

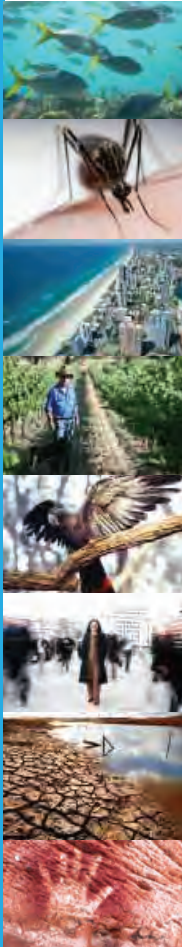
NCCARF

National  
Climate Change Adaptation  
Research Facility

National Climate Change  
Adaptation Research Plan

Emergency Management

2012 Revised Edition



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The role of the National Climate Change Adaptation Research Facility is to lead the research community in a national interdisciplinary effort to generate the information needed by decision-makers in government and in vulnerable sectors and communities to manage the risks of climate change impacts.

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**The views and opinions expressed in this publication not necessarily the views of the Commonwealth and the Commonwealth does not accept responsibility for any information or advice contained herein.**

# **National Climate Change Adaptation Research Plan: Emergency Management**

## **Revised 2012 Edition**

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## EXECUTIVE SUMMARY

Climate change is expected to increase the frequency and intensity of natural disasters, including cyclones, storms, drought, heat waves, bushfires and flooding, with varying degrees of uncertainty about projections for specific hazards. Emergency management organisations are on society's front line in preparing for such events, in preventing the worst forms of damage and harm when they occur, and in managing the post-event recovery phase.

A full understanding of – and preparation for – the risks from climate change, which would inform the adaptation options available to communities to reduce or recover from those risks, requires more than a simple multiplying of existing emergency management capabilities. When natural disasters occur, the consequences of damage and loss are a function of the effectiveness of the disaster mitigation strategies that have been implemented, the activities of the emergency services, and of the resilience of the communities, economic sectors and natural environments affected.

Planning for the increased risks from climate change is still in its early stages within Australia's emergency management sectors, although the National Strategy for Disaster Resilience adopted by COAG in February 2011 sets the national context for adapting to these changes. Research is needed to inform the way in which the various sectors respond to climate change across the prevention, preparedness, response and recovery (PPRR) range of issues across organisations and activities, whilst considering all hazards and key vulnerable groups. Whilst there is a large body of research to assist the emergency management sector to adapt to the current climate, research that considers future conditions is not as well developed. The purpose of this National Climate Change Adaptation Research Plan (NARP) is to identify the research priorities that might help Australian national and state governments and communities respond to extreme events for which disaster planning, preparedness and response may be required.

The NARP was first released in 2009. Since then, Australia has experienced a run of unprecedented natural disasters, including heatwaves, fires and flooding. Significant policies have been agreed, such as the National Strategy for Disaster Resilience, and inquiries held into natural disasters.

In light of these events and developments, NCCARF and the Adaptation Research Network (ARN) for Emergency Management have reviewed and revised the NARP and its priority research question. The changes are summarised below.

### Current state of research

In the past few years, Australia has invested in research about climate change adaptation and emergency management through the NCCARF-managed Adaptation Research Grants Program (ARGP) and through research funded and managed by other organisations, including CSIRO, ARC and VCCCAR.

NCCARF has commissioned 11 research projects for the Emergency Management theme, representing an investment of about \$1.8 million of ARGP funding and a total research value

(all cash and in-kind) of about \$3.8 million. Other NCCARF-managed ARGP research activities relevant to the Emergency Management theme include several projects under NCCARF's Social, Economic and Institutional Dimension theme and in NCCARF's Synthesis and Research Program that are concerned with decision-making and, uncertainty. In addition, research under the Human Health research theme, such as that dealing with heat extremes, will contribute to effective adaptation in the emergency management theme. All of this research will be completed and reported in 2013.

### **Revision of the Emergency Management NARP (2009)**

The NARP for Emergency Management was developed in 2009 by the following drafting team: Tony Pearce (Chair), John Handmer, John Higgins, David King, Jan McDonald, Frank Pagano, John Schneider and Penny Whetton.

The NARP was updated in 2012 by a writing team comprising John Handmer (Chair), Richard McKellar, Blythe McLennan, Joshua Whittaker, Briony Towers, James Duggie and Martine Woolf. The purpose of the update was to ensure the NARP is up-to-date and thus able to provide guidance for research investment for the coming five years. The update is informed by a comprehensive review of the literature undertaken since December 2008 when the NARP was originally drafted (Handmer et al. 2011) and input from the Emergency Management Research Network and from key stakeholders. Experience gained from emergencies associated with extreme weather events between 2009 and 2011 was also taken into account, as was current NCCARF and other research that focusses on the research priorities of the original Emergency Management NARP. This information was used to prepare an 'Update Report' (Handmer et al. 2012) for the Emergency Management NARP, which was a major contributor to this revised Emergency Management NARP (2012). Specifically, the rationale for changes to research priorities and to their priority level is set out in Handmer et al. (2012).

### **Changes to the priority research questions resulting from the 2012 Update**

The conclusion of update process was that all existing Settlements NARP priority research topics should be retained but the prioritisation of several should be changed and the text of two priority research questions should be altered. The specific changes are as follows:

One research priority focussed on 'understanding risks' has been reduced from 'Very High / High' to 'Medium' priority:

- 1.1 Where and how are changes in climate going to put us at greatest risk?

One research priority focussed on 'community and organisational resilience' has been restated to reflect a change in policy focus for emergency management towards 'resilience' and to include a focus on the role of processes:

- 2.2 What behaviours and processes promote community preparedness and preventive strategies and resilience in a changing climate?

Two research priorities focussed on 'community and organisational resilience' have been increased from 'Medium' to 'High' priority:

- 2.1 What does community resilience mean in a changing climate?
- 2.2 What behaviours and processes promote community preventive strategies and resilience in a changing climate?

One research priority focussed on 'regional implications' has been changed from 'How will the climate change adaptive capacity of other countries, particularly those in the Pacific region, impact upon the Australian disaster management system and Australian fire and emergency service organisations?' to:

- 4.1 How will climate change affect the capacity of emergency management systems in Australia and the Pacific region to interact for mutual benefit and support? How can these systems best support adaptation?

### **Revised Emergency Management NARP (2012)**

In conjunction with NARPs for other priority thematic areas, this revised Emergency Management NARP (2012) will continue to guide researchers engaged in generating the information that Australia needs in order to develop an effective and equitable portfolio of adaptive strategies.

This revised NARP identifies four overarching strands to the research agenda for Emergency Management:

1. understanding the changing nature and location of the risks from climate change related natural disasters;
2. enhancing community and organisational resilience to climate change risks;
3. developing and implementing adaptive strategies;
4. understanding the regional implications of climate change impacts for emergency management in Australia.

A number of critical information needs and research gaps are identified under each sub-theme. Ranking research needs into high and low priority is difficult, given that many aspects of research are not directly comparable and time-frames vary. Priorities were developed using the following criteria:

#### **Essential**

Severity of potential impact or degree of potential benefit;

Immediacy of required intervention or response;

Need to change current intervention and practicality of the alternative intervention.

#### **Desirable**

Potential for co-benefits;

Potential to address multiple, including cross-sectoral, issues;

Equity considerations.



**Applying these criteria, the following priorities were identified around four themes:**

<b>4.1 Understanding risk</b>	
4.1.1 Where and how are changes in climate going to put us at greatest risk?	<b>Medium</b>
4.1.2 What tools are needed to enable decision-making under future climate uncertainty?	<b>High</b>
Community and organisational resilience to disasters	
4.2.1 What does community resilience mean in a changing climate?	<b>Very High</b>
4.2.2 What practices and processes promote community preparedness and preventive strategies in a changing climate?	<b>Very High</b>
4.2.3 What are the most effective strategies to ensure that individuals, governments and the private sector adopt better practices in preparing for the increased risk of extremes to communities, business operations or critical infrastructure arising from climate change?	<b>Very High–High</b>
Adaptive strategies	
How will climate change affect the emergency management sector's capacity to support preparedness, response and recovery?	<b>Very High–High</b>
What is the role of the private sector in adaptation through emergency management?	<b>High</b>
Regional implications	
4.4.1 How will climate change affect the capacity of emergency management systems in Australia and the Pacific region to interact for mutual benefit and support? How can these systems best support adaptation?	<b>Medium</b>

### **Implementation**

A detailed Implementation Plan has been prepared outlining the budget, research capability and resource issues, and funding opportunities relevant to the NARP. The ARN for Emergency Management will play a critical role in implementing the NARP, and will contribute to building collaboration, information-sharing and research capacity across the Australian research community.

# 1 CONTEXT AND OBJECTIVES

## 1.1 Introduction

There is now widespread acceptance that human activities are contributing significantly to climate change, and that this change is producing significant physical effects. It is also generally acknowledged that some of these effects are now either present or inevitable, and that their impacts will become more severe if we do nothing to modify our behaviours.

There are two main themes to such modification. *Mitigation* strategies involve actions that are intended to reduce the magnitude of our contribution to climate change (primarily by reducing greenhouse gas emissions) or offset or reverse its effects (for example, by establishing and maintaining forest areas). *Adaptation* strategies involve actions in response to changes that are either inevitable or likely. Adaptation is clearly the overriding priority for emergency service management organisations, to enable them to work with communities to manage these emerging threats.

The recent unprecedented climate related natural disasters afflicting many parts of Australia, including the 2009 heat waves in southern Australia, prolonged droughts across much of south-eastern Australia, the 2009 Black Saturday Bushfires in Victoria and the 2010/11 Queensland floods, have brought Australia's vulnerability to such disasters into sharp focus (see Box 1). Governmental agencies, community organisations, the research community and the private sector are becoming more interested in understanding climate related disasters, their risk to society and potential adaptation strategies.

### Box 1. Some recent examples of extreme climatic events and impacts

The recent 13-year drought in the southern Murray-Darling Basin (MDB) and Victoria was unprecedented compared with other recorded droughts since 1900.

A severe heat wave occurred in southern Australia from 26 January to the 7 February, 2009. There was a record run of days above 43°C at Adelaide and Melbourne. Estimates of deaths resulting from the heat conditions range from 424 to 500 people. Power outages resulting from bushfires and transport system disruptions to the Melbourne rail network caused financial losses estimated at \$800 million. On 7 February, strong, dry north-westerly winds fanned bushfires which claimed 173 lives, mostly in areas northeast of Melbourne.

In early September 2010, there was flooding on many rivers in northern Victoria. In September 2010, a tropical depression formed over the Gascoyne area of Western Australia, producing severe floods in the region. In December 2010 to January 2011, there was widespread flooding across central and southern Queensland. Approximately seventy towns and 200,000 people were affected.

A series of floods hit SE Australia, including river and flash flooding, beginning in December 2010 and early 2011, primarily in the state of Queensland including its capital city, Brisbane. More than 78 per cent of the state (an area bigger than France and Germany combined) was declared a disaster zone. These floods forced the evacuation of thousands of people from towns and cities. At least 70 towns and over 200,000 people were affected. In Emerald, a 16.05 metre peak in the Nogoa River on 31 December set a new record for the town. The Nogoa River peak caused major flooding in Emerald, where between 1000 and 1200 houses were flooded to some degree and approximately 95 per cent of businesses were damaged. Two thousand, four hundred and sixty-three residents registered as evacuees; and more than 400 were forced to stay in evacuation centres. In Brisbane, 22,000 homes and businesses were inundated over January 12 and 13. Altogether there were 2.5 million people affected and an estimated 29,000 homes and businesses suffered some form of inundation. Damage to the state was estimated in excess of \$5 billion. Thirty-five people died in the floods; three remain

missing.

In February 2011, Tropical Cyclone Yasi was one of the most powerful cyclones to have affected Queensland. Tully Sugar Mill recorded pressure of 929 hPa as the eye passed over suggesting wind gusts of about 285 km/h were possible. A 5 metre tidal surge was observed at Cardwell, which was 2.3 metres above the Highest Astronomical Tide (HAT). The Tropical Cyclone left behind significant damage. A disaster situation was declared for a number of coastal and adjacent local government areas from Cairns to Mackay along the coast, and to Mount Isa in the west.

**Source:** Bureau of Meteorology Annual Climate Summary 2009 (2010); Bureau of Meteorology Annual Climate Summary 2010 (2011); and Bureau of Meteorology Severe Tropical Cyclone Yasi (2011). Kiem et al. (2010b), Learning from experience (NCCARF); Queensland Floods Commission of Inquiry: Interim Report (August 2011) <http://www.floodcommission.qld.gov.au/publications/interim-report> - extracted 26 January 2012; National Climate Summary 2011 (Issued 4 January 2012). [http://www.bom.gov.au/announcements/media\\_releases/climate/change/20120104.shtml](http://www.bom.gov.au/announcements/media_releases/climate/change/20120104.shtml) - extracted 26 January 2012.; [http://en.wikipedia.org/wiki/2010%E2%80%932011\\_Queensland\\_floods](http://en.wikipedia.org/wiki/2010%E2%80%932011_Queensland_floods) - - Extracted 26 January 2012;

[http://www.derm.qld.gov.au/environmental\\_management/pdf/tc\\_yasi\\_feb\\_2011.pdf](http://www.derm.qld.gov.au/environmental_management/pdf/tc_yasi_feb_2011.pdf)

*The Courier Mail* Michael Madigan and Sarah Vogler. 25 January 2011. -

<http://www.couriermail.com.au/news/old-flood-advice-fit-for-new-response-to-rising-river/story-e6freon6-1225993905552> - Extracted 26 January 2012.

[http://www.health.vic.gov.au/environment/downloads/heatwave\\_plan\\_vic.pdf](http://www.health.vic.gov.au/environment/downloads/heatwave_plan_vic.pdf)

A full understanding of the risks from climate change and the adaptation options available to communities to manage those risks requires more than a simple multiplying of existing emergency management capabilities. Research will need to inform the way in which the sector responds to climate change across the prevention, preparedness, response and recovery (PPRR) range of activities, and the way it considers all hazards. Whilst there is a large body of research to assist the emergency management sector to adapt to the current climate, research that considers future conditions is not as well developed.

The purpose of this National Climate Change Adaptation Research Plan (NARP) for Emergency Management is to identify research priorities that will enable Australian governments and communities to enhance community and organisational resilience to the risks posed by climate change from the perspective of emergency management.

This NARP for Emergency Management is a guide for researchers, for potential funding bodies, and for potential users of the research, including policy-makers, managers and service providers throughout the Australian emergency services sector.

1. Four overarching strands of research are identified as necessary to meet this objective:
2. Understanding the changing nature and location of risks posed by climate change;
3. Identifying the most effective means to enhance community and organisational resilience;
4. Developing adaptive strategies with which to respond to climate change for use by the community and emergency services;
5. Understanding the regional implications of climate change impacts for emergency management in Australia.

## 1.2 NARP development and update

The National Climate Change Adaptation Framework ('the Framework') was endorsed by the Council of Australian Governments (COAG) in April 2007 as the basis for government action on adaptation over 5–7 years. The Framework includes possible actions to assist vulnerable sectors and regions to adapt to the impacts of climate change. It also includes actions to enhance the knowledge base underpinning climate change adaptation.

In 2007, the Australian Government provided \$126 million over 5 years towards implementing the Framework. The Australian Government established the National Climate Change Adaptation Research Facility (NCCARF, based at Griffith University) to coordinate and lead the Australian research community in generating the biophysical, social and economic information needed to adapt to climate change. About \$27 million is invested in priority research, through the Australian Government's Adaptation Research Grants Program (ARGP), for key sectors, as identified in NARPs, giving effect to Action 1.1 of the Framework, which aims to improve national coordination of climate change adaptation research.

Nine NARPs have now been developed by the Facility in partnership with governments, stakeholders and researchers. NARPs are important tools for coordinating adaptation research across Australia, and are being implemented by NCCARF with assistance from the adaptation research networks (ARNs) and through the participation of all Australian jurisdictions.

The identification of research priorities enables local, state and federal governments and other research investors to fund research that can deliver maximum short and medium-term benefits to the Australian community and provide a broad framework for longer-term research planning. The priority research needs for emergency management are set out in Section 4.5. The full prioritisation matrix is presented in Appendix 2.

In conjunction with NARPs in other priority thematic areas, the Emergency Management NARP guides researchers to generate the information that Australia needs in order to develop an effective and equitable portfolio of adaptive strategies. The ARN for Emergency Management plays a critical role in implementing the NARP, and contributes greatly to building collaboration, information-sharing and research capacity across the Australian research community.

### **The development of the first Emergency Management NARP released in 2009 was led by following writing team:**

Tony Pearce (EMA) (Chair)

John Handmer (RMIT)

John Higgins (DCCEE)

David King (JCU)

Jan McDonald (NCCARF)

Frank Pagano (EMQ)

John Schneider (Geoscience Australia)

Penny Whetton (CSIRO)

Frank Stadler (NCCARF – Secretariat)

Marie Waschka (NCCARF – Secretariat)

The writing team developed the NARP following a national workshop for key stakeholders and lead researchers, whose input provided valuable insights into the information needs and research priorities in the field.

NARPs and Implementation Plans (IPs) are living documents and therefore need to be reviewed and updated to take account of changes to the relevant theme's research environment and end user information needs. This NARP was reviewed and updated in February 2012. The purpose of the first NARP for Emergency Management released in 2009 was to articulate the research agenda for the 'next 5–7 years'. This updated NARP will remain relevant for the next 3-5 years and, depending on research progress and emergent issues, well beyond.

**This revision of the NARP was led by the following team:**

John Handmer (RMIT) (Chair)  
Richard McKellar (NCCARF)  
Blythe McLennan (RMIT)  
Joshua Whittaker (RMIT)  
Briony Towers (RMIT)  
James Duggie (DECWA)  
Martine Woolf (GeoScience Australia)  
Ida Fellegara (NCCARF Secretariat)  
Frank Stadler (NCCARF Secretariat)  
David George (NCCARF Secretariat)

The NARP revision was supported by a review of relevant research and other literature published after the completion of the original NARP in 2009 (Handmer et al. 2011), on-line and other input from stakeholders, including ARN members, and discussions with key stakeholders. In addition, a considerable body of experience gained from emergencies associated with extreme weather events between 2009 and 2011 was also taken into account, as was current NCCARF and other research that focusses on the research priorities of the original Emergency Management NARP. This information was used to prepare an 'Update Report' (Handmer et al. 2012) for the Emergency Management NARP, which was a major contributor to this revised Emergency Management NARP (2012). Specifically, the rationale for changes to research priorities and to their priority level is set out in Handmer et al. (2012).

In this revised NARP, sections 2, 3 and 4 have been significantly altered from the original NARP. In light of the review, the priority rating of three research areas has changed and the research question relating to potential regional implications of climate change has been altered.

Two research priorities addressing community resilience and practices promoting resilience have been upgraded to 'Very High', while priority research question one "Where and how are changes in climate going to put us at greatest risk?" has been reduced to 'Medium'.

The text of the last research question, pertaining to 'regional implications', has been changed to reflect current challenges in relation to Australia's role in the Pacific region. It now reads:

"How will climate change affect the capacity of emergency management systems in Australia and the Pacific region to interact for mutual benefit and support? How can these systems best support adaptation?"

**Recent research and policy development**

A thorough review of the state of the science relating to adaptation responses for extreme events has been coordinated by the IPCC: *Managing the Risks of Extreme Events and*

*Disasters to Advance Climate Change Adaptation* (IPCC 2012). Ross Garnaut has released his 2011 update on climate change in Australia (Garnaut, 2011). At the global and regional levels, the evolving risk from climate change and disasters has recently been examined in the *Global Assessment Report on Disaster Risk Reduction* (UNISDR 2011).

Since 2008, a number of studies have sought to identify the particular features of a 'climate resilient community'. In 2010 NCCARF produced a series of seven historical case studies of extreme climatic events or conditions to examine their impacts, how they were managed and the lessons that could be learned for adaptation to climate change (see Kiem et al. (2010b) or [www.nccarf.edu.au](http://www.nccarf.edu.au)).

In the past few years, Australia has invested in research about climate change adaptation and emergency management through the NCCARF-managed Adaptation Research Grants Program (ARGP) and through research funded and managed by other organisations, including CSIRO, ARC and VCCCAR.

NCCARF has commissioned 11 research projects for the Emergency Management theme (see Appendix 3), representing an investment of about \$1.8 million of ARGP funding and a total research value (all cash and in-kind) of about \$3.8 million. Other NCCARF-managed ARGP research activities relevant to the Emergency Management theme include several projects under NCCARF's Social, Economic and Institutional Dimension theme and in NCCARF's Synthesis and Research Program that are concerned with decision-making and, uncertainty. In addition, research under the Human Health research theme, such as that dealing with heat extremes, will contribute to effective adaptation in the emergency management theme. All of this research will be completed and reported in 2013.

Sparked by the spate of recent natural disasters, there has been significant progress in disaster management policy development. Over the last few years, use of the concept of resilience has become increasingly common in fire and emergency management. This shift is illustrated by, among other things:

- the ICA competition on resilient housing;
- the surge in research programs and groups claiming expertise in the area; and
- the release of the National Strategy for Disaster Resilience adopted by COAG in February 2011 (COAG, 2011).

The increased priority for research relating to resilient communities within the revised NARP for Emergency Management reflects this broader conceptual development within the emergency management sector.

### **1.3 Context of this NARP**

This NARP refers to the emergency management sector, including emergency service organisations, and encompasses prevention, preparedness, response and recovery. It adopts the definition of emergency management endorsed by Emergency Management Australia (EMA), namely:

"Organisation and management of resources for dealing with all aspects of emergencies. Emergency management involves the plans, structures and arrangements which are established to bring together the normal endeavours of government, voluntary and private agencies in a comprehensive and coordinated way to deal with the whole spectrum of emergency needs including prevention, response and recovery"(EMA, 1998).

When climatic and weather phenomena occur, the consequences in damage and loss are a function of the effectiveness of the disaster reduction strategies that have been implemented, the activities of the emergency services, and the resilience of the communities and economic sectors affected. Much of the work in preventing disasters lies in the planning and building regulation sectors of society and government, rather than with agencies responsible for responding to and recovering from emergencies. However, in parts of Australia, it has

become increasingly common to trade-off risks from climatic hazards, such as floods and fire, against improved emergency management. The result of this approach is that areas at risk may be developed for residential purposes on the basis that improved warnings and emergency response will adequately manage the increased risk (Handmer 2008; Molino 2007; see for example the NSW case of *Neate v Shellharbour* 2007, also the subject of a special session at the 2008 Floodplain Management Authorities Wollongong Conference).

The increased risks from climate change also arise in the context of a range of other pressures on, and drivers of change in, emergency management which have not, to date, been consciously planned for. Some of this is a result of uncertainty and lack of knowledge. Inevitably, fire and emergency services agencies, the community and business sector, governments at all levels and the insurance industry must deal with these risks.

There are also longer term strategic issues to address. Most current activity on adaptation and emergency management is focused on improving the capacity of the emergency management system – including prevention (Schipper and Pelling 2006; Mercer 2010; Romieu et al. 2011). A broader question concerns the viability of the current business model in say 30 years time. This could include issues such as:

- What combination of professional and volunteer services and what government role might be appropriate? What types of management and command systems are appropriate for different types, scales and stages of emergencies?
- How might the role of information and communication technologies (ICT) change once the National Broadband Network is in place?

The emergency management sector will also need to confront the substantial increases in complexity and uncertainty that will almost certainly characterise their current and future operating environment. The National Strategy for Disaster Resilience flags an aspect of this new environment.

Emergency services have shown that they are adaptive to change, both ongoing and projected. There has been significant new emphasis on training and up-skilling in areas outside of their direct experience, for instance for dealing with the consequences of security/terror events, based purely on revised threat assessments. For example, bushfire management has progressed significantly in the past decade, consequent upon several major events in south-eastern Australia, and with additional resourcing and improved knowledge arising from research and innovation. Some emergency services can respond to increased demand with their current workforce. Where additional funding is made available to enable emergency services to provide new or expanded services, they have demonstrated a capacity to embrace change and expand their capabilities accordingly.

Climate change creates new imperatives for risk reduction and management. Governments already have powerful strategies to manage the risks that will be altered by climate change, including land-use planning and building control. Risk modelling and assessment can highlight the need to enhance these strategies. Other well-understood adaptive mechanisms such as warning systems and community education awareness and engagement can be brought into play in new locations or with additional emphasis in existing locations. The implementation of such strategies would also have the immediate benefit of reducing the existing risk of severe weather emergencies. New approaches and expertise should enhance this current suite of risk reduction strategies and allow us to identify new ways of reducing the impacts of projected changes in the frequency and severity of extreme weather events.

Climate change increases the already pervasive uncertainty that confronts emergency management arising from, among other things, high levels of inter-annual variability. There is considerable disparity in the certainty with which various impacts are projected to occur (Garnaut, 2011):

**Heat waves:** high level of certainty of increased frequency and intensity;

**Fire danger:** strong evidence that south-eastern Australia will experience an increase in frequency of high fire risk days, with uncertainty about the magnitude of change;

**Rising sea levels and storm surge events:** high level of certainty of some sea level rise resulting from thermal expansion, but rate and extent of rise caused by ice melt uncertain;

Storm surge affected by intensity of storms: less certainty over extent and frequency;

**Rainfall events:** high level of agreement that some areas will become drier, and some areas will be likely to experience intensified rainfall events and therefore suffer an increased risk of flooding, but uncertainty over which areas will be affected and how;

**Tropical cyclones:** considerable uncertainty remains over climate change impacts on the location, frequency and severity of tropical cyclones;

**Strong winds including east coast lows:** East Coast Lows are intense low-pressure systems which occur on average several times each year off the eastern coast of Australia, in particular southern Queensland, NSW and eastern Victoria. While some types of east coast lows have increased in number since 1970, it is still uncertain how climate change is likely to alter their frequency and magnitude;

**Changes in hail:** significant uncertainty over the potential for hail events to increase in some regions.

Ongoing research is examining this uncertainty. At the international level a detailed report about weather extremes and disaster management has been published by the IPCC (IPCC 2012). National studies include AFAC's (the Australasian Fire and Emergency Service Authorities Council, the peak industry body for fire, land management and emergency service organisations in Australia and New Zealand) position paper on 'Climate Change and the Fire and Emergency Services Sector', and reports by Hennessy et al (2007, 2008) that flag potential issues. AFAC's position paper also highlights the potential role of the fire and emergency management sector in limiting the increase in exposure of new residential areas to climatic hazards. However, we also need to understand how effective decisions can be made in the presence of uncertainty, some of which is irreducible. The use of socio-economic scenarios offers one approach. Little work on socio-economic scenario development has been done in Australia, so their use has been limited, compared with the UK's Foresight Future Flooding study and some of the detailed sector studies carried out in northern Europe (Foresight, 2004).

The issues of organisational capacity, response to existing risks, and dealing with uncertainty are set within a broader policy and research initiatives context that informs this NARP. The Council of Australian Governments (COAG) and other bodies have considered the potential impact of climate change on future natural disasters (COAG 2002, 2004; Middelmann 2007), and the potential for catastrophic events caused by natural phenomena (COAG 2004). However, adaptation initiatives have not been a part of these analyses to any great extent.

As a result of recent emergencies, several more focussed inquiries and reports have been produced, including:

- National Action Plan for the Attraction, Support and Retention of Emergency Management Volunteers, September 2009;
- AFAC Climate Change and the Fire and Emergency Services Sector (position paper), September 2009 (AFAC, 2009);
- Final report of the Victorian Fires Royal Commission released, July 2010 (Teague et al. 2010);
- Queensland Floods Commission of Inquiry established, January 2011;
- National Strategy for Disaster Resilience (COAG 2011);
- National Disaster Insurance Review, March 2011; and



- National Climate Change Action Plan for the Emergency Management Sector endorsed, November 2009 (MCPEM-EM 2009).

These Australian initiatives have also been reflected in regional activities, including:

- APEC Emergency Management CEOs' Forum Outcome Report 2009; and
- APEC Workshop on Public Private Partnerships and Disaster Resilience Report January 2011.

In addition, over the past few years, most states have implemented heatwave warning systems and response plans. The work already done provides an existing knowledge base about natural hazard risks and impacts. Many adaptation needs will be strongly place-based, requiring both national- and state-level systems and institutional arrangements, combined with location-specific strategies and interventions.

There is considerable expertise and several mechanisms are already in place for addressing risks under current climatic conditions both nationally and in the states and territories, but these need to be augmented to capture the additional level of risk associated with climate change. An indicative list of policy and planning processes completed or under way is set out in Table 1.

**Table 1.** Policy and planning processes currently completed or under way in Australia at the National level.

<b>Indicative list of major policy and planning processes, established oversight arrangements and products</b>
<p>Processes and organisational arrangements</p> <ul style="list-style-type: none"> <li>• National Emergency Management Committee (NEMC)</li> <li>• National Emergency Risk Assessment Guidelines Committee</li> <li>• Risk Assessment, Measurement and Mitigation Standing Committee</li> <li>• National Partnership Agreement for Natural Disaster Resilience</li> <li>• AFAC (Australian Fire and Emergency Services Authorities Council) consultative processes across agencies.</li> </ul>
<p>Policies and plans</p> <ul style="list-style-type: none"> <li>• National Strategy for Disaster Resilience; COAG, February 2011</li> <li>• NEMC is initiating a process for the development of a Climate Change Adaptation Plan for the emergency management sector</li> <li>• National Risk Assessment and Guidelines</li> <li>• National Emergency Risk Assessment Guidelines (2010)</li> <li>• Climate Change Adaptation Action Plan; Ministerial Council for Police and Emergency Management (2009)</li> <li>• National Emergency Management Projects</li> </ul>
<p>Risk assessments</p> <ul style="list-style-type: none"> <li>• Australian Government National Disaster Resilience Program</li> <li>• Australian Government Critical Infrastructure Resilience Strategy</li> <li>• First-pass National Coastal Vulnerability Assessment</li> <li>• South East Queensland Regional Plan: Climate Change Risk Assessment</li> </ul>

- Climate Change Impacts in NSW

#### Research initiatives

- Australian Fire and Emergency Services Authorities Council: CRC – Fire and Society
- Five national research projects established under the Integrated Assessment of Climate Change 'Impacts on Urban Settlements' sub-program focused on climate change impacts adaptation response
- NCCARF research program (9 research projects in Emergency Management theme)
- CSIRO research
- *National Emergency Management Projects* (<http://www.em.gov.au/nemp>)
- Bushfire CRC
- Resilience Expert Advisory Group
- Australian Government Attorney General Department research program, including National Disaster Resilience Grants
- Geoscience Australia

## 1.4 Scope

The role of the Emergency Management NARP is to help ensure that end users and other stakeholders are in a position to make sound decisions based on the outcomes of appropriate and relevant research; for research investors to make informed research funding decisions; and for researchers to understand the broader context in which to organise their research activities. The NCCARF research process emphasises the value of consistent and sustained engagement between stakeholders and researchers to support research relevance and application.

This NARP identifies critical gaps in the information needed by decision-makers, emergency management agencies and the community, sets research priorities based on these gaps, and identifies capacity that could be harnessed to conduct priority research. Relevant issues include:

- Understand what changes are needed to improve the effectiveness of existing engagement strategies, including understanding how communities arrive at an 'acceptable level of risk';
- Understand the impact of combining climate change and emergency preparedness messaging in the community;
- Communicate and characterise climate change in ways relevant to the sector;
- Develop ideas, policies and options for adaptation in the context of disasters and emergencies, given the high level of uncertainty of climatic projections and potential impacts;
- Inform the revision of building design and construction standards, particularly in areas where storm, flood frequency/magnitude, and bushfires are most likely to increase;
- Inform land-use planning strategies to reduce exposure to increased natural hazards, such as in areas exposed to coastal storm surge and erosion, bushfire and flooding;
- Assist in understanding the trade-offs between options, ranging from warning systems and emergency responses to improved land-use planning and enhanced building design and construction in prevention/reduction of risk, as well as the role of risk transfer alternatives including insurance and government relief;
- Assist in understanding how hazard, vulnerability and exposure and related psycho-social influences combine to influence risk and how this understanding can be used to develop the most effective risk reduction measures;

- Improve information about the impacts of severe weather events (e.g., bushfires, floods and heat waves) on population and infrastructure, including through better understanding of responsiveness and sensitivity of emergency management decision-making to improved information, enhanced sharing and application of baseline data and changing risks due to climate change;
- Design better systems and mechanisms for forecasting the impacts of severe weather events to aid response and recovery activity;
- Integrate research about climate change with other research in the emergency management and other sectors to gain any potential synergies;
- Develop mechanisms for integrating ('mainstreaming') climate change adaptation considerations relevant to disaster and emergency management across portfolios and agencies of government; and
- Understand the implications for changes in responsibilities and liabilities.

While enhanced understanding of these issues should assist emergency managers, the work of emergency management is also greatly affected by the activities of other sectors. These include urban planning, energy, transport and water infrastructure, and public health strategies. This NARP acknowledges the importance of close linkages with these other sectors, but focusses on the research needs that are priorities for the emergency management domain.

## 1.5 Links to, and synergies with, other NARPs

Just as the work of emergency management organisations is strongly affected by the activities of other sectors and agencies, so too are there clear overlaps between this NARP and research priorities in other NARP thematic areas. Some potential areas of synergy or common interest are set out below and will be developed in the implementation of each NARP.

**Settlements and Infrastructure:** There is significant synergy with this theme, particularly in the context of potential damage to buildings and infrastructure from severe storms, floods and bushfires, and the need to put in place or improve efforts to minimise damage, including effective planning controls, suitable building codes and early warning systems. Recent weather events have further clarified the link to this theme. To the extent that the physical and social damage and cost of severe events can be reduced through better land-use planning, building codes, and infrastructure design, these two themes are complementary.

**Social, Economic and Institutional Dimensions:** Many aspects of adaptation and emergency management have social, economic or institutional dimensions. Economic analyses that are used for disaster loss assessment and prediction need to capture the potential damage to buildings and infrastructure, as well as potential casualties, crop damage, and other environmental impacts. Only through a holistic approach with a focus on community resilience will we be able to understand the implications of changes in magnitude and frequency of severe events and develop the best adaptation strategies.

**Human Health:** Ambulance services are part of the emergency services portfolio in some Australian jurisdictions and of the health portfolio in others. Ambulance services and the broader health sector will be beneficiaries of adaptation research addressing risk reduction that might reduce the potential for casualties in extreme (or severe) events, especially in coastal areas, where both the population at risk and the likelihood of such events are likely to increase, leading to both acute and chronic health effects. Heat stress and changed disease impacts on populations are also concerns of the emergency management sector. The preparedness of Australia's health systems for extreme weather events is a specific priority of the NARP for Human Health.

**Freshwater Biodiversity:** Changes in water resources resulting from climate change can affect both freshwater biodiversity and demands for emergency services. Management of

freshwater biodiversity can help mitigate the impact of extreme events such as floods and may be an effective impact prevention or reduction option.

**Primary Industries:** Severe storms and tropical cyclones often damage agriculture. For example, Tropical Cyclone Larry wiped out extensive banana and nut crops in far north Queensland in 2006, as did Tropical Cyclone Yasi in 2011. The impact analyses required for emergency management can provide insights into potential crop damage; knowledge of such damage is also critical to appropriate emergency response and recovery. Plant and animal pest/disease outbreaks can also be concerns of the emergency management sector. On the other hand, land management agencies have an important role to play in leading adaptation in the primary industries sector, including by minimising bushfire risks and exposure to drought and flooding. Climate impacts on primary industries, such as those arising from drought and water availability, can have substantial effects on their vulnerability and resilience increasing the impact of natural disasters.

**Terrestrial Biodiversity:** Natural systems are especially vulnerable to the introduction and spread of invasive species following damaging natural events such as bushfires or cyclones. A key recommendation of the Biodiversity Advisory Committee's 2008 report on *Climate Change and Invasive Species* (Low 2008) was that policy frameworks be developed that anticipate the invasive risks posed by cyclones, floods and other extreme events. It suggested, first, that scenario planning be used to predict the outcomes of different events on different regions and, second, that planning activities consider which actions have the potential to promote invasions after extreme events, and generate plans to reduce the risks. Emergency plans for cyclones and floods should include protocols for preventing the spread of weed seeds and other invasive organisms during rescue and clean-up operations. Pest control and hygiene practices of fire crews, especially when operating in national parks, are also relevant here.

**Indigenous communities:** Since the Emergency Management NARP was first released, NCCARF has developed a NARP for Indigenous Communities. Many Indigenous communities are exposed to natural hazards, including floods, fire, extreme heat, drought, storm surges and tropical cyclones. However there is limited understanding of the vulnerability of those communities to hazards, including their sensitivity to hazards, individuals and communities' coping mechanisms, and their adaptive capacity. Practices and governance arrangements that promote Indigenous community preparedness and resilience to extreme weather events will be imperative to ensure the safety, health and well being of affected communities.

## 2 KEY STAKEHOLDERS AND THEIR INFORMATION NEEDS

There are two key groups of stakeholders involved in the development of the Emergency Management NARP. The first are the end-users of research undertaken in accordance with the NARP. These are individuals and organisations (including government agencies) that make or implement decisions relating to emergency management. This group includes:

- Commonwealth, state and territory emergency management organisations;
- Other agencies and departments that have a direct role in emergency management, for example the health sector through their management of heatwaves, or an indirect role, for example water management agencies;
- National committees and peak bodies such as the National Emergency Management Committee and its sub-committees, the Australasian Fire and Emergency Services Authorities Council (AFAC), Australian Council of State Emergency Services, Australian Emergency Management Volunteer Forum (AEMVF) the Planning Institute of Australia, the Council of Ambulance Authorities and the Police Commissioners' Conference. There are also state and territory equivalents, and private sector bodies;
- The insurance and re-insurance industry including the Insurance Council of Australia;
- Local governments, and planning and development control agencies, including catchment management authorities;
- The general community;
- Non-government organisations, such as the Red Cross, Salvation Army, and other volunteer agencies and community organisations;
- The Bureau of Meteorology, in particular for its role in weather forecasting and warnings and flood information;
- Government and private managers of land and assets potentially affected by extreme events, including national parks, forestry services, and infrastructure; and
- Water Management agencies responsible for regulating river flows and dam levels.

These individuals, organisations and agencies are likely to require, among other things, a better understanding of:

- How institutions, policies and practices for emergency management can respond to new information on changing climate regimes and risk profiles in a cost-effective manner;
- The vulnerability, resilience and adaptive capacity of communities to changed experience of extreme and rare events (damage potential, physical and psychological casualties, social and economic costs, environmental impacts, infrastructure system dependencies and social networks);
- The effects of climate change, including sea level rise, on existing hazard profiles. A range of events could be affected including storm surge and coastal erosion, bushfires, flooding, cyclones, wind and hail damage, particularly in and around major urban centres and areas of high biodiversity value;
- The compounding effects on climate change impacts of demographic, economic and social changes which are already increasing exposure and vulnerability in places such as coasts, forested areas and flood plains and highly urbanised areas;
- The probability of rare events (such as Category 5 cyclones, tornadoes, floods, heat waves) in Australia and how spatial patterns and frequencies of rare events may change.

The key information needs of this group of stakeholders thus relate to:

- Changes to community vulnerability resulting from demographic and other processes, some driven by climate change and some not;
- How the capacity of communities to respond to projected climate impacts can be enhanced;

- Institutional responses to changed climate conditions and resulting changed demands on emergency services;
- How communication options might help manage emerging climate change induced emergency service demands;
- Changes to climate conditions, including changed incidence of extreme events and associated risk profiles; and
- Compounding effects of climate-change derived climate conditions and weather events, such as drought and heat waves.

*Note that information needs (e) and (f) relate to climate science and are therefore not addressed directly by this NARP.*

The second major group are the researchers and funding bodies that will undertake or fund the priority research identified in the NARP<sup>1</sup>. This group includes the small number of researchers who work full time on adaptation and emergency management, a much larger number of organisations and researchers who have some interest in the field, and a variety of agencies who have some connection with emergency management and/or climate change adaptation and who fund research through either providing grants to research organisations or by conducting in-house research.

**The information needs of these groups are:**

- Knowledge of the research priorities set out in the NARP and the rationale for them; and
- Clear articulation of the requirements and expectations of the agencies providing funds.

### **3 EXISTING KNOWLEDGE AND GAP ANALYSIS**

The function of emergency management is to deal with uncertainties and residual risk arising from any source. The function of climate change science is to provide sound climate and weather risk profiles. Emergency management provides a conceptual basis and institutional framework for dealing with risks of increasing uncertainty and complexity. A growing volume of literature is therefore examining the overlap and interactions between emergency management and climate change adaptation, and arguing for a close connection (Mercer 2010; Romieu et al. 2010; Schipper and Pelling 2006; Thomalla et al. 2006). There is, similarly, a growing emphasis internationally on supporting climate change adaptation through disaster risk reduction (Birkmann and von Teichman 2010; IASC and UNISDR 2008; UNISDR 2010).

Nevertheless, there is still relatively little treatment of emergency management in an adaptation context in the peer-reviewed literature – meaning that the quality assurance processes are uncertain for much of the material. Research findings are scattered and have not been synthesised. This is partly because most studies have been done in a developing-country context, and partly because different sectors and disciplines have undertaken their own work in isolation from others.

One convenient way of considering adaptation research in the emergency management sector is to use a three-way classification: (i) climate change science, (ii) risk analysis, and (iii) policy and practice. The first category, climate change science, is the only area where there has been a strong national research effort in Australia. The second and third areas are those where research and knowledge are more limited, especially when it is appreciated that much of the published work refers to developing countries.

The following summary draws on an annotated bibliography prepared by the EMA (2008), literature from the Canadian and Finnish adaptation research networks, the knowledge of the

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<sup>1</sup> Note that most research will be undertaken by a team involving end users throughout the research project, resulting in co-generated research projects and outcomes.

drafting team, and the review of recent research undertaken as part of the revision of this NARP and other sources.

### 3.1 Climate change science

A thorough review of the state of the science coordinated by the IPCC (IPCC 2007, 2012) suggests that further changes in climate are inevitable, regardless of any future success in controlling global greenhouse gas emissions. Importantly for emergency management, we also know that small changes in average temperatures are likely to lead, and in many parts of the world have already led, to substantial changes in extremes, with fewer frosts, more heat waves, droughts, bushfires and storms. A significant scientific literature exists for each type of climatic phenomenon and its negative impacts (see IPCC 2012 for a summary).

The major gap in climate change knowledge for adaptation policy and practice concerns the specifics of changes in location and likelihood (or frequency) of extremes, and the extent to which further science will reduce these uncertainties in useful ways. It appears that knowledge of extremes in the context of climate change will continue to be poorly understood for the foreseeable future.

### 3.2 Risk analysis

Risk analysis and management is fundamental to emergency management. Following normal Australian practice in the emergency management field and that adopted in IPCC 2012, risk is defined as a function of the hazard, exposure to that hazard, and vulnerability or susceptibility to harm and ability to recover. For the risk analysis process, most emergency management publications use the approach of Australian Standard 4360 Risk Management (now largely incorporated into ISO 31000).

Science provides information on the hazard (natural phenomenon), and a range of research informs the issues of exposure and the vulnerability of communities and economies. A long-running research program on community risk is under way at Geoscience Australia. Some of this work is summarised in their publication *Natural Hazards in Australia: Identifying Risk Analysis Requirements* (Middleman 2007). Other groups are also active in documenting risk from natural hazards; for example, Macquarie University's Risk Frontiers and James Cook University's Centre for Disaster Studies and Cyclone Testing Station. Engineering groups and related organisations such as the Australian Building Codes Board are actively involved in research on structures and infrastructure. Many government and research organisations are undertaking or coordinating research into the risks associated with climate change; for example, the Department of Climate Change and Energy Efficiency, the Council of Australian Governments (COAG), the CSIRO Climate Adaptation Flagship, the WA Fire and Emergency Services Authority, the Bushfire CRC, the NSW Rural Fire Service and the Fire and Rescue NSW. A detailed study has been produced on the likely impacts of climate change on bushfire risk (Lucas et al. 2007) and there are also reports on the potential changes in risk from heat waves, droughts and sea level rise, and the probable lack of change in cyclones (Hennessy et al. 2008; Kiem et al. 2010a; Hellman 2010; QUT 2010; Verdon-Kidd et al. 2010).

In spite of these and similar reports, knowledge of the risks remains limited. In particular, vulnerability assessment is at a relatively early stage of development. While estimating exposure may appear straightforward, there is much room for improvement in terms of the consequences cascading through society. Trends in how future climate change will affect the incidence and severity of disasters are poorly understood. This makes it risky to rely on the past as a guide to good practice. Much of the existing research is of limited use for policy. Little of the research in these areas explicitly addresses climate change adaptation within the context of psychological, social, demographic and economic trends. Exceptions include the UK's Foresight Future Flooding study (Foresight 2004) and the Dutch 'climate-proof Netherlands' program (Ireland et al. 2006; Pater and van Drunen 2006). Research reports

from a Canadian climate change adaptation program examine rural vulnerability in depth, as does an unpublished report for the Victorian Department of Sustainability and Environment. In summary, some material exists, but it is scattered throughout different disciplines and sectors.

The adoption, at the November 2011 meeting of the Standing Council for Police and Emergency Management, of the National Emergency Risk Assessment Guidelines highlights the importance placed on comparability of risk assessment and hazard mapping across jurisdictions. The Council plans to take steps to ensure that the results of risk assessments and mapping are published, so that they can support disaster resilience and planning.

### **3.3 Policy and practice**

Even though there are many gaps and weaknesses in research and knowledge in the categories set out above, they appear to be relatively well covered compared with research to support adaptation policy and implementation instruments. Research that is related to, or directly supports, policy and actions to address the risks from general climatic phenomena – in the absence of climate change – is very limited. However, there is considerable literature in the social and health sciences dealing with psychological and social adaptation, behavioural and lifestyle adjustments, and psychosocial impact assessment and intervention (Evans 2001; Evans and Stecker 2004; Lima 2004).

Much of the research considered to be policy-relevant is more about revisiting the science of climate change, and examining its implications in terms of likely impacts, than directly contributing to policy development or implementation. An important exception is work on the economic and financial aspects of a carbon economy – but this is of limited value for adapting to the implications of climate change for emergency management. Within this category, there is research directed at adaptation for specific hazards, and research supporting more generic approaches best described as building resilient communities and sectors (Handmer and Dovers 2007).

A major difficulty is that most existing policy processes – including underlying institutional arrangements, statute law, policy instruments, and public administration mechanisms – demand a sound knowledge base, so there is a strong need for processes that can cope with the very high levels of uncertainty associated with climate change.

## **4 PRIORITY RESEARCH TOPICS**

This section sets out the research priorities identified by the drafting team after consultation with stakeholders and researchers. The section is organised around four sub-themes that align with the issues about which stakeholders require a better understanding:

1. Understanding risk
2. Community and organisational resilience,
3. Adaptive strategies, and
4. Regional implications.

This is followed by a discussion of the overarching issues that need to be considered when setting research priorities. Within each sub-theme, specific research questions are articulated, followed by an explanation of the question and an elaboration on the research that will be needed in order to answer that question.

### **4.1 Understanding risk**

Risks associated with natural disasters will change as the climate changes. This presents a challenge to natural disaster managers and emergency services. These must now adjust to a constantly changing risk profile and accept that historical information about climate-related hazards is no longer an adequate basis for understanding current and future risk.



An appreciation of the risk from climate-related hazards requires an understanding of both the current or baseline risk and how climate change varies that risk. Current risk from climate-related hazards is derived from the following factors:

- The frequency and intensity of the hazard (including spatial extent and duration);
- Community exposure and the relationship with stressors such as demographic change;
- Vulnerability related to socio-economic factors such as future individual wealth, building stock and community awareness, and their interactions;
- Impacts that result from the interaction of those components;
- The resilience of communities, particularly vulnerable communities and groups, to plan for, prepare for, respond to, and recover from these impacts.

Measuring and communicating uncertainty in risk is also essential because we cannot provide accurate projections of future climate change. Moreover, uncertainty about the likelihood of impacts changes the distribution of risk.

A range of factors influence how emergency management agencies respond to risk. One factor is their understanding of that risk. Properly used, better information about climate change risk can help inform the activities of organisations across the PPRR spectrum, including the health system. This section considers the following questions:

- Where and how are changes in climate going to put us at greatest risk?
- What tools are needed to enable decision-making under future climate uncertainty?

Research questions related to community and organisational resilience are discussed in Section 4.2.

#### **4.1.1 Where and how are changes in climate going to put us at greatest risk?**

##### **Context**

There is little argument today that atmospheric CO<sub>2</sub> levels and mean temperatures are rising, but the extent to which this may affect the frequency, magnitude and location of extreme events (i.e., the hazard) remains unclear. Even less clear is how these changes in the hazard will lead to greater impact in terms of physical, economic, social and environmental consequences (i.e., risk). Accordingly, research is needed to enable us to translate our knowledge of climate change into an understanding of the risk, to develop more accurate estimates of the risk, with a focus on those elements where the level of risk is likely to exceed acceptable thresholds for emergency management and/or where the greatest adaptation may be required.

Understanding the changed risk of natural hazards will involve estimating how the frequency and intensity of climate events that give rise to natural hazards are likely to change. This, in turn, will require regional information about specific climate parameters, since different risks are likely to arise in different locations - such as cyclones in the north of Australia (Mason and Haynes 2011), extreme heat in inland areas (QUT 2010), storms (Donat et al. 2011), and general issues about climate extremes and climate change (Planton 2008). The IPCC's special report on extremes includes detailed examinations of likely regional changes for different climate and weather events (IPCC 2012). *State of the Climate 2012 (Australian Government 2012)* provides an updated summary of long-term climate trends in Australia.

Climate change may also lead to new risks through the extension of existing hazards to new locations. For example, the cyclone hazard along the Queensland coastline is expected to change in future, with increased frequency of cyclones further south towards more populated areas (similarly in Western Australia at higher latitudes). Although some research is directed towards these issues, we do not have answers at present for this important new source of risk to major urban areas.

New risks might also arise through the significantly increased probability of two or more natural disasters occurring at the same time, exhausting the resources required for response

and recovery. The implications of combined events must be considered when planning response strategies that assume an ability to mobilise resources from neighbouring regions – or even overseas – to assist with emergency management.

The notion of what constitutes acceptable levels of risk must also be addressed in order to gauge trade-offs between economic costs and social outrage. Some guidance on this question, through the issue of tolerable and intolerable risk, can be found within the National Emergency Risk Assessment Guidelines.

### **Research response**

There are two strands to the research response, both of which have relevance beyond the emergency management sector and can contribute to policy- and decision-making across a range of thematic priority areas.

### **Setting the baseline: assessing current risk**

Firstly, our understanding of future risk can be enhanced by a better understanding of current risk (risk under current or historically recent climate conditions). This is in line with Ministerial agreement at the November 2011 SCPEM meeting. This may require improvement to models to better understand such factors as the relationship between wind speed and building damage, or the way in which wind speeds are modified over complex terrain.

This research strand needs to focus on developing a better understanding of information in the hazard and impact domains:

*Hazard domain:* the detailed characteristics of an event in terms of the spatial distribution and intensity of the attributes that cause damage to people or property. For instance, for a severe storm event, research is required to better understand how basic information about climate or weather can be translated into a spatial description of the distribution of hailstones, severe wind, storm waves or water depth.

*Exposure:* the assets or values that are at risk to damage or loss.

*Impact domain:* the direct damage to property or people and the resulting social disruption and economic loss that constitute a disaster. For instance, we need to better understand (and develop predictive models for) the relationship between the physical description of a flood event and the resulting damages and losses. (This relationship between the imposed hazard and the resulting impact - for a given exposure of people and assets - is referred to as *vulnerability*). At the global and regional level this issue has recently been examined in the *Global Assessment Report on Disaster Risk Reduction* (UNISDR 2011).

Better monitoring and coverage of hazard parameters (such as anemometers for wind, flow gauges for water) and research into factors that contribute to damage or loss will provide critical data to assist in understanding these risks.

### **Climate change-induced risk**

With enhanced understanding of the current risk environment, research can be directed to capture the changing risk associated with climate change, as compounded by demographic and other changes in exposure or vulnerability. For example, in areas of high potential impact due to high population, significant infrastructure or vulnerable communities, we need to understand the differential change in existing risk arising from changes in the severity, frequency and timing of extreme events, and combinations of extreme events. These include:

- Compounding of flooding and coastal risks due to rising sea levels and intense rain events;
- Changes in bushfire intensity and frequency from anticipated increases in the number of extreme fire weather days, decreases in rainfall in southern Australia and changes to fuel loads and curing;

- Changes in wind loads, flooding and storm surge due to changes in frequency and intensity of cyclones and East Coast Lows;
- Increases in periods of extreme high temperature.

Uncertainty exists and will continue to pervade climate projections and risk assessment, despite improvements in model performance. Indeed, some uncertainties are irreducible. Part of this research task must be to gain a better understanding of the probabilities and consequences related to climate change and associated impact events in order to reduce the uncertainty; another part must be to consider tools and strategies to enhance decision-making under uncertainty.

We can deepen our understanding of the vulnerabilities by analysing current or historical analogue events or scenarios and by incorporating this information into an understanding of how our social, economic and physical systems behave when stressed or compromised. This research should help identify the critical points of failure or vulnerability and what combinations of factors (and associated likelihoods) will lead to disastrous consequences.

**Examples include:**

- Examining the relationships between building codes, construction practice and settlement patterns, and the maintenance or degradation of structures over time. Given this information, models can then be extended to capture the changing hazard environment, and tools can be developed for assessing the cost–benefit of adaptation measures such as improved building codes, changes in construction materials and/or how other elements of PPRR (e.g., improved warnings or evacuation procedures) might be brought to bear.
- Targeting specific regions such as those adjacent to or on the southern boundary of current cyclone regions (e.g., south-east Queensland) for special studies to assess the impacts of the increased cyclone hazard under climate change and possible adaptation measures (such as retrofitting current structures) if required.
- Examining the behaviour of key infrastructure as a system, in order to understand how single or multiple infrastructure failures lead to complex or cascading failures in our social, economic and physical infrastructure systems or networks, which in turn can lead to disasters on a local or regional scale.

In the context of climate change, the need for future research in this area lies in translating the consequence analysis approach described above into a better understanding of risk. For example, how do we translate knowledge of how fire damage to electric power transmission lines contributes to electric power blackouts and the downstream loss of income or social disruption to a community, into an understanding of the likelihood of this happening to any given community given potential changes in storm frequency, magnitude and location? Alternatively, how do we best make judgments about the appropriate approach in any given location – for example would it make more sense to focus on identifying the sensitivity of systems and building resilience regardless of the exact likelihood of the hazard?

A significant enhancement of this type of scenario modelling in priority areas is required in order to (i) provide advice to government and industry regarding cost-effective changes in the design and construction of infrastructure systems, and (ii) assess the adaptation/vulnerability implications of forthcoming major investments in physical infrastructure.

NCCARF has commissioned several reports concerned with Australia’s experience in adaptation to extreme weather events, including adaptation to Cyclone Tracy (Mason and Haynes, 2011), and adaptation to extreme heat in inland areas during the 2009 heatwave in south eastern Australia (QUT, 2010).

**Current NCCARF ARGP research in the Emergency Management theme:** One current ARGP research project is concerned with this research question (EM09 01; see Appendix 3).

## 4.1.2 What tools are needed to enable decision-making under future climate uncertainty?

### **Context**

Considering the uncertainty in climate change projections, it can be difficult for emergency service and disaster managers to make adaptation and resource allocation decisions. Mechanisms are needed to ensure that scientific knowledge is translated into better risk management practice. It is therefore important for disaster managers and climate scientists to agree on climate change information that is both scientifically rigorous and useful for decision-making. This is likely to involve an effort from both sides, with scientists providing information tailored to the needs of disaster managers, and managers using the best information that science can provide.

The challenge is to take our improved understanding of risk and translate it into an emergency management strategy covering the whole PPRR spectrum.

### **Research response**

The emphasis for research here is on complementing the improved understanding of risk with better risk management, by developing models of decision-making under uncertainty. A considerable amount of research has been done in the area of uncertainty analysis and its use in decision-making; now known as the field of decision analysis. Notable examples are the research conducted in the context of nuclear power plant safety in the 1970s and 1980s and, more recently, research into the risk of security (Dupont et al. 2008). In both cases, there was a need to develop approaches to decision-making that incorporated a consensus of the available knowledge in an environment of large uncertainty, where the consequences of a failure to act must be weighed against a wide range of possible interventions. In the area of natural hazard risks, the insurance industry has applied advanced natural hazard modelling methods incorporating uncertainty analysis, but there has been little research into incorporating climate change uncertainty into this process. Moreover, models designed for insurance applications have not been extended into the broader context of PPRR in emergency management.

Australian research on the challenge of decision-making in the context of complexity and uncertainty is a fast growing area of research, both in Australia and internationally. There have been numerous studies published on modelling future risks, as well as some research on developing decision support systems and vulnerability assessment tools. Recent published work includes:

- Storm tide modelling (Harper et al. 2009)
- Bushfire evacuation modelling (Taylor and Freeman 2010)
- Bushfire vulnerability assessment (Preston et al. 2009)
- Assessing the vulnerability of rural communities to climate variability and change (Nelson et al. 2010a, 2010b)
- Local government decision-making (Kennedy et al. 2010)
- Gold Coast City Council flood emergency decision support system (Mirfenderesk 2009).

**Current NCCARF ARGP research in the Emergency Management theme:** Two current ARGP research projects are concerned with this research question (EM11 02, EM11 03; see Appendix 3).

## 4.2 Community and organisational resilience

Communities and individuals vary in their capacity to prevent, prepare for, respond to, and recover from natural disasters. Understanding the factors that contribute to these variations and using these insights to build the resilience of communities is an important objective of

the emergency management sector. Climate change complicates this task by adding an extra dimension to the challenges for resilience – the capacity to deal with expanding and changing risks in the future. Note that it is generally assumed that “community” can be defined by location, however increasingly communities are defined by forms of identity other than place such as interest. These non-place based communities are generally dependant on disaster sensitive ITC to function.

A number of questions need to be considered as part of this sub-theme. Specifically, in the context of the capacity of communities to adapt to the changes in emergency risk and impacts that climate change may bring, they can be summarised as follows:

1. What does community resilience mean in a changing climate?
2. What practices and processes promote community resilience in a changing climate?
3. What strategies are most likely to promote these practices and processes?

#### **4.2.1 What does community resilience mean in a changing climate?**

##### ***Context***

The term ‘resilience’ is generally used to describe the capacity of a community or individual to resist the impacts of a disruption or adversity; the capacity to bounce back from the negative impacts of a disruption; or the capacity to adapt to those impacts (Folke 2006; Gallopín 2006). The concept of resilience is closely connected with the ideas of vulnerability and climate change adaptation (Gallopín 2006; Mercer 2010). The research literature in this area is now very large as most sectors of society are employing the term (COAG 2011; Manyena 2006; Pelling 2003; Prosser and Peters 2010). Recent Australian research includes the NCCARF report into the 2008 Queensland floods (Apan et al. 2010); assessment of climate change vulnerability in Australian rural farming communities using a rural livelihoods analysis (Nelson et al. 2010a, 2010b); factors that make for resilient bushfire affected communities (Pooley et al. 2010); and factors that helped or hindered community capacity building after the Canberra Bushfires (Winkworth et al. 2009).

There is a major international research network, the “Resilience Alliance” (Janssen 2007), and a rapidly increasing number of groups in Australia claiming research and consulting expertise in the field of resilience.

In the context of this NARP, disruption or adversity means emergencies and disasters that could be impacted by climate change. This connection between disaster risk reduction (or emergency management in Australia) and climate change, and the links with resilience are now the subject of much research attention (Thomalla et al. 2006; Schipper and Pelling 2006; Mercer 2010). Researchers in the community resilience field broadly agree on what constitute the key components of resilience, although precise definitions vary. Several papers attempt to define the relationships between the concepts of resilience, vulnerability, adaptive capacity and discuss the different ways in which these are employed across the disaster risk reduction and climate change literatures (Prosser and Peters 2006; Manyena 2006; Thomalla et al. 2006; Mercer 2010).

##### **Resilience may be increased by the presence of:**

- Resources required to ensure safety and continuity of core functions/activities;
- Competencies required to use resources to confront problems/adapt to hazard consequences;
- Mechanisms to integrate resources to ensure a coherent societal capacity;
- Mechanisms to ensure sustained availability of resources/competencies (Paton 2006).

To build collective resilience, communities must reduce risk and resource inequities, engage local people in mitigation, create organisational linkages, boost and protect social supports,

and plan for not having a plan, which requires flexibility, decision-making skills, and trusted sources of information that function in the face of unknowns (Norris et al. 2008).

Resilience also requires an understanding of the psycho-social influences on human behavioural change. The recently released National Strategy for Disaster Resilience will have implications for this area (COAG 2011).

Resilience is actively promoted by government and the private and volunteer sectors. However, it is difficult to measure or to judge whether policies and programs are increasing or reducing resilience. Factors broadly considered to contribute to community resilience include knowledge and awareness of natural hazards, effective governance, high social capital, and a range of behaviours related to hazard reduction and hazard response (Norris et al. 2008). A changing climate is likely to affect a number of these factors. For example, awareness of hazards may need to change because of a change in risk; governance arrangements that served the community well in the past may no longer be robust.

The challenge of understanding and building community resilience varies somewhat with the size and type of the community. There is a critical role for all levels of government. For instance, the greater complexity of large urban centres requires the use of more complex research analytical tools and responses than those that may be appropriate for smaller communities. The resilience of rural and remote communities may respond most effectively to long-term relationships with service providers. Cultural factors are also likely to be important, and attention must be paid to possible variations in particular groups distinguished by, for example, language. The resilience of communities to the impact of climate change is an important research priority because building climate resilience will be an important complement to risk-based approaches to climate adaptation. A key research challenge here will be the suitability, quality, and accessibility of fine-scale data.

### ***Research response***

Research is needed to identify the characteristics and indicators of resilience to climate changes in a wide range of different community types, and to determine whether resilience needs to be measured in different ways in a changing climate. Resilience building is most effective when it draws on existing strengths within communities, particularly in social capital and governance (Pelling 2011). Existing characteristics of resilience must be identified in order to introduce intervention strategies for a changing hazard environment.

### **Research questions within the emergency management framework for this topic include:**

- Are there particular features of a 'climate-resilient community'? Does resilience and adaptive capacity depend on the hazard to which people are exposed? Is resilience different in a changing rather than a static climate? Do changes in exposure have a bigger impact on community resilience than changes in natural hazard intensity and frequency? Do climate change related extremes affect a community's resilience indirectly through their impacts elsewhere in society?

### **Recent Australian resilience research includes:**

- A case study of vulnerability and resilience to bushfires in south-east Gippsland with a focus on macro-level root causes (Whittaker 2008; Whittaker et al. 2012).
- Analysis of levels of preparedness for disasters (Eriksen 2010, Prior 2010).
- Bushfire community-safety programs (Elsworth et al. 2008; Handmer and Haynes 2008).
- A preliminary assessment of which Australian rural communities are vulnerable to climate variability and change (Nelson et al. 2010a).
- A qualitative study of the experience of community members after the Canberra bushfires aimed at extracting the factors that are important in creating a competent, resilient community (Pooley et al. 2010).

**A series of studies conducted by NCCARF that identify vulnerability and adaptive capacity in relation to a range of extreme events including:**

- Drought in regional Victoria, New South Wales and Western Australia (Kiem et al. 2010a; Albrecht 2010);
- The 2009 Victorian heat wave (Queensland University of Technology 2010);
- Cyclone Tracy (Mason and Haynes 2010);
- Storm tides, coastal erosion and inundation at the Gold Coast, Byron Bay and Collaroy-Narabeen (Hellman et al. 2010);
- The 2007 Newcastle-Central Coast Pasha Bulker storm (Verdon-Kidd et al. 2010);
- The 2008 Queensland floods (Apan et al. 2010).

**This research led to the following questions:**

- Is there a critical number of same-hazard or different-hazard events which result in a 'tipping point' for a community or population? How will climate change affect this (e.g., by bringing communities closer to the 'tipping point')?
- What is the success and efficacy of hazard awareness and preparedness strategies in specific cultural communities and in a range of demographic and socio-economic groups? How would effectiveness be gauged? Investigation of this topic should build on recent Australian and overseas work, for example: for schools (Finnis et al. 2010; Ronan et al. 2009; Dufty 2009; Towers 2011), bushfire education (Elsworth et al. 2009), disaster preparedness (Nicolopoulos and Hansen 2009), flood education (Dufty 2008).
- How will the impacts of climate change in other sectors change the resilience of communities and organisations?
- What policy, statutory and governance arrangements are most beneficial to enabling community adaptive capacity?

**Current NCCARF ARGP research in the Emergency Management theme:** Two current ARGP research projects are concerned with this research question (EM09 02; EM 09 06; see Appendix 3).

#### **4.2.2 What practices and processes promote community preparedness and preventive strategies in a changing climate?**

##### **Context**

Climate change will affect community resilience and preparedness in three key ways:

- Groups that have hitherto not experienced severe weather events are likely to be exposed. In particular, more populous urban centres may have increased exposure.
- Climate change is likely to pose new risks to groups that might have preparedness – both physical and psychological – for some existing risks, but not for those created by climate change. It is critical that we learn from and overcome past cases of limited community preparedness, especially in larger communities that may be ill-prepared for major events. The potential for climate change to induce impacts from unfamiliar hazards on under-prepared communities is a significant challenge facing disaster managers.
- Community awareness of the risks posed by climate change may provide an opportunity to drive greater and more inclusive preparedness, in which there is an ability to transfer preparedness elements between events (i.e., 'all hazards' planning). The design and effectiveness of warning systems and of community education, awareness and engagement programs may assist in this regard.

##### **Research response**

There is an extensive international literature that covers ideas, examples and guidelines for promoting good community preparedness (Gow and Paton 2008; Greene 2002; Norman

2000; Ronan and Johnston 2005). This includes the issue of the level of preparation of Australian communities to natural disasters and fire emergencies (Nicolopolous and Hansen 2009), and psychological preparation for disasters (Clode 2009; Reser and Morrissey 2009). However, it is probable that a sizeable proportion of the public has not considered the implications of climate change for natural hazards (WMO 2007). In order to define what preparedness for risks altered by climate change might mean, research needs to ascertain how unprepared people are for a range of climate-related hazards, and their level of understanding and acceptance of climate change and its implications for natural hazards.

Alongside this kind of study, research also needs to review the portrayal of climate change, increased hazard risk, as well as the general hazard risk and leadership attitudes portrayed in the media, literature and public policy (Reser et al. 2011). The research challenge is to identify practices and outcomes that will promote preparation and preventive measures to enhance community resilience. It is a bottom-up emphasis that will identify existing behaviours that may be developed further and new behaviours and attitudes that can be promoted to increase resilience.

There is an extensive literature giving examples and guidelines for the dissemination of emergency warnings and information to the community (EMA 2009; Australian Government 2008; Davidson and Wong 2005; Elsberry 1995; Falls 2002; Handmer 2003; King 2004; O'Neil 2004). Climate change does not necessarily require a change in these strategies, but research must identify what the trigger points are for the commencement of the dissemination of emergency warnings and information to the community about potential climate change impacts. There is a need to understand the ability for existing warning system coverage to be expanded and the necessary infrastructure and technology required to permit expansion.

Existing warning systems are designed to target specific populations such as emergency response personnel or those defined by the geographical area exposed to a hazard or via the communication method utilised e.g., mobile phone, radio.

A number of recent studies address the issue of the level of understanding and acceptance of climate change and its implications for natural hazards:

- A study of tropical cyclone risk perceptions in Darwin shows wide difference between perceptions of short term and long term residents (Li 2009);
- A large survey examining public risk perceptions of the threat of climate change both in Australia and Britain, shows very high levels of concern - this study also examines and interrogates methodological issues (Reser et al. 2011); and
- A report for the Department of Planning and Community Development, Victorian Government, examines the role of community engagement in climate change mitigation and adaptation (Fritze et al. 2009).

Other recent material examines how climate change and increased hazard risk are portrayed (Weber and Stern 2011).

Research is needed to develop practices and processes to promote community resilience in a changing climate, especially in large communities that are likely to be exposed to new risks as a result of climate change.

**Current NCCARF ARGP research in the Emergency Management theme:** Several current ARGP research projects are concerned with this research question (EM09 01, EM 09 02, EM09 03, EM09 05, EM11 01, EM11 05; see Appendix 3).



### 4.2.3 What are the most effective strategies to ensure that individuals, governments and the private sector adopt better practices in preparing for the increased risk to communities, business operations or critical infrastructure arising from climate change?

Note that aspects of this topic are also covered by other themes, in particular by the Social, Economic and Institutional NARP and the Settlements and Infrastructure NARP.

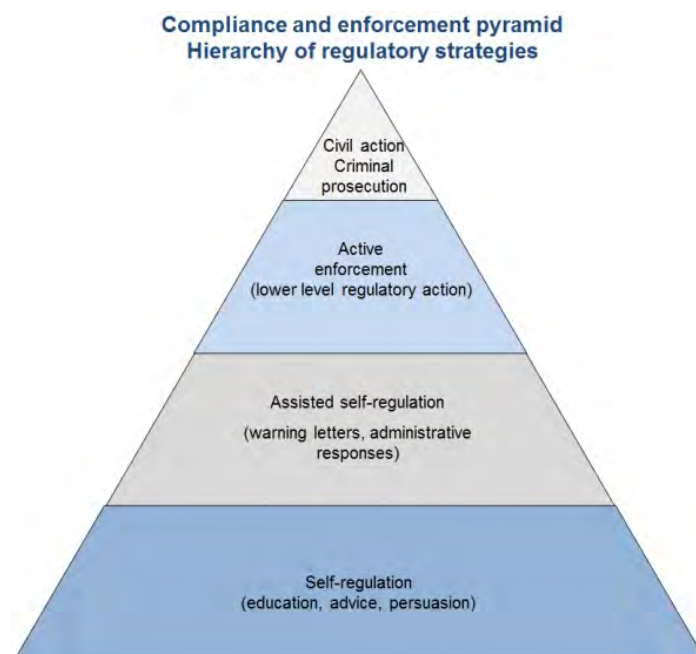
#### Context

A number of mechanisms can be used to promote decisions that reduce vulnerability and discourage decisions that increase vulnerability. These include:

- Providing information and education relating to the impacts of climate change; Creating financial incentives to promote desirable adaptive behaviour, such as reduced insurance premiums for less vulnerable structures;
- Regulation of behaviour through prohibitions, licensing requirements and other legally enforceable mechanisms;
- Policy processes, information flows through public and private organisations, and clarity and coordination of roles and responsibilities.

The key question is how we make or guide individuals, governments and the private sector to adopt better practice in preparing for the increased risk imposed by climate change. A critical issue for adaptation is which mechanism, or combination of mechanisms, is likely to produce the best results in terms of increasing resilience in any given situation. In a disaster context, one of the challenges is how to effect behavioural change before a community experiences a disaster, rather than as a response to it. How do we improve voluntary 'good behaviour' and encourage best practice? Does the market support or hinder this?

One useful framework for considering an appropriate mix of strategies to promote compliance with policy objectives is the compliance/enforcement pyramid which promotes self-compliance as a starting point, with an emphasis on education and cooperative assistance for those at the 'bottom' of the pyramid. Should these strategies fail to achieve compliance, a hierarchy of responses is available, escalating to deterrence through penalties at the 'top' of the pyramid (Figure 1). Research may be needed to develop a better understanding of the process and instruments that could be used in each category, and how to coordinate them.



**Figure 1.** Compliance and enforcement pyramid (after Ayres and Braithwaite, 1992).

Providing information and education and working with communities to develop collaborative responses are the methods of choice for promoting better practices where there are no significant barriers to effective action by private actors.

High-quality information and education that is designed for specific age, ethnic and cultural groups provides a basis for individuals, communities and businesses to manage their own risks from climate change impacts, including changes in natural hazards. All spheres of government also require an adequate information base for emergency management. Better information could include improved disclosure of agreed climate change risks to community members to inform purchasing decisions and encourage adaptive behaviour, and professional up-skilling to encourage better building design, planning decisions etc. However, this approach known as the “knowledge deficit approach” is not well supported in the hazards literature which has found that the connection between knowledge and protective action is weak (e.g. Sims and Bauman, 1983). Hazard education programs are mentioned above, and are active in providing information relating to the impacts of climate change, for example; hazards education in schools (Dufty 2009); bushfire community-safety programs (Elsworth, et al. 2008); different approaches to community flood education emphasising resilience (Dufty 2008); and a Victorian government report on understanding the role of community engagement in climate change mitigation and adaptation. (Fritze et al. 2009).

Financial incentives for better practice are likely to come mainly through the insurance market. For example, insurers may choose to offer reduced insurance premiums for less vulnerable structures and locations. Regulation can be important where there are significant barriers to effective private action or where there are important public goods to protect. There is a number of aspects to insurance including taxation and its capacity to increase climate change and disaster resilience through public-private initiatives (Mills 2005; Mills 2007; Michel-Kerja and de Marcellis-Warin 2006; and otherwise (Warner et al. 2009; Sullivan 2008).

The most significant regulations for emergency management are local guidelines or local planning instruments – linked with higher level government objectives and plans (Daniell et al. 2011). Land use planning is usually aimed at future development but can also be used to rectify historical problems, for example by removing inappropriate development from high hazard areas. Regulatory strategies aimed at promoting community preparedness and response to natural disasters vary from jurisdiction to jurisdiction and serve multiple purposes (for example, building codes set minimum construction standards, planning regulations take account of matters such as urban amenity, heritage values and transport requirements as well as emergency management). Legislation in some states stipulates mandatory compliance with the Australian Building Code or Australian Standards (such as the Emergency Risk Management Standard, itself derived from AS/NZS4360 now AS/NZS ISO 31000-2009). Regulation may suffer from a lack of flexibility and unresponsiveness to new science or understandings. Legal instruments are also subject to judicial interpretation, which often makes the precise operation of regulatory measures uncertain until tested in court. Examples include regulation of behaviour through prohibitions, licensing requirements and other legally enforceable mechanisms, such as land use planning for bushfires (Cottrell and King 2007; Buxton et al. 2011).

### ***Research response***

The objective of research under this sub-theme is to obtain information that will help decision-makers effect social change towards climate-adaptive behaviour. This will involve identifying the mix of information, incentives and regulatory arrangements that will be most effective in promoting behaviour that increases communities’ resilience to climate change risks. Developing this mix may involve identifying theoretical models of social change that can be adapted or applied to the study of natural hazard impacts and climate change and incorporated into tools of social impact analysis. Assessing post-disaster experience may also provide valuable insights into the best techniques and tools for promoting adaptive behaviour (King 2002). Ideally, any analysis of policy instruments should be comparative, so

that the strengths and weaknesses of different policy options are analysed relative to other options. In order to measure progress and behavioural change, data collection and analysis needs to occur on an ongoing, cyclical basis. Action research and longitudinal studies can contribute to the frameworks in which to study change in the lives of organisations and institutions as well as the community. Action research and longitudinal studies also facilitate collaboration between research agencies and clients.

Whatever techniques are used, it will be crucial to understand how best to promote climate change preparedness in specific cultural communities such as Indigenous and non-English-speaking communities, as well as in a range of demographic and socio-economic groups, by measuring the success and efficacy of other hazard awareness and preparedness strategies.

**Potential research topics include:**

- Assessment of the efficacy and cost–benefit of different options for promoting climate change adaptive behaviour, taking into consideration the risks in specific locations, and the cultural and other characteristics of particular communities;
- Assessment of the efficacy of collaborative practices that are already occurring, such as cooperative emergency management planning, and whether regulation may be needed to encourage better long-term planning for the impacts of climate change where the market operates on short-term gains (for example, development is continuing in high-risk locations such as low-lying coastal and fire-prone bush areas because land and property sales provide revenue for local governments and insurance premiums for insurance companies);
- The role of insurance markets in encouraging adaptive behaviour and the possible design of insurance products to achieve these objectives (Sullivan 2008; Warner et al. 2009; Wilkins 2010);
- Public perceptions of climate change risk and the implications for acceptance and tolerance of risk (Norman 2000; Pearce 2003; United Nations 2005; Reser et al. 2011);
- Mechanisms by which to ensure that new property developments and infrastructure are constructed in a risk-appropriate manner consistent with local hazards (Buxton et al. 2011).

**Current NCCARF ARGP research in the Emergency Management theme:** Several current ARGP research projects are concerned with this research question (EM09 02, EM 09 04, EM09 05, EM09 06, EM11 01, EM11 02, EM11 03, EM11 05; see Appendix 3).

### **4.3 Adaptive strategies**

Strategies to prepare for and respond to the impacts of extreme events resulting from climate change will need to be implemented at the individual, household, community, agency and business level. This section examines what capacity-building measures will be required by the emergency management sectors and the potential role of the private sector in supporting disaster response initiatives.

#### **4.3.1 How will climate change affect the emergency management sector's capacity to support preparedness, response and recovery?**

##### ***Context***

The emergency management sector already faces considerable strain from current risks and hazards during periods of high storm, rainfall, and bushfire activity. The sector relies heavily on volunteers and non-government organisations for prevention, preparedness, response, and recovery, and attempts to spread the risk across Australian society (Howard 2009). There are about 500,000 volunteers in the sector, with approximately 350,000 involved in response and recovery activities. The full-time and volunteer resource is already suffering significant stress. Recent research has concluded that many volunteers are struggling to

balance full-time paid work and family responsibilities with higher expectations of compliance and associated training, as well as emergency callouts (Aiken 2000; Evans and Saxton 2003; Institute for Volunteering Research 2004; McLennan 2006; Parkin 2008; Paul 2001; Reinholdt 2000; Woodward and Kallman 2001). Recent studies have examined motivations for volunteering (McLennan and Birch 2008), stress and pressure experienced by volunteers and their families (Cowlshaw et al. 2008, 2010), and challenges and approaches for retaining volunteers (Baxter-Tomkins and Wallace 2009; Parkin 2008).

An increased frequency and severity of disasters from climate change is expected to create additional pressure on the sector. The likelihood of simultaneous events may limit the capacity of each jurisdiction to draw on resources from interstate or the wider region, although the sharing of significant resources across jurisdictions is still relatively recent and its limits have not yet been tested.

### **Research response**

The structure and delivery of emergency management agencies and services will be affected by a range of factors over the coming decades, including demographic shifts, rural adjustment and broader business development. Research is required in order to assess the implications of increased demands specifically arising from climate change on full-time and volunteer emergency service personnel and non-government organisations, and to determine whether the current resourcing mix is the most appropriate for a future changing climate.

#### **Possible research questions include:**

- To what extent will climate change limit the ability of state agencies to draw on resources from other jurisdictions? What alternatives must be developed to ensure adequate resourcing when multiple events coincide?
- What is the capacity of the current emergency management model to adapt to anticipated climate change impacts and how can this be improved?
- How can emergency management agencies ensure adequate resourcing in times of climate-related disasters, both through paid and volunteer personnel?

**NCCARF research:** No current ARGP research projects are concerned with this research question.

- What is the role of the private sector in adaptation through emergency management?

### **Context**

The private sector provides a range of essential goods and services and has a great capacity to respond to opportunity and risk. Stewart et al. (2009), noted that in the context of the USA “While 85 percent of critical infrastructure is owned by the private sector, 100 percent of it exists within communities and impacts the ability of the nation to recover from disasters.” Many local government resources and services have also been outsourced to the private sector, including some used by emergency service organisations for response to emergencies at the local level.

The Trusted Information Sharing Network (TISN) for Critical Infrastructure Resilience provides an environment where business and government can share vital information on security issues relevant to the protection of our critical infrastructure and the continuity of essential services in the face of all hazards.

The TISN agenda is driven by critical infrastructure owners and operators from seven Sector Groups. In addition, two Expert Advisory Groups provide advice on broad aspects of critical infrastructure requiring expert knowledge.

Adaptation responses thus require effective engagement and involvement by the private sector as well as government and local community groups. How and to what extent this can be done is not clear. In recent years, many of the resources and services provided by local

government and utilised by emergency service organisations for response to emergencies at the local level have been outsourced to the private sector. In some cases, therefore, business may become (or may need to become) a contributor to or partner in emergency response. This is starting to occur in telecommunications. The private sector also plays a critical role in releasing staff to perform volunteer duties, often at times when they are most needed at work. It is not clear to what extent this issue has been accounted for in emergency response planning processes or whether this will further affect resource availability. In some circumstances, business may be a beneficiary of emergency management efforts.

### ***Research response***

There is limited research – peer-reviewed or otherwise – that considers the role that businesses can play in assisting emergency management organisations to respond to the changing occurrence of natural hazards linked to climate change. The insurance sector is an exception, with more considerable research (Sullivan 2008; Warner et al. 2009; Mortimer et al. 2011).

It is not clear that assessment of potential climate change impacts on the business sector itself (other than possibly in the critical infrastructure area) has been seriously considered, even as a part of a broader business resilience context. This makes it difficult to analyse adequately the ability of the business sector to play a part in the preparedness for, response to, and recovery from climate change impacts on communities. One exception is a study by Stewart et al. (2009) that examines the role of public-private partnerships in supporting community resilience in the USA.

In order to ascertain how prepared the business sector is to respond to the impacts of climate change, it is important that business understands the risk it faces. As with the broader community, it is not clear that business does in fact understand its risk, let alone factors it into planning. It is only recently that published research has started to examine this issue in Australia (Linnenluecke et al. 2011). Some institutions, such as the Australian Strategic Policy Institute, have commenced dialogue with the business sector about the potential for public-private partnerships in emergency management, albeit not specifically related to climate change.

#### **Research is needed to determine:**

- how businesses can best support emergency management organisations in adapting to climate change, and contribute to community resilience (this may require better understanding of which sectors and industries are more sensitive to climate change-induced disaster and emergency demands);
- whether contemporary commercial management systems enhance or reduce community resilience and adaptive capacity;
- what specific role business could play to enhance emergency preparedness and response capacity;
- the effectiveness of emergency relief and other special economic support mechanisms, including insurance, to enhance the adaptive capacity of private enterprise.

#### ***Climate change impacts on private enterprises***

Research on the impacts of climate change on the private sector is expanding strongly, although this varies by sector. A rapidly growing body of research examines the impacts of climate change on the insurance industry. However, there has been less research on this within Australia with examples including firm relocation as an adaptive response to climate change (Linnenluecke et al. 2011), and work on appropriate approaches by the insurance industry in response to climate change (Wilkins 2010). Research on climate change adaptation strategies by private sectors involved in emergency management remains limited.

#### **Recent Australian research includes:**

- recommendations to strengthen the role of insurance for Australian disaster resilience (Mortimer et al. 2011);
- the contribution of insurance to resilience (Sullivan, 2008); and
- the involvement of the private sector in the creation and management of flood risk (Handmer 2008).
- Recent international examples of research in this area include an overview of the consequences of climate change for the insurance sector in the Netherlands (Botzen et al., 2010) and additionally:
- difficulties of adapting insurance systems in European countries to climate change (Schwarze et al. 2011); and,
- the implications of climate change for insurers (Mills 2007); risk spreading by the insurance industry as a climate change adaptation measure (USA) (Sturm and Oh 2010).

**Current NCCARF ARGP research in the Emergency Management theme:** Two current ARGP research projects are concerned with this research question (EM09 04, EM11 02; see Appendix 3).

## 4.4 Regional implications

### 4.4.1 How will climate change affect the capacity of emergency management systems in Australia and the Pacific region to interact for mutual benefit and support? How can these systems best support adaptation?

#### **Context**

The importance of regional cooperation in the area of disasters and climate change has been underscored by its inclusion in recent APEC and other regional agreements and communiqués. These include the APEC Emergency Management CEOs' Forum Outcome Report 2009 (APEC 2009) and the APEC Workshop on Public Private Partnerships and Disaster Resilience Report, January 2011 (APEC 2011).

This NARP is focused specifically on emergency services and disaster/emergency management research needs in an Australian context. There is, however, a need to understand the potential for climate change impacts affecting our near neighbours to produce flow-on effects for Australia, in order to assess what impact this may have on emergency management in Australia. Barnett (2001) identified climate change and accelerated sea-level rise as a particular problem for Pacific Island countries, and the 'Small islands' chapter of the IPCC's 2007 assessment report (Mimura et al. 2007, p. 689) states that "Small islands, whether located in the tropics or higher latitudes, have characteristics which make them especially vulnerable to the effects of climate change, sea-level rise, and extreme events".

There are two strands to this issue: the first relates to the strain likely to be placed on Australia's emergency management capacity if it is increasingly called on to assist its near Pacific Island and South-east Asian neighbours. Published research on this topic focuses on the implications of climate change for regional security and stability (Dupont et al. 2008 paper for the Garnaut Climate Change Review), rather than natural disasters *per se*. The second is how climate change may alter the current capacity and equipment-sharing arrangements that Australia currently enjoys, especially with the USA.

Australia typically takes the lead in the humanitarian response when natural disasters strike the south-west Pacific. It is generally agreed that it is in our strategic interest to take a leading role, since it will place additional pressure on Australian emergency services and drive calls for migration if countries in the region become more crisis-prone (Locke 2009; Dupont et al. 2008), although this view is challenged by Mortreux and Barnett (2009). Recently, Australia has been active in the region to encourage local resilience – in addition to

providing strong support for enhancing emergency management capacity. Less obvious and less formal has been the high degree of engagement by Australian fire agencies in the region. These agencies work with local fire services in Pacific Island countries to improve their training and equipment, and work to reduce fire disasters, thereby enhancing local capacity to deal with the increased risks posed by climate change.

There has also been research activity around local/traditional knowledge and its role in adaptation/resilience. This is largely focused on proactive disaster risk reduction (Mercer et al. 2007, 2010; Kelman 2010). Campbell (2009) argues that although Pacific and other islands have historically been represented as sites of vulnerability, examination of traditional disaster reduction measures reveals considerable resilience.

The broader region encompasses the USA, especially California. There is an increasing exchange of personnel and equipment between the hemispheres (especially between Australia and the USA). It is likely that the partial dependence on fire-fighting equipment in the northern off-season will become increasingly untenable as fire seasons lengthen and overlap.

There is a need to understand the potential for climate change impacts affecting our near neighbours to produce flow-on effects for Australia, in order to assess what impact this may have on Australia. Barnett (2001) identified climate change and accelerated sea-level rise as a particular problem for Pacific Island countries, and the 'Small islands' chapter of the IPCC's 2007 assessment report (Mimura et al. 2007, p. 689) states that "Small islands, whether located in the tropics or higher latitudes, have characteristics which make them especially vulnerable to the effects of climate change, sea-level rise, and extreme events".

Published research on the strain likely to be placed on Australia's emergency management focuses on the implications of climate change for regional security and stability (Dupont et al. 2008 paper for the Garnaut Climate Change Review), rather than natural disasters *per se*.

### **Research response**

Research is needed into how Australian agencies can best enhance the capacity of nearby countries to deal with the increased challenges of climate change, in order to reduce the potential for community destabilisation and for consequential 'flow-on' impacts to our emergency management system and emergency service organisations.

Research is also needed to understand how the Australian sector could use its strong international industry links to enhance domestic and regional capacity.

A better understanding is also needed of how Australia would manage without international assistance, should available resources become depleted due to the increasing frequency of concurrent climate-driven emergencies occurring here and overseas. A corollary of this is the issue of how to best harness regional and international capacity to enhance domestic and regional capacity.

### **Local/traditional knowledge and resilience**

There has been considerable research activity around local/traditional knowledge and its role in adaptation/resilience, however, this is largely focused on proactive disaster risk reduction, rather than emergency management (Mercer et al. 2007, 2010; Kelman 2010).

Campbell (2009) argues that although Pacific and other islands have historically been represented as sites of vulnerability, examination of traditional disaster reduction measures reveals considerable resilience. He argues that many of the vulnerabilities that do exist are a product of islands' exposure to a 'wider world'.

**Current NCCARF ARGP research in the Emergency Management theme:** One current ARGP research project is concerned with this research question (EM11 04; see Appendix 3).

## 4.5 Research prioritisation

Since resources and capacity currently available in Australia for adaptation research are limited, NCCARF has developed a set of six criteria to be used for prioritising research topics within each thematic NARP (see Appendix 1 for details). These criteria are being used for all the NARPs and consist of three critical (*essential*) considerations:

- Severity of potential impact/degree of potential benefit;
- Immediacy of required intervention/response;
- Need to change current intervention and practicality of the alternative intervention.

There are three additional *desirable* criteria:

- Potential for co-benefits;
- Potential to address multiple, including cross-sectoral, issues;
- Equity considerations.

Ranking areas for research into high and low priority is difficult, given that many aspects of research are not directly comparable and time-frames for research vary. Nonetheless, an attempt has been made to apply the six priority criteria to the summary list of priority questions identified under each of the four sub-themes in Section 4. From this, the following list of priority topics emerged (Table 2). The full assessment matrix is presented in Appendix 2.

**Table 2.** Research priorities for emergency management.

Area	Priority
Understanding risk	
Where and how are changes in climate going to put us at greatest risk?	Medium
What tools are needed to enable decision-making under future climate uncertainty?	High
Community and organisational resilience to disasters	
What does community resilience mean in a changing climate?	Very High
What practices and processes promote community preparedness and preventive strategies in a changing climate?	Very High
What are the most effective strategies to ensure that individuals, governments and the private sector adopt better practices in preparing for the increased risk of extremes to communities, business operations or critical infrastructure arising from climate change?	Very High–High
Adaptive strategies	
How will climate change affect the emergency management sector's capacity to support preparedness, response and recovery?	Very High–High
What is the role of the private sector in adaptation through emergency management?	High
Regional implications	
How will climate change affect the capacity of emergency management systems in Australia and the Pacific region to interact for mutual benefit and support? How can these systems best support adaptation?	Medium





## 5 IMPLEMENTATION PLAN

An Implementation Plan augments this National Adaptation Research Plan for Emergency Management. This section therefore provides a broad overview of the resourcing issues that are likely to arise in the implementation of this NARP. NCCARF will engage with the NEMC and other organisations when moving forward with the implementation plan.

### 5.1 Existing research capacity

Research capacity is a function of the availability of the needed expertise. In the case of this theme, key expertise includes interdisciplinary and inter-sectoral skills. There is scope to enhance Australian adaptation research capacity through international collaboration, as has happened with climate change science. Taking each of the three areas of adaptation research in emergency management in turn:

#### ***Climate change science***

Australia has significant research capacity in climate change science through the Bureau of Meteorology (BoM), CSIRO, CAWCR (a partnership between BoM and CSIRO) and some state government agencies and university research groups. These are well linked in terms of sharing research capacity and tools globally, largely through the Intergovernmental Panel on Climate Change (IPCC).

#### ***Risk analysis***

Substantial technical capacity exists, in particular at Geoscience Australia and many fire and emergency service organisations and universities, especially Macquarie University's Risk Frontiers. In stating that technical capacity is large, there is an assumption that existing work on natural hazards meshes well with work on adaptation questions; this is not necessarily the case. Capacity appears to be much less in non-technical areas that are relevant for vulnerability assessment. There is also little agreement on suitable measures of vulnerability.

#### ***Adaptation policy and practice***

Australia is well served by policy research groups within and outside the public sector, but most of these groups do not work in emergency management and, until very recently, paid little attention to climate change adaptation in any context other than the economics of a low-carbon economy and related trading issues. The establishment of the CSIRO Climate Adaptation Flagship and the National Climate Change Adaptation Research Facility has significantly strengthened and improved the coordination of research capacity in this area.

There are small policy research groups and individuals operating largely in isolation across Australia. Bringing these together would help assess capacity. But it is likely that capacity is lacking, especially in the areas of policy, law, sociology and institutional studies. The research capacity gaps are likely to be largest in the policy and practice areas. Issues include the need to identify specific areas of weakness, and the value of international collaboration.

Australia is already served by a number of information dissemination channels for emergency management-related research, including the Australian Disaster Information Network (AusDIN), the Australian Journal of Emergency Management (AJEM), Geoscience Australia's Natural Hazards Online, and the Australasian Fire and Emergency Services Authority Council's (AFAC) Knowledge Web Network. There are also state-based networks and conferences, but there is scope for increasing the opportunity for direct contact between researchers and practitioners.

## 5.2 Potential collaborations

Given that research funding is limited, it is critical that new activities should avoid duplicating other initiatives. The National Emergency Management Committee (NEMC) is a natural collaborator with NCCARF and other research bodies in implementing this NARP. Valuable linkages can also be made with state-based projects which will have some congruent outcomes, such as Victoria's Future Coasts and VCCCAR and the Queensland Future Coastlines projects.

To ensure that research outputs are capable of easy and prompt uptake, it is essential that the needs of end users be taken into account early in the design of priority research and that end users be involved throughout the research program. Understanding the context and manner in which research will be used will help determine what modes of dissemination and uptake are most appropriate. Very few end users will access research through traditional academic publications, preferring instead toolkits, presentations and workshops, interactive web-based material, CDs and DVDs and so on.

A critical starting point in deciding how best to disseminate information and promote uptake will be to identify relevant primary and secondary end users for particular research priorities. Some work, for example, may directly inform the operational decisions of emergency services agencies. Other research, however, may speak directly to policy-makers, informing their choice of policy intervention. This highlights the need for bottom-up approaches to research that use qualitative and quantitative research methods to gather valuable existing knowledge from local stakeholders and experts from the very beginning of the implementation process. This is particularly important considering that emergency issues are geographically diverse. A bottom-up approach engages emergency workers or practitioners, provides the opportunity to identify local research needs, and ensures that the research is accessible and relevant for emergency practitioners. Support from local emergency organisations will be vital for harnessing and increasing specific knowledge.

There are already a number of key industry groups and peak bodies supporting the work of the stakeholders who will need to use the research outputs of this NARP. NCCARF will work with these groups as well as the research networks for emergency services and emergency management to ensure that existing mechanisms are used as much as possible.

## 5.3 Additional funding sources

In order to fully address the key research objectives outlined in this NARP and to undertake essential research programs, it will be necessary to look for additional funding sources other than those made available through NCCARF. Particularly relevant to the NARP for Emergency Management are key government organisations such as the Commonwealth Attorney General's Department, and state and territory agencies and departments. The NEMC may be able to source and coordinate funding to priority research topics. Likewise, collaborative research with local governments can attract local government co-funding. Furthermore, the insurance industry has a strong interest in this research. It is already engaged in a range of related research activities, and may contribute further to the research effort both financially and through in-kind support such as knowledge exchange. There may also be opportunities for collaborative funding with R&D corporations (such as the CLIMAG program) and the National Health and Medical Research Council (NHMRC).

Two government grant schemes have addressed both ends of the disaster/emergency research spectrum. The Natural Disaster Resilience Program funds mitigation and preventative projects while also providing money for disaster risk management studies. Australian Disaster Research Grants, on the other hand, enabled researchers to study natural disasters in Australia at first hand by visiting disaster areas post-impact. This program has ceased and at present there is no replacement.

Funding and resources may also be accessed through Cooperative Research Centres (CRCs) with research agendas relevant to climate change adaptation research in line with this NARP. The following CRCs are relevant: CRC Bushfire, Antarctic Climate and Ecosystems (ACE) CRC, CRC Aboriginal and Torres Strait Islander Health, CRC Mining, CRC Forestry and CRC for Spatial Information-2.

For adaptation studies with a focus on impacts on indigenous cultural heritage, funding may be obtained through the Indigenous Heritage Program. Research undertaken by Indigenous Australian students or early-career scientists may also attract funding from the ARC Discovery Indigenous Researchers Development Grant Program.

Generally, the Australian Research Council Grants Program would be the first port of call for many researchers and research institutions that seek additional support. Relevant grants offered by the ARC include:

*Discovery Projects:* A variety of fellowships are offered under the scheme to nurture the talents of Australia's most promising early-career researchers and to support established researchers.

*Discovery Future Fellowships:* Future Fellowships are offered to promote research in areas of critical national importance by giving world-class researchers incentives to conduct their research in Australia.

*Linkage Infrastructure, Equipment and Facilities:* The scheme fosters collaboration through its support of the cooperative use of national and international research facilities. Essentially, the scheme provides funding for large-scale cooperative initiatives so that expensive infrastructure, equipment and facilities can be shared by researchers in partnered organisations. The ARC may also fund single-organisation proposals in some circumstances.

*Linkage Projects:* The scheme supports collaborative research and development projects between higher education organisations and other organisations, including within industry, to enable the application of advanced knowledge to problems. Typically, research projects funded under the scheme involve risk. In recommending funding for proposals under Linkage Projects, the ARC may take into consideration the likely benefit of the research to Australian regional and rural communities.

*Linkage International Projects:* The scheme encourages networks and collaborations between researchers, research teams and research centres of excellence in Australia and overseas. Researchers awarded Linkage International funding may participate in national and international exchanges between research organisations.

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## 7 APPENDIX 1

Criteria for setting research priorities in NARPs

The criteria listed below have been used to prioritise the research questions identified in Section 4. Table 2 shows the results of this exercise.

### **Essential**

#### **Severity of potential impact or degree of potential benefit**

What is the severity of the potential impact to be addressed or benefit to be gained by the research? Potentially irreversible impacts and those that have a greater severity (in social, economic or environmental terms) will be awarded higher priority.

#### **Immediacy of required intervention or response**

Research will be prioritised according to the timeliness of the response needed. How immediate is the intervention or response needed to address the potential impact or create the benefit? Research that must begin now in order to inform timely responses will receive a higher priority than research that could be conducted at a later date and still enable a timely response.

#### **Need to change current intervention and practicality of the alternative intervention**

Is there a need to change the intervention used currently to address the potential impact being considered. If yes, what are the alternatives and how practical are these alternative interventions? Research that will contribute to practicable interventions or responses will be prioritised. Does research into the potential impact of the intervention being considered contribute to the knowledge base required to support decisions about these interventions?

### **Desirable**

#### **Potential for co-benefits**

Will the research being considered produce any benefits beyond informing climate adaptation strategies?

#### **Potential to address multiple, including cross-sectoral, issues**

Will the research being considered address more than one issue, including cross-sectoral issues?

#### **Equity considerations**

Will research priorities recognise the special needs of particular groups in Australia?

## 8 APPENDIX 2

Research prioritisation matrix for the National Adaptation Research Plan for Emergency Management and Climate Change

	Critical			Desirable			Overall
	Severity or Benefit	Immediacy	Need to change intervention / Practicality	Potential co-benefits	Cross-sectoral relevance	Equity considerations	Priority ranking
<b>4.1 Understanding risk</b>							
<b>4.1.1.</b> Where and how are changes in climate going to put us at greatest risk?	<b>Medium</b>	<b>Medium</b> More information is needed for increased understanding of current and future risks and to inform ongoing planning. Probably of longer-term importance.	<b>Medium</b> High probability that better information will influence current practice (increased understanding of risk is capable of informing decisions, but will not necessarily do so)	<b>Low</b>	Mapping of risk will contribute to adaptation planning in other National Adaptation Research Plans, e.g., Settlements and Infrastructure		<b>Medium</b>
<b>4.1.2.</b> What tools are needed to enable decision-making under future climate uncertainty?	<b>High</b>	<b>Medium</b> Unless the risk profile shows dramatic change, generally of longer-term importance	<b>High</b> Need better models which incorporate climate change and address the needs of decision-makers				<b>High</b>

<b>4.2 Community and organisational resilience</b>							
<b>4.2.1.</b> What does community resilience mean in a changing climate?	<b>Very High</b> Concept of community resilience comparatively new to the emergency management sector, but many current activities contribute to resilience. Research in the area of community resilience may identify additional strategies.	<b>Very High</b> Building resilience generally medium–long-term strategy, so planning needs to commence as soon as possible, informed by agreement on what the objective of a ‘resilient community’ means in the climate change context	<b>Very High</b> Reason to believe that targeted interventions can help enhance community resilience	Benefits likely to extend to other aspects of communities if resilience is ‘generic’	Relevant across social/economic sectors	Strategies aimed at enhancing community resilience generally start with the least resilient segments of the community	<b>Very High</b>
<b>4.2.2.</b> What practices and processes promote community preparedness and preventive strategies in a changing climate?	<b>As above</b>	<b>As above</b>	<b>As above</b>				<b>Very High</b>
<b>4.2.3.</b> What are the most effective	<b>Very High–High</b> Strong need to	<b>High</b> Techniques and understanding	<b>High</b> Reason to believe that interventions	Benefits likely to enhance community		Strategies aimed at promoting	<b>Very High–High</b>



strategies to ensure that individuals, governments and the private sector adopt better practices in preparing for the increased risk to communities, business operations or critical infrastructure arising from climate change?	identify best techniques for mobilising community to adopt positive behaviours and enhance resilience	needed now in order to implement long-term strategies of social change	will be practicable	resilience more generally		adaptive behaviour should reduce the vulnerability of most vulnerable groups	
<b>4.3 Adaptive strategies</b>							
<b>4.3.1.</b> How will climate change affect the emergency management sector's capacity to support preparedness, response and recovery?	<b>Very High</b> Emergency services already under strain; climate change will exacerbate this	<b>High</b> Need information now to plan for the future	<b>High</b> Reason to believe that emergency management agencies would implement resourcing changes		Enhanced resourcing of emergency management sectors will assist with non-climate emergencies / disasters		<b>Very High-High</b>
<b>4.3.2.</b> What is the role of the private sector in adaptation	<b>High</b> The private sector owns significant	<b>High</b>	<b>High</b> Significant scope for enhanced engagement with				<b>High</b>

through emergency management?	critical infrastructure and is a 'missing link' in disaster preparedness, response and recovery		private sector				
<b>4.4 Regional implications</b>							
<b>4.4.1.</b> How will climate change affect the capacity of emergency management systems in Australia and the Pacific region to interact for mutual benefit and support? How can these systems best support adaptation?	<b>Moderate</b> But increasing with time	<b>Medium</b> Not immediately a large-scale problem, but there is the possibility that equipment might become unavailable at very short notice	<b>Medium</b> Need to change in the case of off-season agreements, but it is not clear what they should be, given resource limitations. There is less certainty about engagement with our region – but it is likely that it should be much broader to foster local resilience.	Addressing these regional implications should help lift resilience for all types of crises.  Potential for solutions in this area to assist regional neighbours – cross-sectoral developmental benefits.		No specific equity issues	<b>Medium</b>

## 9 APPENDIX 3: CURRENT NCCARF (ARGP) RESEARCH PROJECTS FOR EMERGENCY MANAGEMENT

The following table summarises the ARGP- funded research projects that are focussed on the priority research questions identified in the original Emergency Management NARP.

Project Title	Lead Organisation	Lead Investigator
EM09 01 - A spatial vulnerability analysis of urban populations to extreme heat events in Australian capital cities	Monash University	Margaret Loughnan EM09 01
This study will; identify threshold weather conditions for mortality in Australian capital cities; describe spatial distributions of human vulnerability to extreme heat, and provide information to target emergency responses during heat waves. Baseline risk will be used to predict changes in vulnerability in relation to predicted changes in climate extremes associated with climate change.		
EM09 02 - Recovery from disaster experience: its effect on perceptions of climate change risk and on adaptive behaviours to prevent, prepare, and respond to future climate contingencies	James Cook University	Helen Boon EM09 02
The aims of this project are to Identify private and public sector groups' beliefs, behaviours and policies that have supported community resilience to a disaster event and construct a model with findings to help implement appropriate and equitable emergency management policies and mitigation strategies for climate change events.		
EM09 03 - Agent based simulation framework for improved understanding and enhancement of community and organisational resilience to extreme events	RMIT University	Lin Padgham EM09 03
The aims of this project are to develop a modular agent based simulation platform that allows emergency management stakeholders to explore complex multi-scalar, multi-actor, emergency management interactions under uncertain future conditions, in order to promote more effective governance arrangements. The platform is also intended to be a long term decision support tool suitable for the development of agent based simulations which address a range of extreme events, such as coastal flooding, heat stress, etc.		

Project Title	Lead Organisation	Lead Investigator
EM09 04 - Harnessing private sector logistics for emergency food and water supplies in flood prone areas	Australian National University	Leo Dobes EM09 04
<p>Based on the expectation of increased frequency and/or intensity of cyclonic events due to climate change, carry out a nationally-applicable scoping study using the Cairns community to: Estimate the economic benefits of continuity of supply of water and fresh food to isolated communities; Based on the stated alimentary preferences of residents, estimate the additional economic costs of supplying water and food using conventional public sector Emergency Services; and harnessing potential private sector logistical arrangements as an alternative; and to Compare the relative efficiency of public and private sector arrangements, and estimate any additional government subsidies justified by cost-benefit analysis.</p>		
EM09 05 - Public understandings, risk perceptions, and responses to climate change and associated natural disasters	Griffith University	Joseph Reser EM09 05
<p>This project aims to: examine public understandings, risk perceptions, concerns, and adaptations to climate change and natural disasters in Australia, as part of an international collaboration invitation and a national database initiative; To identify ways in which public understandings and responses to the threat and impacts of climate change differ across population sub-groups defined in terms of gender, age, urban/peri-urban/rural residence, and other demographic considerations; To examine the extent to which public understandings of climate change and perceived current and future impacts for Australia include natural disaster events and increased intensity and magnitude of such events and their impacts; To examine the relative salience and importance of climate change and natural disasters as interrelated risk domains vis-a-vis other risk domains and areas of public concern; To examine the extent to which natural disasters that have taken place in Australia over the past decade are understood as reflecting the unfolding impacts of climate change; To examine the extent to which risk perceptions and responses alter with systematically varied item framings relating to temporal (present, near future, far future) and spatial 'distance'; To examine the extent to which direct personal experience with events perceived to be associated with the impacts of climate change mediates or otherwise influences risk perceptions, understandings and adaptation responses; and To provide a baseline from which the nature, direction, and extent of changes in these community risk perceptions, understandings, and adaptation responses over time can be examined and documented.</p>		
EM09 06 - Adaptation of the built environment to climate change induced increased intensity of natural hazards	James Cook University	David King EM09 06
<p>This project will examine the likely impacts on the built environment of increased intensities in weather-related natural hazard events, and will identify the possibilities for the adaptation of regulatory mechanisms in building construction, housing and planning. An analysis of the impacts of climate change on the built environment, and a review of the existing regulatory mechanisms and their effectiveness, will be followed by further modelling of industry best practices and policy recommendations that provide for improved emergency management preparations and response capabilities across a wide range of agencies and organisations.</p>		

Project Title	Lead Organisation	Lead Investigator
EM11 01 - Changing Perceptions about Climate Change	Griffith University	Joseph Reser EM11 01
<p>The research addresses those diverse psychological considerations posed by climate change. How is the Australian public perceiving and understanding the threat of climate change? How are they appraising and responding to what seem to be dire media coverage and risk communications of likely consequences? How do these responses differ from or align with public response to natural disaster and extreme weather threats and events? How do cognitive and emotional responses to the threat of climate change influence and mediate adaptation responses? Importantly, how are these psychological responses and adaptations to the intertwined threats of climate change and natural disasters changing over time, and what psychological impacts and costs are associated with these adaptations and changes? How can a better understanding of these psychological processes and impacts better inform current policies and decision making by local, state, and federal government bodies and agencies and NGO's in enhancing the adaptive capacity and resilience of individuals and communities? Recent research clearly documents high levels of public concern and the complex and often conflicted nature of public understandings and motivations with respect to climate change. How can these psychological considerations and impacts and psychological adaptation avenues and needs be best addressed in terms of policies and risk communication strategies?</p>		
EM11 02 - The Right Tool for the Job: Achieving climate change adaptation outcomes through improved disaster management policies, planning and risk management strategies	Griffith University	Michael Howes EM11 02
<p>Australia is highly susceptible to climate change through impacts such as more frequent and/or intense floods and bushfires. There is considerable uncertainty about when and how disaster management organisations should address climate change adaptation and the appropriate level of priority that should be granted compared to other problems. Effective government responses have been hamstrung by a growing antipathy from the general public and government uncertainty on the most effective approach to both climate change and natural disaster management. It seems that the best available science and extensive public consultations have not been sufficient to produce consensus on the best way forward. This project addresses the problem by creating a new nationally consistent approach with a supporting set of risk assessment tools to identify potential conflict, improve stakeholder engagement, and integrate climate change adaptation into disaster management. These tools are derived from a comparison of several case studies: the 2010-11 Queensland floods; the 2009 Victorian bushfires; the 2011 Perth hills bushfires; and, the preparation of state-wide risk profiles. The research will improve policymaking, planning and emergency risk management by decision-makers at all levels of government.</p>		

Project Title	Lead Organisation	Lead Investigator
EM11 03 - Developing an Excel spread sheet tool for local governments to compare and prioritise investment in climate adaptation	Macquarie University	Stefan Trueck EM11 03
<p>Adaptation decision-making is a challenging task due to the complex web of uncertainties surrounding the future. Currently, decision-makers such as e.g. local governments depend on extensive research consultations to decide on adaptation investments. This renders them ignorant about the hidden uncertainties and assumptions behind the research results. It is dangerous to take decisions based on average values which do not reflect worst-case scenarios. It is also challenging for researchers to communicate this to end-users especially when extreme events or catastrophic risks have to be analysed and possible options need to be evaluated. The proposed project aims to educate stakeholders by creating a tool which will demonstrate the influence of various parameters on the investments they make. Users will be able to enter details regarding extreme events and the tool will visually show relevant charts and graphs that can enhance optimal decisions. Policy makers will benefit from understanding that adaptation decisions have to be made under uncertainty and moreover they will be familiarised with a set of tools that can deal with this uncertainty. The tool has particular use to local governments, but can also be used to understand the impact of extreme events on sectors such as health, agriculture and the insurance industry.</p>		
EM11 04 - Understanding the Pacific's adaptive capacity to emergencies in the context of climate change	University of Technology, Sydney	Juliet Willetts EM11 04
<p>Our Pacific neighbours are increasingly at the mercy of emergency and disaster situations due to climate change. This project will assess Australia's current emergency response systems, the Pacific Islands' current systems and their future needs in order to enable better preparedness in the event of disaster. This project aims to gather in-depth information from experts in the Pacific across four sectors: healthcare; food and nutrition; water and sanitation and psychosocial needs of populations. Two leading Centres at the University of Technology of Sydney will partner with Pacific island country representatives in carrying out this project: The Institute for Sustainable Futures is a leading research institute that creates change towards sustainable futures by focusing on innovation and conducting independent project based research for Australian and international clients. ISF works on projects across a range of research areas which foster lasting change. ISF aims to build independent capacity in their clients by passing on knowledge and skills. The World Health Organization Collaborating Centre at the Faculty of Nursing Midwifery and Health works to improve health, workforce, policy and service delivery throughout Asia/Pacific. Its key areas include leadership capacity development, innovative approaches to education, human resources for health policy, health workforce research and advice, non-communicable diseases and primary health care provision.</p>		

Project Title	Lead Organisation	Lead Investigator
EM11 05 - Exploring the adaptive capacity of emergency management using agent-based modelling	RMIT University	Lin Padgham EM11 05
<p>Much has been said on the impacts of the climate change. However, reports and analysis mainly focuses on scientific and mathematical approaches, offering a series of simulations and facts on changing climate implications for the environment. Less is known about how societies, organisations and individuals are responding or might respond to the challenges of climate changes. It is unclear how well local communities understand climate risk and if they are able to modify various assumptions, such as how long individuals take to react to warning messages, what proportion of people will follow instructions, etc. Agent-based modelling brings together both aspects - social science research and technical computing. Capabilities - to provide more powerful insights and greater ability to constructively contribute to our adaptive capacity. It offers systematically exploration of a wide range of potential future scenarios at a scale that is not possible without computer support. It provides the opportunity for a wide variety of stakeholders to work together with the community using a practical tool to determine solutions to evolving changing climate impacts.</p>		

## 10 APPENDIX 4

### Glossary of Acronyms

AEMVF Australian Emergency Management Volunteers Forum  
AFAC Australian Fire Authorities Council  
AJEM Australian Journal of Emergency Management  
APEC Australian Pacific Economic Cooperation  
ARN Australian Research Network (NCCARF)  
AusDIN Australian Disaster Information Network  
CAWCR Centre for Australian Weather and Climate Research  
COAG Council of Australian Governments  
CSIRO Commonwealth Scientific & Industrial Research Organisation  
DRM Disaster Risk Management  
ECA Economics of Climate Adaptation  
EMA Emergency Management Australia  
EMQ Emergency Management Queensland  
ICA Insurance Council of Australia  
ICT Information & Communication Technologies  
IFRC International Federation of Red Cross and Red Crescent Societies  
IPCC Intergovernmental Panel on Climate Change  
IP's Implementation Plans  
JCU James Cook University  
NARP National Adaptation Research Plan  
NCCARF National Climate Change Research Facility  
NEMC National Emergency Management Committee  
NRAAG National Risk Assessment Framework and Guidelines  
PPRR Preparedness Prevention Response Recovery  
UNISDR United Nations International Strategy for Disaster Risk Reduction  
VCCCAR Victorian Centre for Climate Change Adaptation Research

### **Australian Emergency Management Glossary (EMA):**

<http://www.ema.gov.au/www/emaweb/emaweb.nsf/Page/RWPC01BDEA47E52744ACA25750B00053C0B#ReferenceSeries>

### **United Nations International Strategy for Disaster Risk Reduction Terminology:**

<http://www.unisdr.org/we/inform/terminology>



## Glossary of Terms

Term	Meaning (from <a href="http://www.ipcc.ch/pdf/glossary/ar4-wg2.pdf">http://www.ipcc.ch/pdf/glossary/ar4-wg2.pdf</a> )
Climate	Climate in a narrow sense is usually defined as the 'average weather', or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years.
Extreme	An extreme weather event is an event that is rare at a particular place and time of year.
Rare	Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of the observed probability density function
Vulnerability	Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.



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