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National  
Climate Change Adaptation  
Research Facility

National Climate Change  
Adaptation Research Plan

# Emergency Management



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

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National Climate Change  
Adaptation Research Plan

# Emergency Management



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# Executive Summary

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

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

Planning for the increased risks from climate change is still in its early stages within Australia's emergency management sectors. Research is needed to inform the way in which the various sectors respond to climate change across the prevention, preparedness, response and recovery (PPRR) range of organisations and activities, whilst considering all hazards and key vulnerable groups. Some work has been done in this area, but adaptation research is not well developed in the field of emergency management. The purpose of this Plan is to identify the research priorities that might help Australian governments and communities respond to extreme events for which disaster planning, preparedness and response may be required. In conjunction with National Climate Change Adaptation Research Plans in other priority thematic areas, the National Climate Change Adaptation Research Plan for Emergency Management will guide researchers engaged in generating the information that Australia needs in order to develop an effective and equitable portfolio of adaptive strategies. The Plan identifies three overarching strands to the research agenda for Emergency Management:

1. understanding the nature and location of the risks posed by climate change;
2. enhancing community and organisational resilience to climate change risks;
3. developing and implementing adaptive strategies.

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

## Essential

- severity of potential impact/degree of potential benefit;
- immediacy of required intervention/response;
- need to change current intervention/practicality of intervention.

## Desirable

- potential for co-benefits;
- potential to address multiple, including cross-sectoral, issues;
- distribution and equity of the perceived benefits of any adaptation strategy.

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

## Priority research questions for Emergency Management

### Understanding risk

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

### Priority

Very High – High

High

### Community and organisational resilience

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

### Priority

Medium

High – Medium

Very High – High

### Adaptive strategies

- How will climate change affect the emergency management sector's capacity to support preparedness, response and recovery?
- What is the role of the private sector in adaptation through emergency management?

### Priority

Very High – High

High

### Regional implications

- 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?

### Priority

Medium

## Implementation

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



# 1. Context and objectives

## 1.1 Introduction

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

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

A full understanding of the risks from climate change and the adaptation options available to communities to reduce or recover from those risks requires more than a simple multiplying of existing emergency management capabilities. Research will need to inform the way in which the sector responds to climate change across the prevention, preparedness, response and recovery (PPRR) range of organisations and activities, and the way it considers all hazards. Whilst some work has been done in this area, adaptation research is not well developed in the field of emergency management.

The purpose of this Plan is to identify the research priorities that might help Australian governments and communities in responding to extreme events for which disaster planning, preparedness and response may be required.

The National Climate Change Adaptation Research Facility, established by the Australian Government and hosted by Griffith University, aims to lead the Australian research community in generating the biophysical, social and economic information needed by decision-makers in government and in

vulnerable sectors and communities to manage the risks of climate change impacts.

A key role of the Facility is to coordinate the development of National Climate Change Adaptation Research Plans (NARPs) to identify critical gaps in the information needed by sectoral decision-makers and to set national research priorities. These Plans are being developed in partnership with governments, stakeholders and researchers.

The objective of the National Climate Change Adaptation Research Plan for Emergency Management is to identify priority research to enhance community and organisational resilience to the risks posed by climate change from the perspective of emergency management. Three overarching strands of research are identified to meet this objective:

- understanding the nature and location of risks posed by climate change;
- identifying the most effective means to enhance community and organisational resilience;
- developing adaptive strategies with which to respond to climate change for use by the community and emergency services.

The identification of research priorities will enable local, state and federal governments and other research investors to fund research over the next 5–7 years that can deliver maximum benefit to the Australian community and provide a broad framework for longer-term research planning. The priority research needs for emergency management are set out in Section 4.5. The full prioritisation matrix is presented in Appendix 2.

In conjunction with Research Plans in other priority thematic areas, this Plan will guide researchers in generating the information that Australia needs in order to develop an effective and equitable portfolio of adaptive strategies. The Adaptation Research Network for Emergency Management will play a critical role in implementing the Plan, and will contribute greatly to building collaboration, information-sharing and research capacity across the Australian research community.



## The objective of the National Climate Change Adaptation Research Plan for Emergency Management is to identify priority research to enhance community and organisational resilience to the risks posed by climate change from the perspective of emergency management.

The development of the Plan for Emergency Management was led by the writing team:

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

### 1.2 Context of this Plan

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

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

When climatic phenomena occur, the consequences in damage and loss are a function of the effectiveness of the disaster reduction strategies that have been implemented, the activities of the emergency services, and the resilience of the communities and economic sectors affected. Much of the work in preventing disasters lies in the planning and building

regulation sectors of society and government, rather than in emergency management itself.

In urban development, it has become increasingly common to trade off increased risks from climatic hazards, such as floods and fire, against improved emergency management.

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

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

Climate change creates new imperatives for risk reduction and management. Governments already have powerful risk reduction tools available to counter the most obvious risks that climate change presents, including land-use planning and building control. Risk modelling can highlight the need to amend or upgrade these tools. Other well-understood adaptive mechanisms such as community skilling and warning systems can be brought into play in new locations or with additional emphasis in existing locations. The implementation of such strategies would also have the immediate benefit of reducing the existing risk of severe weather

emergencies. New approaches and expertise should enhance this current suite of risk reduction strategies and allow us to identify new ways of reducing the impacts of projected changes in the frequency and severity of extreme weather events.

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

- *Heat waves*: high level of certainty of increased frequency and intensity.
- *Fire danger*: strong evidence that south-eastern Australia will experience an increase in frequency of high fire risk days, with uncertainty about the magnitude of change.
- *Rising sea levels and storm surge events*: high level of certainty of some sea level rise resulting from thermal expansion, but rate and extent of rise caused by ice melt uncertain.
- *Storm surge affected by intensity of storms*: less certainty over extent and frequency.
- *Rainfall events*: high level of agreement that some areas will become drier, and some areas will be likely to experience intensified rainfall events and therefore suffer an increased risk of flooding, but uncertainty over which areas will be affected and how.
- *Tropical cyclones*: considerable uncertainty remains over climate change impacts on the location, frequency and severity of tropical cyclones; however, there are likely to be more intense events.
- *Changes in hail*: significant uncertainty over the potential for hail events to increase in some regions.

Research is helping to reduce this uncertainty, but we also need to understand how effective decisions can be made in the presence of uncertainty, some of which is irreducible. The use of socio-economic scenarios offers one approach. Little work on developing socio-economic scenarios development has been done in Australia, so their use has been limited compared with the UK's Foresight Future Flooding study and some of the detailed sector studies carried out in northern Europe (Foresight, 2004).

The issues of organisational capacity, response to existing risks, and dealing with uncertainty are set within a broader policy and research initiatives context that informs this Plan. The Council of Australian Governments (COAG) and other bodies have considered the potential impact of climate change on future natural disasters (COAG, 2002, 2004; Middelmann, 2007), and the potential for catastrophic events caused by natural phenomena (COAG, 2004). Adaptation initiatives have not been a part of these analyses to any great extent. The work already done provides an existing knowledge base about natural hazard risks and impacts upon which to build, but adaptation needs will be strongly place-based, requiring both national- and state-level systems and institutional arrangements, combined with location-specific strategies and interventions.

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

This National Climate Change Adaptation Research Plan for Emergency Management identifies critical gaps in the information needed by decision-makers, emergency management agencies and the community, sets research priorities based on these gaps, and identifies capacity that could be harnessed to conduct priority research.

## Table 1. Policy and planning processes currently completed or under way in Australia

### Processes and organisational arrangements

- Australian Emergency Management Committee (AEMC) National Risk Assessment Advisory Group
- National Risk Assessment Guidelines Project for Emergency Management

### Policies and plans

- AEMC is initiating a process for the development of a Climate Change Adaptation Plan for the emergency management sector
- National Risk Assessment Framework and Guidelines adopted by the (AEMC)

### Risk assessments

- Australian Government Natural Disaster Mitigation Program
- First-pass National Coastal Vulnerability Assessment
- South East Queensland Regional Plan: Climate Change Risk Assessment

### Research initiatives

- Australian Fire and Emergency Services Authorities Council: CRC<sup>1</sup> Fire – Environment and Society
- Five national research projects established under the Integrated Assessment of Climate Change ‘Impacts on Urban Settlements’ sub-program focused on climate change impacts and adaptation response

## 1.3 Scope

This National Climate Change Adaptation Research Plan for Emergency Management identifies critical gaps in the information needed by decision-makers, emergency management agencies and the community, sets research priorities based on these gaps, and identifies capacity that could be harnessed to conduct priority research.

The Plan identifies research topics aimed at informing emergency management planning for climate change adaptation across the range of PPRR organisations and activities. It identifies research required to:

- understand what changes are needed to improve the effectiveness of existing engagement strategies, including understanding how communities arrive at an ‘acceptable level of risk’;
- communicate and characterise climate change in ways relevant to the sector;
- develop ideas, policies and options for adaptation in the context of disasters and emergencies, given the high level of uncertainty of climatic projections and potential impacts;
- inform the revision of building design and construction standards, particularly in areas where storm, flood frequency/magnitude, and bushfires are most likely to increase;
- inform land-use planning strategies to reduce exposure to increased natural hazards, such as in areas exposed to coastal storm surge and erosion, bushfire and flooding;
- assist in understanding the trade-offs between options, ranging from warning systems and emergency responses to improved land-use planning and enhanced building design and construction in prevention/reduction of risk, as well as the role of risk transfer alternatives including insurance and government relief;
- assist in understanding how hazard, vulnerability and exposure and related psycho-social influences combine to influence risk and how this understanding can be used to develop the most effective risk reduction measures;
- improve information about the impacts of severe weather events (e.g., bushfires and heat waves) on population and infrastructure, including through better understanding of responsiveness and sensitivity of emergency management decision-making to improved information, enhanced sharing and application of baseline data and changing risks due to climate change;
- design better systems and mechanisms for forecasting the impacts of severe weather events to aid response and recovery activity;
- develop mechanisms for integrating (‘mainstreaming’) adaptation considerations relevant to disaster and emergency management across portfolios and agencies of government;
- understand the implications for changes in responsibilities and liabilities.

1 Cooperative Research Centre

While enhanced understanding of these issues should assist emergency managers in making on-the-ground decisions, it must also be acknowledged that the work of emergency management is greatly affected by the activities of other sectors. These include urban planning, energy, transport and water infrastructure, and public health strategies. This National Climate Change Adaptation Research Plan acknowledges the importance of close linkages with these other sectors, but seeks to identify the research priorities that are specific to the emergency management domain.

#### 1.4 Links to, and synergies with, other National Climate Change Adaptation Research Plans

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

**Settlements and Infrastructure:** There is significant synergy with this theme, particularly

in the context of potential damage to buildings and infrastructure from severe storms, floods and bushfires, and the need to put in place or improve efforts to minimise damage, including early warning systems. To the extent that the physical damage and cost of severe events (and ultimately the social impact) can be reduced through better land-use planning, building codes, and infrastructure design, these two themes are complementary.

**Social, Economic and Institutional**

**Dimensions:** Economic analyses that are used for disaster loss assessment and prediction need to capture the potential damage to buildings and infrastructure, as well as potential casualties, crop damage, and other environmental impacts. It is only through a holistic approach that we will be able to understand the implications of changes in magnitude and frequency of severe events and develop the best adaptation strategies.

**Human Health:** Ambulance services are part of the emergency services portfolio in some Australian jurisdictions and of the health portfolio in others. Ambulance services and the broader health sector will be beneficiaries of adaptation research addressing risk reduction that might reduce the potential for casualties in extreme (or severe) events, especially in coastal areas, where both the population at risk and the likelihood of

This National Climate Change Adaptation Research Plan acknowledges the importance of close linkages with other sectors, but seeks to identify the research priorities that are specific to the emergency management domain.

such events are likely to increase, leading to both acute and chronic health effects. Heat stress and changed disease impacts on populations are also concerns of the emergency management sector. The preparedness of Australia's health systems for extreme weather events is a specific priority of the NARP for Human Health.

#### **Water Resources and Freshwater**

**Biodiversity:** The social and economic impacts of changes in water resources are issues for emergency management to the extent that these issues are either exacerbated by severe events or make severe events more likely. For instance, while drought has historically been considered as being part of natural variability (i.e., not a hazard), the changes in frequency and distribution of drought are likely to fall outside the historically 'normal' range. This also has implications for specific emergency response functions such as fire-fighting, which can be severely compromised when water supplies are depleted. Issues related to flood management are also relevant in this context.

**Primary Industries:** Severe storms and tropical cyclones often damage agriculture. For example, Tropical Cyclone Larry extensively wiped out crops in far north Queensland in 2006. The impact analyses required for emergency management can provide insights into potential crop damage; knowledge of such damage is

also critical to appropriate emergency response and recovery. Plant and animal pest/disease outbreaks can also be concerns of the emergency management sector. On the other hand, land management agencies have an important role to play in leading adaptation in the primary industries sector, including by minimising bushfire risks and exposure to drought.

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



Victorian emergency services plan strategies at the Kilmore East-Murrindindi bushfire, February 2009. Image: CFA Public Affairs/Keith Pakenham.



## 2. Key stakeholders and their information needs

There are two key groups of stakeholders involved in the development of this Research Plan.

The first are the end-users of research undertaken in accordance with the Plan. These are individuals and organisations (including government agencies) who make or implement decisions relating to emergency management. This group includes:

- Commonwealth, state and territory emergency management organisations;
- peak groups such as the Australian Emergency Management Committee and its Advisory Groups, the Australian Council of State Emergency Services, the Planning Institute of Australia, the Council of Ambulance Authorities and the Police Commissioners' Conference;
- the insurance and re-insurance industry;
- local governments, and planning and development control agencies, including catchment management authorities;

- recovery agencies and non-government organisations, such as the Red Cross, Salvation Army, Australian Emergency Management Volunteer Forum (AEMVF), volunteer agencies and community organisations;
- the Bureau of Meteorology, as the predominant authority responsible for the development of effective warning systems and the communication of warning messages to the community
- managers of land and assets potentially affected by extreme events, including national parks and forestry services.

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

- the institutions, policies and practices for emergency management that are more appropriate for a changing climate regime, including the responsiveness and sensitivity of their decision-making to improved information;



**Task force briefing.** Image: NSW State Emergency Service/Erin Pogmore.

- the probability of rare events (e.g. Category 5 cyclones) for Australian communities and how spatial patterns and frequencies may change;
- the vulnerability, resilience and adaptive capacity of communities (damage potential, physical and psychological casualties, social and economic costs, environmental impacts, infrastructure system dependencies and social networks);
- the effects of climate change on existing risk profiles for events such as bushfires, flooding, cyclones, storm surges, wind and hail damage, particularly in and around major urban centres and areas of high biodiversity value;
- the compounding effects of sea level rise on coastal erosion and storm surge;
- the compounding effects on climate change impacts of demographic, economic and social changes which are already increasing coastal exposure and vulnerability.

A second major group are the researchers and funding bodies that will undertake or fund the priority research identified in the Plan, although it is highly likely that a large proportion of the research will be co-generated in partnership with stakeholder agencies.

The role of the National Climate Change Adaptation Research Plan for Emergency Management is to ensure that the target audience can make decisions based on the outcomes of appropriate and relevant research; for research investors to make informed research funding decisions; and for researchers to understand the broader context in which to organise their research activities.



**Queensland Fire & Rescue Service fire training exercise.**  
Image: Queensland Department of Community Safety/Michael Marston.



## 3. Existing knowledge and gap analysis

No broad overview exists of the state of climate adaptation in emergency management. There is now increasing interest and discussion about adaptation to climate change in Australia, but actual implementation is very limited. In general, it is fair to say that there is relatively little treatment of the issue in the peer-reviewed literature – meaning that the quality assurance processes are uncertain for much of the material. Research findings are scattered and have not been synthesised. This is partly because most studies have been done in a developing-country context, and partly because different sectors and disciplines have undertaken their own work in isolation from others.

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

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

### 3.1 Climate change science

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

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

### 3.2 Risk analysis

Risk analysis and management is fundamental to emergency management. Following normal Australian practice in the emergency management field, risk is defined as a function of the hazard, exposure to that hazard, and vulnerability or susceptibility to harm and ability to recover. Most emergency management publications use the approach of Australian Standard 4360 Risk Management.

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



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on the potential changes in risk from heat waves, droughts, sea level rise and cyclones.

In spite of these and similar reports, knowledge of the risks remains limited. In particular, vulnerability assessment is at a relatively early stage of development. While estimating exposure may appear straightforward, there is much room for improvement in terms of the consequences cascading through society. Trends in how future climate change will affect the incidence and severity of disasters are poorly understood. This makes it risky to rely on the past as a guide to good practice. Much of the existing research is of limited use for policy. Little of the research in these areas explicitly addresses climate change adaptation within the context of psychological, social, demographic and economic trends. An exception is the UK's Foresight Future Flooding study (Foresight, 2004). Research reports from a Canadian climate change adaptation program examine rural vulnerability in depth, as does an unpublished report for the Victorian Department of Sustainability and Environment. In summary, some material exists, but it is scattered throughout different disciplines and sectors.

### 3.3 Policy and practice

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

Much of the research considered to be policy-relevant is more about revisiting the science of climate change, and examining its implications in terms of likely impacts,

than directly contributing to policy development or implementation. An important exception is work on the economic and financial aspects of a carbon economy – but this is of limited value for adapting to the implications of climate change for emergency management. Within this category, there is research directed at adaptation for specific hazards, and research supporting more generic approaches best described as building resilient communities and sectors (e.g., Handmer and Dovers, 2007).

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

### 3.4 Information needs

Information management and a knowledge management system, including relevant databases, that allow for an integrated assessment of issues, will enhance the capacity of emergency management organisations to adapt effectively to the impact of climate change. Such an information management system would need to be compatible with others that already exist, in order to allow for the effective sharing of information.

An important issue is who gathers, organises and imposes quality control and makes accessible (or not) information of relevance to adaptation, especially when the goal is coordination across sectors and agencies. A mechanism is needed to ensure that such a database is populated in a systematic way, so as to avoid having incomplete databases that are difficult to work with. We cannot simply wait for research to provide solutions for practitioners to apply. Rather, we need to accept that an adaptive and iterative management approach is needed that can utilise information as it becomes available. A consistent approach to the storage and presentation of information will contribute to this goal.



## 4. Priority research topics

This section sets out the research priorities identified by the writing team after consultation with stakeholders and researchers. The section is organised around four sub-themes:

(i) understanding risk, (ii) community and organisational resilience, (iii) adaptive strategies, and (iv) regional implications; followed by a discussion of the overarching issues that need to be considered when setting research priorities. Within each sub-theme, specific research questions are articulated, followed by an explanation of the question and an elaboration of the research that will be needed in order to answer that question.

### 4.1 Understanding risk

Risks associated with natural disasters will change as the climate changes. This presents a challenge to natural disaster managers and emergency services. These must now adjust to a constantly changing risk profile and accept that historical information about climate-related hazards is no longer an adequate basis for understanding current and future risk. An appreciation of the risk from climate-related hazards requires an understanding of both the current or baseline risk and how climate change varies that risk. Current risk from climate-related hazards is derived from the following factors:

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

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

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

Risks associated with natural disasters will change as the climate changes. This presents a challenge to natural disaster managers and emergency services.

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

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

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

##### Context

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

Understanding the changed risk of natural hazards will involve estimating how the frequency and intensity of climate events that give rise to natural hazards are likely to change. This, in turn, will require regional information about specific climate parameters, since different risks are likely to arise in different locations (e.g., cyclones in the north of Australia, or extreme heat in inland areas).

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

New risks might also arise through the significantly increased probability of two natural disasters occurring at the same time, exhausting the resources required for response and recovery. The implications of combined events must be considered when planning response strategies that assume an ability to mobilise resources from neighbouring regions – or even overseas – to assist with emergency management.



North Eastern Victoria underwater in the floods of October 1993. Image: Sandi Mason.

The notion of what constitutes acceptable levels of risk must also be addressed in order to gauge trade-offs between economic costs and social outrage.

### Research response

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

#### 1. Setting the baseline: assessing current risk

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

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

- *Hazard domain*: the detailed characteristics of an event in terms of the spatial distribution and intensity of the attributes that cause damage to people or property. For instance, for a severe storm event, research is required

to better understand how basic information about climate or weather can be translated into a spatial description of the distribution of hailstones, severe wind, storm waves or water depth.

- *Impact domain*: the direct damage to property or people and the resulting social disruption and economic loss that constitute a disaster. For instance, we need to better understand (and develop predictive models for) the relationship between the physical description of a flood event and the resulting damages and losses. (This relationship between the imposed hazard and the resulting impact is referred to as *vulnerability*.)

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

#### 2. Climate change-induced risk

With enhanced understanding of the current risk environment, research can be directed to capture the additional risk associated with climate change, as compounded by demographic and other changes in exposure or vulnerability. For example, in areas of high potential impact due to high population, significant infrastructure or vulnerable communities, we need to understand



Dropping fire retardant, Swifts Creek, Vic, February 2009.  
Image: CFA Public Affairs/Noel McWilliams.

the differential change in existing risk arising from changes in the severity, frequency and timing of extreme events, and combinations of extreme events. These include:

- compounding of flooding and coastal risks due to rising sea levels and intense rain events;
- changes in bushfire intensity and frequency from anticipated increases in the number of extreme fire weather days, decreases in rainfall in southern Australia and changes to fuel loads and curing;
- changes in wind loads, flooding and storm surge due to changes in frequency and intensity of cyclones and East Coast Lows;
- increases in periods of extreme high temperature.

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

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

Examples include:

- Examining the relationships between building codes, construction practice and settlement patterns, and the maintenance or degradation of structures over time. Given this information, models can then be extended to capture the changing hazard environment, and tools can be developed for assessing the cost–benefit of adaptation measures such as improved building codes, changes in construction materials and/or how other elements of PPRR (e.g., improved warnings or evacuation procedures) might be brought to bear.
- Targeting specific regions such as those adjacent to or on the southern boundary of current cyclone regions (e.g., south-east Queensland) for special studies to assess the impacts of the increased cyclone hazard under climate change and possible



**Tarpaulins cover hailstorm damaged roofs, Blacktown, NSW, December 2007.**  
Image: NSW State Emergency Service.

adaptation measures (such as retrofitting current structures) if required.

- Examining the behaviour of critical infrastructure as a system, in order to understand how single or multiple infrastructure failures lead to complex or cascading failures in our social, economic and physical infrastructure systems or networks, which in turn can lead to disasters on a local or regional scale.

In the context of climate change, the need for future research in this area lies in translating the consequence analysis approach described above into a better understanding of risk. For example, how do we translate knowledge of how fire damage to electric power transmission lines contributes to electric power blackouts, and the downstream loss of income or social disruption to a community, into an understanding of the likelihood of this happening to any given community given potential changes in storm frequency, magnitude and location?

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

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

#### Context

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

from both sides, with scientists providing information tailored to the needs of disaster managers, and managers using the best information that science can provide.

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

#### Research response

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

## 4.2 Community and organisational resilience

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

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

community. Climate change complicates this task by adding an extra dimension to the challenges for resilience – the capacity to deal with expanding and changing risks in the future.

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

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

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

##### Context

The term 'resilience' is generally used to describe the capacity of a community or individual to resist the impacts of a disruption or adversity; the capacity to bounce back from the negative impacts of a disruption; or the capacity to adapt to those impacts. In the context of this Plan, disruption or adversity means emergencies and disasters brought about by climate change. Researchers in the community resilience field broadly agree on what constitute the key components of resilience, although precise definitions vary. Resilience comprises:

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

To build collective resilience, communities must reduce risk and resource inequities, engage local people in mitigation, create organisational

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

Resilience also requires an understanding of the psycho-social influences on human behavioural change.

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

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

### Research response

Research is needed to identify the characteristics and indicators of resilience to climate changes in a wide range of different community types, and to determine whether resilience needs to be measured in different ways in a changing climate. Resilience building is most effective when it draws on existing strengths within communities, particularly in social capital and governance. Existing characteristics of resilience must be identified in order to introduce intervention strategies for a changing hazard environment (Gow and Paton, 2008).

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

- Are there particular features of a 'climate-resilient community'? Does resilience and adaptive capacity depend on the hazard to which people are exposed? Is 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?
- Is there a critical number of same-hazard or different-hazard events which result in a 'tipping point' for a community or

population? How will climate change affect this (e.g., by bringing communities closer to the 'tipping point')?

- What is the success and efficacy of hazard awareness and preparedness strategies in specific cultural communities and in a range of demographic and socio-economic groups?
- What policy, statutory and governance arrangements are most beneficial to enabling community adaptive capacity?

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

#### Context

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

- Groups that have hitherto not experienced severe weather events are likely to be exposed. In particular, more populous urban centres may have increased exposure.
- Climate change is likely to pose new risks to groups that might have preparedness – both physical and psychological – for some existing risks, but not for those created by climate change. It is critical

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, and their level of understanding and acceptance of climate change and its implications for natural hazards.



## The research challenge is to identify practices and outcomes that will promote preparation and preventive measures to enhance community resilience.

that we learn from and overcome past cases of limited community preparedness, especially in larger communities that may be ill-prepared for major events. The potential for climate change to induce impacts from unfamiliar hazards on under-prepared communities is a significant challenge facing disaster managers.

- Community awareness of the risks posed by climate change may provide an opportunity to drive greater and more inclusive preparedness, in which there is an ability to transfer preparedness elements between events (i.e., 'all hazards' planning). The design and effectiveness of warning systems may assist in this regard.

### Research response

There is an extensive international literature that covers ideas, examples and guidelines for promoting good community preparedness (Gow and Paton, 2008; Greene, 2002; Norman, 2000; Ronan and Johnston, 2005). However, it is probable that a sizeable proportion of the public has not considered the implications of climate change for natural hazards (WMO, 2007). In order to define what preparedness for climate change risk might mean, research needs to ascertain how unprepared people are for a range of

climate-related hazards, and their level of understanding and acceptance of climate change and its implications for natural hazards. Alongside this kind of study, research also needs to review the portrayal of climate change and increased hazard risk, as well as the general hazard risk and leadership attitudes portrayed in the media, literature and public policy. The research challenge is to identify practices and outcomes that will promote preparation and preventive measures to enhance community resilience. It is a bottom-up emphasis that will identify existing behaviours that may be developed further and new behaviours and attitudes that can be promoted to increase resilience.

There is an extensive literature giving examples and guidelines for the dissemination of emergency warnings and information to the community (Davidson and Wong, 2005; Elsberry, 1995; Falls, 2002; King, 2004; O'Neil, 2004; Paton, 2000). Climate change does not necessarily require a change in these strategies, but research must identify what the trigger points are for the commencement of the dissemination of emergency warnings and information to the community about potential climate change impacts. There is a need to understand the ability for existing warning



April 25, 2006, Maningrida, Arnhem Land, NT, post Cyclone Monica. Image: Newspix

system coverage to be expanded and the necessary infrastructure and technology required to permit expansion. Existing warning systems are designed to target specific populations such as emergency response personnel or those defined by the geographical area exposed to a hazard or via the communication method utilised, e.g., mobile phone, radio.

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

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

##### **Context**

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

These include:

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

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



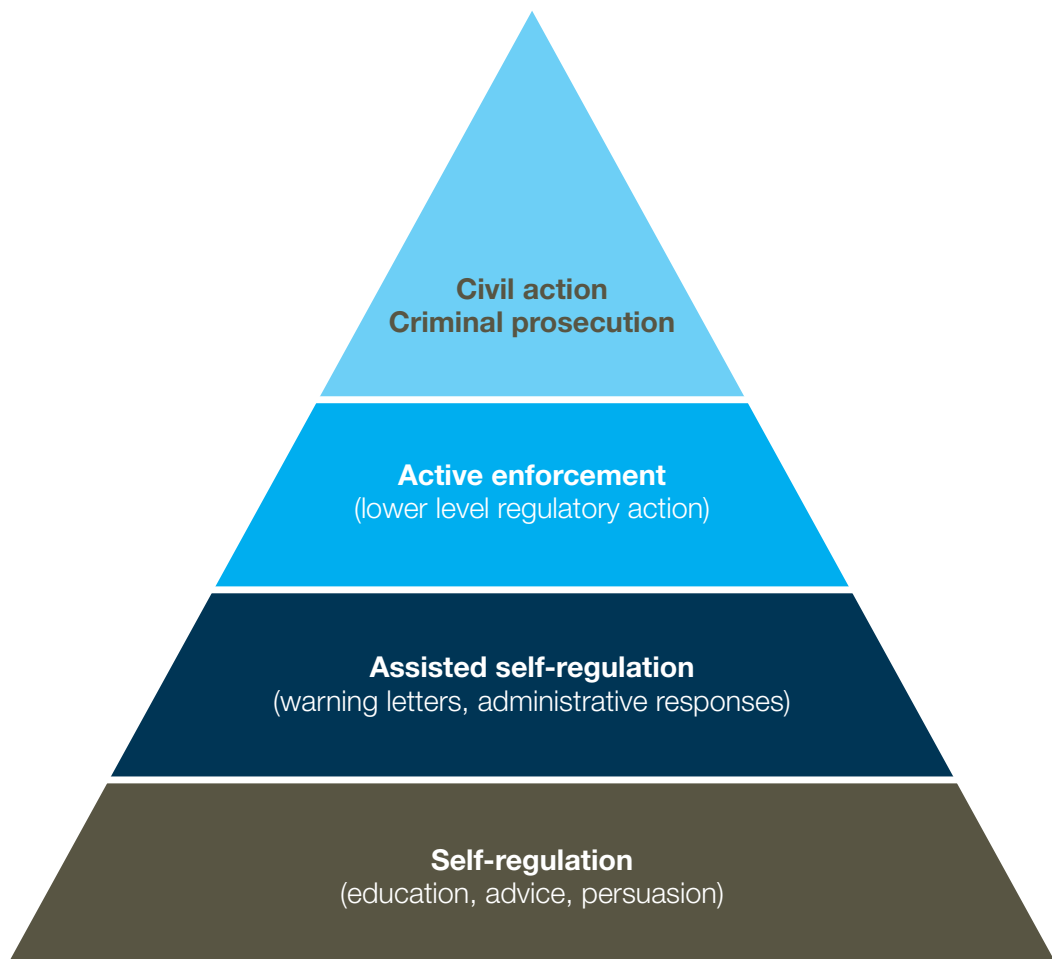
**Australian Defence Force personnel, Innisfail, Qld, post Cyclone Larry, March 2006.**  
Image: Commonwealth of Australia/Sgt John Carroll

One useful framework for considering an appropriate mix of strategies to promote compliance with policy objectives is the compliance/enforcement pyramid which promotes self-compliance as a starting point, with an emphasis on education and cooperative assistance for those at the 'bottom' of the pyramid. Should these strategies fail to achieve compliance, a hierarchy of responses is available, escalating to deterrence through penalties at the 'top' of the pyramid (Figure 1).

Research may be needed to develop a better understanding of the process and instruments that could be used in each category, and how to coordinate them.

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

**Figure 1. Compliance and enforcement pyramid (after Ayres and Braithwaite, 1992).**  
**Hierarchy of regulatory strategies**



High-quality information and education that is designed for specific age, ethnic and cultural groups will allow individuals, communities and businesses to manage their own risks from climate change impacts, including changes in natural hazards. All spheres of government also require an adequate information base for emergency management. Better information could include improved disclosure of agreed climate change risks to community members to inform purchasing decisions and encourage adaptive behaviour, and professional up-skilling to encourage better building design, planning decisions etc.

Financial incentives for better practice are likely to come mainly through the insurance market. For example, insurers may choose to offer reduced insurance premiums for less vulnerable structures and locations. Regulation can be important where there are significant barriers to effective private action or where there are important public goods to protect. The most significant regulations for emergency management are local guidelines or local planning instruments. Regulatory strategies aimed at promoting community preparedness and response to natural disasters vary from

jurisdiction to jurisdiction and serve multiple purposes (for example, building codes set minimum construction standards, planning regulations take account of matters such as urban amenity, heritage values and transport requirements as well as emergency management). Legislation in some states stipulates mandatory compliance with the Australian Building Code or Australian Standards (such as the Risk Management Standard AS4360). Regulation may suffer from a lack of flexibility and unresponsiveness to new science or understandings. Legal instruments are also subject to judicial interpretation, which often makes the precise operation of regulatory measures uncertain until tested in court.

### Research response

The objective of research under this sub-theme is to obtain information that will help decision-makers effect social change towards climate-adaptive behaviour. This will involve identifying the mix of information, incentives and regulatory arrangements that will be most effective in promoting behaviour that increases communities' resilience to climate change risks. Developing this mix may involve identifying theoretical models of social change that can



**The Gap, Brisbane, November 2008.**  
Image: NSW State Emergency Service, Erin Pogmore.

be adapted or applied to the study of natural hazard impacts and climate change, and incorporated into tools of social impact analysis. Assessing post-disaster experience may also provide valuable insights into the best techniques and tools for promoting adaptive behaviour (King, 2002). Ideally, any analysis of policy instruments should be comparative, so that the strengths and weaknesses of different policy options are analysed relative to other options. In order to measure progress and behavioural change, data collection and analysis needs to occur on an ongoing, cyclical basis. Action research and longitudinal studies can contribute to the frameworks in which to study change in the lives of organisations and institutions as well as the community. Action research and longitudinal studies also facilitate collaboration between research agencies and clients.

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

Potential research topics include:

- assessment of the efficacy and cost–benefit of different options for promoting climate change adaptive behaviour, taking into consideration the risks in specific locations, and the cultural and other characteristics of particular communities;
- assessment of the efficacy of collaborative practices that are already occurring, such as cooperative emergency management planning, and whether regulation may be needed to encourage better long-term planning for the impacts of climate change where the market operates on short-term gains (for example, development is continuing in high-risk locations such as low-lying coastal and fire-prone bush areas because

land and property sales provide revenue for local governments and insurance premiums for insurance companies);

- the role of insurance markets in encouraging adaptive behaviour and the possible design of insurance products to achieve these objectives;
- public perceptions of climate change risk and the implications for acceptance and tolerance of risk (Norman, 2000; Pearce, 2003; United Nations, 2005);
- mechanisms by which to ensure that new property developments and infrastructure are constructed in a risk-appropriate manner consistent with local hazards.

## 4.3 Adaptive strategies

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

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

#### Context

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



**Fire near Townsville.** Image: Wally Irwin.

to balance full-time paid work and family responsibilities with higher expectations of compliance and associated training, as well as emergency callouts (Aitken, 2000; Evans and Saxton, 2003; Institute for Volunteering Research, 2004; McLennan, 2006; Parkin, 2008; Paul, 2001; Reinholdt, 2000; Woodward and Kallman, 2001).

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

### **Research response**

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

Possible research questions include:

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

### **4.3.2 What is the role of the private sector in adaptation through emergency management?**

#### **Context**

As climate change increases the frequency and severity of extreme weather events, the private sector must be engaged across the PPRR spectrum, including by contributing to broader societal resilience. How and to what extent this can be done is not clear. In recent years, many of the resources and services provided by local government and utilised by emergency service organisations for response to emergencies at the local level have been outsourced to the private sector. In some cases, therefore, business may become (or may need to become) a contributor to or partner in emergency response. The private sector also plays a critical role in releasing staff to perform volunteer duties, often at times when they are most needed



**Flooding, Coraki, NSW.**

Image: NSW State Emergency Service.

at work. It is not clear to what extent this issue has been accounted for in emergency response planning processes or whether this will further affect resource availability. In some circumstances, business may be a beneficiary of emergency management efforts.

### **Research response**

There is little research – peer-reviewed or otherwise – that considers the role that businesses can play in assisting emergency management organisations to respond to the changing occurrence of natural hazards linked to climate change. Likewise, it is not clear that assessment of potential climate change impacts on the business sector itself (other than possibly in the critical infrastructure area) has been seriously considered, even as a part of a broader business resilience context. This makes it difficult to analyse adequately the ability of the business sector to play a part in the preparedness for, response to, and recovery from climate change impacts on communities.

In order to ascertain how prepared the business sector is to respond to the impacts of climate change, it is important that business understands the risk it faces. As with the broader community, it is not clear that business does in fact understand its risk, let alone factors it into planning. It is only recently that some institutions, such as the Australian Strategic Policy Institute, have commenced dialogue with the business sector about the potential for public–private partnerships in emergency management, albeit not specifically related to climate change.

Research is needed to determine:

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

## **4.4 Regional implications**

### **4.4.1 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 service organisations?**

#### **Context**

This Research Plan is focused specifically on emergency services and disaster/emergency management research needs in an Australian context. There is, however, a need to understand the potential for climate change impacts affecting our near neighbours to produce flow-on effects for Australia, in order

to assess what impact this may have on emergency management in Australia.

There are two strands to this issue: the first relates to the strain likely to be placed on Australia's emergency management capacity if it is increasingly called on to assist its near Pacific Island and South-East Asian neighbours; the second is how climate change may alter the current capacity and equipment-sharing arrangements that Australia currently enjoys, especially with the USA.

Australia typically takes the lead in the humanitarian response when natural disasters strike the south-west Pacific. It is generally agreed that it is in our strategic interest to take a leading role, since it will place additional pressure on Australian emergency services and drive calls for migration if countries in the region become more crisis-prone. Recently, Australia has been active in the region to encourage local resilience – in addition to providing strong support for enhancing emergency management capacity. Less obvious and less formal has been the high degree of engagement by Australian fire agencies in the region. These agencies work with local fire services in Pacific Island countries to improve their training and equipment, and work to reduce fire disasters, thereby enhancing local capacity to deal with the increased risks posed by climate change.

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

### Research response

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

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

A better understanding is also needed of how Australia would manage without international assistance, should available resources become depleted due to the increasing frequency of concurrent climate-driven emergencies occurring here and overseas.



Image: Newspix/Brad Fleet.



## 4.5 Research prioritisation

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

- severity of potential impact/degree of potential benefit;
- immediacy of required intervention/response;
- need to change current intervention/practicality of intervention.

There are three additional *desirable* criteria:

- potential for co-benefits;
- potential to address multiple, including cross-sectoral, issues;
- distribution and equity of the perceived benefits of any adaptation strategy.

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



Clearing storm damage in The Gap, Brisbane, 2008. Image: Commonwealth of Australia/Graham McBean.

Table 2. Research priorities for emergency management

<b>Understanding risk</b>	<b>Priority</b>
<ul style="list-style-type: none"> <li>Where and how are changes in climate going to put us at greatest risk?</li> </ul>	Very High – High
<ul style="list-style-type: none"> <li>What tools are needed to enable decision-making under future climate uncertainty?</li> </ul>	High Priority
<b>Community and organisational resilience</b>	
<ul style="list-style-type: none"> <li>What does community resilience mean in a changing climate?</li> </ul>	Medium
<ul style="list-style-type: none"> <li>What practices and processes promote community preparedness and preventive strategies in a changing climate?</li> </ul>	High – Medium
<ul style="list-style-type: none"> <li>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?</li> </ul>	Very High – High
<b>Adaptive strategies</b>	
<ul style="list-style-type: none"> <li>How will climate change affect the emergency management sector's capacity to support preparedness, response and recovery?</li> </ul>	Very High – High
<ul style="list-style-type: none"> <li>What is the role of the private sector in adaptation through emergency management?</li> </ul>	High
<b>Regional implications</b>	
<ul style="list-style-type: none"> <li>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?</li> </ul>	Medium

# 5. Implementation Plan



A detailed Implementation Plan has been developed to accompany this National Climate Change Adaptation Research Plan for Emergency Management. This section therefore provides a broad overview of the resourcing issues that are likely to arise in the implementation of this Research Plan.

## 5.1 Existing research capacity

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

### Climate change science

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

### Risk analysis

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

### Adaptation policy and practice

Australia is well served by policy research groups within and outside the public sector, but most of these groups do not work in emergency management and, until very recently, paid little attention to climate change adaptation in any context other than the economics of a

low-carbon economy and related trading issues. The establishment of the CSIRO Climate Adaptation Flagship and the National Climate Change Adaptation Research Facility has significantly strengthened and improved the coordination of research capacity in this area.

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

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

## 5.2 Potential collaborations

Given that research funding is limited, it is critical that new activities should avoid duplicating other initiatives. Valuable linkages can be made with state-based projects which will have some congruent outcomes, such as Victoria's Future Coasts and the Queensland Future Coastlines projects.

To ensure that research outputs are capable of easy and prompt uptake, it is essential that the needs of end-users be taken into account early in the design of priority research. Understanding the context and manner in which research will be used will help determine what modes of dissemination and uptake are most appropriate. Very few

end-users will access research through traditional academic publications, preferring instead toolkits, presentations and workshops, interactive web-based material, CDs and DVDs and so on.

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

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

### 5.3 Additional funding sources

In order to fully address the key research objectives outlined in this Research Plan and to undertake essential research programs, it will be necessary to look for additional funding sources other than those made available through NCCARF. Particularly relevant to the National Climate Change Adaptation Research Plan for Emergency Management are key government organisations such as Emergency Management Australia (EMA) and state and territory departments. Likewise, collaborative

research with local governments can attract local government co-funding. Furthermore, the insurance industry has a strong interest in this research. It is already engaged in a range of related research activities, and may contribute further to the research effort both financially and through in-kind support such as knowledge exchange. There may also be opportunities for collaborative funding with R&D corporations (e.g., the CLIMAG program) and the National Health and Medical Research Council.

There are two government grant schemes addressing both ends of the disaster/emergency research spectrum. The Natural Disaster Mitigation Program funds mitigation and preventive projects while also providing money for disaster risk management studies. Australian Disaster Research Grants, on the other hand, enable researchers to study natural disasters in Australia at first hand by visiting disaster areas post-impact.

Funding and resources may also be accessed through Cooperative Research Centres (CRCs) with research agendas relevant to climate change adaptation research in line with this Research Plan.

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

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

- *Discovery Projects*: A variety of fellowships are offered under the scheme to nurture the talents of Australia's most promising early-career researchers and to support established researchers.
- *Discovery Future Fellowships*: Future Fellowships are offered to promote research in areas of critical national importance by giving world-class researchers incentives to conduct their research in Australia.

- *Linkage Infrastructure, Equipment and Facilities:* The scheme fosters collaboration through its support of the cooperative use of national and international research facilities. Essentially, the scheme provides funding for large-scale cooperative initiatives so that expensive infrastructure, equipment and facilities can be shared by researchers in partnered organisations. The ARC may also fund single-organisation proposals in some circumstances.
- *Linkage Projects:* The scheme supports collaborative research and development projects between higher education organisations and other organisations, including within industry, to enable the application of advanced knowledge to problems. Typically, research projects funded under the scheme involve risk. In recommending funding for proposals under Linkage Projects, the ARC may take into consideration the likely benefit of the research to Australian regional and rural communities.
- *Linkage International Projects:* The scheme encourages networks and collaborations between researchers, research teams and research centres of excellence in Australia and overseas. Researchers awarded Linkage International funding may participate in national and international exchanges between research organisations.



**February 7, 2009, Labertouche, Vic.**  
Image: Newspix/Alex Coppel.



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# Appendix 1

## Criteria for setting research priorities in National Climate Change Adaptation Research Plans

The Department of Climate Change and the National Climate Change Adaptation Research Facility are developing a series of National Climate Change Adaptation Research Plans for identified priority theme areas. The Research Plans will identify critical gaps in the information needed by sectoral decision-makers, set research priorities based on these gaps, and identify capacity that could be harnessed to conduct priority research. The criteria listed below will guide the research planning process to set research priorities in the priority theme areas.

### Essential

#### 1. Severity of potential impact/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/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/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

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

	Critical		
	Severity or Benefit	Immediacy	Need to change intervention / Practicality
<b>4.1 Understanding risk</b>  <b>4.1.1.</b> Where and how are changes in climate going to put us at greatest risk?  <b>4.1.2.</b> What tools are needed to enable decision-making under future climate uncertainty?	<b>High</b>  Information is needed for increased understanding of current risks and to inform ongoing planning  Probably of longer-term importance	<b>High</b>  Information is needed for increased understanding of current risks and to inform ongoing planning  Probably of longer-term importance	<b>High–Medium</b>  High probability that better information will influence current practice (increased understanding of risk is capable of informing decisions, but will not necessarily do so)
	<b>High</b>	<b>Medium</b>  Unless the risk profile shows dramatic change, generally of longer-term importance	<b>High</b>  Need better models which incorporate climate change and address the needs of decision-makers
<b>4.2 Community and organisational resilience</b>  <b>4.2.1.</b> What does community resilience mean in a changing climate?  <b>4.2.2.</b> What practices and processes promote community preparedness and preventive strategies in a changing climate?  <b>4.2.3.</b> 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?	<b>High–Medium</b>  Concept of community resilience comparatively new to the emergency management sector, but many current activities contribute to resilience. Research in the area of community resilience may identify additional strategies	<b>High</b>  Building resilience is generally a medium–long-term strategy, so planning needs to commence as soon as possible, informed by agreement on what the objective of a ‘resilient community’ means in the climate change context	<b>High</b>  Reason to believe that targeted interventions can help enhance community resilience
	As above	As above	As above
	<b>Very High–High</b>  Strong need to identify best techniques for mobilising community to adopt positive behaviours and enhance resilience	<b>High</b>  Techniques and understanding needed now in order to implement long-term strategies of social change	<b>High</b>  Reason to believe that interventions will be practicable

Desirable			Overall
Potential co-benefits	Cross-sectoral relevance	Equity considerations	Priority ranking
Low	Mapping of risk will contribute to adaptation planning in other National Climate Change Adaptation Research Plans, e.g., Settlements and Infrastructure		Very High–High Priority
			High Priority
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	Medium Priority
			High–Medium Priority
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 Priority

Critical			
	Severity or Benefit	Immediacy	Need to change intervention / Practicality
<b>4.3 Adaptive strategies</b>			
<b>4.3.1.</b> How will climate change affect the emergency management sector's capacity to support preparedness, response and recovery?	<b>Very High</b> Emergency services already under strain; climate change will exacerbate this	<b>High</b> Need information now to plan for the future	<b>High</b> Reason to believe that emergency management agencies would implement resourcing changes
<b>4.3.2.</b> What is the role of the private sector in adaptation through emergency management?	<b>High</b> The private sector owns significant critical infrastructure and is a 'missing link' in disaster preparedness, response and recovery	<b>High</b>	<b>High</b> Significant scope for enhanced engagement with private sector
<b>4.4 Regional implications</b>			
<b>4.4.1.</b> 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 service organisations?	<b>Moderate</b> But increasing with time	<b>Medium</b> Not immediately a large-scale problem, but there is the possibility that equipment might become unavailable at very short notice	<b>Medium</b> Need to change in the case of off-season agreements, but it is not clear what they should be, given resource limitations. There is less certainty about engagement with our region – but it is likely that it should be much broader to foster local resilience.

Desirable		Overall	
Potential co-benefits	Cross-sectoral relevance	Equity considerations	Priority ranking
	Enhanced resourcing of emergency management sectors will assist with non-climate emergencies /disasters		<b>Very High–High Priority</b>
			<b>High Priority</b>
Addressing these regional implications should help lift resilience for all types of crises.  Potential for solutions in this area to assist regional neighbours – cross-sectoral developmental benefits.		No specific equity issues	<b>Medium Priority</b>



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