

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.ninensn.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

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- 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.

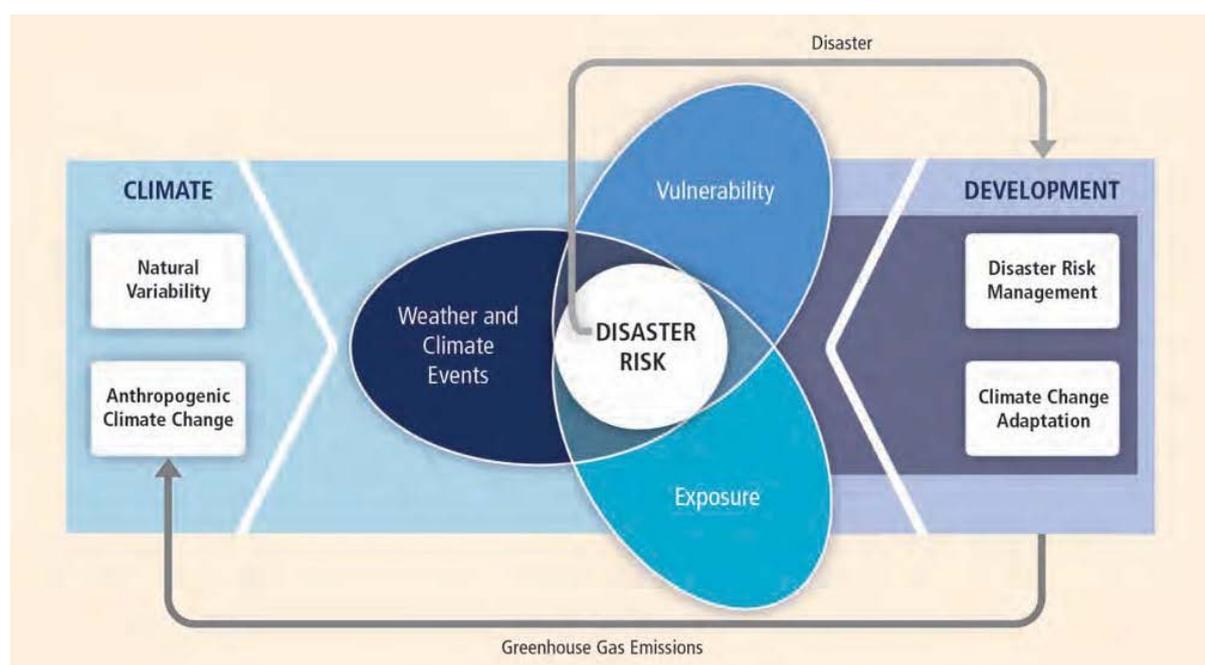
- climate change impacts, adaptation and vulnerability.⁸⁸

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

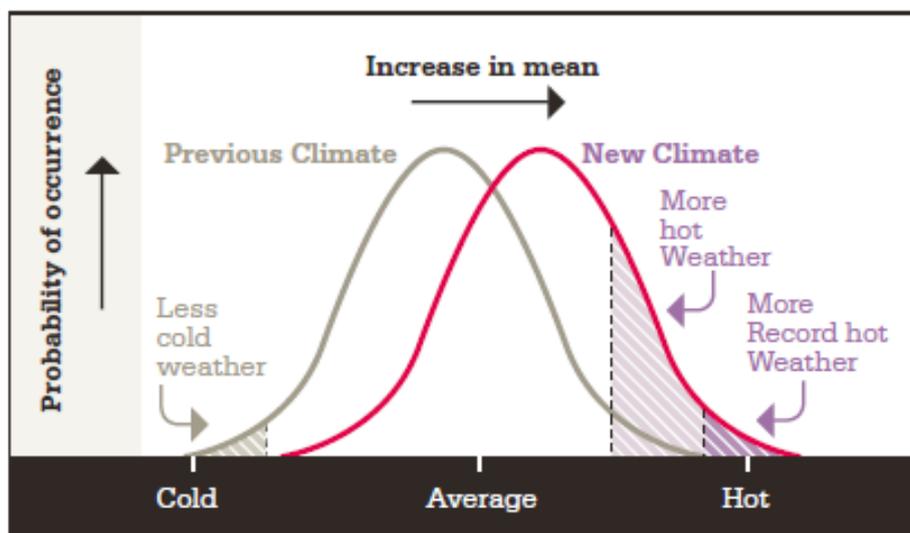
118 Climate Commission, *The Critical Decade: Climate science, risks and responses*, May 2011, p. 3.

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).