extreme Australian summer heat*, January 2013, <http://climatecommission.gov.au/report/off-charts-extreme-january-heat-2013/> (accessed 14 January 2013).

57 Climate Commission, *Off the charts: Extreme Australian summer heat*, January 2013, p. 1.

58 Climate Commission, *Off the charts: Extreme Australian summer heat*, January 2013, p. 1.

- eastern, southern and south-western Australia have become drier over the last 40 years;
- Tasmania's total rainfall has reduced;
- the drought from 1997–2009 in Victoria was the driest period on record in that state;
- most of NSW has experienced a drying trend over the past 40 years;
- there has been a decline in rainfall in southern South Australia since 1970; and
- WA and Tasmania did not experience the increased rainfall seen over parts of southeastern Australia over the last two years.⁵⁹

1.51 With respect to bushfires, the Climate Commission stated that changes 'such as hotter temperatures, longer duration of heat events, high winds due to strong temperature gradients and drier soils and fuel can dramatically exacerbate fire conditions'.⁶⁰ Many regions of Australia have experienced an increase in extreme fire weather, with the main contributors being prolonged periods of low rainfall and increased frequency and intensity of extreme heat.

1.52 The Climate Commission described heat as a 'silent killer' and a leading cause of weather-related deaths in Australia.⁶¹ The Climate Commission explained that recent heatwaves in Australia have resulted in increased hospital admissions for kidney disease, acute renal failure and heart attacks as well as deaths. When Melbourne experienced three consecutive days at or above 43°C during the severe heatwaves in south-eastern Australia in 2009, there were 980 deaths, 374 more (or a 62 per cent increase) than the estimated 606 that would have occurred on average for that time of year.⁶²

Special Climate Statement 43: Extreme January heat

1.53 On 7 January 2013, BOM released its *Special Climate Statement 43: Extreme January heat*.⁶³ According to this:

Large parts of central and southern Australia are currently under the influence of a persistent and widespread heatwave event. This event is ongoing with further significant records likely to be set.⁶⁴

59 Climate Commission, *Off the charts: Extreme Australian summer heat*, January 2013, p. 2.

60 Climate Commission, *Off the charts: Extreme Australian summer heat*, January 2013, p. 2.

61 Climate Commission, *Off the charts: Extreme Australian summer heat*, January 2013, p. 3.

62 Climate Commission, *Off the charts: Extreme Australian summer heat*, January 2013, p. 4.

63 BOM, *Special Climate Statement 43: Extreme January heat*, <http://www.BOM.gov.au/climate/current/statements> (accessed 4 February 2013).

64 BOM, *Special Climate Statement 43: Extreme January heat*, p. 1.

1.54 The statement advised that the last four months of 2012 were abnormally hot across Australia and particularly so for maximum daytime temperatures. For September to December 2012, the average Australian maximum temperature 'was the highest on record with a national anomaly of +1.61°C, slightly ahead of the previous record of +1.60°C set in 2002'.⁶⁵ The Bureau of Meteorology explained that the hot conditions were exacerbated 'by very dry conditions affecting much of Australia since mid 2012 and a delayed start to a weak Australian monsoon'.⁶⁶

1.55 The January heatwave commenced with a build-up of extreme heat in the southwest of Western Australia from 25–30 December 2012 as a high in the Great Australian Bight and a trough near the west coast directing hot easterly winds over the area. Particularly hot conditions occurred on 30 December with Cape Naturaliste experiencing 37.7°C, its hottest December day in 56 years of records.⁶⁷

1.56 From 31 December, the high pressure system began to move eastward. By 4 January 2013, the high pressure system had moved off eastern Australia, with northerly winds directing very hot air into southeast Australia. BOM stated:

Hobart experienced a minimum temperature of 23.4°C on the 4th (its hottest January night on record), followed by a maximum of 41.8°C (its hottest maximum temperature on record for any month in 130 years of records) and the highest temperature observed anywhere in southern Tasmania.⁶⁸

1.57 The area of intense heat moved northeast on 5 January. Areas affected recorded temperatures in excess of 40°C: Marree in South Australia (SA) recording 48.4°C, Yarrowonga in Victoria recording 45.7°C and Hay in NSW recording 47.7°C, breaking its annual daytime temperature record.⁶⁹

State of the Climate 2012

1.58 The *State of the Climate 2012* report is the second such report produced by CSIRO and the Bureau of Meteorology and provides 'a summary of observations of Australia's climate and analysis of the factors that influence it'.⁷⁰ The first State of the Climate report, released in March 2010, highlighted a multi-decadal warming trend over Australia's land and oceans, as well as an increase in record hot days and a decrease in record cold days, a decrease in rainfall in southwest and southeast

65 BOM, *Special Climate Statement 43: Extreme January heat*, p. 1.

66 BOM, *Special Climate Statement 43: Extreme January heat*, p. 1.

67 BOM, *Special Climate Statement 43: Extreme January heat*, p. 1.

68 BOM, *Special Climate Statement 43: Extreme January heat*, p. 1.

69 BOM, *Special Climate Statement 43: Extreme January heat*, p. 2.

70 CSIRO and Australian Bureau of Meteorology, *State of the Climate 2012*, p. 2, http://www.csiro.au/Outcomes/Climate/Understanding/~/_/link.aspx?_id=CBCD40CB66A0482CB949F0F92B60B2A9&_z=z (accessed 4 July 2013).

Australia, an increase in global sea level and increases in global greenhouse gas (GHG) concentrations.⁷¹

1.59 The *State of the Climate 2012* report 'provides an updated summary of long-term climate trends' and 'notes that the long-term warming trend has not changed, with each decade having been warmer than the previous decade since the 1950s'.⁷²

1.60 Some of the key findings in the report were:

- since 1910, Australian annual average daily maximum temperatures have increased by 0.75°C, annual average daily mean temperatures have increased by 0.9°C and annual average overnight minimum temperatures have warmed by more than 1.1°C;⁷³
- 2010 and 2011 were Australia's coolest recorded years since 2001 due to two consecutive La Niña events;⁷⁴
- southwest Western Australia has experienced long-term reductions in rainfall during the winter half of the year;⁷⁵
- there has been a trend towards increased spring and summer monsoonal rainfall across Australia's north, higher-than-normal rainfall across the centre and decreased late autumn and winter rainfall across the south;⁷⁶
- global average mean sea level rose faster between 1993 and 2011 than during the whole of the 20th century;⁷⁷
- sea surface temperatures in the Australian region were very warm during 2010 and 2011, with temperatures in 2010 the highest on record;⁷⁸
- sea surface temperatures have increased by approximately 0.8°C since 1910;⁷⁹
- fossil fuel carbon dioxide emissions increased by more than three per cent per year from 2000 to 2010;⁸⁰
- the concentration of carbon dioxide in the atmosphere in 2011 was higher than at any time for the past 800 000 years;⁸¹

71 CSIRO and BOM, *State of the Climate 2012*, p. 2.

72 CSIRO and BOM, *State of the Climate 2012*, p. 2.

73 CSIRO and BOM, *State of the Climate 2012*, p. 3.

74 CSIRO and BOM, *State of the Climate 2012*, p. 3.

75 CSIRO and BOM, *State of the Climate 2012*, p. 5.

76 CSIRO and BOM, *State of the Climate 2012*, p. 5.

77 CSIRO and BOM, *State of the Climate 2012*, p. 6.

78 CSIRO and BOM, *State of the Climate 2012*, p. 7.

79 CSIRO and BOM, *State of the Climate 2012*, p. 7.

80 CSIRO and BOM, *State of the Climate 2012*, p. 8.

- both natural and human influences affected climate over the past 100 years;⁸²
- it is very likely that most of the surface global warming observed since the mid-20th century is due to anthropogenic increases in GHGs;⁸³
- Australian average temperatures are projected to rise by 1.0°C to 2.0°C by 2070;⁸⁴ and
- an increase in the number of droughts in southern Australia is expected, as is an increase in intense rainfall events in many areas.⁸⁵

Special Report of the IPCC: Managing the risks of extreme events and disasters to advance climate change adaptation

1.61 The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP) to:

...assess in a comprehensive, objective, and transparent manner all the relevant scientific, technical, and socioeconomic information to contribute in understanding the scientific basis of risk of human-induced climate change, the potential impacts, and the adaptation and mitigation options. Beginning in 1990, the IPCC has produced a series of Assessment Reports, Special Reports, Technical Papers, methodologies, and other key documents which have since become standard references for policymakers and scientists.⁸⁶

1.62 In 2012, the IPCC released the *Special Report of the IPCC: Managing the risks of extreme events and disasters to advance climate change adaptation* (SREX). The report 'focuses on the relationship between climate change and extreme weather and climate events, the impacts of such events, and the strategies to manage the associated risks'.⁸⁷

1.63 The SREX combined expertise in three different aspects of managing risks of extreme weather and climate events:

- disaster recovery, disaster risk management and disaster risk reduction;
- the physical science basis of climate change; and

81 CSIRO and BOM, *State of the Climate 2012*, p. 8.

82 CSIRO and BOM, *State of the Climate 2012*, p. 10.

83 CSIRO and BOM, *State of the Climate 2012*, p. 10.

84 CSIRO and BOM, *State of the Climate 2012*, p. 11.

85 CSIRO and BOM, *State of the Climate 2012*, p. 11.

86 IPCC, *Special Report of the IPCC: Managing the risks of extreme events and disasters to advance climate change adaptation* (SREX), 2012, p. viii, <http://ipcc-wg2.gov/SREX/report> (accessed 4 July 2013).

87 IPCC, *SREX*, 2012, p. viii.

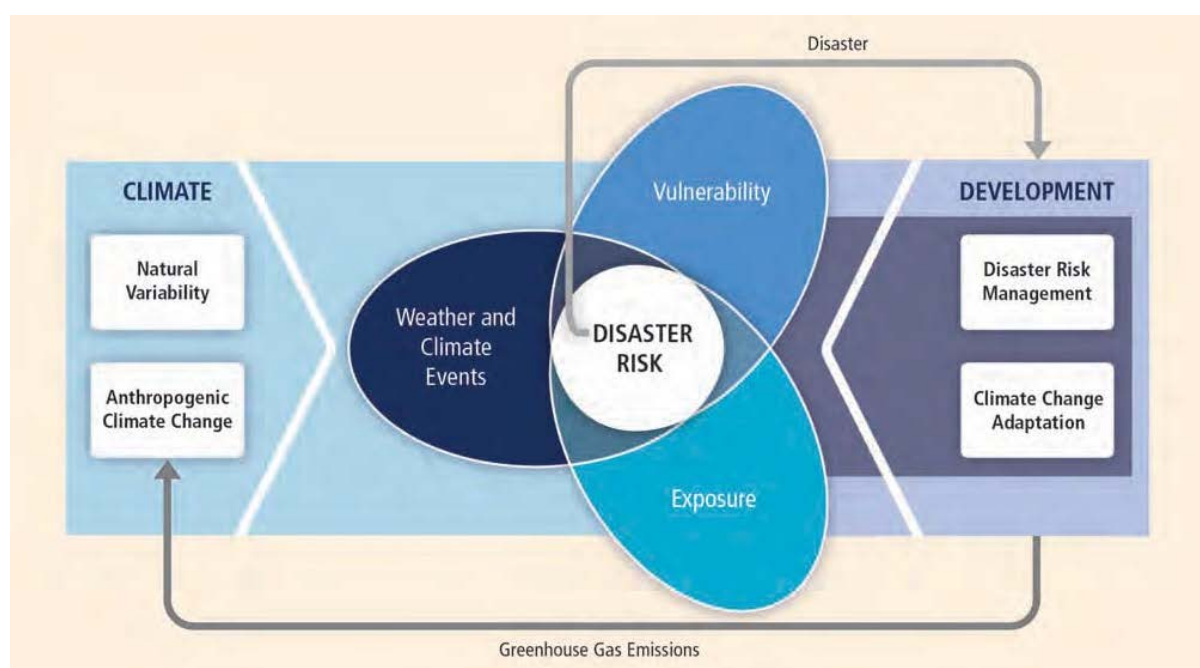
- climate change impacts, adaptation and vulnerability.⁸⁸

1.64 In respect of extreme weather events, SREX stated:

Extremes can contribute to disasters, but disaster risk is influenced by more than just the physical hazards. Disaster risk emerges from the interaction of weather or climate events, the physical contributors to disaster risk, with exposure and vulnerability, the contributors to risk from the human side. The combination of severe consequences, rarity, and human as well as physical determinants make disasters difficult to study. Only over the last few years has the science of these events, their impacts, and options for dealing with them become mature enough to support a comprehensive assessment. This report provides a careful assessment of scientific, technical, and socioeconomic knowledge as of May 2011, the cut-off date for literature included.⁸⁹

1.65 The IPCC provided a diagram illustrating the 'core concepts of SREX'⁹⁰ (see Figure 1.1).

Figure 1.1: Illustration of the core concepts of SREX⁹¹



1.66 In summary, some of SREX's key findings were:

- Exposure and vulnerability are key determinants of disaster risk and of impacts when risk is realised: extreme impacts on human, ecological or

88 IPCC, *SREX*, 2012, p. ix.

89 IPCC, *SREX*, 2012, p. ix.

90 IPCC, *SREX*, 2012, p. 4.

91 IPCC, *SREX*, 2012, p. 4.

physical systems can result from individual extreme weather or climate events. Extreme impacts can also result from non-extreme events where exposure and vulnerability are high or from a compounding of events or their impacts.⁹²

- Extreme and non-extreme weather or climate events affect vulnerability to future extreme events by modifying resilience, coping capacity and adaptive capacity: the cumulative effects of disasters at a local or sub-national level can substantially affect the capacity of communities to prepare for and respond to future disasters.⁹³
- A changing climate leads to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events and can result in unprecedented extreme weather and climate events: changes in extremes can be linked to changes in the mean, variance or shape of probability distributions, or all of these. Many extreme weather and climate events continue to be the result of natural climate variability. Natural variability will be an important factor in shaping future extremes in addition to the effect of anthropogenic change in climate.⁹⁴
- Exposure and vulnerability are dynamic, varying across temporal and spatial scales, and depend on economic, social, geographic, demographic, cultural, institutional, governance and environmental factors.⁹⁵
- Settlement patterns, urbanisation and changes in socioeconomic conditions have all influenced trends in exposure and vulnerability to climate extremes.⁹⁶
- There is evidence of change in some extremes (based on observations gathered since 1950). Confidence in these observed changes depends on the quality and quantity of data and the availability of studies analysing these data.⁹⁷
- There is evidence that some extremes have changed as a result of anthropogenic influences, including increases in atmospheric concentrations of greenhouse gases.⁹⁸
- Economic losses from weather- and climate-related disasters have increased but with large spatial and inter-annual variability.⁹⁹

92 IPCC, *SREX*, 2012, p. 6.

93 IPCC, *SREX*, 2012, pp 6-7.

94 IPCC, *SREX*, 2012, p. 7.

95 IPCC, *SREX*, 2012, p. 7.

96 IPCC, *SREX*, 2012, p. 7.

97 IPCC, *SREX*, 2012, p. 8.

98 IPCC, *SREX*, 2012, p. 9.

99 IPCC, *SREX*, 2012, p. 9.

-
- Increasing exposure of people and economic assets has been the major cause of long-term increases in economic losses from weather- and climate-related disasters.¹⁰⁰
 - Trends in exposure and vulnerability are major drivers of changes in disaster risk.¹⁰¹
 - Data on disasters and disaster risk reduction are lacking at the local level, which can constrain improvements in local vulnerability reduction.¹⁰²
 - Post-disaster recovery and reconstruction provide an opportunity for reducing weather- and climate-related disaster risk and for improving adaptive capacity.¹⁰³
 - National systems are at the core of countries' capacity to meet challenges of observed and projected trends in exposure, vulnerability and weather and climate extremes.¹⁰⁴
 - Confidence in projecting changes in the direction and magnitude of climate extremes depends on many factors, including the type of extreme, the region and season, the amount and quality of observational data, the level of understanding of the underlying processes, and the reliability of their simulation in models.¹⁰⁵
 - Models project substantial warming in temperature extremes by the end of the 21st century.¹⁰⁶
 - It is likely that the frequency of heavy precipitation or the proportion of total rainfall from heavy falls will increase in the 21st century over many areas of the globe.¹⁰⁷
 - There is medium confidence that droughts will intensify in the 21st century in some regions and areas, due to reduced precipitation and/or increased evapotranspiration.¹⁰⁸
 - It is very likely that mean sea level rise will contribute to upward trends in extreme coastal high water levels in the future.¹⁰⁹

100 IPCC, *SREX*, 2012, p. 9.

101 IPCC, *SREX*, 2012, p. 10.

102 IPCC, *SREX*, 2012, p. 10.

103 IPCC, *SREX*, 2012, p. 10.

104 IPCC, *SREX*, 2012, p. 11.

105 IPCC, *SREX*, 2012, p. 11.

106 IPCC, *SREX*, 2012, p. 13.

107 IPCC, *SREX*, 2012, p. 13.

108 IPCC, *SREX*, 2012, p. 13.

109 IPCC, *SREX*, 2012, p. 15.

- There is high confidence that changes in heat waves, glacial retreat and/or permafrost degradation will affect high mountain phenomena such as slope instabilities, movements of mass and glacial lake outburst floods.¹¹⁰
- Extreme events will have greater impacts on sectors with closer links to climate, such as water, agriculture and food security, forestry, health and tourism.¹¹¹
- In many regions, the main drivers of future increases in economic losses due to some climate extremes will be socioeconomic in nature.¹¹²
- Effective risk management generally involves a portfolio of actions to reduce and transfer risk and to respond to events and disasters, as opposed to a singular focus on any one action or type of action.¹¹³
- Multi-hazard risk management approaches provide opportunities to reduce complex and compound hazards.¹¹⁴
- Integration of local knowledge with additional scientific and technical knowledge can improve disaster risk reduction and climate change adaptation.¹¹⁵
- Appropriate and timely risk communication is critical for effective adaptation and disaster risk management.¹¹⁶

The Critical Decade: Climate science, risks and responses

1.67 In May 2011, the Climate Commission released its report *The Critical Decade: Climate science, risks and responses*.¹¹⁷ The report argued:

Over the past two or three years, the science of climate change has become a more widely contested issue in the public and political spheres. Climate science is now being debated outside the normal discussion and debate that occurs within the peer-reviewed scientific literature in the normal course of research. It is being attacked in the media by many with no credentials in the field...The evidence that the Earth's surface is warming rapidly is now exceptionally strong, and beyond doubt. Evidence for changes in other aspects of the climate system is also strengthening. The primary case of the observed warming and associated changes since the mid-20th century—

110 IPCC, *SREX*, 2012, p. 15.

111 IPCC, *SREX*, 2012, p. 16.

112 IPCC, *SREX*, 2012, p. 16.

113 IPCC, *SREX*, 2012, p. 17.

114 IPCC, *SREX*, 2012, p. 17.

115 IPCC, *SREX*, 2012, p. 17.

116 IPCC, *SREX*, 2012, p. 17.

117 Climate Commission, *The Critical Decade: Climate science, risks and responses*, May 2011, <http://climatecommission.gov.au/report/the-critical-decade/> (accessed 4 February 2013).

human emissions of greenhouse gases—is also known with a high level of confidence.¹¹⁸

1.68 In discussing extreme weather events associated with climate change, the report stated:

Many of the impacts of climate change are due to extreme weather events, not changes in average values of climatic parameters. The most important of these are high temperature-related events, such as heatwaves and bushfires; heavy precipitation events; and storms, such as tropical cyclones and hailstorm. The connection between long-term, human-driven climate change and the nature of extreme events is both complex and controversial, leading to intense debate in the scientific community and heated discussion in the public and political arenas.¹¹⁹

1.69 The report continued:

- Modest changes in average values of climatic parameters—for example, temperature and rainfall—can lead to disproportionately large changes in the frequency and intensity of extreme events;
- On a global scale and across Australia it is very likely that since about 1950 there has been a decrease in the number of low temperature extremes and an increase in the number of high temperature extremes. In Australia high temperature extremes have increased significantly over the past decade, while the number of low temperature extremes has decreased.
- The seasonality and intensity of large bushfires in southeast Australia is likely changing, with climate change a possible contributing factor. Examples include the 2003 Canberra fires and the 2009 Victoria fires.
- There is little confidence in observed changes in tropical cyclone activity in the past because of problems with the lack of homogeneity of observations over time. The global frequency of tropical cyclones is projected to either stay about the same or even decrease. However a modest increase in intensity of the most intense systems, and in associated heavy rainfall, is projected as the climate warms.
- On a global scale, several analyses point to an increase in heavy precipitation events in many parts of the world, including tropical Australia, consistent with physical theory and with projections of more intense rainfall events as the climate warms.¹²⁰

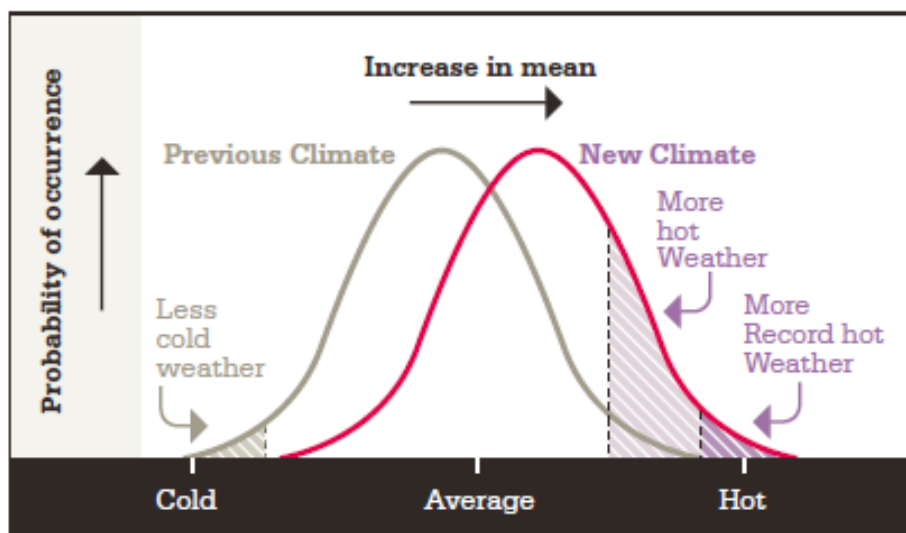
118 Climate Commission, *The Critical Decade: Climate science, risks and responses*, May 2011, p. 3.

119 Climate Commission, *The Critical Decade: Climate science, risks and responses*, May 2011, p. 38.

120 Climate Commission, *The Critical Decade: Climate science, risks and responses*, May 2011, pp 38–39.

1.70 The report explained that, while temperature increases of 1°C or 2°C may seem modest, even a small shift to higher average temperatures leads to a disproportionately large increase in the number of extreme high temperature events (see Figure 1.2).

Figure 1.2: Relationship between temperature means and extremes¹²¹



1.71 With regard to bushfires, the Climate Commission found that '...the intensity and seasonality of large bushfires in southeast Australia appears to be changing, with climate change a possible contributing factor'.¹²² The report noted that while bushfires have long been a feature of ecosystems in southeast Australia, climate change 'affects fire regimes in at least three ways' because of:

- changing precipitation patterns, higher temperatures and elevated atmospheric carbon dioxide concentrations which change the biomass and composition of vegetation (fuel load for fires);
- higher temperatures dry the fuel load, making it more susceptible to burning; and
- the increased probability of extreme fire weather days (conditions with extreme temperature, low humidity and high winds).¹²³

121 From Climate Commission, *The Critical Decade: Climate science, risks and responses*, May 2011, p. 39.

122 Climate Commission, *The Critical Decade: Climate science, risks and responses*, May 2011, p. 40.

123 Climate Commission, *The Critical Decade: Climate science, risks and responses*, May 2011, pp 41–42.

1.72 The report stated that the floods across eastern Australia during 2010 and early 2011 were the consequence of a very strong La Niña event and not the result of climate change.¹²⁴

1.73 The report continued:

The physical connection between a warming climate and more rainfall is relatively straightforward. Higher temperatures, especially of the surface ocean, lead to more evaporation; this leads to higher water vapour content in a warmer atmosphere (which can hold more water vapour); and this in turn induces more precipitation.¹²⁵

Special Climate Statement 38: Australia's wettest two-year period on record; 2010–2011

1.74 On 7 February 2011, the Bureau of Meteorology released its *Special Climate Statement 38: Australia's wettest two-year period on record; 2010–2011*.¹²⁶ The Bureau stated:

Frequent heavy rain events from spring 2010 to autumn 2011, and again in late 2011, lead to Australia's wettest two-year period on record. Averaged across the Australia, total rainfall for 2011 was 705 mm, making it the second-wettest year on record (behind 1974 with 760 mm), and ahead of 2010 (third-wettest) with 703 mm.¹²⁷

1.75 BOM found that the:

...exceptional rainfall was heavily influenced by La Niña conditions...These conditions, coupled with very warm sea surface temperatures to the north of Australia and in the eastern Indian Ocean, contributed to making 2010–2011 Australia's wettest two-year period on record.¹²⁸

1.76 September 2010 was Australia's wettest September on record: it was the wettest September on record for Queensland and the Northern Territory, and the third wettest for SA and WA.¹²⁹ Overall, spring 2010 was the wettest on record for

124 Climate Commission, *The Critical Decade: Climate science, risks and responses*, May 2011, p. 42.

125 Climate Commission, *The Critical Decade: Climate science, risks and responses*, May 2011, p. 42.

126 BOM, *Special Climate Statement 38: Australia's wettest two-year period on record; 2010–2011*, <http://www.BOM.gov.au/climate/current/statements/> (accessed 4 February 2013).

127 BOM, *Special Climate Statement 38: Australia's wettest two-year period on record; 2010–2011*, p. 2.

128 BOM, *Special Climate Statement 38: Australia's wettest two-year period on record; 2010–2011*, p. 2.

129 BOM, *Special Climate Statement 38: Australia's wettest two-year period on record; 2010–2011*, p. 2.

Australia, Queensland, NSW and the Northern Territory, and the second-wettest for SA.¹³⁰

1.77 Early 2011 saw heavy rainfall and associated severe flooding in Queensland and southern parts of Australia. It was the second-wettest summer on record for Australia and WA, the wettest summer on record for Victoria, and the third-wettest summer for SA.¹³¹

1.78 Despite these record-breaking periods of rainfall, BOM stated that the longer term averages still showed much of Australia had received below-average rainfall.¹³²

Climate Change Risks to Australia's Coast

1.79 In 2009, the former Department of Climate Change published a report on *Climate Change Risks to Australia's Coast: A First Pass National Assessment*.¹³³ That report presented the findings of the first national assessment of the risks of climate change for the whole of Australia's coastal zone. The report noted that:

Extreme weather events are also likely to become more intense with climate change, with larger and more damaging storm surge and the possible extension of cyclones further south along both the east and west coasts. These changes will have implications for the capacity of the built and natural environment to withstand and recover from impacts.¹³⁴

1.80 The report identified a number of issues requiring further attention, including needs:

- for national standards and benchmarks for coastal development;
- for regional risk assessments to be undertaken to better identify and manage future risk, particularly where planning can assist in avoiding future development in high risk areas;
- to upgrade building codes and engineering specifications for infrastructure in high-risk areas in the coastal zone;
- to build the capacity of local government; and

130 BOM, *Special Climate Statement 38: Australia's wettest two-year period on record; 2010–2011*, p. 3.

131 BOM, *Special Climate Statement 38: Australia's wettest two-year period on record; 2010–2011*, p. 3.

132 BOM, *Special Climate Statement 38: Australia's wettest two-year period on record; 2010–2011*, p. 3.

133 Department of Climate Change (DCC), *Climate Changes Risks to Australia's Coast: A First Pass National Assessment*, 2009, <http://www.climatechange.gov.au/climate-change/adapting-climate-change/australias-coasts-and-climate-change/coastal-risks-0/climate> (accessed 20 June 2013).

134 DCC, *Climate Changes Risks to Australia's Coast: A First Pass National Assessment*, 2009, p. 7.

- for a national agenda to clarify roles and responsibilities across jurisdictions.¹³⁵

1.81 In June 2011, a supplement to *Climate Change Risks to Australia's Coasts* was released. The *Climate Change Risks to Coastal Buildings and Infrastructure* report identified the exposure of coastal infrastructure to inundation and erosion from a sea level rise of 1.1 metres. The report provided data on the exposure of:

- commercial buildings such as retail precincts;
- light industrial buildings such as warehouses and manufacturing; and
- transport systems such as road, rail and tramways.¹³⁶

135 DCC, *Climate Changes Risks to Australia's Coast: A First Pass National Assessment*, 2009, pp 150–151.

136 See further Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DCCIIS RTE), *National Coastal Risk Assessment*, <http://www.climatechange.gov.au/climate-change/adapting-climate-change/australias-coasts-and-climate-change/xxxx-adapting-coastal-0> (accessed 24 June 2013).

Chapter 2

Recent trends and projections on the frequency of extreme weather events

2.1 This chapter examines evidence received by the committee relating to trends and projections on the frequency and magnitude of extreme weather events, including drought, bushfires, heatwaves, floods and storm surges.¹ The focus of the chapter is on trends and projections in the Australian context, rather than the global context. It also focusses on evidence presented to the committee during this inquiry: relevant recent reports have been outlined in the background discussion in Chapter 1.

2.2 This chapter first examines the general concept of 'extreme weather', followed by general trends and projections on the frequency of extreme weather events. It then considers in turn the trends and projections in Australia in relation to particular extreme weather events, including:

- temperature extremes and heatwaves;
- rainfall extremes, including floods and droughts;
- bushfires;
- tropical cyclones; and
- storm surges and coastal flooding.

2.3 Finally, this chapter briefly considers the gaps and uncertainties in relation to those trends and projections, and areas where further research might be needed.

What is 'extreme weather'?

2.4 Evidence to this inquiry focussed on extreme weather events such as heatwaves, bushfires, droughts, floods and cyclones. The Intergovernmental Panel on Climate Change (IPCC) has defined 'extreme weather' as:

The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable.²

1 See terms of reference (a) and (b)(i) for the inquiry.

2 IPCC, *Special Report of the IPCC: Managing the risks of extreme events and disasters to advance climate change adaptation* (SREX), 2012, p. 5 and see also pp 115–117, http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml#SREX (accessed 4 July 2013).

2.5 The Climate Commission has described an 'extreme weather event' as:

...a weather or climate event which is unusually intense or long, occasionally beyond what has been experienced before. Examples include very high (and low) temperatures, very heavy rainfall (and snowfall in cold climates), and very high wind speeds.³

2.6 The Climate Commission has explained that extreme events occur only rarely, but are noticeable because they are so different from the usual weather and climate, and are associated with adverse impacts on humans, infrastructure and ecosystems. It further noted that extreme weather events are often short-lived abrupt events lasting hours or days—for example, extremely hot days, very heavy rainfall, hail storms, and tropical cyclones. Other extreme events can last much longer, such as drought, which is a 'significant lack of rainfall over a period of months to years'.⁴

2.7 There was some discussion during the committee's inquiry about the difference between 'weather' and 'climate'. The Climate Commission explains that 'climate is what you'd expect, and weather is what you get':

Weather is what we get, day to day, which can vary in the short term. Climate is the long-term average of the weather patterns we experience, usually taken over 30 years or longer. The long-term average gives us a sense of what we can expect the weather to be.⁵

2.8 Professor Neville Nicholls summed up the difference as follows:

Climate is in some sense an integration or aggregation of weather...weather is what we feel; climate is what we expect. It is very difficult to discern between them...⁶

3 Climate Commission, *The Critical Decade: Extreme weather*, April 2013, p. 10; http://climatecommission.gov.au/wp-content/uploads/ExtremeWeatherReport_web.pdf (accessed 6 June 2013).

4 Climate Commission, *The Critical Decade: Extreme weather*, April 2013, p. 10.

5 Climate Commission, *Basics: Weather*, <http://climatecommission.gov.au/basics/weather/> (accessed 14 June 2013); see also Climate Commission, *The Critical Decade 2013: Climate Change Science, Risks and Responses*, June 2013, pp 9–10.

6 Professor Neville Nicholls, Monash University, *Committee Hansard*, 20 February 2013, p. 7.

Trends and projections on the frequency of extreme weather events

General

2.9 It was generally agreed that Australia experiences a highly variable climate.⁷ For example, the Australian Research Council's (ARC) Centre of Excellence for Climate System Science submitted that:

There is large year-to-year variability in the frequency of hot extremes and heavy rain events, heatwaves, droughts and floods across Australia. These are associated with the natural variability of Australia's climate, particularly influenced by large-scale phenomena like El Niño-Southern Oscillation. In eastern Australia El Niño is associated with increased frequency of droughts, while La Niña is associated with increased frequency of heavy rain events and flooding.⁸

2.10 While most Australians are probably familiar with the El Niño-Southern Oscillation, the committee also heard about other natural climate variations that influence Australia's climate, including the Interdecadal Pacific Oscillation, which is a pattern of change detected as warm or cool surface waters in the Pacific Ocean. It shifts phases on a time scale of about 20 to 30 years, and may affect the occurrence of tropical cyclones.⁹

2.11 However, the committee also heard that the climate is changing due to human influences, particularly the burning of fossil fuels.¹⁰ The climate change scenarios put forward by the IPCC and CSIRO show average global temperature increases from 1 to 5 degrees by 2070, depending on the level of greenhouse gas emissions.¹¹

2.12 CSIRO submitted that:

The natural climate variability that underlies all extreme weather events is now influenced and altered by the effect of human-induced warming of the climate system...¹²

7 See, for example, CSIRO, *Submission 93*, p. 3; ARC Centre of Excellence for Climate System Science, *Submission 57*, p. 1.

8 ARC Centre of Excellence for Climate System Science, *Submission 57*, p. 2.

9 Mr Jeff Callaghan, Meteorologist, Green Cross Australia, *Committee Hansard*, 22 February 2013, p. 18 and also pp 21–22; Dr Anthony Kiem, *Submission 5*, p. 1; Professor Stewart Franks, *Submission 102*, p. 1, see also Geoscience Australia, OzCoasts, Climate Change, http://www.ozcoasts.gov.au/indicators/climate_change.jsp (accessed 14 June 2013).

10 See, for example, CSIRO, *Submission 93*, p. 4; Dr Andrew Glikson, *Committee Hansard*, 11 April 2013, p. 18; Dr Anthony Kiem, *Committee Hansard*, 11 April 2013, p. 19; Professor Alan Pears, *Submission 3*; Professor Neville Nicholls, *Submission 1*, p. 2; Professor David Karoly, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 34.

11 See, for example, Professor David Karoly, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 34; Dr Andrew Glikson, *Committee Hansard*, 11 April 2013, p. 12; Australian Academy of Science, *Submission 125*, p. 5; The Climate Institute, *Submission 105*, p. 3.

12 CSIRO, *Submission 93*, p. 4; see also Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 4.

2.13 CSIRO further explained that this changing climate will lead 'to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events'.¹³

2.14 Indeed, the evidence to the committee was that climate change is likely to increase the frequency and intensity of extreme weather events in the coming decades.¹⁴ The Climate Commission reported that:

Climate change is already increasing the intensity and frequency of many extreme weather events, adversely affecting Australians. Extreme events occur naturally and weather records are broken from time to time. However, climate change is influencing these events and record-breaking weather is becoming more common around the world.¹⁵

2.15 The committee also heard that climate change will not necessarily be experienced through gradual trends. Several submitters and witnesses pointed out that 'small changes in mean climate lead to larger changes in extremes'.¹⁶ As a result:

Future climate change impacts will increasingly be experienced first through extreme events rather than gradual changes in mean temperature or rainfall.¹⁷

2.16 Dr Andrew Glikson agreed that all the evidence is pointing to an 'accelerating series of extreme weather events around the world' and that:

This is not a gradual trend...When you look at the behaviour of the atmosphere past and present, it reaches tipping points and from a certain degree of energy in the atmosphere you get very rapid events over periods ranging from decades to maybe a century or two.¹⁸

2.17 Indeed, as outlined in Chapter 1, in recent years Australia has experienced several notable extreme weather events. The Bureau of Meteorology (BoM) submitted that:

13 CSIRO, *Submission 93*, p. 4.

14 CSIRO, *Submission 93*, pp 3–4; Department of Climate Change and Energy Efficiency, *Submission 168*, p. 1; see also The Climate Institute, *Submission 105*, p. 2; Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, pp 4 and 5; Dr Andrew Glikson, *Committee Hansard*, 11 April 2013, p. 12 and *Submission 2*, p. 2; Mr Peter Cosier, Convenor, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 29.

15 Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 4.

16 Wentworth Group of Concerned Scientists, *Submission 24*, p. 1; see also ARC Centre of Excellence for Climate System Science, *Submission 57*, p. 6; Department of Climate Change and Energy Efficiency, *Submission 168*, p. 1.

17 CSIRO, *Submission 93*, p. 5.

18 Dr Andrew Glikson, *Committee Hansard*, 11 April 2013, p. 12 and also p. 19; see also, for example, Dr Anthony Kiem, *Committee Hansard*, 11 April 2013, p. 13; CSIRO, *Submission 93*, p. 5; Academy of Science, *Submission 125*, p. 2; Dr Seth Westra, Dr Michael Leonard, Dr Mark Thyer and Professor Martin Lambert (University of Adelaide), *Submission 44*, p. 2.

Long-term observations show that some extreme weather events are now more common and severe than in the recent past, and model projections of future climate change indicate that further changes are likely.¹⁹

2.18 The Bureau of Meteorology informed the committee that providing warnings for extreme weather events is its 'core business',²⁰ and that:

Over the last decade, the Bureau has been particularly active in issuing severe weather warnings (Figure 1), as Australia has lurched from record drought to record floods and now to record heatwaves. The intensity of each of these events is unprecedented. That they should occur in series within the space of a decade is remarkable.²¹

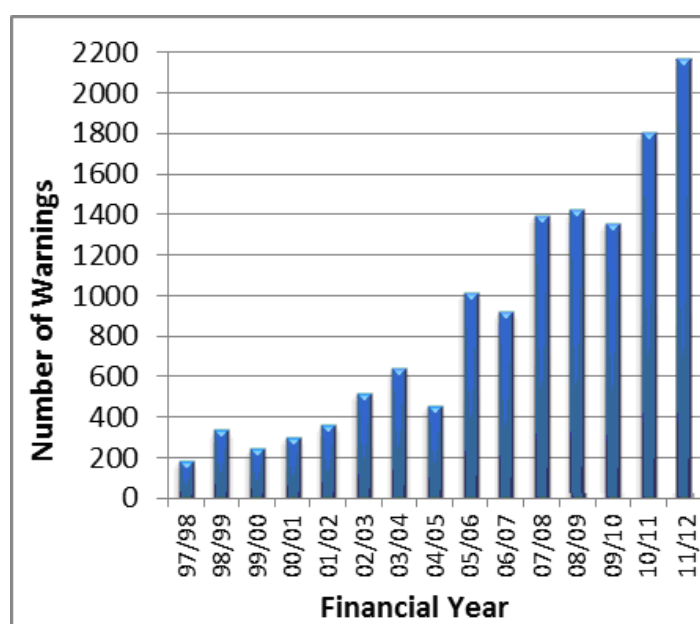


Figure 2.1: Number of severe weather-related warnings issued by the Bureau of Meteorology from July 1997 to June 2012.²²

19 Bureau of Meteorology (BoM), *Submission 65*, p. 3 and see also p. 7.

20 Dr Neville Smith, Deputy Director, Research and Systems, BoM, *Committee Hansard*, 11 April 2013, p. 53.

21 BoM, *Submission 65*, p. 1.

22 BoM, *Submission 65*, p. 2.

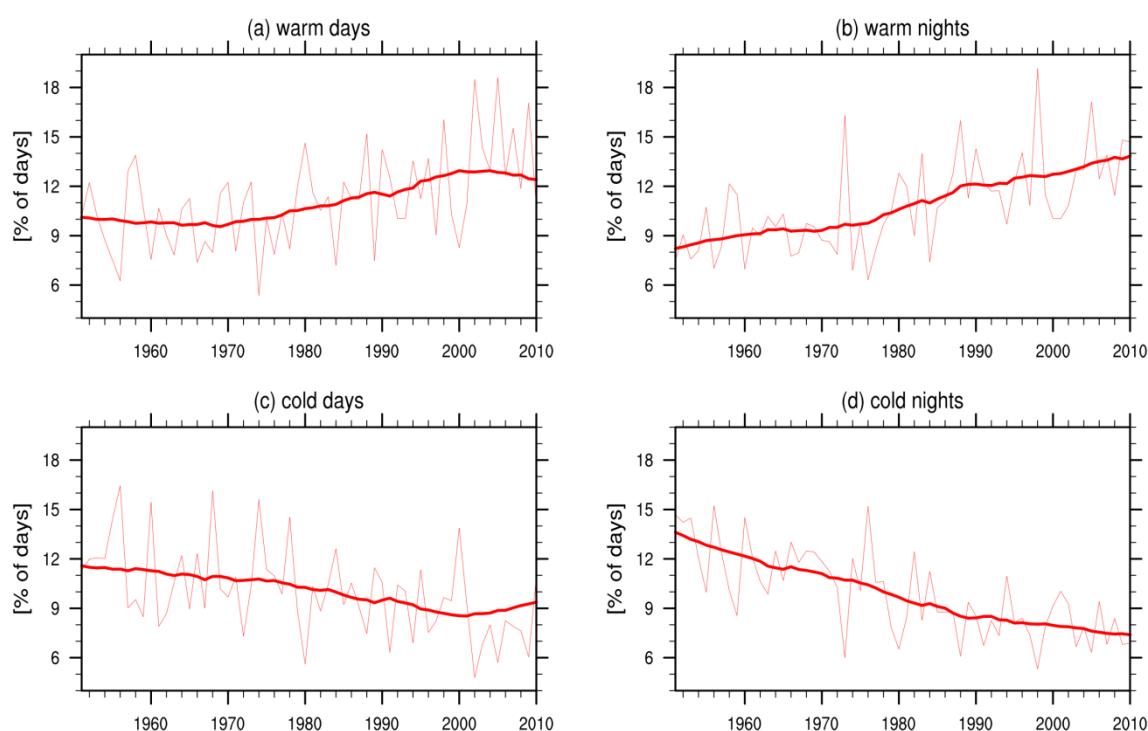
2.19 However, the Bureau noted that 'caution is required in inferring trends in this time series as factors beyond the occurrence of significant weather events may also contribute to these numbers'.²³

Extreme temperatures and heatwaves

Trends

2.20 The committee heard that, in general, there has been a trend towards warmer weather in Australia. In particular, there is an observed trend of more hot days and hot nights and less cold days and cold nights across Australia in the last 50 years (see Figure 2.2 below).²⁴

*Figure 2.2: Trends in indices for temperatures in Australia over 1951-2010*²⁵



2.21 Figure 2.2 shows a time series of indices of the number of warm/cool days (that is, daily maximum temperatures outside the 90th/10th percentile) and warm/cool

23 BoM, *Submission 65*, p. 2.

24 ARC Centre of Excellence for Climate System Science, *Submission 57*, p. 2; Dr Karl Braganza, Manager, Climate monitoring Services, BoM, *Committee Hansard*, 11 April 2013, p. 54; Australian Academy of Science, *Submission 1*, pp 1 and 4; Professor Will Steffen, Commissioner, Climate Commission, *Committee Hansard*, 7 June 2013, p. 9; CSIRO, *Submission 93*, p. 6.

25 ARC Centre of Excellence for Climate System Science, *Submission 57*, p. 5: from Donat, M.G. and L.V. Alexander (2012) "The shifting probability distribution of global daytime and night-time temperatures. *Geophysical Research Letters* 39, L14707.

nights (that is, daily minimum temperatures outside the 90th/10th percentile), averaged over Australia for the period 1951-2010).²⁶

2.22 As can be seen from Figure 2.1, the warming trend is more pronounced in relation to night-time temperatures—that is, 'we are seeing more record-high minimum temperatures during the night'.²⁷ For example, Dr Karl Braganza from the Bureau of Meteorology told the committee that:

In the last decade we are probably setting records for night-time temperatures that are warm at about the rate of five to one compared to cold temperatures. During the day it is about three to one, so record-setting temperatures we have not seen before across the network are three times more likely than cold records.²⁸

2.23 In terms of heatwaves,²⁹ the Bureau of Meteorology submitted that across Australia since the 1950s, there has been a slight increase in the duration of heatwaves, and an increase in the maximum temperatures associated with such events.³⁰ The Climate Commission has similarly reported that the duration and frequency of heatwaves increased over the period 1971–2008, and that the hottest days during heatwaves have become hotter.³¹

2.24 The Bureau of Meteorology noted, however, that there have been:

...marked regional variations in the frequency of occurrence of heatwaves over that time, with decreases in parts of southern coastal Australia (especially south-western Western Australia), and strong increases away from coastal regions. The decreases in heatwave duration across some parts of southern coastal Australia contrast with increases in the frequency of single-day high temperature extremes at many of the same locations over the same period.³²

2.25 The committee also notes that record temperatures in January 2013 resulted in the Bureau of Meteorology adding new colours—purple and pink—to its weather map

26 ARC Centre of Excellence for Climate System Science, *Submission 57*, p. 3.

27 Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 9.

28 Dr Karl Braganza, BoM, *Committee Hansard*, 11 April 2013, p. 54; see also Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 9; The Climate Institute, *Submission 105*, p. 2.

29 A 'heatwave' is generally defined as an extended period—at least three days—with persistent temperatures well above the local average: Climate Commission, *The Critical Decade 2013: Climate Change Science, Risks and Responses*, June 2013, p. 52.

30 BoM, *Submission 65*, p. 10.

31 Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 21; see also Dr Karl Braganza, BoM, *Committee Hansard*, 11 April 2013, p. 54; The Climate Institute, *Submission 105*, p. 2.

32 BoM, *Submission 65*, pp 10–11.

to denote temperatures once considered off the scale: 50–52°C and 52–54°C respectively.³³

Projections

2.26 The trend of increases in the number of hot days and hot nights and decreases in cold days and cold nights was projected to continue into the future.³⁴ For example, the Bureau of Meteorology predicted that:

It is very likely that the observed trends in the frequency and magnitude of warm daily temperature extremes will continue and, depending on emission scenario, potentially accelerate under future global warming. All regions of Australia are likely to experience significant increases in temperature extremes in this century.³⁵

2.27 These temperature increases are also associated with projections for increasing frequency and intensity of heatwaves in Australia.³⁶

2.28 CSIRO submitted that 'the number of days over 35°C is expected to increase significantly by 2030 for many locations in Australia'.³⁷ Indeed, the Climate Commission reported that:

...for Adelaide, Melbourne and Canberra the observed annual number of hot days is increasing more quickly than the climate models projected. In these cities the annual number of hot days occurring now is at the level projected for around 2030...³⁸

2.29 The Antarctic Climate and Ecosystems Cooperative Research Centre submitted that its detailed analysis had found that in Tasmania:

Hot summer days and heat waves are projected to increase in Tasmania in the future. Under a high greenhouse gas emissions scenario the number of summer days warmer than 25°C is projected to double or triple that of the recent climate record. The largest increases in extreme temperature are projected to be in spring and autumn, with increases greater than 4°C leading to a lengthening of the summer season. Heat waves (three days in a

33 See further: ABC, *Heat drives bureau back to the drawing board*, at: <http://www.abc.net.au/news/2013-01-09/temperatures-into-uncharted-waters/4458162>; and also The Climate Institute, *Submission 105*, p. 2.

34 ARC Centre of Excellence for Climate System Science, *Submission 57*, p. 2; CSIRO, *Submission 93*, p. 12.

35 BoM, *Submission 65*, p. 11.

36 ARC Centre of Excellence for Climate System Science, *Submission 57*, p. 2; see also Professor Nathaniel Bindoff, Program Leader, Climate Futures, Antarctic Climate and Ecosystems CRC (CRC), *Committee Hansard*, 10 April 2013, p. 23; Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 22.

37 BoM, *Submission 65*, p. 3.

38 Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 22 and Table 1.

row above 28°C) are expected to become more frequent – up to four times more frequent than historical records for Launceston, for example.³⁹

Rainfall extremes: floods and droughts

Trends

2.30 Both the CSIRO and the Bureau of Meteorology submitted that there is evidence of 'systematic changes in rainfall patterns' in Australia. They pointed to the following trends in recent decades:

- decreased late autumn and winter rainfall in southern Australia since the 1980s;
- increased spring and summer monsoonal rainfall in northern Australia; and
- a 15% decline in winter rainfall in southwest Western Australia since the 1970s.⁴⁰

2.31 Professor Will Steffen from the Climate Commission explained that the likely reason behind the decline in southwest Western Australia is that:

...the rain-bearing fronts off the Southern Ocean that give south-west WA its rainfall...have slipped southward by a degree or two in latitude, and that is because of the warming of the climate system; it pushes the mid-latitude jet streams toward the poles on both sides of the equator.⁴¹

2.32 The Bureau of Meteorology noted that the 'systematic decline in autumn-winter rainfall across southern Australia likely exacerbated the severity of the Millennium Drought'.⁴²

2.33 Dr Braganza from the Bureau of Meteorology told the committee that the reduction of rainfall in the winter months is problematic for water catchments:

It is an important time of the year to lose the rainfall because it is during that time that we prime the catchment. We get wetter soils during that period. That allows run-off to occur during the subsequent months into winter. So the 10 to 20 per cent reduction in rainfall during that time leads to a 60 per cent reduction in stream flow. You can see that most obviously

39 Antarctic Climate and Ecosystems CRC, *Submission 160*, p. 1; see also Dr Anthony Press, Chief Executive Officer, Antarctic Climate and Ecosystems CRC, *Committee Hansard*, 10 April 2013, p. 23.

40 BoM, *Submission 65*, pp 15 and 18; CSIRO, *Submission 93*, pp 6–7; Dr Karl Braganza, Manager, Climate Monitoring Services, BoM, *Committee Hansard*, 11 April 2013, p. 54; see also Australian Academy of Science, *Submission 1*, pp 1 and 5; The Climate Institute, *Submission 105*, p. 3; Conservation Council of Western Australia, *Submission 100*, p. 2; Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 10.

41 Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, pp 10–11.

42 BoM, *Submission 65*, p.17. Note that the 'Millennium Drought' is discussed in Chapter 1.

in Perth and south-west WA, where catchments are around the 20 per cent mark.⁴³

2.34 Dr Braganza noted that there have also been increases in rainfall intensity, or heavy rainfall events:

When you go to rainfall intensity—really heavy rainfall events—in the last three years we have had a lot of records set. We have had record sea-surface temperatures around Australia, which is, in some ways, co-variable with the rainfall; it influences how much rainfall we get.⁴⁴

2.35 The Climate Commission reported that, while there is considerable variability in rainfall across Australia, there has been:

- a significant increase in the frequency of heavy rainfall events in northwest Australia; and
- a slight decrease (not statistically significant) in the number of heavy rainfall events in southeast and southwest Australia.⁴⁵

Projections

2.36 In general terms, the Bureau of Meteorology submitted that, with global warming, the planet's hydrological cycle is predicted to intensify, which essentially means 'more heavy rainfall and more severe droughts'.⁴⁶ The Bureau explained that, as the Earth's atmosphere warms, the amount of moisture it can hold also increases and that 'this is expected to result in increases in heavy rainfall events and consequent flooding'.⁴⁷ At the same time, global warming is also expected to increase evaporation, leading to more severe drought conditions in 'dry' regions of the globe.⁴⁸

2.37 More specifically for Australia, the Bureau of Meteorology explained that 'changes in Australian rainfall and drought patterns are dependent on complex changes in the global atmospheric circulation', and warned that there is uncertainty as to the 'future frequency, timing and spatial extent of those changes' due to the high variability of rainfall in Australia.⁴⁹ These, and other, uncertainties are discussed in further detail later in this chapter.

43 Dr Karl Braganza, Manager, Climate Monitoring Services, BoM, *Committee Hansard*, 11 April 2013, p. 54.

44 Dr Karl Braganza, BoM, *Committee Hansard*, 11 April 2013, p. 54.

45 Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 27.

46 BoM, *Submission 65*, p. 14; see also, for example, Dr Andrew Glikson, *Submission 2*, p. 6.

47 BoM, *Submission 65*, p. 14; see also Professor Nathaniel Bindoff, Antarctic Climate and Ecosystems CRC, *Committee Hansard*, 10 April 2013, p. 24; Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 10.

48 BoM, *Submission 65*, p. 14; see also Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 10.

49 BoM, *Submission 65*, p. 14.

2.38 However, the Bureau of Meteorology submitted that most climate model projections indicate:

- rainfall decreases in southern and eastern Australia during the cooler months, particularly in winter and spring;
- increased drought threat for southern Australia as a result of reduced mean rainfall and higher temperatures; and
- rainfall intensity will likely increase across Australia.⁵⁰

2.39 CSIRO submitted the 'changes in seasonal-average rainfall affect the incidence of drought and floods'.⁵¹ So, for example, 'drought occurrence is expected to increase over most of southern Australia, especially in south-western Australia'.⁵² CSIRO further submitted that modelling in relation to future drought conditions indicates that:

...by 2030, it is likely...that a 1-in-20 year drought during the 20th century may become a 1-in-10 year drought over south west Western Australia. By 2050, this could include the Murray-Darling Basin, South Australia and Victoria, and by 2070 this could extend to eastern New South Wales and Tasmania. No significant increases in drought frequency are projected for the northwest WA or northern and central Queensland.⁵³

2.40 CSIRO further submitted that climate change projections suggest that 'the Murray-Darling Basin will be on average drier in the future', and that future droughts in the Murray-Darling Basin may be longer, more frequent and more severe.⁵⁴

2.41 The Bureau of Meteorology reported less confidence in predicting future rainfall changes across northern Australia.⁵⁵ However, the Bureau stated that:

[it has] high confidence in projections of warming and increased atmospheric moisture, and associated increases in heavy rainfall will likely contribute to a generalised increased flood threat during the tropical wet season in the future. It is, however, more difficult to predict the future frequency of severe flooding, due to the inherent, and likely increasing, year to year variability of Australian rainfall.⁵⁶

50 BoM, *Submission 65*, pp 14–15; see also Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 10.

51 CSIRO, *Submission 93*, p. 7.

52 CSIRO, *Submission 93*, p. 13; see also Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 10; Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 36.

53 CSIRO, *Submission 93*, p. 13. Note their quotation references a paper by: Kirono D.G.C., Kent D.M., Hennessy, K.J. and Mpelasoka, F., 2011, 'Characteristics of Australian droughts under enhanced greenhouse conditions: Results from 14 global climate models', *Journal of arid environments* 75(6): 566–575.

54 CSIRO, *Submission 93*, p. 13.

55 BoM, *Submission 65*, p. 14.

56 BoM, *Submission 65*, p. 19.

2.42 The Climate Commission reported that research indicates that in Australia:

...it is more likely than not that heavy rainfall events will become more frequent as the temperature increases...Regionally, increases in heavy rainfall are expected to be less evident in regions where mean rainfall is projected to decline...such as southern Australia.⁵⁷

2.43 At the same, the CSIRO submitted that 'increases in extreme daily rainfall are expected over most of the continent in the future'.⁵⁸ The committee was also advised that there is emerging evidence that high intensity, short-duration rainfall bursts, which lead to flash flooding, may be increasing in intensity.⁵⁹

2.44 In Tasmania, the Antarctic Climate and Ecosystems Cooperative Research Centre (CRC) noted that it had conducted a detailed analysis of future extreme events. In relation to rainfall, this analysis found that:

There will [be] more frequent and more intense extreme rainfall events interspersed with longer dry periods of no rain. It is projected that there will be an increase of about 25% in the number of days of extremely high rainfall in both the south west and north east of Tasmania. Peak intensity rainfall events are projected to increase across Tasmania, leading to increased flash flooding. Accompanying this increased intensity of rainfall will be a decrease in the total number of rain days, and thus longer periods between rain events.⁶⁰

2.45 The centre further noted that extreme and record rainfall events are projected to become more frequent:

...in some places a 1:200 year event will become a 1:20 year event. Flooding in the Mersey, Forth and Huon Rivers is expected to increase significantly.⁶¹

Bushfires

Trends

2.46 Recent devastating bushfire seasons in Australia have been outlined in Chapter 1. The committee heard that bushfire danger is likely to increase in the future, and the bushfire season is likely to be longer, particularly as result of the projected increases in hot days and droughts.

2.47 The Bureau of Meteorology explained that:

57 Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 29.

58 CSIRO, *Submission 93*, p. 3 and also p. 12.

59 Dr Seth Westra, Dr Michael Leonard, Dr Mark Thyer and Professor Martin Lambert (University of Adelaide), *Submission 44*, p. 3; see also Professor Nathaniel Bindoff, Antarctic Climate and Ecosystems CRC, *Committee Hansard*, 10 April 2013, p. 24.

60 Antarctic Climate and Ecosystems CRC, *Submission 160*, p. 1.

61 Antarctic Climate and Ecosystems CRC, *Submission 160*, p. 2; see also Dr Anthony Press, Antarctic Climate and Ecosystems CRC, *Committee Hansard*, 10 April 2013, p. 23.

Fire is a natural part of the Australian environment, with some areas (particularly southern and eastern Australia) being prone to catastrophic bushfires. Bushfire threat is typically associated with high temperatures, low humidity, strong winds and high fuel load. Bushfires become catastrophic when all of these conditions occur in combination...⁶²

Projections

2.48 The committee received evidence that the projected increases in hot days and in consecutive dry days and droughts will lead to increased frequencies of days with extreme fire danger.⁶³ For example, the Australian Academy of Science observed that 'there is a clear observed association between extreme heat and catastrophic bushfires'.⁶⁴ And that:

A rise of a few degrees in mean temperature would greatly increase the number of days of extreme heat and extreme or catastrophic bushfire risk, for example from a few days to tens of days per year in southern and eastern Australia.⁶⁵

2.49 The Bureau of Meteorology agreed that:

Projected rising temperatures and likely decreases in winter and spring rainfall across southern Australia...will also contribute to an increased bushfire threat. In addition, climate modelling shows the potential for an increase in the frequency of the summer-time weather systems that are associated with the most extreme and damaging bushfire activity in south-eastern Australia. However, the change in future fire activity is more difficult to determine because fire behaviour depends also on fuel type and accumulation, which may change in the future due to changes in rainfall, fire frequency and other factors.⁶⁶

2.50 CSIRO noted its projections that warmer and drier conditions are expected in future over southern and eastern Australia, and that 'consequently, an increase in fire weather risk is likely, with more days of extreme risk and a longer fire season'.⁶⁷

62 BoM, *Submission 65*, p. 12; see also CSIRO, *Submission 93*, p. 8; Bushfire CRC, *Submission 71*, p. 1; Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 10; Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 41.

63 ARC Centre of Excellence for Climate System Science, *Submission 57*, p. 7; Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 10; Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 42; Bushfire CRC, *Submission 71*, p. 2.

64 Australian Academy of Science, *Submission 1*, p. 5; The Climate Institute, *Submission 105*, p. 1 and Attachment 1: Lucas, C., K. Hennessy, G. Mills and J. Bathols, 'Bushfire weather in southeast Australia: recent trends and projected climate change impacts', Bushfire CRC and Australian BoM, September 2007.

65 Australian Academy of Science, *Submission 1*, p. 7.

66 BoM, *Submission 65*, p. 12. Note the original quote contains a number of footnoted references. See also Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 10.

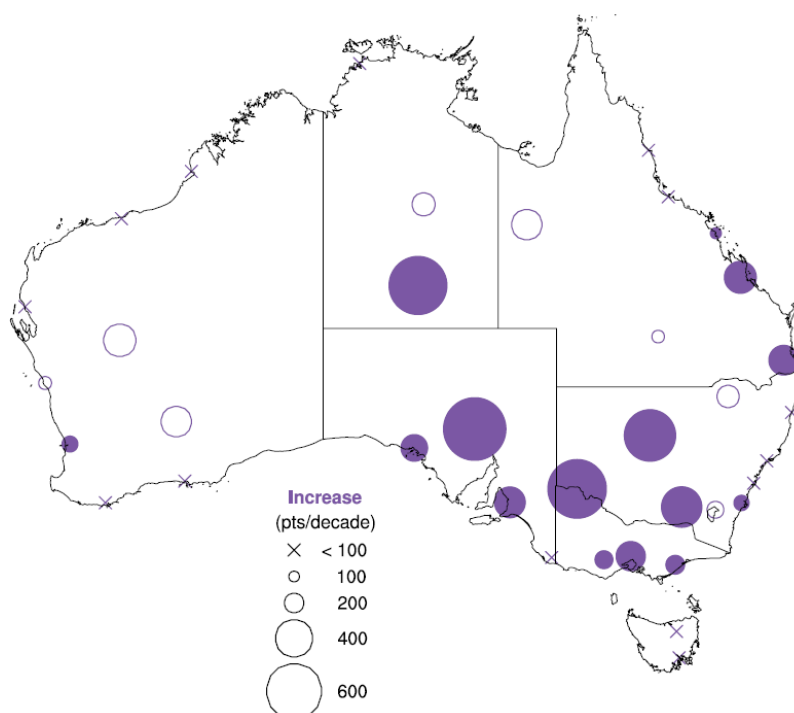
67 CSIRO, *Submission 93*, p. 14.

2.51 The Conservation Council of Western Australia (CCWA) submitted its concern that the drying trend in southwest Western Australia will result in increased risk of bushfire:

...with WA's southern forests becoming more vulnerable to fire events as they dry out and certain woodland flora (e.g., the Karri forests, which require average rainfall of over 1250ml a year in order to survive) are rendered marginal.⁶⁸

2.52 Several submissions also pointed to the annual cumulative Forest Fire Danger Index (FFDI), which essentially 'sums' daily fire weather danger across the year. For example, the Bureau of Meteorology noted that the FFDI has 'increased *significantly* across many Australian locations since the 1970s'⁶⁹ (see Figure 2.2). It was also pointed out that the number of locations with significant increases is greatest in the southeast of Australia, while the strongest trends occurred inland rather than near the coast.⁷⁰

Figure 2.3: Trends in annual cumulative Forest Fire Danger Index⁷¹



2.53 The ARC Centre of Excellence for Climate System Science explained that:

68 Conservation Council of Western Australia, *Submission 100*, p. 2.

69 BoM, *Submission 65*, p. 12; Dr Karl Braganza, BoM, *Committee Hansard*, 11 April 2013, p. 55; Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 41.

70 BoM, *Submission 65*, p. 12; see also CSIRO, *Submission 93*, p. 8; ARC Centre of Excellence for Climate System Science, *Submission 57*, pp 4 and 7; Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 10.

71 Source: Clarke, H., Lucas, C and Smith, P., 'Changes in Australian fire weather between 1973 and 2010', *International Journal of Climatology*, 2012; from BoM, *Submission 65*, p. 13; see also CSIRO, *Submission 93*, p. 8.

...in summer rainfall-dominated tropical north-east Australia, mean and extreme FFDI are projected to decrease or remain close to 20th century levels;

...in south-east continental Australia, FFDI is projected to increase strongly by 2100;

...the fire season is projected to start earlier in [south-east Australia], potentially leading to a longer overall fire season.⁷²

2.54 Several submissions noted that the largest increases in seasonal FFDI have occurred during spring and autumn, which indicates a longer fire season.⁷³

2.55 The committee also heard that, following the Black Saturday bushfires in Victoria, a new fire risk category of 'catastrophic' had been added to fire danger indicators to allow for conditions that were 'off the record'.⁷⁴

Tropical cyclones

Trends

2.56 Tropical cyclones are defined as:

...low pressure systems that form over warm, tropical waters and have gale force winds (sustained winds of 63km/h or greater and gusts in excess of 90km/h near the centre)... The gale force winds can extend hundreds of kilometres from the cyclone centre.⁷⁵

2.57 The Bureau of Meteorology reported that, on average, the Australian region experiences about 11 tropical cyclones per year, but the number varies significantly from year to year.⁷⁶

2.58 The committee heard that there is no evidence of significant trends in the total numbers of tropical cyclones in the Australian region.⁷⁷ In particular, the Bureau of Meteorology submitted that the 'relatively short time span of consistent records,

72 ARC Centre of Excellence for Climate System Science, *Submission 57*, p. 7.

73 BoM, *Submission 65*, p. 12; CSIRO, *Submission 93*, p. 8; Dr Karl Braganza, BoM, *Committee Hansard*, 11 April 2013, p. 55; ARC Centre of Excellence for Climate System Science, *Submission 57*, p. 7.

74 Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 10.

75 BoM, *About Tropical Cyclones*, at: <http://www.bom.gov.au/cyclone/about/> (accessed 14 June 2013).

76 BoM, *Submission 65*, p. 19.

77 CSIRO, *Submission 93*, p. 8.

combined with high year-to-year variability, makes it difficult to discern any clear trends in tropical cyclone frequency or intensity for the Australian region'.⁷⁸

2.59 On the other hand, Mr Jeff Callaghan from Green Cross Australia observed that tropical cyclones in Queensland are affected by multi-decadal cycles such as the Interdecadal Pacific Oscillation, and that the second half of the 19th century was a much more active period for cyclones than the 20th century.⁷⁹

Projections

2.60 Noting the problems with lack of reliable long-term records for cyclones in Australia, the general consensus in evidence to the committee was that cyclones are likely to be more intense in the future, but there is unlikely to be an increase in the overall number of cyclones. For example, Professor Steffen from the Climate Commission told the committee that:

In principle, we are going to see a change in cyclone behaviour, and that is pretty obvious because the sea surface temperature is rising. This means there is more energy in those surface waters, and that is where cyclones draw their energy from. However, the interesting thing is that it looks like we will not have more cyclones—in fact we will either have about the same or perhaps a little fewer...but, on balance, they are going to be more intense when they do occur.⁸⁰

2.61 It was explained that the reason cyclones will be more 'intense' is because the wind speeds will be higher and there will be more rainfall.⁸¹ In terms of the frequency of cyclones, the Climate Commission has explained:

...the vertical gradient in temperature through the atmosphere, that is, the difference between the temperature near the surface of the Earth and the temperature higher up in the atmosphere, is likely to decrease as the atmosphere continues to warm. The formation of tropical cyclones most readily occurs when there are very warm conditions at the ocean surface and when the vertical gradient is strong. As the vertical gradient weakens, it is likely that fewer tropical cyclones will form.⁸²

78 BoM, *Submission 65*, p. 20; see also Mr Peter Davies, Acting Chief Information Officer, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, p. 3; Dr Neville Smith, Deputy Director, Research and Systems, BoM, *Committee Hansard*, 11 April 2013, p. 56; Dr Karl Braganza, BoM, *Committee Hansard*, 11 April 2013, p. 60; Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 41; Australian Meteorological and Oceanographic Society, *Submission 72*, p. 5.

79 Mr Jeff Callaghan, Green Cross Australia, *Committee Hansard*, 22 February 2013, p. 18, see also p. 21.

80 Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 12; Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 56.

81 Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 12; see also Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, pp 55–56.

82 Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 55.

2.62 The Bureau of Meteorology similarly submitted that global climate change projections indicate that 'there will be less tropical cyclones in overall number', but a greater number of particularly intense cyclones. It noted that 'this is consistent with recent findings for the Australian region'.⁸³

2.63 CSIRO agreed that tropical cyclones in northern Australia 'are likely to become more intense with a decrease in frequency'.⁸⁴ CSIRO also noted that sea-surface temperatures are important for cyclone formation, and that sea-surface temperatures have 'been at or near record high values off the western Australian coast in recent years'.⁸⁵ CSIRO also noted that the modelling projections indicate southward movement of around 100km in the 'decay' region of cyclones (the region into which weakened tropical cyclones migrate).⁸⁶ However, Dr Stafford Smith from CSIRO warned that there is a lot of uncertainty as to whether cyclones will move further south.⁸⁷

2.64 At the same time, Insurance Australia Group told the committee that research by its dedicated meteorology team indicated that over the next 50 years, 'the number of the most destructive category 4 and 5 tropical cyclones forming in waters off Eastern Australia could increase and track further south'.⁸⁸

2.65 The committee was told it is difficult to make projections in relation to thunderstorms, because they tend to be very localised.⁸⁹ At the same time, Insurance Australia Group submitted that its research into the future climate impacts of severe hail storms in the Sydney region indicated that there could be 'a doubling of hailstorms with hailstones greater than 10 centimetres in diameter in the greater Sydney region over the next 50 years'.⁹⁰

Storm surges and coastal flooding

Trends

2.66 The committee heard that rising sea levels are likely to cause damage to coastlines by exacerbating coastal flooding and erosion from storm surges and cyclones.

83 BoM, *Submission 65*, p. 20.

84 CSIRO, *Submission 93*, p. 3.

85 CSIRO, *Submission 93*, p. 8.

86 CSIRO, *Submission 93*, p. 14.

87 Dr Mark Stafford Smith, Science Director, CSIRO Climate Adaptation Flagship, *Committee Hansard*, 11 April 2013, p. 55.

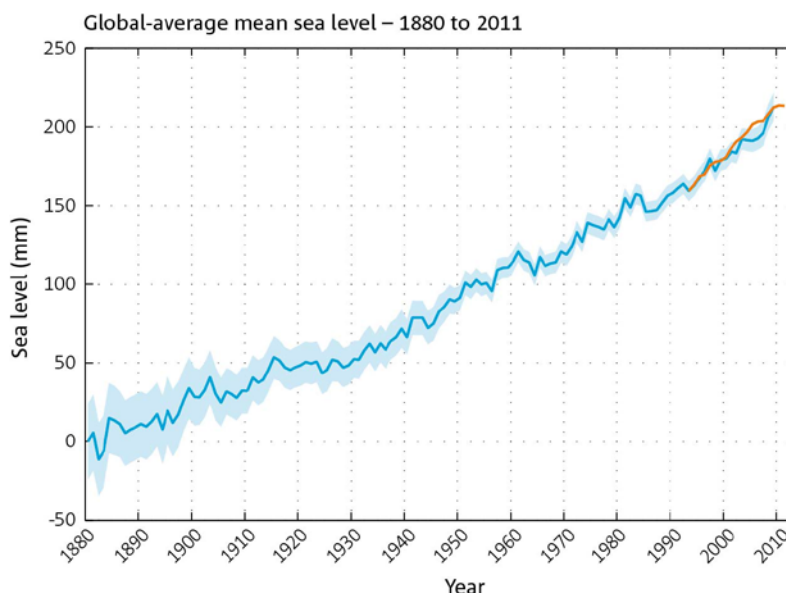
88 Insurance Australia Group, *Submission 144*, p. 14.

89 Australian Meteorological and Oceanographic Society, *Submission 72*, p. 8; see also Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 56.

90 Insurance Australia Group, *Submission 144*, p. 14.

2.67 The Bureau of Meteorology submitted that average sea level globally has risen by around 21cm in total over the last century, and that the rate of sea level rise is now around 3.1mm per year (see Figure 2.4).⁹¹

Figure 2.4: Global average mean sea level: 1880 to 2011⁹²



2.68 The Bureau of Meteorology noted that the projection is for a further average global sea level rise of between 18 and 59 cm by the end of this century, with the eventual rise depending upon the future emissions.⁹³ It was explained that this sea level rise is due to the expansion of ocean water as it warms, and the addition of new water from the melting of land-based ice such as glaciers and ice sheets.⁹⁴

2.69 Around Australia, the observed sea level rise is slightly greater than the global average, although there is considerable variation around the Australian continent. The Bureau of Meteorology noted that rates of sea level rise in northern Australia are

91 BoM, *Submission 65*, p. 20; see also CSIRO, *Submission 93*, p. 9; Australian Academy of Science, *Submission 125*, p. 6; Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 11; Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 47.

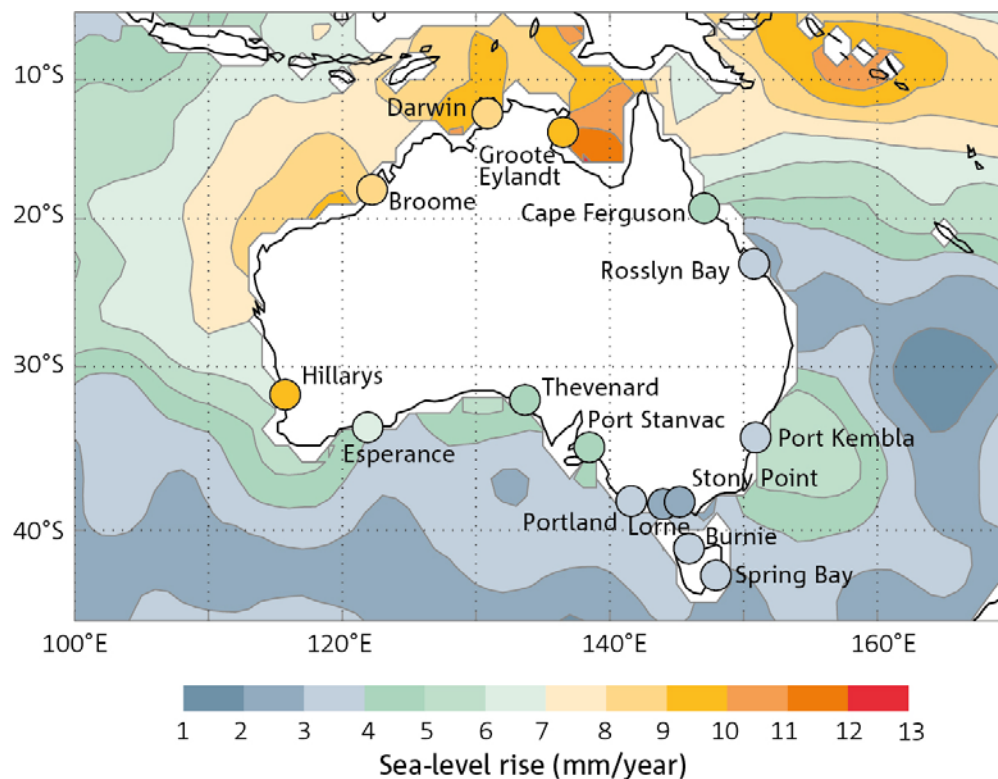
92 BoM, *Submission 65*, p. 21, which states: 'High-quality global sea-level measurements have been available from satellite altimetry since the start of 1993 (red line), in addition to the longer-term records from tide gauges (blue line, with shading providing an indication of the accuracy of the estimates)'. Source: BoM and CSIRO, *State of the Climate 2012*, 2012, Oceans, p. 3.

93 BoM, *Submission 65*, p. 22; see also Australian Academy of Science, *Submission 125*, p. 6; Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 49; Australian Sea Level Rise Partnership, *Submission 172*, p. 1.

94 Australian Sea Level Rise Partnership, *Submission 172*, p. 1; see also Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 49; Dr Andrew Glikson, *Committee Hansard*, 11 April 2013, p. 19.

amongst the highest in the world, with current rates up to 1 cm rise per year (see Figure 2.5).⁹⁵

*Figure 2.5: The rate of sea-level rise around Australia from January 1993 to December 2011*⁹⁶



95 BoM, *Submission 65*, p. 20.

96 As measured by coastal tide gauges (circles) and satellite observations (contours): BoM, *Submission 65*, p. 22; Source: BoM and CSIRO, 2012, *State of the Climate 2012*, Oceans, p. 3, <http://www.csiro.au/en/Outcomes/Climate/Understanding/State-of-the-Climate-2012/Oceans.aspx> (accessed 14 June 2013).

2.70 As Professor Steffen from the Climate Commission noted:

Around the Top End, the rate of sea level rise in Australia is about three times the global average. The Southern Ocean, along the southern coast of Australia, is less than the global average. Around the east coast, it is about the global average.⁹⁷

2.71 Professor Steffen told the committee that 'one of the most certain aspects of climate change is that sea levels are going to rise', but 'there is a lot of uncertainty about how much sea level is going to rise'.⁹⁸ He explained that:

...there is already a lot of heat in the ocean that has not worked its way through the system yet. The water is still expanding in response to that. And then on top of that is we are starting now to get additional water flowing into the ocean from melting glaciers and ice caps.⁹⁹

2.72 The committee heard that rising sea levels will exacerbate coastal flooding and erosion from 'storm surges'. A 'storm surge' is:

...a rise above the normal sea level resulting from strong onshore winds and/or reduced atmospheric pressure. Storm surges accompany tropical cyclones as they make landfall but can also be formed by intense low-pressure systems in non-tropical areas, such as 'East Coast Lows' in the Tasman Sea.¹⁰⁰

2.73 Storm surges can cause extensive flooding of coastal areas, and are worst when they coincide with a particularly high tide.¹⁰¹ Submitters explained that higher sea levels will amplify the effects of storm surges:

The frequency and impacts of coastal flooding from extreme events such as storm surges will be significantly amplified by sea level rise, because the surges take place on a higher background sea level.¹⁰²

2.74 The Bureau of Meteorology submitted that 'it has been estimated that an average sea-level rise of 50 cm will result in a 10-1000 times increase in the frequency of coastal flooding depending on the particular location around the Australian coastline'¹⁰³ (see Figure 2.6).

97 Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 11.

98 Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 11.

99 Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 11.

100 Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 44; see also Griffith Centre for Coastal Management, *Submission 58*, p. 1.

101 Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 44.

102 Australian Academy of Science, *Submission 125*, p. 7; see also Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 44; BoM, *Submission 65*, p. 23; Conservation Council of Western Australia, *Submission 100*, p. 4.

103 BoM, *Submission 65*, p. 23.

Figure 2.6: Projected increase in frequency of flooding events from the sea for a sea-level rise of 0.5m¹⁰⁴



2.75 CSIRO similarly explained that a sea-level rise of 50 cm might mean that:

Extreme events that now happen every 10 years, on average, would happen about every 10 days in 2100, and become even more frequent around Sydney, with smaller increases around Adelaide and along parts of the Western Australian coast.¹⁰⁵

2.76 Professor Steffen noted that these effects are already being observed in areas with reliable records, such as Fremantle and Fort Denison in Sydney, where there has been about a threefold increase in flooding events since 1950.¹⁰⁶ The Climate Commission has also reported that the Torres Strait Islands are also increasingly vulnerable to flooding as a result of increases in sea levels.¹⁰⁷

104 BoM, *Submission 65*, p. 24.

105 CSIRO, *Submission 93*, p. 15, citing Department of Climate Change, *Climate Change Risks to Australia's Coast: A First Pass National Assessment*, 2009; see also Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 51; see also Conservation Council of Western Australia, *Submission 100*, p. 4.

106 Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 11.

107 Climate Commission, *The Critical Decade 2013: Climate Change Science, Risks and Responses*, June 2013, p. 74; Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 48.

2.77 Another concern related to the increased risk of severe coastal flooding events where coastal settlements are inundated by water from both seaward and landward directions. That is, where there is a combined impact from:

- (i) the combination of storm surge, a high tide and a higher sea level, and
- (ii) flooding rivers from the catchments behind the settlements.¹⁰⁸

2.78 For example, the Climate Commission noted that:

Little research has yet been done to connect these two phenomena and produce an overall change in risk factor for this type of 'double whammy' coastal flooding event. However, the rises in sea level over the 21st century, which are virtually certain, coupled with the projections of a modest increase in the frequency of heavy rainfall events for southern Australia suggest that the risk of these 'double whammy' flooding events will increase.¹⁰⁹

2.79 The Bureau of Meteorology also submitted that, due to higher sea levels, weak to moderate strength tropical cyclones will be likely to generate more coastal flooding than at present, and severe cyclones are more likely to result in very serious damage to coastlines through flooding and erosion associated with storm surges.¹¹⁰

2.80 The committee heard concerns about the impacts of sea level rise in certain states. For example, in Tasmania, analysis of future extreme weather events found that an increase in mean sea level of between 5 and 14 cm by 2030 will lead to:

...1:100 year storm tide events doubling in frequency. By the end of the 21st century the 1:100 storm tide is projected to be an annual event for higher emissions scenarios...The addition of more intense rainfall events will exacerbate the impacts of sea-level rise on flooding in rivers (and vice versa).¹¹¹

2.81 The Northern Territory Police, Fire and Emergency Services advised that they had done some storm surge mapping of the Darwin area which took into account probable sea level rises over the next 50 to 100 years. This mapping indicated that

108 Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 51; see also Insurance Australia Group, *Submission 144*, pp 13–14; Antarctic Climate and Ecosystems CRC, *Submission 160*, p. 2 and Attachment 3.

109 Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 51.

110 BoM, *Submission 65*, p. 24; Source: Hunter, J., Allison, I. and Jakszewicz, T. C., *ACE CRC Report Card: Sea-Level Rise 2012*, Antarctic Climate and Ecosystems CRC, Hobart, Australia, 2012.

111 Antarctic Climate and Ecosystems CRC, *Submission 160*, p. 2 and Attachment 3; see also Dr Anthony Press, Antarctic Climate and Ecosystems CRC, *Committee Hansard*, 10 April 2013, p. 23.

some remote communities may 'go under in a big storm surge event ... [but] the effect on Darwin is not really that great'.¹¹²

Uncertainties in future projections

2.82 There was some discussion during the committee's inquiry about uncertainty in terms of projections of future extreme weather events. However, little uncertainty was expressed about the fact that the climate is changing, and that these changes are being influenced by anthropogenic forces. For example, Dr Glikson told the committee that 'ninety-five point five per cent of the peer-reviewed literature on which the science is based agrees about the effect of greenhouse gases'.¹¹³

2.83 CSIRO submitted that the two main areas of uncertainty relating to the projections of future climate are:

...the level of humanity's future greenhouse gas and aerosol emissions; and the response of the Earth's climate system to those emissions. These uncertain factors will affect the speed and extent of expected climate change.¹¹⁴

2.84 The Bureau of Meteorology agreed that the rate and magnitude of future changes to climate will be determined by the future level of greenhouse gas emissions, 'and a series of complex environmental feedbacks'.¹¹⁵

2.85 The committee heard that there is uncertainty about the specific impacts of climate change—that is, 'how will extreme events change: where will they change, when will they change and what will be the combination'?¹¹⁶

2.86 Dr Stafford Smith from the CSIRO told the committee that:

...the details of future climate change are often perceived as imponderably uncertain, but in reality we have got very high confidence that change is actually happening. Indeed, some variables such as rising temperature extremes are much more certain for the future than others, and even for the ones which are less certain there are a whole range of risk mitigation approaches which are widely used in society in other contexts which are appropriate for different sorts of uncertainty.¹¹⁷

2.87 The committee was told that the IPCC uses standard terminology to communicate the degree of uncertainty in its projections of the impacts of climate

112 Mr Peter Davies, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, p. 1.

113 Dr Andrew Glikson, *Committee Hansard*, 11 April 2013, p. 18; see also Dr Anthony Kiem, *Committee Hansard*, 11 April 2013, p. 19; CSIRO, *Submission 93*, p. 4.

114 CSIRO, *Submission 93*, p. 10; see also Mr Ian Dunlop, *Submission 86*, p. 4.

115 BoM, *Submission 65*, p. 2.

116 Dr Anthony Kiem, *Committee Hansard*, 11 April 2013, p. 19.

117 Dr Mark Stafford Smith, CSIRO, *Committee Hansard*, 11 April 2013, p. 53; see also CSIRO, *Submission 93*, p. 5.

change.¹¹⁸ For example, the level of confidence in the evidence is expressed using the qualifiers 'very low, low, medium, high and very high'.¹¹⁹ The likelihood of a particular outcome is expressed in terms of probability as set out in Table 2.1 below.

Table 2.1: Terms used by the IPCC to indicate the assessed likelihood¹²⁰

Term	Likelihood of the outcome
<i>Virtually certain</i>	99-100% probability
<i>Very likely</i>	90-100% probability
<i>Likely</i>	66-100% probability
<i>About as likely</i>	33-66% probability
<i>Unlikely</i>	0-33% probability
<i>Very unlikely</i>	0-10% probability
<i>Exceptionally unlikely</i>	0-1% probability

2.88 So the IPCC has stated that, for example:

- It is *virtually certain* that increases in the frequency and magnitude of warm daily temperature extremes and decreases in cold extremes will occur in the 21st century at the global scale;
- It is *very likely* that the length, frequency, and/or intensity of warm spells or heat waves will increase over most land areas;...
- It is *likely* that the frequency of heavy precipitation or the proportion of total rainfall from heavy falls will increase in the 21st century over many areas of the globe;...
- there is *medium confidence* that droughts will intensify in the 21st century in some seasons and areas, due to reduced precipitation and/or increased evapotranspiration;...
- it is *very likely* that mean sea level rise will contribute to upward trends in extreme coastal high water levels in the future; [and]
- There is *high confidence* that locations currently experiencing adverse impacts such as coastal erosion and inundation will continue to do so in

118 See also Professor Neville Nicholls, *Submission 1*, pp 1–4 and *Committee Hansard*, 20 February 2013, p. 8; CSIRO, *Submission 93*, p. 5; IPCC SREX, 2012, p. 21.

119 The IPCC also uses the terms 'limited, medium or robust' to describe the available evidence, and the degree of agreement about the evidence is expressed as 'low, medium or high'.

120 See CSIRO, *Submission 93*, p. 5; IPCC SREX, 2012, p. 21.

the future due to increasing sea levels, all other contributing factors being equal.¹²¹

2.89 Professor Nicholls explained that:

We are confident, for instance, that a hot day that occurs only about once every 20 years currently will occur about every year or two by the end of the century in most parts of the world. On the other hand, although heavy rainfall days are expected to become more frequent and heavier, the magnitude of the change is expected to be much less than for temperature. We are also less confident about this rainfall projection. The actual increase may be substantially more or less than our current expectation. These uncertainties can complicate the development of ways to adapt to our changing climate.¹²²

2.90 In terms of projections for Australia, the committee heard that the level of confidence also varies depending on the particular climate variable. For example, the general consensus before the committee was that there is a high degree of confidence in the projections about temperatures, but less confidence in rainfall.¹²³ In particular, uncertainty was expressed about whether 'flood risk will increase or decrease in the majority of Australia'.¹²⁴ Similarly, there is some uncertainty about the future frequency and intensity of tropical cyclones in Australia.¹²⁵

2.91 The uncertainty in the area of rainfall was attributed to higher natural variability in rainfall in Australia due to influences such as the El Niño Southern

121 IPCC SREX, 2012, pp 13 and 15 (and see Chapter 1 for more information on the findings of the IPCC SREX); see also Professor Neville Nicholls, *Submission 1*, p. 8; and Australian Meteorological and Oceanographic Society, *Submission 72*, pp 3–4.

122 Professor Neville Nicholls, *Committee Hansard*, 20 February 2013, p. 7.

123 See, for example, CSIRO, *Submission 93*, p. 5; Dr Anthony Kiem, *Committee Hansard*, 11 April 2013, p. 13; Dr Karl Braganza, BoM, *Committee Hansard*, 11 April 2013, pp 54 and 60; Dr Blair Trewin, President, Australian Meteorological and Oceanographic Society, *Committee Hansard*, 20 February 2013, p. 20; Australian Meteorological and Oceanographic Society, *Submission 72*, p. 6; ARC Centre of Excellence for Climate System Science, *Submission 57*, p. 6; Professor Neville Nicholls, *Committee Hansard*, 20 February 2013, p. 7; Dr Seth Westra, Dr Michael Leonard, Dr Mark Thyer and Professor Martin Lambert (University of Adelaide), *Submission 44*, p. 3.

124 Dr Seth Westra, Dr Michael Leonard, Dr Mark Thyer and Professor Martin Lambert (University of Adelaide), *Submission 44*, p. 4; see also BoM, *Submission 65*, p. 19.

125 BoM, *Submission 65*, p. 20.

Oscillation.¹²⁶ The committee was told that climate models 'do not currently realistically simulate' these natural cycles.¹²⁷

Areas needing more research and analysis

2.92 The committee heard that there are areas where the knowledge and data is good, while other areas need further research and analysis.

2.93 In terms of collection of information and observations about weather, the committee was told that Australia generally has very good temperature records, rainfall measurements, and sea level records going back 100 years in places.¹²⁸ For example, Dr Neville Smith of the Bureau of Meteorology described Australia's climate records as 'pretty sound and robust, though perhaps not to the detail that we want in some regions'.¹²⁹ He also stated that Australia has 'both world-class weather forecast models and world-class climate models'.¹³⁰

2.94 Several submitters and witnesses emphasised the need for continued support for the work of existing organisations such as the Bureau of Meteorology, CSIRO, and the Bushfire CRC. For example, witnesses welcomed the work of the Bushfire CRC in relation to bushfires, and the recent announcement of \$47 million in funding to turn the Bushfire CRC into the Bushfire and Natural Hazards CRC.¹³¹ Similarly, the Australian Meteorological and Oceanographic Society submitted that:

Long-term, consistent, high-quality sets of observed climate are critical to the detection of climate change. Many of these observations are derived from the Bureau of Meteorology's routine observing network. Australia is a world leader in the development of such data sets but their continuation is dependent on the existence of a high-standard observations network, and the availability of adequate resources to maintain that network at a high standard.¹³²

126 See, for example, Professor Will Steffen, Climate Commission, *Committee Hansard*, 7 June 2013, p. 11; Climate Commission, *The Critical Decade: Extreme Weather*, April 2013, p. 28; Australian Academy of Science, *Submission 125*, p. 5; Dr Andrew Glikson, *Committee Hansard*, 11 April 2013, p. 13; Dr Blair Trewin, Australian Meteorological and Oceanographic Society, *Committee Hansard*, 20 February 2013, p. 20; Dr Karl Braganza, BoM, *Committee Hansard*, 11 April 2013, p. 54.

127 Dr Anthony Kiem, *Committee Hansard*, 11 April 2013, p. 13.

128 Dr Neville Smith, BoM, *Committee Hansard*, 11 April 2013, p. 56; Dr Karl Braganza, BoM, *Committee Hansard*, 11 April 2013, p. 60; see also Dr Blair Trewin, Australian Meteorological and Oceanographic Society, *Committee Hansard*, 20 February 2013, p. 21; Australian Meteorological and Oceanographic Society, *Submission 72*, pp 7, 9.

129 Dr Neville Smith, BoM, *Committee Hansard*, 11 April 2013, p. 56.

130 Dr Neville Smith, BoM, *Committee Hansard*, 11 April 2013, p. 58.

131 Mr Gary Morgan, Chief Executive Officer, Bushfire CRC, *Committee Hansard*, 20 February 2013, pp 13-14; Mr Paul Considine, Manager Operations, Australasian Fire and Emergency Services Authorities Council, *Committee Hansard*, 20 February 2013, p. 5.

132 Australian Meteorological and Oceanographic Society, *Submission 72*, p. 9.

2.95 The Wentworth Group of Scientists told the committee that:

We should harness the high-quality science that this country has invested in over many years to improve our emergency response capabilities to manage extreme weather by improving our capability to predict and monitor the movement and intensity of these weather systems in real time, whether it be droughts, cyclones, bushfires, floods or storm surges.¹³³

2.96 Professor Nicholls expressed the view that improved weather forecasts are a good way to reduce the deleterious impacts of weather and climate extremes.¹³⁴ Similarly, the Bureau of Meteorology submitted that:

Early warning systems have proven time and time again to be the most effective and cost efficient approach to mitigating economic losses and loss of life arising from severe weather.¹³⁵

2.97 The committee notes that the Commonwealth government recently conducted an independent review on the Bureau of Meteorology's capacity to respond to future extreme weather and natural disaster events and to provide seasonal forecasting services. That review made a number of recommendations including, for example, the need to improve the arrangements for flood monitoring, forecasting and warning across Australia. The Bureau noted that 'the government is currently giving consideration to the recommendations of this review'.¹³⁶ The Bureau also noted in its submission that there are coordination issues in relation to flood river level monitoring, and also flash flood warnings.¹³⁷ This is discussed further in Chapter 5.

2.98 The committee heard that there are some areas needing further research. For example, the committee heard that there is a gap in knowledge when it comes to predicting cyclones in Australia. For example, Australian records for tropical cyclones rely on satellites which only go back to the seventies and eighties, and therefore there is only a small sample size.¹³⁸ So, for example, WWF-Australia and the Northern Territory emergency services expressed the view that 'more research is required to reduce the levels of uncertainty' around the projections in relation to tropical cyclones in Australia.¹³⁹ Mr Peter Davies of the Northern Territory Police, Fire and Emergency Services told the committee that many of the models being used to predict the impact

133 Mr Peter Cosier, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 29.

134 Professor Neville Nicholls, *Submission 1*, p. 5 and see also p. 1.

135 BoM, *Submission 65*, Attachment A, p. 2.

136 BoM, *Submission 44*, p. 26; and Department of Sustainability, Environment, Water, Population and Communities, *Review of the Bureau of Meteorology's extreme weather and forecasting capacity*, at: <http://www.environment.gov.au/about/bom/> (accessed 20 June 2013).

137 BoM, *Submission 44*, pp 28–29.

138 Dr Neville Smith, BoM, *Committee Hansard*, 11 April 2013, p. 56; and Dr Karl Braganza, BoM, *Committee Hansard*, 11 April 2013, p. 60.

139 WWF-Australia, *Submission 124*, p. 5; Mr Peter Davies, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, p. 3.

of climate change are based on American models of cyclones that haven't been tested in the Australian environment.¹⁴⁰

2.99 Similarly, Insurance Australia Group submitted that:

...there are extremely few measurements of the intensity/central pressure, eye size and radius of storm force winds and storm surges of tropical cyclones, despite their potential to inflict extreme damage on communities near their paths. In the USA there is a routine program of aerial reconnaissance to quantify the physical size and intensity of these systems but there is no similar program in Australia.¹⁴¹

2.100 However, the committee heard cyclone prediction has improved in recent years due to advances in computing. Dr Smith from the Bureau of Meteorology provided some recent examples:

If you took us back 10 years, we could not have given the forecast for tropical cyclone Yasi, simply because we did not have the computers. Now both we and other weather agencies have the ability to do tropical cyclone Yasi—and Rusty was the most recent example, off the North-West Gulf—five or even seven days out.¹⁴²

2.101 Further improvements to supercomputing power would allow for high resolution analysis and could improve forecasting of extreme weather events. Such analysis would focus on:

the probabilities; ... the spread of possible outcomes, so you can start to give some guidance about the likelihood that a certain community might be impacted more heavily or less heavily than another community.¹⁴³

2.102 Indeed, several submitters and witnesses, particularly local government associations, expressed a desire for more work to be done to provide data and projections for climate change and extreme weather events at a local level.¹⁴⁴ For example, the Australian Conservation Foundation (ACF) submitted that:

Extreme weather events are geographically specific, and not consistent across the nation or even within any one state. Wherever possible, extreme weather trends need to be as granular as possible. Specific sea level inundation assessments for vulnerable cities such as Cairns are good examples of local, specific extreme weather assessments. This level of

140 Mr Peter Davies, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, p. 3.

141 Insurance Australia Group, *Submission 144*, p. 6.

142 Dr Neville Smith, BoM, *Committee Hansard*, 11 April 2013, p. 58.

143 Dr Neville Smith, BoM, *Committee Hansard*, 11 April 2013, p. 59.

144 Dr Adrian Beresford-Wylie, Chief Executive, Australian Local Government Association, *Committee Hansard*, 11 April 2013, p. 1; Local Government Association of Queensland, *Submission 68*, p. 3; see also discussion of this in Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, pp 125–128.

specificity is not found across the nation and across the spectrum of extreme weather types.¹⁴⁵

2.103 Dr Smith from the Bureau of Meteorology told the committee that to get forecasting to a more local level:

[It] just comes down to resolution—how many grid points you can put in your model, and that just depends on the size of the supercomputer.

So there is a decision we have to make with government about how much investment we should put in supercomputing versus the return we get by being able to have higher resolution...¹⁴⁶

2.104 At the same time, the committee heard that work is being done to provide forecasts and projections at regional and local levels.¹⁴⁷ For example, the Australian Meteorological and Oceanographic Society noted that a number of regional assessments of climate change impacts have been produced, including:

- the Indian Ocean Climate Initiative (for Western Australia);¹⁴⁸
- Climate Futures for Tasmania;¹⁴⁹ and
- the South-Eastern Australian Climate Initiative.¹⁵⁰

2.105 However, the Australian Meteorological and Oceanographic Society noted that:

Neither IOCI nor SEACI, which were both joint projects involving various Commonwealth and State agencies, have received ongoing funding and both have been, or are in the process of being, wound up, which is a concern for the future availability of regionally-specific assessments.¹⁵¹

2.106 In terms of regional and local projections, the Griffith Centre for Coastal Management submitted information about its research project to produce a pilot real-time storm surge forecasting system for Queensland.¹⁵² They identified a number of constraints and actions that would improve the accuracy of such forecasting, including

145 Australian Conservation Foundation, *Submission 36*, p. 2.

146 Dr Neville Smith, BoM, *Committee Hansard*, 11 April 2013, p. 58; see also BoM, *Submission 65*, Attachment A.

147 Dr Blair Trewin, Australian Meteorological and Oceanographic Society, *Committee Hansard*, 20 February 2013, p. 20; Ms Mara Bunn, Chief Executive Officer, Green Cross, *Committee Hansard*, 22 February 2013, p. 17; Griffith Centre for Coastal Management, *Submission 58*, p. 1.

148 See further: www.ioci.org.au (accessed 20 June 2013).

149 See further: http://www.dpac.tas.gov.au/divisions/climatechange/adapting/climate_futures (accessed 20 June 2013); and Antarctic Climate and Ecosystems CRC, *Submission 125*, p. 1. Noted that some of the results of this initiative have been discussed in this chapter.

150 See further: www.seaci.org (accessed 20 June 2013).

151 Australian Meteorological and Oceanographic Society, *Submission 72*, pp 2–3.

152 Griffith Centre for Coastal Management, *Submission 58*, p. 1.

improvements to data availability and collection in terms of bathymetry,¹⁵³ wind, wave and water level measurements; and further research into the dynamics of storm surge propagation through the Great Barrier Reef.¹⁵⁴ For example, the Griffith Centre suggested that 'Australia's network of storm tide gauges is sparse relative to the length of coastline and the expanding vulnerable population'.¹⁵⁵

2.107 However, the committee notes that the Queensland government reported that Queensland has 25 fully operational storm surge monitoring gauges.¹⁵⁶

2.108 Others gaps in Australia's observation network were also identified. For example, Dr Todd Lane from the Australian Meteorological and Oceanographic Society noted that there are gaps in Australia's radar network:

The Bureau of Meteorology have expanded their radar network considerably in recent years and are still expanding the network, but along the coastlines there are still gaps in coverage. There are places in Far North Queensland which do not receive any radar coverage at all and parts of the Northern Territory as well. There are these sizeable gaps in the radar network when you compare it to other countries. The UK is entirely covered by radar. In the US there are only a couple of small gaps around the country. But Australia has some very large gaps. If we are talking about major investment in infrastructure for detecting flooding rains, radar could be one of those things.¹⁵⁷

2.109 The committee also heard that more research is needed on the interaction between human-induced climate change and large-scale natural climate variations, such as the El Niño/Southern Oscillation and the Pacific Decadal Oscillation/Interdecadal Pacific Oscillation.¹⁵⁸ Others emphasised the need for more research in the area of rainfall and the drivers of floods and drought. For example, Dr Anthony Kiem told the committee that research funding is needed to increase understanding of

153 'Bathymetry' is the study and mapping of seafloor topography. It involves obtaining measurements of the depth of the ocean and is equivalent to mapping the topography on land: See further Geoscience Australia, *Bathymetry*, at: <http://www.ga.gov.au/marine/bathymetry.html> (accessed 24 June 2013).

154 Griffith Centre for Coastal Management, *Submission 58*, pp 4–5; see also Professor Rodger Tomlinson, Director, Griffith Centre for Coastal Management, Griffith University, *Committee Hansard*, 22 February 2013, p. 24.

155 Griffith Centre for Coastal Management, *Submission 58*, p. 6.

156 Letter from The Hon Ros Bates MP, Minister for Science, Information Technology, Innovation and the Arts, Queensland Government dated 30 January 2013.

157 Dr Todd Lane, Vice President, Australian Meteorological and Oceanographic Society, *Committee Hansard*, 20 February 2013, p. 22.

158 Mr Jeff Callaghan, Green Cross Australia, *Committee Hansard*, 22 February 2013, pp 18 and 22; Dr Anthony Kiem, *Submission 5*, pp 1–2; Professor Stewart Franks, *Submission 102*, p. 1.

'the drivers of flood and drought risk in Australia...especially at the local or catchment scale'.¹⁵⁹ Others agreed that:

There is currently a lack of substantive research into understanding how the interaction of likely increases in flood-producing rainfall and the net drying of catchments will increase future flood risk...¹⁶⁰

2.110 In terms of rainfall records, Dr Blair Trewin from the Australian Meteorological and Oceanographic Society informed the committee that:

For remoter areas, records are often short term and, perhaps surprisingly, some of the coastal areas are not as good for rainfall records as they could be—sites have moved around and that sort of thing.¹⁶¹

2.111 The Australian Meteorological and Oceanographic Society suggested that 'the potential exists to reduce such data voids through the strategic opening of new stations'.¹⁶² Others identified a need for more rain gauges to help predict flash flood warnings.¹⁶³

2.112 Insurance Australia Group called for more work in the area of storm surges:

...the threat of storm surge for most parts of Australia has been limited to simple sea level rise scenarios rather than taking into account potential changes in the weather systems likely to produce a storm surge and the detailed bathymetry and coastal zone features that will modify and, in some cases, increase the threat of storm surge in coastal regions.

There is a need to more accurately quantify the risks facing properties in coastal and estuarine regions, particularly in locations where there is a merging of the riverine floods with coastal storm surge effects.¹⁶⁴

2.113 Insurance Australia Group further noted that there has been 'no thorough investigations into likely changes in the distribution or seasonality of severe storms in the future' and that:

This research, with the involvement of the insurance industry, is very important if our major urban centres are to be made more resilient to the impacts of these storms in the future.¹⁶⁵

159 Dr Anthony Kiem, *Committee Hansard*, 11 April 2013, p. 13; see also Australian Meteorological and Oceanographic Society, *Submission 72*, p. 7.

160 Dr Seth Westra, Dr Michael Leonard, Dr Mark Thyer and Professor Martin Lambert (University of Adelaide), *Submission 44*, p. 3.

161 Dr Blair Trewin, Australian Meteorological and Oceanographic Society, *Committee Hansard*, 20 February 2013, p. 21; see also Australian Meteorological and Oceanographic Society, *Submission 72*, pp 7, 9.

162 Australian Meteorological and Oceanographic Society, *Submission 72*, p. 9.

163 Mr Paul Considine, Australasian Fire and Emergency Services Authorities Council, *Committee Hansard*, 20 February 2013, p. 2.

164 Insurance Australia Group, *Submission 144*, pp 13–14.

Committee comment

2.114 The committee recognises the evidence that climate change is likely to increase the frequency and intensity of extreme weather events in the coming decades. The committee also recognises the fundamental importance of being able to predict and monitor extreme weather to enable us to manage and improve our capability to respond to future extreme weather events. In this respect, the committee commends organisations such as the Bureau of Meteorology and CSIRO for their excellent work in this area. The committee considers that this work is fundamental to Australia's future planning to manage extreme weather events and in relative terms Australia is very well served by the extent of work already undertaken. The committee therefore recommends that the Commonwealth government, through the Bureau of Meteorology and CSIRO, continue to support data collection and research to improve forecasting of extreme weather events, especially early warning capabilities.

Recommendation 1

2.115 The committee recommends that the Commonwealth government, through the Bureau of Meteorology and CSIRO, continues to support data collection and research to improve forecasting of extreme weather events, especially early warning capabilities.

2.116 The committee also heard that there is a need for more data and research to make predictions at a more local level for future planning purposes. On that basis, the committee recommends that the Bureau of Meteorology and CSIRO continue their work to improve projections and forecasts of extreme weather events at a more local level, especially in relation to events such as flooding or storm surges.

Recommendation 2

2.117 The committee recommends that the Bureau of Meteorology and CSIRO continue to improve projections and forecasts of extreme weather events at a more local level.

2.118 The committee notes that a number of areas for further research were identified during the course of the committee's inquiry. In particular, the committee acknowledges that there is a need to conduct further research to improve understanding of the interaction between large-scale natural climate variations, climate change and extreme weather events.

The committee recognises that there are areas where there is a high degree of confidence in the projections of future extreme weather, particularly in relation to future temperatures. However, there are other areas where there is less confidence and further research is needed, particularly in relation to changes to future rainfall patterns and the associated floods and droughts. There is also uncertainty in relation to the implications of climate change for tropical cyclones in Australia. The committee therefore recommends that the Bureau of Meteorology and CSIRO conduct further

165 Insurance Australia Group, *Submission 144*, p. 14; see also Australian Meteorological and Oceanographic Society, *Submission 72*, p. 8.

research to increase understanding in these areas and that Australia cooperatively engage, where appropriate, with international research initiatives in these areas.

Recommendation 3

2.119 The committee notes the linkage between climate change and extreme weather events and recommends that the Bureau of Meteorology and CSIRO conduct further research to increase understanding in the areas of:

- **the interaction between large-scale natural variations, climate change and extreme weather events;**
- **the impacts of climate change on rainfall patterns and tropical cyclones; and**
- **that Australia cooperatively engage, where appropriate, with international research initiatives in these areas.**

Chapter 3

Costs and impacts of extreme weather events

3.1 The costs and impacts of extreme weather events are wide-reaching, ranging from the financial costs incurred by governments, businesses and households to the impacts on the physical and psychological health of those individuals who have experienced such natural disasters.

3.2 As outlined in the previous two chapters, droughts, bushfires, floods, storms and heatwaves are just some of the extreme weather events that have affected Australia over recent decades. The extent of these extreme events means that many Australians have experienced and in some way been affected by them. These events damage and destroy homes, livestock, crops, infrastructure and ecosystems. Exposure to these disasters is not just related to climate change, with Australians becoming increasingly vulnerable to extreme weather events as the population grows and expands across the continent. This means the costs and impacts of extreme weather events can be expected to increase into the future.

3.3 Financial costs can broadly be divided into preventative/risk-management costs, which are incurred prior to an event, and post-event costs, which are incurred after an extreme weather event, and include the cost of reconstruction following a natural disaster, losses from business interruption and compensation. This chapter considers post-event financial costs, impacts on physical and psychological health, other social impacts, particularly on vulnerable members of the community, and impacts on the environment.

Financial costs of extreme weather events

3.4 Estimates of the cost of extreme weather events are usually taken from insurance data or figures of government spending. These estimates of cost can be vastly different depending upon the methodology used, however, all estimates of the cost of extreme weather events show that they cost Australians billions of dollars every year with predictions of costs set to increase in the future.

3.5 The committee heard varying estimates of the total financial cost of extreme weather events in Australia, ranging from approximately \$900 million to \$4 billion annually.¹ The two most frequently quoted figures come from a 2001 report by the former Bureau of Transport Economics (BTE) and a 2008 article by Ryan Crompton and John McAneney.² A number of insurance bodies also submitted to the inquiry

1 For example see Centre for Risk and Community Safety (CRCS), *Submission 59*, pp 5–6; Actuaries Institute, *Submission 67*, p. 1; Green Cross Australia, *Submission 141*, p. 18; and Insurance Australia Group (IAG), *Submission 144*, p. 16.

2 R. Crompton and J. McAneney, 'Normalised Australian insured losses from meteorological hazard: 1967–2006', *Environmental Science and Policy*, vol. 11, 2008. Note that the Bureau of Transport Economics (BTE) is now known as the Bureau of Infrastructure, Transport and Regional Economics (BITRE) and is part of the Commonwealth Department of Infrastructure and Transport.

their estimates of the cost of extreme weather events based on amounts paid by private insurers for property damage.

3.6 The BTE estimated that natural disasters (including earthquakes) cost the Australian community \$37.8 billion in 1999 prices over the period of 1967–1999.³ The average annual cost of these disasters during this period was \$1.14 billion (including the costs of deaths and injuries).⁴ The BTE noted that the average annual cost was strongly influenced by three extreme events: Cyclone Tracy (1974), the Newcastle earthquake (1989) and the Sydney hailstorm (1999).⁵ The BTE found that if these three events are removed from the calculations, the average annual cost declines to \$860 million.⁶

3.7 The BTE also noted that the annual cost of disasters is highly variable:

The annual cost in years in which extreme events do not occur can be as high as \$2.7 billion in 1999 prices. In years in which extreme events occur, the total cost can be much higher. As a result, it is not possible to assess whether the annual cost is increasing or decreasing over time.⁷

3.8 In its calculations, the BTE relied on the Emergency Management Australia (EMA) database which includes insured loss data from the Insurance Council of Australia, plus broader cost estimates from sources such as newspaper reports.⁸

3.9 In their article, *Normalised Australian insured losses from meteorological hazards: 1967–2006*, Crompton and McAneney used insurance claim data to estimate average annual weather-related normalised damage over that 40 year period at \$820 million, with a standard deviation of \$960 million.⁹ Crompton and McAneney normalised their data for inflation, population, wealth and building standards at 2006

3 BTE, *Economic costs of natural disasters in Australia*, Commonwealth of Australia, Canberra, 2001, p. xvi, available at: http://www.bitre.gov.au/publications/2001/files/report_103.pdf (accessed 29 May 2013).

4 BTE, *Economic costs of natural disasters in Australia*, Commonwealth of Australia, Canberra, 2001, p. xvi. Estimated averages costs were \$1.3 million for a fatality, \$317 000 for a serious injury and \$10 600 for a minor injury. The estimated total cost of deaths and injuries during the period 1967–1999 was \$1.4 billion at an average cost of \$41 million per year.

5 BTE, *Economic costs of natural disasters in Australia*, Commonwealth of Australia, Canberra, 2001, p. xvi.

6 BTE, *Economic costs of natural disasters in Australia*, Commonwealth of Australia, Canberra, 2001, p. xvi.

7 BTE, *Economic costs of natural disasters in Australia*, Commonwealth of Australia, Canberra, 2001, p. xvi.

8 BTE, *Economic costs of natural disasters in Australia*, Commonwealth of Australia, Canberra, 2001, p. xiv.

9 R. Crompton and J. McAneney, 'Normalised Australian insured losses from meteorological hazard: 1967–2006', *Environmental Science and Policy*, vol. 11, 2008, p. 374.

levels. They concluded that increasing insured losses due to natural hazards in Australia is a result of increasing dwelling numbers and value.¹⁰

3.10 The Actuaries Institute estimated the average cost of annual weather-related general insurance claims to be \$1.9 billion for homes, \$1.0 billion for commercial property and \$0.4 billion for motor vehicles, giving a total cost of \$3.3 billion per annum.¹¹ This total comprises \$1.1 billion for wind damage, \$700 million for hail damage, \$700 million for flood damage, \$500 million for cyclone damage and \$300 million for bushfire damage.¹² However, the Actuaries Institute noted that the actual cost of extreme weather events would be much higher than these estimates if other incidentals were included.¹³ The Actuaries Institute stated:

To place this \$3.3bn in context, this cost represents the property damage costs borne by private insurers only and we highlight that there are also substantial costs that are met from other sources. Such further costs include public infrastructure damage, non-property economic losses (such as the impact of increased unemployment) and life and health insurance. We have not quantified and considered non-economic impacts on natural ecosystems, social and economic infrastructure.¹⁴

3.11 In a report released on 20 June 2013, Deloitte Access Economics calculated that between 2000 and 2012, the insured losses borne by insurers as a result of natural disasters totalled \$16.1 billion, an average of over \$1.2 billion per year.¹⁵ The total economic cost of natural disasters in Australia was estimated in the Deloitte report to average around \$6.3 billion per year.¹⁶ Deloitte further claimed that the forecast annual cost in real terms of natural disasters (across government, business and communities) in Australia could double by 2030 and reach \$23 billion by 2050.¹⁷

3.1 The Deloitte report also sought to quantify the cost of natural disasters to Australian governments. Deloitte estimated that total annual costs to governments of natural disasters is around \$700 million per year in real terms and that Australian governments collectively face approximately 11 per cent of the total economic costs

10 R. Crompton and J. McAneney, 'Normalised Australian insured losses from meteorological hazard: 1967–2006', *Environmental Science and Policy*, vol. 11, 2008, p. 375.

11 Actuaries Institute, *Submission 67*, p. 1.

12 Actuaries Institute, *Submission 67*, p. 1. They note that these projections are averages and there will be considerable volatility from year to year. These projections also represent a single point estimate as part of a range of possible results.

13 Actuaries Institute, *Submission 67*, p. 1.

14 Actuaries Institute, *Submission 67*, p. 1.

15 Deloitte Access Economics, *Building our nation's resilience to natural disasters*, June 2013, p. 17.

16 Deloitte Access Economics, *Building our nation's resilience to natural disasters*, June 2013, p. 19.

17 Deloitte Access Economics, *Building our nation's resilience to natural disasters*, June 2013, p. 19.

of natural disasters, of which 80 per cent is outlaid by the Commonwealth government.¹⁸ The Deloitte report forecast that the annual costs to Australian governments of natural disasters will increase to \$2.3 billion in real terms over the period to 2050.¹⁹

3.12 Insurance Australia Group (IAG), the parent company of a number of insurers, similarly submitted that natural disasters over the past five years in Australia have caused over \$3 billion of damage to private property and infrastructure.²⁰ According to IAG:

The Australian and Queensland Governments have incurred over \$7.5 billion in reconstruction and recovery costs related to the 2010–11 Queensland floods and Cyclone Yasi. Insurers have paid out more than \$3.7 billion to policyholders for the same events. Even before the events of the last five years Australia's annual average insured losses due to natural perils was estimated at around \$1 billion.²¹

3.13 According to the Actuaries Institute, the most costly extreme weather event in Australia since 1999 was the January 2011 floods in Queensland and northern NSW at an economic loss of \$6 billion.²² The Australian Business Roundtable for Disaster Resilience and Safer Communities also found that 2011 'was the worst year on record in Australia for natural disasters' because of '[a]n unprecedented number of natural disasters' with total insured losses of around \$12 billion.²³ Crompton and McAneney estimated that, when normalised for 2006 prices, Tropical Cyclone Tracy (1974) cost \$3.65 billion and the Ash Wednesday bushfires (1983) cost \$1.63 billion.²⁴

3.14 The table below illustrates the most costly Australian weather related disasters from 1999 to 2011 based on figures from the Actuaries Institute.

18 Deloitte Access Economics, *Building our nation's resilience to natural disasters*, June 2013, p. 20.

19 Deloitte Access Economics, *Building our nation's resilience to natural disasters*, June 2013, p. 20.

20 IAG, *Submission 144*, p. 16.

21 IAG, *Submission 144*, p. 16.

22 Actuaries Institute, *Submission 67*, p. 13.

23 Australian Business Roundtable for Disaster Resilience and Safer Communities, 'A better way to protect Australia from natural disasters', Media release, 20 June 2013, http://www.iag.com.au/news/shareholder/20130620_abrt_protect_austr_natural_disasters.shtml (accessed 5 July 2103).

24 R. Crompton and J. McAneney, 'Normalised Australian insured losses from meteorological hazard: 1967–2006', *Environmental Science and Policy*, vol. 11, 2008, p. 375.

Table 3.1: Most costly Australian weather related disasters 1999 to 2011²⁵

Year	Event	Economic Loss (\$ billion)
2011	Queensland and NSW floods	6.00
2007	Newcastle and Hunter Valley storms and floods	2.15
1999	Sydney hailstorm	2.12
2011	Tropical Cyclone Yasi	2.00
2006	Tropical Cyclone Larry	1.50
2009	Victorian bushfires (Black Saturday)	1.44
2010	Perth hailstorm	1.35
2010	Melbourne hailstorm	1.29

Difficulty calculating cost estimates

3.15 As shown in the examples above, disaster cost estimates in Australia are largely drawn from insurance claim data or insurance data with some augmentation.²⁶ The difficulty in relying on insurance data to assess the financial cost of extreme weather events is that it only accounts for insured losses which represent only a fraction of the total cost of a disaster.²⁷ The Centre for Risk and Community Safety (CRCS) at the Royal Melbourne Institute of Technology University highlighted the difficulty in relying only on insurance data for cost estimates:

...they [insurance data] 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.²⁸

3.16 The CRCS noted that for these reasons the estimate by the BTE differs to that of Crompton and McAneney.²⁹ The figures calculated by the BTE were based on insurance data combined with other estimates, normalised for inflation only and included the cost of the Newcastle earthquake. Crompton and McAneney's figures, on the other hand, were based solely on insurance data and were normalised for inflation, population, wealth and building standards.

25 Actuaries Institute, *Submission 67*, p. 1.

26 CRCS, *Submission 59*, p. 5.

27 CRCS, *Submission 59*, p. 5.

28 CRCS, *Submission 59*, p. 5.

29 CRCS, *Submission 59*, p. 6.

3.17 The CRCS acknowledged that heatwaves and drought, which are expected to become more frequent with higher global temperatures, are not included in most disaster impact data. The CRCS stated that because drought has a slower onset and does not directly result in death, injury or property damage, it is not often included in the same class of disasters as bushfires or floods.³⁰ The CRCS noted that this is despite drought being 'considered to be the most economically costly extreme weather event Australians face'.³¹

3.18 The Actuaries Institute similarly noted that some weather events are not covered by general insurance and are therefore not captured in insurance data on the cost of natural disasters:

Two perils that are primarily not met by private insurers are Drought and Action of the Sea and are therefore omitted from our cost estimates shown above. We are of the view that the additional cost for Drought and Actions of the Sea can be significantly larger than the increase in privately insured costs.³²

3.19 The CRCS concluded that 'estimating the cost of extreme weather in Australia is not straightforward. Data and methodology can lead to significantly different estimates'.³³

Cost to government

3.20 A significant part of the financial cost of extreme weather events is borne by the three levels of government in Australia: the Commonwealth government, state and territory governments and local governments. The Commonwealth government plays a coordinating role in allocating emergency funding to state and territory governments in the event of natural disasters, whilst state, territory and local governments must meet additional costs associated with infrastructure damage, clean up and the provision of support services. In addition to these costs, there is also likely a level of forgone revenue to governments as a result of the economic disruption of extreme weather events.

Commonwealth government

3.21 The Commonwealth government's primary funding mechanism for assisting with the social and economic impacts of extreme weather events is the Natural Disaster Relief and Recovery Arrangements (NDRRA).³⁴ The NDRRA provides partial reimbursement to the states and territories for expenditure on certain relief and recovery measures, such as personal hardship and distress assistance, restoration or replacement of essential public assets, and loans, subsidies and grants for affected

30 CRCS, *Submission 59*, p. 5.

31 CRCS, *Submission 59*, p. 5.

32 Actuaries Institute, *Submission 67*, p. 2.

33 CRCS, *Submission 59*, p. 6.

34 Attorney-General's Department (AGD), *Submission 64*, p. 5.

communities, small businesses and primary producers.³⁵ The Commonwealth government may reimburse up to 75 per cent of actual expenditure by the state or territory for expenditure in a financial year.³⁶ The NDRRA does not cover expenditure relating to the natural environment or human health.

3.22 To be eligible for NDRRA assistance, states and territories are required to have public assets insured or to have access to adequate capital to restore public assets if commercial insurance is not available or is not cost effective.³⁷ States and territories are also required to undertake effective mitigation strategies to reduce the impact of natural disasters.³⁸

3.23 The Commonwealth government has spent over \$6.1 billion in NDRRA in the past five financial years (between 2007–08 and 2011–12).³⁹ A significant portion of this funding was spent in response to the 2011 Queensland floods. Table 3.2 below shows the Commonwealth government's expenditure on NDRRA in recent years.

*Table 3.2: Natural Disaster Relief and Recovery Arrangements payments (\$ million)*⁴⁰

Year	NSW	Vic	Qld	WA	SA	Tas	ACT	NT	Aust
2011–12	...	...	2 951.0	1.7	...	...	...	7.9	2 960.6
2010–11	...	500.0	2 256.0	...	...	...	...	2.4	2 758.4
2009–10	6.1	4.3	104.5	...	...	...	...	2.7	118.3
2008–09	...	270.5	...	...	...	...	...	9.6	280.0
2007–08	7.7	...	...	...	2.0	0.6	...	7.2	16.9
Total	13.8	774.8	5 311.5	1.7	2.0	0.6	...	29.8	6134.2

3.24 For certain severe events the Commonwealth government may also provide assistance directly to individuals through the Australian Government Disaster Recovery Payment (AGDRP) and ex gratia assistance such as the Disaster Income Recovery Subsidy (DIRS).⁴¹

³⁵ AGD, *Submission 64*, p. 5.

³⁶ AGD, *Submission 64*, p. 5.

³⁷ AGD, *Submission 64*, p. 5.

³⁸ AGD, *Submission 64*, p. 5.

³⁹ AGD, *Submission 64*, p. 5.

⁴⁰ AGD, *Submission 64*, p. 5.

⁴¹ AGD, *Submission 64*, p. 5.

State and territory governments

3.25 State and territory governments bear primary responsibility for the protection of life, property and the environment within their borders in the event of a natural disaster. As such, state and territory governments incur the cost of extreme weather events in the areas of preparation, response and recovery.

3.26 The committee heard evidence from the South Australian and Northern Territory governments on the financial costs of natural disasters.⁴² The South Australian State Emergency Management Committee (SEMC) informed the committee that the average annual economic cost of extreme weather events in the state is over \$67 million.⁴³ The SEMC stated:

In a South Australian context extreme weather economic costs have historically been spread across three hazard classes with average annual economic costs over the period 1967–1999 as follows:

Floods—\$26.26 million [per annum]

Storms—\$23.5 million [per annum]

Bushfires—\$17.27 million [per annum].⁴⁴

3.27 The SEMC noted that these cost estimates are based on the 2001 BTE report and that 'it is likely that more contemporary analysis factoring in recent high impact and high cost events in South Australia...would make these average annual economic costs significantly higher'.⁴⁵ The SEMC suggested there would be benefit in improving the national evidence base on the costs of natural disasters by refreshing the BTE data.⁴⁶

3.28 In addition to floods, storms and bushfires, the South Australian SEMC recognised that other hazards have the potential to add to the long term costs of extreme weather in South Australia, including damage to infrastructure and residential housing from sea inundation and coastal erosion.⁴⁷ The impact of unprecedented extreme heatwaves across south eastern Australia is also likely to impact on the state, leading to health impacts and disruptions to essential services, including electricity and transport.⁴⁸

3.29 The SEMC also stated that:

42 South Australian State Emergency Management Committee (South Australian SEMC), *Submission 162*, p. 4; and Northern Territory Government, *Submission 129*, p. 4.

43 South Australian SEMC, *Submission 162*, p. 4.

44 South Australian SEMC, *Submission 162*, p. 4.

45 South Australian SEMC, *Submission 162*, p. 4.

46 South Australian SEMC, *Submission 162*, p. 5.

47 South Australian SEMC, *Submission 162*, p. 5.

48 South Australian SEMC, *Submission 162*, p. 5.

...it is difficult to ascertain the exact benefit of mitigation efforts on recovery costs. Currently there is no nationally consistent approach to the identification and collection of post-disaster assessment information. Hence data is currently not captured or analysed in a way to allow nationally consistent analysis and comparison.

The South Australian government therefore suggested that there would be national benefit in the establishment of a common and consistent system of data collection and analysis across all states and territories.⁴⁹

3.30 The SEMC stated that 'this may provide an avenue for improving the knowledge base of natural disasters in Australia, and could be used to help guide or inform decision making'.⁵⁰

3.31 The Northern Territory government informed the committee that extreme weather events are likely to impact on northern Australia in the form of more intense daily rainfall events, severe thunderstorms and tropical cyclones.⁵¹ Central Australia has also been impacted by changing vegetation and animal populations which have resulted in extreme fire events and feral animal issues.⁵²

3.32 The Northern Territory government identified that these effects of extreme weather are likely to lead to increased flood situations, increased exposure to coastal issues such as storm surge and a rise in water levels, and increased occurrence of extreme temperatures which will reduce infrastructure life and increase maintenance demands.⁵³

Local government

3.33 Local governments often face costs from extreme weather events when infrastructure and services are affected. For example, the Brisbane City Council advised the committee that the 2011 Queensland floods resulted in \$400 million worth of damage to major infrastructure and homes, in addition to economic, environmental and social impacts.⁵⁴ The Townsville City Council informed the committee that there have been over thirty-five weather related events that have affected the area since 1970.⁵⁵ According to the council, major repairs and reconstruction works have been undertaken to repair damaged infrastructure, with the cost continuing to escalate.⁵⁶

3.34 The Local Government Association of Queensland (LGAQ) lamented the fact that currently available cost data 'is often not in holistic, manageable formats that

49 South Australian SEMC, *Submission 162*, p. 5.

50 South Australian SEMC, *Submission 162*, p. 5.

51 Northern Territory Government, *Submission 129*, p. 4.

52 Northern Territory Government, *Submission 129*, p. 4.

53 Northern Territory Government, *Submission 129*, p. 4.

54 Brisbane City Council, *Submission 123*, p. 2.

55 Townsville City Council, *Submission 32*, p. 1.

56 Townsville City Council, *Submission 32*, p. 3.

could assist councils to properly understand the potential overall costs of extreme weather events'.⁵⁷ The LGAQ stated that:

The intrinsic environmental, cultural and social value of natural assets is difficult to measure before extreme weather events and even more difficult to estimate as a component of the broader community loss after the event.

Methodologies for the measurement of potential community impacts should be available that assess a wide range of community, social, environmental and economic impacts to enable the development of broad-based mitigation strategies for severe weather.⁵⁸

The role of insurance

3.35 Discussion of the financial costs associated with extreme weather events and their attribution to governments, businesses and households is inextricably linked to insurance. The problems of non- and under-insurance were cited during the course of the inquiry and are defined as:

- **non-insurance** is a situation where a person does not have an insurance policy, or an insurance policy is held but an event occurs which is excluded from coverage by that policy;
- **under-insurance** occurs when the sum insured is below the rebuilding or replacement cost of the insured property.⁵⁹

3.36 Non-insurance and under-insurance can have a significant impact on who bears the costs of damage caused by extreme weather events. As the Insurance Council of Australia explained, businesses and households either choose to transfer risk to an insurer by taking out insurance or they choose to accept higher risk themselves by under-insuring or choosing not to insure at all and then likely seek financial assistance from government in the event of damage caused by an extreme weather event.⁶⁰

3.37 The availability and affordability of insurance was the subject of discussion during the course of the inquiry. The evidence to the committee was that home insurance premiums have risen significantly in recent years⁶¹ (see Figure 3.1). In particular, following recent extreme weather events some businesses and households in Queensland, New South Wales and Victoria have seen their insurance premiums increase significantly.

57 LGAQ, *Submission 68*, p. 4.

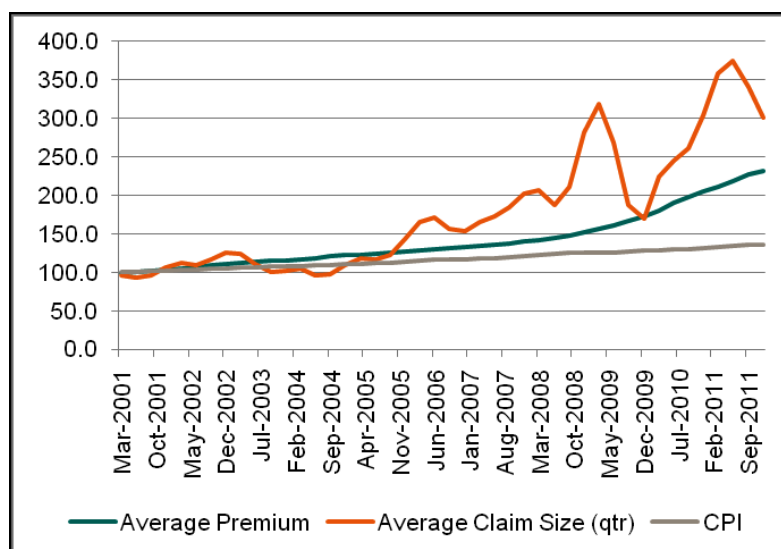
58 LGAQ, *Submission 68*, p. 4.

59 Chris Latham, Peter McCourt and Chris Larkin, 'Natural Disasters in Australia: Issues of funding and insurance', November 2010, pp 16–17.

60 Mr Alex Sanchez, General Manager Policy—Economics and Taxation, Insurance Council of Australia, *Committee Hansard*, 10 April 2013, p. 16.

61 IAG, *Submission 144*, p. 27; Suncorp, *Submission 77*, Attachment 1, p. 10.

Figure 3.1: Home Building Insurance - Trend Data⁶²



3.38 CGU Insurance advised the committee that these increases in insurance premiums have occurred in specific geographic locations where, historically, these areas have underpaid for their insurance:

...the events of recent years have been largely focused around Queensland and northern New South Wales, but we have also had one-off events. We had a major hailstorm event in Perth. We have had three events in Victoria. We are not seeing extraordinary growth in premium rates in Western Australia, South Australia or metropolitan Melbourne. What we are seeing is relatively significant increases in those areas that have, in historical terms, probably underpaid, based on past performance. The premiums that we are seeing at the moment, the increases that we are seeing at the moment, are probably in large part isolated to those segments of the community that are at greatest risk, where the losses have occurred. So we are seeing significant movements in Northern Queensland, parts of northern New South Wales and some regional centres.⁶³

3.39 Suncorp explained in its submission that:

...insurance pricing is a reflection of the risk and the value of the asset being insured. Insurers take particular care in ensuring our products are appropriately priced, using risk data collected over decades from multiple sources (e.g. the National Flood Information Database) to ensure we understand the degree and type of risk to be insured.⁶⁴

62 Suncorp, *Submission 77*, Attachment 1 (Suncorp, *Risky Business, Insurance and Natural Disaster Risk Management*, Policy Document), p. 10.

63 Mr Malcolm Freeman, General Manager, Business Partners, CGU Insurance Ltd, *Committee Hansard*, 10 April 2013, p. 16.

64 Suncorp, *Submission 77*, p. 2.

3.40 The Insurance Council of Australia (ICA) also offered an explanation for the recent premium increases as well as the decision by some insurers to no longer offer insurance in certain 'high risk areas':

Many Australian property insurers have responded to these changes (in the reinsurance market) with premium increases and by reviewing their risk exposure. Some insurers have subsequently taken steps to reduce their exposures to high risk areas if they could not achieve necessary premium increases commensurate with the risk in those areas.⁶⁵

3.41 The Actuaries Institute explained that:

The availability and affordability of insurance today has been influenced to some degree by the recent catastrophes in Australia (eg. Brisbane Floods) but also by such factors as low investment yields, higher reinsurance costs and more accurate address based pricing. Currently, many properties in high risk flood zones are able to purchase insurance but at unaffordable prices...⁶⁶

3.42 The Actuaries Institute submitted that premiums are likely to increase further in the future. Indeed, it predicted that 'an increase in weather related claims cost due to climate change would lead to a further 50% increase in premiums'.⁶⁷ The Actuaries Institute further predicted that:

Under climate change and in the absence of significant risk mitigation initiatives, it is likely that:

- More properties will be at risk of Flood, Cyclone and Storm Surge and will become uninsurable and unaffordable
- Bushfire prone areas will increase (small pockets may become uninsurable) but the additional cost for most is likely to be spread over the community
- Coastal Inundation (eg. King Tide) will remain uninsurable
- Premiums may rise for Storm and Hail but the additional cost will be spread over the community.⁶⁸

3.43 Suncorp submitted that 'risk reduction is key to ensuring a sustainable and accessible insurance industry'.⁶⁹ Indeed, many submissions outlined a number of ways in which risk (and hopefully therefore insurance premiums) can be reduced.⁷⁰ Some of these are discussed elsewhere in this report, including improving understanding of risk

65 Insurance Council of Australia, *Submission 15*, p. 1.

66 Actuaries Institute, *Submission 67*, p. 3.

67 Actuaries Institute, *Submission 67*, p. 2.

68 Actuaries Institute, *Submission 67*, p. 3.

69 Suncorp, *Submission 77*, p. 2.

70 See, for example, Suncorp, *Submission 77*, p. 2; ICA, *Submission 15*, pp 3, 8–13; Dr Sandra Schuster, *Submission 49*, Attachment 1, pp 4–5; Floodplain Management Association, *Submission 62*, pp 3–4; IAG, *Submission 144*, pp 29–34.

through better quality data, improved dissemination of appropriate information, better planning and strengthened building codes and adequate preparedness and mitigation measures. For example, the Floodplain Management Association argued that 'more accurate flood level predictions would lead to lower insurance premiums as the risks are more accurately assessed'.⁷¹

3.44 Increases in insurance premiums predictably result in a reduction in insurance coverage, even where consumers have experienced an extreme weather event and are more aware of the risks they face. CGU Insurance explained:

CHAIR: ...does that mean you are seeing more people drop their insurance coverage in those areas?

Mr Freeman: In those areas, yes.

CHAIR: That is despite the fact that obviously they have a higher understanding—

Mr Freeman: They do.

CHAIR: of the risk they face because they have lived through those risks.

Mr Freeman: And it is an issue that goes to the heart of the affordability debate.⁷²

3.45 The Insurance Council of Australia agreed:

CHAIR: ...The simple fact is, the higher the cost of insurance, the higher the cost of property insurance, the less households there are who are insured.

Mr Sanchez: ...yes.⁷³

3.46 A reduction in private insurance coverage has the impact of shifting the costs of repair and reconstruction following an extreme weather event from private insurers to individuals and also to governments, by way of assistance packages and payments. This in turn can have the perverse effect of further discouraging households from insuring their property as they believe, if they are affected by a natural disaster, they will receive financial assistance from government. The Northern Territory government described this as 'a very complex issue', outlining the problem as follows:

Part of the problem we have here is that the best places to live for 99 per cent of the time are the worst places to be when the extreme event comes along. The Brisbane floods down the river are a classic example of that. Insurance and insurance costs then tend to drive where people will want to live into the future, and that must be good. Planning has got to take into account the extreme events over the long term and therefore the cost to government if people are allowed to build in places where they should not build, because at some point the builder will walk away. If the mitigation

71 Floodplain Management Association, *Submission 62*, p. 3.

72 Mr Malcolm Freeman, CGU Insurance Ltd, *Committee Hansard*, 10 April 2013, p. 16.

73 Mr Alex Sanchez, ICA, *Committee Hansard*, 10 April 2013, p. 14; see also Dr Sandra Schuster, *Submission 49*, Attachment 1, p. 5.

they have put in place on that building fails, it eventually becomes a problem for the landowner and, if they do not have money for insurance, then for the state government or the Territory government. I suppose you have that classic problem of those who can afford to insure do, but if they see other people being bailed out because they have not insured then why should they insure? Of course, insurance prices are going up dramatically all over Australia and, I presume, the world where these events occur.⁷⁴

3.47 Professor David King similarly described the problem, and put forward a case for compulsory insurance:

If [households] do not have insurance then either the government is going to be bailing them out or areas are going to be declared unsafe and people are going to be relocated. So the alternatives are pretty dire. What was mentioned by a lot of people when we were doing this research was that you have to have compulsory third-party insurance to drive a car, so why don't we have compulsory insurance for hazard protection for household and house insurance?...If we all paid insurance for hazard protection then the cost per household would be dramatically reduced...The counterargument to it is: why should people who have built in sensible places, who are not in a hazard zone, subsidise people who are living in hazardous areas? There are two very strong arguments both in favour of a move towards compulsory insurance and against it.⁷⁵

3.48 IAG suggested that the tax treatment of insurance should be addressed as part of the question of affordability:

...there are two parts to the question that we are addressing here. The first one is about insurance affordability and how we make sure that the broader spectrum of community can continue to afford insurance and protect their assets so that they do not ultimately fall back to government. For us we see tax as being a large component of the affordability discussion and we are trying to have a look at ways that we can make that more specific to each of the individual risks. That is our suggestion around land taxes and so on.⁷⁶

3.49 Suncorp agreed that:

State-based insurance taxes, levies and duties currently form a significant deterrent to obtaining insurance cover in all States, due to the impost on price. The current combination of an Emergency Services Levy, GST and Stamp Duty can increase the cost of insurance policies in New South Wales by more than 40%. The transition away from state-based insurance taxes to more equitable and efficient taxation systems will help support insurance

74 Mr Peter Davies, Acting Chief Information Officer, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, p. 4.

75 Associate Professor David King, Director, Centre for Disaster Studies, James Cook University, *Committee Hansard*, 22 February 2013, p. 9.

76 Ms Julie Batch, Group General Manager, Reinsurance, IAG, *Committee Hansard*, 10 April 2013, p. 14.

affordability and therefore improve economic resilience to extreme weather events.⁷⁷

Committee comment

3.50 The impact of extreme weather events can be ameliorated by appropriate insurance. However, as noted by some submitters during the course of the inquiry, non-insurance and under-insurance have been a significant hindrance to recovery from and adaptation to recent extreme weather events.⁷⁸

3.51 The committee is aware that both the Productivity Commission and the Treasury have recommended reform to Australia's taxation system as it applies to general insurance. The Productivity Commission found that state and territory insurance taxes and levies can distort the ways that households and businesses manage risks and that removing state and territory taxes and levies on general insurance would facilitate effective adaptation to climate change. The Productivity Commission stated that such reform would improve the affordability of insurance for some households and businesses, and ensure that premiums more closely reflect the level of risk faced, and that it may also reduce levels of non-insurance and under-insurance.⁷⁹ The Productivity Commission therefore recommended that:

State and territory taxes and levies on general insurance constitute a barrier to effective adaptation to climate change. State and territory governments should phase out these taxes and replace them with less distortionary taxes.⁸⁰

3.52 The Australia's Future Tax System Review (known as the 'Henry tax review') similarly argued in its final report that taxes on general insurance should be removed.⁸¹ The Henry tax review stated:

Australia has several other taxes that should be phased out over time, including insurance duties...Imposing specific taxes on insurance deters people from insuring their property and encourages them to bear unnecessary risks, rather than pooling risk with others. Rates of non-insurance (for building and content insurance) generally are higher at lower incomes, yet low-income people are less able to bear the risk.⁸²

3.53 And:

77 Suncorp, *Submission 77*, p. 3; see also ICA, *Submission 15*, p. 6.

78 See, for example, Dr Sandra Schuster, *Submission 49*, Attachment 1, pp 5–6; Australian Council of Social Services (ACOSS), *Submission 142*, p. 9.

79 Productivity Commission, *Barriers to effective climate change adaptation*, September 2012, pp 306–307.

80 Productivity Commission, *Barriers to effective climate change adaptation*, September 2012, p. 307.

81 The Treasury, *Australia's future tax system—Report to the Treasurer*, December 2009, pp xviii and 94.

82 The Treasury, *Australia's future tax system—Report to the Treasurer*, December 2009, p. 58.

The rates of non-insurance and under-insurance vary throughout Australia. While States with higher taxes on insurance do not always have higher rates of non-insurance and under-insurance, there are other reasons why differences in States may persist (such as differences in perceived levels of risk). Further, there is evidence that after Western Australia stopped basing its fire services levy on insurance, the level of non-insurance for both building and contents declined (Tooth & Barker 2007). Another study found that if the fire services levy, insurance duty and the insurance protection tax were removed, an additional 300,000 households across Australia would purchase contents insurance and an additional 69,000 households across Australia would purchase building insurance (Tooth 2007).

As well as being inefficient by leading to under-insurance or non-insurances, insurance taxes can also be inequitable. Rates of non-insurance (for building and content insurance) generally decline with higher incomes, and non-insurance can also be higher for certain demographic groups, such as retirees with mortgages and single parents (Tooth & Barker 2007). Because of their financial positions, people in these groups may be more vulnerable in the case of loss.⁸³

3.54 The Henry tax review also recognised that insurance taxes acting as a deterrent to insurance may also lead to an increase in government expenditure in the event of a disaster. The final report cited the ACT government's experience following the Canberra bushfires in 2003:

...after the 2003 Canberra bushfires the ACT Government provided an additional \$5,000 to each affected household that did not have contents insurance, in addition to the \$5,000 provided to all whose homes were destroyed.⁸⁴

3.55 Ultimately, the Henry tax review recommended that 'inefficient State consumption taxes, such as insurance taxes' should be abolished⁸⁵ and:

All specific taxes on insurance products, including the fire services levy, should be abolished. Insurance products should be treated like most other services consumed within Australia and be subject to only one broad-based tax on consumption.⁸⁶

3.56 With respect to subsidising insurance, the Productivity Commission recommended against government subsidy of household or business property insurance, whether directly or by underwriting risks, because in the Commission's view:

83 The Treasury, *Australia's future tax system—Report to the Treasurer*, December 2009, p. 473.

84 The Treasury, *Australia's future tax system—Report to the Treasurer*, December 2009, p. 473.

85 The Treasury, *Australia's future tax system—Report to the Treasurer*, December 2009, p. 91.

86 The Treasury, *Australia's future tax system—Report to the Treasurer*, December 2009, p. 94.

...subsidies would not reduce the physical risks that individual properties face, but would mean that governments bear some of the losses to these properties.

Government intervention would be more effective when closely targeted at a well-defined market failure or equity objective, supported by clear evidence. Alternative reform options may be more appropriate ways to meet policy objectives. For example, there would be net benefits for the community from phasing out taxes and levies on insurance, ensuring land-use and building regulation can facilitate adaptation, or by appropriately providing information and disaster-mitigation infrastructure to reduce exposure to risks...Addressing barriers to adaptation in these areas may largely address community concerns about the provision, affordability and uptake of insurance.⁸⁷

3.57 In its response to the Productivity Commission report, the Commonwealth government agreed that 'governments should not subsidise household or business property insurance, either directly or by underwriting risks'.⁸⁸ In its response, the government also noted that, following the series of extreme weather events in late 2010 and early 2011, it had commissioned the Natural Disaster Insurance Review. The response indicated that the government has implemented a number of recommendations from that review, including to enhance consumer awareness of flood risk and flood insurance and to establish a National Insurance Affordability Council (NIAC) to manage the national coordination of flood and other disaster risk management.⁸⁹ It further noted that:

The Government's policies announced or implemented in response to the Review, including funding of \$100 million over 2 years for mitigation works and the establishment of NIAC, broadly reflect the Productivity Commission's recommendations that phasing out taxes and levies on insurance, ensuring land-use and building regulation facilitate risk management and appropriately providing information and disaster mitigation infrastructure to reduce exposure to risks may be more appropriate ways to meet policy objectives with respect to the provision, affordability and uptake of insurance.⁹⁰

3.58 The committee supports the findings of both the Productivity Commission's report on barriers to effective climate change adaptation and the Henry tax review that disincentives to insurance, such as the taxes and levies applied to insurance by the states and territories should be addressed. Removing these disincentives and

87 Productivity Commission, *Barriers to effective climate change adaptation*, September 2012, p. 321.

88 Australian Government response to the Productivity Commission report: Barriers to Effective Climate Change Adaptation, March 2013, p. 13.

89 Australian Government response to the Productivity Commission report: Barriers to Effective Climate Change Adaptation, March 2013, pp 13–14.

90 Australian Government response to the Productivity Commission report: Barriers to Effective Climate Change Adaptation, March 2013, p. 14.

encouraging households to insure their property should alleviate some of the costs to all levels of government in the event of damage to private property caused by an extreme weather event.

3.59 The committee acknowledges that the loss of revenue from abolition of these taxes and levies would create a budgetary issue for the states and territories. The committee therefore recognises that such reform may best be achieved nationally with Commonwealth government involvement through a Council of Australian Governments (COAG) reform process.

Recommendation 4

3.60 The committee recommends that disincentives to insurance, such as taxes and levies applied by the states and territories, should be removed as part of a national reform process.

Impacts on industry

3.61 Extreme weather events can have significant impacts on industry and business through direct and indirect means. Floods, storms, droughts and fires have the potential to destroy crops, decimate agricultural land, damage forestry plantations and reduce availability of water supply. Extreme weather events may indirectly affect industry through road closures, the shutting down of factories and the loss of essential services, such as electricity and water. Ultimately, the costs incurred by industry due to extreme weather events will be passed on to consumers or the lost production from such events will result in reduced economic activity and fewer local jobs.

3.62 The Centre for Policy Development asserted that 'without action to adapt to more variable and extreme weather, by 2050 Australia could lose \$6.5 billion in agricultural production'.⁹¹ In its report, *Farming smarter, not harder*, the Centre noted that Australia is ranked in the top five exporters of commodities like wheat, beef, dairy, mutton and lamb.⁹² Farm products account for over 10 per cent of Australia's exports worth \$3.59 billion.⁹³

3.63 The report observed that extreme weather events could have the greatest impacts on global agricultural production and prices:

Periods of volatility have recently coincided with droughts and floods in major supply regions, with extreme weather a driver of each of three price

91 Centre for Policy Development, *Submission 56*, p. 1.

92 Laura Eadie and Christopher Stone, *Farming smarter, not harder: Securing our agricultural economy*, Centre for Policy Development, November 2012, p. 5, http://cpd.org.au/wp-content/uploads/2012/10/cpd_land_report_EMBARGOED_UNTIL_1_NOV.pdf (accessed 30 May 2013).

93 Laura Eadie and Christopher Stone, *Farming smarter, not harder: Securing our agricultural economy*, Centre for Policy Development, November 2012, p. 5.

spikes in the last 5 years. Changes in weather patterns will also increase the pressure of weeds, pests and disease on agricultural production.⁹⁴

3.64 The report noted that despite the acknowledged and perceived effect of extreme weather on agricultural prices, current price forecasts have not considered the impact of a potential shift in the frequency of extreme weather events on regional production or on global prices.⁹⁵ The report further recognised that early action will be necessary to reduce the risk of agricultural price spikes.⁹⁶

3.65 The Centre for Policy Development advised that investment in research and development of more resilient crop varieties and mitigation needs to start immediately.⁹⁷

3.66 The CRSC estimated the total cost to the Victorian economy of bushfire damage to the agricultural industry at \$92 million per annum.⁹⁸ 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.⁹⁹

3.67 The Australian Forest Products Association (AFPA), representing the forest, wood and paper products industry, acknowledged that extreme weather events and a changing climate will impact on forestry businesses.¹⁰⁰ In particular, a hotter drier environment with increased risk of bushfires and cyclonic activity, greater variability and intensity of rainfall and soil erosion will affect forestry operations.¹⁰¹

3.68 According to AFPA, the forestry industry is one of Australia's largest manufacturing industries with an annual turnover of \$21 billion.¹⁰² It contributes around 0.6 per cent to Australia's gross domestic product, 6.7 per cent of manufacturing output and employs approximately 76 800 people. The industry is predominantly based in regional areas and is socio-economically important to those areas.¹⁰³

94 Laura Eadie and Christopher Stone, *Farming smarter, not harder: Securing our agricultural economy*, Centre for Policy Development, November 2012, p. 19.

95 Laura Eadie and Christopher Stone, *Farming smarter, not harder: Securing our agricultural economy*, Centre for Policy Development, November 2012, p. 20.

96 Laura Eadie and Christopher Stone, *Farming smarter, not harder: Securing our agricultural economy*, Centre for Policy Development, November 2012, p. 20.

97 Laura Eadie and Christopher Stone, *Farming smarter, not harder: Securing our agricultural economy*, Centre for Policy Development, November 2012, p. 10.

98 CRCS, *Submission 59*, p. 8.

99 CRCS, *Submission 59*, p. 8.

100 Australian Forestry Products Association (AFPA), *Submission 37*, p. 2.

101 AFPA, *Submission 37*, p. 2.

102 AFPA, *Submission 37*, p. 1.

103 AFPA, *Submission 37*, p. 2.

3.69 The CRCS estimated that the current total cost to the Victorian economy due to bushfire damage to the timber industry (including business disruption costs) is \$185 million per annum.¹⁰⁴ Furthermore, the CRCS claimed that, with no adaptive change, by 2050 increases in bushfire damage to the timber industry will have cost the Victorian economy an additional \$2.85 billion over and above a 'no climate change' scenario.¹⁰⁵

3.70 The Australian National Retailers Association (ANRA), which represents retailers who employ around 500 000 people and account for more than \$100 billion in annual turnover, highlighted some of the indirect costs associated with extreme weather events.¹⁰⁶ ANRA noted that the 2011 Queensland floods closed roads and destroyed infrastructure, resulting in delays to stock reaching affected areas and increases in cost.¹⁰⁷ The ANRA stated:

In many instances the changed delivery methods involved a significant increase in transport and logistics costs (estimated at multiple times the cost for delivery under more normal circumstances). However, none of these additional costs were passed on in the form of higher prices for Queensland consumers.¹⁰⁸

Impacts on infrastructure

3.71 Major infrastructure (such as roads, bridges, rail lines, ports, electricity networks and water supplies) is vulnerable to extreme weather events. Damage to infrastructure is generally immediate and costly, and as noted above, has subsequent ramifications for people and business.¹⁰⁹ Repair of infrastructure is accepted as a high priority, as it is essential to recovery efforts and getting people's lives and industry back up and running.

3.72 In 2012 the Climate Institute published its report, *Coming ready or not: Managing climate risks to Australia's infrastructure*, identifying the effect of weather events on Australia's infrastructure.¹¹⁰ The report noted that:

...infrastructure...is a critical enabler for activity across all sectors of the economy, and because its exposure to climate change puts other parts of society at risk. Infrastructure sectors are interdependent; when one is

104 CRCS, *Submission 59*, p. 8.

105 CRCS, *Submission 59*, p. 9.

106 Australian National Retailers Association (ANRA), *Submission 110*, p. 1.

107 ANRA, *Submission 110*, p. 1.

108 ANRA, *Submission 110*, p. 2.

109 The Climate Institute, *Submission 105*, p. 4.

110 The Climate Institute, *Coming ready or not: Managing climate risks to Australia's infrastructure*, 2012, http://www.climateinstitute.org.au/verve/resources/TCI_ComingReadyorNot_ClimateRiskstoInfrastructure_October2012.pdf (accessed 31 May 2013).

damaged others may be impaired. Climate impacts to infrastructure cascade through the economy and are felt throughout the community.¹¹¹

3.73 Modelling for the 2008 Garnaut Review conservatively estimated that the annual cost of unmitigated climate change on Australia's infrastructure would reach 0.5 per cent of gross domestic product (GDP) (about \$9 billion) in 2020 and 1.2 per cent of GDP (\$40 billion) in 2050.¹¹²

3.74 The CSIRO emphasised that the impact of extreme weather events on Australia's infrastructure will be exacerbated by the accelerated deterioration of the structural reliability of infrastructure due to a changing climate and increasing carbon concentration.¹¹³ The CSIRO explained that increasing carbonation of the atmosphere and rising sea levels will increase cracking and corrosion of concrete, timber and steel structures.¹¹⁴ Heatwaves which last for several days also have significant impacts on how buildings and infrastructure perform: for example, how well buildings maintain temperature for comfort, safety and reduction of fire hazards may be affected by increasing extreme weather events.¹¹⁵

Health impacts of extreme weather events

3.75 The effects of extreme weather events have a significant impact on society as a whole and the health of Australians. Storms, floods and bushfires present a real danger to people's lives, causing death and serious injury. Communities affected by disasters may also experience stress and emotional anguish during the event and for a significant period of time afterwards. Rises in average temperatures and more frequent heatwaves are also considered to present a substantial threat to human health.¹¹⁶

3.76 The Australian Medical Association (AMA) identified that changes in the frequency, intensity and duration of future weather events will expose growing numbers of Australians to hazards that affect their health. According to the AMA, extreme weather events will have both direct and indirect impacts on human health:

...it is predicted that Australia will experience more heat waves, extreme fire weather, severe storms, and drought across southern parts of the continent. Some of the health effects accompanying these changes will be direct, such as increases in mortality and morbidity associated with heat waves. Other health impacts will be indirect, including damage to health infrastructure, depression and post-traumatic stress disorder, increasing health inequities, and an erosion of the social determinants of good health.

111 The Climate Institute, *Coming ready or not: Managing climate risks to Australia's infrastructure*, 2012, p. 3.

112 R. Garnaut, *The Garnaut Climate Change Review, Final report and technical appendices*, Canberra, 2008, <http://www.garnautreview.org.au/2008-review.html> (accessed 5 July 2013), see also Climate Institute, *Submission 105*, p. 4.

113 CSIRO, *Submission 93*, p. 18.

114 CSIRO, *Submission 93*, p. 18.

115 CSIRO, *Submission 93*, pp 18–19.

116 CSIRO, *Submission 93*, p. 3.

When estimating the overall financial costs associated with extreme weather events, it is imperative that consideration is given to the significant costs arising from health impacts.¹¹⁷

3.77 The Climate and Health Alliance (CAHA) similarly noted that 'there are serious implications for human health and wellbeing and safety from extreme weather events', that are both direct and indirect.¹¹⁸ The CAHA stated:

The risks posed by the increasing frequency and severity of extreme weather events such as heatwaves, fires, floods and storms and the injuries, deaths and trauma cause physical, emotional, and financial harm, and leave a legacy of health disadvantage for those affected, and their communities.¹¹⁹

3.78 It was noted by the AMA that the nature of extreme weather events ensures that effects are unevenly distributed.¹²⁰ Where people live, their income level, as well as health and social contexts will be a factor in determining the effect that extreme weather events have on people. The AMA stated:

There is a growing recognition that the distribution of weather-related health impacts has been, and will continue to be, uneven, falling more heavily on low-income populations and those with chronic health conditions. Other factors associated with increased vulnerability include age, disability, homelessness, social isolation, poor English language skills, and residing in rural and remote communities.¹²¹

3.79 In Australia, the direct health effects of extreme weather events have recently been highlighted by:

- the south-east Australian heat wave in late January 2009 which resulted in 374 excess deaths in Victoria over what would be expected;
- the Victorian bushfires in early February 2009 which killed 173 people...; and
- the 2010–2011 Queensland floods which killed 33 people and affected ... over two and a half million people.¹²²

3.80 Historically, cyclones and bushfires have been some of the most deadly weather events in Australia. For example, Cyclone Mahina struck the Bathurst Bay region of far north Queensland in March 1899. This destructive Category 5 cyclone

117 AMA, *Submission 104*, p. 4.

118 CAHA, *Submission 52*, p. 5.

119 CAHA, *Submission 52*, p. 5.

120 AMA, *Submission 104*, p. 6.

121 AMA, *Submission 104*, p. 6.

122 CSIRO, *Submission 93*, p. 16.

destroyed a pearling fleet and resulted in approximately 400 lives lost.¹²³ In December 1974 Cyclone Tracy killed 71 people in Darwin.¹²⁴ Apart from the devastating Black Saturday bushfire in 2009, the most destructive fires have been the Black Friday bushfire in January 1939 which resulted in 71 deaths across southern Australia and the Ash Wednesday bushfire in February 1983 which resulted in 75 deaths in South Australia and Victoria.¹²⁵

3.81 In addition to the deaths attributable to extreme weather events, there are many other indirect health effects. Submitters to the inquiry identified some of the potential health impacts associated with heatwaves, bushfires and storms and flooding.

Heatwaves

3.82 Heatwaves are considered to be the 'silent killer' of extreme weather events and are the leading cause of weather related deaths in Australia.¹²⁶ The CAHA identified that a heatwave in Victoria from 26 January 2009 to 1 February 2009 resulted in excess deaths of 374 people over and above what would be expected—a 62 per cent increase in overall mortality.¹²⁷ The AMA noted that:

Heatwaves have a greater impact on population health in Australia than any other natural hazard, and are associated with significant increases in mortality and morbidity rates....[D]eaths associated with extreme heat are predicted to more than double if Australia does not improve the way these events are handled.¹²⁸

3.83 The effects of heatwaves include heat stroke, dehydration, raised body temperatures and impaired cognitive function.¹²⁹ Loss of power supply during a heatwave substantially increases the risk of people dying and is also associated with increased accidents.¹³⁰ It has also been shown that heatwaves lead to an increase in the

123 Emergency Management Australia website, 'Australian Emergency Management Knowledge Hub: Cyclone Mahina', <http://www.emknowledge.gov.au/resource/?id=42> (accessed 5 June 2013).

124 Emergency Management Australia website, 'Australian Emergency Management Knowledge Hub: Cyclone Tracy', <http://www.emknowledge.gov.au/resource/?id=386> (accessed 5 June 2013).

125 Emergency Management Australia website, 'Australian Emergency Management Knowledge Hub: Black Friday', <http://www.emknowledge.gov.au/resource/?id=350>; Emergency Management Australia website, 'Australian Emergency Management Knowledge Hub: Ash Wednesday', <http://www.emknowledge.gov.au/resource/?id=131> (accessed 5 June 2013).

126 AMA, *Submission 104*, p. 5; and Doctors for the Environment Australia (DEA), *Submission 108*, p. 5.

127 DEA, *Submission 108*, p. 8.

128 AMA, *Submission 104*, p. 5.

129 DEA, *Submission 108*, p. 5.

130 CAHA, *Submission 52*, p. 9.

incidence of food-borne illnesses, as bacteria such as salmonella thrive in higher temperatures.¹³¹

3.84 The Australian Nursing Federation also observed that heatwaves result in increased doctor visitations, ambulance callouts and presentations to emergency departments and hospital admissions.¹³²

3.85 The risk of heat related health impacts is increased for the elderly, infants and people suffering from existing medical problems (such as heart and pulmonary disease, diabetes, alcoholism, spinal-cord injuries and mental illness). According to the AMA:

The risk of heat-related mortality and morbidity is increased for people with pre-existing illnesses, including cardiovascular disease, psychiatric, neurological and cognitive impairment, diabetes, cancer and obesity. Some medications used to [treat] these conditions may also increase vulnerability to heart-related health effects by compromising thermoregulation, thermal awareness, mobility, or the ability to adopt protective behaviours.¹³³

3.86 The CAHA also identified that the homeless and people who work outside or with minimal access to cooling systems are at an increased risk from heatwaves.¹³⁴

Bushfires

3.87 Bushfires cause injuries and fatalities, lead to people losing their homes and businesses, and communities losing schools and other services such as healthcare.¹³⁵ Some of the most severe health impacts of bushfires are from burns and heat exhaustion due to exposure to extremely high temperatures.¹³⁶ Bushfires also expose people to toxic smoke, particulate matter and increased levels of ground level ozone exposure which can cause respiratory illness and deaths.¹³⁷

3.88 The AMA identified that:

A particular risk in hot weather in Australia is bush fires [sic] and related health risks from smoke and burns. In addition to large scale loss of life and injury, the effects of increased air pollution can impact on respiratory disease among populations that are not directly affected by fire. Bushfire can damage local infrastructure, lead to the contamination of water supplies, and disrupt the delivery of health services. Long term health consequences include post-traumatic stress, depression and anxiety.¹³⁸

131 CAHA, *Submission 52*, p. 10.

132 Australian Nursing Federation, *Submission 20*, p. 6.

133 AMA, *Submission 104*, p. 5.

134 CAHA, *Submission 52*, p. 9.

135 CAHA, *Submission 52*, p. 7.

136 DEA, *Submission 108*, p. 6.

137 CAHA, *Submission 52*, p. 7.

138 AMA, *Submission 104*, p. 6.

3.89 The CAHA also identified longer term health problems associated with bushfires, including alcoholism:

There is also longer term health issues associated with bushfires. The 1983 Ash Wednesday fires were associated with subsequent increased general illness, significant increases in alcohol and drug abuse and an almost 300% increase in mental illness. Professional and volunteer fire fighters and other emergency services personnel are being exposed to unprecedented and likely worsening levels of physical and psychological stress and danger.¹³⁹

Storms and flooding

3.90 The major direct health impacts of floods and storms are associated with injury and death due to drowning and trauma. According to the CAHA, the most common injuries are sprains, lacerations and abrasions.¹⁴⁰ Floods may also be associated with electrical injuries and hypothermia as a result of contact with flood waters.

3.91 Storms and flooding can also impact on human health through an increased incidence of water-borne diseases, diarrhoeal disease, respiratory infection and skin infections.¹⁴¹ Longer-term impacts may include mould in houses that trigger respiratory problems, post-traumatic stress and depression.¹⁴² The damage that storms and flooding inflict on buildings may also result in reduced medical services and limit the ability of medical response teams to get to affected communities. The CAHA noted that:

Floods and cyclones disrupt normal services and can severely affect health care services: the 2011 Qld floods caused 1,396 surgical cases to be cancelled, which led to a 73% increase in waiting times for elective surgery. In addition the Queensland floods caused 33 deaths and destroyed over 36000 homes.¹⁴³

3.92 Doctors for the Environment Australia (DEA) remarked on the longer-term health effects of floods:

More frequent and/or intense storms and floods can result in injuries, diseases, mental health effects and death. Studies have indicated that 70% of people required to move out of homes due to flooding have reported health problems (both physical and mental with children being particularly susceptible to the latter), whilst almost 2/3 of those affected by floods reported that their health had been adversely affected.¹⁴⁴

139 CAHA, *Submission 52*, p. 7.

140 CAHA, *Submission 52*, p. 9.

141 DEA, *Submission 108*, p. 7.

142 DEA, *Submission 108*, p. 7.

143 CAHA, *Submission 52*, p. 9.

144 DEA, *Submission 108*, p. 6.

Psychological impacts

3.93 Mental health problems following a disaster are a key public health issue.¹⁴⁵ The Australian Psychological Society (APS) informed the committee that mental health impacts differ according to the type, suddenness and scale of the catastrophe, and the social, historical and cultural context in which it occurs.¹⁴⁶ Impacts are compounded by the vulnerability of individuals and communities, the appropriateness of emergency responses, and the resources available to provide support and rebuild.¹⁴⁷

3.94 The APS stated:

Mental health problems following a disaster include not only the direct psychological impact of the disaster itself, but also difficulties with managing the emotional difficulties arising from confronting the secondary stressors that disasters generate, like subsequent displacement, unstable housing, and lack of access to support services and employment.¹⁴⁸

3.95 The APS raised concerns that large numbers of people may also suffer from a range of psychological and social problems that are not severe enough to constitute significant mental health problems requiring specialist intervention, but are distressing enough to cause disruptions to work, family life, relationships and everyday life.¹⁴⁹ These impacts may include displacement and relocation, loss of social connections, increased stress and feelings of hopelessness, increased conflict and increased family stress.¹⁵⁰

Social impacts of extreme weather events

3.96 A number of communities around Australia have experienced the devastating effects of extreme weather events in recent years, such as southern Queensland and northern NSW from floods and parts of Victoria from bushfire and heatwaves. These events have destroyed homes, caused people to lose their jobs and placed families under financial stress. The Australian Council of Social Service (ACOSS) highlighted that:

While Australia is a resilient nation, emergencies can have a significant impact on the wellbeing of individuals and communities, having the potential to cause great physical, financial and emotional hardship, as well as loss of life. As such, it is important that consideration of the total cost of the impacts of extreme weather events, which are likely to become more frequent and intense as a result of climate change, include consideration of their social costs, particularly their impact on communities, those more

145 Australian Psychological Society (APS), *Submission 22*, p. 6; see also Department of Health and Ageing, *Submission 126*, pp 2–3.

146 APS, *Submission 22*, p. 6.

147 APS, *Submission 22*, p. 6.

148 APS, *Submission 22*, pp 6–7.

149 APS, *Submission 22*, p. 7.

150 APS, *Submission 22*, p. 7.

vulnerable and disadvantaged within them and the services that support them.¹⁵¹

3.97 People experiencing poverty and inequality are affected first and worst by both direct and indirect exposure to extreme weather events.¹⁵² ACOSS observed that people on low incomes, the unemployed, the elderly, people with disabilities and single parents are often those who suffer the most.¹⁵³ Studies conducted by ACOSS following the 2011 Queensland floods showed that these groups were disproportionately affected as a result of a lack of insurance (or under-insurance), loss of employment through disruptions to and closure of local businesses, loss of rental tenancies and the inability to meet higher bond payments, increased pressure on public housing waiting lists and increased living costs.¹⁵⁴

3.98 During disasters and immediately after, communities are also affected by losses of electricity and water supplies leaving people without heating, cooling, lights and lifts. ACOSS noted that following Hurricane Sandy in New York (2012), the loss of electricity stranded the elderly and disabled and endangered their health:

Without power, lifts and lights in the affected buildings could not cooperate, effectively stranding tens of thousands of residents—many of whom were elderly or living with a disability or chronic health problem—in freezing and pitch black apartments. People in wheelchairs were unable to evacuate, diabetics were left without access to insulin and residents attempting to heat their homes using their stoves suffered carbon monoxide poisoning.¹⁵⁵

Commonwealth government assistance

3.99 In certain natural disasters the Commonwealth government may provide some additional assistance to individuals at the request of the states and territories (which have primary responsibility for the protection of life and property).¹⁵⁶ The respective roles and responsibilities of the Commonwealth, state and territory governments are outlined in further detail in Chapter 5.

3.100 As noted in paragraph 3.21, for certain severe events, the Commonwealth government may provide assistance directly to individuals in addition to the assistance available from the states and territories under the NDRRA.¹⁵⁷ The Australian Government Disaster Recovery Payment (AGDRP) provides a one-off payment to individuals affected by a major disaster to assist with their recovery.¹⁵⁸ The

151 Australian Council of Social Services (ACOSS), *Submission 142*, p. 8.

152 ACOSS, *Submission 142*, p. 8.

153 ACOSS, *Submission 142*, p. 8.

154 ACOSS, *Submission 142*, pp 8–9.

155 ACOSS, *Submission 142*, p. 9.

156 AGD, *Submission 64*, p. 17.

157 AGD, *Submission 64*, p. 17.

158 AGD, *Submission 64*, p. 17.

Commonwealth government expenditure on AGDRP in recent years is detailed in Table 3.3 below.

*Table 3.3: Australian Government Disaster Recovery Payment (\$ million)*¹⁵⁹

Year	NSW	Vic	Qld	WA	SA	Tas	ACT	NT	Aust
2012–13	2.3	...	0.7	...	...	...	...	...	3.0
2011–12	45.1	7.9	20.0	0.2	...	...	...	...	73.3
2010–11	13.4	39.1	767.2	8.1	...	...	...	...	827.7
Total	60.8	47.0	787.9	8.3	0.0	0.0	0.0	0.0	904.0

3.101 Ex gratia assistance may also be made available for certain severe disasters including the Disaster Income Recovery Subsidy (DIRS). The DIRS is generally an equivalent payment to the Newstart Allowance and made available for up to 13 weeks. For example, the Attorney-General's Department stated:

Following the flooding that occurred in many states across Australia during 2010–11, an ex gratia DIRS payment was made available to individuals, small businesses and farmers who had been impacted by the flooding and could demonstrate a loss of income.¹⁶⁰

Community organisations

3.102 ACOSS highlighted that, despite the severity of extreme weather impacts on communities, national and state-based emergency management and other relevant policy frameworks do not adequately resource community service organisations to fulfil the critical role they can and do play in supporting communities and individuals responding to and recovering from emergencies.¹⁶¹ ACOSS stated:

Community service organisations are embedded within their communities, deliver key services across local communities, have in-depth knowledge of local people, history, risks and vulnerabilities and are best placed to understand and identify their support needs. The services they provide are a critical feature of Australian society, complementing the income support system as well as health and education systems. As such, community service organisations comprise an essential component of the social infrastructure in human settlements. Indeed, for many people experiencing poverty, disadvantage and social exclusion, these organisations are often the primary source of connection to the broader community and form the basis of their resilience to everyday adversity as well as in times of crisis.¹⁶²

¹⁵⁹ AGD, *Submission 64*, p. 18.

¹⁶⁰ AGD, *Submission 64*, p. 18.

¹⁶¹ ACOSS, *Submission 142*, pp 9–10.

¹⁶² ACOSS, *Submission 142*, p. 9.

3.103 In 2013 the National Climate Change Adaption Research Facility (NCCARF), Climate Risk and ACOSS released a report on the community sector's preparedness for climate change and extreme weather events.¹⁶³ The report—*Adapting the community sector for climate extremes*—found that community service organisations (CSOs) are 'highly vulnerable and not well prepared to respond to climate change or extreme weather events'.¹⁶⁴ Many small and medium-sized organisations are at risk of permanent closure as a result of major damage to physical infrastructure and disruptions to critical services.¹⁶⁵

3.104 The authors of the report conducted a survey of CSOs to determine the impacts they and their client groups would suffer as a result of physical infrastructure failure and the inherent capacity within organisations to support community resilience to impacts.¹⁶⁶ The report found that one week after an extreme weather event, 50 per cent of organisations that sustain serious damage to their premises would still be out of operation and 25 per cent might never provide services again.¹⁶⁷

3.105 The report concluded that despite the problem of CSO vulnerability and the severity of its consequence, the community sector has been overlooked in climate change adaption policy settings and research agendas. Furthermore, the report stated that:

At present, CSOs perceive an overwhelming range of barriers to action. Key amongst these is a lack of financial resources and skills and the concern that adaption is 'beyond the scope' of the sector's core business.¹⁶⁸

3.106 The report recommended that the Commonwealth government establish a Community Sector Adaption Fund to support capacity and resilience building projects for CSOs and their clients.¹⁶⁹ It also recommended that the community services sector be resourced and supported.¹⁷⁰

163 K. Mallon, et al., *Adapting the community sector for climate extremes*, National Climate Change Adaption Research Facility (NCCARF), Gold Coast, 2013, available at: http://www.nccarf.edu.au/sites/default/files/attached_files_publications/Mallon-Adapting-Community-Sector-Climate-Extremes.pdf (accessed 4 June 2013).

164 K. Mallon, et al., *Adapting the community sector for climate extremes*, NCCARF, Gold Coast, 2013, p. 4.

165 K. Mallon, et al., *Adapting the community sector for climate extremes*, NCCARF, Gold Coast, 2013, p. 4.

166 K. Mallon, et al., *Adapting the community sector for climate extremes*, NCCARF, Gold Coast, 2013, p. 3.

167 K. Mallon, et al., *Adapting the community sector for climate extremes*, NCCARF, Gold Coast, 2013, p. 4.

168 K. Mallon, et al., *Adapting the community sector for climate extremes*, NCCARF, Gold Coast, 2013, p. 4.

169 K. Mallon, et al., *Adapting the community sector for climate extremes*, NCCARF, Gold Coast, 2013, p. 134.

170 K. Mallon, et al., *Adapting the community sector for climate extremes*, NCCARF, Gold Coast, 2013, pp 134–135.

Committee comment

3.107 The committee commends CSOs for their significant contribution during and after extreme weather events. It is the committee's view that the important role of CSOs in assisting communities and individuals during times of natural disaster should be recognised and supported.

3.108 The committee urges authorities to give due regard to CSOs in both planning responses to and responding to extreme weather events, in particular those organisations that provide vital services to vulnerable groups.

Recommendation 5

3.109 The committee recommends relevant authorities work with community service organisations in both planning responses to and responding to extreme weather events, in particular those organisations that provide vital services to vulnerable groups.

Impacts on natural ecosystems

3.110 Extreme weather events can also have significant impacts on natural ecosystems, including biodiversity and water resources. Several submissions expressed concern, for example, about the impacts of bushfires on native species and their habitat.¹⁷¹ However, the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) advised that 'different species may respond in opposite ways to the same extreme weather event', and that while bushfires may destroy populations, even whole species, at the same time they can 'result in the rejuvenation or overpopulation of others'.¹⁷²

3.111 Others expressed concern about the impacts of extreme weather events on southwest Western Australia (WA), a known global biodiversity 'hotspot'.¹⁷³ For example, WWF-Australia submitted that a 'number of recent extreme weather events have provided a worrying insight into the potential impacts of climate change on some of the region's most important species', including the endangered:

- Carnaby's black cockatoo, found only in southwest WA, where an extreme heatwave left over 145 cockatoos dead;¹⁷⁴ and
- black-footed rock wallaby, which has been adversely impacted by recent droughts reducing their food supplies: 'the drought of 2010 is believed to have

171 Wildlife Preservation Society of Queensland - Gold Coast and Hinterland, *Submission 122*, p. 1; Gecko-Gold Coast and Hinterland Environment Council Association, *Submission 121*, p. 6; Environment East Gippsland, *Submission 146*, p. 2.

172 SEWPaC, *Submission 61*, p. 2.

173 WWF-Australia, *Submission 124*, p. 9; Mr Piers Verstegen, Director, CCWA, *Committee Hansard*, 7 March 2013, p. 7; CCWA, *Submission 100*, p. 2.

174 See also Climate Commission, *The Critical Decade: Extreme weather*, April 2013, p. 16 for more discussion of the impacts of extreme heat on terrestrial ecosystems.

been the major underlying cause of the population crash that appeared to occur in that year'.¹⁷⁵

3.112 The Conservation Council of Western Australia (CCWA) was particularly concerned about the impacts of extreme weather events, including drought, heatwaves and bushfires, on the forests of southwest Western Australia.¹⁷⁶ They told the committee that 'huge areas of forests' have died or gone into ecological collapse due to drought events.¹⁷⁷ They argued that extreme weather events would make natural ecosystems more vulnerable to impacts of other activities such as forestry.¹⁷⁸

3.113 Extreme weather events can also have an impact on marine ecosystems. For example, WWF-Australia submitted that extreme weather events have had a particularly severe impact on the Great Barrier Reef, including:

- extensive coral bleaching from high sea surface temperatures;¹⁷⁹
- damage from storms and cyclones—for example, Cyclone Yasi in 2011 caused damage to approximately 15 per cent of the Great Barrier Reef and its ecological effects are likely to be evident for decades;¹⁸⁰
- increased sediment and nutrient loads from heavy rainfall and flooding, which can contribute to coral mortality and adversely impacts on seagrass and turtles.¹⁸¹

3.114 Mr Piers Verstegen from the CCWA also discussed the impacts of extreme weather events, particularly ocean current and temperature changes, on marine ecosystems and fisheries:

Australia's most valuable fishery, the rock lobster fishery, has collapsed. A lot of science is now pointing to the fact that that is due to ocean current and temperature changes. An ocean heatwave has been identified and that has had a significant ecological impact on those marine environments that we rely on for our productive fisheries.¹⁸²

175 WWF-Australia, *Submission 124*, p. 9.

176 Mr Piers Verstegen, CCWA, *Committee Hansard*, 7 March 2013, p. 7; CCWA, *Submission 100*, p. 2.

177 Mr Piers Verstegen, CCWA, *Committee Hansard*, 7 March 2013, pp 2, 7, 11–12; CCWA, *Submission 100*, p. 2.

178 Mr Piers Verstegen, CCWA, *Committee Hansard*, 7 March 2013, p. 7; CCWA, *Submission 100*, pp 2 and 11.

179 WWF-Australia, *Submission 124*, p. 8; see also Climate Commission, *The Critical Decade: Extreme weather*, April 2013, p. 17.

180 WWF-Australia, *Submission 124*, p. 8; see also Climate Commission, *The Critical Decade: Extreme weather*, April 2013, p. 54.

181 WWF-Australia, *Submission 124*, p. 8.

182 Mr Piers Verstegen, CCWA, *Committee Hansard*, 7 March 2013, p. 8 and see also pp 13–14.

3.115 In terms of the costs of extreme weather events as they relate to natural ecosystems, SEWPaC submitted that:

Extreme weather events can also result in complete changes in ecosystem functionality, an outcome that would have significant financial, economic and social impacts for the management of that ecosystem into the future. Costing these impacts is a challenging proposition, even if only the cost of physical restoration is considered.¹⁸³

3.116 SEWPaC further advised that:

Due to the significant costs involved in restoring natural ecosystems following extreme weather events, the Australian Government is generally called on to provide funding support. For example, the Caring for our Country initiative invested \$10.5 million following the 2009 Victorian bushfires and \$9.9 million after the floods and cyclones of 2010.¹⁸⁴

3.117 Concern was also expressed that climate change and extreme weather events 'will exacerbate pre-existing threats to Australia's natural environment'.¹⁸⁵ Professor Lesley Hughes from the Wentworth Group of Concerned Scientists agreed:

Our ecosystems are potentially in dire need of assistance with climate change simply adding to the existing stresses that we have already put upon them... We are already seeing species reacting to climate change by shifting their distributions, by having alterations in their life cycles and by increased mortality during heatwaves and other extreme events.¹⁸⁶

3.118 For this reason, several submissions highlighted the need to build resilience in natural ecosystems.¹⁸⁷ For example, the Wentworth Group of Concerned Scientists argued that more frequent and intense extreme weather events will have significant environmental consequences, and that there is a need to build resilience in natural ecosystems:

The most important response is for the Commonwealth government to support no regrets actions to restore the health of our soils, vegetation and waterways so that these assets are best placed to adapt to these impacts.¹⁸⁸

3.119 SEWPaC advised that there are a number of policies and programs aimed at improving the resilience of natural ecosystems to the impacts of climate change and extreme weather events, including the Biodiversity Fund; Caring for our Country;

183 SEWPaC, *Submission 61*, p. 2.

184 SEWPaC, *Submission 61*, p. 2.

185 WWF-Australia, *Submission 124*, p. 6; see also Mr Piers Verstegen, CCWA, *Committee Hansard*, 7 March 2013, p. 7; CCWA, *Submission 100*, pp 2 and 11.

186 Professor Lesley Hughes, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 29.

187 See, for example, Mr Piers Verstegen, CCWA, *Committee Hansard*, 7 March 2013, pp 8 and 14.

188 Mr Peter Cosier, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 29.

National Wildlife Corridors Plan; and Australia's Native Vegetation Framework.¹⁸⁹ Other relevant initiatives cited by SEWPaC included the National Water Initiative.¹⁹⁰ Finally, SEWPaC noted that one of the core objectives of the Murray-Darling Basin Plan and the Water for the Future programs is to 'improve the resilience of the environmental and community systems of the basin'.¹⁹¹

189 SEWPaC, *Submission 61*, p. 5.

190 SEWPaC, *Committee Hansard*, 11 April 2013, p. 64; SEWPaC, *Submission 61*, pp 5–6.

191 SEWPaC, *Committee Hansard*, 11 April 2013, p. 64; SEWPaC, *Submission 61*, pp 5–6.

Chapter 4

Preparing for extreme weather events

Introduction

4.1 A major focus of this inquiry was to consider how well prepared the Australian community, together with utilities, essential and emergency services and industry are for the predicted increase in the number and intensity of extreme weather events. The impacts of past extreme weather events and projected future impacts are discussed in other chapters.

4.2 Many witnesses made a strong argument for decreasing human effects on the environment in order to reduce the impact of extreme weather events. However, the reality is that cyclones, heavy rainfall causing floods, rising sea levels and tidal surges, heatwaves or bushfires have always been a factor in Australia's climate and will continue to be so, probably to an increasing extent. For this reason, improving the nation's preparedness for these events remains an important way to reduce the risk and impact on people, property and economic stability. The concepts which underpin such preparedness are those of adaptation and mitigation and these are discussed in detail in this chapter. The chapter commences with a consideration of the evidence about preparedness in key sectors and then examines how this applies in emergency situations.¹

Adaptation and mitigation

4.3 Adaptation and mitigation are strategies which refer to positive preparation for extreme events. Specifically, adaptation refers to how societies and ecologies adjust to accommodate new weather patterns, while mitigation refers to measures that are undertaken to reduce the impact of potentially disastrous events when they do occur. Adaptation and mitigation are 'very, very closely related' according to Associate Professor David King of the Centre of Disaster Studies:

We feel that adaptation is one strategy encompassed within mitigation and that if you are trying to get people to be prepared for the next hazard event then you are helping them in terms of adaptation for long-term changes and for increased regularity of events.²

4.4 The Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCS RTE) defined adaptation as 'managing the impact of

1 See terms of reference (c) and (d).

2 Associate Professor David King, Director, Centre of Disaster Studies, James Cook University, *Committee Hansard*, 22 February 2013, p. 10.

climate change'.³ The department described government funded research into adaptation and the linkage between overarching information and practical implementation:

...the government provid[es] the information on which adaptation decisions are based....When it comes to decision making, you need these two things to come together, being the capability at the local level to use that information and to look at how decisions are robust to a range of future scenarios.⁴

General preparedness

4.5 This section describes information received by the committee about Australia's preparedness for extreme weather events. The committee was advised that preparedness varies across the country. While some outstanding examples of adaptation in some geographical locations were presented, deficiencies and gaps were also identified. Likewise some sectors appeared to be better prepared than others. As the Director of the National Climate Change Adaptation Research Facility (NCCARF) put it, all levels of government and the private sector are 'on a pretty steep learning curve with respect to extreme events'.⁵

4.6 Mr John Connor of the Climate Institute described preparedness as 'patchy':

...we compiled Australia's first-ever sectoral resilience and readiness indicators for these sectors. We were surprised, given Australia's history of extremes, that the readiness was patchy. It was poorly coordinated and reliant on historic data. Our infrastructure managers are walking backwards with blinkers on into an uncertain and high-risk feature.⁶

4.7 Associate Professor Laura Stocker from the Curtin University Sustainability Policy Institute went so far to say that there was inadequate planning by the state government and general ignorance in communities.⁷

4.8 The committee heard that in contrast, in the Northern Territory where extreme events occur more regularly, this regularity means that preparations for and responses to such events are better developed.⁸

3 Ms Benedikte Jensen, First Assistant Secretary, Adaptation, Science and Communications Division, DIICCS RTE, *Committee Hansard*, 11 April 2013, p. 62.

4 Ms Benedikte Jensen, DIICCS RTE, *Committee Hansard*, 11 April 2013, p. 63.

5 Professor Jean Palutikof, NCCARF, *Committee Hansard*, 10 April 2013, p. 31.

6 Mr John Connor, Chief Executive Officer, The Climate Institute, *Committee Hansard*, 11 April 2013, p. 38.

7 Associate Professor Laura Stocker, Coastal Collaboration Cluster, Curtin University Sustainability Policy Institute, *Committee Hansard*, 7 March 2013, p. 17.

8 Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, pp 1–6.

I would just like to say by way of introduction that the Northern Territory is quite used to having emergency events every year. It is well practised in the management of flooding through the wet season as a matter of course, with towns being cut off as a matter of course. So a lot of what might be seen as an emergency down in the southern regions is a fact of life up here and we are organised to deal with it.⁹

4.9 The committee was advised that the business sector was conspicuously absent from long-term planning for extreme weather. Mr Ian Dunlop, formerly an executive in the energy industry advised the committee that, in his view, business leaders had underestimated both the extent and speed of climate change.¹⁰

Implementation

4.10 This section provides an overview of some of the issues relating to implementation of strategies for adaptation and mitigation. Green Cross Australia gave an example of how the twin strategies of mitigation and adaptation can deliver benefits:

...where you can integrate adaptation and mitigation it is a great idea. When we talk to companies like BlueScope Steel that have rooftops that resist hail and also are painted white—so there are less insurance claims, there is less damage from storms, they are reflective and cooler to live in—it just strikes us as a win-win.¹¹

4.11 Professor David Karoly, representing the Wentworth Group of Concerned Scientists, described some successful adaptations taking place in Australia in response to previous disasters, but noted that much more was needed:

In fact, what has happened in Australia over time is changes—very sensible changes—in adaptation to past extreme events, such as Cyclone Tracy leading to changes in building codes in northern Australia, or changes in protection against wildfires, and the massive improvements that we have had in the technology and infrastructure that is now available, such as the helicopters and the aircraft, for fighting bushfires. There have been massive adaptive responses. They are not sufficient.¹²

9 Mr Peter Davies, Acting Chief Information Officer, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, pp 1 & 4.

10 Mr Ian Dunlop, *Committee Hansard*, 7 June 2013, pp 17 & 19.

11 Ms Mara Bun, Chief Executive Officer, Green Cross Australia, *Committee Hansard*, 22 February 2013, p. 17.

12 Professor David Karoly, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 33.

4.12 Despite these positive examples, according to the Australian Local Government Association (ALGA), there has been a reduction in local mitigation projects in recent years.¹³

4.13 Similarly, Mr Glenn Evans of the Floodplain Management Association claimed that flood risk management plans have been left unimplemented due to lack of funding and that 'flood mitigation has ceased to be a top-of-mind issue in all levels of government'.¹⁴ Mr Evans was of the view that local councils had reduced numbers of staff with necessary expertise, leading to increased delays in implementation.¹⁵

4.14 Mr Evans expressed concern that assessment of flood risk in land use planning did not take place at the appropriate time in the process:

There needs to be an assessment of the flood risk of land proposed for development right at the beginning of the planning process. In New South Wales the assessment of flood risk often happens a fair way up the chain. You might actually be at the development application stage before there are detailed flood assessments. By that time there are already financial commitments to develop that site. Even if the site may be deemed a suitable risk, there are often huge additional costs involved in building things on that site to suit the flood risk; whereas, if the assessment of flood risk had been carried out initially it might have been decided, "This is not really a good place to build".¹⁶

4.15 Mitigation for flooding often takes the form of protective walls, but witnesses indicated that flood planning is more complex than simply erecting defences. While protective infrastructure can reduce vulnerability to floods, the committee was advised that 'they also bring problems because they can encourage more and more development behind them and no levy is going to stop every flood'.¹⁷ This concern was echoed by Mr Evans who argued that levees can cause complacency about flood risk:

There will nearly always be a bigger flood than what you design for...If it overtops, it comes very quickly and it becomes too late for people to evacuate, so there is the potential for disaster...[Locals] ignored the advice [to evacuate] because there was a mitigation structure in place.¹⁸

13 Mr Adrian Beresford-Wylie, Chief Executive, ALGA, *Committee Hansard*, 11 April 2013, p. 2.

14 Mr Glenn Evans, Executive Officer, Floodplain Management Association, *Committee Hansard*, 10 April 2013, p. 21.

15 Mr Glenn Evans, Floodplain Management Association, *Committee Hansard*, 10 April 2013, p. 21.

16 Mr Glenn Evans, Floodplain Management Association, *Committee Hansard*, 10 April 2013, p. 21.

17 Professor John McAneney, Managing Director, Risk Frontiers, *Committee Hansard*, 10 April 2013, p. 4.

18 Mr Glenn Evans, Floodplain Management Association, *Committee Hansard*, 10 April 2013, p. 22.

4.16 Another weakness in general land use planning was identified by NCCARF who stated that local government:

...lack[s] the support that they need in terms of policy, regulation and legislation in order to feel that they are able to act around adaptation. Especially people working in local government but also people working in [the] private sector do not feel that they have got the regulatory framework that allows them to act with confidence.¹⁹

4.17 A significant aspect of mitigation is how it is to be funded, as multiple local projects, many as yet uncostered, would be involved. The Insurance Australia Group (IAG) has analysed funding as having two aspects: affordability of insurance (see Chapter 3) and government access to funding. IAG advised the committee that:

The first one is about insurance affordability and how we make sure that the broader spectrum of community can continue to afford insurance and protect their assets so that they do not ultimately fall back to government...

The second piece then is: how does government actually get access to funding and coordinate funding to be able to invest in mitigation that will ultimately reduce the economic cost of losses over time?²⁰

4.18 Representatives of the insurance industry alerted the committee to the practical implications of adapting to extreme weather events:

From the insurance industry's perspective, the need for adaptation to extreme weather conditions is not a theoretical exercise or something that we need to contemplate doing in 10, 20 or 30 years' time; it is something that we are paying money and claims about right now, so we actually need to see adaptation of the built environment sooner rather than later.²¹

4.19 While the committee heard some good news in relation to mitigation and adaptation at a local level, evidence presented to the committee suggests that there is much to be done before adaptation and mitigation strategies are being adequately implemented.

Communication and coordination

4.20 The committee considered evidence that poor communication, inadequate coordination and inconsistency are among the most significant barriers to preparation for extreme weather events. The challenge of coordination across different jurisdictions and sectors is discussed in detail in Chapter 5 and will only be briefly addressed here. However, from the evidence the committee notes that while some progress has been made in communicating important messages to enable community

19 Professor Jean Palutikof, NCCARF, *Committee Hansard*, 10 April 2013, p. 31.

20 Ms Julie Batch, Group General Manager, Reinsurance, IAG, *Committee Hansard*, 10 April 2013, p. 14.

21 Mr Karl Sullivan, General Manager Policy–Risk and Disaster Planning Directorate, Insurance Council of Australia (ICA), *Committee Hansard*, 10 April 2013, p. 10.

members and organisations to be better prepared for extreme weather events, there is still much work to be done in this area.

4.21 Dr Cassandra Goldie, Chief Executive Officer of the Australian Council of Social Service (ACOSS), encouraged the Commonwealth government to take an active role in collaboration:

We think there is a need for a deliberate process at that level to draw up what has worked, to work out what is scalable and what does need to be mandated, and what on the alternative needs to be enabling. ...Also I think we do need to be ensuring there is a way to get through to local organisations. We also see local government having a key role here in providing the frameworks for the ongoing coordination of local action.²²

4.22 Dr Blair Trewin from the Australian Meteorological and Oceanographic Society observed that:

There is definitely a need for improving communication between the agencies doing research and people on the ground who are at the sharp end of climate change adaptation.... Another part of that is making sure there is good and relevant resource material available from the science community in a form that is accessible to other decision makers.²³

4.23 Another example of confusion was this description by the Tasmanian Branch of the Environmental Defenders Office:

At a recent climate change adaptation forum in Hobart, numerous council representatives expressed frustration at the volume of conflicting information regarding climate change impacts and the difficulty in obtaining credible, consistent advice to guide their policy decisions.²⁴

4.24 The implication of a lack of coordination and communication is that if people do not know who is responsible or how to organise the multiple strands of adaptation and mitigation, then preparedness will be disjointed and much less effective.

4.25 The committee also heard evidence that there are two aspects of communication which are relevant—communication between instrumentalities and sectors, and communication to citizens on the ground in vulnerable situations.

4.26 The Australian Conservation Foundation (ACF) noted the following principles of effective communication:

- local specific information

22 Dr Cassandra Goldie, ACOSS, *Committee Hansard*, 11 April 2013, p. 49.

23 Dr Blair Trewin, President, Australian Meteorological and Oceanographic Society, *Committee Hansard*, 20 February 2013, p. 21.

24 Environmental Defenders Office (Tasmania), *Submission 148*, p. 3.

- research on the best way of communicating the risks of climate change and extreme weather so citizens are prepared.²⁵

4.27 The committee considers that good communication with local groups is vital if such principles are to be applied, yet representatives of community service organisations told the committee that these groups are routinely left out of prior planning and collaboration, and consider that they are not adequately resourced for the demands of extreme events.²⁶

What we have identified is that, when these things come along, they actually cripple the [community service] organisations that look to their needs...[A]fter a week 50 per cent of those organisations who provide food, medicine, disabled access and so on would not be operating...

...when we have organisations which are well prepared and are operational...they become part of the solution. Indeed, they take some of the load off our traditional services.²⁷

4.28 In a time of emergency, communication takes on a particular urgency. However, a number of witnesses provided information about the cost of having good communication systems in place. The committee was advised by the Northern Territory Police, Fire and Emergency Services:

Luckily for us in the Territory one of the television stations plays a lot of emergency management advertising free; otherwise, we would not be able to afford it. But routine messages are really important. And increasingly doing them from a national perspective is also important...so that there is a consistent message being given to them about how to handle an emergency.²⁸

4.29 Dr Michael Eburn described for the committee a lack of clarity about people's responsibilities during Black Saturday:

Right down to the chief officers of those agencies, people were unclear on what their responsibility was. That comes down to the state legislation. I think state disaster plans are, despite their best efforts, very unclear about who is in charge of what and, in particular, about where the police sit against everybody else. That leads to a lot of confusion.²⁹

25 ACF, *Submission 36*, p. 2.

26 Dr Karl Mallon, Director, Science and Systems, Climate Risk Pty Ltd, *Committee Hansard*, 11 April 2013, p. 50; *Committee Hansard*, 11 April 2013, pp 46f.

27 Dr Karl Mallon, Climate Risk Pty Ltd, *Committee Hansard*, 11 April 2013, p. 50.

28 Mr Peter Davies, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, p. 5.

29 Dr Michael Eburn, *Committee Hansard*, 11 April 2013, p. 16.

4.30 Communication of heat alerts is an area where there has been some success and Australian systems have used lessons learned from reports of disasters in Europe. Professor Nicholls advised the committee that:

In Melbourne we had a system in place before the 2009 heatwave the weekend before Black Saturday and we know that worked quite well. It has been further developed by the Department of Human Services in Victoria and their counterparts in other parts of Australia are also doing a good job to improve these sorts of systems. We can always do better but I think it is one of the success stories of the last decade.³⁰

4.31 Good communication within the community was raised as a critical aspect of medical and health preparedness. The Australian Medical Association (AMA) advised that GPs should be anticipating more extreme conditions and advising at-risk groups in advance:

...we see the elderly eight or nine times a year, on average, in our surgeries; and there is an opportunity for primary-care providers, as part of their preventive health impacts with their patients, to actually explain to people about ventilation, perspiration, evaporation and when it is appropriate to switch on that air conditioner...

The other time of life we have to be really careful of is infancy...New parents do not know some of these clues, and it is up to us to tell them.³¹

Knowledge and social capital

4.32 One of the major themes that came out of evidence presented to the committee was that of the need for improvements in community understanding and knowledge about how to prepare for and respond to, extreme weather events, and for this knowledge to be based on solid research and empirical evidence.

4.33 Submitters to this inquiry expressed deep concern about changes to climate and weather patterns, and many questioned the current level of education and public awareness in relation to how to manage extreme weather events.³² The committee also heard from witnesses and submitters who suggest that people and organisations need to build relationships and social capital in order to be able to prepare and respond appropriately to extreme weather events.³³

4.34 The City of Melbourne advised the committee of their research to determine residents' preparedness for impacts of weather changes predicted for Melbourne. This research found that that 35 per cent of residents and 50 per cent of businesses perceive

30 Professor Neville Nicholls, *Committee Hansard*, 20 February 2013, p. 9.

31 Dr Steve Hambleton, President, AMA, *Committee Hansard*, 11 April 2013, p. 27.

32 Ms Mara Bun, Green Cross Australia, *Committee Hansard*, 22 February 2013, p. 17.

33 Mr David Cummins, *Submission 25*, p. 1; Ms Mara Bun, Green Cross Australia, *Committee Hansard*, 22 February 2013, p. 23.

a risk from extreme weather events. Only 53 per cent felt prepared for very hot days and only 41 per cent for flooding.³⁴ Only 16 per cent of businesses knew how to develop a flood plan.³⁵ The City of Melbourne suggested that 'ambiguity surrounding roles and responsibilities in preparing for extreme weather events...hampers the ability of the local government sector to prepare for and manage [them]'.³⁶

The need for research

4.35 For the Australian community to be better prepared for extreme weather events, accessible and straightforward communication of complex scientific and economic information is important. Research gaps and the need for improved observations and data collection around extreme weather was discussed in Chapter 2. The following section of the report considers research into effective preparedness for extreme weather events.

4.36 Ms Olivia Kember of the Climate Institute noted that in some circumstances there may be pressure for information to be withheld and that this may hinder adaptation and mitigation:

For some of these issues, there are going to be groups that stand to lose value by the disclosure of the true risks that they are facing. So there is always a risk that there will be political pressure for those findings not to be disclosed, which I think comes back to why we think disclosure early and often is really important.³⁷

4.37 It was apparent to the committee that submitters and witnesses on the whole believed that sound research was very important. Both the Bureau of Meteorology (BoM) and CSIRO noted that physical data is fairly straightforward, but 'the nonphysical and social data starts to get harder'³⁸ and that:

...there is plenty of science in other areas, including the social sciences, looking at things like barriers to adaptation, which we still have quite a bit to do on to understand...³⁹

4.38 Dr Mark Stafford Smith from CSIRO added that:

34 The City of Melbourne, *Submission 63*, p. 1.

35 The City of Melbourne, *Submission 63*, p. 3.

36 The City of Melbourne, *Submission 63*, p. 3.

37 Ms Olivia Kember, National Policy and Research Manager, The Climate Institute, *Committee Hansard*, 11 April 2013, p. 42.

38 Dr Neville Smith, Deputy Director, Research and Systems, BoM, *Committee Hansard*, 11 April 2013, p. 56.

39 Dr Mark Stafford Smith, Science Director, CSIRO Climate Adaption Flagship, *Committee Hansard*, 11 April 2013, p. 57.

...responding to sea level rise [is] very complex. We are moving really into the social sciences of people's responses there and I do not think that is resolved.⁴⁰

4.39 Some witnesses indicated that much more research is needed to enable effective decision-making and recommendations about reliable preparedness strategies. Others indicated there are knowledge gaps in certain areas,⁴¹ and a need for more long-term funding for specialist research to be undertaken by well prepared and competent scientists.⁴²

Infrastructure

4.40 Some of the impacts of extreme weather events on infrastructure and the subsequent disruptions to Australian communities and businesses are discussed in Chapter 3. Preparedness for extreme weather events requires that infrastructure is adapted appropriately for such events and that it has built-in qualities to mitigate the worst effects of these events. Such adaptations refer both to physical structures and to organisational structures that support them.

4.41 The Climate and Health Alliance (CAHA) advised the committee that the predicted 1–5 degree rise in the earth's temperature could have catastrophic impacts on human life and health.⁴³ The CAHA presented the committee with research to show that current infrastructure is inadequate to respond to the impacts likely to ensue from more intense and frequent heatwaves. Indeed, problems already exist:

...heatwaves in Melbourne and Adelaide in 2009 put power supplies, morgue capacity and transport systems under stress. In Adelaide, railways buckled under the heat and commercial refrigeration vans were hired as makeshift morgues.⁴⁴

4.42 The Climate Institute stressed the interdependence of infrastructure and described the roll-on effect of extreme heat leading to such events as buckling railway lines resulting in the closure of services, preventing employees from getting to work

40 Dr Mark Stafford Smith, Science Director, CSIRO Climate Adaption Flagship, *Committee Hansard*, 11 April 2013, p. 57.

41 Dr Blair Trewin, Australian Meteorological and Oceanographic Society, *Committee Hansard*, 20 February 2013, p. 20.

42 Dr Blair Trewin, Australian Meteorological and Oceanographic Society, *Committee Hansard*, 20 February 2013, p. 22. See also Mr Paul Considine, Manager, Operations, Australasian Fire and Emergency Services Authorities Council (AFAC), *Committee Hansard*, 20 February 2013, p. 5; Mr Gary Morgan, Bushfire Cooperative Research Centre, *Committee Hansard*, 20 February 2013, Dr Anthony Kiem, *Committee Hansard*, 11 April 2013, pp 13 and 12–15; Ms Fiona Armstrong, Convenor, CAHA, *Committee Hansard*, 20 February 2013, p. 30.

43 Ms Fiona Armstrong, CAHA, *Committee Hansard*, 20 February 2013, p. 25.

44 Ms Fiona Armstrong, CAHA, *Committee Hansard*, 20 February 2013, p. 25.

and resulting in a loss to businesses. The institute suggested that better scenario-based planning could allow people and organisations to be prepared for impacts:

[W]e do think there should be better focus on two- and four-degree scenarios for risk management and risk planning across government, and that governments are doing. We do think there are key tests that agencies with oversight of standards, such as the building commission, need...Finally, the Commonwealth should be a leader in...getting agencies themselves to look at and disclose those risks.⁴⁵

4.43 It was generally agreed that extreme weather events also require much greater numbers of personnel on the ground to assist with, and manage impacts.⁴⁶ Professor Nicholls observed:

...one of the problems with adaptation of any sort to climate change, particularly with something like this, is that it is a very personnel intense, that you would need a lot of people to be talking to a lot of other people.⁴⁷

4.44 Engineers Australia defined two aspects of infrastructure preparedness: operational and strategic. Operational preparedness is 'geared to preparing, responding and recovering so that when damage occurs to infrastructure, continuity is rapidly restored'. Strategic preparedness is 'geared to preventing damage from occurring or minimising its impact'. Engineers Australia emphasised that it is difficult to assess preparedness as there are no standard metrics across Australia.⁴⁸ In the absence of rigorous measurements, they based their conclusions on examination of responses to recent disastrous events. Their conclusion was that there is reasonable operational preparedness but 'a low level of strategic preparedness'.⁴⁹

4.45 It was noted that preparedness was patchy across different sectors.⁵⁰ According to the Climate Institute, water infrastructure is quite well prepared, and some property areas, but with transport and electricity infrastructure 'there were some issues where we found very poor preparation, very much reliance on historical data'.⁵¹

4.46 The South Australian State Emergency Management Committee (SEMC) felt that South Australia was well prepared for emergencies:

45 Mr John Connor, The Climate Institute, *Committee Hansard*, 11 April 2013, pp 39–40.

46 Mr Paul Considine, AFAC, *Committee Hansard*, 20 February 2013, p. 3; Mr Andrew Coghlan, National Manager, Emergency Services, Australian Red Cross, *Committee Hansard*, 20 February 2013, pp 32–34.

47 Professor Neville Nicholls, *Committee Hansard*, 20 February 2013, p. 10.

48 Engineers Australia, *Submission 128*, p. 7.

49 Engineers Australia, *Submission 128*, p. 8.

50 Ms Olivia Kember, The Climate Institute, *Committee Hansard*, 11 April 2013, p. 40.

51 Mr John Connor, The Climate Institute, *Committee Hansard*, 11 April 2013, p. 40.

The SEMC supports the national policy shift towards building community resilience to natural disasters...

South Australia has undertaken a Critical Infrastructure Protection program in line with the national critical infrastructure model. Under this program South Australian Government authorities collaborate with the owners and operators of critical infrastructure to ensure risk assessments are undertaken and protective mitigation measures implemented.⁵²

4.47 University of Queensland researchers gave evidence from the 2010-11 Queensland floods on the issue of food security. The general disruption caused crops to be spoilt, products not to reach processing plants, severely reduced distribution, food shortages and price increases. While alternative transportation, supply sources and relaxing quality standards mitigated the impact to some extent, their evidence suggests inadequate preparation especially among community members who resorted to panic buying.⁵³ The submission commented that:

...some sections of the community suffered from low levels of 'food literacy' during and after the floods. Food literacy captures peoples' ability to identify and use fresh and nutritious food, ensuring a healthy diet and avoiding waste.⁵⁴

4.48 The Local Government Association of Queensland (LGAQ) drew attention to exclusions and limitations in the Natural Disaster Relief and Recovery Arrangements Determination which mean that 'only one betterment application had been approved so far'.⁵⁵ The LGAQ stated that:

From a long term resilience building perspective, of the 73 councils in Queensland the LGAQ estimates that the majority of councils are not where they should be...Approximately 2/3 of councils will have undertaken some work in a particular area.⁵⁶

4.49 It attributed lack of adaptation strategies to a paucity of good quality data, limited people and financial resources, and failure by communities to demand action.⁵⁷

52 SEMC, *Submission 162*, p. 9.

53 Ms Amy McMahon, Dr Kiah Smith, Ms Jane Muller, Mr Paul Belesky and Professor Geoffrey Lawrence, *Submission 35*, pp 3–4.

54 Ms Amy McMahon, Dr Kiah Smith, Ms Jane Muller, Mr Paul Belesky and Professor Geoffrey Lawrence, *Submission 35*, p. 7.

55 Local Government Association of Queensland, *Submission 68*, p. 4.

56 Local Government Association of Queensland, *Submission 68*, p. 4.

57 Local Government Association of Queensland, *Submission 68*, p. 4.

Electricity, transport and water

4.50 As mentioned above, the committee heard that the preparedness of essential services, such as electricity, transport and water, to cope with extreme weather events is variable.

4.51 Mr James Hanson from the Conservation Council of Western Australia commented on the correlation between very hot weather and energy demand. Some relevant policy measures that have been proposed are:

- increasing the price of power to reflect the cost of producing the power;
- smart meters; and
- managing peaks over short high intensity demand periods.⁵⁸

4.52 However, these mitigation measures are not necessarily in place.

4.53 Attention was drawn to the vulnerability of local electricity services where power poles (particularly wooden poles) and wires may fail and cause fires during heat waves, while transformers should be operable under all conditions.⁵⁹

4.54 At the macro level, the Clean Energy Council submitted that since the electricity sector is the major source of Australia's greenhouse gas emissions, preparation should be underway to make 'a rapid switch to low carbon heating, cooling and electricity generation'.⁶⁰

4.55 In the transport sector, the Climate Institute suggested that railways were responding positively and 'putting in place plans to improve. They have extended their risk assessment to cover climate change'.⁶¹

4.56 The Australia National Retailers Association (ANRA) noted the importance of getting supplies into disaster areas. During the 2011 Queensland floods, stock was damaged while roads were cut (see also Chapter 3):

Despite this challenge, the use of novel methods for overcoming constraints in the transport networks - incorporating aspects of the road, rail, air and sea freight networks from as far away as Adelaide, Sydney and Darwin - meant that households in isolated areas did not go without basic necessities for survival.⁶²

4.57 However, ANRA also noted room for improvement:

58 Mr James Hanson, Climate and Energy Program Manager, Conservation Council of Western Australia, *Committee Hansard*, 7 March 2013, p. 11.

59 Conservation Council of South Australia, *Submission 120*, p. 4.

60 Clean Energy Council, *Submission 118*, pp 3 & 4.

61 Ms Olivia Kember, The Climate Institute, *Committee Hansard*, 11 April 2013, p. 41.

62 ANRA, *Submission 110*, p. 1.

- there was no mechanism for any dialogue with retailers initially;
- there were perceived difficulties in Australian Defence Force participation because of regulations and lack of common standards for packing; and
- applying normal trading restrictions limited availability of essential items.⁶³

4.58 The committee was advised that Sydney Water had undertaken some studies to evaluate its strengths and opportunities under climate change conditions. Research data indicated that the five water utilities surveyed were:

- Reasonably strong in their ability to "survive a crisis";
- Less able in the area of "thriving in a world of uncertainty";
- Strong on the emergency side but business as usual has more room for improvement.⁶⁴

4.59 In its submission, the Water Services Association of Australia (WSAA) summarised its progress to respond to extreme weather events through:

- diversifying water supplies;
- reducing water use;
- improving the way utilities manage waterways and wetlands;
- changing the way decisions are made;
- rethinking advice for development in flood prone and vulnerable coastal areas;
- planning for risk.⁶⁵

Telecommunications

4.60 The ability of agencies and citizens to respond to extreme weather events is particularly reliant on telecommunication and communications networks. The committee heard that the major issue for telecommunications is whether operations continue effectively in an extreme weather event. The capacity of communication networks to deal with emergencies and natural disasters was the subject of a previous inquiry by this committee and more information on this topic may be found in that report.⁶⁶

63 ANRA, *Submission 110*, p. 2.

64 WSAA, *Submission 76, Attachment 2 (Benchmarking resilience)*, p. 5.

65 WSAA, *Submission 76*, p. 7.

66 Senate Environment and Communications References Committee, *The capacity of communication networks and emergency warning systems to deal with emergencies and natural disasters*, November 2011.

4.61 A range of communications technologies have been used effectively in recent times to warn people of impending weather crises.⁶⁷ However, while weather forecasting is much more accurate than in the past, the committee heard that people still need convincing to trust and act on this information.⁶⁸

4.62 In disaster situations, telecommunications can be adversely affected. Ms Yve Earnshaw, Director of Dunalley Community Neighbourhood Centre, described the needs of the Nubeena community in Tasmania after the recent bushfire:

There were thousands of people trapped in the region and there was no power. We went and opened up the community house with a generator—it is my and my husband's own generator. Basically, we plugged it in and set up some computers, and we got an old telephone to plug into the wall because, of course, with no power, only old landlines would work. We wondered what was going to happen. Then, over the next few days, literally hundreds of people came through the house to use the internet and to charge their mobile phones...There were no communications available in the region, virtually, except for emergency personnel.⁶⁹

4.63 Telstra's submission asserted its growing capacity in relation to extreme weather events. It noted its Global Operations Centre, Major Incident Management and training of technical staff so that they can be 'highly effective in responding to extreme weather events'.⁷⁰ Telstra advised the committee of its corporate Crisis Management team, which both resolves crisis generated problems and also anticipates planning required for such crises.⁷¹

4.64 The Australian Mobile Telecommunications Association (AMTA) submitted that existing networks are well placed to deal with extreme weather events and itemised examples of effective responses. The capability depends on:

...having in place appropriate processes and the ability to deploy personnel and resources quickly and efficiently. Appropriate processes and protocols include having established points of contact for ESOs [Emergency Service Organisations] and network operators.⁷²

4.65 AMTA also noted that:

...the resilience of mobile networks in bushfire-prone areas is partially dependent on maintaining a schedule of back burning around mobile base stations. This is an example of how regular preparedness processes are vital

67 Mr Paul Considine, AFAC, *Committee Hansard*, 20 February 2013, p. 2.

68 Professor Neville Nicholls, *Committee Hansard*, 20 February 2013, p. 9.

69 Ms Yve Earnshaw, Dunalley Community Neighbourhood Centre Inc., *Committee Hansard*, 11 April 2013, p. 47.

70 Telstra, *Submission 112*, p. 2.

71 Telstra, *Submission 112*, p. 2.

72 AMTA *Submission 79*, p. 3.

to ensuring the resilience of telecommunications networks during natural disasters or emergencies.⁷³

4.66 The Department of Broadband, Communications and the Digital Economy (DBCDE) said that providers had learnt from recent events and are updating their responses. Temporary systems are being used 'routinely' to circumvent loss of function when infrastructure is damaged. Their submission referred to quick responses in recent bushfire events. The National Broadband Network (NBN) is designed with back-up built into it and it has 'specified high availability and reliability targets for its Long Term Satellite System'.⁷⁴ In addition, the government is working with states and territories to 'improve the effectiveness, clarity and consistency broadcasting emergency warnings'.⁷⁵

Construction and property

4.67 The most significant adaptation for the construction and property industry is to build structures in places which will not be risk prone under changed climate conditions. Yet in this area the committee heard much evidence that there is confusion of responsibilities and often resistance from individuals and organisations who do not factor these risks into their plans.

4.68 The most important mitigation strategy is to make buildings according to specifications which will limit damage in extreme conditions. Witnesses and submitters advised the committee that progress was being made, although existing buildings and building standards need updating.

4.69 The Insurance Council of Australia (ICA) identified several steps to preparing for extreme weather events:

- The first is creating better buildings... we are interested in building code changes to enhance the durability of property...
- We are keen to see a requirement at a national level for the risk-appropriate use of available land... to develop [floodplains] ... in a risk-appropriate fashion...
- We need to create an informed, risk-aware community by providing clear, credible, understandable hazard information at a property level for all individuals so that they can make the right decisions about their future in that location and how to insure themselves appropriately...
- We need to work to protect those existing communities from the exposures they have now through better mitigation.⁷⁶

73 AMTA Submission 79, p. 5

74 DBCDE), Submission 66, p. 2.

75 DBCDE, Submission 66, p. 3.

76 Mr Karl Sullivan, ICA, Committee Hansard, p. 11.

Where structures are built

4.70 The summation of the causes of loss through natural disasters given by Professor John McAneney from Risk Frontiers was that:

...the increasing cost of natural disasters is mainly driven by more and more stuff being built in harm's way. These losses and this trend cannot be attributed yet to global climate change.⁷⁷

4.71 The Wentworth Group of Concerned Scientists noted the historical legacy of inappropriate building sites:

We have allowed infrastructure to go to places which are in harm's way to natural forces....So extreme event phenomena have impacted adversely on our society ever since the Governor Macquarie days. What we do not have is a clear articulation as to what is at risk now and what could be at risk in the future with growing population.⁷⁸

4.72 Information from the Coastal Collaboration Centre stated that certain highly vulnerable coastal areas in Western Australian would be exempted in legislation from limitations on development due to projected sea-level rise. These included areas in Bunbury and Derby:⁷⁹

That state coastal planning policy includes a response to increased expectations of sea-level rise. The policy drafted by the [state] Department of Planning is definitely an improvement ...[but] interpretation [of that policy] is likely to mean that development will probably continue on the coast in certain coastal development nodes and that areas that are identified as critical for economic return will be exempt from the increased setback for coastal planning.⁸⁰

4.73 The committed heard evidence which placed state and local government at the centre of decisions for land usage. Mr Paul Considine from the Australasian Fire and Emergency Services Authorities Council (AFAC) suggested that the key issue is that property owners understand and explicitly accept the level of risk that comes with their usage. He rejected the common idea that responsibility rested with emergency services:

77 Professor John McAneney, Risk Frontiers, *Committee Hansard*, 10 April 2013, p. 1.

78 Professor Bruce Thom, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 30.

79 Associate Professor Laura Stocker, Coastal Collaboration Cluster, Curtin University Sustainability Policy Institute, *Committee Hansard*, 7 March 2013, p. 17.

80 Associate Professor Laura Stocker, Coastal Collaboration Cluster, Curtin University Sustainability Policy Institute, *Committee Hansard*, 7 March 2013, p. 16.

What we want people to understand is that using land which is subject to natural catastrophes comes with risks and that those risks cannot be deferred to emergency services or passed on. They have to be accepted.⁸¹

4.74 Professor Rodger Tomlinson also commented on the issue of land values and building in unsuitable places:

To be a little bit flippant, it seems that the closer you get to the shoreline the more value there is, if you just look at property values...[Property owners] do not really respond because they want to be there—until it is too late, of course.⁸²

4.75 The Northern Territory Police gave a succinct summary of this dilemma:

Part of the problem we have here is that the best places to live for 99 per cent of the time are the worst places to be when the extreme event comes along.⁸³

4.76 He emphasised the importance of a long term view in planning which would acknowledge that if people build in vulnerable places and their houses fall, they will have to deal with that, and, if they are not able, state and territory governments will be expected to bear the costs.⁸⁴

4.77 Professor Thom expressed concern that the finance sector did not consider disaster risk when giving loans for houses:

But with coastal areas there is no doubt that many people are prepared to still live in vulnerable areas and not have insurance; but still they get loans to have houses there. This really bothers me.⁸⁵

4.78 The committee was advised that appropriate land use may be undermined by ill-informed decisions. For example, Climate Future claimed that:

...the NSW Govt. has stated that Councils should no longer use the benchmarks for sea level rise set in 2010. Instead they have to develop their own benchmarks. This has left many Councils in limbo with no support for action to reduce storm impacts on the community.⁸⁶

81 Mr Paul Considine, AFAC, *Committee Hansard*, 20 February 2013 p. 4.

82 Professor Rodger Tomlinson, Director, Griffith Centre for Coastal Management, Griffith University, *Committee Hansard*, 22 February 2013, p. 27.

83 Mr Peter Davies, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, p. 7.

84 Mr Peter Davies, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, p. 7.

85 Professor Bruce Thom, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 32.

86 Climate Future, *Submission 50*, p. 3.

4.79 Similarly the Director of the Centre for Disaster Studies at James Cook University, Associate Professor King, noted problems with Queensland legislation:

The Queensland State Planning Policy 1/03 has not been effective in guiding land use planning in vulnerable locations. ...Ideally the primary planning legislation should directly identify hazard mitigation planning under the act, so that it is central to planning rather than an add-on through a state planning policy. This will require a significant rewriting of the Sustainable Planning Act (or a new act) in Queensland, and most probably in other states as well. Issues of public safety have to be compulsory, not an option of best practice.⁸⁷

4.80 Mr Evans from the Floodplain Management Association also noted inappropriate siting of buildings and said that future development should not occur in places which require flood levees or other mitigation strategies.⁸⁸

4.81 Several witnesses drew attention to inadequacies in the important area of flood mapping. For example, Associate Professor King emphasised the need for comprehensive flood studies: 'In some cases [this] is going to be expensive, but you cannot make any decisions until you have these comprehensive studies'.⁸⁹ This was a point he returned to several times in speaking with the committee, summarising in these terms:

Good, comprehensive flood mapping makes it possible to define where these areas are—which are the most vulnerable—to rank them in terms of vulnerability and then to begin a process of perhaps trying to persuade people to relocate, to sell their houses and to gradually rezone over a long period of time. It will not be a short process.⁹⁰

How structures are built

4.82 The committee heard that there are two major issues in construction:

- having building codes which are better aligned with increased risks from more frequent and more intense extreme weather events; and
- providing incentives which facilitate 'building better', not just replacing damaged structures.

4.83 Associate Professor King submitted that:

87 Associate Professor David King, Centre for Disaster Studies, James Cook University, *Submission 82*, p. 3.

88 Mr Glenn Evans, Floodplain Management Association, *Committee Hansard*, 10 April 2013, p. 22.

89 Associate Professor David King, Centre for Disaster Studies, James Cook University, *Committee Hansard*, 22 February 2013, p. 11.

90 Associate Professor David King, Centre for Disaster Studies, James Cook University, *Committee Hansard*, 22 February 2013, pp 14–15.

Education to improve the house-building process (regulation, design, construction, certification and maintenance) aimed at all parties (designer, builder, certifier, and owner) will enhance community resilience.⁹¹

4.84 Research of the Association for Mitigation Studies for Top End Cyclones Inc. (AMSTECI) concluded that Darwin is at risk from category 5 cyclones but is not adequately prepared for this. AMSTECI reported that buildings put up since 1983 would not withstand category 5 wind speeds and that cyclone shelters do not meet relevant standards.⁹²

4.85 Mr Adrian Beresford-Wylie from ALGA identified difficulties in improving buildings after a disaster:

That is the idea that, if a piece of infrastructure is destroyed, the original disaster relief arrangements allowed funding to restore it to its pre-existing state before the disaster struck. ... The relief arrangements do provide for betterment, which is to rebuild that infrastructure to a better standard. Even though there have been changes to the betterment clauses contained in the disaster relief arrangements, it is still difficult to address the challenge facing local government infrastructure.⁹³

4.86 The Australian Sustainable Built Environment Council commented that:

...our new buildings and suburbs are being built based on past climate information not on predicted future climate change. This risks leaving a legacy of urban communities being underprepared for future climate change impacts.⁹⁴

4.87 The experience of Green Cross Australia in Queensland showed that a major barrier to mitigating property damage is the impulse to immediately replace property that has been destroyed, instead of taking a little more time to create a better built environment. Nevertheless, Green Cross Australia reported that people were very responsive to a green building guide. Local recovery committees in Victoria after Black Saturday had also worked with the government to encourage people to 'build it back green'. Green Cross Australia articulated the hope that:

...increasingly homes will come out of the ground that can actually have lower insurance premiums because they are designed to withstand hazards in a much better way, and are also highly sustainable.⁹⁵

91 Associate Professor David King, Centre for Disaster Studies, James Cook University, *Submission 82*, p. 2.

92 AMSTECI, *Submission 344*, pp 3–5.

93 Mr Adrian Beresford-Wylie, ALGA, *Committee Hansard*, 11 April 2013, p. 3.

94 Australian Sustainable Built Environment Council, *Submission 119*, p. 2.

95 Ms Mara Bun, Green Cross Australia, *Committee Hansard*, 22 February 2013, p. 19.

4.88 The committee is encouraged by the concept of 'building better' and believes that this is one of the means by which Australians will mitigate the effects of future extreme weather events. The committee was also pleased to receive evidence of 'getting it right' after Cyclone Yasi:

Cyclone Yasi showed that things were actually working...The North Queensland community felt very much that it was 'get on with it'. And they did. The fact that they got on with it and dealt with it...without loss of life and without an enormous loss of housing shows that people did know what to do.⁹⁶

Forestry and agriculture

4.89 The committee heard that the forestry and agriculture industries are particularly vulnerable to bushfires. In its submission the Australian Forest Products Association (AFPA) stated:

The greatest impacts of climate change on forests will be associated with the hotter drier environment, with increased risk of bushfires and cyclonic activity, greater stress on trees increasing susceptibility to pest and disease incursions and decreasing productivity, and greater variability and intensity of rainfall influencing hydrological cycles and potential soil erosion.⁹⁷

4.90 In response to this scenario, in November 2009, the *National Climate Change and Commercial Forestry Action Plan 2009-1012* was produced to guide forestry action and adaptation. Timber Queensland has also prepared a guide for industry to respond to cyclones.⁹⁸

4.91 AFPA felt that:

Effective bushfire management appears to be a problem of social and political commitment to effective preventative land management rather than a case of scientific and operational complexity. A well-coordinated land management strategy could help reduce fire risk.⁹⁹

4.92 Professor Bindoff from Antarctic Climate and Ecosystems Cooperative Research Council described some positive uptake of adaptation strategies in Tasmania around rye-grass. The Tasmanian Farmers and Graziers Association has worked with the viticulture industry so that 'people who are going to invest in grapes now are

96 Associate Professor David King, Centre for Disaster Studies, James Cook University, *Committee Hansard*, 22 February 2013, p. 13.

97 AFPA, *Submission 37*, p. 2.

98 AFPA, *Submission 37*, p. 3.

99 AFPA, *Submission 37*, p. 5.

thinking about what kinds of grapes they are going to plant' for success in higher temperatures.¹⁰⁰

4.93 The Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) told the committee of successful research into soil resilience:

[We] know now that the Mallee is more resilient to loss of soil because of the investments that are being made in improving natural resource management across both farmers and off-farm management. We are also improving the policy environment in terms of corridors and what connectivity means in terms of improving resilience as well. So this is a key focus of our work both at a programmatic level and in our policy construct.¹⁰¹

4.94 These few examples demonstrate once again that preparedness is variable across sectors and regions.

Natural environment

4.95 The natural environment is both a subject for protection from extreme weather and an agent for mitigating its effects. The consistent message from those commenting on the natural environment was, in the words of Mr Peter Cosier from the Wentworth Group of Concerned Scientists, that:

...the single most effective thing to do in terms of securing the health of the landscape in the face of significant change is to get your ecosystems into a healthy condition. It is a no-regrets action. We should be doing it anyway.¹⁰²

4.96 Sometimes this means work to restore ecosystems. The Wentworth Group explained:

The two things that are very strong in the case of catchments are first and foremost to maintain our native vegetation in place...The second thing is to minimise the extraction of water from our river system so that our ecosystems are in a good place to respond to the extremes of drought and flooding circumstances.¹⁰³

100 Professor Nathaniel Bindoff, Program Leader, Climate Futures, Antarctic Climate and Ecosystems Cooperative Research Council, *Committee Hansard*, 10 April 2013, pp 27–28.

101 Mr Sean Sullivan, First Assistant Secretary, Biodiversity Conservation Division, Department of Sustainability, Environment, Water, Population and Communities (SEWPaC), *Committee Hansard*, 10 April 2013, p. 64.

102 Mr Peter Cosier, Convenor, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 35.

103 Dr John Williams, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 30.

4.97 Moreover, protecting natural features also protects the human environment, as Professor Tomlinson's example of Geraldton in Western Australia illustrates.

There is a fringing reef there that basically protects Geraldton as a piece of land. If sea levels rise, unless you keep propping up the reef then you lose that protection. That is a valid issue, but you would need to look in detail at the extent to which the reef would be degraded by things like ocean acidification and how that is relative to sea level rise.¹⁰⁴

4.98 Mr Sullivan described another example:

...studies post Yasi which showed that, where we had intact mangroves—and we were lucky that basically 97 per cent of mangroves were intact within that zone where Yasi came across the coast—the estimated damage bill would have been significantly higher in terms of damage to ecosystems, infrastructure and people and human lives if they were not intact.¹⁰⁵

4.99 Professor Hughes of the Wentworth Group stressed that:

...the main way that we can deal with [species adaptation] and help our ecosystems and our species be in the best shape for the future is to reduce all of the other threats, particularly habitat loss but also pollution and over harvesting, to improve the health of our landscapes. Mainly what we need to do is turn the clock back on habitat loss and vegetation clearing.¹⁰⁶

4.100 In the case of systems, WWF-Australia emphasised that there are limits to adaption and that therefore mitigation must be accelerated.¹⁰⁷ They believed that current progress is inadequate:

Federal, state and local governments have various adaptation programs in place to build resilience and provide habitat protection; unfortunately the extent of the programs remains inadequate, or they are under threat of reduced funding, wind-back or repeal...Too much investment has gone toward temporary fixes rather than securing protected areas and enduring conservation arrangements.¹⁰⁸

Committee comment

4.101 As the discussion in the preceding sections demonstrates, there are multiple dimensions to evaluating whether essential services and key sectors of the Australian community are adequately prepared for extreme weather events. Some sectors and

104 Professor Rodger Tomlinson, Griffith Centre for Coastal Management, *Committee Hansard*, 22 February 2013, p. 26.

105 Mr Sullivan, SEWPAC, *Committee Hansard*, 11 April 2013, pp 68–69.

106 Professor Lesley Hughes, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 35.

107 WWF-Australia, *Submission 124*, pp 2, 13.

108 WWF-Australia, *Submission 124*, p. 11.

regions are well-prepared and have taken into account the potential impacts of future extreme weather events; others are inadequately prepared and do not have a grasp on the possible implications of a changing climate leaving them particularly vulnerable to future natural disasters.

4.102 The committee agrees that more can and should be done to improve coordination between the states and territories. Such coordination would improve nationwide confidence that communities can adapt to extreme events and prevent disasters.

4.103 So far as the evidence is reliable and credible, the committee believes it is essential for landowners and prospective landowners to be aware and fully informed of the risks associated with their location or proposed buildings. The committee is mindful of the pressure tighter building codes may place on housing costs; however, the committee believes that reasonable precautions should be required against foreseeable and realistic risks. The committee recommends that credible and reliable flood mapping activities and the development of other information that would best inform landowners or prospective landowners of realistic potential risks from extreme weather events are prioritised and used to inform land use planning laws.

Recommendation 6

4.104 The committee recommends that credible and reliable flood mapping activities and the development of other information that would best inform landowners or prospective landowners of potential risks from extreme weather events are prioritised and used to inform land use planning laws.

4.105 It is also the committee's view that building codes should incorporate mitigation measures that take into account foreseeable and realistic risks from extreme weather events.

Recommendation 7

4.106 The committee recommends that building codes incorporate mitigation measures that take into account foreseeable risks from extreme weather events.

The health sector

General preparedness

4.107 According to *The Lancet*, in a series published in 2009, 'climate change is likely to be the greatest threat to human health this century':

...so it is something we should be taking really seriously, both in terms of mitigation, trying to avoid the absolutely unmanageable consequences to human health from climate change, and in terms of early adaptation so that we can survive or adapt to cope with them. Extreme weather is a very good

example of that. With preparedness for our health services, our emergency services and many other things, we could probably reduce the impacts.¹⁰⁹

4.108 Dr Steve Hambleton, President of the Australian Medical Association (AMA), strongly argued for active planning to mitigate illness and death exacerbated by increased temperatures and extreme events. In his opening statement he said:

There is no doubt that we need to do better planning. Extreme weather events pose a significant challenge to human health, and as the peak medical organisation we believe that preparing communities, service providers and governments for these health impacts is a public health priority...

We do need to minimise and manage the health impacts of these more frequent, intensive weather events and we are concerned that the current policy response nationally is inadequate...

We certainly acknowledge the importance of some jurisdictions already where some good things have happened. Much of it has been reactive rather than proactive, though. The National Strategy for Disaster Resilience has improved coordination, but there are some fundamental gaps.¹¹⁰

4.109 The CAHA described the effects on people of a warming world and claimed that:

Australians are neither prepared for, nor informed about, the dangers of the warming climate and the severity and scale of extreme events they are likely to experience in coming years and decades. The unprecedented national heatwave of January 2013, floods of 2011, wild weather of 2012, and bushfires of 2009 give an insight into the weather of a warming world...

Australia healthcare systems are ill-prepared to cope with extreme events and Australia's health professionals lack understanding of the health impacts of climate change. This affects the ability of both individuals and the health care system to prepare for and respond to extreme weather events. This puts lives at risk.¹¹¹

4.110 An example was provided by the CAHA with reference to Cyclone Larry in 2006 where:

Innisfail Hospital [was] forced to close, the Herberton Hospital los[t] power, and a leaking roof at the Atherton Hospital forc[ed] a partial evacuation. The demand for services overwhelmed available human

109 Dr George Crisp, Adviser, Conservation Council of Western Australia, *Committee Hansard*, 7 March 2013, p. 8.

110 Dr Steve Hambleton, AMA, *Committee Hansard*, 11 April 2013, p. 22.

111 CAHA, *Submission 75*, p. 2.

resources and nurses were required to travel from Brisbane to provide support to the region.¹¹²

4.111 The committee heard there is more can be done to improve the understanding about the health impacts of climate change and extreme weather events amongst health professionals.¹¹³

4.112 This view was corroborated by Dr Eugenie Kayak, from Doctors for the Environment Australia (DEA), who stated:

Extreme weather events have challenged and will challenge the existing capacity of our health services as well as put increasing demands on it to deliver this level of care. They will also directly jeopardise the ability of the health sector to care for and look after the wounded.¹¹⁴

4.113 DEA recommended setting up a national disaster and recovery fund to provide finance for extreme weather events and to remove the added pressure they cause to existing health service budgets.¹¹⁵

4.114 The committee heard criticism of the Department of Health and Ageing (DoHA) and health system:

We have a huge department called DoHA and they closed their environmental health section recently—it had four people and an operating budget of \$1 million. This is just laughable; it is a tick-the-box affair. They argue that environmental health matters are the responsibility of the states and territories....We would have hoped that, after these major events, they would have had funding boosts. Instead, in some states who seem to have an allergy to the word 'environment' they have actually closed some of those down. We think this really increases Australia's risk.¹¹⁶

Health and emergencies

4.115 In emergency situations health services are put to the test. This section discusses some of the key observations of stakeholders as to health services' capacity to mitigate disaster. There are encouraging examples of effective strategies but also deficiencies to learn from. Witnesses made a range of suggestions to improve operations in the future.

4.116 The committee heard from the Department of Health and Ageing about some areas where the Commonwealth helps in emergency situations. The Australian Medical Assistance Teams (AusMATs), established under the auspices of the

112 CAHA, *Submission 75*, p. 12.

113 Ms Fiona Armstrong, CAHA, *Committee Hansard*, 20 February 2013, p. 30.

114 Dr Eugenie Kayak, Victorian Chair, DEA, *Committee Hansard*, 20 February 2013, p. 26.

115 Dr Eugenie Kayak, DEA, *Committee Hansard*, 20 February 2013, p. 26.

116 Dr Elizabeth Hanna, *Committee Hansard*, 11 April 2013, p. 14.

Australian Health Protection Principal Committee (AHPPC) which comprises every state chief health officer, are:

...teams of health professionals who not only are expert in their own profession but also have been given training in disasters, and are able to support themselves if they are away for two weeks from a normal base.¹¹⁷

4.117 The committee heard that these teams have been effective in providing medical support, along with National Incident Room in the Office of Health Protection which provides assistance with the management of spontaneous volunteers during an emergency.¹¹⁸

4.118 The Northern Territory has the National Critical Trauma Centre in Darwin, increasing its capacity to deal with health issues in the north of the country.¹¹⁹

4.119 A critical health area during emergencies is the provision of pharmaceuticals:

In order to support the Community Service Obligation in times of crisis, The Pharmacy Guild of Australia, the Department of Health, CSO Agency and CSO Distributors work together to turn their regular reporting and communicating channels into an effective emergency response mechanism, sharing information on road access to towns and pharmacies, facilitating contingency planning in cases where a supply warehouse may become compromised and coordinating the supply of medicines to emergency services when stock needs to be flown into isolated towns.¹²⁰

4.120 The committee heard evidence that this was successfully accomplished during a number of extreme weather events in Queensland.¹²¹

4.121 According to the Department of Health and Ageing, knowledge has developed in the pharmaceutical supply chain which allows more effective dispensing in a time of emergency:

[There has been] an exploration of recent trends in pharmaceutical manufacturing and getting us a much better understanding of that. It is a rapidly moving, rapidly developing and fluid industry that is seeing quite a bit of concentration of manufacturing sites in fewer places around the world. ...

[I]t is much more along the lines of just-in-time supply, throughout the supply chain, rather than big stockpiles in warehouses. That is what we are focused on so that we have a contingency plan ready to go.¹²²

117 Dr Jenny Firman, DoHA, *Committee Hansard*, 7 June 2013, p. 6.

118 Dr Jenny Firman, DoHA, *Committee Hansard*, 7 June 2013, p. 7.

119 Mr Peter Davies, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, p. 6.

120 National Pharmaceutical Services Association, *Submission 169*, p. 2.

121 National Pharmaceutical Services Association, *Submission 169*, p. 2.

4.122 There is evidence of work on the ground in helping people be prepared in their neighbourhoods. Red Cross has devoted increasing resources to preparedness rather than simple responsiveness. The committee was told of a program called REDiPlan, which 'works with households to be informed, to make a plan, to get a kit and to know their neighbours'.¹²³

4.123 Although these examples of good work are positive, the committee heard further evidence to indicate that psychological, research and structural barriers remain which still need attention.

4.124 Dr Alexander Donald experienced the cyclone in Cairns and commented on the needs in the health sector. These included easier access to expertise and stock, and what he called 'templates' for managing nursing homes, hospitals, aged care, mental health patients and vulnerable people. He believed that these facilities did not necessarily have the resources to develop their own disaster response plans. He also identified a lack of planning in who should take responsibility and that ad hoc decisions about staff allocation in hospitals were taken. Dr Donald believed that a 'flying squad' of clinical staff should be prepared which could come in immediately to the area affected.¹²⁴

4.125 Dr Donald's comments on the capacity of the health sector in disaster situations were endorsed by Dr Hanna¹²⁵ and Dr Hambleton, who also raised the issue of what happens when medical personnel are themselves the subjects of the disasters:

With disaster planning...We have not actually said: "When we are unable to staff the department because they are looking after their families, what do we do?" That is where local jurisdictions will be overwhelmed, and we will need a broader plan.¹²⁶

4.126 Dr Hambleton described specific scenarios where better coordination or knowledge could have alleviated major problems:

In Brisbane the AMA in Queensland, to its credit, coordinated doctors locally to volunteer. Why wasn't that a plan that was ready to go? Large medical centres like my own let it be known that anybody who was affected by a flood could come in and get bulk-billed, so there was no financial barrier for those people who maybe had no resources. Why isn't there a registry somewhere, or why isn't the government causing a registry to be built, so they know who is ready to volunteer?¹²⁷

122 Mr Rob Cameron, Assistant Secretary, Office of Health Protection, DoHA, *Committee Hansard*, 7 June 2013, p. 7.

123 Mr Andrew Coghlan, Australian Red Cross, *Committee Hansard*, 20 February 2013, p. 32.

124 Dr Alexander Donald, *Committee Hansard*, 11 April 2013, pp 7–11.

125 Dr Elizabeth Hanna, *Committee Hansard*, 11 April 2013, p. 14.

126 Dr Steve Hambleton, AMA, *Committee Hansard*, 11 April 2013, p. 25.

127 Dr Steve Hambleton, AMA, *Committee Hansard*, 11 April 2013, p. 23.

There was a train crash. There was [a] GP down the road with emergency medicine training who did not even know it had occurred but who could have been part of that response process.¹²⁸

How do you evacuate an entire hospital if you do not have a plan? If there are no plans in place, if there is no accreditation system that says you have to have a disaster plan, how are you going to engage with your community? How are you going to continue to provide services? These are the sorts of roles that are centralised and can be facilitated by government.¹²⁹

4.127 While cyclones and bushfires are dramatic and obvious, the effects of heatwaves often creep upon communities unnoticed. Using figures from Brisbane based research, Professor Barnett from the Queensland University of Technology commented on health effects of heatwaves. He warned against over reliance on early warning systems:

...whilst they may seem to be a good idea, there is no good evidence (from Australia or elsewhere) to show that they work...

It is incredibly difficult to predict the number of deaths caused by a heatwave, because the numbers will depend on many things including: its timing...if there is a power cut...whether it occurs during a holiday (as elderly people may be left alone), and the number of vulnerable people which changes from week-to-week. These difficulties mean any early warning system is likely to have frequent false alarms, which may then undermine public confidence so that they then do not react to a well-timed warning.¹³⁰

4.128 Witnesses often linked infrastructure weaknesses and health risk. The Australian Nursing Federation (Victorian Branch) believed that cost cutting, bed closures, waiting times and workforce reductions were impacting significantly on the hospital system and would only exacerbate problems in an extreme weather event.¹³¹

4.129 According to Professor Reser, although there is plenty of information available, there is very limited evaluation of it and of how different strategies, sources, materials and experiences might combine to produce effective 'convergence risk communication and disaster preparedness materials'.¹³²

Psychological preparedness

4.130 Several experts in the social and medical fields drew the committee's attention to the significant aspect of psychological readiness to deal with an extreme weather

128 Dr Steve Hambleton, AMA, *Committee Hansard*, 11 April 2013, p. 24.

129 Dr Steve Hambleton, AMA, *Committee Hansard*, 11 April 2013, p. 24.

130 Professor Adrian Barnett, *Submission 28*, p. 3.

131 Australian Nursing Federation (Victorian Branch), *Submission 20*, pp 8–10.

132 Professor Joseph Reser, Australian Psychological Society (APS), *Committee Hansard*, 20 February 2013, pp 24–25.

event. What seems clear is that *how* information is presented is as important as *what* information is presented in eliciting appropriate adaptation and mitigation actions.

4.131 Health professionals and psychologists gave some examples of effective responses:

...very positive psychological and behavioural adaptation is happening in Australia right now. I think we need to capitalise on that ... it is a very effective kind of understanding and if we are able to better understand public understanding, we could better engage with the public on this matter.¹³³

4.132 Professor Reser from the Australian Psychological Society commented on psychological preparedness. He said that Australia was leading research in this area:

...psychological preparedness and situational preparedness go hand-in-hand. If you do not have psychological preparedness and if you do not have some idea of how you are going to be feeling and operating and how other people are going to be operating in an emergency situation, actually that physical preparedness is not going to do you as much good as it could.¹³⁴

4.133 The Australian Nursing Federation (Victorian Branch) referred to the Victorian Disaster Mental Health Workforce Capacity Survey, which revealed that:

[There are] mental health risks to members of the community when faced with the consequences of a natural disaster...Victoria is a State exposed to risk in respect to future natural disasters so investment in service improvement is warranted.¹³⁵

Emergency services

4.134 Prevention of most extreme weather events is normally out of human control; therefore, the focus of this inquiry has been on adapting to them and taking actions that mitigate such events becoming human and social catastrophes. Emergency services play a key role in mitigating the impact of extreme weather events and therefore must ensure they themselves are adapted for projected future extreme weather events.

Prevention and resources

4.135 As already discussed earlier in this chapter, planning for land use which takes into account possible extreme weather is crucial. For instance, witnesses such as the Centre for Disaster Studies strongly recommended that local councils should develop

133 Professor Joseph Reser, APS, *Committee Hansard*, 20 February 2013, p. 27.

134 Professor Joseph Reser, APS, *Committee Hansard*, 20 February 2013, pp 28–9.

135 Australian Nursing Federation (Victorian Branch), *Submission 20*, p. 10.

floodplain mapping and management plans based in best practice.¹³⁶ The theme of good local risk knowledge is also extremely relevant to emergency situations. Mr Paul Considine of AFAC noted that it was not the place of emergency services to dictate land use and be solely responsible for communicating risk; residents should have good knowledge of their environmental context:

So it is very necessary, I would submit, that people who live in bushfire prone areas understand their environment, understand the risks inherent in living where they do and understand that getting a warning may just be part of the picture.¹³⁷

4.136 The Northern Territory Police, Fire and Emergency Services explained that they have been training people in emergency management. Actions taken include the placement of cyclone shelters, translating emergency management messages into local languages, distributed through schools or on air and developing 'an extensive network of volunteer fire brigade and Bushfires NT units'.¹³⁸ An annual process of data update and briefing of key personnel to prepare indigenous remote communities was also described.¹³⁹

4.137 Mr Gary Morgan, Chief Executive Officer of the Bushfire Cooperative Research Centre (Bushfire CRC), said that with a changing natural environment and expectations 'current practices will not sustain [fire agencies] into 2020'.¹⁴⁰ He elaborated on adequate preparedness for the future:

...in the area of preparedness, first of all, you need the knowledge for how you are going to address the issues that may arise. Then you need to have information on how to use the technologies that are there, how to communicate the messages and how to get a clear response to those messages by the community and by the agency personnel to make sure that, under that shared responsibility, everybody is able to act in accord to save lives, property, assets and the environment, and that is about a whole lot of unanswered questions. Right at the moment we know that we cannot address the issues into the future unless we have new ways of doing so.¹⁴¹

4.138 The necessity for adequate funding was referred to by several witnesses. Mr Jody Nobbs, also from Northern Territory Police, Fire and Emergency Services,

136 Associate Professor David King, Centre for Disaster Studies, James Cook University, *Submission 82*, p. 3

137 Mr Paul Considine, AFAC, *Committee Hansard*, 20 February 2013, p. 2.

138 Mr Peter Davies, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, p. 2.

139 Mr Peter Davies, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, pp 3–4.

140 Mr Gary Morgan, Chief Executive Officer, Bushfire CRC, *Committee Hansard*, 20 February 2013, p. 12.

141 Mr Gary Morgan, Bushfire CRC, *Committee Hansard*, 20 February 2013, p. 13.

told the committee that the major support the Commonwealth government might give is the provision of money:

It would be nice if we could overcome the vertical fiscal imbalance somewhat—that is to say, of course, that the Commonwealth has the money and we have the responsibilities. Clearly, we really appreciate the contribution it has given over time through various grant schemes that we run up here in the Territory, which have had a huge impact on our ability to respond [to] emergencies. We would like those sorts of schemes to be strengthened. I also note that mitigation up here is very expensive. The dirt roads that flood every year get washed out and isolate people, and it is not cost effective from the Territory's perspective to replace that sort of infrastructure.¹⁴²

4.139 AFAC commented on the resource implications of more frequent and intense weather events for the agencies it represents, namely 34 government fire, land management and emergency services bodies:

This would necessitate an increase in the standing capacity of agencies both to prepare for and to respond to emergencies...This has implications both for funding staff and infrastructure, but also for maintaining the very large volunteer engagement...

Much larger emergency events...will require more extensive arrangements for surge capacity to be in place. It is simply uneconomic...to maintain full-time fire and emergency services that are capable of combatting all conceivable incidents.¹⁴³

4.140 With respect to the Commonwealth's role in emergency services, the Attorney-General's Department provided a comprehensive list of projects supported by the government. These include aerial firefighting, telephone warning systems and flood risk information.¹⁴⁴

4.141 The Department of Human Services pointed to its role in improving emergency responses, and particularly the centrality of the National Emergency Call Centre Surge Capability (NECCSC) established in 2009:

The NECCSC allows states and territories and Australian Government agencies to divert excess call loads received on their emergency (non-000) lines to the department and the Australian Taxation Office.¹⁴⁵

142 Mr Jody Nobbs, Acting Director, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, pp 4–5.

143 AFAC, *Submission 38*, p. 3.

144 Attorney-General's Department, *Submission 64*, pp 11–16.

145 Department of Human Services, *Submission 116*, p. 2.

Effectiveness

4.142 The committee received information which demonstrated that preparations had been effective and that the community could be confident about emergency responses in critical situations. Instances of good communication, emergency preparedness planning and well-executed disaster management were given.

4.143 In November 2012 Telstra launched the world's first Emergency Alert warning system to send SMS alerts via landline and mobile phone.¹⁴⁶ Telstra claimed that in 2010–11, under disastrous conditions, its staff were prepared and able to restore services. The submission stated that 'in many cases the existence of multiple networks in affected areas meant that alternative forms of communication were still able to be maintained'.¹⁴⁷

4.144 Although Save the Children recommended more targeted emergency plans for children, the good news was that:

...from a child-focused perspective, examples can be found of proactive approaches to including the specific needs of children in Emergency Preparedness Plans. This can be seen at State level in Victoria and in certain Local Government Areas.¹⁴⁸

4.145 Townsville City Council claimed that:

The disaster management process is well exercised and coordinated in our local area with clear delineation of roles and responsibilities between agencies and respective levels of government.¹⁴⁹

4.146 A substantial number of witnesses commented on positive bushfire responses and the committee heard that actions to deal with bushfires have benefitted from improved telecommunications and dissemination of knowledge. For example, the Bureau of Meteorology was commended by the Bushfire CRC for its contribution to research in smoke trajectories, fire spread and fire modelling, and to providing fire alerts in enough time for effective action.¹⁵⁰ In turn, the Tasmania Fire Service expressed its desire to publicly thank the Bushfire CRC for its input to which they attributed the fact that in the recent fires no lives had been lost.¹⁵¹

4.147 It was stated that good communications are at the 'heart' of the responses of both emergency services and communities in an emergency bushfire situation and that

146 Telstra, *Submission 112*, p. 3; also AMTA, *Submission 79*.

147 Telstra, *Submission 112*, p. 5.

148 Save the Children Australia, *Submission 111*, p. 2.

149 Townsville City Council, *Submission 32*, p. 4.

150 Mr Gary Morgan, Bushfire CRC, *Committee Hansard*, 20 February 2013, p. 14.

151 Senator Milne, *Committee Hansard*, 20 February 2013, p. 13.

it is 'absolutely...a fundamental principle of emergency management that information flow is critical to successful outcomes'.¹⁵²

4.148 The committee was advised that fire services have done a lot of work in developing a range of warning systems and message interfaces in recent years, including internet solutions and the Australasian Inter-service Incident Management System. AFAC emphasised that:

[P]ublic information and getting warnings out should now be in the forefront of the minds of incident managers across Australia and the importance of doing so can be elevated in some circumstances to be equally important to get the information out as it is to get the fire out.¹⁵³

4.149 However, a concern repeatedly raised with the committee was that when infrastructure dependent on electricity or communications towers are brought down by fires, many technologies will not work and that people must be able and willing to keep informed through multiple means, not least the battery-operated radio.¹⁵⁴

4.150 AFAC explained that they are working cooperatively with state and territory emergency services under a memorandum of understanding. They cited substantial sharing of resources across borders in the Victorian Black Saturday bushfires, and the Queensland floods/Cyclone Yasi of 2010–11. However, AFAC also warned that there may be occasions when simultaneous demands are made in several states.¹⁵⁵

4.151 With respect to floods there were also positive stories. An example of success was the claim by Mr Cameron, Manager of Disaster Operations at Brisbane City Council that:

Queensland disaster management arrangements, which are based upon the Disaster Management Act 2003, have a proven history of providing efficient response and recovery for a multitude of emergency events ranging from cyclones through to flooding.¹⁵⁶

4.152 He elaborated further on improved responses between 2008 and the 2011 flood due to better intelligence capability:

[The Brisbane Incident Management System] had a rapid damage assessment and ability to get a better situation more quickly. This did aid in the effective response in 2011.¹⁵⁷

4.153 Townsville City Council claimed that:

152 Mr Paul Considine, AFAC, *Committee Hansard*, 20 February 2013, p. 5.

153 Mr Paul Considine, AFAC, *Committee Hansard*, 20 February 2013, p. 2.

154 Mr Paul Considine, AFAC, *Committee Hansard*, 20 February 2013, p. 6.

155 AFAC, *Submission 38*, p. 5.

156 Mr Jason Cameron, Brisbane City Council, *Committee Hansard*, 22 February 2013, p. 1.

157 Mr Jason Cameron, Brisbane City Council, *Committee Hansard*, 22 February 2013, p. 5.

The disaster management process is well exercised and coordinated in our local area with clear delineation of roles and responsibilities between agencies and respective levels of government.¹⁵⁸

Shortfalls

4.154 Balancing these positive stories of the effectiveness and success of emergency services in recent natural disasters were a range of suggestions from submitters and witnesses as to areas where emergency services could be improved.

4.155 There are two aspects to resourcing emergency services. Firstly, there is the need to have enough personnel for day-to-day operations especially if extreme weather is occurring more often, causing more frequent and intense demands. AFAC explained:

...agencies need, as I am sure they are, to be aware that that is happening and they need to consider how that is going to be resourced, be that through increasing their full-time establishment, increasing seasonal workers—for instance, employing more firefighters during the fire season—or be it by maintaining and improving the recruitment of the volunteer establishment.¹⁵⁹

4.156 Secondly, there is coping with emergency events that necessitate a sudden increase or 'surge' in resource provision. Dealing with this needs 'some advance strategic planning for how greater workloads may be handled'.¹⁶⁰

4.157 The Bushfire CRC drew to the committee's attention the importance of quick responses to indications of bushfire danger. He stated that:

If you do not have the ability to respond quickly, the fire is going to get larger; the larger the fire gets, the harder it is to put out; the harder it is to put out, the greater the costs. That is where there is a benefit cost analysis of investing early and investing in the right knowledge, the right people, the right places and the right equipment to enable the response to be adequate.¹⁶¹

4.158 With increasing extreme weather events and the prolonging of the fire season in both hemispheres, a new difficulty is that international backup resources may not be available.

...there have been times when they have been having major fires running a lot longer in their season than they normally do and when ours have started

158 Townsville City Council, *Submission 32*, p. 4.

159 Mr Paul Considine, AFAC, *Committee Hansard*, 20 February 2013, p. 2.

160 Mr Paul Considine, AFAC, *Committee Hansard*, 20 February 2013, p. 3.

161 Mr Gary Morgan, Bushfire CRC, *Committee Hansard*, 20 February 2013, p. 13.

a lot earlier. If that trend continues, we are going to get to the stage where we are battling for resources.¹⁶²

4.159 The National Secretary of United Firefighters Union of Australia, Mr Peter Marshall, gave some hard figures on the need for increased levels of operational staff:

[T]he current population and climate change forecasts for operational staff needed to address increased bushfire activity would suggest a 28 to 40 per cent increase in operational staff—that is an extra 660 to 990 full-time employees—between now and 2026. This is for Victoria only. The basis for that is that we are looking at a temperature increase, from CSIRO predictions, of one to five degrees Celsius up to 2070.¹⁶³

4.160 He quoted corroborating research into increased temperatures commissioned by the World Bank.¹⁶⁴ These figures are based only on Victorian needs, so if accurate, would be multiplied several times for all of Australia.

4.161 The committee was presented with a number of suggestions for improving data collection and dissemination. With respect to flooding, Mr Considine suggested that a more comprehensive network of rainfall gauges would improve the reliability of predictions for flash floods:

In order to accurately predict flash flooding, it is necessary to have a good network of rainfall gauges, be they automatic rainfall gauges or be they monitored. And that is a weakness that I think state emergency services have recognised.¹⁶⁵

4.162 The need for specific data to evaluate storms was raised by Professor Rodger Tomlinson.

The nature of our work is very much about fundamental understanding and getting quite specific information for particular areas. That requires a great deal of detailed information for particular areas and often if there is a gauge or other instrumentation some distance away it is very, very difficult to implement that. From other work that I have been doing, for the Victorian government, I am very aware of quite significant gaps in the Waverider information, for example, on the coastline of Victoria.¹⁶⁶

162 Mr Gary Morgan, Bushfire CRC, *Committee Hansard*, 20 February 2013, p. 14.

163 Mr Peter Marshall, United Firefighters Union of Australia, *Committee Hansard*, 20 February 2013, p. 16.

164 Mr Peter Marshall, United Firefighters Union of Australia, *Committee Hansard*, 20 February 2013, p. 16.

165 Mr Paul Considine, AFAC, *Committee Hansard*, 20 February 2013, p. 2.

166 Professor Rodger Tomlinson, Griffith Centre for Coastal Management, *Committee Hansard*, 22 February 2013, p. 25.

4.163 He also pointed to the:

...importance of making sure that the current data collection programs around the country are maintained and enhanced, because without data you may as well not bother with a computer program.¹⁶⁷

4.164 Mr Davies from the Northern Territory Police, Fire and Emergency Services advised that they had some concerns about the cyclone data provided by the Bureau of Meteorology:

A lot of the models used to calculate what will happen in the future with climate change, are based on American models, particularly with regard to cyclones. These models have never been tested practically in the Australian environment, so a lot of the data has changed over time. That is, the techniques that were used 20 years ago to monitor the cyclones have changed so that the quality of data going back over those years is variable. This is quite an important issue. ...there is some concern about whether the historical data is accurate....

...it is quite frightening that we are not doing enough research into the Australian environment.¹⁶⁸

4.165 Locals Into Victoria's Environment commented in respect to sea level analysis that:

A prudent risk management approach would demand that this full range of possible outcomes — including those with the most extreme impacts at the high end of the range at 2 metres — be incorporated into the government's assessment and adaptation work. But it has not...

Instead, the government's work is based on three scenarios, none of which exceed 1.1 metres, a height which is little more than half that which the scientists are telling us could occur.¹⁶⁹

4.166 The manager of Brisbane City Council disaster operations called for nationwide consistency—in legislation, terminology, systems operational procedures and understanding of activation levels.

[Consistent legislation] would allow for consistency at all levels. Whilst we may change things like processes and procedures and standardisation of the actual activities themselves, standardising who is responsible for what and where across a nationalised spectrum would certainly allow for that more efficient and effective response to disasters, which, as we see, sometimes

167 Professor Rodger Tomlinson, Griffith Centre for Coastal Management, *Committee Hansard*, 22 February 2013, p. 26.

168 Mr Peter Davies, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, p. 3.

169 Locals Into Victoria's Environment, *Submission 10*, p. 8.

cross borders and occasionally require support from a number of agencies, including those federal agencies.¹⁷⁰

4.167 Likewise Professor Thom testified to the desirability for national consistency in methodologies and standards, saying:

[W]e actually need to have a national methodology that is consistent so that we do not have state-by-state variation or local council by local council variation and so that the local councils or whatever regional authorities are involved can go to that national body and seek the appropriate information...¹⁷¹

Committee comment

4.168 The evidence presented in this inquiry shows that the Australian community generally, and at local levels, is increasingly aware of predicted changes in weather patterns that will lead to more extreme events, and that they need to be prepared for this. Media coverage has ensured that recent catastrophes such as the Victorian bushfires and Brisbane floods are in the forefront of the public imagination.

4.169 However, the committee heard that the Australian community is still on a 'steep learning curve' as to what to do about the increasing probability of extreme weather events. Some sectors, such as telecommunications, are advanced in utilising the latest knowledge and technologies. In other areas, research work is incomplete, understanding is patchy and implementation is captive to a lack of clarity about responsibilities or resource deficiency.

4.170 The committee was particularly concerned by evidence that many facilities caring for vulnerable sectors of society do not necessarily have the resources to develop their own disaster response plans to enable them to respond appropriately to extreme weather events. Some of these facilities, such as hospitals, may not only be impacted by such events but also at the 'frontline' of responding to extreme weather events. It is therefore essential to ensure that all such facilities have emergency management plans in place.

Recommendation 8

4.171 The committee recommends that Commonwealth, state and territory governments ensure that all facilities caring for vulnerable groups, in particular hospitals, schools, childcare and aged care facilities, have emergency management plans, relevant to their geographic settings, in place and regularly revised.

170 Mr Jason Cameron, Brisbane City Council, *Committee Hansard*, 22 February 2013, p. 2. See also pp 6 & 7.

171 Professor Bruce Thom, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 31.

4.172 The committee also believes that the very existence of this inquiry will start to raise the level of activity, but follow on action is needed. The most effective areas where the Commonwealth can contribute are by:

- ensuring that there is collaboration in knowledge production;
- coordinating structural and sectoral bodies; and
- providing resources and demanding accountability in their use.

Chapter 5

Developing a national response to extreme weather: coordination, roles and responsibilities

Introduction

5.1 This chapter considers the roles and responsibilities of the Commonwealth, state, territory and local governments in Australia, as well as coordination between the different levels of government in managing and responding to extreme weather events. This chapter also discusses progress towards effective national coordination of climate change response and risk management, including areas for improvements.¹

The division of responsibilities between different levels of government

5.2 This section considers the responsibilities of the Commonwealth, state and territory and local governments in Australia in relation to extreme weather events and climate change adaptation.² As the Commonwealth government has noted, 'identifying the roles of government in adapting to climate change is the first step in building a coordinated approach'.³

Commonwealth

5.3 At the federal level, a number of departments and agencies have roles and responsibilities relevant to managing and responding to extreme weather events. The roles of key departments and agencies are set out below.

5.4 The Attorney-General's Department provides national coordination of emergency management, enabling a 'whole-of-nation, resilience based approach to preventing, preparing for, responding to and recovering from disasters'.⁴ Some of the Attorney-General's Department's work in this area includes the *Critical Infrastructure Resilience Strategy*, which aims to ensure the resilience and continued operation of Australia's critical infrastructure and the continuity of essential services in the face of all hazards, including extreme weather events.⁵

5.5 The Attorney-General's Department, through its Emergency Management Australia Division also operates the Australian Crisis Coordination Centre which is a 'dedicated all-hazards facility'. The Crisis Coordination Centre 'monitors and informs

1 See terms of reference (e), (f) and (g).

2 Note that 'adaptation' is defined by the *National Climate Change Adaptation Framework* as 'a process by which strategies to moderate, cope with, and take advantage of climate events are enhanced, developed and implemented': p. 20. Therefore, strategies to manage the increasing frequency of extreme weather events are a component of climate change adaptation.

3 Australian Government response to the Productivity Commission report: *Barriers to Effective Climate Change Adaptation*, March 2013, p. 8.

4 Attorney-General's Department, *Submission 64*, p. 2.

5 Attorney-General's Department, *Submission 64*, p. 7.

on domestic and international weather events which may impact, or cause disruptions to Australians'.⁶ The Centre also:

- centralises and coordinates information across the Australian government, states and territories during a crisis in Australia;
- coordinates Australian government physical and financial assistance for disaster relief – including Disaster Recovery Payments;⁷
- maintains the Disaster Assist website, which aims to provide 'better access to information about recovery assistance following a disaster';⁸ and
- maintains response plans to provide Australian government assistance to states and territories in response to an emergency—and, in particular, the Australian Government Disaster Response Plan.⁹

5.6 A number of agencies are involved in the dissemination of information relating to extreme weather events. For example, as discussed in Chapter 2, the Bureau of Meteorology is involved monitoring, assessment and forecasting of Australia's weather and climate system, and provides forecasts and issues weather warnings. It often works collaboratively with state and territory governments when issuing those warnings.¹⁰ The Commonwealth Scientific and Industrial Research Organisation (CSIRO), and particularly its Climate Adaption Flagship, undertakes research designed to deliver 'the best available scientific information and expertise to support Australia's efforts to adapt to climate change today in a practical and effective way'.¹¹

5.7 The Department of Human Services, in the event of emergencies caused by extreme weather events, has responsibilities to:

- ensure the continuity of payments and services, including delivering emergency payments;
- support pharmacists in dispensing Pharmaceutical Benefit Scheme medicines;

6 Attorney-General's Department, *Submission 64*, p. 17.

7 Attorney-General's Department, *Submission 64*, p. 17; see also Attorney-General's Department, *Disaster assistance*, <http://www.ag.gov.au/EmergencyManagement/DisasterAssistance/Pages/default.aspx> (accessed 24 June 2013).

8 Australian government, *Australian Government Disaster Assist*, <http://www.disasterassist.gov.au/Pages/default.aspx> (accessed 24 June 2013).

9 Attorney-General's Department, *Crisis Coordination Centre*, <http://www.ag.gov.au/EmergencyManagement/Pages/CrisisCoordinationCentre.aspx> (accessed 24 June 2013).

10 Bureau of Meteorology, *Submission 65*, pp 4 and 26.

11 CSIRO, Climate Adaptation Flagship, <http://www.csiro.au/org/ClimateAdaptationFlagshipOverview> (accessed 24 June 2013); see also CSIRO, *Submission 93*, p. 3.

- participate in local and state/territory recovery committees, including delivering services from established recovery centres; and
- support national emergency call centre surge capability to allow federal, state and territory government agencies to divert excess call loads received on their emergency (non-triple zero) call lines to the Department of Human Services.¹²

5.8 In 2011, the Department of Human Services implemented its own Emergency Management Framework which outlines the command, control and coordination arrangements for emergency responses.¹³

5.9 The health implications of extreme weather events were considered in Chapter 3. The Department of Health and Ageing (DoHA) submitted that, in the event of an extreme weather event of 'national consequence', its primary role is to 'provide leadership and national health sector coordination', including:

...provision of expert health advice and national policy development, logistical coordination of extra jurisdictional health sector resources (human, equipment and peripherals) and linkages to international health authorities and bodies.¹⁴

5.10 DoHA noted that the Australian Health Protection Principal Committee, which reports to the Australian Health Ministers' Advisory Council, has produced the National Health Emergency Response Arrangements to 'articulate the strategic arrangements and mechanisms for the coordination of the Australian health sector in response to emergencies of national consequence'.¹⁵

5.11 DoHA also advised that it had responsibilities in relation to aged care service providers, including supporting them in relation to risk management for emergency events to ensure continuity of care for people who receive aged care services, with minimal disruption; and providing advice and education to support them to develop adequate emergency management plans.¹⁶ In terms of mental health, the department also noted that Commonwealth funded mental health programs can be used in the medium to long term to support people affected by loss and trauma as a result of extreme climate event.¹⁷

5.12 The critical importance of telecommunications in the context of extreme weather events was discussed in chapter 4. The Department of Broadband, Communications and the Digital Economy (DBCDE) noted that 'while the government monitors developments, the maintenance and resilience of the commercial

12 Department of Human Services, *Submission 116*, p. 1; see also Department of Health and Ageing (DoHA), *Committee Hansard*, 7 June 2013, p. 7 for further discussion on maintaining supplies of pharmaceuticals in emergencies.

13 Department of Human Services, *Submission 116*, p. 2.

14 DoHA, *Submission 126*, pp 1–2.

15 DoHA, *Submission 126*, p. 1 and *Committee Hansard*, 7 June 2013, pp 1 and 4.

16 DoHA, *Submission 126*, p. 2; see also and *Committee Hansard*, 7 June 2013, p. 2.

17 DoHA, *Submission 126*, pp 2 and 3 and *Committee Hansard*, 7 June 2013, p. 3.

telecommunications network is ultimately a matter for the telecommunications carriers'.¹⁸ That department also noted that the Commonwealth government has developed *National Guidelines for the Request and Broadcast of Emergency Warnings* in consultation with state and territory governments and peak broadcast media bodies. The guidelines aim to improve the effectiveness and consistency of arrangements between all broadcast media, and all emergency management organisations, for the request and broadcast of emergency public warnings.¹⁹

5.13 The committee notes that a number of other Commonwealth departments may also be involved in managing and responding to extreme weather events, including the Department of Agriculture, Fisheries and Forestry, which provides assistance and support to farm families in times of drought.²⁰

5.14 The Department of Defence and the Australian Defence Forces may also be involved extreme weather events. Where civilian resources are inadequate, unavailable or cannot be mobilised in time, emergency *Defence Assistance to the Civil Community* arrangements enable the Australian Defence Force to contribute in order to save human life, alleviate suffering and prevent loss of animal life or property. Provision of Defence assistance follows a request from the relevant state or territory government to Emergency Management Australia. Over recent years, Australian Defence Force personnel have been involved in a number of domestic natural disaster relief efforts, including, for example, after Tropical Cyclone Yasi in north Queensland; and the Victorian bushfires in 2009.²¹

5.15 Finally, the leading agency coordinating the Commonwealth government's response in terms of adaptation for climate change is the Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCSRTE).²² DIICCSRTE advised that climate change adaptation work across the Australian government is guided by several key policy documents, including the *National Climate Change Adaptation Framework* (Adaptation Framework) agreed by COAG in 2007; and the 2010 Australian government *Adapting to Climate Change: An*

18 Department of Broadband, Communications and the Digital Economy (DBCDE), *Submission 66*, p. 1.

19 DBCDE, *Submission 66*, p. 3.

20 Department of Agriculture, Forestry and Fisheries, *Drought Programs and Rural Assistance*, at: <http://www.daff.gov.au/agriculture-food/drought> (accessed 24 June 2013). Note that the National Drought Reform Program will be implemented from 1 July 2014 and will replace previous 'exceptional circumstances payments' which were considered 'no longer appropriate in the face of a variable climate': *National Drought Program Reform* at <http://www.daff.gov.au/agriculture-food/drought/drought-program-reform> (accessed 24 June 2013).

21 Australian Army, *Disaster relief at home*, at: <http://www.army.gov.au/Our-work/Community-engagement/Disaster-relief-at-home> (accessed 24 June 2013).

22 DIICCSRTE, *Committee Hansard*, 11 April 2013, p. 65.

Australian Government Position Paper (Adaptation Position Paper).²³ The Adaptation Framework is discussed later in this chapter.

5.16 The 2010 Adaptation Position Paper notes that 'different levels of government have different responsibilities and will therefore have different roles in helping Australia adapt to the impacts of climate change'.²⁴ The Adaptation Position Paper identifies four key roles for the Australian government in climate change adaptation:

- maintaining a strong, flexible economy and social safety net;
- leading national reform;
- managing Commonwealth assets and programs; and
- providing national science and information.²⁵

5.17 The Adaptation Position Paper identifies six national priority areas for action: water, coasts, infrastructure, natural ecosystems, natural disaster management, and agriculture.²⁶ In terms of natural disaster management, the paper simply states that 'action is required to ensure that we have the capacity to respond to a likely increase in natural disasters'. The paper also highlights the importance of embedding adaptation considerations and responses within existing policy and institutional frameworks.²⁷

5.18 The Adaptation Position Paper also states that a 'Climate Futures Report' will be produced every five years 'to track our progress on positioning Australia to adapt to climate change' and 'to evaluate how effective our collective adaptation efforts are'. It proposes that an initial Climate Futures Report will be produced before the end of 2010.²⁸ However, at the time of writing, no Climate Futures Report appears to have been published.²⁹

23 Department of Climate Change and Energy Efficiency (DCCEE), *Adapting to Climate Change in Australia—An Australian Government Position Paper*, 2010, <http://www.climatechange.gov.au/climate-change/publications/adapting-climate-change-australia%E2%80%9494-australian-government-position-paper> (accessed 7 June 2013).

24 DCCEE, *Adapting to Climate Change in Australia—An Australian Government Position Paper*, 2010, p. 9.

25 DIICSRTE, *Answers to question on notice*, 11 April 2013, p. 4; see also DCCEE, *Adapting to Climate Change in Australia—An Australian Government Position Paper*, 2010, pp 9–10.

26 DCCEE, *Adapting to Climate Change in Australia—An Australian Government Position Paper*, 2010, pp 11–13.

27 DCCEE, *Adapting to Climate Change in Australia—An Australian Government Position Paper*, 2010, pp 12–13.

28 DCCEE, *Adapting to Climate Change in Australia—An Australian Government Position Paper*, 2010, p. 16.

29 See also Tom Arip, 'Government's climate future report in distant future', *Sydney Morning Herald*, 29 August 2011, <http://www.smh.com.au/national/governments-climate-future-report-in-distant-future-20110828-1jgm.html> (accessed 24 June 2013).

Whole-of-government coordination between Commonwealth government departments

5.19 In terms of coordination between Commonwealth government departments in relation to management of extreme weather events, DIICCSRTE advised that an Interdepartmental Committee on Adaptation was established in 2008 to provide a mechanism for whole-of-government consultation and coordination on climate change adaptation policy and reform.³⁰ DIICCSRTE further told the committee that 'a strong focus of the Committee for 2012–13 was on agreeing a coordinated whole-of-government response to the Productivity Commission's inquiry into barriers to effective climate change adaptation'.³¹

5.20 However, some submissions called for a new independent Commonwealth government agency to coordinate climate change adaptation responses. The Australian Network of Environmental Defender's Offices (ANEDO), for example, suggested that the role of the Climate Commission could be expanded:

...there is a need for an authoritative climate change adaptation body, which will undertake investigation and planning, coordinate other institutions and actors, and advise government and the public generally. Presently, the Climate Commission has a limited remit along these lines, but its functions and resources are limited and they are not targeted specifically to the climate adaptation problem. The Climate Change Authority has a mandate generally limited to review of mitigation efforts. What is required is an institution...dedicated to development of adaptive capacity....The Climate Commission could be developed into such an entity, providing advice and recommendations on both mitigation and adaptation issues.³²

States and territories

5.21 Some submissions to this inquiry expressed the view that the Commonwealth government has a limited role with respect to responding to and managing extreme weather events and that primary responsibility rests with state and territory governments in their emergency management capacity. For example, the Attorney-General's Department advised that:

30 DIICCSRTE, *Answers to question on notice*, 11 April 2013, p. 3. The committee meets at least four times a year, and membership includes the Department of Prime Minister and Cabinet; Department of Sustainability, Environment, Water, Population and Communities; Department of Agriculture, Fisheries and Forestry; Attorney-General's Department; Department of Health and Ageing; Treasury; Department of Defence; Department of Infrastructure and Transport; Department of Resources, Energy and Tourism; Department of Human Resources; Department of Finance and Regulations; and Department of Regional Australia, Local Government, Arts and Sport.

31 DIICCSRTE, *Answers to question on notice*, 11 April 2013, p. 3.

32 ANEDO, *Submission 107*, p. 6.

...primary responsibility for the protection of life, property and the environment rests with the States and Territories in their capacity as first responders during times of emergency.³³

5.22 State and territory governments also have primary responsibility in the areas of health, in particular the delivery of hospital care. DoHA advised that:

State and territory health authorities have well established emergency management legislation, and well-rehearsed and integrated emergency management arrangements. Jurisdictional health authorities have existing command and control structures for the management of health facilities, public health units and pathology laboratory services. Additionally, in some jurisdictions ambulance services also come under the health authority response arrangements.³⁴

5.23 DoHA further submitted that each state and territory is responsible for determining its own internal coordination mechanisms to give effect to the National Health Emergency Response Arrangements.³⁵ For example, the committee was advised that state governments have their own heat plans—to provide information messages and to deal with the increased loads on hospitals.³⁶

5.24 State and territory governments also manage major infrastructure that may be affected by extreme weather (for example ports, transport networks).³⁷ Finally, state and territory governments, in conjunction with local government, are also responsible for a range of relevant regulation, including building codes and land use planning regulations.³⁸ These issues are considered later in this chapter.

5.25 At the same time, the committee heard that some states may lack capacity and coordination in the area of climate change adaptation.³⁹ For example, Associate Professor Laura Stocker expressed the view that the West Australian government 'in general does not identify climate science and coastal adaptation as a critical issue outside of the Department of Planning, who happen to work in that area'.⁴⁰ Associate

33 Attorney-General's Department, *Submission 64*, p. 2; see also DoHA, *Committee Hansard*, 7 June 2013, p. 1.

34 DoHA, *Submission 126*, p. 2.

35 DoHA, *Submission 126*, p. 2.

36 DoHA, *Committee Hansard*, 7 June 2013, pp 4–5.

37 Local Government Association of Queensland, *Submission 68*, p. 5; Northern Territory government, *Submission 129*, p. 13.

38 Adaptation Position Paper, p. 9.

39 See, for example, Mr Piers Verstegen, Director, Conservation Council of Western Australia, *Committee Hansard*, 7 March 2013, p. 14; Associate Professor Laura Stocker, Coastal Collaboration Cluster, Curtin University Sustainability Policy Institute., *Committee Hansard*, 7 March 2013, pp 16–17.

40 For example, Associate Professor Laura Stocker, *Committee Hansard*, 7 March 2013, p. 17.

Professor Stocker expressed the view that this is particularly due to concerns about liability.⁴¹ This issue is discussed further later in this chapter.

Role of local government

5.26 The committee heard that local governments play a key role in dealing with extreme weather events. Indeed, local government was described as being at the 'front line' of climate change.⁴² For example, the Western Australian Local Government Association (WALGA) submitted that:

Local Governments are increasingly at the forefront of climate change adaptation impacts, whether it is the impact on Local Government asset such as roads or planning for sea level rise impacts on coastal communities. Recently, it has become vital for Local Governments to prioritise preparedness for extreme weather events as the number of instances continues to rise.⁴³

5.27 The Victorian Centre for Climate Change Adaptation Research noted that:

Local governments have a critical role to play in climate change adaptation. The impacts of climate change are local and contextual. Further, often local government has the best knowledge of the local circumstances and is most closely in contact with those who will bear the costs and benefits of climate change impacts. Thus, it is the most appropriate level of government for many adaptation actions.⁴⁴

5.28 In particular, local governments coordinate and facilitate disaster management in their local area and lead community recovery operations.⁴⁵ In some states, this role is stipulated through legislation; for example in Western Australia local governments' key responsibilities in relation to emergency management are stipulated in the *Emergency Management Act 2005* (WA) and *Bush fires Act 1954* (WA).⁴⁶

5.29 Similarly, the Brisbane City Council submitted that, under the Queensland *Disaster Management Act 2003*, it has an all hazards management plan, which is reviewed and tested annually and includes comprehensive disaster management arrangements for specific events. So, for example, during the 2011 floods, the Brisbane City Council set up a Local Disaster Coordination Centre to ensure a

41 For example, Associate Professor Laura Stocker, *Committee Hansard*, 7 March 2013, p. 16.

42 ANEDO, *Submission 107*, p. 8; see also COAG, *Roles and responsibilities for climate change in Australia*, <http://www.climatechange.gov.au/roles-and-responsibilities-climate-change-australia> (accessed 24 June 2013).

43 WALGA, *Submission 91*, p. 5; see also Tablelands Regional Council, *Submission 101*, p. 2.

44 Victorian Centre for Climate Change Adaptation Research, *Submission 165*, p. 8.

45 Local Government Association of Queensland, *Submission 68*, p. 5; see also Townsville City Council, *Submission 32*, p. 5; Tablelands Regional Council, *Submission 101*, p. 2.

46 WALGA, *Submission 91*, p. 2.

'coordinated council and interagency response' and which included 'relevant liaison officers from external agencies' to ensure seamless communication and support.⁴⁷

5.30 However, as noted in chapter 2, local governments are calling for more localised data to understand how climate change will affect them at the local level.⁴⁸

5.31 Local government is also responsible for the administration of relevant local planning and development regulations, and building codes. Building codes are discussed later in this chapter.

5.32 Some submitters called for more resources to support local government in relation to planning and implementation of climate change adaptation measures, including preparation and review of climate change adaptation plans and disaster response plans, and standard planning instruments.⁴⁹ For example, ANEDO stated:

The status of local government and the resources, skills, information and competence available to local governments need to be boosted substantially.⁵⁰

5.33 The Productivity Commission report recommended that:

To help clarify roles and responsibilities of local government for climate change adaptation, the state and Northern Territory governments should publish and maintain a comprehensive list of laws that delegate roles to local governments. This would assist both state and local governments assess whether local governments have the capacity to discharge their roles effectively.⁵¹

5.34 The Australian government agreed in principle to this recommendation, but noted that it is primarily a matter for state and territory governments, and that it would refer the recommendation to those governments for consideration.⁵²

Developing effective coordination between governments

5.35 Submitters noted the need for a nationally coordinated and collaborative approach to deal with extreme weather events.⁵³ As the Australian Local Government Association (ALGA) observed:

47 Mr Jason Cameron, Brisbane City Council, *Committee Hansard*, 22 February 2013, p. 1.

48 See, for example, Mr Adrian Beresford-Wylie, Chief Executive, Australian Local Government Association (ALGA), *Committee Hansard*, 11 April 2013, p. 1.

49 See, for example, Northern Alliance for Greenhouse Action, *Submission 47*, p. 4; ANEDO, *Submission 107*, p. 8.

50 ANEDO, *Submission 107*, p. 8.

51 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, recommendation 8.1.

52 *Australian government response to the Productivity Commission report: Barriers to Effective Climate Change Adaptation*, March 2013, p. 8.

53 See, for example, Local Government Association of Queensland, *Submission 68*, p. 5; Mr Adrian Beresford-Wylie, ALGA, *Committee Hansard*, 11 April 2013, p. 5; Mr Karagiannakis, Insurance Australia Group, *Committee Hansard*, 10 April 2013, p. 11.

...the reality is that disaster mitigation and addressing disasters really requires a partnership between the three levels of government. One of the issues that often comes up is the debate around roles and responsibilities between the three levels of government, but the reality is it is supposed to be an integrated partnership between the three levels of government.⁵⁴

5.36 Similarly, the Local Government Association of Queensland recognised that 'no one level of government is able to properly manage all elements of disaster management, which include prevention, preparation, response and recovery' and 'nor can any one element be properly managed in isolation'.⁵⁵

5.37 The Australian Medical Association (AMA) submitted:

Planning for the impacts of climate change and extreme weather requires efforts beyond any single agency or portfolio, and greater efforts are required to achieve a whole-of-government approach and better coordination across agencies and portfolios, and across different tiers of government.⁵⁶

5.38 Others also highlighted the importance of strong national leadership by the Commonwealth government in relation to climate change adaptation and responding to extreme weather events.⁵⁷ For example, the Conservation Council of Western Australia argued:

...it really requires a federal government process to comprehensively assess what the risks are across different jurisdictions and in different communities and then look at what the appropriate response is from a local government to a state government to a federal government level and, in some cases, it will be various combinations of those.⁵⁸

5.39 Dr Steven Hambleton from the AMA agreed:

In many cases it is a response at a local level...We cannot rely on local governments and even state governments to get it right. There needs to be some leadership at a federal level.⁵⁹

5.40 The committee heard that there have been a number of initiatives, particularly by the Council of Australian Governments (COAG), in recent years attempting to improve the coordination in relation to the management of climate change adaptation and extreme weather events. The committee heard that coordination between different levels of government has increased in recent years, but there is still room for

54 Mr Adrian Beresford-Wylie, ALGA, *Committee Hansard*, 11 April 2013, p. 5.

55 Local Government Association of Queensland, *Submission 68*, p. 5.

56 AMA, *Submission 104*, p. 11.

57 See, for example, ANEDO, *Submission 107*, p. 5; Dr Steve Hambleton, President, AMA, *Committee Hansard*, 11 April 2013, p. 22.

58 Mr Piers Verstegen, Conservation Council of Western Australia, *Committee Hansard*, 7 March 2013, p. 11.

59 Dr Steve Hambleton, AMA, *Committee Hansard*, 11 April 2013, p. 24.

improvement. Various initiatives and areas for improvements are discussed further below.

Role of the Council of Australian Governments (COAG)

5.41 Several submitters and witnesses suggested that COAG can and should play a role in improving inter-governmental coordination in relation to extreme weather events.⁶⁰ Indeed, the committee heard that have been a number of initiatives by COAG recently to attempt to improve the coordination in relation to the management of climate change and extreme weather events. These include the:

- Select Council on Climate Change;
- National Strategy for Disaster Resilience; and
- National Climate Change Adaptation Framework.

Select Council on Climate Change

5.42 COAG established a Select Council on Climate Change in February 2011. The purpose of the Select Council on Climate Change was to:

- support an effective response to climate change policy issues with national implications; and
- provide a forum for the Australian government to engage with states, territories, local government and New Zealand on program implementation issues.⁶¹

5.43 As the Productivity Commission noted in its recent report on Barriers to Climate Change Adaptation (as outlined in Chapter 1):

...the COAG Select Council on Climate Change provides a forum for the Australia Government to work with state, territory and local governments on implementing climate change programs.⁶²

5.44 In 2012, the Select Council on Climate Change adopted a statement on *Roles and Responsibilities for Climate Change Adaptation in Australia*.⁶³ This document outlines the respective roles of the Commonwealth, state, territory and local governments in helping Australia adapt to the impacts of climate change. In terms of the Commonwealth's role, it largely reflects the Adaptation Position Paper as

60 See, for example, Dr Michael Eburn, *Committee Hansard*, 11 April 2013, p. 21; Mr Paul Considine, Australian Fire and Emergency Services Authorities Council (AFAC), *Committee Hansard*, 20 February 2013, p. 4; Mr Jason Cameron, Brisbane City Council, *Committee Hansard*, 22 February 2013, p. 2; see also Deloitte Access Economics, *Building our nation's resilience to natural disasters*, June 2013, p. 24.

61 DIICCSRTE, *Answers to question on notice*, 11 April 2013, p. 4.

62 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, p. 328.

63 Available at: <http://www.climatechange.gov.au/roles-and-responsibilities-climate-change-australia> (accessed 24 June 2013); see also DIICCSRTE, *Answers to question on notice*, 11 April 2013, p. 4.

discussed earlier in this chapter. It further states that the focus for state and territory governments should be on:

...ensuring appropriate regulatory and market frameworks are in place, providing accurate and regionally appropriate information, and delivering an adaptation response in areas of policy and regulation that are within the jurisdiction of the state. This includes key areas of service delivery and infrastructure, such as emergency services, the natural environment, planning and transport.⁶⁴

5.45 In terms of local government, the statement recognises that:

Local governments are on the frontline in dealing with the impacts of climate change. They have a critical role to play in ensuring that particular local circumstances are adequately considered in the overall adaptation response and in involving the local community directly in efforts to facilitate effective change. They are strongly positioned to inform State and Commonwealth Governments about the on-the-ground needs of local and regional communities, to communicate directly with communities, and to respond appropriately and in a timely manner to local changes.⁶⁵

5.46 The Victorian Centre for Climate Change Adaptation Research noted:

The Statement of Roles and Responsibilities is necessarily 'high level' and meant to provide general guidance, but implementation of the Statement needs to take account of the suitability of its approach for application in the many situations in which there is not a clear line between public and private and between local, state and federal jurisdictions, or where there are 'gaps' in the allocation of requisite authority.⁶⁶

5.47 The committee notes that the last meeting of the Select Council was in March 2013. DIICCSRTE advised that the Select Council on Climate Change has recommended to COAG that a permanent body to discuss ongoing joint issues related to climate change is not required and that climate change adaptation work should continue under the COAG Standing Council on Environment and Water.⁶⁷ However, the committee notes that this does not appear to be reflected in the current list of strategic priorities of the Standing Council on Environment and Water.⁶⁸

64 *Roles and Responsibilities for Climate Change Adaptation in Australia*, <http://www.climatechange.gov.au/roles-and-responsibilities-climate-change-australia> (accessed 24 June 2013).

65 COAG, *Roles and Responsibilities for Climate Change Adaptation in Australia*, <http://www.climatechange.gov.au/roles-and-responsibilities-climate-change-australia> (accessed 24 June 2013).

66 COAG, Victorian Centre for Climate Change Adaptation Research, *Submission 165*, p. 2.

67 DIICCSRTE, *Answers to question on notice*, 11 April 2013, p. 3; see also COAG Select Council on Climate Change, *Third meeting communique*, 22 March 2013, <http://climatechange.gov.au/climate-change/select-council-climate-change/meeting-communiqu%C3%A9s-and-papers/third-meeting> (accessed 25 June 2013).

68 See COAG Standing Council on Environment and Water, at: <http://www.scew.gov.au/> (accessed 24 June 2013).

5.48 The committee is also aware that the Productivity Commission has recommended that COAG commission an independent public inquiry to develop an appropriate response to managing the risks of climate change to existing settlements.⁶⁹ The Commonwealth government responded that it would 'consult with state and territory governments on the best way to address this issue'.⁷⁰

National Strategy for Disaster Resilience

5.49 Another initiative by COAG frequently referred to in submissions is the *National Strategy for Disaster Resilience—Building the resilience of our nation to disasters* (National Disaster Strategy), endorsed by COAG in 2011. The Attorney-General's Department explained that the purpose of the National Disaster Strategy is to:

...provide high-level guidance on disaster management to federal, state, territory and local governments, business and community leaders and the not-for-profit sector. The Strategy focuses on priority areas to build disaster resilient communities across Australia and recognises that disaster resilience is a shared responsibility for individuals, households, businesses and communities, as well as for governments.⁷¹

5.50 The Australian-New Zealand Emergency Management Committee⁷² is responsible for the implementation of the National Disaster Strategy. Implementation is also being overseen by the Standing Council on Policy and Emergency Management, which comprises responsible ministers from the Commonwealth, states, territories, New Zealand and a representative of the Australian Local Government Association.⁷³

5.51 Submitters were generally supportive of this strategy, expressing the view that it had improved coordination. For example, Dr Steve Hambleton from the AMA expressed the view that the National Strategy had 'improved coordination' but told the committee it still has some significant gaps around the health impacts of extreme weather events.⁷⁴

69 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, recommendation 11.1 and see further Chapter 11.

70 *Australian government response to the Productivity Commission report: Barriers to Effective Climate Change Adaptation*, March 2013, p. 11.

71 Attorney-General's Department, *Submission 64*, p. 2.

72 Membership of the committee comprises representations from the Commonwealth, states, territories, New Zealand and the Australian Local Government Association: see Attorney-General's Department, *Submission 64*, p. 3.

73 Attorney-General's Department, *Submission 64*, p. 2; see also Western Australian Local Government Association, *Submission 91*, p. 3.

74 Dr Steve Hambleton, AMA, *Committee Hansard*, 11 April 2013, p. 22. See also AMA, *Submission 104*, p. 2.

5.52 The Australian Red Cross believed that one of the strengths of the National Disaster Strategy was that it recognises the importance of collaboration.⁷⁵

5.53 Dr Michael Eburn also spoke positively about COAG providing high level guidance through the National Disaster Strategy, saying the role of COAG is:

... to set that high level policy and to then encourage and work with the states, who then have to encourage and work with their local governments to give it effect and teeth.⁷⁶

5.54 Mr Peter Davies from the Northern Territory Police, Fire and Emergency Services described the situation in the Northern Territory:

...the relationship between the Commonwealth and the Territory in terms of the flow of information has improved dramatically in recent years. Emergency management has become far more professional in recent years through the now Emergency Management Committee, and the cross-fertilisation of ideas has been really good.⁷⁷

5.55 However, the committee also heard that there is still considerable room for improvement in coordination in relation to emergency management. For example, the committee heard there is a need for better national coordination of fire services. Mr Peter Marshall, National Secretary, United Firefighters Union of Australia said:

It is our experience that the fire services are not coordinated to the extent where there is a central body that has standard policies and procedures. This was borne out in the royal commission here in Victoria, where the interoperability of the fire services was virtually non-existent. That is not in the interests of the public and it is not in the interests of the government to fund the fire services...We do not have common standard operating procedures across Australia. Each fire service does their own thing.⁷⁸

5.56 These differences in operating procedures impact the ability of firefighters from one jurisdiction (for example NSW) to effectively assist in fire operations in other states (for example Tasmania).⁷⁹

5.57 The committee notes that poor coordination in the area of emergency management was considered at length by the Productivity Commission in its report on *Barriers to effective climate change adaptation*. The Productivity Commission observed that:

75 Mr Andrew Coghlan, National Manager, Emergency Services, Australian Red Cross, *Committee Hansard*, 20 February 2013, p. 33.

76 Dr Michael Eburn, *Committee Hansard*, 11 April 2013, p. 21.

77 Mr Peter Davies, Acting Chief Information Officer, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, p. 5.

78 Mr Peter Marshall, United Firefighters Union of Australia, *Committee Hansard*, 20 February 2013, p. 17.

79 Mr Peter Marshall, United Firefighters Union of Australia, *Committee Hansard*, 20 February 2013, p. 17.

Each emergency service organisation has its own legislation, organisational hierarchy, training programs, operational processes and resources — which may result in a fragmented (or 'silo') approach to emergency management.⁸⁰

5.58 The Productivity Commission made a detailed recommendation that the Australian government undertake a public and independent review of disaster prevention and recovery arrangements.⁸¹

Committee comment

5.59 Compatibility and interoperability between emergency service organisations has been the subject of ongoing discussion. As noted in chapter 4, the committee examined this issue in part during its November 2011 inquiry into the capacity of communications networks and emergency warning systems to deal with emergencies and natural disasters. The committee also notes the recent report of the Parliamentary Joint Committee on Law Enforcement examining *Spectrum for public safety mobile broadband*.⁸²

5.60 The committee urges Australian governments to specifically address issues of compatibility and capacity to facilitate the most effective interoperability of emergency service organisations and their key personnel, especially for fire services.

Recommendation 9

5.61 The committee recommends that Australian governments specifically address issues of compatibility and capacity to facilitate the most effective interoperability of emergency service organisations and their key personnel, especially for fire services.

National Climate Change Adaptation Framework

5.62 In 2007 the *National Climate Change Adaptation Framework* (Adaption Framework) was endorsed by COAG. The Adaptation Framework 'covers a range of cooperative actions between all Australian governments to begin to address key demands from business and the community for targeted information on climate change impacts and adaptation options'.⁸³ The framework identified two priority areas for potential action: building understanding and adaptive capacity; and reducing

80 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, p. 248 and see also Chapter 13.

81 See further Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, recommendation 13.1 and also Appendix 3 of this report.

82 Parliamentary Joint Committee on Law Enforcement, *Spectrum for public safety mobile broadband*, July 2013.

83 See further: DIICCS RTE, *Adaptation framework*, <http://www.climatechange.gov.au/climate-change/adapting-climate-change/adaptation-framework> (accessed 7 June 2013); see also Australian Risk Policy Institute, *Submission 70*, p.1; Australian Red Cross, *Submission 127*, p. 9.

vulnerability in key sectors and regions. It also promised the establishment of an 'Australian centre for climate change adaptation'.⁸⁴

5.63 In terms of extreme weather events, the framework identified two potential areas for action in relation to natural disaster management:

- undertake research to improve knowledge on the nature and expected extent of changes to existing risk profiles as a result of climate change for key events such as bushfires, flooding, cyclones, storm surges, wind and hail damage; and
- incorporate climate change issues into the planning for natural disaster response management, including the review of the 'National Disaster Mitigation Programme';⁸⁵ and improving information for emergency services and communities to foster awareness of climate change and adaptation responses.⁸⁶

Implementation of the framework

5.64 However, submitters generally argued more work is needed to fully implement and build on the framework. The Climate Institute submitted that the framework:

...provides an adequate foundation for government action to improve Australia's readiness for climate change. One of the most important aspects of the Framework is as a tool to drive better coordination of action across all levels of government. However, the lack of progress made in implementing the Framework is deeply concerning.⁸⁷

5.65 The Australian Risk Policy Institute argued that Australia needs to 'move beyond' the framework; simply 'positioning' Australia to act on climate change was not enough.⁸⁸ The AMA and the Climate Institute called for a 'refresh' of the framework.⁸⁹ The Hon Robin Chapple MLC, while describing the framework as a 'valuable and key statement of intent' noted that 'it is unclear as to whether the aims outlined in the Framework have been achieved'.⁹⁰

5.66 In suggesting that the framework be refreshed, the Climate Institute expressed the view that:

Australia still lacks a nationally coordinated approach to managing climate risks to major infrastructure, with much of the burden of policy

84 National Climate Change Adaptation Framework, April 2007, p. 6.

85 Note that this program has been superseded by the Partnership Agreement on Natural Disaster Resilience and the National Disaster Strategy.

86 See further: DIICCSRTE, *Adaptation framework*, April 2007, p. 27.

87 The Climate Institute, *Submission 105*, p. 5.

88 Australian Risk Policy Institute, *Submission 70*, p.1.

89 The Climate Institute, *Submission 105*, p. 2; AMA, *Submission 104*, p. 11.

90 The Hon. Robin Chapple MLC, *Submission 167*, p. 6.

implementation left to local councils – the least-resourced and most decentralized level of government. Information on Australia's preparedness for likely climate impacts is fragmentary and dispersed.⁹¹

5.67 At the local government level, the City of Melbourne submitted that there are still opportunities for improvement in effective national coordination of responses, strategies and support for adaptation activities. The City of Melbourne expressed the view that 'advancements in this area have not been felt at a local government level'.⁹² Others, such as the Local Government Association of Queensland, noted that the framework was due to be reviewed in 2011, but this 'does not appear to have occurred'.⁹³

5.68 However, DIICCSRTE advised that, between 2007 and 2012, the Commonwealth government provided \$126 million to establish the 'Australian Centre for Climate Change Adaptation Program' to support the implementation of the Adaptation Framework.⁹⁴ The committee notes that the DIICCSRTE website lists government 'initiatives contributing towards the implementation of the framework'. It is stated that these include:

- *CSIRO Climate Adaptation National Research Flagship*—investment of \$44m over five years for CSIRO to develop scientific solutions to help Australia adapt to the impacts of climate change and to inform national planning, regulation and investment decisions.
- *Climate Change Adaptation Research Facility (NCCARF)*—a Research Facility based at Griffith University in Queensland to bring together national expertise to help Australia, our industries and communities adjust to the impacts of climate change.
- *Australia's Farming Future*—provides \$130m over four years to improve the ability of primary producers to respond to climate change and manage their emissions.
- *Caring for our Coasts*—helping local communities protect the Australian coastline and prepare for the impact of climate change.
- *National Coastal Vulnerability Assessment*—to help better understand how climate change may impact our coastal communities.
- *Forest Industries Climate Change Research Fund*—\$5 million to address major knowledge gaps about the impact of climate change on forestry and forest industries in Australia.

91 The Climate Institute, *Submission 105*, p. 5.

92 City of Melbourne, *Submission 63*, p. 5.

93 Local Government Association of Queensland, *Submission 68*, p. 6.

94 DIICCSRTE, *Answers to question on notice*, 11 April 2013, p. 3.

- *Local Adaptation Pathways Program*—provided around \$2m in funding to help local government build their capacity to respond to the likely impacts of climate change.⁹⁵
- *Climate Change Adaptation Skills for Professionals Program*—an investment of almost \$2m to fund tertiary education, training institutions and professional associations to revise or develop professional development and accreditation programs for architects, planners, engineers and natural resource managers.
- *Water for the Future*—provides \$12.9 billion and aims to secure the water supply of all Australians, with four key priorities: taking action on climate change; securing water supplies; using water wisely; and supporting healthy rivers.⁹⁶

5.69 However, the committee also notes that some of these initiatives are no longer being funded, including the National Climate Change Adaptation Research Facility (NCCARF).

National Climate Change Adaptation Research Facility

5.70 As noted above, one of the key initiatives arising out the Adaptation Framework, was NCCARF, which the committee understands is not being funded beyond 30 June 2013.

5.71 The Commonwealth government provided \$50 million to fund NCCARF which was formed in 2008 to lead research in:

...a national interdisciplinary effort to generate the biophysical, social and economic information needed by decision-makers in government, and in vulnerable sectors and communities, to manage the risks of climate change impacts.⁹⁷

5.72 NCCARF has done this through three main programs:

- research to develop new information;
- networks that coordinate Australia's research community, build capacity and support effective interaction between research and decision-making communities; and
- outreach activities.⁹⁸

95 See also DIICCSRTE, *Answers to question on notice*, 11 April 2013, p. 2; Ms Benedikte Jensen, First Assistant Secretary, Adaptation, Science and Communication Division, DIICCSRTE, *Committee Hansard*, 11 April 2013, p. 63.

96 DIICCSRTE, *Government actions*, at: <http://www.climatechange.gov.au/climate-change/adapting-climate-change/adaptation-framework/government-actions> (accessed 21 June 2013).

97 NCCARF, *Submission 40*, p. 2; DIICCSRTE, *Answers to question on notice*, 11 April 2013, p. 3; DIICCSRTE, *Committee Hansard*, 11 April 2013, p. 63.

98 NCCARF, *Submission 40*, p. 2.

5.73 NCCARF focused on delivering information to decision-makers to support climate change adaptation investments and initiatives, and to allow end users of the research to be involved. In this way, NCCARF sought to build the capacity of the Australian community to adapt effectively to climate change impacts.⁹⁹

5.74 NCCARF's research portfolio of 142 projects involves 33 Australian universities, 61 Commonwealth, state and local government entities, and 26 private institutions. These are focussed on adapting to the impacts of extreme events, which are predicted to be a key outcome of climate change.¹⁰⁰ This has built research capacity within universities about adaptation, and also amongst decision makers and communities¹⁰¹ and was described by the Director of NCCARF, Professor Palutikof, as placing 'Australia in a globally leading position with respect to climate change adaptation'¹⁰² with the corollary being an understanding of extreme events.¹⁰³

5.75 NCCARF supported eight thematic networks that have around 5000 members. These thematic networks were:

- emergency management;
- settlements and infrastructure;
- human health;
- social, economic and institutional dimensions (including climate change adaptation as it relates to Australia's Indigenous communities);
- water resources and freshwater biodiversity;
- marine biodiversity and resources;
- terrestrial biodiversity; and
- primary industries.¹⁰⁴

5.76 These networks played a significant role in facilitating communication between researchers and those implementing appropriate adaptations. As the committee was told, NCCARF has interpreted scientific information to make it meaningful to the practitioner community and has acted as a:

...broker between the scientific community and the practitioner community to ensure that there is a common understanding of needs and also to act as an interpreter of the information about future climate change on behalf of decision-makers. We can work with decision-makers to help them to understand how much we know about climate change going forward, where

99 NCCARF, *Submission 40*, p. 2.

100 NCCARF, *Submission 40*, p. 3.

101 Professor Palutikof, Director, NCCARF, *Committee Hansard*, 10 April 2013, p. 29.

102 Professor Palutikof, NCCARF, *Committee Hansard*, 10 April 2013, p. 29.

103 Professor Palutikof, NCCARF, *Committee Hansard*, 10 April 2013, p. 29.

104 NCCARF, *Submission 40*, p. 3.

the uncertainties lie and how practitioners can work with those uncertainties in order to maximise the benefit of climate model output.¹⁰⁵

5.77 Many saw the value in the interdisciplinary work that NCCARF was facilitating, contributing to a cohesive research agenda around adaptation for extreme weather events. Witnesses expressed concern about the future of this good work once funding for NCCARF ceased, and especially about the capacity of decision makers to make evidence based decisions.¹⁰⁶

5.78 Professor Bruce Thom, an expert on coastal management, representing the Wentworth group, expressed his regret at the imminent conclusion of NCCARF, stating that '...we are going to leave lots of decision making, both in the private sector and in the public sector, in the lurch'.¹⁰⁷ He went on to say:

The CSIRO have their adaptation flagship, so there is an entity there, but that does not do the same sort of thing that NCCARF did, which was coming out of those types of projects that were very much linked to a lot of local government concerns. When you have these sorts of programs and you start them up for four years, you are really only just getting going.¹⁰⁸

5.79 Professor David Karoly also pointed out the contribution that NCCARF had made in relation to preparedness for extreme weather events:

The NCCARF had a disaster management and emergency response network in addition, and that will also disappear as a network. That was one of the few that were really coordinated across Australia in terms of research on changes in natural disasters in response to climate change.¹⁰⁹

5.80 Associate Professor Stocker explained the gap which would occur with NCCARF's cessation:

NCCARF have done an important job in hosting regular conferences, where we have all been able to meet and share ideas and information. The lack of ongoing funding for NCCARF is a problem for climate adaptation. The CSIRO is also doing good work and a lot of universities are doing coastal and climate adaptation work. But NCCARF had been the agency that was bringing all of that together and trying to coordinate it.¹¹⁰

105 Professor Palutikof, NCCARF, *Committee Hansard*, 10 April 2013, p. 30.

106 Dr Elizabeth Hanna, *Committee Hansard*, 11 April 2013, pp 14–15; Dr Anthony Kiem, *Committee Hansard*, 11 April 2013, pp 13 and 17–18; Professor Lesley Hughes, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 36; see also Glover, L, 'Speaking up for climate change adaptation', *The Conversation*, 11 March 2013.

107 Professor Bruce Thom, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 36.

108 Professor Bruce Thom, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 36.

109 Professor David Karoly, Wentworth Group of Concerned Scientists, *Committee Hansard*, 11 April 2013, p. 39.

110 Associate Professor Stocker, *Committee Hansard*, 7 March 2013, p. 16.

5.81 Associate Professor Stocker highlighted the importance of NCCARF's collaborative work:

The process of collaboration is incredibly important with climate adaptation because it is such a complex and interdisciplinary area. You have physical oceanographers, you have meteorologists, you have geomorphologists. Then there is the whole social side of the research about institutional arrangements and what institutional arrangements are best... We need mechanisms whereby we can have collaborative coproduction of knowledge.¹¹¹

5.82 The committee was advised that NCCARF was only ever intended to be a five year program, and had been extended by a further year to the end of June 2013. Further funding was not allocated to NCCARF in the 2013–14 federal budget.¹¹²

Gaps in the framework

5.83 The committee also heard there are gaps in the National Climate Change Adaptation Framework which need to be addressed. For example, Save the Children Australia pointed out that the Adaptation Framework 'does not mention children, families, or schools anywhere in its consideration of building understanding and adaptive capacity, nor in reducing sectoral and regional vulnerability'.¹¹³

5.84 The AMA commented that although COAG committed to including a national strategy for health and climate change in the Adaptation Framework, this has not occurred:

...a critical shortcoming in the current Adaptation Framework is the failure to develop a National Strategy for Health and Climate Change. The AMA recommends that this strategy be developed to complement the National Adaptation Framework, and to ensure Australia can better respond to the future health impacts of climate change and extreme weather events.¹¹⁴

5.85 Dr Steve Hambleton of the AMA explained that the Australian government needs to:

...develop a comprehensive and coordinated national strategy for climate change and health. We need policy leadership at this level to drive action and co-operation across all tiers of government—state governments, local governments and local sectors, with local groups being engaged.¹¹⁵

5.86 The AMA argued:

Despite the profound health risks posed by climate change and extreme weather events, the response to these risks has been characterised by a lack

111 Associate Professor Stocker, *Committee Hansard*, 7 March 2013, p. 17.

112 DIICSRTE, *Answers to questions on notice*, 11 April 2013, pp 2–3.

113 Save the Children, *Submission 111*, p. 6.

114 AMA, *Submission 104*, p. 11–12; see also Doctors for the Environment Australia, *Answers to questions on notice*, 20 February 2013, pp 1–2.

115 Dr Steve Hambleton, AMA, *Committee Hansard*, 11 April 2013, p. 22.

of national coordination and policy leadership... the national framework perpetuates the silo mentality that demarcates policy into discrete areas, and provided little impetus for the whole-of-government response needed to respond to climate change...It is critical a refreshed national framework supports improved communication and joint planning between portfolios, including health and ageing, environment, and infrastructure. Greater consideration is also needed to link the framework into other relevant national strategies and actions plans, and to articulate the respective roles and responsibilities of different tiers of government.¹¹⁶

5.87 Ms Fiona Armstrong from the CAHA also called for a national strategy on how to respond to the health risk of climate change:

Certainly there needs to be engagement across the sectors and between portfolios. We think it is regrettable that there is not currently much interaction between the climate and health portfolios. We could be developing policy that is very effective in terms of meeting our climate commitments and addressing and improving public health at the same time, but unless we have integration between these portfolios that will not occur. A national plan for climate and health would sit, I imagine, within the health portfolio but it would need to integrate closely with a whole range of other sectors to be effective.¹¹⁷

5.88 However, DoHA submitted that it is currently conducting an assessment across jurisdictions of the 'readiness of the Australian health system to respond to climate change'. DoHA explained that the assessment has a primary focus on governance and planning mechanisms within the health system and will enable identification of actions required to improve the health system's responsiveness to climate change.¹¹⁸

Other areas for improvements to coordination

5.89 Submitters also suggested a number of other areas where there is a need for better coordination and responses between and across governments. These included:

- legislative and regulatory reform at the national level;
- coordination and dissemination of information;
- construction standards and building codes; and
- land use planning.

5.90 These are considered in further detail below.

116 AMA, *Submission 104*, pp 11–12.

117 Ms Fiona Armstrong, Convenor, Climate and Health Alliance, *Committee Hansard*, 20 February 2013, p. 28.

118 DoHA, *Submission 126*, p. 4.

Legislative and regulatory reform

5.91 A number of submitters argued that legislative and regulatory reform at a national level would assist in the coordination of climate change management. For example, the Local Government Association of Queensland (LGAQ) said 'the consensus is that the establishment of systems, standards and legislative and regulatory frameworks to effectively coordinate and empower key sectors (in particular local government) is overdue'.¹¹⁹

5.92 Brisbane City Council similarly argued national legislation and standards would improve coordination. Mr Jason Cameron, Manager, Disaster Operations told the committee:

Consistent nationwide disaster and emergency management legislation and standardisation would provide increased opportunities for interoperability and support between states and territories across Australia. Consistency in the areas of responsibility, terminology, naming conventions, funding and strategic program arrangements would further assist local areas in enhancing preparedness and achieving greater community resilience. Examples of these areas may include incident management systems, terminology, levels of activation, interoperability between agencies and a nationalised disaster management set of standards.¹²⁰

5.93 Finally, Dr Michael Eburn argued that the Commonwealth has 'not clearly defined its role' in responding to extreme weather events and that 'effective national coordination of response to extreme weather events caused by climate change' ideally requires overarching Commonwealth natural disaster legislation.¹²¹ Dr Eburn pointed out that Australia does not have an individual statutory officer to manage and coordinate the federal response, unlike countries like the United States.¹²² He believed Commonwealth legislation should be enacted to provide for a national coordinator 'with the necessary powers to require agencies and states to be coordinated'.¹²³

5.94 Dr Eburn gave the following example to illustrate the need for legislation that defines and clarifies Commonwealth powers and key roles and responsibilities:

Assume there were some disaster in Australia and we needed to fly in a supply of medication that had not gone through the therapeutic goods assessment process but needed urgent clearance, and it was going to be flown into Sydney airport outside the curfew hours. I think there were 11 separate emergency declarations that had to be made by different ministers declaring that this was an emergency, rather than having the ability of the

119 LGAQ, *Submission 68*, p. 5.

120 Mr Jason Cameron, Brisbane City Council, *Committee Hansard*, 22 February 2013, p. 1.

121 Dr Michael Eburn, *Submission 8*, p. 9 and *Committee Hansard*, 11 April 2013, p. 15.

122 Dr Michael Eburn, *Submission 8*, pp 3–4.

123 Dr Michael Eburn, *Submission 8*, p. 9.

Commonwealth to declare: "This is an emergency. All these things will come into play".¹²⁴

5.95 As noted earlier in this chapter, submitters and witnesses also identified the need to clarify concerns about liability, which may be stymying coordination between state and territory governments. Dr Eburn noted that his research indicated that liability issues are 'horribly overstated':

If you actually look at how often litigation occurs it is incredibly rare and, so far, liability has not been established against these agencies, because the courts recognise they are making tough decisions in tough times in imperfect situations.¹²⁵

5.96 Nevertheless, the committee heard that liability concerns affect both state and local governments. The ALGA stated that councils are concerned about liability stemming from planning decisions when looking at adaptation to climate change.¹²⁶

5.97 Associate Professor Stocker commented that liability issues are also a concern for state governments. She expressed the view that the Western Australian government 'is certainly keen to divest itself of all responsibility and liability in terms of storm surge or sea level rise'. She further noted that:

Local government is very anxious that that liability is going to end up on their plate. They neither have the financial nor technical capacity to make the responses that they need to make now. They also very concerned about injurious affection. If they make decisions that disadvantage, for example, a developer, they are worried about being sued by that developer. They are very concerned about legal liability. Whether they act to respond to sea level rise or whether they do not act, they are concerned about legal liability either way. They would like the Commonwealth government, as it is expressed to me, to clarify and alleviate their concerns about liability.¹²⁷

5.98 ANEDO similarly submitted that:

Among other changes that need to be implemented in respect of local government are development of uniform national provisions for local government liability for climate-related impacts...¹²⁸

5.99 The committee notes that the Productivity Commission recommended that:

Local governments' uncertainty about their legal liability is a barrier to effective climate change adaptation. State governments should clarify the

124 Dr Michael Eburn, *Committee Hansard*, 11 April 2013, p. 15.

125 Dr Michael Eburn, *Committee Hansard*, 11 April 2013, p. 16.

126 Mr Adrian Beresford-Wylie, ALGA, *Committee Hansard*, 11 April 2013, p. 2.

127 Associate Professor Laura Stocker, *Committee Hansard*, 7 March 2013, p. 16.

128 ANEDO, *Submission 107*, p. 8.

legal liability of councils with respect to climate change adaptation matters and the processes required to manage that liability.¹²⁹

5.100 The Australian government noted in its response to the Productivity Commission report that it had funded two reports to help clarify legal liability issues of concern to local government, but acknowledged that 'local governments' current uncertainty about their legal liability is a potential barrier to effective climate change adaptation'.¹³⁰

5.101 The committee notes that the Productivity Commission rejected suggestions of a systematic review of regulations to identify constraints to effective climate change adaptation, noting that it had already identified a number of regulatory barriers and proposed reforms to address them.¹³¹ However, as noted earlier, the Productivity Commission did recommend, for example, that the Australian government commission an independent review of disaster prevention and recovery arrangements.¹³²

Coordination and dissemination of information

5.102 The committee was informed that there could be better coordination and dissemination of information relating to extreme weather events.¹³³ The committee notes that data collection, research and projections in relation to extreme weather events have also been discussed in chapter 2. For example, the Australian Local Government Association argued councils need more data on the likely impact of weather changes at the local level to help them 'make more informed decisions'.¹³⁴

5.103 The committee also heard that improvements could be made in relation to flood warnings, mapping and monitoring. For example, local governments carry much of the responsibility when it comes to flood risk management. The Bureau of Meteorology noted that local governments are responsible for issuing flash flood warnings.¹³⁵ Flood risk mapping in NSW is the responsibility of councils.¹³⁶ Similarly

129 Productivity Commission, *Report: Barriers to Effective Climate Change Adaptation*, recommendation 8.2 and see discussion at pp 168–169.

130 Australian government response to the Productivity Commission report: *Barriers to Effective Climate Change Adaptation*, March 2013, p. 9.

131 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, p. 331.

132 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, recommendation 13.1, p. 273.

133 Deloitte Access Economics, *Building our nation's resilience to natural disasters*, June 2013, p. 10.

134 Mr Adrian Beresford-Wylie, Chief Executive, Australian Local Government Association, *Committee Hansard*, 11 April 2013, p. 1.

135 Bureau of Meteorology, *Submission 65*, p. 28.

136 Mr Glenn Evans, Executive Officer, Floodplain Management Association, *Committee Hansard*, 10 April 2013, p. 19.

in Queensland, the LGAQ argued the 'burden of data collection, modelling and analysis' for local planning has been left to local governments to do.¹³⁷

5.104 The Bureau of Meteorology noted that flood level monitoring is one area that could be improved. The Bureau relies on river level data from state agencies and local governments which vary in capacity; for example most agencies are unable to service monitoring equipment 24 hours a day seven days a week.¹³⁸ There is also a lack of consistency around flash flood warnings—many local governments 'lack the resources and technical expertise' to deliver quality flash flood warnings.¹³⁹

5.105 The Bureau of Meteorology concluded that the current problems associated with flood monitoring are not due to a lack of effort or goodwill, but rather 'there are simply too many players with varied responsibilities and capacities, for an adequate, let alone future-ready, national flood monitoring network to eventuate'.¹⁴⁰

5.106 The committee also heard examples of where stakeholders are working together to improve flood coordination. For example, the Floodplain Management Association works with local, state and federal governments to 'develop and implement appropriate policies to reduce flood risks in the future'.¹⁴¹ The organisation has a membership of around 100 local councils, flood mitigation trusts, businesses and catchment authorities.

5.107 The committee is also aware that the Productivity Commission considered this issue in its report on *Barriers to Effective Climate Change Adaptation*.¹⁴² The Commonwealth government, through Geoscience Australia, is establishing a flood risk information portal, to 'provide a single access point to flood mapping data' and to 'improve the quality, availability and accessibility of flood mapping information in Australia'.¹⁴³ As the Productivity Commission noted:

This is an important initiative. Better coordination of flood mapping across Australia will allow for improved management of flood risk in the current climate. It will also provide a stronger basis for future measures to adapt to changes in flood risk due to climate change.¹⁴⁴

137 Local Government Association of Queensland, *Submission 68*, p. 3.

138 Bureau of Meteorology, *Submission 65*, p. 29.

139 Bureau of Meteorology, *Submission 65*, p. 29.

140 Bureau of Meteorology, *Submission 65*, p. 29.

141 Mr Glenn Evans, Floodplain Management Association, *Committee Hansard*, 10 April 2013, p. 19.

142 See Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, Chapter 7, pp 117–145.

143 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, p. 136; and *Australian Government response to the Productivity Commission report: Barriers to Effective Climate Change Adaptation*, March 2013, p. 7.

144 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, p. 136; and see also recommendation 7.1.

5.108 The Productivity Commission further considered that:

...this initiative should also be expanded over time to encompass other natural hazards (particularly bushfires). A single source for natural hazard information would make it easier to assess the quality and consistency of existing information and identify areas for improvement.¹⁴⁵

5.109 In response, the Commonwealth government noted that:

... the coordination and dissemination of natural hazard information, including flood risk, coastal inundation, bushfires and extreme weather elements, will continue to be a core role for the Australian government.¹⁴⁶

Construction standards and building codes

5.110 A number of submitters and witnesses raised the need for improved and nationally consistent construction standards and building codes.¹⁴⁷ For example, insurance industry representatives argued coordinating building codes (to improve the durability of houses to withstand extreme weather events) would help reduce future risk.¹⁴⁸ The Brisbane City Council argued 'there is a key role for the State Government in developing and maintaining building standards for buildings in flood risk areas'.¹⁴⁹

5.111 The experience of recent natural disasters demonstrates the value of improved construction standards. Associate Professor David King, Director of the Centre for Disaster Studies, James Cook University, described how older homes in North Queensland suffered increased damage from Cyclone Yasi:

Yasi hit all the way from Cairns down to Townsville. All of that whole coast was within the cyclone impact and suffered fairly extensive damage. But the houses stood up. Wherever you went afterwards, the post-1980s houses were relatively undamaged....There was remarkable security and stability in the housing stock of North Queensland.¹⁵⁰

5.112 He attributed this to improvements in building codes:

There was legislation. There was a code. You had to build that way from around 1980—the late seventies onwards. Most of the damage was to houses that were pre-1970s, flimsily built houses—fibro, timber. The older

145 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, p. 136; and see also Suncorp, *Submission 77*, p. 2.

146 *Australian Government response to the Productivity Commission report: Barriers to Effective Climate Change Adaptation*, March 2013, p. 8.

147 See for example Professor John McAneney, Managing Director, Risk Frontiers, *Committee Hansard*, 10 April 2013, p. 1; Mr Karl Sullivan, General Manager Policy – Risk and Disaster Planning Directorate, Insurance Council of Australia, *Committee Hansard*, 10 April 2013, pp 10–11.

148 Ms Julie Batch, Group General Manager, Reinsurance, Insurance Australia Group, *Committee Hansard*, 10 April 2013, p. 15.

149 Brisbane City Council, answer to question on notice, p. 1.

150 Associate Professor David King, *Committee Hansard*, 22 February 2013, p. 13.

houses were the ones you see in the pictures of total destruction. When you are looking at the whole of the community, you can see these pockets of total destruction and the majority of the houses are virtually untouched. So building codes work. From that, I conclude the legislation works.¹⁵¹

5.113 Mr Davies of the Northern Territory Police, Fire and Emergency Services also noted that nationally coordinated building codes have assisted in preparedness for cyclones. He argued the construction standards have led to less damage from cyclones:

The building codes issue has been taken up nationally. We subscribe to national building codes, so where they are adjusted in regard to those sorts of projections the NT government follows along. For cyclones, for instance, we are region C. That drives the way our houses are constructed up here. As you would have seen from recent events on the east coast, the houses built to those construction standards performed very well in quite major cyclones.¹⁵²

5.114 Several submissions supported the need for national coordination in terms of developing uniform standards.¹⁵³ The committee notes that there is a National Construction Code, which has been developed and maintained by the Australian Building Codes Board, which reports to the COAG Building Ministers' Forum. The Productivity Commission recommended that this forum should 'develop a work program to embed consideration of climate change in the National Construction Code'.¹⁵⁴ The Commonwealth government noted in its response that the Building Ministers' Forum has agreed to the inclusion of climate change adaptation in their forward work program.¹⁵⁵

Land use planning

5.115 A number of submitters and witnesses raised the importance of risk informed land use planning in preparing for climate change and the impact of weather changes.¹⁵⁶ As outlined earlier in this chapter, land use planning is a responsibility of both state and local governments. However, CSIRO noted that:

151 Associate Professor David King, *Committee Hansard*, 22 February 2013, p. 13.

152 Mr Peter Davies, Northern Territory Police, Fire and Emergency Services, *Committee Hansard*, 7 March 2013, p. 1.

153 See, for example, Victorian Centre for Climate Change Adaptation Research, *Submission 165*, p. 8.

154 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, p. 328 and recommendation 10.1.

155 *Australian government response to the Productivity Commission report: Barriers to Effective Climate Change Adaptation*, March 2013, p. 10.

156 See for example Mr Paul Considine, AFAC, *Committee Hansard*, 20 February 2013, p. 4; Mr Glenn Evans, Floodplain Management Association, *Committee Hansard*, 10 April 2013, p. 21; Climate Action Network Australia, *Submission 92*, p. 2.

A key issue is that the ability of one tier of government to make a decision (within its respective responsibility) is constrained or even compromised by decisions at another level of government. For instance where local governments have statutory responsibilities for local planning and development controls, they do not generally have the capabilities to manage many of the legal and financial risks generated from those decisions. This is particularly the case in implementing planning controls on private property for storm surge events and coastal inundation where local governments have repeatedly looked to State Government to provide adequate legislative protection, regulatory clarity and or financial support to guard against legal action arising from local decisions made in the public good to limit risk.¹⁵⁷

5.116 The committee was also concerned to hear that local governments do not always have the capacity or resources to adequately plan for climate change or extreme weather events when making planning decisions.

5.117 Professor Palutikof, from the National Climate Change Adaptation Research Facility, argued that a lot of people working in local government 'lack the support that they need in terms of policy, regulation and legislation in order to feel that they are able to act around adaptation'.¹⁵⁸ ANEDO submitted that there is a need for standard planning instruments to provide guidance to local government on matters such as coastal planning in the context of climate change.¹⁵⁹

5.118 Submitters noted the need for land planning to consider the risk posed by extreme weather events; and for the community to be informed of these risks when choosing to live there. For example, the Northern Alliance for Greenhouse Action identified an:

...urgent need for climate change impacts, including extreme weather events, to be incorporated into local governments' planning and implementation of infrastructure and services, as well as urban planning and design.¹⁶⁰

5.119 The Australasian Fire and Emergency Services Authorities Council (AFAC) argued emergency services can only do so much if people continue to live in areas of high risk. Mr Paul Considine told the committee that AFAC considered land use planning to be 'an extremely important issue':

...choices are being made by people and by governments across Australia about the use to which people may put land and about the areas which will and will not be developed...What we want people to understand is that using land which is subject to natural catastrophes comes with risks and that those risks cannot be deferred to emergency services or passed on. They have to be accepted. If the decision is made to use the land in a particular

157 CSIRO, *Submission 93*, p. 26.

158 Professor Jean Patricia Palutikof, NCCARF, *Committee Hansard*, 10 April 2013, p. 31.

159 ANEDO, *Submission 107*, p. 8.

160 Northern Alliance for Greenhouse Action, *Submission 47*, p. 3.

way, the risks should be understood and it should be understood that emergency services cannot fill that gap.¹⁶¹

5.120 The ALGA believed that there has been less cooperation and discussion around planning and climate change adaptation since the dissolution of the COAG Local Government and Planning Ministers' Council. The ALGA called for the resurrection of that forum to discuss planning issues, particularly in relation to natural disasters and climate change.¹⁶² For example, the South Australian State Emergency Management Committee (SEMC) noted that the ministerial council had published guidelines on 'Planning Safer Communities', which suggests, among other matters, that land use planning consider strategic controls on the use and development of land in high risk areas.¹⁶³

5.121 The committee notes, once again, that the Productivity Commission considered land-use planning issues in its report on *Barriers to Effective Climate Change Adaptation*. The Productivity Commission stated that:

Local governments should consider the impacts of climate change in land-use planning decisions and should also consider changes to land-use planning regulations.¹⁶⁴

5.122 The Productivity Commission further recommended that:

As a priority, state and territory governments should ensure that land-use planning systems are sufficiently flexible to enable a risk management approach to incorporating climate change risks into planning decisions at the state, territory, regional and local government levels. Consideration should be given to:

- transparent and rigorous community consultation processes that enable an understanding of the community's acceptable levels of risk for different types of land use
- the timeframe of risks and the expected lifetime of proposed land use
- the costs and benefits of land use.

State and territory governments should provide appropriate guidance to local governments to implement these provisions in local government schemes.¹⁶⁵

5.123 The Commonwealth government agreed in principle to this recommendation in its response, noting that it would refer the recommendation to the states and territories for consideration.¹⁶⁶

161 Mr Paul Considine, AFAC, *Committee Hansard*, 20 February 2013, p. 4.

162 Mr Adrian Beresford-Wylie, ALGA, *Committee Hansard*, 11 April 2013, p. 4.

163 State Emergency Management Committee, *Submission 162*, pp 18–19.

164 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, p. 327.

165 Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, recommendation 9.1 and p. 188.

Need for collaboration with the community and business

5.124 Finally, the committee heard that solutions to climate change at the local level require a collaborative research response from scientists and local communities. Associate Professor Laura Stocker explained why collaboration is so important:

No one person has all the answers, so we actually need a vehicle for coming together and working together, not just as scientists, but with a community. Local people have knowledge, Indigenous people have knowledge. We need mechanisms whereby we can have collaborative coproduction of knowledge. That knowledge that emerges from those collaborative exercises is critical in terms of generating knowledge which is both applicable and local and, therefore, usable by local governments. That is what we are struggling with at the moment. We are pulling all the different types of information together and making it applicable and locally relevant to, say, the City of Mandurah or the cities of Bunbury or Busselton.¹⁶⁷

5.125 The Australian Council of Social Service (ACOSS) argued that governments need to collaborate more with the third sector when it comes to emergency planning, response and management. Dr Cassandra Goldie, Chief Executive Officer, explained ACOSS's position:

...we think really important planning must be done around collaboration and coordination. I am struck by the number of times when I have listened to government leaders talk about these events they talk about the role of the SES and the police—all the important emergency services—and the impact on businesses and farming communities, but it is rare for them to talk in any shape or form about this really important third sector of community organisations. Our expertise is in collaboration and coordination and human relationships. In the end, that is what is going to make the difference in terms of whether we recover quickly and well and we are stronger after that or we are going to be worse off and for a long time. So participation of our sector is absolutely vital.¹⁶⁸

5.126 Similarly, the Australian Red Cross recommended that a stronger focus is given to the role of community organisations as contributors to emergency management policy and practice development.¹⁶⁹

5.127 For example, the Australian Red Cross noted that the National Strategy for Disaster Resilience recognised that emergency management and disaster resilience is a partnership between communities, agencies, the private sector and governments. It felt that membership of relevant committees, including, for example, the Australia New

166 Australian government response to the Productivity Commission report: *Barriers to Effective Climate Change Adaptation*, March 2013, pp 9–10.

167 Associate Professor Laura Stocker, *Committee Hansard*, 7 March 2013, p. 17.

168 Dr Cassandra Goldie, ACOSS, *Committee Hansard*, 11 April 2013, p. 46.

169 Australian Red Cross, *Submission 127*, pp 30–31.

Zealand Emergency Management Committee should reflect this 'shared responsibility'.¹⁷⁰

5.128 The committee notes that the role of businesses, households and the community is recognised in a number of relevant initiatives outlined in this chapter, including the COAG statement on *Roles and Responsibilities for climate change in Australia* and the National Disaster Strategy.

5.129 Indeed, the Victorian Centre for Climate Change Adaptation Research noted that the emphasis in current policy is on 'shared responsibility' for disaster risk management and adaptation, involving business, households, industry and community organisations as well as government.¹⁷¹ The Centre agreed that all Australians need to take some level of responsibility, but noted that:

...this does not negate the need for government involvement, especially in the areas of strategic planning, risk mitigation and provision of resources. In many cases government, particularly at a federal level, is more appropriately positioned to access and collate information, assess and broker insurance needs, and implement large scale or resource intensive risk mitigation measures. Further, some sections of the community are not in a position to mitigate risk, because of age, infirmity or poverty. This is an issue of particular note in regions at risk, such as in rural and remote areas and for highly vulnerable communities.¹⁷²

Committee comment

5.130 Australia has experienced severe extreme weather events in recent years; and the evidence to the committee suggests that we are likely to experience them in greater frequency and/or intensity in the future. Preparing for, and responding to, extreme weather events requires cooperation, collaboration and coordination across a range of sectors and governments.

5.131 At the same time, national leadership by the Commonwealth government is also required. The Commonwealth government's own position paper on climate change adaptation identifies the importance of leadership at a national level in terms of managing and responding to extreme weather events. Rather, during the course of the inquiry, it became apparent to the committee that the Commonwealth government's oversight of its response to climate change and extreme weather events has not achieved all that is required. Key documents, such as the National Climate Change Adaptation Framework, have not been reviewed or properly implemented. Promised reports measuring Australia's progress on adapting to climate change, such as the 'Climate Futures Report', have not materialised.

5.132 The committee notes that a number of initiatives designed to implement the National Climate Change Adaptation Framework have been discontinued, including

170 Australian Red Cross, *Submission 127*, p. 30.

171 Victorian Centre for Climate Change Adaptation Research, *Submission 165*, p. 4.

172 Victorian Centre for Climate Change Adaptation Research, *Submission 165*, p. 5.

NCCARF. The committee agrees that NCCARF has created valuable opportunities for researchers, practitioners and academics to share their knowledge and experiences, to identify gaps in policy and practice and to build capacity around adaptation for extreme weather events. NCCARF also did this by publishing easy to read and understand fact sheets and practice guides, and providing accessible forums and seminars on a range of topics related to adaptation.

5.133 While the committee is pleased to see improvements in recent years in terms of coordination between different government agencies at the local, state and territory and Commonwealth level, particularly work by COAG, there is clearly still room for improvement.

5.134 The committee agrees with evidence that COAG should coordinate responses across governments to climate change and extreme weather events. The committee notes evidence that climate change adaptation work will continue under the Standing Council on Environment and Water. The committee considers that COAG should continue to play an important role in improving coordination across governments in relation to climate change adaptation and managing extreme weather events. A number of areas where such coordination could be improved have been discussed in this chapter.

5.135 In this context, the committee notes that the Productivity Commission made a number of recommendations in its report on *Barriers to Effective Climate Change Adaptation* (please see Appendix 3 of this report). These recommendations were designed to help clarify roles and responsibilities of various levels of government in Australia in relation to climate change and extreme weather events. The committee broadly endorses the recommendations of the Productivity Commission and, where possible, suggests that the Australian government implement those recommendations as soon as practicable.

Recommendation 10

5.136 The committee recommends that the Commonwealth government works with state and territory governments to continue to implement the recommendations of the Productivity Commission report, where possible, to improve coordination in relation to climate change adaptation.

Senator Simon Birmingham
Chair

Australian Greens' Additional Comments

The Australian Greens generally agree with the committee's conclusions and recommendations, but they make the following additional comments.

1 The urgent need to reduce greenhouse gas emissions

While this inquiry was principally focused on the rising cost of extreme weather events and the need to adapt to climate change, the imperative to reduce greenhouse gas emissions to avoid future climate change impacts received relatively little attention. In reality, however, it is not possible to consider climate change adaptation without recognition of the need to urgently reduce emissions.

The inquiry report does touch on the Climate Commission report *The Critical Decade 2013: Climate Science, Risks and Responses*, noting the Commission said that 'some progress is being made globally to reduce carbon emissions but far more needs to be done'. However more detail would be appropriate. For example the Climate Commission report also said that:

...to have a 75% chance of staying within the 2°C limit, we can emit no more than 1,000 billion tonnes of CO₂ from 2000 to mid-century. In the first 13 years of this period, we have already emitted nearly 400 billion tonnes, about 40% of the total allowable budget. That leaves a budget of just over 600 billion tonnes of CO₂ for the next 35-40 years, after which the world economy needs to be completely decarbonised. Worse yet, the rate at which we are spending the budget is still much too high, and is growing. For example, from 2011 to 2012, global CO₂ emissions rose by 2.6%. Under a business-as-usual model, with emissions growing at 2.5% per annum, we are on track to have completely used up the allowable global emissions budget within the next 16 years, that is, by 2028 [Emphasis added].

While the Climate Commission was discussing global emissions, it is obvious that the weak emission reduction targets of 5–25 per cent by 2020 adopted by Labor and the Coalition are not consistent with the urgent imperative described above.

2 Inadequate national leadership by the Commonwealth government

All tiers of Government are responsible for preparation for and recovering from natural disasters and extreme weather events. The evidence presented to the committee makes it clear, however, that existing plans are frequently unimplemented and preparations are uncoordinated. These failures must be sheeted home to the Commonwealth. The Greens strongly endorse the committee's observation that:

5.131 At the same time, national leadership by the Commonwealth government is also required. The Commonwealth government's own position paper on climate change adaptation identifies the importance of leadership at a national level in terms of managing and responding to extreme weather events. Rather, during the course of the inquiry, it became apparent to the committee that the Commonwealth government's oversight

of its response to climate change and extreme weather events has not achieved all that is required. Key documents, such as the National Climate Change Adaptation Framework, have not been reviewed or properly implemented. Promised reports measuring Australia's progress on adapting to climate change, such as the 'Climate Futures Report', have not materialised.

The Greens contend, however, that is not sufficient for the committee to simply recommend that the Commonwealth government should implement the findings of the Productivity Commission inquiry into *Barriers to Effective Climate Change Adaptation*. Rather, we believe the committee should condemn the government for its failure to lead and coordinate efforts to prepare for and recover from natural disasters and extreme weather events. The buck passing, particularly onto local governments which frequently lack the required capacity, needs to cease.

Further the Greens argue that:

- the Commonwealth government should ensure that risks associated with a range of global warming scenarios should be integrated into all relevant national policies, standards, targets and oversight; and
- Commonwealth agencies should report on climate risk readiness (along with their emission mitigation efforts), for a range of warming scenarios.

3 Serious lack of risk mitigation funding

The Greens contend that the report does not adequately address the problem on inadequate expenditure on risk mitigation.

The Insurance Australia Group commented that the emergency management community generally accepts that one dollar spent on risk mitigation can save at least two dollars in recovery costs. But Australian government spending on mitigation initiatives represents around only 3 per cent of what it spends on post-disaster recovery and reconstruction.

The Productivity Commission has reached a similar conclusion, noting that effective emergency management requires striking the right balance between preventing and preparing for disasters on the one hand, and responding to and recovering from them on the other. The Commission highlighted that compared to the \$6.7 billion spent on disaster recovery over the last 6 years, only \$0.18 billion has been spent on disaster mitigation.

According to the insurance industry we need to increase investment in disaster mitigation and resilience strategies. The \$27 million per annum allocated for mitigation works under the National Partnership Agreement on Natural Disaster Resilience is inadequate.

Additional funding is needed to allow additional protective works including barrages for unusual tides, levee banks, sea walls, properly maintained fire breaks and access trails, improved flood drainage and dams.

Most recently the Australian Business Roundtable for Disaster Resilience and Safer Communities has called for an annual program of Australian government expenditure

on pre-disaster resilience of \$250 million. The Roundtable calculated that at the national level this level of expenditure has the potential to generate budget savings of \$12.2 billion for all levels of government (including \$9.8 billion for the Australian government) and would reduce natural disaster costs by more than 50% by 2050.

The Roundtable makes three key recommendations each of which the Greens strongly endorse:

- (1) Improve co-ordination of pre-disaster resilience by appointing a National Resilience Advisor and establishing a Business and Community Advisory Group.
- (2) Commit to long term annual consolidated funding for pre-disaster resilience.
- (3) Identify and prioritise pre-disaster investment activities that deliver a positive net impact on future budget outlays.

4 Maintaining funding of the National Climate Change Adaptation Research Facility

The committee report rightly noted that many expert witnesses lamented the cessation of funding of the National Climate Change Adaptation Research Facility (NCCARF). We concur for example with the following observations in the report:

5.73 NCCARF focused on delivering information to decision-makers to support climate change adaptation investments and initiatives, and to allow end users of the research to be involved. In this way, NCCARF sought to build the capacity of the Australian community to adapt effectively to climate change impacts.

5.77 Many saw the value in the interdisciplinary work that NCCARF was facilitating, contributing to a cohesive research agenda around adaptation for extreme weather events. Witnesses expressed concern about the future of this good work once funding for NCCARF ceased, and especially about the capacity of decision makers to make evidence based decisions.

The Greens regard this year's cessation of NCCARF's funding as a significant failure of the Commonwealth government. We believe one of the recommendations of the committee should be that the government maintain the National Climate Change Adaptation Facility for a second 5 years funding round.

Recommendation 1

That the Commonwealth government protect communities from extreme weather by increasing expenditure on pre-disaster resilience to around \$350 million a year. A National Resilience Advisory Group should be established to ensure supported projects are appropriately prioritised and targeted.

Recommendation 2

Maintain funding of the National Climate Change Adaptation Research Facility for further 5 years.

**Senator Christine Milne
Senator for Tasmania**

Appendix 1

Submissions, form letters, tabled documents, additional information, correspondence and answers to questions taken on notice

Submissions

- 1 Professor Neville Nicholls
- 2 Dr Andrew Glikson
- 3 Adjunct Professor Alan Pears AM
- 4 Mr David Gould
- 5 Dr Anthony Kiem
- 6 Asia Pacific Strategy
- 7 Dandenong Ranges Renewable Energy Association Inc
- 8 Dr Michael Eburn
- 9 Risk Frontiers
- 10 Locals Into Victoria's Environment (LIVE) and David Spratt
- 11 Mr Loch Wilson
- 12 Ms Amy-Rose West
- 13 Latrobe Valley Sustainability Group
- 14 Mr David Tones
- 15 Insurance Council of Australia
- 16 Mr Sam Marginson
- 17 Bushwalking Victoria
- 18 Mr Phil Browne
- 19 Ms Kath Freihaut
- 20 Australian Nursing Federation (Victorian Branch)
- 21 Mr Colin Gibson

- 22 Australian Psychological Society
- 23 Ms Eileen Ray
- 24 Wentworth Group of Concerned Scientists
- 25 Mr David Cummings
- 26 Wodonga Albury Towards Climate Health
- 27 Ararat Greenhouse Action Group
- 28 Dr Adrian Barnett
- 29 Master Builders Australia
- 30 Mr Daryl Sherger
- 31 Sustainable Business Group of Australia
- 32 Townsville City Council
- 33 Environment Victoria
- 34 Tasmanian Arboretum
- 35 Ms Amy McMahon, Dr Kiah Smith, Ms Jane Muller, Mr Paul Belesky and
Professor Geoffrey Lawrence
- 36 Australian Conservation Foundation
- 37 Australian Forest Products Association
- 38 Australasian Fire and Emergency Service Authorities Council (AFAC)
- 39 The Australian Greens Victoria
- 40 National Climate Change Adaptation Research Facility (NCCARF)
- 41 Australian Stable Population Party
- 42 VCOSS
- 43 Mr Brent Walker
- 44 Dr Seth Westra, Dr Michael Leonard, Dr Mark Thyer and Professor Martin
Lambert (University of Adelaide)
- 45 Ms Rachel Anne Carter
- 46 450 Parts Per Million
- 47 Northern Alliance for Greenhouse Action

48	Healesville Environment Watch Inc. and C4
49	Dr Sandra Schuster
50	Climate Future
51	Mr Gavin E Cerini
52	Climate and Health Alliance
53	Professor John Dodson
54	Green Building Council of Australia
55	Professor Rodney Keenan
56	Centre for Policy Development
57	ARC Centre of Excellence for Climate System Science
58	Griffith Centre for Coastal Management
59	Centre for Risk and Community Safety
60	Dr Trevor Kerr
61	Department of Sustainability, Environment, Water, Population and Communities
62	Floodplain Management Association
63	The City of Melbourne
64	Attorney-General's Department
65	Bureau of Meteorology
66	Department of Broadband, Communications and the Digital Economy
67	Actuaries Institute
68	Local Government Association of Queensland
69	Surf Life Saving Australia
70	Australian Risk Policy Institute
71	Bushfire CRC
72	Australian Meteorological and Oceanographic Society
73	Mr Charlie Arnott

74	Friends of the Earth
75	Climate and Health Alliance
76	Water Services Association of Australia
77	Suncorp
78	Dr Marion Carey
79	Australian Mobile Telecommunications Association
80	Dr Rowan O'Hagan
81	Mr Yasir Assam
82	Professor David King, Centre for Disaster Studies, James Cook University
83	Mr Jean Dind
84	Mr Stuart Burns
85	Ryde Environment Group
86	Mr Ian Dunlop
87	Australian Institute for the Conservation of Cultural Material (AICCM), Victorian Division
88	Ms Catherine Moore
89	Mr Jon Graham
90	Mrs Penelope Graydon
91	Western Australian Local Government Association
92	Climate Action Network Australia
93	CSIRO
94	Ms Angela Rats
95	Mr John Loty
96	Mr Ramashi Mitra
97	The Hon Jan Barham MLC
98	Ms Fran Thompson
99	Mr John Anselmi

100	Conservation Council of Western Australia
101	Tablelands Regional Council
102	Professor Stewart W Franks
103	Oxfam Australia
104	Australian Medical Association
105	The Climate Institute
106	Dr Ian Wilson
107	Australian Network of Environmental Defender's Offices (ANEDO)
108	Doctors for the Environment Australia
109	Centre for Social Responsibility in Mining, University of Queensland
110	Australian National Retailers' Association
111	Save the Children Australia
112	Telstra
113	Australian Centre for Financial Studies and the Victorian Centre for Climate Change Adaptation Research
114	Mr Lawrence A Wilson
115	Australian Youth Climate Coalition
116	Department of Human Services
117	Emerald for Sustainability (EmFSus) Inc
118	Clean Energy Council
119	Australian Sustainable Built Environment Council
120	Conservation Council SA
121	Gecko-Gold Coast and Hinterland Environment Council Association Inc
122	Wildlife Preservation Society of Queensland - Gold Coast and Hinterland
123	Brisbane City Council
124	WWF-Australia
125	Australian Academy of Science

- 126 Department of Health and Ageing
- 127 Australian Red Cross
- 128 Engineers Australia
- 129 Northern Territory Government
- 130 Mr Michael Baldock
- 131 Religious Society of Friends (Quakers) in Australia
- 132 Mr Scott Hickie
- 133 Mr Kevin E Trenberth
- 134 Mr Kevin Mason
- 136 Ms Christine Simpson
- 137 Ms Megan Armstrong
- 138 Ms Caroline Kades
- 139 Ms Maria Tedesco
- 140 Ms Phillipa Carmody
- 141 Green Cross Australia
- 142 Australian Council of Social Services (ACOSS)
- 143 United Firefighters Union of Australia
- 144 Insurance Australia Group
- 145 Eagle Junction State School
- 146 Environment East Gippsland Inc
- 147 Dr John Hunter
- 148 Environmental Defenders Office (Tas)
- 149 PricewaterhouseCoopers
- 150 Peter, Beverley and Hannah Rubenach
- 151 Mr Benjamin Beccari
- 152 Baltech Pty Ltd
- 153 Mr Brian Rebbeschi

154	Mrs Ruth Haig
155	Ms Jode Wiggins
156	Name Withheld
158	Ms Patina Schneider
159	Tasmania Fire Service
160	Antarctic Climate and Ecosystems Cooperative Research Centre
161	Dr Alexander Donald
162	South Australia State Emergency Management Committee
163	Mr Phill Parsons
164	CHOICE
165	Victorian Centre for Climate Change Adaptation Research (VCCCAR)
166	Professor Roger Stone
167	The Hon Robin Chapple MLC
168	Department of Climate Change and Energy Efficiency
169	National Pharmaceutical Services Association
170	Spatial Industries Business Association
171	Civil Aviation Safety Authority
172	Australian Sea Level Rise Partnership, Global Change Institute, The University of Queensland
173	Mr John McLean
174	Mr Philip S Clark
175	Ms Susan Cooke
176	Ms Julie Marlow
177	Mr Hinton J Lowe
178	Ms Karen Winnett
179	Ms Dawn Robey
180	Mr Gerard Siero

181	Ms Lorraine Leach
182	Ms Nola Webber
183	Ms Kerry Bos
184	Mr Tom Edwards
185	Ms Emma Rooksby
186	Ms Kathryn Kelly
187	Mr Lawrence A Wilson
188	Albert Parker and Tom Watson
189	Mrs Angela Kearns
190	Mr Justin Field
191	Mr Robert Coburn
192	Mr David Reid
193	Ms Julie Muir
194	Mr Stephen Soames
195	Ms Margaret Cusack
196	Ms Lindy Collins
197	Name Withheld
198	Ms Margaret Hilder
199	Mr Daniel Garcia
200	Mr Paul Taylor
201	Mr John Squires
202	Climate Change Australia - Hastings Branch
203	Ms Jackie Rovensky
204	Mr Peter Foster-Bunch
205	Mr Thomas McLoughlin
206	Mr George Adamson
207	Name Withheld

208	Mr Ian Rose
209	Ms Tamara York
210	Ms Nicola Murray
211	Mr Adrian Price
212	Mr Paul Martin
213	Ms Vanessa Richardson
214	Mr Roger Seccombe
215	Ms June Askew
216	Mr David Clarke
217	Mr Neil Rankine
218	Ms Roel Beekman
219	Ms Rosalie Schultz
220	Mr Phill Parsons
221	Ms Tracey Baglin
222	Ms Siobhan Foster
223	Mr Sean Corrigan
224	Mr Edward Brown
225	Mr Guy Langham
226	Ms Jill Haynes
227	Ms Bronwyn Winfield
228	Mr John Duczek
229	Mr Matthew Anstey
230	Ms Cheryl Dooley
231	Mr Thomas Grieg
232	Mr Joe Wolfe
233	Mr Mark Brown
234	Ms Vicki Sullivan

235	Mr Doug Young
236	Ms Linda Young
237	Ms Beth Tarilton
238	Ms Margaret Atkinson
239	Mr Patrick Darley-Jones
240	Mr Fred Hart
241	Mr Peter Fawcett
242	Mr Paul Stephen
243	Ms Rosie Knott
244	Mr Robert Gavin
245	Mr Peter Carroll
246	Ms Patricia Kowal
247	Ms Sandra Bayley
248	Ms Dawn Nettheim
249	Mr Jonathan Arthur
250	Mr Michael Mardel
251	Mr Ric Day
252	Ms Brenda Mason
253	Ms Lesley Bain
254	Ms Rosalind Ross
255	Ms Angela Lindstad
256	Mr Anthony Barnes
257	Ms Ziggy Koenigseder
258	Mr Lester Irving
259	Mr Richard Stanford
260	Ms Maureen Cooper
261	Mr Tobin Saunders

262	Mr Lindsay Gardner
263	Ms Leonie Lyall
264	Ms Elizabeth Long
265	Mr David Connolly
266	Ms Rosalie Miles
267	Ms Hilary Whitehouse
268	Ms Julie Ingleby
269	Mr Kevin Haskew
270	Mr Joe Friend
271	Mr Bob Hawkins
272	Ms Gwen Atkinson
273	Mr Bernard Terry
274	Ms Renee Goossens
275	Ms Lee Miller
276	Ms Eileen Whitehead
277	Ms Jane Brownrigg
278	Mr Ian Parker
279	Ms Patricia Asch
280	Ms Hana Jestribek
281	Ms Kerry Johnson
282	Ms Sarah McLoughlin
283	Ms Mary Scott
284	Mr Richard Winkler
285	Ms Amber Wells
286	Ms Emma Dempsey
287	Mr Reg Morrison
288	Ms Sarah Corfe

289	Ms Amber Flynn
290	Ms Fern Veit
291	Ms Triona Allen
292	Mr Ross Macdonald
293	Ms Jan Lacey
294	Ms Catherine Smith
295	Ms Edwina Mullany
296	Mr Jacob Anson
297	Ms Pat Grainger
298	Ms Nya Murray
299	Ms Heather Hubert
300	Ms Leonie Brialey
301	Ms Rosemary Blemings
302	Mr Brad Schmidt
303	Mr Gosta Lynga
304	Mr Bob Gregory
305	Mr Steven Stewart
306	Mr Duncan Gardner
307	Ms Siobhan Holmes
308	Mr Dorte Planert
309	Mr Jack Claff
310	Ms Lorelle Denham
311	Mr Robert Jenkins
312	Mr Pete Malavisi
313	Ms Christina Martin
314	Ms Louise Crossley
315	Ms Rachel Donovan

316	Mr Soleman Massoud
317	Ms Lyn Sheills
318	Mr Kevin Shaw
319	Ms Helene Dorval
320	Ms Lyndall McCormack
321	Ms Heather Auld
322	Mr Michael Watkins
323	Ms Linda Link
324	Ms Jo-Anne Seater
325	Ms Jennifer Esbenshade
326	Mr John Giacon
327	Mr Lisa Morrison
328	Ms Vera Costello
329	Mr David Chang
330	Ms Wendy Catling
331	Ms Lynda Cord
332	Mr Jeremy Eccles
333	Ms Marie Cowling
334	Ms Amanda Allen
335	Ms Lou Baxter
336	Ms Sue Pratt
337	Mr Travis Edwards
338	Investor Group on Climate Change
339	Name Withheld
340	Mr Peter Thompson
341	Ms Lenore Keough
342	Mr John Englart

343 Mr David Leigh

344 Association for Mitigation Studies for Top End Cyclones Inc.

Form letters

A form letter was received by 5 submitters.

Tabled documents

Summary of the key points of the UFUA submission, tabled by the United Firefighters Union of Australia, at public hearing, Melbourne, 20 February 2013

Communicating About Health Risks: The Important Role of Preparatory Communications in Large-Scale Health Risks – What the Risk-Communications Science Tells Us, APA office of Public Communications, May 2006, tabled by the Australian Psychological Society, at public hearing, Melbourne, 20 February 2013

Presentation paper, tabled by Dr Andrew Glikson, at public hearing, Canberra, 11 April 2013

Paper, 'Infrastructure Interdependencies and Business-Level Impact, A new approach to climate risk assessment', December 2012, tabled by The Climate Institute, at public hearing, Canberra, 11 April 2013

Correspondence

Correspondence received from The Hon. Lynn MacLaren MLC, Member for South Metropolitan Region, Legislative Council Western Australia, dated 12 March 2013

Additional information

- 1 Additional information provided by the Commissioner for Environmental Sustainability Victoria - Climate change Victoria: the science, our people and our state of play
- 2 Additional information provided by Adjunct Professor Peter Fisher, RMIT - Resilient Coastal City Regions: Planning for Climate Change in the United States and Australia
- 3 Additional information provided by Prof. David Karoly, School of Earth Sciences, University of Melbourne (from public hearing, Canberra, 11 April 2013)
- 4 Additional information provided by the Central Goldfields Shire: Project Brief, Community Resilience Mentorship Initiative (CRMI) Scoping Project

Correspondence

Correspondence received from The Hon. Lynn MacLaren MLC, Member for South Metropolitan Region, Legislative Council Western Australia, dated 12 March 2013

Answers to questions taken on notice

- 1 Bushfire Cooperative Research Centre - Answers to questions taken on notice (from public hearing, Melbourne, 20 February 2013)
- 2 Australasian Fire and Emergency Services Authorities Council - Answers to questions taken on notice (from public hearing, Melbourne, 20 February 2013)
- 3 Doctors for the Environment Australia - Answers to questions taken on notice (from public hearing, Melbourne, 20 February 2013)
- 4 Australian Medical Association - Answer to a question taken on notice (from public hearing, Canberra, 11 April 2013)
- 5 Brisbane City Council - Answers to questions taken on notice (from public hearing, Brisbane, 22 February 2013)
- 6 CSIRO - Answer to a question taken on notice (from public hearing, Canberra, 11 April 2013)
- 7 Insurance Council of Australia - Three reports requested on notice (from public hearing, Sydney, 10 April 2013)
- 8 Department of Industry, Innovation, Climate Change, Science, Research, and Tertiary Education - Answers to questions on notice (from public hearing, Canberra, 11 April 2013)

Appendix 2

Public hearings

Wednesday, 20 February 2013 – Melbourne

Australasian Fire and Emergency Services Authorities Council

Mr Paul Considine, Manager, Operations, Urban, Fire and State Emergency Services

Professor Neville Nicholls, Private capacity

Bushfire Cooperative Research Centre

Mr Gary Morgan, Chief Executive Officer

United Firefighters Union of Australia

Commander Brendan Angwin, Manager, Training Development, Metropolitan Fire Brigade, Melbourne

Ms Ruth Kershaw, Economist, EB Economics

Mr Peter Marshall, National Secretary

Ms Joanne Watson, National Industrial Officer

Australian Meteorological and Oceanographic Society

Dr Todd Lane, Vice President

Dr Blair Trewin, President

Climate and Health Alliance

Ms Fiona Armstrong, Convenor

Doctors for the Environment Australia

Adjunct Associate Professor Marion Carey, National Management Committee Member

Dr Eugenie Kayak, Victorian Chair and Member, National Management Committee

Australian Psychology Society

Ms Health Gridley, Manager of Public Interest

Professor Joseph Reser, Member, Disaster Preparedness and Response Reference Group

Australian Red Cross

Mr Andrew Coghlan, National Manager, Emergency Services

Friday, 22 February 2013 – Brisbane**Brisbane City Council**

Mr Jason Cameron, Manager, Disaster Operations

Centre for Disaster Studies, James Cook University

Associate Professor David King, Director

Green Cross Australia

Ms Mara Bun, Chief Executive Officer

Mr Jeffrey Callaghan, Meteorologist

Miss Lisa-Catherine Wilhelmseder, Head of Programs

Griffith Centre for Coastal Management, Griffith University, Gold Coast Campus, Southport

Professor Rodger Tomlinson, Director

Thursday, 7 March 2013 – Perth**Northern Territory Police, Fire and Emergency Services**

Mr Jody Nobbs, Acting Director

Mr Peter Davies, Acting Chief Information Officer

Conservation Council of Western Australia

Dr George Crisp, Volunteer, Adviser, Affiliate Group Member

Mr James Hanson, Climate and Energy Program Manager

Mr Piers Verstegen, Director

Coastal Collaboration Cluster, Curtin University Sustainability Policy Institute

Associate Professor Laura Stocker, Deputy Leader

Wednesday, 10 April 2013 – Sydney**Risk Frontiers**

Mr Ryan Crompton, Catastrophe Risk Scientist

Professor John McAneney, Managing Director

Insurance Australia Group

Ms Julie Batch, Group General Manager, Reinsurance

Mr George Karagiannakis, Head of Government and Industry Relations

Mr Malcolm Freeman, General Manager, Business Partners, CGU Insurance Ltd

Insurance Australia Council

Mr Alex Sanchez, General Manager Policy – Economics and Taxation

Mr Karl Sullivan, General Manager Policy – Risk and Disaster Planning
Directorate

Floodplain Management Association

Mr Glenn Evans, Executive Officer

Antarctic Climate and Ecosystems Cooperative Research Council

Professor Nathaniel Bindoff, Program Leader, Climate Futures

Dr Anthony Press, Chief Executive Officer

National Climate Change Adaptation Research Facility

Professor Jean Palutikof, Director

Thursday, 11 April 2013 – Canberra

Australian Local Government Association

Mr Adrian Beresford-Wylie, Chief Executive

Dr Alexander Donald, Private capacity

Dr Michael Eburn, Private capacity

Dr Andrew Glikson, Private capacity

Dr Elizabeth Hanna, Private capacity

Dr Anthony Kiem, Private capacity

Australian Medical Association

Ms Corinne Dobson, Senior Policy Officer

Dr Steve Hambleton, President

Wentworth Group of Concerned Scientists

Mr Peter Cosier, Member and Convenor

Dr Richard Davis, Member

Dr Ronnie Harding, Member

Professor Lesley Hughes, Member

Professor David Karoly, Member

Mr Tim Stubbs, Environmental Engineer

Professor Bruce Thom, Member

Dr John Williams, Member

The Climate Institute

Mr John Connor, Chief Executive Officer

Ms Olivia Kember, National Policy and Research Manager

Mr David Gould, Private capacity**Australian Council of Social Service**

Ms Yve Earnshaw, Director, Dunalley Community Neighbourhood Centre Inc

Dr Cassandra Goldie, Chief Executive Officer

Ms Emily Hamilton, Senior Research and Policy Officer

Dr Karl Mallon, Director, Science and Systems, Climate Risk Pty Ltd

Bureau of Meteorology

Dr Karl Braganza, Manager, Climate Monitoring Services

Dr Neville Smith, Deputy Director, Research and Systems

CSIRO

Dr Mark Stafford Smith, Science Director, CSIRO Climate Adaptation Flagship

Department of Climate Change and Energy Efficiency

Ms Benedikte Jensen, First Assistant Secretary, Adaptation, Science and Communication Division

Department of Sustainability, Environment, Water, Population and Communities

Mr Richard McLoughlin, Assistant Secretary

Mr Anthony Slatyer, First Assistant Secretary

Mr Sean Sullivan, First Assistant Secretary, Biodiversity Conservation Division

Friday, 7 June 2013 – Canberra**Department of Health and Ageing**

Ms Megan Morris, First Assistant Secretary, Office of Health Protection

Mr Rob Cameron, Assistant Secretary, Office of Health Protection

Dr Jenny Firman, Principal Medical Adviser, Office of Health Protection

Climate Commission

Professor Will Steffen, Climate Commissioner

Mr Ian Dunlop, Private capacity

Appendix 3

Recommendations from Productivity Commission Inquiry Report on Barriers to Effective Climate Change Adaptation

Productivity Commission Inquiry Report No. 59, 19 September 2012¹

Assessing reform options and identifying priority reforms

RECOMMENDATION 5.1

Reforms to address barriers to effective climate change adaptation should be assessed on a case-by-case basis to determine whether they are likely to deliver net benefits to the community. This should include consideration of any risks to their implementation.

If there is a high degree of confidence that reforms will deliver net benefits, they should be implemented without delay.

If there is uncertainty about the net benefits of reform options, there could be a case for delaying implementation or adopting a flexible approach until decision makers have better information on the factors that affect their decisions, particularly if the up-front costs are large and the benefits are likely to be distant.

'No regrets' policies

RECOMMENDATION 6.1

Australian governments should implement policies that help the community deal with the current climate by improving the flexibility of the economy. This would also build adaptive capacity to deal with future climate change. This includes reforms to:

- *taxes that influence the way resources are used, such as land tax exemptions and conveyancing duty, which could inhibit the mobility of labour or capital*
- *government transfers that reduce incentives to adjust to changing circumstances, such as reforms to drought support as outlined in the Productivity Commission's 2009 inquiry*
- *regulations that impose unnecessary costs or inhibit competition or flexibility and could impede climate change adaptation by reducing the ability of*

¹ Productivity Commission, *Inquiry Report: Barriers to effective climate change adaptation*, March 2013, <http://www.pc.gov.au/projects/inquiry/climate-change-adaptation/report> (accessed 19 June 2013).

businesses, households or other entities to respond to changing circumstances, such as restrictions to water trading.

Information provision

RECOMMENDATION 7.1

The Australian Government initiative to improve the coordination and dissemination of flood-risk information should proceed in the most cost-effective way, be regularly updated and be expanded over time to encompass other natural hazards. Guidelines to improve the quality and consistency of risk information should also be regularly updated and take climate change into account where feasible.

Local government

RECOMMENDATION 8.1

To help clarify roles and responsibilities of local government for climate change adaptation, the state and Northern Territory governments should publish and maintain a comprehensive list of laws that delegate regulatory roles to local governments. This would assist both state and local governments to assess whether local governments have the capacity to discharge their roles effectively.

RECOMMENDATION 8.2

Local governments' uncertainty about their legal liability is a barrier to effective climate change adaptation. State governments should clarify the legal liability of councils with respect to climate change adaptation matters and the processes required to manage that liability.

Land-use planning

RECOMMENDATION 9.1

As a priority, state and territory governments should ensure that land-use planning systems are sufficiently flexible to enable a risk management approach to incorporating climate change risks into planning decisions at the state, territory, regional and local government levels. Consideration should be given to:

- transparent and rigorous community consultation processes that enable an understanding of the community's acceptable levels of risk for different types of land use*
- the timeframe of risks and the expected lifetime of proposed land use*
- the costs and benefits of land use.*

State and territory governments should provide appropriate guidance to local governments to implement these provisions in local government schemes.

Building regulation

RECOMMENDATION 10.1

The Council of Australian Governments' Building Ministers' Forum should provide formal direction to the Australian Building Codes Board to:

- *monitor projections of climate change risks to buildings*
- *revise the standards in the National Construction Code to take into account these projections where this delivers a net benefit to the community.*

This body of work should be transparently and formally incorporated in the Australian Building Codes Board's annual work program.

Existing settlements

RECOMMENDATION 11.1

The Council of Australian Governments should commission an independent public inquiry to develop an appropriate response to managing the risks of climate change to existing settlements. The inquiry should:

- *explore, via extensive consultation with all levels of government and the community, in a variety of locations, the community's acceptable levels of risk for public and private assets*
- *identify the options available to manage climate change risks to these assets*
- *assess the benefits and costs of each option*
- *establish policy frameworks that can be applied by state, territory and local governments.*

State and territory governments should draw on the findings of the inquiry to:

- *manage risks to their own assets*
- *clarify roles and responsibilities for managing climate change risks for each level of government and the community*
- *provide appropriate support to local governments that face capacity constraints.*

Emergency management

RECOMMENDATION 13.1

The Australian Government should commission an independent public review of disaster prevention and recovery arrangements. This should be broader than the

review currently being conducted by the Attorney-General's Department. The review should cover the Natural Disaster Relief and Recovery Arrangements, as well as the funding mechanisms for disaster mitigation, including the National Partnership Agreement on Natural Disaster Resilience. This review should:

- consider whether arrangements lead to inadequate disaster-mitigation infrastructure investments or insurance decisions, or reduce the incentives of state and territory governments to appropriately manage their risks*
- clearly outline the process for the identification of disaster-mitigation infrastructure needs, the provision and appropriate funding of this infrastructure, and the allocation of operational responsibilities*
- evaluate the adequacy of current arrangements for the provision of post-disaster assistance, including guidelines and processes for project evaluation and the criteria for approving and funding the betterment of essential public assets*
- consider the balance of resources devoted to prevention and preparedness relative to response and recovery through a cost–benefit analysis of reform options*
- involve extensive consultation with the community and all levels of government.*

The role of insurance

RECOMMENDATION 16.1

State and territory taxes and levies on general insurance constitute a barrier to effective adaptation to climate change. State and territory governments should phase out these taxes and replace them with less distortionary taxes.

RECOMMENDATION 16.2

The Australian Government should only proceed with reforms that require all household insurers to offer flood cover if it can be demonstrated that the benefits to the wider community would exceed the costs.

RECOMMENDATION 16.3

Governments should not subsidise household or business property insurance, whether directly or by underwriting risks.