

Submission to the Recent trends in and
preparedness for extreme weather events Inquiry
by Ben Beccari

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About Ben Beccari

Ben Beccari is a disaster manager with 9 years of experience in the voluntary, government and international development sectors. In his role as the Manager, Mitigation and Risk Management with the NSW Ministry for Police and Emergency Services he was a representative on the NSW State Emergency Management Committee's Climate Change Working Group and the National Emergency Management Committee's Risk Assessment, Measurement and Mitigation Subcommittee and involved with the development of risk management policy.

His full CV can be viewed at <https://www.linkedin.com/pub/ben-beccari/34/a9b/b3>

This submission is an edited version of several blog articles written on this enquiry. They can be found at <http://casuscalamitas.wordpress.com>

Summary

Climate change is not the only driver of increased natural disaster risk and the impact of climate change on extreme weather is unlikely to be the greatest threat posed by climate change. Nevertheless climate change could have significant implications disaster management in Australia.

An increasing trend in heatwaves and bushfire weather has been observed in Australia and linked to climate change. Although some trends have been observed in other extreme weather, notably tropical cyclones, the confidence in these trends is lower and their attribution to climate change unclear.

Understanding of present trends in extreme weather is hampered by a lack of long timescale, consistent, wide coverage and quality data on these phenomena. The statistics of rare events make detection of climate change signals in extreme weather difficult.

Climate change will increase the incidence and severity of heatwaves, drought and bushfire weather over many parts of the country. Sea level rise will increase the frequency of storm surge and coastal erosion events. The number of weak tropical cyclones are expected to decrease but the number of intense tropical cyclones are expected to increase.

The trend for other hazards is less clear, although there is some evidence that the incidence of flash flooding will rise. There could be considerable regional variation with the incidence and severity of some extreme weather phenomena increasing in some areas and decreasing in others. There remains considerable uncertainty about how climate change will impact many extreme weather phenomena.

The cost of extreme weather events in Australia is approximately \$4-7 billion, but there are difficulties in developing an accurate and comprehensive figure. Drought is likely the most costly hazard. With a limited understanding of present disaster costs it is difficult to develop projections for climate change, but it is likely that increases in the cost of extreme weather events will likely be dwarfed by other climate impacts.

The response of the insurance industry to climate change is difficult to predict. However current issues with the availability and affordability of flood insurance are likely to increase under climate change. Properties in the coastal zone that could be impacted by sea level rise will also become an increasing problem that will need to be addressed by governments, perhaps through risk transfer arrangements such as land swaps.

There are variety of key sectors in Australia that need to be prepared for extreme weather events. These are best characterised as community lifelines rather than critical infrastructure. Despite numerous government programs and coordination efforts there is large variation in the preparedness between and within key sectors. In many cases the understanding of sector preparedness is poor or non-existent. The interconnectedness of key sectors and this fragmented preparedness effort leads to a society that is less prepared than the sum of its parts.

Prevention of the impacts of extreme weather events is an activity largely outside of the responsibilities of the emergency services. Land-use planning and building controls can be very successful in reducing losses for new development, whilst property buy-back and land swaps can

remove risks to existing development. The impact of extreme weather on new development suggests that land use planning and building controls can be further tightened. Retrofitting is a policy response that has been largely unexplored by governments in Australia.

Hazard defences like levees and asset protection zones are effective disaster prevention measures but high costs can lead to poor maintenance reducing their effectiveness. The upgrade of defences to provide the same level of protection in a climate changed future is likely to be very expensive.

State and Territories are the primary emergency managers in Australia, with local government implementing many programs of the states and the Federal Government coordinating state activities. The division of responsibilities between state and local government varies across the country, especially in emergency response. There are some gaps in national emergency management arrangements particularly around inter-jurisdictional and international assistance mechanisms.

There are many other important climate impacts on emergency management that may eclipse increases in severe weather. Other long-term threats including demographic shifts, globalisation, technological trends, emerging diseases and reduced fossil fuel use will pose serious challenges to emergency managers into the future. Climate change is connected to many other serious global risks that could impact Australia and our preparedness could be substantially improved. The interconnectedness of global risks poses substantial challenges for Australian governments. New mechanisms, such as a National Risk Commission, should be established to improve understanding and policy responses to these national risks.

Current Trends of Extreme Weather Events

(a) recent trends on the frequency of extreme weather events, including but not limited to drought, bushfires, heatwaves, floods and storm surges;

The impact of climate change on extreme weather is concerning because extreme weather can affect society. If a tropical cyclone impacts a stretch of uninhabited coastline it receives little coverage.

A recent string of high profile disasters have many asking if climate change is involved. Crompton and McAneney examined disaster losses in Australia since 1967.¹ They found that population growth, increasing wealth and development accounted for all increases in insured losses in Australia over the last 40 years. The impact of climate change on disasters cannot yet be detected in this data. This is consistent with global findings of normalised loss studies.²

Disaster loss data is incredibly noisy with the highest loss years experiencing around 50 times the loss of the lowest loss years. When compared against the drivers of growth in population and wealth the modest warming experienced to date would be difficult to separate out. The corollary to this is that if a signal was detected in disaster loss data with only modest warming having occurred, predicted warming of 4-6°C³ would be very concerning.

To detect any trends it is better to examine data on the extreme weather phenomena themselves. These data are less noisy and doesn't have to contend with competing drivers like population growth.

This approach presents challenges too. For many phenomena quality data and good coverage may only extend back 30 or 40 years. This timescale can make it difficult to separate out natural variability or make inferences about very rare events such as 1% Annual Exceedance Probability floods. Climate change could still be having an impact on a particular extreme weather phenomenon, but if the impact is small it might not *yet* be possible to detect it. This uncertainty isn't evidence of absence⁴, currently detectable changes would be very worrying.

The most recent publication that examines multiple extreme weather hazards is *Australian Climate and Weather Extremes: Past, Present and Future*, published by the Department of Climate Change in 2008.⁵ It covers the issues quite well but as research in this field is fast progressing, the summary below will cite any more up to date sources:

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- 1 Crompton, Ryan, and McAneney, John, 2008: The cost of natural disasters in Australia: The case for disaster risk reduction. *Australian Journal of Emergency Management*, **23** (4), 43-46
http://www.riskfrontiers.com/publications/The_Cost_of_natural_disasters.pdf
 - 2 Bouwer, Laurens M., 2011: Have Disaster Losses Increased Due to Anthropogenic Climate Change?. *Bull. Amer. Meteor. Soc.*, **92**, 39–46. doi: <http://dx.doi.org/10.1175/2010BAMS3092.1>
 - 3 Peters, Glen P., Andrew, Robbie M., Boden, Tom et. al., 2013: The challenge to keep global warming below 2 °C. *Nature Climate Change*, **3**, 4–6. doi: <http://10.1038/nclimate1783>
 - 4 Jones, Roger, 2011: Spinning Uncertainty? The IPCC Extreme Weather Report and the media. *The Conversation*, 23/11/11 <https://theconversation.edu.au/spinning-uncertainty-the-ipcc-extreme-weather-report-and-the-media-4402>
 - 5 Nicholls, Neville. 2008: *Australian Climate and Weather Extremes: Past, Present and Future*, Department of Climate Change, Commonwealth of Australia,
<http://www.climatechange.gov.au/~media/publications/science/weather-extremes.pdf>

Tropical Cyclones

The number of weak and moderate tropical cyclones appears to have decreased although this could be due to changes in observation techniques. The number of intense tropical cyclones appears to have increased. This is consistent with warmer ocean temperatures under climate change, however more research is needed to understand the drivers behind these changes.⁶ There is ongoing discussion in the scientific literature on trends in tropical cyclones in the Australian region.

Bush Fire

Determining long-term trends in bush fire is challenging due to the large proportion of human induced bush fires⁷. The closest proxy is to look at bushfire weather which is indicated by the Forest Fire Danger Index (FFDI). The Bushfire CRC and others have examined trends in FFDI across south-eastern Australia.^{8,9} They found that the median FFDI (a measure of the overall strength of a fire season) has increased, although this was only significant in South Australia and inland areas of NSW and Victoria. Evidence was also found of changes in seasonality with trends differing over spring, summer and autumn in different areas. The sum of FFDI over a fire season (which measures both the season strength and length) also increased, except for some coastal stations and Canberra, with the largest trends being in inland areas.

Temperature is one of the key variables in FFDI and changes in temperature are linked to global. It is likely that trends towards more severe bush fire weather can be linked to climate change.

Heatwave

Consistent with trends in average temperatures the number of hot days, hot nights and record hot temperatures have been increasing.¹⁰ Record hot temperatures are now two to four times as likely as record lows.¹¹ More importantly mean minimum temperatures and the number of hot nights are increasing and the number of cold nights and cold extremes are decreasing.¹² Heatwaves are most dangerous when temperatures fail to drop to comfortable levels overnight.

The impact of these changes on heatwaves is complex. A heatwave is prolonged hot temperatures, so simple temperature records don't provide the full picture. Deo et.al. investigated trends in the

6 Nicholls, Neville. 2008: *Australian Climate and Weather Extremes: Past, Present and Future*, Department of Climate Change, Commonwealth of Australia,
<http://www.climatechange.gov.au/~media/publications/science/weather-extremes.pdf>

7 Bryant, C., 2008: *Understanding bushfire: trends in deliberate vegetation fires in Australia*. Technical and background paper no. 27. Canberra: Australian Institute of Criminology
<http://aic.gov.au/publications/current%20series/bfab/41-60/bfab051.html>

8 Lucas, C., Hennessy K., Mills, G., and Bathols, J., 2007: *Bushfire Weather in Southeast Australia: Recent Trends and Projected Climate Change Impacts*, Consultancy Report prepared for The Climate Institute of Australia
<http://www.royalcommission.vic.gov.au/getdoc/c71b6858-c387-41c0-8a89-b351460eba68/TEN.056.001.0001.pdf>

9 Clarke, H., Lucas, C. and Smith, P., 2012: Changes in Australian fire weather between 1973 and 2010. *International Journal of Climatology*. DOI: [10.1002/joc.3480](https://doi.org/10.1002/joc.3480)

10 Karoly, David, England, Matthew and Steffan, Will, 2013: Off the Charts: Extreme Australian Summer Heat. Report prepared for the Climate Commission.
http://climatecommission.gov.au/wp-content/uploads/CC_Jan_2013_Heatwave4.pdf

11 Trewin, Blair and Vermont, Harrison, 2010: Changes in the frequency of record temperatures in Australia, 1957-2009, *Australian Meteorological and Oceanographic Journal*, **60**, 113-119
<http://www.bom.gov.au/amm/docs/2010/trewin.pdf>

12 Nicholls, *Australian Climate and Weather Extremes: Past, Present and Future*

severity of heatwaves across Australia.¹³ The study examined the average apparent temperature (which takes into account relative humidity) of the worst 3-day heat wave each year. It found that heatwave severity is increasing across eastern and south-eastern Australia by 1-4°C per decade. No statistically significant trend was found in western and northern Australia.

As with changes in bush fire weather climate change is likely behind this increase.

Drought

A drought is more than just a lack of rain, the extreme dryness that characterises drought is also contributed to by increased evaporation. Lacking detailed and long timescale measurements of soil moisture, examination of trends in Australian drought conditions look at rainfall and proxies for evaporation, like temperature.

Records show that recent Australian droughts have been no worse in terms of lack of rain, than droughts earlier in the 20th century.¹⁴ However increased temperatures during recent droughts has increased evaporation. Increased temperatures could be increasing the severity of drought, even with no decline in rainfall. Studies of various drought indices, such as the Palmer Drought Severity Index, have had mixed results in showing any trends. One study found that over the period 1950-2008 eastern Australia became drier and western Australia wetter in terms of drought conditions.¹⁵ However the Palmer Drought Severity Index has been criticised and may not accurately indicate drought conditions.¹⁶

However drought doesn't paint the full picture when it comes to agriculture and the environment. There has been a long term trend towards drier average conditions over much of eastern Australia and south-west Western Australia with fewer very wet years and deficiencies in autumn and early winter rainfall.¹⁷ Although some of these changes are in part due to natural variability, anthropogenic climate change is also a factor. This pattern makes it more difficult for drought-impacted areas to recover, and in particular store water for periods of drought.

Flood

Most analysis of flooding trends has focussed on rainfall, particularly daily rainfall. The latest research was summarised in a recent discussion paper prepared for the review of Australian Rainfall and Runoff.¹⁸ At the daily timescale it found no statistically significant increase in extreme rainfall,

13 Deo, R. C., McAlpine, C. A., Syktus, J., et. al. 2007: On Australian heat waves: time series analysis of extreme temperature events in Australia, 1950 - 2005. In: *MODSIM07: International Congress on Modelling and Simulation: Land, Water and Environmental Management: Integrated Systems for Sustainability*, 10-13 Dec 2007, Christchurch, New Zealand
<http://eprints.usq.edu.au/7418/>

14 Nicholls, *Australian Climate and Weather Extremes: Past, Present and Future*

15 Dai, A., 2011: Characteristics and trends in various forms of the Palmer Drought Severity Index during 1900–2008, *J. Geophys. Res.*, **116**, D12115, doi:[10.1029/2010JD015541](https://doi.org/10.1029/2010JD015541).

16 Sheffield, J., Wood, E.F. and Roderick, M.L. 2012: Little change in global drought over the past 60 years, *Nature*, **491**(7424), 435-8. doi: 10.1038/nature11575

17 2011 Australian State of the Environment Committee, 2011: *State of the Environment 2011*, Independent report to the Australian Government Minister for Sustainability, Environment, Water, Population and Communities, <http://www.environment.gov.au/soe/2011/report/atmosphere/2-1-current-state-climate.html>

18 Westra, Seth, 2011: *Implications of Climate Change on Flood Estimation: Discussion Paper for the Australian Rainfall and Runoff Climate Change Workshop No.2*, Report prepared for Engineers Australia.

although there is some evidence to suggest that extreme rainfall is decreasing where average rainfall is decreasing. It did find evidence for increases in extreme sub-daily and sub-hourly rainfall, having possible consequences for flash flooding.

Looking at flooding records is more complex as changes to catchments over time from land use and infrastructure like dams and levees can also cause changes to flood frequency and severity. This has also been addressed in relation to the review of Australian Rainfall and Runoff.¹⁹ The paper found a downward trend in annual maximum flood peaks across the country, particularly in south-east and south-western Australia. Upwards trends were observed in north-western Australia with mixed results in Queensland. However the report cautions that the short record for many of the stations examined means that the trend observed may be due to climate variability rather than climate change. Further research is needed.

Storm Surge, Extreme waves and Coastal Erosion

With a rise in sea level averaging 1.2mm/year over 1920-2000 the frequency of extreme sea level events are increasing. In the two locations with a long timescale quality dataset (Fort Denison in Sydney and Fremantle) a study have found that extreme sea level recurrence intervals were around 3 times shorter after 1950 than before. There is also some evidence that extreme sea level events are rising faster than mean sea level.²⁰

Storm surges are often concurrent with heavy seas. This combination can lead to coastal erosion damaging coastal infrastructure, property and beach amenity. Onshore wave data is limited so investigations have examined various proxies for it.²¹ In northern Australia extreme waves are strongly associated with tropical cyclones so any change in their frequency will also impact waves. An increase in the frequency of large wave events has been observed in southern Australia, although this is most likely linked with trends in the Southern Annular Mode. Further investigation of wave climate is needed.

Thunderstorms and Hail

Thunderstorms can produce extreme winds, very heavy rainfall, large hail and tornadoes. Increases in population and the development of technology like weather radar have made the detection of these phenomena much easier. This makes determining long term trends very difficult. An increase in the number of thunder days has been observed over southeastern Australia but its source is unclear.²²

An increase in monitoring has been reflected by a massive increase in the number of hailstorms reported over NSW. At the same time however the reported frequency of hailstorms over Sydney

http://www.arr.org.au/Website_links/CC_Workshop_DiscussionPaper_Final.pdf

19 Rahman, Aatur, Haddad, Khaled, Zaman, Mohammed et. al. 2012: *Australian Rainfall and Runoff Revision Projects, Project 5, Regional Flood Methods, Stage 2 Report*. Report prepared for Engineers Australia.

http://www.arr.org.au/Website_links/ARR_Project5_Stage2_Report_Final_.pdf

20 Nicholls, *Australian Climate and Weather Extremes: Past, Present and Future*

21 Hemer, M. A., McInnes, K., Church, J. A. et. al., 2008: *Variability and trends in the Australian wave climate and consequent coastal vulnerability*. Project Report. CSIRO.

<http://www.climatechange.gov.au/publications/coastline/wave-climate.aspx>

22 Davis, S., Walsh, K.J.E., 2008: Southeast Australian Thunderstorms. Are they increasing in frequency?, *Australian Meteorological Magazine*, 57, 1-11

<http://www.bom.gov.au/amoj/docs/2008/davis.pdf>

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has decreased.

Other approaches to investigating these phenomena use downscaling, examining atmospheric conditions which cause thunderstorms. One study found that the conditions conducive to the formation of cool season tornadoes have increased.²³

Wind Storms

Investigations of trends in extreme wind speeds in Australia are probably the least developed of all climate variables. Extreme winds can come from a range of weather systems further complicating the detection and attribution of any trend.

The only area where any investigation has occurred is Bass Strait, where some changes in wind speed (as measured by pressure gradient) have been observed. Exactly what this means for extreme wind speed, or whether it can be generalised to the rest of Australia is unclear.²⁴

²³ Nicholls, *Australian Climate and Weather Extremes: Past, Present and Future*

²⁴ *ibid*

Future Projections of Extreme Weather Events

(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*

Here we come across the first mistake of the terms of reference. Both the IPCC and the CSIRO projections were released in 2007 and based on models run prior to that. No new report released by these bodies to date and there has been substantial work done by others in the meantime. Any projections based on these scenarios are likely to be conservative, and the inquiry should canvass the full range of projections.

Uncertainty and Climate Change

There are massive uncertainties when it comes to climate change including in:

- the success or otherwise of emissions reductions efforts;
- historical data to calibrate computer models;
- computer models don't simulate extreme weather very well;
- computer models don't produce regional projections with high confidence; and
- the actual costs of natural disasters and extreme weather events.

Risk is defined as the effect of uncertainty on objectives.²⁵ The implication of this is simple: the higher the uncertainty, the higher the risk. Uncertainty should be a call to more urgent action to mitigate risk, not less.

Extreme Weather, future projections

The *Australian Climate and Weather Extremes: Past, Present and Future*, report also deals with projections of future climate impacts on extreme weather.²⁶ Additionally the emergency services in Australia, concerned about climate change impacts on natural hazards, have been conducting and publishing reviews of the literature. At least NSW²⁷ and QLD²⁸ have commissioned specific reports on extreme weather, with NSW taking the additional step of regionalising those reports. Various states and territories are also undertaking climate modelling projects, with extreme weather being a

²⁵ ISO 31000:2009, *Risk management – Principles and guidelines*, International Standards Organisation

²⁶ Nicholls, *Australian Climate and Weather Extremes: Past, Present and Future*

²⁷ NSW Office of Environment and Heritage, 2011: *Impacts of Climate Change on Natural Hazards Profiles*, NSW Government

<http://www.environment.nsw.gov.au/climatechange/naturalhazardprofiles.htm>

²⁸ Risk Frontiers, 2011: *State-wide Natural Hazards Risk Assessment, Report 6: Australian Natural Disaster Losses and Climate Change: Implications for Disaster Risk Management*, report prepared for Queensland Department of Community Safety.

<http://disaster.qld.gov.au/Disaster%20Resources/Documents/Report%206.pdf>

key climate phenomena investigated (NSW/ACT²⁹, QLD³⁰, WA³¹, TAS³², SA³³ these projects are at various stages and reports for some are available). Many local governments have also incorporated changes to the risk of extreme events in their climate change risk assessments.

Tropical Cyclones

Various projects have forecast tropical cyclones in the Australian region to decrease in overall number and duration but increase in intensity and produce more rainfall. Some models have also shown tropical cyclone tracks to shift 100-200km southward. There is substantial variation in the magnitude of the changes shown by these models and the effects in different regions in Australia.³⁴

However due to the significant variability in the cyclone record, studies estimate that it would take 60-100 years for a trend to be observed in cyclone frequency, intensity and damage.³⁵

Obviously sea-level rise will also impact the storm surge from tropical cyclones having consequences for those areas already vulnerable to storm surge such as Cairns.

Bush Fire

Rising temperatures will drive an increase in the number of extreme fire weather days across much of the continent, except Tasmania.³⁶ Many areas could experience an increase of 4-5 times the number of very extreme fire weather days and some areas could experience a catastrophic fire weather day on average every 3 years.³⁷ Projected changes appear to mirror current trends, with the most significant increases in inland NSW and northern Victoria.

Fire Danger in different areas will also be driven by changes to rainfall and relative humidity. Both are expected to decrease in QLD where the number of Extreme Fire Danger days could increase by 2-4 times by 2050.³⁸

Climate change could also impact fuel loads, both by changing the vegetation patterns and the amount of fuel they produce and by possibly reducing the opportunity fire agencies have to undertake prescribed burning. One study has found that fuel loads in eucalyptus forests are expected

29 NSW / ACT Regional Climate Modelling Project, University of NSW, accessed 14/01/2013

<http://www.ccrc.unsw.edu.au/NARcliM/>

30 Climate System Research, Queensland Climate Change Centre of Excellence, accessed 14/01/2013

<http://www.ehp.qld.gov.au/climatechange/centre/research.html>

31 Indian Ocean Climate Initiative – Western Australia, accessed 14/01/2013

<http://www.ioci.org.au/>

32 Climate Futures for Tasmania, Department of Premier and Cabinet, accessed 14/01/2013

http://www.dpac.tas.gov.au/divisions/climatechange/adapting/climate_futures

33 Development of an agreed set of climate change projections for South Australia, Goyder Institute for Water Research, accessed 14/01/2013

<http://goyderinstitute.org/index.php?id=31>

34 Nicholls, *Australian Climate and Weather Extremes: Past, Present and Future*

35 Risk Frontiers, *State-wide Natural Hazards Risk Assessment, Report 6: Australian Natural Disaster Losses and Climate Change: Implications for Disaster Risk Management*

36 Nicholls, *Australian Climate and Weather Extremes: Past, Present and Future*

37 Lucas et. al., *Bushfire Weather in Southeast Australia: Recent Trends and Projected Climate Change Impacts*

38 Risk Frontiers, *State-wide Natural Hazards Risk Assessment, Report 6: Australian Natural Disaster Losses and Climate Change: Implications for Disaster Risk Management*

to decrease, but not significantly.³⁹ Changes could also occur to grassfire risk due to changes to cropping under a changing climate. Increases to the length and severity of the fire season are likely to limit the period for prescribed burning to winter in many areas⁴⁰, although there is likely to be regional variation. In some areas the number of days with suitable weather for prescribed burning could increase.⁴¹

Heatwave

Both average and very hot temperatures are expected to increase with global warming. This will make heatwaves more intense. As with current trends most research has focussed on recurrence of very hot temperatures and not examined frequency of a heatwave event. Some of the more recent modelling has examined days over 35°C (the impact of which will vary considerably across the country). By 2100 the frequency of days with this maximum temperature will be 3 times higher in Melbourne, 4 times in Sydney, 2.5 times in Adelaide and Perth, 20 times in Brisbane, 3 times in Hobart and 6 times in Canberra. The average temperature will shift in Darwin such that the number of days over 35°C will go from 9 days in 2008 to 10 months of the year by 2100.⁴²

In WA heatwave intensity is expected to increase, particularly over western inland and northern areas; frequency expected to decrease over the central region, but increase over the south-west; and duration to increase in central areas of south Western Australia.⁴³

Drought

Climate models are predicting a decline in average rainfall over much of Australia particularly during winter and spring. Much drought in Australia is driven by El Niño and how it will vary under climate change is unclear. Nevertheless models are predicting more droughts over Australia and an increase in drought indices over eastern Australia.⁴⁴

Flood

There is considerable variation in modelled predictions for extreme rainfall with some models are predicting a general increase in rainfall intensity and others predicting a decrease although all have considerable spatial variation.⁴⁵ Increases in extreme rainfall at shorter durations could be larger which could potentially increase flash flooding in cities and other small catchments (which are

39 Penman, T.D. and York, A. 2010: Climate and recent fire history affect fuel loads in Eucalyptus forests: Implications for fire management in a changing climate, *Forest Ecology and Management*, **260**(10), 1791-1797

<http://www.bushfirecrc.com/publications/citation/2046>

40 Bushfire CRC, 2006: Climate Change and its impact on the management of bushfire, Fire Note 4

<http://www.bushfirecrc.com/managed/resource/firenoteclimate190906.pdf>

41 NSW Office of Environment and Heritage, Impacts of Climate Change on Natural Hazards Profiles

42 Hughes, Lesley and McMichael, Tony, 2011: The Critical Decade, Climate Change and Health, Report prepared for the Climate Commission

http://climatecommission.gov.au/wp-content/uploads/111129_FINAL-FOR-WEB.pdf

43 Indian Ocean Climate Initiative, 2012: *Western Australia's Weather and Climate: A Synthesis of Indian Ocean Climate Initiative Stage 3 Research*. CSIRO and BoM, Australia

http://www.ioci.org.au/publications/ioci-stage-3/doc_download/121-ioci-3-synthesis-report-summary-for-policy-makers.html

44 Holper, Paul N., 2011: *Climate change, science information paper: Australian Rainfall: Past, present and future*, CSIRO, Australia.

<http://www.cawcr.gov.au/publications/otherreports/rainfall.pdf>

45 Nicholls, *Australian Climate and Weather Extremes: Past, Present and Future*

mostly along Australia's coasts).⁴⁶

In southwest WA, modelling is predicting a general decrease in extreme daily rainfall, although with some spatial variation. Similar effects are predicted in north-west WA.⁴⁷

In Tasmania modelling indicates increases in the number of very wet days, more intense extreme one day rainfall and a significant increase to the intensity of very short duration (6-minutes) rainfall, particularly in eastern Tasmania. One location is predicted to have the 200 year ARI (for rainfall in 24 hours) change to the 20 year ARI, although this is at the extreme end of projected changes. Seasonal changes to rainfall are also predicted. The Tasmanian Climate Futures project has also been one of the few to directly feed these rainfall projections into flood models. They found that larger rivers will be unaffected by changes to rainfall intensity, though smaller catchments and the headwaters of larger catchments could see flood heights (for a given ARI) increase by 0.2-1.2m.⁴⁸

Storm Surge, Extreme waves and Coastal Erosion

As mean sea levels increase so will the frequency of extreme sea level events. The change will depend much on current variability in extreme sea levels. In Tasmania, for example, the current 100 year ARI extreme sea level could occur every year by the end of the century under rising sea levels.⁴⁹

Increased extreme sea levels will also have consequences for flooding in estuarine environments like coastal lakes. Changes to storms that cause extreme water levels are unclear but some studies have suggested an increase (above the changes caused by rising sea levels) to storm surge frequency and intensity.

Increased erosion of sandy beaches is expected with rising sea levels. The Bruun Rule (which has been the subject of some criticism⁵⁰) estimates that for every 3mm in sea level rise, beaches will erode by 0.15-0.3m. Thus for 50-100cm of sea level rise this century beaches could erode by 25-100m, although this will vary from location to location.

There is much uncertainty in projected changes to wave climate across the country. In NSW the maximum storm wave height may increase, but further research particularly on east coast lows is needed.⁵¹

Increased mean sea levels will also increase tsunami risk around the country.

46 Westra, *Implications of Climate Change on Flood Estimation: Discussion Paper for the Australian Rainfall and Runoff Climate Change Workshop No.2*,

47 Indian Ocean Climate Initiative *Western Australia's Weather and Climate: A Synthesis of Indian Ocean Climate Initiative Stage 3 Research*.

48 ACE CRC 2010: *Climate Futures for Tasmania extreme events: the summary*, Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania.

49 ibid

50 Cooper, J Andrew G. and Pilkey, Orrin H., 2004: Sea-level rise and shoreline retreat: time to abandon the Bruun Rule. *Global and Planetary Change*, **43**, 157-171

51 NSW Office of Environment and Heritage, *Impacts of Climate Change on Natural Hazards Profiles*

Thunderstorms and Hail

There has been considerable regional variation in predictions for future hailstorms. Modelling has forecast a decrease in hail frequency for Melbourne and Mt. Gambier, an increase in hail frequency for Queensland, and an increase in the frequency of large hailstones in Sydney.⁵²

Wind Storms

Some models suggest that westerly gales, which are a common cause of wind damage in southern Australia could decline in some areas as wind belts shift southwards.⁵³

However extreme winds are expected to increase over much of Tasmania, increasing losses from damage to older buildings, although current building codes are considered to be adequate to 2100.⁵⁴

⁵² Nicholls, *Australian Climate and Weather Extremes: Past, Present and Future*

⁵³ NSW Office of Environment and Heritage, *Impacts of Climate Change on Natural Hazards Profiles*

⁵⁴ ACE CRC, *Climate Futures for Tasmania extreme events: the summary*

The costs and benefits of extreme weather events

In assessing the costs of extreme weather events and impacts on natural ecosystems, social and economic infrastructure and human health it is also important to recognise the real benefits of extreme weather. In some areas tropical cyclones and floods contribute significantly to seasonal rainfall (up to 50% in some parts of WA) recharging natural and man-made water storages. Periodic flooding is also important for many ecosystems and can have agricultural and pastoral benefits. Investigation of flooding in the Murray Darling Basin suggests that the benefits of flooding there are significantly underestimated.⁵⁵

Many systems, particularly natural systems, are well adapted to coping with extreme weather events. However climate changes to average conditions could stress systems to the point where they are no longer able to cope with extreme events. No study I know of has investigated this sort of interaction in any ecosystem or sector. In terms of ecosystem consequences this type of impact could very well be the most significant.

Analyses of the costs of natural disasters rarely cover all sectors (including the natural environment) and all events. Cost estimates will depend on the methodology used. There is significant discussion on how to estimate the loss in some sectors and how to value disaster benefits (e.g. rebuilding is an economic stimulus, the funding for which flows *into* Australia from the global reinsurance industry). Determining economic losses for disasters are very difficult and there are issues with comparing loss estimates derived for different events and hazards.⁵⁶ Most analyses tend to focus on a specific event, disaster and/or sector. For example:

- The economic impacts of the 2011 Queensland Floods⁵⁷
- Estimated costs of tropical cyclones in Western Australia⁵⁸
- Research on the CO₂ released by bush fires and their impact on catchment hydrology, with forest regrowth absorbing more water.⁵⁹
- The Final Report of the Victorian Bushfires Royal Commission which provides a comprehensive, though conservative, estimate of the total costs of the 2009 Black Saturday disaster.⁶⁰

55 Kingsford, Richard, 2012: More Flooding in the Murray-Darling Basin could be good news for farmers, The Conversation, 25/10/12

<https://theconversation.edu.au/more-flooding-in-the-murray-darling-basin-could-be-good-news-for-farmers-10321>

56 Handmer, John, 2003: The Chimera of Precision: Inherent uncertainties in disaster loss assessment, *The Australian Journal of Emergency Management*, 18(2), 88-97

<http://www.em.gov.au/Documents/Chimera%20of%20Precision.pdf>

57 IBISWorld, 2011: Queensland Floods: The Economic Impact, Special Report January 2011

<http://www.ibisworld.com.au/common/pdf/QLD%20floods%20special%20report.pdf>

58 McBride, John L., 2012: The estimated cost of tropical cyclone impacts in Western Australia, A Technical Report for The Indian Ocean Climate Initiative (IOCI) Stage 3

http://www.ioci.org.au/publications/doc_download/120-the-estimated-cost-of-tropical-cyclone-impacts-in-western-australia.html

59 Australian Institute of Criminology, Cost of Bushfires, Bushfire Arson Bulletin No. 60, 8/12/09

http://www.aic.gov.au/documents/F/B/5/%7BFB5A7347-7C0D-477C-B911-6847849FB516%7Ddbfab060_001.pdf

60 2009 Victorian Bushfires Royal Commission, and Teague, Bernard. 2010: *2009 Victorian Bushfires Royal Commission : final report* 2009 Victorian Bushfires Royal Commission, Melbourne

<http://www.royalcommission.vic.gov.au/Commission-Reports>

The costs of preventing, preparing for and responding to extreme weather disasters also needs to be considered. A study investigating fire (primarily urban fire) found that the total cost to Australia is over \$12 billion (or 1.3% of GDP), however only 14% of this was from the consequences of fire with the remainder being spent on anticipation (e.g. compliance with building codes) and response (e.g. funding of the fire services).⁶¹

The nearest equivalent study on natural disasters only examined expenditure by federal, state and local governments directly associated with emergency services and disaster mitigation, response and recovery (ignoring the private sector and expenditure with co-benefits such as on land use planning and building code systems). The results showed that the majority of Federal expenditure was on relief and recovery, the majority of State and Territory expenditure was on preparedness and response and the majority of local government expenditure was on mitigation. Most disaster related expenditure is by the states and territories, followed by the Commonwealth, followed by local government.⁶²

A number of studies have given estimates of annualised costs of natural disasters in Australia ranging from 1.07 billion⁶³ to 1.65 billion⁶⁴ (adjusted for inflation to 2011 dollars) Some studies have confined themselves to insured losses whilst others have attempted to include economic losses, and the cost of deaths and injuries (including from lost productivity). Other methods of estimation focus on damage to the built environment, Risk Frontiers estimated that the equivalent of 44,400 dwellings were destroyed between 1900 and 1999.⁶⁵ Note that all these figures include losses due to earthquakes and landslides, which represent about 13% of total losses and exclude the impacts of drought and heatwaves.

There are data issues for all these studies though as smaller disasters are likely to go unreported, there was little data collection for historical disasters, and detailed analyses tend to focus on larger more recent disasters. These difficulties mean that all estimates are likely to be conservative and the real cost of disasters much higher.

PricewaterhouseCoopers prepared a report on heatwaves which surveyed some of the impacts, but did not calculate an annualised figure.⁶⁶ Bambrick et. al. in a paper commissioned for the Garnaut review looked at current and projected loss of life, hospitalisations and lost workdays due to temperature-related morbidity and mortality. They found (relative to a baseline without climate change) deaths in the Northern Territory (1159%), Queensland (548%) and Western Australia (62%)

61 Ashe, Brian, McAneney, K.J., Pitman, A.J., 2009: Total Cost of Fire in Australia, *Journal of Risk Research*, **12**(2), 121-136, DOI [10.1080/13669870802648528](https://doi.org/10.1080/13669870802648528)

62 Bureau of Transport and Regional Economics, 2002: *COAG Review of Natural Disaster Relief and Mitigation Arrangements: Government Expenditure Analysis*, Commonwealth of Australia, Canberra <http://www.em.gov.au/Documents/Govt%20Expenditure%20Analysis.pdf>

63 Crompton and McAneney, The Cost of Natural Disasters in Australia: the Case for Risk Reduction,

64 Bureau of Transport Economics, 2001: *Economic Costs of Natural Disasters in Australia*, Report 103, Commonwealth of Australia, Canberra. http://www.bitre.gov.au/publications/2001/report_103.aspx

65 Risk Frontiers, 2011: *State-wide Natural Hazards Risk Assessment, Report 2: Historical analysis of natural hazard building losses, fatalities and expenditure for Queensland*, report prepared for Queensland Department of Community Safety. <http://www.disaster.qld.gov.au/Disaster%20Resources/Documents/Report%202.pdf>

66 PricewaterhouseCoopers Australia, 2011: *Protecting human health and safety during severe and extreme heat events: A National Framework*, Report prepared for the Department of Climate Change and Energy Efficiency <http://www.pwc.com.au/industry/government/assets/extreme-heat-events-nov11.pdf>

would be higher, whilst they would fall in the southern states by 2100.⁶⁷ They also found a similar pattern in loss of economic productivity. In pure productivity loss temperature related illness and death costs the Australian economy about \$1.4 billion per year (assuming the value of a workday to be \$400). This does not include the cost of hospitalisations (which would add about \$50 million), temperature impacts on infrastructure and the social impact of temperature-related illness and death.

I have not been able to find any estimate of annualised costs of drought. A 'back-of-the-envelope' calculation (assuming 1 in 3 years are drought affected, and drought on average impacts about 0.6% of GDP) estimates that drought costs the Australian economy about \$2-3 billion on average per year.

This would make drought the most costly extreme weather event. Adding estimates for temperature extremes, drought and other natural disasters suggest extreme weather costs Australia somewhere in the vicinity of \$4-7 billion per year.

However to put things in context road accidents cost \$27 billion per year⁶⁸, overweight and obesity \$21 billion per year⁶⁹, influenza \$7 billion per year⁷⁰, crime \$36 billion per year⁷¹, transport-related air pollution \$2.7 billion per year⁷², work related illness and injury \$60.6 billion per year⁷³, illicit drugs \$8 billion per year, alcohol \$15 billion per year and smoking \$31 billion per year⁷⁴.

Cost of other climate change impacts

The cost of climate impacts in Australia could be greater than 10% of GNP by the end of the century (about \$142 billion per year in present dollar terms).⁷⁵

67 Bambrick, Hilary, Dear, Keith, Woodruff, Rosalie et. al. 2008: The impacts of climate change on three health outcomes: temperature related mortality and hospitalisations, salmonellosis and other bacterial gastroenteritis, and population at risk from dengue, Report prepared for the Garnaut Climate Change Review
[http://www.garnautreview.org.au/CA25734E0016A131/WebObj/03-AThreehealthoutcomes/\\$File/03-A%20Three%20health%20outcomes.pdf](http://www.garnautreview.org.au/CA25734E0016A131/WebObj/03-AThreehealthoutcomes/$File/03-A%20Three%20health%20outcomes.pdf)

68 Road Safety, Department of Infrastructure and Transport, accessed 17/01/13,
<http://www.infrastructure.gov.au/roads/safety/>

69 Colagiuri, Stephen, Lee, Crystal M.Y., Colagiuri, Ruth et. al. 2010: The cost of overweight and obesity in Australia, *Med J Aust*, 192(5), 260-264
<https://www.mja.com.au/journal/2010/192/5/cost-overweight-and-obesity-australia>

70 Davis, Grant 2010: *Social and Economic Costs of Influenza*, Risk Logic, accessed 17/01/13
<http://www.risklogic.com.au/2010/10/social-and-economic-costs-of-influenza/>

71 Rollings, K., 2008: *Counting the costs of crime in Australia: a 2005 update*. Research and public policy series no. 91. Canberra: Australian Institute of Criminology.
<http://www.aic.gov.au/publications/current%20series/rpp/81-99/rpp91.html>

72 Bureau of Transport and Regional Economics, 2005: *Health Impacts of Transport Emissions in Australia: Economic Costs*, Working Paper 63, Commonwealth of Australia, Canberra
http://www.bitre.gov.au/publications/2005/files/wp_063.pdf

73 Safe Work Australia, 2012: *The cost of work-related injury and illness for Australian employers, workers, and the community, 2008–09*, Commonwealth of Australia, Canberra
<http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/660/Cost%20of%20Work-related%20injury%20and%20disease.pdf>

74 Collins, David J., Lapsley, Helen M., 2008: The costs of tobacco, alcohol & illicit drug abuse to Aust. society in 2004/05 – Summary Version, report prepared for the Department of Health and Aging.
[http://www.nationaldrugstrategy.gov.au/internet/drugstrategy/publishing.nsf/Content/mono66/\\$File/mono66.pdf](http://www.nationaldrugstrategy.gov.au/internet/drugstrategy/publishing.nsf/Content/mono66/$File/mono66.pdf)

75 Garnaut, Ross., 2008: *The Garnaut climate change review : final report*, Cambridge University Press, Port Melbourne, Vic.
<http://garnautreview.org.au/>

The impact of climate change on natural hazards is unlikely to be its greatest cost for Australia. In the Murray Darling Basin alone 97% of agricultural production (about \$18 billion per year) could be wiped out by 2100.⁷⁶ These figures suggest that prolonged loss of rainfall, rather than drought per se, will be responsible for most of the economic damages to agriculture from climate change.

Damage to the tourism industry is also expected. The Great Barrier Reef is worth \$5.4 billion annually to the national economy.⁷⁷ Severe and irreversible damage is predicted to occur to the reef with climate change, which would wipe out this contribution.⁷⁸

In other sectors anticipating climate change impacts is more complex. For road infrastructure a generally drier climate could decrease maintenance costs. On the other hand more hot days would make roads more susceptible to intense rainfall which may increase in some areas. The magnitude of these effects could lead to an overall reduction, increase or no change in road infrastructure costs due to climate change.⁷⁹

Climate change migrants from Pacific islands could average 43,000 annually by 2050, many of whom would travel to Australia.⁸⁰ Were they to be treated in a similar framework to current asylum seekers it could cost Australia upward of \$4.7 billion per year.

It's estimated that there is \$226 billion of commercial, industrial residential and transport assets exposed to a sea level rise of 1.1 metres by 2100.⁸¹ A gradual relocation of these assets will cost somewhere in the vicinity of \$3 billion per year on average. However, coastal erosion and inundation will not happen gradually. If these assets are replaced when destroyed the peak annual cost can be expected to be much higher.

Availability and Affordability of Insurance

I'm going to mainly consider home insurance, which was examined extensively in the context of flooding in the Natural Disaster Insurance Review.⁸² I will draw on that inquiry's final report and its submissions heavily here.

For the vast proportion of properties in Australia natural disaster risk doesn't contribute significantly to household premiums. Availability and affordability of insurance is only currently an issue for

⁷⁶ Ibid.

⁷⁷ Access Economics Pty. Ltd. 2009: Economic Contribution of the Great Barrier Reef Marine Park 2006-07, report prepared for the Great Barrier Reef Marine Park Authority
http://www.gbrmpa.gov.au/_data/assets/pdf_file/0009/5598/gbrmpa_RP98_Economic_Contribution_Of_The_GBR_MP_2009.pdf

⁷⁸ Garnaut, *The Garnaut climate change review : final report*

⁷⁹ ibid

⁸⁰ Koser, Khalid, 2012: *Environmental Changes and Migration: Implications for Australia*, Lowy Institute for International Policy, Sydney
<http://www.lowyinstitute.org/publications/environmental-change-and-migration-implications-australia>

⁸¹ Department of Climate Change and Energy Efficiency, 2011: *Climate Change Risk To Coastal Buildings and Infrastructure*, Commonwealth of Australia, Canberra
<http://www.climatechange.gov.au/~media/publications/coastline/riskscoastalbuildings.pdf>

⁸² Australia Treasury, 2010: *Natural Disaster Insurance Review: Inquiry into flood insurance and related matters*, Commonwealth of Australia, Canberra
http://www.ndir.gov.au/content/report/downloads/NDIR_final.pdf

hazards with high spatial variability, mainly flooding.

There are approximately 100,000 properties in Australia where flood insurance premiums are estimated to be significantly (3-14 times) above the base insurance price.⁸³ These properties are located in areas with an ARI of flooding of 50 years or less. Using the risk bands suggested by the Insurance Council of Australia and assuming climate change would increase everyone to the next highest risk band (a conservative approximation) the total amount of flood premiums paid in Australia would double from about \$450million to \$760million. Most of this increase would be borne by those already facing unaffordable premiums although this group would grow by 50%.

Insurance for homes in North Queensland against tropical cyclone raises premiums, compared to similar homes in non-cyclone prone areas, by 3-4 times. However there is no evidence this has a great effect on rates of insurance in these areas. There have been some issues raised about affordability and availability of insurance in these areas, although it is unclear whether this is due to lack of competition in the local market or the underlying risk profile.⁸⁴ As climate change is not expected to significantly increase tropical cyclone losses over the short-medium term it is unlikely to have a major impact on insurance in north Queensland.

One under-appreciated issue is coastal erosion. It is generally not covered by insurance and the future loss of the property and the land on which it sits is an almost certainty. This hazard will only increase with climate change. As the loss of a property will only occur once and be total, arrangements other than insurance will need to be investigated to transfer this risk.

The use of insurance as a climate change adaptation tool has been examined by [Booth and Williams](#). They note that climate change could increase the unavailability and unaffordability of insurance, particularly for low income earners.⁸⁵ Additionally Bell surveys the availability of coverage for different extreme weather events.⁸⁶

83 Insurance Council of Australia, 2011: Response to 2011 Natural Disaster Insurance Review

http://www.ndir.gov.au/content/submissions/issues_paper_submissions/Insurance_Council_of_Australia.pdf

84 Australia Treasury, *Natural Disaster Insurance Review: Inquiry into flood insurance and related matters*

85 Booth, Kate and Williams, Stewart, 2012: Is insurance an under-utilised mechanism in climate change adaptation? The case of bushfire management in Tasmania, *Australian Journal of Emergency Management*, 27(4), 38-45

<http://www.em.gov.au/Publications/Australianjournalofemergencymanagement/Currentissue/Pages/IsinsuranceanunderutilisedmechanisminclimatechangeadaptationThecaseofbushfiremanagementinTasmania.aspx>

86 Bell, Justine, 2011: Insurance for extreme weather events in Australia – current policy trends, and future directions. *Macquarie Journal of Business Law*, 8, 339-357

http://www.businessandconomics.mq.edu.au/our_departments/accounting_and_corporate_governance/docs/publications/past_editions/volume_8/16Bell.pdf

The Preparedness of Key Sectors

(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;

What is a key sector?

Many in the community and emergency management sector discuss critical infrastructure in relation to key sectors. Unfortunately in Australia critical infrastructure has a specific counter-terrorism related definition⁸⁷, that is security focussed and not scalable to anything below a national level. A more appropriate term is 'community lifelines':

assets, services, supply chains and networks that if damaged, disrupted or destroyed would cause a severe degradation in the functioning of a community

The importance of this definition is that it's scalable and focusses on the functioning of communities, making it more compatible with the concept of resilience.

Considering this definition it would be prudent to add to the list of sectors in the Terms of Reference:

- Food supply: In cities the systems that supply food to the population are large, complex and depend on many other pieces of infrastructure.
- Waste Management: The removal, treatment and disposal of both solid (garbage) and liquid (sewage) wastes is crucial to the physical and psychological health of communities.
- Financial Services: People are increasingly conducting transactions online and using debit and credit cards. Most individuals keep limited reserves of cash on hand. Financial services are highly dependent on telecommunications. The ability of people to purchase daily necessities and produce economic activity is dependent on access to these financial services.
- Education: Although communities can function for short periods without them, long-term well-being is dependent on access to quality educational services.
- Community and welfare services: Governments provide a range of crucial community services including child protection, income support, family support services, domestic violence services and out-of-home care. These services are generally targeted at the most vulnerable members of communities. Many of these services are outsourced by Government to NGOs.
- Liquid Fuels: Petrol, diesel and LPG are essential to the transport of people and goods as well as the operation of machinery, including emergency equipment. In turn the supply of these fuels depends on transport to get them to points of distribution and electricity to operate pumping equipment. The import and refining of these products is also relevant.
- Gas supply: In many areas of the country heating and cooking are commonly powered by gas.

Preparedness of all these key sectors involves two elements. The first is business continuity, the

⁸⁷ Rothery, Mike, 2005: Critical Infrastructure Protection and the Role of the Emergency Services, *Australian Journal of Emergency Management*, 20(2),45-50

ability to continue operations and provide normal services in the event of a disaster and quickly restore any disrupted services. However for many sectors continuity is not enough. During a disaster key sectors are subject to increased demand or demand for different services. For example the health sector needs to care for greater numbers of sick and injured, the waste sector needs to remove and dispose of large amounts of debris and community services need to source emergency accommodation, food and clothing for evacuees.

Assessing Preparedness: The Challenge

In the absence of actual extreme weather it is very difficult to assess the performance of many of these key sectors, particularly where its activities are primarily conducted by the private sector. Government inquiries tend to focus on the activities of Government agencies and emergency services in particular. Consideration of the private sector tends to only extend so far as to count the costs to them, not the preparedness measures that they had in place.

Much of the information on private sector or critical infrastructure preparedness is in documents that are confidential for commercial or security reasons.

These key sectors are made up of many companies, government organisations and NGOs. Because of the interdependence in many of these networks any individual weakness weakens the whole system. The organisations that do report on their preparedness and business continuity activities are unlikely to be representative of their broader sector.

One of the most important and under-investigated issues in disaster and risk management is the interconnectedness of many community lifelines. Failure in any one sector can impact other sectors causing them to fail resulting in *infrastructure cascade failure*. Most investigations of this phenomena have focused on the centrality of electricity networks and considered threats like terrorism⁸⁸, electromagnetic weapons⁸⁹, hackers⁹⁰ and space weather⁹¹.

Coordination by Government

The Federal Government through its Critical Infrastructure Resilience Strategy⁹² and Trusted Information Sharing Network(TISN) brings together many large Government and private sector infrastructure operators. However the TISN doesn't include numerous smaller organisations and local governments who often provide many of these key services and it focuses on cyber and conventional security with little attention paid to natural hazards.

A number of states and territories have arrangements for the coordination of the government

88 Szumilas, Alexander, Swerhun, Bryce and Lye, Jeannette, 2011: Watts at Stake?: Protecting North Americas energy infrastructure from cascading failure and terrorist threats, *Dalhousie Journal of Interdisciplinary Management*, 7 (2) <http://ojs.library.dal.ca/djim/article/view/2011vol7SzumilasSwerhunLye>

89 Foster, John S., Gjeldre, Earl, Graham, William R. et al. 2008: *Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack*, United States Government, Washington DC http://empcommission.org/docs/A2473-EMP_Commission-7MB.pdf

90 Tsang, Rose, 2009: Cyberthreats, Vulnerabilities and Attacks on SCADA Networks, unpublished paper. http://gspp.berkeley.edu/iths/Tsang_SCADA%20Attacks.pdf

91 Billings, Lee 2012: The Looming Threat of a Solar Superstorm, *Popular Mechanics*, accessed 17/01/13 <http://www.popularmechanics.com/science/space/deep/the-looming-threat-of-a-solar-superstorm-6643435>

92 Australian Government, 2010: Critical Infrastructure Resilience Strategy, Commonwealth of Australia, Canberra <http://www.tisn.gov.au/Documents/Australian+Government+s+Critical+Infrastructure+Resilience+Strategy.pdf>

agencies and private sector organisations which provide essential functions in an emergency. See

- NSW Functional Area Supporting Plans⁹³
- Victoria Emergency Management Manual⁹⁴ (though it's unclear how the recently released Emergency Management White Paper will change these arrangements)
- Queensland State Disaster Management Plan⁹⁵ (see Section 7.3.2)
- ACT Emergency Arrangements⁹⁶
- Tasmanian Emergency Management Plan⁹⁷ (Section 5.5)
- South Australia Functional Services⁹⁸
- Northern Territory All Hazards Arrangements⁹⁹ (see Annex B and C)
- Western Australia Support Plans¹⁰⁰

Of all the states and territories NSW appears (based on the existence, public availability and detail of plans for coordination of essential function) to have the most mature arrangements in this area.

Government activities are not necessarily indicative of sectoral preparedness. As with investigations into the costs of disasters, reports on the preparedness of various sectors are often fragmented, incomplete and don't consider cascading effects. Preparedness for extreme weather events should be part of organisations' broader business continuity and risk management activities. Presence and quality of these programs should be indicative of a greater level of extreme weather preparedness, even in the absence of specific extreme weather measures.

How Prepared are the Key Sectors?

Multiple Sectors: The most recent and comprehensive report comes from The Climate Institute. It covered water, property, electricity, road and rail and financial services and included case studies of current preparedness activities by some organisations. It found that only the water sector was reasonably well prepared for extreme events, with levels in other sectors low. It also expressed concern over the fragmentation of the preparedness activities of Government and businesses and the

93 Ministry for Police and Emergency Services, Supporting Plans, accessed 17/01/13, NSW Government, Sydney <http://emergency.nsw.gov.au/content.php/557.html>

94 State of Victoria, 2012: Emergency Management Manual Victoria, Victorian Government, Melbourne <http://www.justice.vic.gov.au/emanuals/emmv/default.htm>

95 State Disaster Management Group, 2011: Queensland State Disaster Management Plan, Queensland Government, Brisbane <http://www.disaster.qld.gov.au/Disaster%20Resources/Documents/State%20Disaster%20Management%20Plan%20June%202011.pdf>

96 ACT Emergency Services Agency, 2012: *Emergency Arrangements*, ACT Government, Canberra <http://esa.act.gov.au/emergency-management/emergency-arrangements/>

97 State Emergency Service – Tasmania, 2012: *Tasmanian Emergency Management Plan*, Tasmanian Government, Hobart <http://www.ses.tas.gov.au/Library/temp/Appendix%205.5%20Emergency%20Management%20Plans.pdf>

98 South Australian Fire and Emergency Services Commission, 2012: *State Emergency Management Plan*, Government of South Australia, Adelaide <http://www.safecom.sa.gov.au/public/download.jsp?id=3799>

99 Northern Territory Emergency Service, 2011: *Northern Territory All Hazards Emergency Management Arrangements*, Northern Territory Government, Darwin http://www.pfes.nt.gov.au/~media/Files/Forms_Licences_Permits_Publications/Emergency/Factsheets/nt-all-hazards-emergency-management-arrangements.ashx

100 State Emergency Management Committee Secretariat, *State Emergency Management Plans*, Government of Western Australia, Perth, accessed 17/01/13 <https://extranet.fesa.wa.gov.au/sites/emwa/Pages/stateemergencymanagementplans.aspx>

interconnectedness of infrastructure.¹⁰¹

A 2006 review of business continuity planning by the NSW Auditor General of 15 agencies involved in electricity, water, ports and health found that overall the plans were adequate. The report found that in some agencies there was fragmentation of BCP arrangements, inadequate priority given by senior management and a lack of testing of plans.¹⁰²

Telecommunications: Telecommunications, particularly telecommunications infrastructure is concentrated in the hands of just a handful of providers. In the critical mobile phone sector both Telstra¹⁰³ and Optus¹⁰⁴ appear too be well prepared for and practised in emergency response although Vodafone¹⁰⁵ appears to have some room for improvement. There are still key vulnerabilities in the telecommunications system though, the need for an inquiry into the recent Warrnambool exchange fire suggests the operators' business continuity arrangements have some way to go¹⁰⁶.

Forestry: There is little information on the preparedness of the Forestry sector even for bush fire, for which plantations are particularly vulnerable. The Victorian Auditor General found in 2003 that plantation owners were only taking those preparedness measures that were required by regulation.¹⁰⁷

Community Services: A 2009 Australian National Audit Office Report found that Centrelink had relatively mature business continuity systems, although made some recommendations for improvement.¹⁰⁸ A subsequent report found that Centrelink's response to the 2009 bush fires and floods was excellent, although its business-as-usual activities did suffer a drop in performance as a result.¹⁰⁹

Waste Management: Research on the aftermath of the 2009 Victorian Bush fires found that there was no prior planning for disaster waste management. A process for dealing with the debris generated was established during the recovery process. It was recommended that local government

101The Climate Institute, 2012: *Coming Ready or Not: Managing climate risks to Australia's infrastructure*, Sydney http://www.climateinstitute.org.au/verve/_resources/TCI_ComingReadyorNot_ClimateRiskstoInfrastructure_October2012.pdf

102NSW Auditor General, 2006: Compliance Testing on Business Continuity Planning, Auditor General's Report to Parliament 2006 Volume Four, Sydney

http://www.audit.nsw.gov.au/ArticleDocuments/153/05_Vol_4_2006_Compliance_Testing.pdf.aspx?Embed=Y

103Sporton, Phil, 2012: Hoping for the Best, preparing for the worst, *Telstra Exchange Blog*, accessed 17/01/13 <http://exchange.telstra.com.au/2012/11/08/hoping-for-the-best-preparing-for-the-worst/>

104Optus, 2011: *Optus Submission to the Queensland Floods Commission of Inquiry*, http://www.floodcommission.qld.gov.au/_data/assets/file/0007/6478/Optus_Submission_1.PDF

105Manning, James, 2012: Vodafone outage leaves customers in the lurch, *Sydney Morning Herald*, 29/11/12. <http://www.smh.com.au/digital-life/mobiles/vodafone-outage-leaves-customers-in-the-lurch-20121129-2aj7s.html>

106Department of Broadband, Communications, and the Digital Economy, 2012: *Media Release: Inquiry to learn lessons from Warrnambool exchange fire*, Commonwealth of Australia, Canberra http://www.minister.dbcde.gov.au/media/media_releases/2012/192

107Auditor General Victoria, 2003: Fire Prevention and Preparedness, Government of Victoria, Melbourne http://download.audit.vic.gov.au/files/fire_report.pdf

108Australian National Audit Office, 2009: Business Continuity Management and Emergency Management in Centrelink, Commonwealth of Australia, Canberra http://www.anao.gov.au/~media/Uploads/Documents/2008%2009_audit_report_46.pdf

109Australian National Audit Office, 2010: Emergency Management and Community Recovery Assistance in Centrelink, Commonwealth of Australia, Canberra http://www.anao.gov.au/~media/Uploads/Documents/2009%2010_audit_report_36.pdf

authorities (who generally have responsibility for solid waste management) develop plans for dealing with the debris generated in future disasters.¹¹⁰

Transport: The West Australian Auditor General examined the business continuity planning of Port Authorities and found only one out of the four major ports in WA had mature BCM arrangements.¹¹¹

Health: The Australian Health Protection Committee has regularly conducted a National Health Disaster Management Capability Audit, although the last was in 2008. It found that Australia's health services are well prepared to cope with disaster and undertaking activities to improve their preparedness. However, most analyses of health preparedness don't address private hospitals and continuity of general practice and pharmaceutical services. These need to be addressed.¹¹²

Agriculture: Agricultural vulnerabilities were examined in the 2006 report *Creating Our Future: Agriculture and Food Policy for the Next Generation*. It found that agriculture though highly vulnerable is generally well prepared for extreme weather under the present climate, but that further adaptations will be needed for the future.¹¹³

The level of preparedness and understanding of that level, vary across the different sectors. Factors in sectoral preparedness appear to include:

- External audit or other accountability measures
- Dominance by large Government or private sector organisations
- Experience of recent extreme weather events
- Highly visible service delivery

The only of these areas that can be easily modified are accountability measures like audits, inquiries and regular reporting. Properly applied these activities could increase the preparedness of many of these key sectors.

110Brown, Charlotte, Milke, Mark and Seville, Erica, 2011: Disaster Waste Management following the 2009 Victorian Bushfires, *Australian Journal of Emergency Management*, **26**(2), 17-22

<http://www.em.gov.au/Documents/AJEM%20Issue%2026.2%20-%20Disaster%20waste%20management%20following%20the%202009%20Victorian%20bushfires.PDF>

111Office of the Auditor General Western Australia, 2012: Second Public Sector Performance Report 2012, Government of Western Australia, Perth

http://www.audit.wa.gov.au/reports/pdfreports/insert2012_11.pdf

112Australian Health Protection Committee: 2010: *National Health Disaster Management Capability Audit – 2008*, Commonwealth of Australia, Canberra

[http://www.health.gov.au/internet/main/publishing.nsf/Content/9799811C9B162FDBCA25771300203961/\\$File/2008-capability-audi.pdf](http://www.health.gov.au/internet/main/publishing.nsf/Content/9799811C9B162FDBCA25771300203961/$File/2008-capability-audi.pdf)

113Agriculture and Food Policy Reference Group, 2006: *Creating Our Future: Agriculture and Food Policy for the Next Generation*, Commonwealth of Australia, Canberra

http://www.daff.gov.au/_data/assets/pdf_file/0008/248390/creating_our_future_part_e.pdf

Prevention of Extreme Weather Disasters

(d) an assessment of the preparedness and the adequacy of resources in the emergency services sector to prevent and respond to extreme weather events;

With the many recent disasters there have been numerous commissions, inquiries, inquests and other reports examining preparedness and making recommendations. There have been nearly 100 disaster related inquiries in Australia since 2000.¹¹⁴ There is also a trend towards other jurisdictions responding to and taking on the recommendations of these inquiries. There's no doubt that the preparedness of our emergency services is improving all the time.

This section assumes the Terms of Reference means preventing extreme weather induced disasters rather than the phenomena themselves. With the exception of activities such as prescribed burning, emergency services generally have small roles in the prevention of extreme weather disasters.

Those charged with preventing disasters are largely based in other government departments, local government and the private sector. Disaster prevention activities can be divided into three main areas: land use planning and building construction, hazard modification and hazard defences.

Land use planning and building construction

Land use planning can be applied to deal with any hazard with spatial variation. In Australia this includes bushfire, flood, coastal erosion and storm surge. All Australian States and territories have planning arrangements to address natural hazards of varying strength and detail.

Planning arrangements for natural hazards should be focussed on three primary and competing aims:

- Development in hazard prone areas should not create a risk-to-life. Importantly this should consider likely human behaviour in an emergency event. Evacuation from the property and area shouldn't be just feasible in an emergency, given that people often don't heed evacuation warnings, it should be likely.¹¹⁵
- Development in hazard prone areas should not create an unreasonable risk of significant damage or destruction of the property.
- Hazard prone areas should not be unreasonably sterilised.

Although many planning standards seem to meet these principles on paper none pay proper attention to the first. Application of planning standards has been criticised in NSW¹¹⁶ (which arguably has the most mature floodplain management system in the country) for their laissez-faire attitude to risks to life. Over-reliance on the "people save houses, houses save people" mantra may have contributed to development that placed people at risk during extreme bush fires.¹¹⁷ States are

¹¹⁴See Annex.

¹¹⁵Pfister, N., 2002: The case of an evacuation from Grafton, March 2001, *Australian Journal of Emergency Management*, 17 (2), 19-29
http://www.ses.nsw.gov.au/content/documents/pdf/research-papers/42898/Community_response_to_flood_warnings.pdf

¹¹⁶Molino, Steven, 2008: Out of the flood and into the fire, *Floodplain Manager*, 4(2)
<http://www.molinostewart.com.au/images/reports/intothefire.pdf>

¹¹⁷Griffiths, Tom, 2012: The Disturbing Logic of Stay or Go, *Inside*, accessed 17/01/13

winding back coastal protection laws^{118,119} that will increase the number of properties eventually lost to sea level rise and multiply that loss by encouraging the construction of expensive coastal protection works that will eventually fail.

Authorities need to develop clear and practical guidelines that take a precautionary approach with respect to life safety.

Planning for these hazards requires detailed hazard modelling, the data collection for which can be very expensive. Reducing development in hazard prone areas also requires political commitment – a willingness to stand up to the development lobby who benefit from building in these areas. This can make prevention of these disasters a very expensive exercise.

For new construction the best way to reduce disaster risk is through implementation of building codes. For instance, the tropical cyclone building codes have been so effective that their impact on disaster losses needed to be controlled for when normalising those losses.¹²⁰ State Governments legislate to apply the building codes and can choose to apply more (or less) stringent controls.

Implementation of building codes is largely the responsibility of the private sector, although state and local governments provide an important monitoring and compliance role. However construction standards could be increased and there needs to be more to marry them to the hazard that a property is exposed to.

One area that receives very little attention is designing houses to better cope with heat waves. The current tendency is to build the building and install an air conditioner. The use of energy efficient design and appropriate materials can increase the capacity of a house to cope with high heat and reduce reliance on air conditioners, thus decreasing strain on electricity networks.

Unfortunately land use planning and building codes can't do much for existing risks. The equivalent measures for existing properties are buyback/land swaps and retrofitting.

Property Buyback and Land Swaps

Voluntary purchase schemes have been used across Australia as a floodplain management measure. It's most extensive application has probably been in NSW where somewhere in the vicinity of several hundred properties have been purchased since the 1980s.

However property purchase tends to be expensive and have a low benefit-cost ratio. Most schemes are implemented where there is high risk-to-life, such as flash flood zones and other areas where evacuation is difficult. The expense, limited availability of funding and voluntary nature of these programs make them difficult to implement.

An alternative to voluntary purchase is a land swap, where a council trades a piece of safer land for

<http://inside.org.au/the-disturbing-logic-of-stay-or-go/>

118Hawley, Megan, 2012: Winding back of coastal protection laws, Lindsay Taylor Lawyers, Sydney

http://www.lindsaytaylorlawyers.com.au/in_focus/index.php/2012/11/winding-back-of-coastal-protection-laws/

119Arup, Tom, 2012: State eases sea level regulations, The Age, accessed 17/01/13

<http://www.theage.com.au/victoria/state-eases-sea-level-regulations-20120605-1zu9i.html>

120Crompton and McAneney, The Cost of Natural Disasters in Australia: the Case for Risk Reduction,

the hazard prone land. This has been applied in Grantham, QLD after the 2011 floods. The difference from voluntary purchase is that land swaps allow whole communities to be relocated. It could be applied in other areas of Australia, though it's likely to only be practical post-disaster.

Land swaps could also be considered for properties at risk of coastal erosion. This would give these property owners an exit strategy for when they eventually lose their land (and house) due to coastal erosion. However there is no framework in most of the country's planning legislation to enable land swaps. Councils would also need to identify appropriate sites ahead of time, so they are able to make offers post-disaster.

Retrofitting

The most practical way to protect old construction against hazards is through retrofitting. Retrofitting a building to protect it and its occupants from natural hazards can be significantly more expensive than building those changes in from the start. In almost all circumstances the owner is expected to fund the changes themselves. One exception to this has been voluntary house raising, to mitigate against flooding. Buildings of a suitable construction can be raised to reduce the frequency that they're flooded, but funding for homeowners is dependent on them being in an area where a scheme is operated by their council.

The Victorian Government has produced the only Australian example, that I'm aware of, of a manual to help homeowners retrofit their properties.¹²¹ Other examples of guidance also exist internationally¹²², but there needs to be greater information provision to owners and builders to encourage retrofitting.

Knowledge of how to retrofit properties is probably not enough given the cost required to implement many of the measures. A number of options to provide the right incentive could be investigated such as low/no interest loans, grants and product subsidies.

Insurance is another possible option. The Federal Government has been consulting with stakeholders in its response to the Natural Disaster Insurance Review. Insurers already take into account crime prevention measures (locks, bars, alarms etc.) when assessing premiums, it should be possible to do this with other hazards.

Hazard Modification

It is really only possible to modify floods and bushfires. Floods can be reduced by either reducing run-off or damming the flow for later release. Most large catchments in Australia already have some form of dam on them, some of which do have a flood mitigation function. However they all have a primary water storage purpose and as we saw in Brisbane they're far from 100% effective in reducing flooding. Although flood detention basins can be effective at reducing (but not eliminating) flash flooding in urban areas, as infrastructure they are best considered as defences.

121Country Fire Authority, 2010: A Guide to Retrofit your Home for Better Protection from a Bushfire, Government of Victoria, Melbourne
http://www.buildingcommission.com.au/resources/documents/BPC2280.1.1_Bushfire_Retrofit_%28Final_for_Web%29.pdf

122United States, 2012: *Engineering principles and practices for retrofitting flood-prone residential structures*. [Washington, D.C.]: Federal Emergency Management Agency.
<http://www.fema.gov/library/viewRecord.do?id=1645>

Bushfire on the other hand can be modified in a range of ways. Various interventions can reduce fire ignition, such as total fire bans and programs to combat arson. The one that receives the most attention is prescribed burning.

There's a lot of research on prescribed burning (and other fuel management techniques)¹²³ out there which can help form policy responses. There's two possible limiting factors on prescribed burning, weather and resources. For prescribed burning to be most effective it needs to be concentrated in and around the urban bushland interface. This makes applying resources to the problem rather easier (as that's where most bushfire volunteers are), but weather becomes trickier to deal with. Firstly the weather needs to be in a Goldilocks zone dry enough and warm enough for the bushland to burn, but not so hot and windy that the fire gets out of control. Secondly wind and atmosphere conditions need to be right to prevent smoke from lingering near the burned area and causing health problems, car accidents, flight delays and damage to grape crops.

Hazard Defences

Properly designed, maintained and understood hazard defences can be a key feature of a resilient community. Defences can be employed against bushfire (firebreaks, asset protection zones and other infrastructure that help firefighters protect property) coastal erosion and inundation (seawalls, artificial beaches, beach scraping or nourishment etc.) and flooding (levees, channels and floodgates).

These defences can be expensive pieces of infrastructure and they're only a real option for properties that are already at risk. Hazard defences are also not 100% effective (or if they are, they are prohibitively expensive), though not everyone understands this. The main problem with hazard defences is that for them to be effective, they need to be maintained.

A study in NSW found serious deficiencies in the availability of information on the maintenance and condition of urban levees. There is also confusion about levee ownership in other states.¹²⁴ The maintenance and upgrade (if the levee is found to be deficient) of a levee can be an expensive exercise, particularly for asset owners with constrained budgets. For inland councils with limited rate bases, it may be difficult to politically justify levee maintenance during drought conditions.

Asset Protection Zones are a key component of the NSW Planning for Bushfire Protection guidelines. Although their construction can form part of the development consent for a property there are no regulations requiring their maintenance. Where maintenance is difficult or expensive it is unlikely to occur. On the other hand appropriate design of asset protection zones can contribute to better maintenance.¹²⁵

To provide the same level of protection in the future the upgrading of hazard defences to cope with climate change could be very expensive. For the 3,600km of coastal flood defences in the

¹²³AFAC Knowledge Web, Fuel Management: Research and Reports, accessed 17/01/13

http://knowledgeweb.afac.com.au/research/fire_management/fuel

¹²⁴Molino, Steven, 2008: Levees – Defence or Disaster?, *Floodplain Manager*, 4 (4)

<http://www.molinostewart.com.au/images/reports/defenceordisaster.pdf>

¹²⁵Pinfold, Debbie, 2009: Bushfire Protection Measures – Will They Be There When Needed?, *Proceedings of the EPLA Conference 2009*

<http://www.royalcommission.vic.gov.au/getdoc/0bbfe246-a332-49b2-8b8f-35027eae9fe/EXP.019.001.0092>

Submission to the Recent trends in and preparedness for extreme weather events Inquiry by Ben Beccari

[Netherlands](#), on top of an annual maintenance cost of €100,000/km upgrades could cost between €4 and €11 million per km.¹²⁶

¹²⁶Hillen, M.M., Jonkman, S.N., Kanning, W. et. al. 2010: Coastal defence cost estimates: case study of the Netherlands, New Orleans and Vietnams, Delft University of Technology, Delft, Netherlands
http://www.waterbouw.tudelft.nl/fileadmin/Faculteit/CiTG/Over_de_faculteit/Afdelingen/Afdeling_Waterbouwkunde/sectie_waterbouwkunde/news/doc/Coastal_defence_cost_estimates.pdf

Federalism and Emergency Management

(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;

The division of emergency management responsibilities is a product of Australia's history of federalism¹²⁷. In addition to the balance of constitutional and legislative responsibilities vertical fiscal imbalance and horizontal fiscal inequity also play a key role in the current emergency management relationship between the different levels of government,

Local Government

Local governments are created and regulated by the states (and the Northern Territory) who retain fairly sweeping powers to sack, appoint, overrule and otherwise direct councils. Thus the division of responsibilities between state and local governments is different for each state in Australia.

(A quick note – when I use the term local level, I refer to the local grouping of emergency services and support agencies including local government. In some circumstances local level can be synonymous with local government, but this is usually not the case)

In Queensland, for example, disaster response is managed by the local government in their role as the chair of the Local Disaster Management Group (LDMG).¹²⁸

In NSW disaster response is managed by the combat agency (such as the SES or Rural Fire Service) or where there is no combat agency by senior police officers in their statutory roles as Emergency Operations Controllers.¹²⁹ Councils provide key support functions to the emergency response including emergency operations centre facilities and plant and equipment.

There are also large differences in the politicisation of local disaster management. In Queensland the chair of the LDMG is the Mayor or another elected member.¹³⁰ In NSW the chair of the Local Emergency Management Committee is the General Manager.¹³¹

The response to anything beyond a routine accident is a whole of state approach with emergency services and support agencies activated at state, regional and local levels. Each level will apply itself to the emergency where it most effective. For example the state level may manage state-wide media, the regional level direct emergency resources to local areas of most need and the local level manage an evacuation.

127Wilkins, Roger, 2010: Federalism and the Emergency Services, *Australian Journal of Emergency Management*, 25(1), 3-6

<http://www.em.gov.au/Documents/Roger%20Wilkins.pdf>

128Department of Community Safety, 2012: Disaster Management Arrangements, accessed 17/01/13

http://www.disaster.qld.gov.au/About_Disaster_Management/DM_arrangements.html

129Ministry for Police and Emergency Services, NSW Emergency Management Arrangements (Summary), accessed 17/01/13 <http://www.emergency.nsw.gov.au/content.php/495.html>

130Department of Community Safety, Disaster Management Arrangements

131NSW Parliament, State Emergency and Rescue Management Act 1989 Act165,

http://www.austlii.edu.au/au/legis/nsw/consol_act/searma1989331/s28.html

Decision making, despite the authority being vested in one individual, will often be a joint effort with involvement from state, regional and local officials across multiple agencies. This 'unified command' enabled by improved communications and other decision support tools is increasingly becoming a feature of modern emergency management.

Outside of response emergency management responsibilities of local government tend to be a little more consistent across the country. They all have key roles in implementing state government planning legislation as well as expectations that they will undertake mitigation activities and be a key player in disaster recovery. However responsibilities for mitigation may not be clearly articulated by many states. Key policies are often implemented by encouraging local government to undertake mitigation activities rather than requiring them to do so.

The appropriate division of responsibilities between state and local government will vary between the states and territories depending on their size, hazard portfolios and general role and regulation of local government.

Federal Government

The Federal Government's role in emergency management ties in with constitutional powers on telecommunications, defence, meteorology, census, banking and insurance, quarantine, social welfare and foreign affairs. Any additional roles arise through federal cooperation.

Meteorology

The Bureau of Meteorology is the most important counter-disaster agency of the Federal Government. The meteorological and hydrological forecasts it produces underpin the nations' warning systems. Timely and accurate warnings are arguably behind the large reductions in disaster deaths in Australia over the last 200 years.¹³² The BoM works closely with emergency services to issue disaster warnings and provide specialised forecasting for counter-disaster operations. This is reflected in the respect and increasing demand for the BoM's severe weather services.¹³³

Defence

When disasters occur there is often a call to 'send in the army'.¹³⁴ However Australia doesn't have a particularly large defence force. Nor does Australia have anything like the National Guard in the USA, which are specifically based in states and called upon when a state of emergency is declared.

State based emergency services now have extensive experience and capacity in the management of natural and other disasters. This is quite clear when you compare the ADF strength of about 80,000 permanent forces and active reservists (of whom about 3300 are on overseas deployment¹³⁵) with

¹³²Middelmann, Miriam H. 2007: *Natural Hazards in Australia: Identifying Risk Analysis Requirements*, Commonwealth of Australia, Canberra
http://www.ga.gov.au/webtemp/image_cache/GA10757.pdf

¹³³Parliamentary Secretary for Sustainability and Urban Water, 2012: *Media Release: Review of the Bureau of Meteorology's Capacity*, Commonwealth of Australia, Canberra
<http://www.environment.gov.au/minister/farrell/2012/mr20120608.html>

¹³⁴Yates, Athol and Bergin, Anthony, 2010: *Special Report Issue 28 - Here to help: Strengthening the Defence role in Australian disaster management*, Australian Strategic Policy Institute, Canberra
http://www.aspi.org.au/publications/publication_details.aspx?ContentID=241

¹³⁵Department of Defence, 2013: *Global Operations*, Commonwealth of Australia, Canberra, accessed 17/01/13

the roughly 255,000 ambulance, fire and SES personnel. Australia also has about 56,000 police and another 100,000 volunteers with organisations like the Red Cross, ADRA, Anglicare etc.

Given the strength, funding and experience of the nation's emergency services the idea that a defence takeover of emergency response in extreme conditions (other than in a security emergency) would improve the situation is far-fetched.

Nevertheless ADF assistance can be very useful in disaster situations. It's provided under arrangements called Defence Assistance to the Civil Community which detail how the ADF provides non-security related assistance to the states and territories.¹³⁶ These arrangements allow local defence resources to be used for nearby emergencies or in more significant disasters special resources, like aircraft for transporting equipment and emergency personnel, to be called in.

International Assistance

The external affairs power gives the Commonwealth the responsibility for both coordinating Australia's response to overseas disasters and coordinating any international assistance provided to Australia in the event of a major disaster. Although Australia has a proud record of assisting our neighbours in disasters a review by the International Federation of the Red Cross found problems with our humanitarian assistance frameworks, including inconsistencies with our treaty commitments. The review also found large gaps in Australian legislation, including state legislation, and emergency management policy when it comes to the provision of international assistance to Australia.¹³⁷

Census

The Australian Bureau of Statistics through its census and other statistical activities collect, analyse and provide valuable information for risk assessment activities conducted by the states – as do other agencies such as Geoscience Australia.

Telecommunications

The Federal Government regulates the telecommunications sector and provides for the national emergency number 000. As telecommunications become increasingly important in disaster response further regulation may be needed to ensure continuity of service.

Banking and Insurance

The Federal Government regulates the banking and insurance industries. Insurance is a key measure to protect individuals, businesses and governments from the effect of disaster loss and is becoming increasingly contentious in recent times. Natural Disaster Insurance was the subject of a recent review which made a number of wide-reaching recommendations.¹³⁸ Although proposed by the

<http://www.defence.gov.au/op/index.htm>

136Department of Defence, 2004: *Defence Instructions (General): Defence Assistance to the Civil Community: Policy and Procedures*, Commonwealth of Australia Canberra

<http://www.royalcommission.vic.gov.au/Documents/Document-files/Exhibits/WIT-6002-001-0011>

137Eburn, Michael, 2010: *Legal Preparedness for International Disaster Response in Australia: Laws, Policies, Planning and Practices*, International Federation of Red Cross and Red Crescent Societies, Geneva

<http://www.ifrc.org/PageFiles/80197/193900-australian-cs-EN.pdf>

138Australia Treasury, *Natural Disaster Insurance Review: Inquiry into flood insurance and related matters*

review it doesn't build a strong case for the establishment of a Government natural disaster insurer. Government should regulate the industry to ensure the availability of disaster insurance (although not necessarily affordability – a risk based price could encourage mitigation) and potentially provide subsidies to low income-earners in disaster prone areas to make insurance more affordable.

Social Welfare

The Federal Government operates Australia's pension system, which provides a range of social welfare support. The Government also provides direct financial support in the form of a one-off payment for people affected by disasters.¹³⁹ Without the pension system and the existence of Centrelink this direct assistance would probably not occur. States and Territories also provide financial and other support to disaster affected businesses (including primary producers) and individuals.

Coordination and Leadership

The Federal Government plays a key role in national disaster management through its leadership and coordination of activities of the states and territories across the disaster management spectrum. Most of this is undertaken by various divisions of the Attorney-Generals Department, although certain hazard specific coordination is addressed by other agencies. In the response phase this task is undertaken by Emergency Management Australia. The Australian Emergency Management Institute plays a key role in the knowledge management of disaster resilience through its journal, training programs, library and website. Policy coordination occurs through the Federal Government's chair and support of the National Emergency Management Committee and its sub-committees.

There have been a number of recent calls for improved disaster management capacity at the Commonwealth level, especially for catastrophic natural disasters.^{140,141,142} The Commonwealth lacks emergency legislation that would allow the appointment of a 'coordinator in chief' for the response of Commonwealth departments and override Commonwealth legislation (both actions are key features of state emergency legislation – activated when a State of Emergency is declared). The Federal Government also does not publish its plans on the Australian Emergency Management website.

139 Government of Australia, 2013: Guide to Social Security Law: 1.2.6.20 Australian Government Disaster Recovery Payment (AGDRP) – Description, Canberra
http://guidesacts.fahcsia.gov.au/guides_acts/ssg/ssguide-1/ssguide-1.2/ssguide-1.2.6/ssguide-1.2.6.20.html

140 McHugh, Liam, 2012: *Black Swan in the Engine Room: Australia's Ability to Manage Catastrophic Disaster in the Pilbara*, Future Directions International, Nedlands, Western Australia
<http://www.futuredirections.org.au/publications/northern-australia/725-black-swan-in-the-engine-room-australia-s-ability-to-manage-catastrophic-disaster-in-the-pilbara.html>

141 Bergin, Anthony, 2011: *King-hit: preparing for Australia's disaster future*, Australian Strategic Policy Institute, Canberra
http://www.aspi.org.au/publications/publication_details.aspx?ContentID=299

142 Catastrophic Disasters Emergency Management Capability Working Group, 2005: *Review of Australia's Ability to Respond to and Recover from Catastrophic Disasters*, Australian Emergency Management Committee, Canberra
<http://www.ag.gov.au/RightsAndProtections/FOI/Documents/Review%20of%20Australias%20Ability%20to%20Respond%20to%20and%20Recover%20from%20Catastrophic%20Disasters%20-%20Report%20October%202005.pdf>

The States

National emergency management policy specifies that the states have primacy for the management of disasters including prevention, preparation, response and recovery.

Emergency Services

Australia is unusual internationally in that we have a small number of large, state-based police and emergency services. In most other countries fire and rescue services and the emergency management capabilities attached to them are local organisations. For example NSW has a similar population to Washington State in the USA. NSW has 1 police force, 2 fire services, 1 ambulance service and 1 state emergency service. Washington State has 204 law enforcement agencies¹⁴³ and 419 fire departments¹⁴⁴ alone.

In some regards Australia's fire and state emergency services are more like militaries in their ability to rapidly mobilise large numbers of resources across large distances in short timeframes.

The emergency services are the main organisations in Australia, responding to, planning for and undertaking much of the research and policy development on natural disasters. They also lead community engagement activities.

Land use planning and building controls

State Governments are responsible for strategic and statutory land use planning and the implementation of the nationally agreed building code. Land-use planning and building controls are one of the most effective and cheapest disaster mitigation options for governments (although the opportunity and compliance costs for the private sector are largely unknown). Recent disaster losses suggest that these measures are not being as effectively used as they could be. The activities of the Land Use Planning and Building Codes Taskforce appear to be trying to address some of these gaps.¹⁴⁵

Establishment and maintenance of public infrastructure

This includes infrastructure that might be impacted by a disaster (like ports and bridges), infrastructure that can help during a disaster (like fire stations and hospitals) and disaster mitigation infrastructure (like levees and fire breaks). Particularly important is the maintenance of infrastructure – it increases its disaster resilience and ensures it functions properly during a disaster.

Although disaster infrastructure is usually built in less exposed areas or to a more resilient standard other types of public infrastructure are often not. This includes a lot of transport infrastructure such as roads, rail and bridges which are commonly damaged by flooding and electricity distribution

143Bureau of Justice Statistics, 2008: *Census of State and Local Law Enforcement Agencies*, Department of Justice, Washington, USA
<http://bjs.ojp.usdoj.gov/content/pub/pdf/cslla08.pdf>

144Fire Fighting News, 2013: *Washington Fire Departments*, accessed 17/01/13
<http://www.firefightingnews.com/fdDirectoryList-US.cfm?statecodeID=WA>

145Australian Emergency Management Institute, 2012: *National Strategy for Disaster Resilience: Land Use Planning*, Commonwealth of Australia, Canberra
<http://www.em.gov.au/Publications/Australianjournalofemergencymanagement/Currentissue/Pages/AJEMvolume27%20no%203/NationalStrategyforDisasterResilienceLanduseplanning.aspx>

which can cause and is damaged by bushfire. When infrastructure is destroyed Governments should rebuild it to a more disaster resilient standard.

Health Services

The States and Territories operate the nation's hospitals and public health systems. These systems look after the sick and injured in an emergency and are the front line against public health emergencies like pandemics.

Coordination and Leadership

The states and territories are also responsible for leading and coordinating emergency management within their jurisdictions and with other jurisdictions. Most states and territories have some sort of central agency which play a key policy coordination role and undertake various 'all-hazards' activities. This function extends to coordinating the efforts of the private and NGO sectors.

Long Term Challenges in Emergency Management

The remaining terms deal with Australia's overall response to climate change adaptation and national coordination of risk management. The impact of climate change on severe weather events is far from the only climate impact relevant to emergency management. Climate change adaptation is far from the only emerging challenge in emergency management. The interconnectedness of many current and emerging threats poses significant challenges for Australia's policy makers.

(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.

Although there is still massive uncertainty about the magnitude and direction of changes in many extreme weather variables, the risk of large changes will require emergency management officials to redouble efforts in disaster mitigation, land use planning, community education and engagement and response capability development.

Climate change poses a number of additional challenges to emergency management beyond the projected increases in the incidence and severity of some extreme weather events. These include:

- Long term declines in rainfall leading to reduced water availability for fire-fighting.¹⁴⁶
- The spread of infectious diseases to more populated areas of Australia as the climate warms.¹⁴⁷
- An increase in the incidence of disasters in our region increasing demands on our overseas response.¹⁴⁸
- The impact of climate change on agriculture which could increase the vulnerability of rural communities.¹⁴⁹ Greater vulnerability will increase disaster losses and further drive increasing urbanisation in Australia.

Climate change is far from the only challenge facing emergency management in present times. Present risks are largely being driven by increasing exposure (through rising population growth and wealth) and there are a number of other serious existing and emerging challenges that will require new approaches. Many of these issues could increase disaster risks greater than any increase from

146Thornton, Richard, 2010: *The Future of Fire*, Bushfire CRC, Melbourne

<http://www.bushfirecrc.com/blog/richard-thornton/future-fire>

147Harley, David, Bi, Peng, Hall, Gillian, et. al. 2011: Climate Change and Infectious Diseases in Australia: Future Prospects, Adaptation Options, and Research Priorities, *Asia Pac J Public Health*, **23** (2) 54S-66S, doi: [10.1177/1010539510391660](https://doi.org/10.1177/1010539510391660)

148Human Rights and Equal Opportunity Commission, 2008: Background Paper: Human Rights and Climate Change http://humanrights.gov.au/about/media/papers/hrandclimate_change.html

149Hanna, Elizabeth G., Bell, Erica, King, Debra et. al. 2011: Climate Change and Australian Agriculture: A Review of the Threats Facing Rural Communities and the Health Policy Landscape, *Asia Pac J Public Health*, **23**(2) 105S-118S, doi: [10.1177/1010539510391459](https://doi.org/10.1177/1010539510391459)

climate change. These long term threats¹⁵⁰ include:

- The global threat of infectious diseases.¹⁵¹ Increased global connectivity, intensive farming and contact between human and animal populations is increasing the threat from new and existing pathogens. The intentional or accidental release of experimental and weaponised diseases could also drive a global pandemic.¹⁵² Even seasonal flu presents challenges for the community at large and emergency services.¹⁵³
- Population growth, decline and demographic transition. The Australian population is growing, with both immigration and natural increase contributing.¹⁵⁴ However population growth is slowing and populations aging. This demographic transition¹⁵⁵ will increase the size of vulnerable populations and reduce the resource base of the emergency services. Demand on emergency services will increase and its capacity will shrink. By the end of this century global population could be declining, posing serious challenges for governments and the services they provide.¹⁵⁶
- Environmental degradation.¹⁵⁷ Globally and in Australia environments are degrading, due to direct pressures and climate change with consequences for emergency management. Ecosystems provide important disaster mitigation services.¹⁵⁸ The degradation and loss of these ecosystems will increase a host of disaster threats and demands for expensive structural mitigation. Meanwhile desertification and biodiversity loss will have serious implications for food security and human health.
- The collapse of carbon-based economies. Fossil fuels are critical to transport, food production and emergency response efforts. As supplies become more restricted and expensive, through over-exploitation or deliberate reduction in use there will be broader consequences as societies adjust to the use of renewable energy sources and fossil fuel alternatives¹⁵⁹ in agri-chemicals, pharmaceuticals and materials. Emergency services will not

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- 150Bissell, Richard A., Bumbak, Andrew, Echebi, Partick et. al., 2009: Long-Term Global Threat Assessment: Challenging New Roles for Emergency Managers, *Journal of Emergency Management*, 7(1), 19-37
<http://training.fema.gov/EMIWeb/edu/docs/catastrophe/Session%20%20-%20Appendix%201%20-%20Long-Term%20Global%20Threat%20Assessment.pdf>
- 151Aguirre, A.A., Tabor, G.M., 2008: Global factors driving emerging infectious diseases, *Ann N Y Acad Sci.*, **1149**, 1-3. doi: [10.1196/annals.1428.052](https://doi.org/10.1196/annals.1428.052)
- 152Phillips, Carleton J., Harrington, Anne M., Yates, Terry L. et. al. 2009: *Global Disease Surveillance, Emergent Disease Preparedness and National Security*, Texas Tech University
<http://www.nsr1.ttu.edu/publications/miscpubs/global%20disease.pdf>
- 153O'Leary, Cathy, 2012: Flu Crisis Swamps Perth Hospitals, *The West Australian*, 12/07/12
<http://au.news.yahoo.com/thewest/a/-/breaking/14205636/flu-crisis-swamps-perth-hospitals/>
- 154Australian Bureau of Statistics, 2010: Population Growth – Past, Present and Future, Commonwealth of Australia, Canberra
<http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4102.0Main+Features10Jun+2010>
- 155Chen, Haili, Maki, Norioand Hayashi, Haruo, 2009: Evaluating the Impact of Demographic Transition in the Context of the Tokai-Tonankai-Nankai Earthquake, Japan, *Journal of Natural Disaster Science*, **31**(2), 21-32
http://www.jsnds.org/contents/jnds/31_2_21.pdf
- 156Rosseau, Richard, 2012: The Coming Global Population Decline, *Diplomatic Courier* 05/10/12
<http://www.diplomaticcourier.com/news/topics/global-cities/1223>
- 157United Nations Environment Program, 2005: Environmental Management and Disaster Preparedness, Paper developed from Thematic Session at the World Conference on Disaster Reduction
http://www.unep.or.jp/ietc/Publications/DM/wcdr_session_report.pdf
- 158Estrella, Marisol and Saalismaa, Nina 2010: Demonstrating the Role of Ecosystems Based Management for Disaster Risk Reduction, Prepared by the Partnership for Environment and Disaster Risk Reduction
http://pedrr.net/portals/0/PEDRR_GAR_paper_April_2011.pdf
- 159Stern, Nicolas, 2006: The Stern Review on the Economic Effects of Climate Change. Population and Development Review, **32**, 793–798. doi:[10.1111/j.1728-4457.2006.00153.x](https://doi.org/10.1111/j.1728-4457.2006.00153.x)

be immune¹⁶⁰ and will need to develop alternatives for transport and the powering of equipment that don't depend on fossil fuels.

- Changes in warfare. The rise of transnational terrorism¹⁶¹ and blurring of lines between state and non-state actors is a global challenge. The increasing use of non-conventional weapons,¹⁶² including cyber attacks, pose challenges for emergency managers in preparing for these sort of threats.
- Globalisation of economic activity and transportation. As economic production becomes more globalised and local economic self-sufficiency is lost, Australia becomes increasingly dependent on our global neighbours. The loss of certain capacities and just-in-time delivery practices means disaster events in other countries can pose serious threats to Australia. For example a large portion of the pharmaceuticals used in Australia depends on a small number of factories that produce them, which in turn depend on a small number of factories which produce the raw materials.¹⁶³ Disasters and disaster response are becoming more globalised, posing challenges for international assistance. Emergency managers can no-longer just be concerned with local threats.¹⁶⁴
- Technological changes and dependency. We are increasingly dependent on telecommunications and satellite technologies. This exposes Australia to new risks from the failure of these technologies caused by natural disasters, systems faults, human intervention and severe space weather. New technologies, especially social media, also create opportunities for emergency managers for new forms of operations management, community engagement and emergency warning. However dependence on these systems, which are often operated by companies outside of Australia, creates new risks and there are few opportunities to regulate these businesses to ensure continuity.

Emergency management is not the only sector that needs to respond to long term threats like climate change. The World Economic Forum publishes reports on global risks seeking to identify short, medium and long term threats and their interconnections. The most recent report was released in 2013 and outlines a range of transnational threats with wealth gaps and unsustainable government debt being the top two. The report rated Australia's overall preparedness for all the global threats as average.¹⁶⁵

The report identifies five emergency management related risks:

160Barnett, Daniel J. 2009: Peak Oil, Implications for Disaster Preparedness and Response, John Hopkins Center for Public Health Preparedness, Baltimore

http://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-for-public-health-preparedness/Images/Peak_Oil_and_Health_Slides/Barnett_handouts.pdf

161Cox, Catherine W., 2008: Manmade Disasters: A Historical Review of Terrorism and Implications for the Future, *Online Journal of Issues in Nursing*, **13**(1)

<http://www.nursingworld.org/MainMenuCategories/ANAMarketplace/ANAPeriodicals/OJIN/TableofContents/vol13/2008/No1Jan08/ArticlePreviousTopic/ManmadeDisasters.html>

162Schreiber, S., Yoeli, N., Paz, G. et. al. 2004: Hospital preparedness for possible nonconventional casualties: an Israeli experience, *Gen Hosp Psychiatry*, **26**(5), 359-66

<https://www.ncbi.nlm.nih.gov/pubmed/15474635>

163Quilty, Simon, 2012: Cutting off Australia's drug supply: why outsourcing isn't the solution, *The Conversation*, 27/09/12 <http://theconversation.edu.au/cutting-off-australias-drug-supply-why-outsourcing-isnt-the-solution-8025>

164Alexander, David, 2006: Globalisation of Disaster: Trends, Problems and Dilemmas, *Journal of International Affairs*, **59**(2), 1-22

http://www.policyinnovations.org/ideas/policy_library/data/01330/_res/id=sa_File1/alexander_globofdisaster.pdf

165Lee Howell (editor in chief), 2013: *Global Risks 2013 — Eighth Edition*, World Economic Forum, Geneva <http://reports.weforum.org/global-risks-2013/>

- Persistent extreme weather events
- Unprecedented geophysical destruction
- Vulnerability to pandemics
- Vulnerability to geomagnetic storms
- Terrorism

A large number of risks connected to these, both as drivers and flow-on effects. The following risks are connected to 3 or more of the above, with those connected to 4 or more in bold:

- Critical systems failure
- **Critical fragile states**
- Diffusion of weapons of mass destruction
- Failure of climate change adaptation
- **Food shortage crises**
- Global governance failure
- Irremediable pollution
- **Mismanaged urbanisation**
- Prolonged infrastructure neglect
- **Rising greenhouse gas emissions**
- **Severe income disparity**
- Unforeseen consequences of climate change mitigation
- Water supply crises

Aside from climate change little attention is being paid to many of these existing and emerging threats. What work is being done is often in isolation and doesn't address the interconnections of many of these risks either in their understanding or policy response.

Australia lacks an integrative approach to risk management across governments, increasing its vulnerability to many of these existing and long-term threats. The International Standard Risk Management focusses on the creation of risk management systems and the governance of risk – arguing that risk management needs to be central to an organisation's business for risk to be appropriately recognised and managed.¹⁶⁶ An analysis of public inquiries in the UK found that severe adverse outcomes were associated with multiple systemic governance failures including¹⁶⁷:

- Poor strategic risk management
- Closed culture
- Poor working relationships
- Low levels of accountability
- Poor leadership
- Poor information for decision makers
- Lack of clarity

It is ultimately these factors that are responsible for a host of man-made and 'natural' disasters. This

¹⁶⁶ISO 31000:2009, *Risk management – Principles and guidelines*, International Standards Organisation

¹⁶⁷Audit Commission, 2003: *Corporate Governance: Improvement and Trust in Local Public Services*, United Kingdom Government, London

<http://www.audit-commission.gov.uk/SiteCollectionDocuments/AuditCommissionReports/NationalStudies/CorporateGovernance.pdf>

is especially the case for long-term, high consequence and low probability risks. Without an organisational culture geared towards risk management, it is unlikely to respond to even clear signs of impending disaster.¹⁶⁸

Public inquiries play a key role in public policy in Australia¹⁶⁹ and at least 100 disaster related inquiries have been conducted since 2000.¹⁷⁰ One common criticism levelled at public inquiries is that they are quick to disband and little attention is paid to the implementation of inquiry recommendations. Aside from the Victorian Bushfires Royal Commission Implementation Monitor¹⁷¹ there appears to be other concerted effort to publicly and transparently monitor the implementation of inquiry recommendations.

Australia needs to establish an independent, statutory inter-governmental body to advise Australian governments on significant and national risks (a National Risk Commission or NRC). The NRC could be modelled on the Productivity Commission, which has been integral to the establishment of sound economic policy in Australia¹⁷².

The NRC should be an inter-governmental body able to respond to references from the Federal or any state or territory government. The NRC should regularly produce a broad and wide ranging National Risk Assessment (which could be modelled on the UK's National Risk Register¹⁷³, the WEF's Global Risks Reports¹⁷⁴) as well as more detailed and specific risk assessments on certain topics (for example food security or the vulnerability of infrastructure to geomagnetic storms). It should also have:

- a mandate that extends beyond disasters and climate change to include social, economic, security and health related risks;
- broad investigatory capabilities, including the ability to review internal and confidential government documents and where necessary the ability to compel expert testimony;
- the ability to require governments to respond to report recommendations;
- the ability to monitor the implementation of report recommendations;
- the ability to monitor the implementation of recommendations of relevant official inquiries;
- a mandate to champion the improvement of risk management systems and risk governance of all levels of government and the private sector; and
- a mandate to link national risk related research and activities of all governments, research institutions and the private sector to reduce duplication of effort.

The NRC should have a focus on transparency, accountability and the continuous improvement of risk governance. Where possible the NRC should make its reports public.

¹⁶⁸Gerstein, Marc, 2008: *Flirting With Disaster*, Union Square Press
<http://flirtingwithdisaster.net/>

¹⁶⁹Prasser, S., 1985: public inquiries in Australia: an overview. *Australian Journal of Public Administration*, **44**: 1–15.
doi: [10.1111/j.1467-8500.1985.tb02422.x](https://doi.org/10.1111/j.1467-8500.1985.tb02422.x)

¹⁷⁰See Annex

¹⁷¹Victorian Bushfires Royal Commission Implementation Monitor, accessed 17/01/13
<http://www.bushfiresmonitor.vic.gov.au/home/about+us/>

¹⁷²Banks, Gary and Carmichael, Bill, 2007: Domestic Transparency in Australia's economic and trade reforms: The role of the Commission, paper was presented to the Lowy Institute and Tasman Transparency Group Conference, *Enhancing Transparency in the Multilateral Trading System*, 4 July 2007, Sydney
<http://www.oecd.org/regreform/regulatorypolicy/39217022.pdf>

¹⁷³Cabinet Office, 2012: National Risk Register of Civil Emergencies, Government of the the United Kingdom, London, http://www.cabinetoffice.gov.uk/sites/default/files/resources/CO_NationalRiskRegister_2012_acc.pdf

¹⁷⁴Howell, *Global Risks 2013 — Eighth Edition*

Recommendations

Research, Risk Assessment and Understanding

1. COAG should commission a feasibility study into the establishment of a National Risk Commission to review and advise governments on risks to the safety, security and well-being of the nation.
2. Research and policy responses related to natural disasters and climate change should consider broader climate change impacts and other long-term trends and threats in disaster management.
3. The Bureau of Meteorology, CSIRO and Geoscience Australia should collaborate to regularly release a report summarising both the observation of any trends in extreme weather and the understanding of whether they are related to anthropogenic climate change. The report should also survey the literature on future projections of the incidence of extreme weather events and costs.
4. Further research on historical climatology of extreme weather is needed. In particular investigation of extreme winds (and the synoptic phenomena that cause them), floods, extreme waves, thunderstorms and tropical cyclones is needed.
5. Federal, State and Local Governments should, consistent with their contexts, continue to undertake and improve on risk assessments on natural hazards and, where possible, publish online copies of these risk assessments.
6. The Attorney-Generals Department should incorporate an easily searchable database on these risk assessments into the Emergency Management Knowledge Hub and improve linkages between the hub and other federal Government databases, for example the Australian Flood Studies Database.
7. Further research is needed to better understand the costs of extreme weather events, including economy wide costs and the impact on human health. The costs expended by governments and the private sector on disaster preparedness and mitigation also require investigation.

Insurance

8. Federal and State and Territory Governments should continue programs of work to improve the affordability and availability of insurance in particular for flooding and tropical cyclone damage.
9. The Federal Government should give further consideration to the report and recommendations of the *Natural Disaster Insurance Review* and the *House Inquiry into the operation of the insurance industry during disaster events*.

Preparedness of Key Sectors

10. Governments should collaborate with industry associations and research institutions to undertake broad-scale assessments of the disaster preparedness of key sectors to assist

improvements.

11. Businesses (including Government organisations where they are the owner or operator of a community lifeline) should assess their vulnerabilities to extreme weather events and ensure they are addressed in their businesses continuity planning and risk management arrangements.
12. The Federal Government should shift its resilience focus from critical infrastructure to community lifelines.
13. Government activities around community lifeline preparedness should be expanded to include all levels of Government, businesses of all sizes and focus on all threats including extreme weather, other natural hazards, accidents, counter-terrorism, cyber-security and climate change. These activities need to address interdependence in infrastructure.
14. To improve accountability Government regulators should require reporting on preparedness activities from large infrastructure operators. Government auditors should also regularly assess the business continuity, risk management and emergency preparedness of key lifelines. These reports should be publicly available.

Land Use Planning and Building Codes

15. State and Territory Governments should review their land-use planning systems to ensure they are effective in mitigating disasters.
16. Governments should shift land use planning focus towards an approach based on the full range of risks (including property destruction and loss of life)
17. Utilising knowledge on disaster psychology governments should develop risk-to-life land use planning standards that account for likely human behaviour.
18. Governments should establish strong requirements for passive cooling and energy efficiency measures in the National Construction Code to address increasing heat wave risks.
19. The Federal Government should establish national sea level rise benchmarks for land use planning and develop model planning legislation for land swaps
20. Governments should publish clear, understandable and targeted guidelines to assist homeowners and builders to retrofit properties
21. Governments should investigate possible incentives including insurance to encourage homeowners, businesses and infrastructure owners to retrofit their properties

Mitigation

22. Governments should to develop better policies to ensure the maintenance of hazard defences.
23. State and Territory Governments should ensure infrastructure is constructed to a disaster resilient standard when being built, or returned to a more disaster resilient standard if

destroyed or damaged by disaster.

Relationship between State and Local Government

24. State Governments and the Northern Territory should better specify expectations of local governments for the prevention of, preparedness for, response to and recovery from emergencies. Where not already established, state governments should strengthen requirements for local government to undertake disaster mitigation activities.

International Assistance

25. The Federal Government should establish a panel, including membership of relevant humanitarian and emergency management organisations, to review Australia's overseas disaster assistance frameworks and make relevant recommendations
26. The National Emergency Management Committee establish a working group to review Australia's ability to accept international disaster assistance and make relevant recommendations

Annex – A List of Previous Disaster Inquiries

This annex contains a list of all disaster related inquiries conducted in Australia since 2000. It includes any agency, coronial, judicial, independent, audit or parliamentary investigation into a specific disaster or a general disaster related topic that makes recommendations. It does not include parliamentary inquiries into disaster related bills; strategies (for example the National Disaster Resilience Strategy); reports that are not publicly available; or those commissioned by NGOs, associations and the private sector.

Federal

COAG

(includes inquiries from Ministerial and Standing Councils and Intergovernmental working groups)

- [2002 - Natural Disasters in Australia: Reforming mitigation, relief and recovery arrangements](#)
- [2005 - Inquiry on Bushfire Mitigation and Management](#)
- [2005 - Review of Australia's Ability to Respond to and Recover From Catastrophic Disasters](#) (review was not originally publicly available but has since been released under FOI)
- [2009 - Recommendations on the Role of AEMO and the Effectiveness of Current Gas and Electricity Emergency Arrangements](#)

Parliamentary

- [2003 - A Nation Charred: Inquiry into the Recent Australian Bushfires](#)
- [2006 - Inquiry into Australia's response to the Indian Ocean Tsunami](#)
- [2008 - Inquiry into climate change and environmental impacts on coastal communities](#)
- [2010 - Inquiry into Bushfires in Australia](#)
- [2011 - The capacity of communication networks and emergency warning systems to deal with emergencies and natural disasters](#)
- [2011 - The asset insurance arrangements of Australian state governments](#)
- [2012 - Inquiry into the operation of the insurance industry during disaster events](#)
- [2013 - Recent trends in and preparedness for extreme weather events \(yet to report\)](#)

Royal Commission

- [2008 - Equine Influenza Inquiry](#)

Independent

- [2005 - Tsunamis - Does anyone have to die?](#)
- [2011 - Natural Disaster Insurance Review](#)
- [2012 - Review of the Bureau of Meteorology's extreme weather and seasonal forecasting](#)

capacity

Agency

- [2000 - Consumer Understanding of Flood Insurance](#)
- [2010 - Working Better Together: An NGO perspective on improving Australia's coordination in disaster response](#)

Audit

- [2000 - Commonwealth Emergency Management Arrangements](#)
- [2003 - Pest and Disease Emergency Management Follow-on Audit](#)
- [2003 - Business Continuity Management Follow-on Audit](#)
- [2003 - Business Continuity Management and Emergency Management in Centrelink](#)
- [2005 - Review of the Evaluation Methods and Continuous Improvement Processes for Australia's National Counter-Terrorism Coordination Arrangements](#)
- [2007 - Australia's Preparedness for a Human Influenza Pandemic](#)
- [2008 - Emergency Management Australia](#)
- [2009 - Business Continuity Management and Emergency Management in Centrelink](#)
- [2010 - Emergency Management and Community Recovery Assistance in Centrelink](#)

New South Wales

Parliamentary

- [2000 - NSW Rural Fire Service](#)
- [2001 - Oil Spills in Sydney Harbour \(Inquiry\)](#)
- [2002 - Inquiry into the 2001/2002 Bushfires](#)
- [2004 - Ambulance Service of NSW: Readiness to respond \(Inquiry\)](#)
- [2004 - Fire Services Funding \(Inquiry\)](#)
- [2006 - Inquiry into Managing Animal and Plant Diseases](#)
- [2008 - Major Infectious Disease Outbreaks: Readiness to Respond - Examination of Auditor-General's Report \(Performance Audit\) \(Inquiry\)](#)
- [2011 - Kooragang Island Orica chemical leak](#)

Independent

- 2005 - Special Commission of Inquiry into the Waterfall Rail Accident, [Volume 1](#) & [Volume 2](#). See progress reports on recommendations [here](#).
- [2009 - Recovery Coordinator's Report of the Mid North and Far North Coast Flood Recovery - May 2009](#)

Audit

- [2002 - Managing Animal Disease Emergencies](#)

- [2005 - Coordination of State Rescue Services](#)
- [2006 - Major Infectious Disease Outbreaks: Readiness to Respond](#)

Queensland

Independent

- [2007 - The Final Report of the Operation Recovery Task Force: Severe Tropical Cyclone Larry](#)
- [2009 - Report on a Review of Disaster Management Legislation and Policy in Queensland](#)
- [2012 - Queensland Floods Commission of Inquiry](#)
- [2013 - Queensland Emergency Services Review](#)

Coronial

- [2006 - Palace Backpackers Hostel Fire](#)
- [2012 - Inquest into the deaths caused by the South-East Queensland floods of January 2011](#)

Audit

- [2004 - Audit of the Queensland Disaster Management System](#)
- [2008 - Management of Rural Fire Services in Queensland](#)
- [2011 - National Partnership Agreement for Natural Disaster Reconstruction and Recovery](#)

Australian Capital Territory

Parliamentary

- [2008 - ACT Fire and Emergency Services Arrangements](#)

Independent

- [2003 - The Inquiry into the Operational Response to the January 2003 Bushfires](#)
- [2003 - The Report of the Bushfire Recovery Taskforce](#)

Coronial

- 2006 - The Canberra Firestorm: Inquests and Inquiry into Four Deaths and Four Fires between 8 and 18 January 2003 [Volume 1](#) & [Volume 2](#)

Audit

- [2003 - Emergency Services](#)
- [2009 - Delivery of Ambulance Services to the ACT Community](#)

Victoria

Parliamentary

- [2000 - Inquiry into the Control of Ovine Johne's Disease in Victoria](#)
- [2008 - Inquiry into the Impact of Public Land Management Practices on Bushfires in Victoria](#)
- [2012 - Inquiry into Flood Mitigation Infrastructure in Victoria](#)

Royal Commission

- 2010 - [2009 Victorian Bushfires Royal Commission](#)

Independent

- [2011 - The review of the 2010-11 Flood Warnings and Response](#)

Coronial

- [2002 - Inquest into the Linton Wildfire](#)

Agency

(includes reports prepared by the Emergency Services Commissioner in their statutory role)

- [2003 - Inquiry into the 2002-2003 Victorian Bushfires](#)
- [2005 - Improving Emergency Response at Melbourne Airport](#)
- [2008 - Marine Emergency Framework Review Final Report](#)
- [2008 - Review of the April 2008 Windstorm](#)
- [2008 - Westpoint Chemical Fire Community Report](#)
- [2011 - Review of the February 2011 Tostaree Fire](#)
- [2011 - Towards a more disaster resilient and safer Victoria Green Paper: Options and Issues](#)
- [2012 - North East Victoria Flood Review](#)

Audit

- [2003 - Fire Prevention and Preparedness](#)
- [2004 - Beating the Bugs: Protecting Victoria's Economically Significant Crops from Pests and Diseases](#)
- [2005 - Managing Stormwater Flooding Risks in Melbourne](#)
- [2008 - Biosecurity Incidents: Planning and Risk Management for Livestock Diseases](#)
- [2009 - Preparedness to Respond to Terrorism Incidents Essential Services and Critical Infrastructure](#)
- [2010 - The Department of Human Services' Role in Emergency Recovery](#)
- [2010 - Business Continuity Management in Local Government](#)

Tasmania

Parliamentary

- [2003 - Report on Ambulance Services in Tasmania](#)

Coronial

- [2009 - Beaconsfield Mine Disaster Coronial Inquest](#)

Audit

- [2011 - Bushfire Management](#)

South Australia

Parliamentary

- [2005 - Eyre Peninsula Bushfire and Native Vegetation](#)
- [2012 - Natural Resources Committee Bushfire Inquiry](#) - This committee seems to have had several inquiries into bush fires in SA with activity in 2006, 2009 and 2012. Some of the report links appear to be broken
- [2012 \(yet to report\) - Community Safety and Emergency Services in South Australia](#).

Independent

- [2003 - Review of the Emergency Services Sector \(Dawkins Review\)](#)
- [2008 - Review of the Fire and Emergency Services Act 2005](#)

Coronial

- [2008 - Wangary Fires Inquest](#)

Agency

- [2008 - Volunteer Administrative Workload Review](#)

Northern Territory

Coronial

- 2010 - [Ashmore Reef Boat Explosion - SEIV 36](#)

Western Australia

Parliamentary

- [2001 - Bellevue Hazardous Waste Fire Inquiry](#)
- [2006 - Inquiry into Fire and Emergency Services Legislation](#)
- [2007 - Inquiry into Western Australia's Natural Disaster Relief Arrangements](#)
- [2012 - Inquiry into the State's preparedness for this year's fire season](#)
- [2012 - The Toll of Trauma on Western Australian Emergency Staff and Volunteers](#)

Independent

- [2011 - Perth Hills Bushfires 2011 Review](#)
- [2012 - Special Inquiry into the November 2011 Margaret River Bushfire](#)

Coronial

- [2012 - Coroner's inquest into SIEV 221 - Christmas Island](#)

Audit

- [2004 - Responding to Major Bushfires](#)
- [2009 - Coming Ready or Not: Preparing for Large-scale Emergencies](#)
- [2012 - Second Public Sector Performance Report 2012](#)