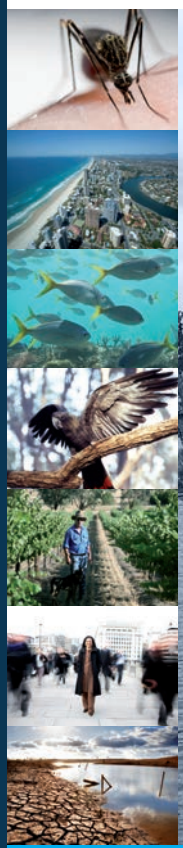
Update 2012

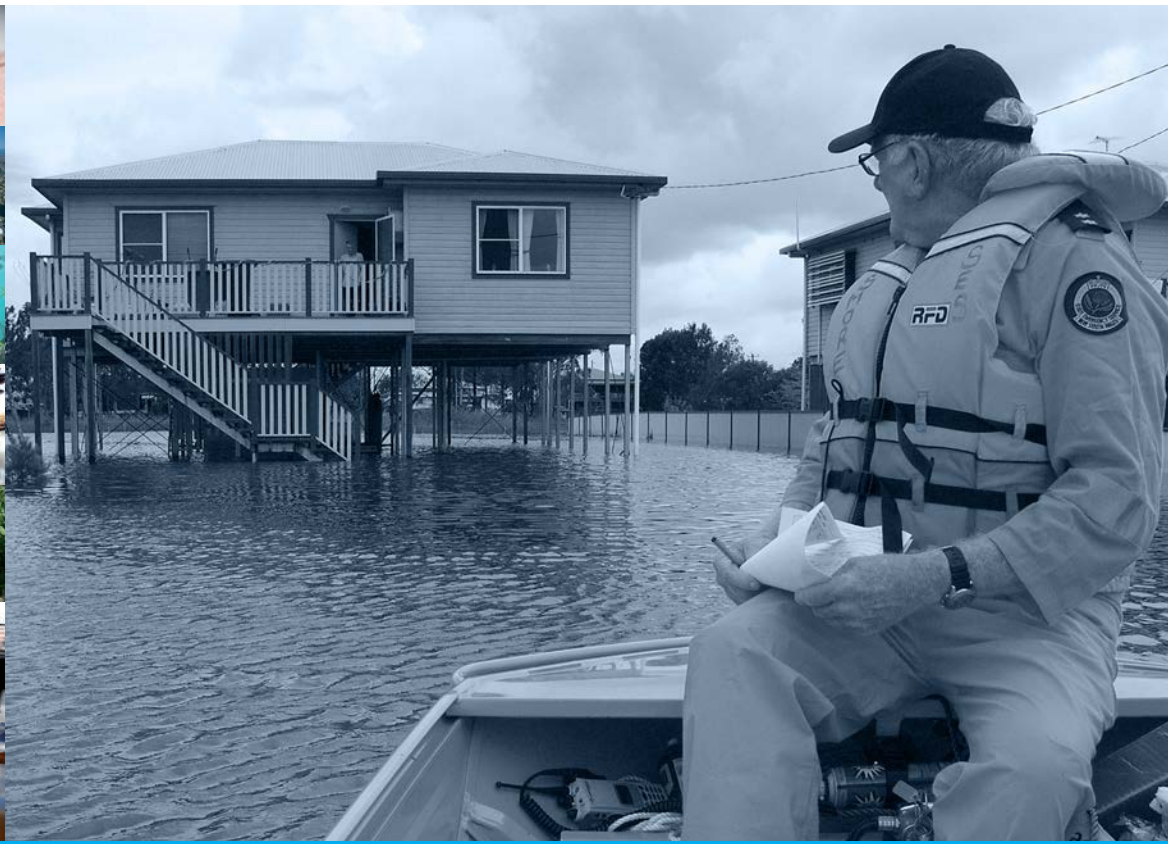
NCCARF
National
Climate Change Adaptation
Research Facility

National Climate Change
Adaptation Research Plan

Emergency Management

Update 2012





ISBN: 978-1-921609-52-7

NCCARF Publication 15/12

Published by the National Climate Change Adaptation Research Facility
Email nccarf@griffi th.edu.au
Website www.nccarf.edu.au

Please cite this report as:
Handmer J, McKellar R, McLennan B, Whittaker J, Towers B, Duggie J, Woolf M, 2012, *National Climate Change Adaptation Research Plan: Emergency Management – Update 2012*, National Climate Change Adaptation Research Facility, Gold Coast, 34pp.

Acknowledgement
The National Climate Change Adaptation Research Facility hosted by Griffith University is an initiative of, and funded by, the Australian Government, with additional funding from the Queensland Government, Griffith University, Macquarie University, Queensland University of Technology, James Cook University, The University of Newcastle, Murdoch University, University of Southern Queensland, and University of The Sunshine Coast.
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.

National Climate Change Adaptation Research Plan:

Emergency Management - Update 2012

Authors:

John Handmer (RMIT University - Chair)
Richard McKellar (NCCARF)
Blythe McLennan (RMIT University)
Joshua Whittaker (RMIT University)
Briony Towers (RMIT University)
James Duggie (Department of Environment and Conservation, WA)
Martine Woolf (Geoscience Australia)

Secretariat
Ida Fellegara (NCCARF)
Frank Stadler (NCCARF)
David George (NCCARF)

February 2012

NCCARF
National
Climate Change Adaptation
Research Facility

TABLE OF CONTENTS

EXECUTIVE SUMMARY

National Climate Change Adaptation Research Plan:

Emergency Management:

Update: February 2012

The National Climate Change Adaptation Research Plan (NARP) for Emergency Management (Pearce *et al*. 2010), an initiative of the National Climate Change Adaptation Research Facility (NCCARF), was produced to identify key climate change adaptation research priorities for emergency management. The NARP for Emergency Management (Emergency Management NARP) has been revisited and its research priorities have been updated to ensure currency and to provide guidance for research investment over the next five years.

Updated research priorities are identified based on:

- Changes to stakeholder needs since the Emergency Management NARP was completed in 2009;
- Relevant research published since the Emergency Management NARP was completed; and
- Areas of current and new research focus in relation to the Emergency Management NARP.

Stakeholder information needs have not changed significantly. However, stakeholder awareness and needs have become more clearly stated or relatively more important as a result of a series of weather-derived emergencies that have occurred since 2009. Several significant inquiries have been held and reported in relation to these emergencies. In addition, the National Strategy for Disaster Resilience was adopted by COAG in February 2011, setting a national context for adapting to increased risks from climate change.

Climate change adaptation for emergency management is a rapidly expanding research area. Handmer *et al*. (2011) reviewed over 119 research articles and other publications in the last few years since the original Emergency Management NARP was completed. The update of the Emergency Management NARP used Handmer *et al*. (2011) extensively.

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 research will also generate information and insights relevant to decision-making about climate change adaptation and emergency management. For example, several projects under NCCARF's Social, Economic and Institutional Dimension theme and in NCCARF's Synthesis and Research Program are concerned with decision-making, uncertainty and other topics that will be pertinent to emergency management. 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 within two to three years.

The conclusion of this revisit and update is that most existing Emergency Management NARP priority research questions should be retained. However, the prioritisation of several should be changed and two priority research questions should be revised.

These 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 in priority from 'Medium' and 'High-Medium' priority respectively, to 'Very 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 restated, 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?

An updated table of high priority research questions is provided in Section 6 of this report, and an updated research prioritisation table is provided in Appendix 2 of this report.

The changes to research priorities and their prioritisation that have been identified in this report have been encapsulated in the updated Emergency Management NARP (2012) (Handmer et al. 2012)).

1 INTRODUCTION

The National Climate Change Adaptation Research Plan (NARP) for Emergency Management (Pearce *et al*. 2009), an initiative the National Climate Change Adaptation Research Facility (NCCARF), was produced to identify key climate change adaptation research priorities for emergency management. The NARP for Emergency Management (Emergency Management NARP) has been revisited and its research priorities updated in 2012 to ensure it is able to provide guidance for research investment over the next five years.

The revisit and update is informed by a comprehensive review of the literature which has appeared since December 2008 when the Emergency Management NARP was originally drafted (Handmer *et al*. 2011) and a summary of current NCCARF research addressing research priorities identified in the Emergency Management NARP (Appendix 3). Information about priority needs of emergency management stakeholders was gained from a survey of the Emergency Management Adaptation Research Network and from key stakeholders. Other reports have also contributed to this update, including the recent IPCC publication, *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (the SREX Report)* (IPCC 2012). Further stakeholder input to the revisit and update of the NARP was secured through seeking comment on a draft updated NARP from 70 key stakeholders.

The revisited and updated NARP and this Update report identify updated research priorities, based on:

- changes to stakeholder needs since the Emergency Management NARP was completed;
- relevant research published since the Emergency Management NARP was completed; and
- areas of current research focus in relation to the Emergency Management NARP.

A discussion of each research priority and any updates to them are set out in Section 4 of this report.

An updated table of priority research questions resulting from this revisit is provided in Section 6 of this report, and an updated research prioritisation table is provided in Appendix 2 of this report.

Considerable research is now being undertaken about climate change impacts, adaptation and emergency management. Eleven projects have been funded from Adaptation Research Grants Program (ARGP) funding to address research priorities identified in the Emergency Management NARP. These are listed in Table 1.Research being undertaken in fields other than emergency management will also generate information and insights relevant to decision-making about climate change adaptation and emergency management. For example, several projects under NCCARF's Social, Economic and Institutional Dimension theme and in NCCARF's Synthesis and Integrative Research Program are concerned with decision-making, uncertainty and other topics that will be pertinent to emergency management. All of the research NCCARF manages will be completed and reported by mid-2013.

2 MAJOR CHANGES TO STAKEHOLDER INFORMATION NEEDS SINCE 2009

Recent climate related natural disasters afflicting many parts of Australia, include the 2009 heat waves in southern Australia, prolonged droughts across much of south-eastern Australia in the first decade of this century, the 2009 Black Saturday Bushfires in Victoria and the 2010/11 Queensland floods. These 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 have thus become more interested in understanding climate related disasters, their risk to society and potential adaptation strategies. Specific changes to stakeholder needs are included in Section 4 (below).

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

HEATWAVES 2009: A severe heatwave 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. The events of the January 2009 heatwave in Victoria resulted in an estimated 374 premature deaths compared with the same period over the previous five years and serve as a reminder that the impact of heatwaves on human health is real and life-threatening. On 7 February, strong, dry north-westerly winds fanned bushfires which claimed 173 lives, mostly in areas northeast of Melbourne.

FLOODS SEPTEMBER 2010: 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.

CYCLONE 2011: 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 m tidal surge was observed at Cardwell, which was 2.3 m 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.

FLOODS DECEMBER 2010 – JANUARY 2011: 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%of the state (an area bigger than France and G ermany combined) was declared a di saster zone. T hese 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 m 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 120 0 houses were flooded to some degree and approximately 95% 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.

Sources:

Bureau of Meteorology Annual Climate Summary 2009 (2010);

Bureau of Meteorology Annual Climate Summary 2010 (2011);

Bureau of Meteorology Severe Tropical Cyclone Yasi (2011);

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 - extracted 26 January 2012.;*

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

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

3 MAJOR RESEARCH FINDINGS SINCE 2009

Research published since the Emergency Management NARP was completed has been reviewed by Handmer *et al*. (2011). This report reviewed and summarised over 119 relevant research publications published between 2009 and 2012. The report was structured to clarify the research published in relation to the research priorities of the Emergency Management NARP. Key findings from Handmer *et al*. (2011) have been included in Section 4 (below), with representative references. See Handmer *et al*. (2011) for a full review of publications.

4 UPDATED INFORMATION FOR SECTION 4 OF THE EMERGENCY MANAGEMENT NARP

This section summarises information that has become available since the Emergency Management NARP was completed and outlines the consequences for research prioritisation. The information in this section is primarily taken from Handmer *et al*. (2011), and from comments on the draft updated Emergency Management NARP that was circulated to key stakeholders for comment.

All research questions listed in a NARP are important questions that merit research support. The NARP prioritises these using a set of six objective criteria:

1. Severity of potential impact to be avoided or degree of potential benefit to be derived (essential);
2. Immediacy of required intervention or response (essential);
3. Need to change current intervention and practicality of alternative intervention (essential);
4. Potential for co-benefit (desirable);
5. Cross-sectoral relevance (desirable);
6. Equity considerations (desirable).

As a result of the information and analysis in this section, the priority of some research questions has been changed (e.g. from 'High' to 'Medium') indicating a change in the relative importance of a research question from a national perspective. However, the relative prioritisation between research questions may differ between regions, stakeholders or research investors, a matter that is not considered here.

Section 4 of the Emergency Management NARP is structured into four emergency management sector themes (understanding risk, community and organisational resilience, adaptive strategies, and regional implications).

NARP Section 4.1 Understanding Risk: Priority research questions

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

The IPCC's SREX Report includes a detailed examination of likely regional changes for different climate and weather events (IPCC 2012). The report suggests a very likely increase in heat wave episodes over land surfaces, fewer days of frost and more heavy precipitation events. The global trends for drought duration are less consistent between models and downscaling methodologies, due to their regional variability, and changes of wind-related extremes are also regionally dependent, and associated with a poleward displacement of the mid-latitude storm tracks.

State of the Climate 2012 (Australian Government 2012) provides an updated summary of long-term climate trends in Australia. It notes that the rate of very hot (greater than 40°C) daytime temperatures has been increasing since the 1990s and the frequency of extreme (record) hot days has been more than double the frequency of extreme cold days during the past ten years. The report also noted that Southwest Western Australia had experienced its lowest rainfall on record in 2010 while record high rainfall was experienced in 2010 and 2011 in southeast Australia.

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). One current ARGP research projects is concerned with this research question (EM09 01; see Appendix 3). Handmer *et al*. (2011) noted that the gap in knowledge about the specifics of changes in location and likelihood (or frequency) of extremes remains but increasingly sophisticated modelling is helping to reduce it.

- SUMMARY - This issue is important but, in the short term, adaptation investments will need to occur within the context of uncertainty.

Update outcome: Retain Priority research question 1.1 unchanged, but reduce its priority from 'High' to 'Medium' in view of ongoing high levels of climate science investment.

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

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);
- Modelling the impacts of climate change on coastal areas (Sinclair 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); and,
- Gold Coast City Council flood emergency decision support system (Mirfenderesk 2009).

Two current ARGP research projects are concerned with this research question (EM11 02, EM11 03; see Appendix 3).

- SUMMARY - While considerable research effort has been applied to this topic, it requires further investment.

Update outcome: Retain Priority research question 1.2 unchanged and maintain its 'Medium' priority.

NARP Section 4.2 Community and Organisational Resilience: Priority research questions

2.1 What does community resilience mean in a changing climate?

The concept of resilience has become increasingly used in fire and emergency management, as illustrated by state committees or round tables on the subject, the ICA policy on resilience, the surge in research programs and groups claiming expertise in the area, and the release of the National Strategy for Disaster Resilience (COAG, 2011).

Are there particular features of a 'climate-resilient community'?

In 2010 NCARF produced seven historical case studies that examined the impacts of and responses to extreme climatic events:

- Cyclone Tracy which destroyed Darwin on Christmas Day, 1974 (Mason and Haynes 2010);
- Drought in two rural communities (Kiem et al. 2010a);
- The February 2009 heatwave in Melbourne and Adelaide (QUT 2010);
- The 2008 Queensland floods (Apan et al. 2010);

- Storm tides, coastal erosion and inundation at the Gold Coast, Byron Bay and Collaroy-Narabeen (Hellman et al. 2010); and,
- The Pasha Bulker storm that struck Newcastle in June 2007 (Verdon-Kidd et al. 2010).

In a synthesis report of the case studies, Kiem et al. (2010b) propose that a resilient community is likely to be:

i. Convinced about the reality for action;
ii. Informed about what is likely to happen and realistic about the uncertainties;
iii. Prepared to respond to climate change;
iv. Responsive to new knowledge about risks for climate change and the potential for response;
v. Connected to, knowledgeable about and supportive of its vulnerable members; and
vi. Flexible and willing to take on board new practices, even transformational changes.

Other recent research concerned with key features of a 'resilient community' includes:

- The disaster resilience of place (DROP) model, with variables such as ecological, social, economic, institutional, infrastructure, and community competence (Cutter et al. 2010);
- Case studies about bushfires in south-east Gippsland (Whittaker 2008), Canberra bushfires (Pooley et al. 2010) and flooding in Queensland (Keogh et al. 2011);
- A preliminary assessment of the vulnerability of Australian rural communities (Nelson et al. 2010a, 2010b); and,
- Characteristics of disaster-resilient communities (Twigg 2009).

Conclusion: This topic appears to be relatively well researched.

Does resilience and adaptive capacity depend on the hazard to which people are exposed? Is it 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?

The relative impacts of exposure and natural hazard intensity/frequency on community resilience have been modelled (Crompton and McAneney 2008; Crompton et al. 2010). Crompton et al. (2010, 2011) contend that exposure has a greater impact on disaster losses than hazard frequency or intensity. However, Nicholls (2011) argued that increased damages resulting from more frequent and intense fires might be offset by a decrease in vulnerability.

Conclusion: This topic appears to have received limited research attention.

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 (by bringing communities closer to the 'tipping point')?

An expanding body of literature has focussed on identifying tipping points within ecological systems (c.f. Scheffer et al., 2009) but there is a lack of empirical research examining the role of climate change in bringing communities closer to their tipping points. Renaud et al. (2010) and the Resilience Alliance (2009) contend that tipping points in social systems are difficult to determine even when a demonstrated shift has occurred. Even researchers on large-scale physical systems have questioned whether critical tipping points can be identified before they are reached (Lenton et al. 2008). Nevertheless Renaud et al. (2010) argue that decision makers need to anticipate community tipping points *before* they occur.

Conclusion: The question of tipping points as posed in the orginal NARP remains important.

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?

Research has sought to evaluate the efficacy of various hazard awareness and preparedness strategies in a range of different communities and groups including women (Eriksen et al. 2010; Proudley 2008), children (Dufty 2009; Ronan et al. 2010; Finnis et al. 2010; Towers 2011),

indigenous groups (Becker et al. 2008; Mercer et al. 2009), and people of low socio-economic status (Ojero et al. 2010). However, no research has been found in relation to the elderly, the disabled, and non-English speaking communities in Australia.

Research findings highlight the way in which specific groups can be marginalised from emergency management practices and processes, and demonstrate the tangible benefits that including these groups has for building resilient communities. This being the case, more research with these groups is needed.

Conclusion: More research on vulnerable groups is required.

Two current ARGP research projects are concerned with this research question (EM09 02; EM 09 06; see Appendix 3).

- SUMMARY - Handmer et al. (2011) report a growing interest and focus on resilience in relation to emergency management generally, including about climate change induced risk and impacts.

Update outcome: Retain Priority research question 2.1 unchanged but increase its priority from 'Medium' to 'High' in view of the increased focus on this approach in emergency management planning and investment.

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

Several key research issues are identified in the NARP discussion of this priority research topic; the assessment is structured in terms of these research issues.

In order to define what preparedness for climate change risk might mean, research needs to ascertain how unprepared people are for a range of climate-related hazards.

The general finding to emerge from recent research is that levels of physical preparedness for climate related hazards (e.g. fire, flood, storm), are low:

- Few households are prepared for natural disaster, nearly 20% had a least one member who would have difficulty evacuating in an emergency; nearly 30% lacked stored drinking water and 70% lacked sufficient food for seven days (Nicolopoulos and Hansen 2009);
- Eriksen et al. (2010) found that only 43% of survey respondents among rural landholders in south-eastern NSW had prepared a bushfire action plan and most people with a plan had not written their plans or discussed them with other family members;
- Prior and Paton (2008) reported that residents affected by a bushfire on the east coast of Tasmania undertook preparations only after a fire warning had been received;
- Whittaker and Handmer (2010) reported that whilst two thirds of residents affected by the Black Saturday bushfires reported having a bushfire plan, these plans varied substantially in their quality and usefulness for fire preparedness. Many respondents living in more suburban areas had done nothing to prepare as they did not consider themselves to be at risk.

Reviews have highlighted the importance of psychological preparedness for climate-related hazards (Clode 2009; Reser and Morrissey 2009), but hazard knowledge and risk perceptions do not necessarily correlate with levels of physical preparedness (Sims and Baumann 1983; Solberg et al. 2010; Whittaker and Handmer 2010; Eriksen et al. 2010).

Conclusion: This issue appears to be relatively well researched.

What is the level of understanding and acceptance of climate change and its implications for natural hazards?

Since 2008, a substantial amount of research has investigated levels of public understanding and acceptance of climate change (Brody et al. 2008; Kellstedt et al. 2008; Semenza et al. 2008; Weber and Stern 2011; Wardekker et al. 2009; Whitmarsh 2008). However, only one Australian/British

study has examined the public's understanding of the interrelationships between climate change and natural hazards or disasters (Reser et al. 2011). This study found that public understanding and concern about climate change were often related to extreme weather events.

Conclusion: This issue appears to require further research.

How are climate change and increased hazard risk portrayed? How is the general hazard risk portrayed? How are leadership attitudes portrayed in the media, literature and public policy?

Several recent US and UK studies have shown that climate change coverage in the media has perpetrated an informational bias by significantly diverging from the consensus view in climate science that humans contribute to climate change (Anderson 2009; Boykoff 2008a, 2008b; Boykoff and Smith 2010; Doulton 2009; Hulme 2009; Nibett 2009). However, recent research investigating the portrayal in the Australian media of climate change and its implications for increased hazard risk is lacking. An extensive literature search also failed to locate recent research examining the portrayal of leadership attitudes in the media, literature and public policy.

Conclusion: This issue appears to require further research.

What are the most appropriate trigger points for the commencement of the dissemination of emergency warnings and information to the community about potential climate change impacts?

Whilst there is an extensive literature on the dissemination of warnings for hazard events, no research addressing warnings about potential climate change impacts could be located.

Conclusion: This issue appears to require further research.

What is the ability for existing warning system coverage to be expanded and what infrastructure and technology will be required to permit expansion?

No research could be located on this topic.

Conclusion: This issue appears to require further research.

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).

- SUMMARY - This issue is becoming more important to stakeholders, but has so far received relatively limited research input or investment. As noted in the text for Priority research question 2.1 (above), the concept of resilience is increasingly used in emergency management policies, strategies and processes in Australia.

Update outcome: Revise Priority research question 2.2 as set out below to reflect the increased focus on resilience and the importance of processes and increase its priority from 'High - Medium' to 'Very High'.

Priority research question 2.2 as restated:

> ***2.2 What behaviours and processes promote community preventive strategies and resilience in a changing climate?***

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?

Several options are relevant to this priority research topic; the assessment is structured in terms of these options – community education, financial incentives, land-use regulation and coordinating organisational roles.

Community education

Recent research has identified several practices and processes that promote community preparedness and preventive strategies.

- A combination of top-down and bottom-up approaches (Lowe et al. 2008);
- Coupling mass communication techniques with community engagement (Prior and Paton 2008);
- A four-component model of flood education (Dufty 2009);
- Four causal processes that effectively promote the adoption of preparedness and preventive strategies (Elsworth et al. 2009);
- The value of participation in Community Fireguard CF groups to enhance preparedness and prevention (Clode 2009);
- How pre-existing local knowledge influences the uptake of risk messages for bushfire hazards (Eriksen and Prior 2010);
- Neighbourhood level wildfire mitigation programs in Canada (FireSmart-ForestWise), Australia (Community Fireguard) and the US (Firewise Communities) for building community resilience and relationships between residents and government agencies (McGee 2011) and,
- A nationally accredited course that helps to develop climate risk management strategies (George et al. 2007).

Financial incentives

Tooth and Barker (2007) reported that approximately 23% of Australian households do not have a building or contents insurance policy. Sullivan (2008) recommended removing taxes on insurance premiums, citing a report by Tooth and Barker (2007) that removing all NSW insurance premium taxes would result in an additional 150,000 households taking out home and contents insurance.

Land use regulation

Land use regulation is a key emergency management mechanism in a changing climate (Buxton et al. 2011; Norman 2008). Buxton et al. (2011) draws attention of the use by the Victorian Civil and Administrative Tribunal of the precautionary principle (O'Riordan and Cameron 1994) to prevent dwelling construction in an 'inappropriate' location. Norman (2008) proposed a set of principles including: regional planning, policy integration, financial incentives, and innovative regulatory mechanisms. As land use regulation is a future-oriented strategy it is little use where settlement has already taken place, and needs to be complemented with informal approaches that facilitate adaptation at the household level (Birkmann 2010).

Policies and processes that enhance information flows through public and private organisations

Pelling et al. (2008) identified social learning and institutional aspects of multilevel environmental governance in the flow of information and knowledge about climate change adaptation. Bosomworth (2011) identified the critical role of both formal and informal social relationships in enhancing or restricting the flow of information within and between emergency management organisations in the context of changing climate.

Clarity and coordination of organisational roles and responsibilities

Australian and international research has addressed organisational functioning in emergency situations, such as command and control networks on Black Saturday, collaborative emergency management activities and leadership strategies in the United States (Waugh and Streib 2006) and an operational emergency management framework for resilience in the United States (Kahan et al. 2009).

Several current ARGP research projects are concerned with this research question (EM09 02, EM09 04, EM09 05, EM09 06, EM11 01, EM11 02, EM11 03, EM11 05; see Appendix 3).

- SUMMARY - Further work is required in Australia to identify effective risk management strategies for climate changes impacts.

Update outcome: Retain Priority research question 2.3 unchanged and maintain its 'Very High – High' priority.

NARP Section 4.3 Adaptive strategies: Priority research questions

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

Considerable research in this area has focused on volunteers, given their large role in the Australian emergency management sector (Howard 2009). Studies have examined motivations for volunteering (McLennan 2008), stress and pressure experienced by volunteers and their families (Cowlishaw et al. 2010; Cowlishaw et al. 2008), and challenges and approaches for retaining volunteers (Baxter-Tomkins and Wallace 2009; Parkin 2008).

While very little research has directly examined the resourcing mix needed by the sector to adapt and respond to climate change, resourcing needs are considered in several studies. These include resourcing to support volunteers, providing critical infrastructure and resourcing through public-private partnerships, and decision-making tools that can support planning for future resource allocation.

No current ARGP research projects are concerned with this research question (see Appendix 3).

- SUMMARY - Understanding and maintaining the emergency management sector's capacity to respond effectively to climate change remains a high priority.

Update outcome: Retain Priority research question 2.3 unchanged and maintain its 'Very High – High' priority.

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

The role of insurance in reducing disaster risk and thus advancing adaptation has been explored (Schwarze et al. 2010; Sullivan 2008; Warner et al. 2009) and recommendations made to strengthen the role of insurance for Australian disaster resilience (Mortimer *et al.* 2011). The role of public-private partnerships to support hazard mitigation and community resilience has been examined (; Committee on Private-Public Sector Collaboration to Enhance Community Disaster Resilience, 2010; Stewart et al. 2009; Tompkins and Hurlston 2010). Potential benefits for the private sector from reconstruction following extreme events may undermine incentives for risk reduction (Handmer 2008).

What will be the impacts of climate change on private enterprise?

Considerable international research examines the impacts of climate change on the insurance industry (Botzen et al. 2010; Sturm and Oh, 2010) and insurers (Maynard, 2008; Mills, 2007); and challenges for adapting insurance systems to climate change (Schwarze et al. 2011). Only one study investigates the Australia insurance industry's capacity to respond to climate change (Wilkins, 2010). However, insurance for other sectors has been examined, including agriculture (Crimp et al. 2008; Nelson 2009), viticulture (Webb et al. 2008), fisheries (Allison et al. 2009; Cochrane et al. 2009; Brander 2010; Jennings and Brander 2010), and tourism (Hernandez and Ryan 2011; Tulsi et al. 2011).

Two current ARGP research projects are concerned with this research question (EM09 04, EM11 02; see Appendix 3).

- SUMMARY - The absence of research on the role of the private sector in emergency management adaptation was noted in the original NARP. There has been some recent research but it is a relatively new area and there is a strong need for further research.

Update outcome: Retain Priority research question 3.2 unchanged and maintain its 'High' priority.

NARP Section 4.4 Regional implications: Priority research questions

4.1 How will the climate change adaptive capacity of other countries, particularly those in the Pacific region, impact upon the Australian emergency management system and Australian fire and emergency services?

The Australian government has initiated several relevant regional activities, including the APEC Emergency Management CEOs' Forum Outcome Report 2009; and an APEC Workshop on Public Private Partnerships and Disaster Resilience Report (January 2011). There are several issues within this research topic, as set out below.

What is the potential for climate change impacts affecting our near neighbours to produce flow-on effects for Australia?

While the vulnerability to climate change of Pacific Island countries and other small islands has been well established (Barnett 2001; Mimura et al. 2007; King and Smithers 2009) there is no evidence that this will have any direct flow-on effects for Australia. Mortreux and Barnett (2009) challenge the assumption that climate change will result in large-scale migration from Tuvalu.

Most climate driven migration in Pacific Island nations is internal (Locke 2009; Dupont et al. 2008). However, Dupont et al. (2008) advise that the effects of climate change will require increased efforts on cooperative regional solutions and Australian leadership.

What level of strain is 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?

Recent research on this topic focuses on the implications of climate change for regional security and stability (Dupont et al. 2008) rather than natural disasters or emergency management per se.

No research has been found on the potential strain that climate change could place on broader regional relationships, especially with California with whom there is an increasing exchange of personnel and equipment. This area continues to be a significant research gap.

How can Australian agencies enhance the capacity of nearby countries to deal with the increased challenges of climate change?

Whilst no research addressing this question directly could be located, several areas of research appear to be relevant to the issues raised, including constraints to regional cooperation and partnerships in the Asia Pacific (Hughes 2005) and the re-conceptualisation of governance in the Pacific Islands Forum's 'Pacific Plan' (Roberts et al. 2007).

There has been substantial recent research into the role of local and traditional knowledge in adaptation/resilience (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. Mercer et al. (2007, 2010) argue that by tapping into local and traditional knowledge Australia might enhance the capacity of its neighbours whilst avoiding many of the constraints on regionalism identified by Hughes (2005) and Roberts et al. (2007). The Pacific - Australia Climate Change Science and Adaptation Planning Program (PACCSAP) is part of the Australian Government's International Climate Change Adaptation Initiative (ICCAI) to meet high priority climate change adaptation needs in vulnerable countries in the Pacific and East Timor. The Bureau of Meteorology and CSIRO through their research partnership in the Centre for Australian Weather and Climate Research (CAWCR) are providing a collaborative research environment for implementing PACCSAP and in particular building capacity in partner country National Meteorological Services (Pacific Climate Change Science Program, 2012 http://www.cawcr.gov.au/projects/PCCSP/ - extracted 29 April 2012).

Should available resources become depleted due to the increasing frequency of concurrent climate-driven emergencies occurring here and overseas, what is Australia's capacity to manage without international assistance?

No recent research addressing this issue could be located.

One current ARGP research project is concerned with this research question (EM11 04; see Appendix 3).

- SUMMARY - This topic, as initially stated, was concerned with potential impacts on Australia resulting from climate change adaptive capacity of countries in the Pacific region. Under current understanding of the relevant issues, this research question would be better stated as a mutual issue, between Australia and other Pacific region countries.

Update outcome: Restate Priority research question 4.1 in terms of the mutual and shared nature of climate change impacts and responses for Pacific region countries and keep as a 'Medium' priority.

Priority research question 4.1 as restated:

> ***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?***

New proposed research priorities not included in the original NARP

Several research topics that were not included in the original Emergency Management NARP were identified by Handmer et al. (2011) and from consultation with stakeholders. This section outlines how those topics are to be addressed.

New Topic 1: Integrating disaster risk reduction and climate change adaptation

Connections and interactions between disaster risk reduction and climate change adaptation have been increasingly emphasised (AFAC 2011; Mercer 2010; Romieu et al. 2010; Schipper and Pelling 2006; Thomalla et al. 2006; IASC and ISDR 2008; ISDR 2011).

International research has examined ways to improve these links (Birkmann and von Teichman, 2010), but there has been limited policy and research attention to disaster risk reduction in Australia.

Context within NCCARF's research program: While this topic is not explicitly stated as a separate item in the Emergency Management theme and NARP, it is implicitly included in other themes, including Settlements and Infrastructure and Human Health. In addition, it would be encompassed by the Research Topics in Section 4.2 (Community and organisational resilience to disasters).

Update Outcome: This topic is already included in several research themes and questions and therefore does not need to be included as a new research question.

New Topic 2: Good governance mechanisms

"Good governance" refers to accountability, participation, predictability and transparency in disaster risk reduction (Ahrens and Rudolph 2006; Lewis and Mioch 2005), especially important for disaster management decision-making under conditions of uncertainty and complexity (Amendola et al. 2008). Research has included:

- Participatory approaches used in Japan (Bajek et al. 2008).
- Local level strategic planning (Prabhakar et al. 2009) and local government engagement (King 2008; Lewis and Mioch 2005).
- Local and indigenous knowledge (Ellemor 2005; Mercer et al. 2010; Veland et al. 2010).

Context within NCCARF's research program: Governance is specifically addressed in the Social Economic and Institutional Dimensions (SEID) theme, NARP and research program.

Update Outcome: This topic will be addressed through the SEID theme and therefore does not need to be included as a new research question.

New Topic 3: Decision-making in the context of complexity and uncertainty

Climate change generates great uncertainty and complexity for all themes, including emergency management planning and response. Projecting future risks, and developing decision support systems and vulnerability assessment tools have received considerable attention in the emergency management sector, such as:

- Storm tide modelling (Harper et al. 2009);
- Gold Coast City Council flood emergency decision support system (Mirfenderesk 2009);
- Modelling the impacts of climate change on coastal areas (Sinclair 2009);
- Bushfire evacuation modelling (Taylor and Freeman 2010);
- Bushfire vulnerability assessment (Preston et al. 2009); and,
- Vulnerability of rural communities (Nelson et al. 2010a, 2010b).

Context within NCCARF's research program: NCCARF has commissioned several studies concerned with uncertainty within the Adaptation Research Grants Program (ARGP) and the Synthesis and Integration Research Program.

Update Outcome: This topic is already being addressed within the NCCARF research portfolio and therefore does not need to be included as a new research question.

New Topic 4: Adaptation and emergency management in urban areas

Urban areas are at high risk from climate change impacts because they have high population and considerable infrastructure and they have key roles for regional or national economic, political and social processes (Birkmann et al. 2010). Significant impacts of climate change on urban areas are likely to be:

- Sea level rise on coastal cities (including the effects of storm surges);
- Extreme events on built infrastructure;
- Higher average temperatures and/or extreme events on human health;
- Energy use (heating and cooling, energy for pumping water); and
- Water availability and resources.

This topic has received considerable attention, including:

- Overview of impacts and adaptation strategies (Hunt and Watkiss 2011);
- Review of adaptation strategies for nine cities (Birkmann et al. 2010);
- Contribution of disaster risk reduction to urban adaptation (Solecki et al. 2011);
- Urban vulnerability in low income nations (Bicknell et al. 2009);
- Mapping urban vulnerability to enhance adaptation and mitigation (Rosenzweig et al. 2011);
- Governance for urban adaptation cities (Corfee-Morlot et al. 2009);
- Strategic and statutory planning for minimising impacts on urban areas (Garnaut 2011); and,
- Integrated assessment of urban impacts from climate change (Li et al. 2010).

Context within NCCARF's research program: NCCARF's Adaptation Research Networks for Settlements and Infrastructure and for Emergency Management have organised a joint workshop to explore this topic. The subject matter of this topic is encompassed in the NARPs for both themes.

Update Outcome: This topic is already being addressed within the NCCARF research portfolio and therefore does not need to be included as a new research question.

5 CHANGES TO THE RESEARCH TOPICS AND PRIORITIES

This update has resulted in changes to the Priority Research Questions of the Emergency Management NARP 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 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' and 'High-Medium' priority respectively, to 'Very 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 restated** 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?

An updated table of high priority research questions is provided in Section 6 of this report, and an updated research prioritisation table is provided in Appendix 2 of this report.

6 RESEARCH PRIORITIES FOR EMERGENCY MANAGEMENT (2012)

1. Understanding risk	
1.1 Where and how are changes in climate going to put us at greatest risk?	Medium
1.2 What tools are needed to enable decision-making under future climate uncertainty?	High
2. Community and organisational resilience to disasters	
2.1 What does community resilience mean in a changing climate?	Very High
2.2 What behaviours and processes promote community preventive strategies and resilience in a changing climate?	Very High
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?	Very High–High
3. Adaptive strategies	
3.1 How will climate change affect the emergency management sector's capacity to support preparedness, response and recovery?	Very High–High
3.2 What is the role of the private sector in adaptation through emergency management?	High
4. Regional implications	
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?	Medium

7 ACRONYMS

AFAC	Australasian Fire and Emergency Service Authorities Council
APEC	Asia-Pacific Economic Cooperation
ARC	Australian Research Council
ARGP	Adaptation Research Grant Program (Commonwealth Funding to support adaptation research commissioned against priorities identified in NARPs.
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
IASC	International Air Services Commission
ICA	Insurance Council of Australia
IPCC	Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
NARP	National Climate Change Adaptation Research Plan
NCCARF	National Climate Change Adaptation Research Facility
QUT	Queensland University of Technology

8 REFERENCES

AFAC. 2011. *Climate Change and the Fire and Emergency Services Sector.* Paper prepared for AFAC.

http://www.afac.com.au/positions/Climate_Change_and_the_Fire_and_Emergency_Services_Sector Last accessed 15th September, 2011.

Ahrens, J. and Rudolph, P. M. 2006. The importance of governance in risk reduction and disaster management. *Journal of Contingencies and Crisis Management,* 14(4), 207-220.

Allison, E., Perry, A., Badjeck, M., Adger, N., Brown, B., Conway, D., Halls, A., Pilling, G., Reynolds, J., Andrew, N., and. Dulvy, N. 2009 Vulnerability of national economies to the impacts of climate change on fisheries. *Fish and Fisheries,* 10(2), 173-196.

Amendola, A., Linnerooth-Bayer, J., Okada, N. and Shi, P. 2008. Towards integrated disaster risk management: case studies and trends from Asia. *Natural Hazards,* 44(2), 163-168.

Anderson, A. 2009. Media politics and climate change: towards a new research agenda. *Sociology Compass,* 3(2), 166-182.

Apan, A., Keogh, D.U., King, D., Thomas, M., Mushtaq, S. and Baddiley, P. 2010. *The 2008 Floods in Queensland: A Case Study of Vulnerability, Resilience and Adaptive Capacity*. Report for the National Climate Change Adaptation Research Facility, Gold Coast, Australia.

Australian Government, 2012, State of the Climate 2012, available at http://www.bom.gov.au/announcements/media_releases/ho/stateClimate2012.pdf

Bajek, R., Matsuda, Y. and Okada, N. 2008. Japan's Jishu-bosai-soshiki community activities: Analysis of its role in participatory community disaster risk management. *Natural Hazards,* 44(2), 281-292.

Barnett, J. 2001. Adapting to climate change in Pacific Island countries: the problem of uncertainty. *World Development,* 29(6), 977-93.

Baxter-Tomkins, T. and Wallace, M. 2009. Recruitment and retention of volunteers in emergency services. *Australian Journal on Volunteering,* 14, 39-49.

Becker, J., Johnston, D., Lazrus, H., Crawford, G. and Nelson, D. 2008. Use of traditional knowledge in emergency management for tsunami hazard: A case study from Washington State, USA. *Disaster Prevention and Management,* 17(4), 488-502.

Bicknell, J., Dodman, D. and Satterthwaite, D. 2009. *Adapting Cities to Climate Change: Understanding and Addressing the Development Challenges*. Oxford: Earthscan.

Birkmann, J., Garschagen, M., Kraas, F. and Quang, N. 2010. Adaptive urban governance: new challenges for the second generation of urban adaptation strategies to climate change. *Sustainability Science,* 5, 185–206.

Birkmann, J. and von Teichman, K. 2010. Integrating disaster risk reduction and climate change adaptation: key challenges—scales, knowledge, and norms. *Sustainability Science,* 5(2), 171-184.

Bosomworth, K. 2011. *Exploring a capacity for adaptive governance in the (bush) fire management policy sector: the role of bureaucrats and reflexive learning.* Unpublished doctoral dissertation, RMIT University.

Botzen, W., van den Bergh, J. and Bouwer, L. 2010. Climate change and increased risk for the insurance sector: a global perspective and an assessment for the Netherlands. *Natural Hazards,* 52(3), 577-598.

Boykoff, M.T. 2008a. Lost in translation? United States television news coverage of anthropogenic climate change, 1995–2004. *Climate Change,* 86(1), 1-11.

Boykoff, M.T. 2008b. The cultural politics of climate change discourse in UK tabloids. *Political Geography,* 27(5), 549-569.

Boykoff, M.T. and Smith, J. 2010. Media representations of climate change. In C. Lever-Tracy (Ed.), *Routledge handbook of climate change and society* (pp. 210-218). Routledge: London.

Brander, K. 2010. Predicting the effects of climate change on marine communities and the consequences for fisheries. *Journal of Marine Systems,* 79(3), 418-426.

Brody, S., Zahran, S., Vedlitz, A. and Grover, H. 2008. Examining the Relationship Between Physical Vulnerability and Public Perceptions of Global Climate Change in the United States. *Environment and Behaviour,* 40(1). 72-95.

Buxton, M., Haynes, R., Mercer, D., and Butt, A. 2011. Vulnerability to bushfire risk at Melbourne's urban fringe: The failure of regulatory land use planning. *Geographical Research,* 49(1): 1-12.

Campbell, J. 2009. Islandness: vulnerability and resilience in Oceania. *Shima: The International Journal of Research into Island Cultures,* 3(1), 85-97.

COAG. 2011, National Strategy for Disaster Resilience adopted by COAG, February 2011

Clode D. 2009. *Psychological preparedness for bushfires*. Country Fire Authority: Burwood .

Cochrane, K., De Young, C., Soto, D. and Bahri, 2009. Climate change implications for fisheries and aquaculture. Overview of current scientific knowledge. *FAO Fisheries and Aquaculture Technical Paper* 530. pp. 212.

Committee on Private-Public Sector Collaboration to Enhance Community Disaster Resilience. 2010. *Private-public sector collaboration to enhance community disaster resilience: a wrokshop report.* National Academy of Sciences: Washington.

Corfee-Morlot, J., Kamal-Chaoui, L., Donovan, M., Cochran, I., Robert., A. and Teasdale. P. 2009. *Cities, Climate Change and Multilevel Governance.* Paris: OECD.

Cowlishaw, S., Evans, L. and McLennan, J. 2010. Work–family conflict and crossover in volunteer emergency service workers. *Work and Stress,* 24(4), 342-358.

Cowlishaw, S., Evans, L. and McLennan, J. 2008. Families of rural volunteer firefighters. *Rural Society,* 18(1), 17-25.

Crimp, S, Howden, M., Power, B., Wang, E. and De Voil, P. 2008. *Global climate change impacts on Australia's wheat crops.* CSIRO: Queensland.

Crompton, R.P. and McAneney, K.J. 2008. The cost of natural disasters in Australia: the case for disaster risk reduction, *Aust. J. Emergency Management,* 23, 43-46.

Crompton, R., McAneney, K.J., Chen, K., Pielke Jr., R. and Haynes, K. 2010. Influence of Location, Population and Climate on Building Damage and Fatalities due to Australian Bushfire: 1925-2009. *Weather, Climate, and Society*, 2, 300-310.

Crompton, R., McAneney, K.J., Chen, K., Pielke Jr., R. and Haynes, K. 2011. Reply to the Nicholls (2011) comment on Crompton et al. (2010), "Influence of location, population, and climate on building damage and fatalities due to Australian bushfire: 1925–2009". *Weather, Climate, and Society*, 3, 63-66.

Cutter, S., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E. and Webb, J. 2010. A place-based model for understanding community reilisence to natural disasters. *Global Environmental Change,* 18, 598-606.

Doulton, H. 2009. Ten years to prevent catastrophe? Discourses of climate change and international development in the UK press. *Global Environmental Change,* 19(2), 191-202.

Dufty, N. 2009. Natural Hazards Education in Australian Schools: How Can We Make It More Effective?. *Australian Journal of Emergency Management,* 24(2), 13-16.

Dupont, A., Lusthaus, J., Phipps, T., Pitman, A., Rayfuse, R., Thomson, M. and Pearman, G. 2008. *Climate change and security: managing the risk.* Paper prepared for the Garnaut Climate Change Review. http://www.garnautreview.org.au/CA25734E0016A131/WebObj/05Security/$File/05%20Security.pdf. Last accessed 27 April 2011.

Ellemor, H. 2005. Reconsidering emergency management and indigenous communities in Australia. *Global Environmental Change Part B: Environmental Hazards,* 6(1), 1-7.

Elsworth G., Gilbert J.,Rhodes A., Goodman H. 2009. Community Safety Programs for Bushfire: What Do They Achieve, and How? , Australian Journal of Emergency Management, 24, 2, 17-25.

Eriksen, C., Gill, N. and Head, L. 2010. Bushfire and everyday life: Examining the awareness-action 'gap' in changing rural landscapes. *Geoforum,* 41(5), 814-825.

Eriksen, C. and Prior, T. 2011. The art of learning: wildfire, amenity migration and local environmental knowledge. *International Journal of Wildland Fire,* 20(4), 612-624.

Finnis, K., Johnston, D., Ronan, K. and White, J. 2010. Hazard perceptions and preparedness of Taranaki youth. *Disaster Prevention and Management,* 19(2), 175-184

Garnaut, R. 2011. *The Garnaut review 2011: Australia in the Global Response to Climate Change.* New York: Cambridge.

George, D.A., Clewett, J.F., Birch, C.J., Wright A.H. and Allen, W.R. 2007. Development and accreditation of an applied climate education unit for sustainable land use in Australia. *Journal of Sustainable Agriculture,* 29(4), 87-108.

Handmer, J., McLennan, B., Towers, B., Whittaker, J. and Yardley, F. 2011. *Emergency management and climate change: An updated review of the literature*. NCCARF, Gold Coast.

Handmer, J., McKellar R, McLennan, B., Towers, B., Whittaker, J., Duggie J and Woolf, M. 2012. *2012 Update: National Climate Change Adaptation Research Plan for Emergency Management*. NCCARF, Gold Coast.

Harper, B., Hardy, T., Mason, L., Fryar, R. 2009. Developments in storm tide modelling and risk assessment in the Australian region. *Natural Hazards,* 51(1), 225-238.

Helman, P., Thomalla, F. and Metusela, C. 2010. *Storm tides, coastal erosion and inundation*. Report for the National Climate Change Adaptation Research Facility, Gold Coast, Australia.

Hernandez, A. and Ryan, G. 2011. Coping with climate change in the tourism industry: a review and agenda for future research. *Tourism and Hospitality Management*, 17(1). 79-90.

Howard, B. 2009. Feature story: Climate change and the volunteer emergency management sector. *National Emergency Response,* 22(3), 8-11.

Hughes, A.V. 2005. Strengthening regional management: a review of the architecture for regional co-operation in the Pacific. Report to the Pacific Islands Forum. http://www.sopac.org/sopac/docs/RIF/06_AV%20Hughes%20Report_CONSULTATIVE_DRAFT(1).pdf Last accessed 27 April 2011.

Hulme, M. 2009. *Why we disagree about climate change: understanding controversy, inaction and opportunity.* Cambridge: UK.

Hunt, A. and Watkiss, P. 2011. Climate change impacts and adaptation in cities: a review of the literature. *Climate Change,* 104, 13-49.

IASC and ISDR. 2008. Disaster risk reduction strategies and risk management practices: Critical elements for adaptation to climate change. *Submission to the UNFCCC Adhoc Working Group on Long Term Cooperative Action*, Inter-Agency Standing Committee; International Strategy for Disaster Reduction.

IPCC, 2012. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.

ISDR. 2011. Strengthening climate change adaptation through effective disaster risk reduction. *International Strategy for Disaster Reduction. Briefing Note 03,* http://www.unisdr.org/files/16861_ccbriefingnote3.pdf Extracted 24 May 2012.

Jennings, S. and Brander, K. 2010. Predicting the consequences of climate change on marine communities and the consequences for fisheries. *Journal of Marine Systems,* 79(3), 418-426.

Kahan, J., Allen, A. and George, J. 2009. An Operational Framework for Resilience. *Journal of Homeland Security and Emergency Management*, 6(1), 1-47.

Keelty, M. 2011. *A Shared Responsibility: The report of the Perth Hills bushfire February 2011 review*. Western Australian Government: Perth.

http://sharedservices.servicenet.wa.gov.au/bushfire/Perth_Hills_Bushfire_Report_Feb_2011.pdf

Kellstedt, P., Zahran, S. and Vedlitz, A. 2008. Personal efficacy, the information environment, and attitudes towards global warming and climate change in the United States. *Risk Analysis*, 28(1), 113-126.

Kelman, I. 2010. Hearing local voices from Small Island Developing States for climate change. *Local Environment,* 15 (7), 605-19.

Kennedy, D., Stocker, L. and Burke, G. 2010. Australian local government action on climate change adaptation: Some critical reflections to assist decision-making. *Local Environment,* 15(9), 805-816.

King, D. and Smithers, S. 2009. Climate Change Migration from Low-Lying small Island Communities. In G. Asrar (Ed.) *Climate Sense*. World Meteorological Organization, Tudor Rose, Leicester. pp. 50-52.

Keogh D.U., Apan, A., Mushtaq S., King, D. and Thomas M. 2011. Resilience, vulnerability and adaptive capacity of an inland rural town prone to flooding: a climate change adaptation case study of Charleville, Queensland, Australia. *Natural Hazards*, 59(2), 699–723.

Kiem, A.S., Askew, L.E., Sherval, M., Verdon-Kidd, D.C., Clifton, C., Austin, E., McGuirk, P.M. and Berry, H 2010a. *Drought and the Future of Rural Communities: Drought impacts and adaptation in regional Victoria, Australia*. Report for the National Climate Change Adaptation Research Facility, Gold Coast, Australia.

Kiem, A.S., Verdon-Kidd, D.C., Boulter, S. and Palutikof, J. 2010b. *Learning from experience: Historical Case Studies and Climate Change Adaptation.* Report for the National Climate Change Adaptation Research Facility, Gold Coast, Australia.

Lenton, T., Held, H., Kriegler, E., Hall, J., Lucht, W., Rahmstorf, S. and Schellnuber, H. 2008. *Tipping elements in the earth's climate system.* Proceedings of the National Academy of Sciences of the United States of America, 105(6), 1786-1793

Lewis, D. and Mioch, J. 2005. Urban vulnerability and good governance. *Journal of Contingencies and Crisis Management,* 13(2), 50-53.

Li, G., Dovers, S., Sutton, P., Guillaume, J., Hutchinson, M., Dyball, R., Proust, K., Carroll, L. and Troy, P. 2010. *IACCIUS: Synthesis Report on Integrated Assessment of Climate Change Impacts on Urban Settlements.* Canberra: Fenner School of Environment and Society, The Australian National University.

Locke, J.T. 2009. Climate change-induced migration in the Pacific Region: sudden crisis and long-term developments. *The Geographical Journal,* 175(3), 171-80.

Lowe, T., Haynes, K. and Bryne, G. 2008. Resilience at the urban interface: the community fire unit approach. In J. Handmer and K. Haynes (Eds.), *Community bushfire safety* (pp. 21-35).

McGee, T. 2011. Public engagement in neighbourhood level wildfire mitigation and preparedness: Case studies from Canada, the US and Australia. *Journal of Environmental Management,* 92(10), 2542-2532.

McLennan, J. B. and Adrian, A. 2008. Why would you do it?: Age and motivation to become a fire service volunteer. *Australian and New Zealand Journal of Organisational Psychology,* 1(1), 7-11.

Mason, M. and Haynes, K. 2010. *Adaptation Lessons from Cyclone Tracy.* Report for the National Climate Change Adaptation Research Facility, Gold Coast, Australia.

Maynard, T. 2008. Climate Change: Impacts on Insurers and How They Can Help With Adaptation and Mitigation. *The Geneva Papers on Risk and Insurance,* 33*,* 140-146.

Mercer, J., Dominey-Howes, J., Kelman, I. and Lloyd, K. 2007. The potential for combining indigenous and western knowledge in reducing vulnerability to environmental hazards in small island developing states. *Environmental Hazards,* 7, 245-56.

Mercer, J. 2010. Disaster risk reduction or climate change adaptation: Are we reinventing the wheel? *Journal of International Development,* 22(2), 247-264.

Mercer, J., Kelman, I., Taranis, L. and Suchet-Pearson, S. 2010. Framework for integrating indigenous and scientific knowledge for disaster risk reduction. *Disasters,* 34(1), 214-239.

Mills, E. 2007. Synergisms between climate change mitigation and adaptation: an insurance perspective. *Mitigation and Adaptation Strategies for Global Change,* 12(5), 809-842.

Mimura, N., Nurse, L., McLean, R., Agard, J., Briguglio, L., Lefale, P., Payet, R. and Sem, G. 2007: S*mall islands. Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 687-716.

Mirfenderesk, H. 2009. Flood emergency management decision support system on the Gold Coast, Australia. *Australian Journal of Emergency Management,* 24(2), 50-58.

Mortimer, E., Bergin, A. and Carter, R. 2011. Sharing risk: Financing Australia's disaster resilience. (Vol. 37) Barton, Australian Strategic Policy Institute.

Mortreux, C. and Barnett, J. 2009. Climate change, migration and adaptation in Funafuti, Tuvalu. *Global Environmental Change,* 19, 105-12.

NCCARF. 2012, Current research on Climate change adaptation and emergency management, NCCARF, Gold Coast.

Nelson, R., Kokic, P., Crimp, S., Martin, P., Meinke, H., Howden, S. M. and Nidumolu, U. 2010a. The vulnerability of Australian rural communities to climate variability and change: Part II-Integrating impacts with adaptive capacity. *Environmental Science and Policy,* 13(1), 18-27.

Nelson, R., Kokic, P., Crimp, S., Meinke, H. and Howden, S. M. 2010b. The vulnerability of Australian rural communities to climate variability and change: Part I-Conceptualising and measuring vulnerability. *Environmental Science and Policy,* 13(1), 8-17.

Nelson, G., Rosegrant, M., Koo, J., Roberston, R., Sulser, T., Zhu, T., Ringler, C., Msangi, S., Palazzo, A., Batka., M., Magalhaes, M., Valmonte-Santos, R., Ewing, M. and Lee, D. 2009. *Climate change: impact on agriculture and costs of adaptation.* International Food Policy Research Institute: Washington DC.

Nibett, M. 2009. Communicating climate change: why frames matter for public engagement. *Environment: Science and Policy for Sustainable Development,* 51(2), 12-23.

Nicholls, N., 2011. Comments on "Influence of Location, Population, and Climate on Building Damage and Fatalities due to Australian Bushfire: 1925–2009". *Weather, Climate, and Society,* 3, 61-62.

Nicolopoulos, N. and Hansen, E. 2009. How well prepared are Australian communities for natural disasters and fire emergencies? Australian Journal of Emergency Management, 24(1). 60-66.

Norman, B. 2008. "Principles for an intergovernmental agreement for coastal planning and climate change in Australia." *Habitat International* 33(3), 293-299.

Ojero, Moseley, C., Lynn, K. and Bania, N. 2010. Limited Involvement of Socially Vulnerable Populations in Federal Programs to Mitigate Wildfire Risk in Arizona. *Natural Hazards Review,* 12(28), 28-36.

O'Riordan, T. and Cameron, J. 1994. *Interpreting the precautionary principle.* Earthscan: London.

Pacific Climate Change Science Program. 2012. http://www.cawcr.gov.au/projects/PCCSP/ - extracted 29 April 2012.

Parkin, D. 2008. Future challenges for volunteer based emergency services. *Australian Journal of Emergency Management*, 23(2), 61-67.

Pearce, T., Handmer, J., Higgins, J., King, D., McDonald, J., Pagano, F., Schneider, J. and Whetton, P. 2009. *National Climate Change Adaptation Research Plan for Emergency Management.* National Climate Change Adaptation Research Facility, Gold Coast.

Pelling, M., High, C., Deering, J. and Smith, D. 2008. Shadow spaces for social learning: a relational understanding of adaptive capacity to climate change within organisations. *Environment and Planning A,* 40(4), 867-884.

Pooley, J., Cohen, L. and O'Connor, M. 2010. Bushfire communities and resilience: what can they tell us? *Australian Journal of Emergency Management,* 25(2), 33-38.

Prabhakar, S., Srinivasan, A. and Shaw, R. 2009. Climate change and local level disaster risk reduction planning: need, opportunities and challenges. *Mitigation and Adaptation Strategies for Global Change,* 14(1), 7-33.

Preston, B., Brooke, C., Measham, T., Smith, T. and Gorddard, R. 2009. Igniting change in local government: lessons learned from a bushfire vulnerability assessment. *Mitigation and Adaptation Strategies for Global Change,* 14(3), 251-283.

Prior, T. and Paton, D. 2008. Understanding the Context: The value of community engagement in bushfire risk communication and education: observations following the East Coast Tasmania bushfires of December 2006. *The Australasian Journal of Disaster and Trauma Studies,* 2. Retrieved from http://www.massey.ac.nz/~trauma/issues/2008-2/prior.htm. Last accessed 25th July, 2011.

Proudley, M. 2008. Fires, families, and decisions. *Australian Journal of Emergency Management,* 23(1), 37-43.

Queensland University of Technology. 2010. *Impacts and adaptation response of infrastructure and communities to heatwaves: the southern Australian experience of 2009.* Report for the National Climate Change Adaptation Research Facility, Gold Coast, Australia.

Renaud, F., Birkmann, J., Damm, M. and Gallopin, G. 2010. Understanding multiple thresholds of coupled social–ecological systems exposed to natural hazards as external shocks. *Natural Hazards,* 55(3), 749-763.

Reser, J. and Morrissey, S. 2009. The crucial role of psychological preparedness for disasters. *InPsych:The Bulletin of the Australian Psychological Society,* 31(2), 14-15.

Reser, J., Pidgeon, N., Spence, A., Bradley, G., Glendon, A. and Ellul, M. 2011. *Public Risk Perceptions, Understandings, and Responses to Climate Change in Australia and Great Britain: Interim Report.* Report for the National Climate Change Adaptation Research Facility, Gold Coast, Australia.

Resilience Alliance. 2009. *Assessing resilience in social-ecologial systems: workbook for practioners.* http://www.resalliance.org/index.php/resilience_assessment. Last accessed 25th July, 2011

Roberts, S.M., Wright, S. and O'Neill, P. 2007. Good governance in the Pacific? Ambivalence and possibility. *Geoforum,* 38, 967-84.

Romieu, E., Welle, T., Schneiderbauer, S., Pelling, M. and Vinchon, C. 2010. Vulnerability assessment within climate change and natural hazard contexts: revealing gaps and synergies through coastal applications. *Sustainability Science,* 5(2) 159-170.

Ronan, K., Crellin, K. and Johnston, D. 2010. Correlates of hazard education for youth. *Natural hazards,* 53, 503-526.

Rosenzwieg, C., Solecki, W., Hammer, S. and Mehrotra, S. 2011. *Climate change and cities: First assessment report of the urban climate change research network.* Cambridge: Cambridge, UK. pp. 312.

Scheffer, M., Bascompte, J., Brock, W., Brovkin, V., Carpenter, S., Dakos, V., Held, H., van Nes, E., Rietkerk, M. and Sugihara, G. 2009. Early-warning signals for critical transitions. *Nature,* 461, 53-59.

Schipper, L. and Pelling, M. 2006. Disaster risk, climate change and international development: scope for, and challenges to, integration. *Disasters,* 30(1), 19-38.

Schwarze, R., Schwindt, M., Weck-Hannemann, H., Raschky, P., Zahn, F. and Wagner, G. G. 2011. Natural hazard insurance in Europe: Tailored responses to climate change are needed. *Environmental Policy and Governance,* 21(1), 14-30.

Semenza, J., Hall, D., Wilson, D., Bontempo, B., Sailor, D. and George, L. 2008. Public perception of climate change: voluntary mitigation and barriers to behaviour change. *American Journal of Preventative Medicine,* 35 (5), 479-487.

Sims, J. and Baumann, D. 1983. Educational programs and human response to natural hazards. *Environment and Behaviour,* 15, 165-89.

Sinclair, M. 2009. The impacts of climate change. *Hydro International,* 13(5),), http://www.hydro-international.com/issues/articles/id1081-The_Impacts_of_Climate_Change.html. Extracted 24 May 2012.

Solberg, C., Rossetto, T. and Joffe, H. 2010. The social psychology of seismic hazard adjustment: re-evaluating the international literature. *Natural Hazards and Earth Science Systems, 10,* 1663-1677.

Solecki, W., Leichenko, R. and O'Brien, K. 2011. Climate change adaptation strategies and disaster risk reduction in cities: connections, contentions, and synergies. *Current Opinion in Environmental Sustainability*, 3(3), 135-141.

Stewart, G. T., Kolluru, R. and Smith, M. 2009. Leveraging public-private partnerships to improve community resilience in times of disaster. *International Journal of Physical Distribution and Logistics Management,* 39, 343-364.

Sturm, T. and Oh, E. 2010. Natural disasters as the end of the insurance industry? Scalar competitive strategies, alternative risk transfers, and the economic crisis. *Geoforum,* 41(1), 154-163.

Sullivan, K. 2008. Policy implications of future increases in extreme weather events due to climate change. *Australian Journal of Emergency Management*, 23(4): 37-42.

Taylor, M.A.P. and Freeman, S.K. 2010. A review of planning and operational models used for emergency evacuation situations in Australia. *Procedia Engineering,* 3, 3-14

Thomalla, F., Downing, T., Spanger-Siegfried, E., Han, G. and Rockström, J. 2006. Reducing hazard vulnerability: towards a common approach between disaster risk reduction and climate adaptation. *Disasters,* 30(1), 39-48.

Tooth, R. and Barker, G. 2007. The Non Insured: Who, Why and Trends. http://www.insurancecouncil.com.au/IssuesSubmissions/Issues/NonInsurance/tabid/1299/Default.aspx Last accessed 15th September, 2011.

Tompkins, E.L. and Hurlston, L.A. 2010. Public-private partnerships for storm risk management in the Cayman Islands. Centre for Climate Change Economics and Policy, Sustainability Research Institute. Paper No. 21.

Towers, B. 2011. *Children's knowledge of vulnerability and resilience to bushfires*. Unpublished doctoral dissertation, University of Tasmania, Hobart, Australia.

Tulsi, B., Delacy, T., Calgaro, E. and Jopp, R. 2011. Designing Robust Tourism Industry Responses to Climate Change Impacts on the Great Ocean Road Destination and Tourism System, *In* M. Gross (Ed.). *CAUTHE 2011 National Conference: Tourism: Creating a Brilliant Blend* (pp. 932-937). Adelaide: University of South Australia.

Twigg, J. 2009. Characteristics of a Disaster Resilient Community: A Guidance Note (Version 2). University College, London.

http://community.eldis.org/.59e907ee/Characteristics2EDITION.pdf Last accessed 10th February, 2012.

Veland, S., Howitt, R. and Dominey-Howes, D. 2010. Invisible institutions in emergencies: Evacuating the remote Indigenous community of Warruwi, Northern Territory Australia, from Cyclone Monica. *Environmental Hazards,* 9, 197-214.

Verdon-Kidd, D.C., Kiem, A.S., Willgoose, G. and Haines, P. 2010. *East Coast Lows and the Newcastle/Central Coast Pasha Bulker storm*. Report for the National Climate Change Adaptation Research Facility, Gold Coast, Australia.

Wardekker, J.A., Peterson, A. and van der Sluijs, J.P. 2009. Ethics and public perception of climate change: exploring Christian voices in the U.S policy debate. *Global Environmental Change*, 19, 512-521.

Warner, K., Ranger, N., Surminski, S., Arnold, M., Linnerooth-Bayer, J., Michel-Kerja, E. and Herweijer, C. 2009. Adaptation to climate change: Linking disaster risk reduction and insurance. *United Nations ISDR (International Strategy for Disaster Reduction) Secretariat,* Geneva, Switzerland.

Waugh , W. and Streib, G. 2006. Collaboration and Leadership for Effective Emergency Management. *Public Administration Review,* 66, 131-140.

Webb, L.B., Whetton, P.H. and Barlow, E.W.R. 2008. Climate change and wine grape quality in Australia. *Climate Research,* 36, 99-111.

Weber, E. and Stern, P. 2011. Public understanding of climate change in the United States. *American Psychologist,* 66(4), 315-328.

Whitmarsh, L. 2008. What's in a name? Commonalities and differences in public understanding of "climate change" and "global warning". *Public Understanding of Science*, 18, 401-420.

Whittaker, J. 2008. *Vulnerability to bushfire in south-eastern Australia: a case study from East Gippsland, Victoria.* Unpublished Phd Dissertation. RMIT University, Melbourne. pp. 293.

Whittaker, J. and Handmer, J. 2010. Community Bushfire safety: a review of post-Black Saturday research. *Australian Journal of Emergency Management*, 25(4), 7-14.

Wilkins, M. 2010. The need for a multi-level approach to climate change - An Australian insurance perspective. *The Geneva Papers,* 35(2), 336-348.

9 APPENDIX 1: CRITERIA FOR SETTING RESEARCH PRIORITIES

The criteria listed below will guide the research planning process to set research priorities.

1. **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.

2. **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.

3. **Need to change current intervention and practicality of 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

4. **Potential for co-benefits**

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

5. **Potential to address multiple, including cross-sectoral, issues Potential for co-benefits**

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

6. **Distribution and equity of the perceived benefits of any adaptation strategy**

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

APPENDIX 2: RESEARCH PRIORITISATION TABLE

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

2.1. What does community resilience mean in a changing climate?	**Very High** 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.	**Very High** 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	**Very High** 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	**Very High**
2.2. What behaviours and processes promote community preventive strategies and resilience in a changing climate?	As above	As above	As above				**Very High**
2.3. What are the most effective strategies to ensure that individuals, governments and the private sector adopt better practices in	**Very High–High** Strong need to identify best techniques for mobilising community to adopt positive behaviours and enhance	**High** Techniques and understanding needed now in order to implement long-term strategies of social change	**High** Reason to believe that interventions will be practicable	Benefits likely to enhance community resilience more generally		Strategies aimed at promoting adaptive behaviour should reduce the vulnerability of most vulnerable groups	**Very High–High**

preparing for the increased risk to communities, business operations or critical infrastructure arising from climate change?	resilience						
3 Adaptive strategies							
3.1. How will climate change affect the emergency management sector's capacity to support preparedness, response and recovery?	**Very High** Emergency services already under strain; climate change will exacerbate this	**High** Need information now to plan for the future	**High** Reason to believe that emergency management agencies would implement resourcing changes		Enhanced resourcing of emergency management sectors will assist with non-climate emergencies / disasters		**Very High–High**
3.2. What is the role of the private sector in adaptation through emergency management?	**High** The private sector owns significant critical infrastructure and is a 'missing link' in disaster preparedness, response and recovery	**High**	**High** Significant scope for enhanced engagement with private sector				**High**
4 Regional implications							
4.1. How will	**Moderate**	**Medium**	**Medium**	Addressing these		No specific	**Medium**

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?	But increasing with time	Not immediately a large-scale problem, but there is the possibility that equipment might become unavailable at very short notice	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.	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.		equity issues	

10 APPENDIX 3: CURRENT NCCARF (ARGP) RESEARCH PROJECTS FOR THE EMERGENCY MANAGEMENT THEME

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 Number and 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**
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**
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**
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 Number and 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**
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.		
EM09 05 - Public understandings, risk perceptions, and responses to climate change and associated natural disasters	**Griffith University**	**Joseph Reser**
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 (local, national, global) '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 prospectively examined and documented.		
EM09 06 - Adaptation of the built environment to climate change induced increased intensity of natural hazards	**James Cook University**	**David King**
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.		

Project Number and Title	Lead Organisation	Lead Investigator
EM11 01 - Changing Perceptions about Climate Change	**Griffith University**	**Joseph Reser**
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?		
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**
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.		
EM11 03 - Developing an Excel spread sheet tool for local governments to compare and prioritise investment in climate adaptation	**Macquarie University**	**Stefan Trueck**
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		

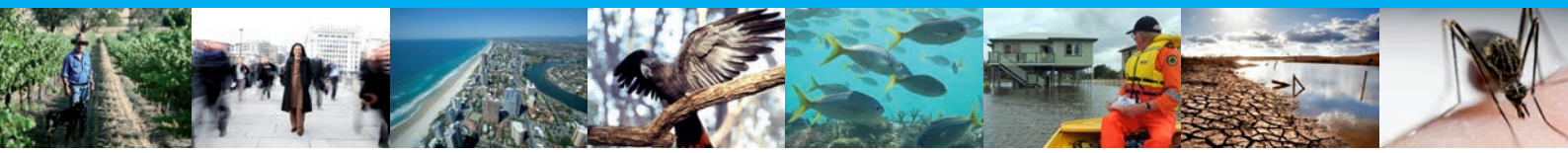
Project Number and Title	Lead Organisation	Lead Investigator
regarding extreme events and the tool will visually show relevant charts and graphs that can enhance optimal decisions. Policy makers will benefit from understanding that adaptation decisions have to be made under uncertainty and moreover they 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.		
EM11 04 - Understanding the Pacific's adaptive capacity to emergencies in the context of climate change	**University of Technology, Sydney**	**Juliet Willetts**
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.		
EM11 05 - Exploring the adaptive capacity of emergency management using agent-based modelling	**RMIT University**	**Lin Padgham**
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.		

NCCARF

National
Climate Change Adaptation
Research Facility

Griffith University, Gold Coast Campus
Parklands Drive, Southport
Qld 4222, Australia

Telephone 07 5552 9333
Facsimile 07 5552 7333



Australian Government
Department of Climate Change and Energy Efficiency

Griffith UNIVERSITY

Queensland Government

MACQUARIE UNIVERSITY

QUT

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

JAMES COOK UNIVERSITY AUSTRALIA

USQ UNIVERSITY OF SOUTHERN QUEENSLAND fulfilling lives

University of the Sunshine Coast

Murdoch UNIVERSITY