



Australian Government  
Productivity Commission

# Barriers to Effective Climate Change Adaptation

Productivity Commission  
Draft Report

April 2012

This is a draft report prepared for further public consultation and input. The Commission will finalise its report after these processes have taken place.

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#### ***The Productivity Commission***

The Productivity Commission is the Australian Government's independent research and advisory body on a range of economic, social and environmental issues affecting the welfare of Australians. Its role, expressed most simply, is to help governments make better policies, in the long term interest of the Australian community.

The Commission's independence is underpinned by an Act of Parliament. Its processes and outputs are open to public scrutiny and are driven by concern for the wellbeing of the community as a whole.

Further information on the Productivity Commission can be obtained from the Commission's website ([www.pc.gov.au](http://www.pc.gov.au)) or by contacting Media and Publications on (03) 9653 2244 or email: [maps@pc.gov.au](mailto:maps@pc.gov.au)

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# Opportunity for further comment

You are invited to examine this draft and provide written comment or attend a public hearing. The deadline for all written responses is Friday 8 June 2012.

The Commission will hold public hearings during early July 2012. The hearings will be held in locations where there is sufficient interest from participants. Those interested in attending the public hearings can register their interest on the inquiry website ([www.pc.gov.au/projects/inquiry/climate-change-adaptation](http://www.pc.gov.au/projects/inquiry/climate-change-adaptation)) or by email ([climate-adaptation@pc.gov.au](mailto:climate-adaptation@pc.gov.au)). Confirmation of dates and venues will be advertised in major newspapers, on our website and through our circulars.

The final report will be prepared after submissions have been received and will be forwarded to the Australian Government in September 2012.

## Commissioners

For the purposes of this inquiry and draft report, in accordance with section 40 of the *Productivity Commission Act 1998* the powers of the Productivity Commission have been exercised by:

Dr Wendy Craik	Presiding Commissioner
Mr Jonathan Coppel	Commissioner
Dr Neil Byron	Associate Commissioner

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## Terms of reference

### **Productivity Commission Inquiry into Regulatory and Policy Barriers to Effective Climate Change Adaptation**

I, Bill Shorten, Assistant Treasurer and Minister for Financial Services and Superannuation, pursuant to Parts 2 and 3 of the *Productivity Commission Act 1998* hereby request that the Productivity Commission undertake an inquiry into regulatory and policy barriers to effective climate change adaptation. The Commission will report within 12 months of receipt of this reference and will hold hearings for the purpose of this inquiry.

### **Background**

Climate change adaptation is action by households, firms, other organisations and governments to respond to the impacts of climate change that cannot be avoided through climate change mitigation efforts. An effective national adaptation response will require all levels of government, the private sector and intermediary markets to contribute to that response.

This inquiry will assist COAG to advance climate change adaptation reforms in Australia by examining the policy frameworks required to facilitate effective adaptation, and the costs and benefits of various adaptation options so as to identify the highest priority reforms. In undertaking this review the Commission will also assess the effectiveness and efficiency of market based approaches in facilitating adaptation.

### **Scope of the Inquiry**

The Commission is requested to assess the regulatory and policy barriers to effective adaptation. In undertaking the review, the Commission should identify any specific barriers that may act to inhibit effective adaptation to unavoidable climate change.

The Commission should identify high priority reform options to address any identified barriers to effective adaptation. The Commission should also:

- examine the costs and benefits of the options to address those barriers where it is feasible to do so, including a 'no change' (maintaining the status quo) option; and

- 
- assess the role of markets (including insurance markets) and non-market mechanisms in facilitating adaptation, and the appropriateness of government intervention.

In undertaking its inquiry, the Commission should take into account the relevant policies of all levels of government and the work on adaptation undertaken under the auspices of COAG. The Commission should consult with relevant Australian Government, state and territory and local government agencies, and other key stakeholders.

The Commission is to provide both a draft and a final report, and the reports will be published. The Government will consider the Commission's recommendations, and its response will be announced as soon as possible after the receipt of the Commission's report.

BILL SHORTEN  
20 September 2011



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- B Australian approaches
- C International approaches
- D Modelling approaches

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# Abbreviations and explanations

## Abbreviations

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABCB	Australian Building Codes Board
AER	Australian Energy Regulator
BCA	Building Code of Australia
BOM	Bureau of Meteorology
CAPP	Coastal Adaptation Decisions Pathways Program
CIPMA	Critical Infrastructure Program for Modelling and Analysis
CGE	Computable General Equilibrium
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
GDP	Gross Domestic Product
GIAM	Global Integrated Assessment Model
GTAP	Global Trade Analysis Project
IAM	Integrated Assessment Models
IPCC	Intergovernmental Panel on Climate Change
LAPP	Local Adaptation Pathways Program
LRP	Legislative Review Program
MMRF	Monash Multi-Region Forecasting
NCCARF	National Climate Change Adaptation Research Facility
NDRRA	Natural Disaster Relief and Recovery Arrangements
OECD	Organisation for Economic Co-operation and Development
PC	Productivity Commission
PE	Partial Equilibrium
RIS	Regulation Impact Statement

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TISN	Trusted Information Sharing Network
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

## Explanations

Draft recommendations	<i>Draft recommendations in the body of the report are highlighted using bold italics with an outside border, as this is.</i>
Requests for further information	<i>Information requests are paragraphs highlighted using italics, as this is.</i>



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# OVERVIEW

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## Key points

- The weight of scientific evidence suggests that the climate is changing and will continue to do so for the foreseeable future.
- Australians would need to adapt to the impacts of a changing climate, notwithstanding current and future efforts to reduce global greenhouse gas emissions.
  - Adaptation encompasses actions by households, businesses, governments and communities.
  - Within limits, the impacts of gradual climate change should be manageable. Few systemic barriers to climate change adaptation have been identified and Australians have a long history of coping with climate variability and structural change.
  - Uncertainty surrounding changes to the frequency, intensity, location and timing of extreme weather events requires a risk management approach to adaptation.
- Policy reforms that would help people, firms and governments deal with *current climate* variability and extreme weather events should be prioritised. These ‘no-regret’ or ‘low-regret’ reforms would deliver benefits and build adaptive capacity for responding effectively to future impacts. Examples include:
  - reducing perverse incentives in tax, transfer and regulatory arrangements that impede the mobility of labour and capital
  - improving information on climate risks by increasing the quality and availability of natural hazard mapping
  - clarifying the roles, responsibilities and legal liability of local governments, and improving their capacity to manage climate risks
  - improving emergency management arrangements
  - avoiding regulatory distortions in insurance markets.
- The case for implementing reforms now to address barriers to adaptation to uncertain *future climate* trends is less clear.
  - For reforms with low up-front costs and potentially large but distant benefits some preparatory action could be worthwhile. The case is stronger for reforms that would deliver benefits under a range of climate change scenarios. For instance:
    - ... producing and disseminating localised (downscaled) climate projections
    - ... designing flexible planning regulation to respond to uncertain climate change impacts
    - ... developing approaches to managing risks to existing settlements.
  - Where measures have high up-front costs, there is likely to be a benefit to the community in deferring action until better information becomes available.
- Some individuals and certain communities are likely to face greater challenges in adapting to the impacts of climate change. In the main, the tax and transfer system can help these groups adapt to the impacts of gradual climate change.

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# Overview

The weight of scientific evidence suggests that Australia's climate is changing and will continue to change for the foreseeable future, notwithstanding climate change mitigation action. Average temperatures and sea levels are projected to rise gradually and rainfall patterns to change. The risk of extreme weather events could increase — such as changes in the location, intensity and frequency of cyclones, droughts or bushfires. Significant uncertainty surrounds these impacts (box 1).

## **Box 1      The science of climate change**

Direct observations of the climate show that average temperatures have increased over the past century both across Australia and globally. The majority of scientific opinion suggests that it is very likely that most of the increase in global average temperatures since the mid-twentieth century is due to increases in greenhouse gas emissions caused by human activities (IPCC 2007c).

Increases in average temperatures are projected to accelerate in the future as global greenhouse gas emissions continue to rise, but climate change is expected to continue to occur gradually, unfolding over decades and centuries.

The timing and magnitude of future changes to the climate are uncertain. Scientific understanding of the climate system is incomplete, and the future trajectory of global greenhouse gas emissions is unclear. Consequently, projections of increases in average temperatures, and changes to other aspects of the climate — such as ocean temperatures, precipitation and extreme weather events — are subject to wide ranges, particularly at regional and local levels.

These changes will affect households, businesses, communities and governments. For example, households could experience hotter summers or be exposed to more severe storms and cyclones. More frequent droughts could affect the viability of some farming businesses and higher temperatures would be likely to change the profile of electricity demand. From the perspective of governments, climate change could increase demand for some services, such as fire-fighting and healthcare, and may require changes to the way these services are provided.

Adaptation involves taking these changes into account in decisions, and where appropriate, taking actions that moderate the threats as well as grasping the new opportunities that are created. Regardless of mitigation efforts to reduce greenhouse gas emissions, some change in climate is inevitable and adaptation will be required (box 2).

## Box 2 What are mitigation and adaptation?

The community can respond to climate change in two broad ways.

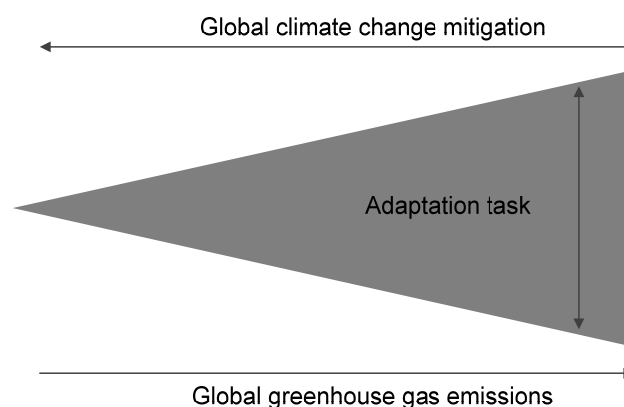
**Climate change mitigation** refers to actions to address the causes of climate change. This generally involves actions to reduce anthropogenic emissions of greenhouse gases that may contribute to the warming of the atmosphere (IPCC 2007c). The carbon price in Australia and the EU Emissions Trading Scheme are examples of mitigation policies.

**Climate change adaptation** refers to actions to respond and adjust to changes in the climate. The inquiry's terms of reference define adaptation as:

... action by households, firms, other organisations and governments to respond to the impacts of climate change that cannot be avoided through climate change mitigation efforts.

Climate change mitigation involves taking steps to reduce or avoid changes in the climate, whereas adaptation involves adjusting to the climate as it changes and the impacts are felt (for example, changing agricultural practices in response to more frequent droughts, or building infrastructure that can cope with higher temperatures).

Some warming of the atmosphere is projected to be 'locked in' due to past greenhouse gas emissions and inertia in the climate system. The extent of future emissions is uncertain, and hinges on many factors — including global population growth, technological change and the outcome of international negotiations to reduce emissions. This means that while mitigation needs to be pursued on a global scale to influence the extent of climate change that occurs, adaptation responses can be pursued independently at the local or national level. This does not mean that climate change adaptation and mitigation are unrelated; the adaptation task will be reduced where global climate change mitigation efforts are strong.





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The Productivity Commission has been asked by the Australian Government to assess regulatory and policy barriers to effective adaptation to climate change, and to identify high-priority reforms to address these barriers. In doing so, the Commission has been asked to examine the benefits and costs of a range of policy options (including market and non-market mechanisms, and the option of maintaining the status quo), and to take into account the relevant policies of all levels of government and the work on climate change adaptation undertaken through the Council of Australian Governments (COAG).

### **What is ‘effective’ climate change adaptation?**

Responding to change and managing risks are a normal part of daily life. Adaptation to climate change can be thought of as a part of this ongoing process of risk management — identifying, evaluating and responding to changes in risks faced to minimise damage from harmful events and maximise gains from new opportunities. Generally speaking, households, businesses and other organisations are capable of managing the climate variability and the risks they face. This is because people have an incentive to assess the costs and benefits of taking action to mitigate the impacts of climate change on themselves. For example, faced with higher summer temperatures, households will make decisions about insulating or shading their homes, buying cooling appliances or even moving location. At the same time, businesses will respond to changes in input costs and consumer demand to remain profitable.

‘Effective’ climate change adaptation should be interpreted to mean adaptation actions that enhance the wellbeing of the community. This can include actions that benefit the community as a whole, or actions that benefit a specific region or group. When people are able to identify and evaluate the impacts and risks they face (for example, through market signals and information), they will generally manage them in a way that makes them better off than would otherwise be the case. Accordingly, individuals, businesses and local communities are best placed to make these decisions in ways that reflect their own circumstances and risk preferences. In most cases, autonomous management of climate risks by households, businesses and communities will lead to outcomes that improve the wellbeing of the community as a whole.

### **What is a ‘barrier’ to effective climate change adaptation?**

The impacts of climate change will be pervasive and adaptation efforts could be impeded in myriad ways. A ‘barrier’ to effective climate change adaptation would

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restrict people's ability to identify, evaluate or manage risks in a way that maximises community wellbeing (box 3). For example, inquiries into recent floods and bushfires have found that the community faces barriers to managing the risks of extreme weather events. Reducing such barriers could assist adaptation over time.

### **Box 3      Barriers to effective climate change adaptation**

Barriers to effective climate change adaptation may result from one or more of:

- *market failures* — conditions that prevent markets from achieving the most efficient allocation of resources. For example, a barrier to adaptation could occur where there is insufficient or inadequate information on climate change impacts for consumers, organisations or the private sector to make well-informed adaptation decisions. Information can be underprovided by private markets when the same piece of information can be used by more than one person and it is difficult to exclude others from using that information (that is, it has 'public good' characteristics). This results in prices too low to deliver the level of information society prefers
- *regulatory barriers* — regulations that inhibit effective adaptation. For example, a lack of integration of building and planning regulation could create a barrier to adaptation where one or neither system addresses a particular environmental hazard (such as riverine flooding) leading to gaps in the regulatory framework
- *governance and institutional barriers* — governance arrangements that are not consistent with best practice and impede coordination between governments and agencies, reduce accountability or lead to authorities being allocated responsibilities for which they do not have sufficient capacity to carry out effectively. For example, the current legal liability of councils is uncertain when making land-use planning decisions relating to land that is subject to future climate change risks. In some cases, councils may defer decisions as they are uncertain about the legal implications of their decisions
- *behavioural barriers* — ways people process information and make decisions, which could act as a barrier to effective adaptation. For example, individuals may have trouble weighing up costs and benefits that occur over long timeframes. As a result, some may respond to the long timeframes and uncertain impacts of climate change by procrastinating and deferring adaptation decisions that would be in their own best interest.

Recognising that barriers to effective climate change adaptation could arise in a range of public policy areas, the Commission has focused on cross-sectoral policy issues rather than identify barriers sector by sector. However, adaptation challenges facing individual sectors (such as agriculture and water) are used as illustrative examples throughout the report.

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## What is the role for government in climate change adaptation?

Most adaptation would occur without the need for government intervention. For example, resource-based industries and associated communities that would be directly affected by climate change are starting to adjust how they do business and manage the risks they face. At the same time, farmers are adjusting crop types and planting times as weather patterns change (box 4).

### **Box 4      Individuals, businesses and governments are already adapting to climate change**

#### **Infrastructure**

Infrastructure owners are already considering the risks of climate change. For example, Brisbane Airport Corporation is considering climate change adaptation in its New Parallel Runway Development. The runway site is potentially subject to inundation. In order to mitigate these risks, the Corporation is raising the site for the development above the projected 1-in-100-year flood level and building a new seawall and tidal channels.

#### **Local governments**

Some local governments have undertaken climate change risk and vulnerability assessments, developed adaptation action plans and taken some actions in response. For example, Redland City Council (Queensland) developed an adaptation plan covering the period 2010–15 in response to an assessment of the climate change risks facing its local area. Specific actions include further analysis of risks, updating bushfire mapping and management plans, and investigating options to manage risks, including ‘planned retreat’. Another example is Clarence City Council (Tasmania), which has adopted a risk management approach to addressing climate change in land-use planning decisions, including the use of ‘triggers’, where approval for development is given until a predefined event occurs.

#### **Agriculture**

Farmers have responded to forecasts of changing weather patterns by modifying crop planting times, crop types (including opportunistic planting of summer or winter crops), and choice of fungicides and fertilisers. For example in parts of Queensland, wheat is now planted three to four weeks earlier than previously (CSIRO 2008).

Moreover, there do not appear to be many policy and regulatory barriers that prevent owners and operators of infrastructure from considering and responding to climate change risks. For example, Sydney Water has implemented a Climate Change Adaptation Program which examines how climate change will affect Sydney Water’s infrastructure, operations and customers. This includes assessing exposure to a range of natural hazards and implementing adaptation responses.

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In responding to the gradual impacts of climate change, the community can draw on its experience of dealing with Australia's already variable climate. In this sense, adaptation to climate change constitutes a form of structural change. The key lesson from past structural changes — such as from trade liberalisation, innovations in information technology and shifts in the terms of trade — is that a well-functioning, flexible economy is crucial to ongoing prosperity in the face of change. Provided Australia's economy has sufficient flexibility in its regulatory and other arrangements that condition choices, households, businesses and communities will be well placed to manage most of the long-term impacts of climate change.

While it is appropriate that households, businesses and the community are responsible for managing the climate risks they face (given that the costs and benefits of adaptation are largely private), governments have a role in facilitating effective adaptation to climate change. This role might include:

- managing climate change risks effectively in their own activities
- ensuring regulatory and policy frameworks do not unnecessarily impede private risk management by limiting flexible and innovative adaptation responses or blunting price signals
- correcting market failures (for example, by arranging for the provision of public goods such as information and disaster-mitigation infrastructure) where the benefits to the community exceed the costs
- managing the distributional impacts of climate change for disadvantaged and vulnerable groups.

The existence of a 'barrier' to effective adaptation only indicates that there is *potential* for governments to improve outcomes by removing or reducing the adverse impacts of that barrier. In some cases, there may be little that governments can do to address identified barriers. In other cases, government policy may impose more costs than the barrier itself. For example, where governments subsidise premiums for household or business property insurance (whether directly or by underwriting risks), the costs to the community are likely to exceed any benefits. In this case, alternative options may be more appropriate for meeting policy objectives.

To identify policy, regulatory and governance barriers, existing policy settings must be assessed to determine whether they provide the right incentives for households, businesses, communities and governments to manage climate change risks. For example, government-provided health services could come under increased pressure due to climate change. The best response is likely to be maintaining an appropriately-resourced, 'fit-for-purpose' health system, while monitoring and evaluating outcomes to ensure that health objectives are being met.

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In contrast, identifying market failures will involve examining whether there are areas where private markets would not adequately promote the wellbeing of the community in the absence of suitable regulation. For example, government policy to improve the general health of ecosystems, habitats and species can increase their resilience to the range of pressures they face and improve their capacity to adapt to climate change.

Managing the distributional impacts of climate change involves recognising that climate change will not affect everyone equally and that specific policy responses may be required to address equity concerns. But care must be taken to avoid interventions that could diminish incentives to manage risks.

### **Identifying reform priorities for adaptation**

There are numerous potential barriers to effective climate change adaptation, and a range of policy options that could be pursued to address them. The challenge for policy makers is to identify the reforms that are most likely to increase the wellbeing of the community. These are the reforms that should be prioritised.

For some policy options, uncertainty about the impacts of climate change can complicate the task of identifying and quantifying the benefits and costs of addressing barriers to effective adaptation. However, as reflected in the ‘precautionary principle’, uncertainty about climate change impacts should not prevent policy makers from taking action to facilitate adaptation by addressing barriers. Instead, the presence of uncertainty is one factor that should be considered when assessing the types of policies that are most likely to increase community wellbeing. In particular, some policy options would be likely to have benefits that exceed their costs under a range of climate scenarios. Reforms with these characteristics should be a higher priority than in areas where there is significant uncertainty about the benefits and costs of action.

#### *The value of a ‘real options’ approach*

One tool that can help to identify reforms that are likely to deliver net benefits is the ‘real options’ approach. The idea behind the real options approach is that in some cases, people have to make decisions under uncertainty. If they have a reasonable expectation that their knowledge will increase in the future to reduce the level of uncertainty, there could be benefits in delaying action (particularly costly action) until better information is available. This is clearly the case with climate change — we know quite a lot about the current climate, but are less certain about future

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climate trends. Understanding of the location, timing and severity of future extreme weather events is less certain again.

In such cases, the real options approach emphasises taking action where there is confidence that the benefits will exceed the costs (which is more likely where there is a greater certainty). Where there is less certainty, policy makers should try to identify options that will help them to address current concerns while retaining flexibility to take further actions in the future.

Climate variability and extreme weather events are having adverse effects today, and there are potential reforms that could help people to better manage the risks they currently face. Such reforms are likely to yield benefits in the current climate, regardless of uncertainty about the future climate. In addition, they are likely to build capacity to adapt to future climate change. For that reason, these reforms should be prioritised, provided the costs are proportionate.

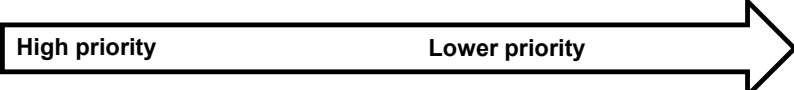
Some reforms would address barriers to adaptation to uncertain future climate trends, and would only have benefits under certain climate change scenarios. The benefits of reforms to address these barriers are much less certain, and as a result, they should be a lower priority. However, where there are low-cost, reversible actions that can be taken to prepare for future climate change, these should be considered.

Reforms of both types have been identified in a range of policy areas, and across all levels of government (figure 1).

### **Prioritise reforms that deliver benefits in the current climate**

Reform measures that offer net benefits to the community regardless of future climate change should be given priority and pursued immediately. The Commission has identified a number of these high-priority ‘no-regret’ measures, as well as some ‘low-regret’ reforms that address more specific barriers to managing risks in the current climate. These should be addressed as soon as is practicable. Examples include barriers in the areas of information provision, local government, land-use planning and building regulation, and emergency management.

Figure 1 Reform priorities by level of government

		
<b>Risks</b>	<i>Current climate risks</i>	<i>Possible future climate risks</i>
<b>Characteristics</b>	High degree of certainty	Significant uncertainty
<b>Effective adaptation</b>	Take action today to improve risk management and build adaptive capacity	Take preparatory actions that are low cost and reversible
<b>Australian Government</b>	<ul style="list-style-type: none"> <li>Review natural disaster recovery arrangements</li> <li>Improve hazard mapping</li> <li>Ensure the National Construction Code takes climate change into account</li> <li>Reform transfers that impede adaptation (such as drought support)</li> </ul>	<ul style="list-style-type: none"> <li>Provide downscaled climate projections</li> </ul>
<b>State and territory governments</b>	<ul style="list-style-type: none"> <li>Clarify the roles, responsibilities and legal liability of local governments</li> <li>Better align building and planning regulation</li> <li>Phase out inefficient taxes (such as taxes on insurance and property transfers)</li> </ul>	<ul style="list-style-type: none"> <li>Make changes to land-use planning regulations to respond to uncertain future climate change impacts</li> </ul>
<b>Local governments</b>	<ul style="list-style-type: none"> <li>Improve communication of hazard information to residents</li> </ul>	<ul style="list-style-type: none"> <li>Consider new planning instruments</li> </ul>
<b>National coordination (possibly through COAG)</b>	<ul style="list-style-type: none"> <li>Clarify roles and responsibilities in emergency management</li> <li>Pursue ongoing economic reforms to enhance flexibility and adaptive capacity</li> </ul>	<ul style="list-style-type: none"> <li>Establish guidelines for managing climate change risks to existing settlements</li> </ul>

### *Economic reform can build the adaptive capacity of the community*

Economic reform that addresses market failures, or addresses the unintended consequences of current policies, could improve people's management of current climate risks. Existing policies may limit the ability of markets to reallocate resources in response to extreme weather events and future climate change. For instance, taxes on property transfers (stamp duties) can inhibit the movement of labour and capital and the efficient use of land, and state and territory insurance taxes and levies can distort the ways in which households and businesses manage the risks they face. Replacing these inefficient taxes with less distortionary taxes, such as broadly based land taxes, would likely enhance economic performance, as well as the community's ability to respond to a changing climate.

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Other barriers arise when government policies, such as some government transfers, reduce incentives for people to manage their own risks. For example, in its current form, government support during drought reduces incentives for agricultural businesses to be self-reliant and impedes economic and social adjustment to changing circumstances. Implementing the reforms recommended in the Commission's 2009 drought policy inquiry (PC 2009) would enhance incentives for agricultural businesses to adapt to both the current and future climate.

*The quality and coordination of hazard risk information could be improved*

There is significant scope for improving information provision relating to natural hazards in the current climate such as flooding, cyclones and bushfires. Households, businesses and governments require this information to effectively prepare for and manage natural hazards. There is a role for governments to produce or acquire this information in order to undertake their own functions, but also to provide it to the broader community. For example, local governments require information on hazards to make effective land-use planning decisions. Households and businesses also need information on hazards to support decisions on where to locate or how to protect their properties.

The Australian Government is currently in the process of developing guidelines for future flood mapping and is establishing a single portal, hosted by Geoscience Australia, to make all government-held flood maps (including those of state, territory and local governments) publicly available. This initiative should be expanded over time to cover other natural hazards. Where feasible, the guidelines should take into account the potential impacts of climate change. It will also be important to accompany this with regular consultation between providers and users of climate change information, so that all hazard maps provided through this portal can be used effectively by end users, including local governments.

*Government provision and funding of climate information*

Governments already provide a range of information on climate change trends, projections and impacts to the public. However, scientific uncertainties and the costs of provision mean there are limits to the information governments can acquire and use themselves, or provide to the public. Public funding decisions for adaptation information and research will need to be made on a case-by-case basis and informed by the best available evidence.

Widespread dissemination of the information that governments have collected and used themselves will inform the public policy debate, as well as give individual



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non-government entities substantial platforms for making informed adaptation decisions. Those companies or households that desire more detailed or localised information should expect to pay for that information themselves, unless there are strong public good elements that warrant government provision.

*Effective local government is crucial to managing climate risk*

Local governments have an important role to play in assisting communities to understand the impacts of climate change and in establishing and implementing options to address climate risks. The Commission has identified several barriers to effective service delivery by local governments in the current climate.

- *The roles and responsibilities of local government are not particularly clear* — these include responsibilities for managing the risks of climate change, especially in the areas of land-use planning and emergency management, but also extend to many areas beyond adaptation. As a first step to clarifying these roles and responsibilities, state and territory governments should compile and publish a comprehensive and up-to-date list of laws that impose responsibilities on local governments.
- *Local governments have capacity constraints* — shortages of professional and technical expertise, and financial constraints, are preventing some councils from planning for climate change and implementing effective adaptation actions. There is also inadequate information and guidance to support local government decision making — a large volume of guidance material is currently provided to councils to assist them to make decisions about adaptation, but this does not appear to be meeting the requirements of some councils.
- *Legal liability concerns are hindering adaptation for many local governments* — for instance, some councils are reluctant to release information on the vulnerability of properties to climatic events because they are concerned that this could negatively impact on the value of some properties or lead to legal disputes. In other cases, it may be perceptions about legal liability that are hindering effective adaptation, rather than the underlying legal arrangements themselves.

It is not always clear which of these factors (or combination of them) constitute the most significant barriers. Nonetheless, there is clearly a need for reform. Local governments are established by state and territory legislation and have various responsibilities conferred on them through state and territory laws. It is the responsibility of state and territory governments to ensure that councils have the capacity to fulfil their regulatory functions, including those that relate to climate change adaptation. This includes clarifying where legal liability for adaptation lies and the appropriate processes for councils to manage their liability.

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### *Emergency management arrangements could be improved*

Improving the management of emergencies in the current climate will enhance the management of future risks as the intensity, frequency, duration or location of extreme weather events change. While the whole community has a role to play in managing emergencies, governments have a specific role of providing ‘public goods’ relating to emergency management. These can include early-warning systems, disaster-mitigation infrastructure, and funding for emergency-response services.

The effectiveness of emergency management could be improved by better coordinating and clarifying the roles and responsibilities of emergency service providers. As reviews after recent disasters (such as the Victorian bushfires and Queensland floods) have shown, roles and responsibilities are sometimes unclear, overlap, or there are gaps in coverage. While some state governments have commenced reform in this area, further work is required.

Effective emergency management also requires striking the right balance between preventing and preparing for disasters on the one hand, and responding to and recovering from them on the other. Following recent disasters, concerns have been raised that both private and government prevention and preparedness actions have been inadequate, imposing significant costs on the community after a disaster has occurred. Improving the balance will require better coordination between infrastructure planning and funding, along with detailed planning that assesses all possible options for managing emergencies, within a cost–benefit framework.

Existing Australian Government funding of states’ and territories’ costs to rebuild infrastructure following a natural disaster — the Natural Disaster Relief and Recovery Arrangements — may give rise to ‘moral hazard’. This could occur where states do not face the full cost of rebuilding infrastructure and thus may have reduced incentives to ensure that infrastructure is resilient to extreme weather events, or to make decisions about its design and location that could reduce the costs to the wider community. While some initial steps have been taken in response to this issue, the Australian Government should commission an early public review of these arrangements, ideally with a preliminary report to be delivered prior to the start of the 2012–13 summer. It should consider alternative arrangements, including the use of lump-sum funding and appropriate cost–benefit analysis of reform options in all phases of emergency management: prevention, preparedness, response and recovery.

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### *Planning and building regulations could be better integrated*

In some cases, the vulnerability of people and buildings to climate change impacts will depend on how well building standards (which generally control how to build) and planning regulations (which generally control where to build) are integrated in managing environmental hazards. However, there is evidence that, in some cases, building and planning regulations have not been well integrated. Efforts to better align these systems would lead to benefits in both the current and future climate.

In some cases, the distinction between building and planning regulation is blurred. For example, where local governments impose building regulation through local planning instruments, this can create duplication and overlap in regulation. In other cases, one or neither system addresses a particular hazard (for example, riverine flooding), leading to gaps in the regulatory framework.

### **The case for reforms to help manage an uncertain future climate is less clear**

Some barriers to adaptation may not be having material effects today, but could prevent effective adaptation to the long-term effects of climate change (such as sea-level rise). Because the impacts of climate change would arise over a long period, such reforms might not deliver material benefits until many years into the future and could have material costs now. In these cases, the rationale for an immediate government response is weaker.

Reforms that have relatively low current costs and potentially large, but highly uncertain, benefits in the distant future are not recommended as priorities. While there could be a case for preparatory action in these circumstances, the case is likely to be stronger where benefits will be realised under a range of climate scenarios.

### *Information is required to support adaptation to the future climate*

Just as better information on climate hazards could improve the ability of the community to manage current climate risks, better information about climate change could improve the community's ability to plan for future climate risks.

Governments could usefully provide local-scale projections of climate change. These projections, generated by 'downscaling' global-scale climate projections, would expand the information available for effective climate change adaptation to both governments and the community.

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### *Land-use planning regulation needs to be flexible to respond to climate change*

Land-use planning regulation in Australia has, until recently, been based on an assumption of a static climate and variable weather patterns. In recent years, as data have become more reliable, governments and regulators have begun to consider projected climate change impacts. However, the extent to which planning frameworks incorporate expected climate change impacts varies considerably by jurisdiction and type of hazard.

Where planning systems are modified to take into account climate change, regulations should:

- facilitate a risk management approach
- incorporate transparent and rigorous community consultation processes and take into account the community's acceptable levels of risk for different types of land use
- consider the full costs and benefits of land use from a community-wide perspective.

A risk management approach to land-use planning could include real options and regular monitoring of risks and adaptive responses by all levels of government. This would require flexible planning frameworks at the state and territory level, such that local governments can use a range of planning instruments to manage risks in their local area, including some potentially novel approaches for new development approvals. For example, some local governments are trialling 'time-bound' or 'trigger-bound' tools (where approval for development can be given for a specified time period only, or until an identified event occurs — a 'trigger') so that land-use planning decisions better reflect climate change risk as it develops.

There is evidence that state and territory planning frameworks do not readily accommodate such approaches. It is important that state and territory planning regulation enables local governments to adopt a risk management approach to climate change in local schemes. Land-use planning systems are regularly reviewed and several state and territory governments are currently undertaking reviews of land-use planning settings. These review processes provide an opportunity to ensure that planning regulation is sufficiently flexible to respond to the impacts of climate change.

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*New approaches may be needed to manage climate change risks to existing settlements*

Addressing climate change risks for existing areas of human settlement requires consideration of whether, how and when governments should ‘protect’ cities or towns, or relocate communities from high-hazard risk areas. Currently, there is no well-established policy response to this issue.

It may be necessary to develop national approaches or principles to support strategic management of climate change risks for existing settlements. Following this inquiry, the COAG Select Council on Climate Change and any successor should consider these issues when developing national adaptation priorities and work plans.

### **Managing the distributional impacts of climate change**

Some people have less capacity than others to adapt to the impacts of climate change. Disadvantaged groups may find it more difficult to identify the risks they face, and may have less capacity to manage those risks. In some cases, the impacts of climate change could exacerbate the causes of disadvantage.

The impacts of climate change are just one among an array of challenges likely to be faced by disadvantaged individuals and communities in the future. Structural adjustment associated with climate change will occur in the context of ongoing economic, social, political and technological change. Measures to alleviate disadvantage and manage distributional impacts should reflect the range of influences, rather than focusing on climate change adaptation alone.

This report proposes a range of reforms that would deliver benefits in both the current and future climate contexts. These reforms are intended to improve the adaptive capacity of the community as a whole, including those people and groups with less capacity than others to adapt to climate change. For example, improving emergency management arrangements would lead to improved preparation for and recovery from natural hazards, benefiting affected members of the community. In the main, the social security and tax systems, and other standard adjustment measures (such as job search, placement and training services), will be the most appropriate means of assisting the adjustment process and moderating adverse distributional impacts (PC 2001b). In the event of extreme climatic events, more targeted, temporary support measures would likely be important to complement the social safety net, but care must be taken to avoid measures that diminish the incentive to manage risk.

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## Implementing adaptation reforms

The effects of climate change will be experienced at a local level. This suggests that local governments, followed by state and territory governments, will be responsible for most government adaptation actions and for implementing many of the reforms to remove barriers to adaptation.

- Local government reforms include improving the communication of climate change information to local communities, particularly with respect to climate hazards, and the incorporation of new land-use planning instruments into planning systems.
- State and territory governments will need to provide support to local government. In particular, it is necessary for state and territory governments to clarify the roles, responsibilities and legal liability of local governments and to ensure they have adequate resources to fulfil their functions.
- The Australian Government should support the efforts of local, state and territory governments by addressing barriers to effective adaptation that are national in scale, or where a national or regional approach can be delivered more efficiently. This includes reforms to better coordinate emergency management responses and research and information provision. Beyond these areas, there is no apparent broad coordinating role for the Australian Government. Adaptation-specific reforms that require national coordination could be pursued through the COAG Select Council on Climate Change and any successor.

Australian, state and territory government agencies have a role in addressing barriers to effective climate change adaptation in their own portfolio areas. For example, Australian Government agencies such as Geoscience Australia, the Bureau of Meteorology, the CSIRO and the Climate Commission are well placed to improve the quality and availability of information about the impacts of climate change and develop tools to assist the formulation of adaptation strategies. More broadly, all levels of government should manage climate change risks in their areas of policy responsibility.

Addressing barriers to climate change adaptation will also require coordination and agreement between levels of government, including in difficult and contentious areas of policy requiring strong political leadership.

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# Draft recommendations

## Assessing reforms and setting priorities

DRAFT RECOMMENDATION 4.1

*Reforms to address barriers to effective risk management in the current climate should be implemented without delay, where they are likely to deliver net benefits.*

*In relation to barriers to adaptation to uncertain future climate trends, the case is less clear.*

- Where a reform has low up-front costs and potentially large benefits, albeit with long time periods between the costs being incurred and the benefits being received, there could be a case for preparatory action. The case is likely to be stronger if the reform will deliver benefits under a range of climate change scenarios.*
- Where measures have high up-front costs, the community is likely to benefit by deferring high-cost options until better information becomes available.*

## Building adaptive capacity

DRAFT RECOMMENDATION 5.1

*Australian governments should implement policies that help the community deal with the current climate by improving the flexibility of the economy. This would also build adaptive capacity for dealing with future climate change. This includes reforms to:*

- taxes that influence the way resources are used, such as land tax exemptions and conveyancing duty, which could inhibit the mobility of labour, capital, or both*
- government transfers that reduce incentives to adjust to changing circumstances, such as the reforms recommended in the Commission's 2009 inquiry into drought support*
- regulations that impose unnecessary costs or inhibit competition or flexibility and could impede climate change adaptation by reducing the ability of firms, households or other organisations to respond to changing circumstances, such as restrictions to water trading.*

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## Information provision

### DRAFT RECOMMENDATION 6.1

*The Australian Government initiative to improve the coordination and dissemination of flood-risk information should be expanded over time to encompass other natural hazards. Guidelines to improve the quality and consistency of risk information should be regularly updated and take climate change into account where feasible.*

## Local government

### DRAFT RECOMMENDATION 7.1

*There is uncertainty about the roles and responsibilities for adaptation by local governments, including in the areas of land-use planning, coastal management, and emergency management. As a first step to clarifying these roles and responsibilities, state and Northern Territory governments should publish a comprehensive list of laws which delegate regulatory roles to local governments. This would assist state, territory and local governments to assess whether local governments have the capacity to effectively discharge their roles.*

### DRAFT RECOMMENDATION 7.2

*Uncertainty about the legal liability of local governments is emerging as a barrier to effective climate change adaptation. State and Northern Territory governments should clarify the legal liability of local governments regarding climate change adaptation matters and the processes required to manage that liability.*

## Planning and building regulation

### DRAFT RECOMMENDATION 8.1

*As a priority, land-use planning systems should be revised to ensure that they are sufficiently flexible to enable a risk management approach to incorporating climate change risks into planning decisions. In doing this, consideration should be given to:*

- transparent and rigorous community consultation processes that enable an understanding of the community's acceptable levels of risk for different types of land use*
- the timeframe of risks and the expected life time of proposed land use*
- the costs and benefits of different types of land use.*



*As a priority, the Building Ministers' Forum should ensure that the National Construction Code and associated standards (including those developed by Standards Australia) take climate change impacts into account. As soon as practicable:*

- the Building Ministers' Forum should provide a formal response to the Australian Building Codes Board's 2010 review of the Building Code of Australia under climate change*
- the Australian Building Codes Board should develop a formal work program that outlines its approach to incorporating climate change in the National Construction Code over time. This work program should reflect any formal government response to the 2010 review of the Building Code of Australia.*

*The Australian Government should give consideration to the public funding requirements for the Australian Building Codes Board and Standards Australia to undertake this work.*

*The Council of Australian Governments' Select Council on Climate Change should consider, as part of its adaptation work plan, appropriate responses to managing the risks of climate change to existing settlements in high-hazard risk areas.*

## **Emergency management**

*The Australian Government should commission an independent public review of the Natural Disaster Relief and Recovery Arrangements. This review should commence as soon as possible and desirably produce a preliminary report by the end of October 2012. The review should consider whether the arrangements lead to inadequate infrastructure investments or insurance decisions, or reduce the incentives of state and territory governments to appropriately manage their risks. It should also examine alternative arrangements or funding models.*

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## The role of insurance

### DRAFT RECOMMENDATION 12.1

*State and territory taxes and levies on general insurance constitute a barrier to effective adaptation to climate change. State and territory governments should phase out these taxes and replace them with less distortionary taxes.*

### DRAFT RECOMMENDATION 12.2

*The Australian Government should only proceed with reforms that require all household insurers to offer flood cover if it can be demonstrated that the benefits to the wider community would exceed the costs. These benefits and costs should be assessed, and any reforms implemented, after barriers to effective climate change adaptation in other policy areas are addressed.*

### DRAFT RECOMMENDATION 12.3

*Governments should not subsidise premiums for household or business property insurance, whether directly or by underwriting risks. This would impose a barrier to effective adaptation to climate change.*

## Reform priorities

### DRAFT RECOMMENDATION 13.1

*The Australian Government should focus on national policy responses in areas such as emergency management, research and information provision. Existing agencies will have a role in managing policy responses in these areas.*

*The Council of Australian Governments' Select Council on Climate Change, and any successor, should coordinate policy responses in areas where cooperation between levels of government is required.*

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# Information requests

## *Hazard risk information*

### INFORMATION REQUEST 6.1

*How useful are property title documents, property certificates, rates notices and rental contracts as means for communicating natural hazard risk information to households and businesses? What alternatives are available? What costs and risks would state and local governments incur in providing such information?*

## *Local governments' legal liability*

### INFORMATION REQUEST 7.1

*The Commission notes the current arrangements in New South Wales to limit the legal liability of local governments through the Civil Liability Act 2003 (NSW) and the Local Government Act 1979 (NSW), and seeks further information on whether this approach (or alternatives) could fully address the legal liability issues facing local governments in other jurisdictions when dealing with climate change adaptation.*

## *Planning and building regulation*

### INFORMATION REQUEST 8.1

*To what extent do current state and territory land-use planning frameworks facilitate or impede the use of different land-use planning tools, such as time-limited development approvals or 'triggers'? What changes are required to state and territory planning frameworks to address any impediments?*

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INFORMATION REQUEST 8.2

*The Commission seeks views on individual, business and community preferences for managing the risks of climate change for existing settlements.*

- *What levels of climate change risk are appropriate for existing settlements? Does this differ for private and public assets?*
- *What approaches should governments take to ensure these levels of 'acceptable' risk are maintained?*
- *In what circumstances should governments use 'protect', 'accommodate' or 'retreat' options for managing climate change risks to existing settlements?*

INFORMATION REQUEST 8.3

*The Commission is seeking submissions on gaps or overlaps between land-use planning and building regulations that may act as barriers to adaptation.*

*Infrastructure*

INFORMATION REQUEST 9.1

*Are there any examples where the economic regulation of infrastructure has impeded investments to facilitate adaptation?*

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# 1 Introduction

The Australian Government has asked the Productivity Commission to assess regulatory and policy barriers to effective climate change adaptation.

## 1.1 The background to this inquiry

The weight of scientific evidence indicates that the earth's climate is changing. While there is uncertainty about the precise timing, size and location of climate change impacts, current projections indicate that over the coming decades people will have to adapt to higher average temperatures, rises in sea levels, changing rainfall patterns and more intense and possibly more frequent extreme weather events.

Most adaptation to climate change will occur autonomously, as households, businesses, governments, community groups and other organisations respond to environmental changes and market signals to manage the climate risks they perceive. However, barriers to adaptation could arise due to certain characteristics of markets, institutional and governance arrangements, government policies and the way people make decisions.

The Commission's tasks are to identify barriers to effective climate change adaptation, to identify high-priority reform options to address these barriers and to examine the policy frameworks required to facilitate effective adaptation.

### **The Australian adaptation policy framework**

Acting through the Council of Australian Governments (COAG), the Australian, state and territory governments agreed on a *National Adaptation Framework* in 2007. This set out 15 policy areas for potential adaptation action. The Australian Government allocated \$126 million over five years in the 2007-08 budget to implement the framework. This funding is in place until the end of the 2011-12 financial year.

More recently, the Australian Government position paper on adaptation to climate change 'sets out the Australian Government's vision for adapting to the impacts of

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climate change and proposes practical steps to realise this vision’ (DCCEE 2010a, p. 1). Climate change adaptation has been incorporated into a number of Australian Government policy areas, including water, agriculture and emergency management (appendix B). Some state and territory governments have enacted climate change legislation which includes provisions for adaptation, while others have adopted dedicated adaptation strategies (appendix B). Intergovernmental coordination of adaptation continues for the coming year through the COAG Select Council on Climate Change, which is responsible for developing national adaptation priorities and work plans. (The Select Council is due to provide a final report to COAG on 31 March 2013.)

Governments of other countries have begun to address the challenge of climate change adaptation by enacting policy frameworks and strategies (box 1.1). At an international level, the Cancun Adaptation Framework, to which the Australian Government is a party, commits signatories to implement adaptation measures (appendix C).

#### **Box 1.1 Selected countries’ adaptation policy frameworks**

##### **United Kingdom**

The UK Government has adopted an explicit legislative framework to support adaptation. Under the Climate Change Act (UK) 2008, the Government must assess climate change risks and implement strategies to manage these. The UK Climate Impacts Programme disseminates a range of information and guidance, and large utilities and their regulators are required to report on how they are addressing climate change risks. Further, an Adaptation Sub-Committee has been established to advise the UK Government on adaptation policy.

##### **United States**

At the federal level, the US Government provides climate-related research and information, and requires federal government agencies to implement strategies to manage climate change risks. In addition, some state and local governments have adopted adaptation frameworks and strategies, which often set out how climate change will be considered in infrastructure, planning and environmental decisions.

##### **New Zealand**

The New Zealand Government provides information to facilitate adaptation, including some guidance for local governments. At the national level, there is no formal legislative or policy framework for climate change adaptation.

*Source:* Appendix C.

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## Defining ‘effective’ climate change adaptation

The inquiry terms of reference ask the Commission to ‘assess regulatory and policy barriers to effective adaptation’, but leave the meaning of ‘effective adaptation’ open to interpretation. Inquiry participants expressed a range of views on the meaning of ‘effective’ adaptation.

Adaptation to climate change refers to actions taken by households, businesses, other organisations, governments and communities in response to the impacts of climate change (box 1.2). It can include actions taken pre-emptively to reduce the risks of climate change impacts, or in response to impacts as they happen.

### Box 1.2 Some key concepts in climate change adaptation

#### Adaptation

There are numerous definitions of climate change adaptation. For example, the terms of reference for this inquiry define adaptation as:

... action by households, firms, other organisations and governments to respond to the impacts of climate change that cannot be avoided through climate change mitigation efforts.

Other definitions have included adaptation by ecosystems as well as human societies, and have emphasised that adaptation will involve taking advantage of opportunities, as well as responding to threats (IPCC 2007a; UNDP 2004).

#### Maladaptation

‘Maladaptation’ refers to adaptation actions that ultimately leave the community worse off — the costs of maladaptive actions exceed their benefits.

#### Adaptive capacity and resilience

Faced with uncertainty about the impacts of climate change, it is impossible for households, businesses and governments to prepare for every possible eventuality. However, people can take actions that increase their ability to deal with impacts as they arise. Two concepts that relate to this idea are ‘adaptive capacity’ and ‘resilience’.

- Adaptive capacity is the ability to adjust to new ways of doing things in the face of climate change (including moderating damages, taking advantage of opportunities and coping with consequences).
- Resilience is the ability to experience and recover from external impacts (that is, to ‘bounce back’) (IPCC 2001; UNDP 2004).

Both concepts refer to the ability to deal with uncertain future impacts. In the context of this inquiry, the practical differences between adaptive capacity and resilience do not seem significant. Barriers to adaptation could limit adaptive capacity and resilience, and reforms to address barriers could increase both adaptive capacity and resilience.

Sources: IPCC (2001, 2007a); UNDP (2004)

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In general, ‘effective’ refers to producing the desired result. So the definition of ‘effective adaptation’ depends on the objective of adaptation. The *Productivity Commission Act 1998* (Cwlth) directs the Commission to have regard to the need to achieve ‘higher living standards for all members of the Australian community’. Taking this as the overall objective of public policy, ‘effective adaptation’ could be defined as action taken in response to the impacts of climate change that increases the wellbeing of the community, taking into account all of the positive and negative impacts, the distributional impacts and the timing of the impacts.

This definition recognises that there is an ‘optimal’ level of adaptation. The community could undertake too little adaptation, or too much. Adaptation could be done too early, or too late, and actions could be pursued in locations or sectors of the economy that do not deliver the best possible outcomes. As the Australian Industry Greenhouse Network (sub. 29, p. 1) observed, it is not possible to measure the overall level of adaptation or target a particular level as optimal:

... just as the rate of climate change at a local level is not yet able to be measured, the rate of efficient adaptation for businesses is also unable to be assessed as ‘too much’ or ‘too little’ at any point in time.

However, by assessing individual adaptation actions it may be possible to identify options that are likely to take the community closer to the optimal level (if the benefits exceed the costs) or leave it further away (if the costs exceed the benefits).

The benefits and costs of reforms to address barriers to adaptation could include market impacts (which can be measured in dollar terms) and non-market impacts (such as ecosystem conservation). To be ‘effective’, adaptation would need to increase the wellbeing of the community, taking into account all of the benefits and costs. Given that climate change is expected to take place over many decades, the timing of the impacts of reforms would also need to be explicitly considered.

Identifying options that will increase the wellbeing of the community is complicated by the uncertainty about future climate change impacts. But uncertainty should not lead to inaction. Decision-support tools exist that can help decision makers identify policy options that are likely to increase community wellbeing. One approach is the ‘precautionary principle’, which states that uncertainty about the future should not justify failure to take cost-effective action to prevent irreversible damage. The ‘real options’ approach can help to identify cost-effective reform options that are likely to increase the wellbeing of the community (chapter 4).



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Equity is also an important consideration, and was raised by several inquiry participants in response to an issues paper published in October 2011 (box 1.3). For example, Good Shepherd Australia New Zealand (sub. 20, p. 2) observed that:

Climate change will impact on each individual differently depending on their age, occupation, gender, region, socioeconomic status and other factors and there will be a widely varying degree of adaptive capacity and resilience depending on one's unique situation.

Disadvantaged groups are likely to have less capacity to adapt to the impacts of climate change than the rest of the community. Remote Aboriginal and Torres Strait Islander communities, often already experiencing disadvantage, could experience particularly significant impacts. The distributional effects of reforms to address barriers to effective climate change adaptation should be taken into account to determine whether they are likely to increase the wellbeing of the community as a whole.

### **Box 1.3 'Effective adaptation' — participants' views**

#### **Alternative definitions**

Some participants proposed alternative definitions of 'effective adaptation' or additional considerations that should be taken into account. For example, the Tasmanian Government (sub. 51) broadly agreed with the proposed definition, while emphasising that the effects on the community and the environment and the timing of adaptation are important elements of effective adaptation.

The Department of Climate Change and Energy Efficiency (sub. 57, p. 4) stated that: 'Effective adaptation is the ability to make and implement the best possible decisions', and that the characteristics of 'effective adaptation' include action that is 'proportionate', 'robust', 'iterative' and 'cross cutting'.

Bluescope Steel (sub. 8, p. 3) stated that the definition 'should include and encourage the development of resilience in our built environment, economy and communities'.

#### **Equity**

Several participants recommended that the definition of 'effective adaptation' should take into account the effects of adaptation actions on disadvantaged groups. For example, the Victorian Local Governance Association (sub. 3, p. 4) stated:

... interventions and strategies that disproportionately benefit those individuals or groups with the least capacity for taking action on their own will bring a higher overall net benefit to the community as a whole.

The Brotherhood of St Laurence (sub. 74) also emphasised the importance of considering marginalised groups, as did the Australian Institute of Aboriginal and Torres Strait Islander Studies (sub. 62), Good Shepherd Australia New Zealand (sub. 20), the NCCARF Adaptation College (sub. 21) and other participants.

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## 1.2 The scope of the inquiry

The focus of this inquiry is on reforms to policy frameworks that would address barriers to effective adaptation. The role of the inquiry was not to identify particular infrastructure or building projects that should or should not be carried out (or projects that should have been carried out already). Nonetheless, the scope of the inquiry is broad. It covers:

- both the long-term impacts arising from gradual climate change (such as changes in rainfall patterns) and the impacts of extreme weather events
- adaptation by people (individually and collectively) to the impacts of climate change and reforms that could reduce barriers to adaptation by ecosystems
- the effects of reforms on people in different areas (reforms that benefit people in one area could have negative effects on people in other areas)
- the effects of reforms on people with different levels of income and wealth
- the effects of reforms over time (because the impacts of climate change will take place over an extended period, the benefits and costs of reforms could accrue to future generations).

As specified in the terms of reference, the inquiry took into account relevant policies at all levels of government in Australia, as well as intergovernmental approaches (such as through COAG).

Most emissions-reduction policies fall outside the scope of the inquiry. For example, the issue of how households will ‘adapt’ to higher electricity prices arising from a carbon price is outside the inquiry’s scope. Globally, climate change mitigation policies will be relevant for adaptation in the sense that they could influence the degree and nature of the climate change to which people will have to adapt. But in general, most domestic mitigation policies are unlikely to constitute a barrier to adaptation, and as such were not directly relevant to this inquiry.

## 1.3 The Commission’s approach

The Commission has been guided by the terms of reference and the Productivity Commission Act. In broad terms, the approach has been to:

- identify potentially significant barriers to effective adaptation
- assess whether there is a case for reform
- identify options for reform (including maintaining the status quo)

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- consider which reform options would most likely deliver a net benefit
  - set priorities for reform with a view to increasing the wellbeing of the community as a whole.

The characteristics of climate change have guided the Commission's approach to assessing reform options. In particular, there is significant uncertainty about the nature and magnitude of the impacts of climate change, particularly at a local scale (which is where the majority of adaptation actions will need to take place). Also, the impacts of climate change are expected to occur over an extended period, which has implications for the standard cost–benefit analysis framework.

While uncertainty and long timeframes do pose challenges for policy analysis, the overall goal of public policy remains the same: to implement reforms that are likely to deliver net benefits to the community as a whole in the long term. This overall objective has guided the Commission in making its recommendations for reform priorities (chapter 4).

- Some reforms would deliver net benefits by removing barriers to effective risk management in the current climate, and would constitute a good base on which to develop further adaptation responses as the climate changes in the future. These reforms should be implemented without delay.
- For reforms that have large up-front costs, and potentially large but distant benefits, there could be a case for taking some preparatory action now. The case is likely to be stronger if the benefits would be expected under a range of climate change scenarios.
- Where the costs of reforms are large, and the benefits highly uncertain, there could be benefits in delaying action until better information is available and the benefits are more certain.
- Reforms to address barriers to adaptation should be reviewed to determine whether they have been effective.

## **1.4 Conduct of the inquiry**

The terms of reference for this inquiry were received from the Assistant Treasurer on 20 September 2011.

The inquiry was advertised in national and metropolitan newspapers, and was promoted on the Commission's website. The Commission has consulted widely with stakeholders, drawing on input from participants through visits, roundtable discussions and written submissions (appendix A). The Commission released an

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issues paper in October 2011, and received 79 submissions prior to the release of this draft report.

It is important to note that this is only a draft report, and is being made available for interested parties and the general public for their consideration and response. Further submissions are invited, and public hearings will be held following the release of the draft report. The Commission will then prepare a final report, which it will submit to the Australian Government in September 2012.

The Commission is grateful to all inquiry participants for meeting with Commissioners and staff, participating in roundtables, making written submissions and providing other information to the Commission.

## **1.5 Guide to the report**

There are three parts to the report. The first part (chapters 2–4) sets out some background information and describes the approach the Commission has taken to assessing barriers and reform options. Key issues for this section include the potential impacts of climate change, some policy-relevant characteristics of climate change (such as uncertainty and long timeframes), the different types of barriers to adaptation, and the analytical framework the Commission has used to assess reform options and set priorities.

The second part of the report assesses reform options in a range of policy areas. The focus of chapter 5 is on reforms across broad areas (such as tax reform and water policy) that would enhance the community's ability to deal with the impacts of climate change. Chapter 6 deals with the role of information in climate change adaptation, barriers that might lead to inadequate provision of information, and the possible role for governments. Subsequent chapters assess barriers faced by local governments (chapter 7), barriers in planning and building regulations (chapter 8); the development, financing and regulation of infrastructure (chapter 9); emergency management (chapter 10); environmental and health services (chapter 11); and the role of insurance (chapter 12). The final chapter (13) summarises reform priorities.

The main body of the report is supported by appendixes that describe Australian and overseas approaches to adaptation (appendixes B and C respectively), and the use of modelling tools in climate change and adaptation policy analysis (appendix D).

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## 2 Understanding and responding to the impacts of climate change

### Key points

- Climate change is projected to lead to higher average temperatures, rises in sea levels and changes in rainfall patterns. These changes are projected to occur gradually.
- Climate change is also projected to change the frequency and intensity of extreme weather events such as heatwaves. These changes may be more noticeable than gradual changes, though individual extreme weather events cannot be easily attributed to climate change.
- The magnitude, timing and geographic location of many of these changes is subject to significant uncertainty. Key sources of uncertainty include the future trajectory of greenhouse gas emissions, effects of mitigating policies and incomplete scientific understanding of the impacts of greenhouse gases on the climate system.
- These changes are expected to have diverse and complex impacts on industries, communities and the natural environment.
  - Within limits, there are many reasons to believe these impacts are manageable. Australia has a long history of coping with climate variability and has handled many diverse, complex and uncertain structural changes in the past.
- Responding to climate change impacts will involve building adaptive capacity and taking actions to adapt to anticipated climate changes.
  - Possible measures to enhance adaptive capacity include improving the ability and preparedness of society and the economy to deal with change, and the provision of accurate and timely information on potential impacts and options for adaptation.
  - The actions taken by individuals, communities, firms and governments to adapt are likely to vary widely reflecting differences in exposure to climate change, perceptions of the future, preferences for time and risk, underlying adaptive capacity and other factors relevant to adaptation decisions.
  - In some cases actions to adapt may be 'transformational', but the Commission has not identified any examples of transformational action that require fundamental changes to regulation or policy frameworks.

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Australia's climate is projected to change significantly over the next century. Average temperatures and sea levels are expected to gradually rise and rainfall patterns to gradually change. Extreme weather events such as heatwaves and droughts could also alter in intensity, frequency, location and duration.

These changes could have far reaching economic, social and environmental consequences, but are also subject to significant uncertainty. This reflects an incomplete scientific understanding of the climate system and the unclear future trajectory of global greenhouse gas emissions. Extreme weather events, which may be the main way that climate change is experienced, are generally subject to greater uncertainty than gradual changes.

Adaptation to climate change can help to moderate the threats and grasp the opportunities that come with climate change. However, the uncertainty, as well as the diversity, complexity and long timeframes associated with climate change impacts, generates challenges for adapting to climate change and developing adaptation policy. Australia's experience coping with climate variability and confronting a range of previous structural changes and shocks to the economy suggest that, within limits, many aspects of these challenges are manageable.

## **2.1 Projected climate change for Australia**

Eulogised by Dorothea Mackellar (2010, p. 3) as a land 'of droughts and flooding rains', Australia has a long history of dealing with climate variability and weather extremes. The historical variability of Australia's rainfall significantly exceeds that of comparable locations around the world (Nicholls, Drosowsky and Lavery 1997). Farmers recognise drought as a normal feature of their operating environment and many native plants and animals have evolved to cope with extended periods of low rainfall (BOM 2010; Botterill and Fisher 2003). Other weather-related events such as bushfires, floods and cyclones have an equally long history.

In addition to a high degree of natural variability, Australia's climate is changing. Since 1950, the CSIRO and Bureau of Meteorology (BOM) (2007) note a warming trend of 0.16°C per decade, an increase in the frequency of extremely hot days and nights, and a decrease in extremely cold days and nights. During the twentieth century, sea levels around Australia also rose about 1.2 mm per year (Church et al. 2006).

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Projections of future climate change include gradual changes to a range of climate variables including average temperatures, precipitation and sea level.<sup>1</sup> As a consequence of these gradual changes, projections also suggest changes in the frequency and intensity of extreme weather events (such as heatwaves and hailstorms) although these projections tend to be more uncertain. These two forms of climate change are likely to have different implications for climate change adaptation.

## **Gradual changes**

### *Temperature*

Average annual temperatures are projected to increase across Australia over coming decades. By 2070, the average temperature increase for Australia as a whole is projected to be between 1.0°C and 2.5°C under a ‘strong mitigation’ scenario, and between 2.2°C and 5.0°C under a ‘no mitigation’ scenario relative to 1990 (CSIRO and BOM 2007). As the wide ranges of these projections indicate, there is a significant degree of uncertainty about future temperature increase even when a particular future emissions path is assumed (section 2.2). The size of the temperature increase also varies by location with inland areas generally projected to experience larger increases than coastal areas (figure 2.1).

### *Precipitation*

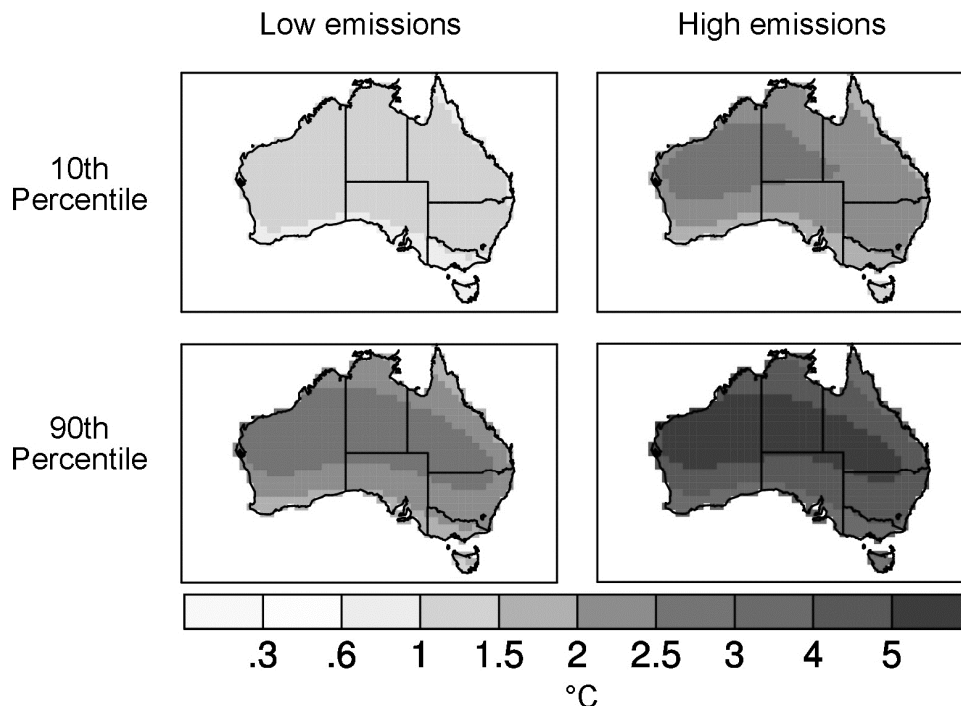
Precipitation is affected by factors such as wind patterns and retention of water vapour in the atmosphere, both of which are altered by rising atmospheric temperatures (CSIRO and BOM 2007). Changes in precipitation are subject to greater uncertainty than changes in temperature as the relationship between greenhouse gas emissions and precipitation is less direct and hence less well understood.

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<sup>1</sup> Most climate change projections discussed in this section are drawn from the CSIRO and BOM’s 2007 technical report *Climate Change in Australia*, which incorporates findings from the Intergovernmental Panel on Climate Change’s (IPCC) Fourth Assessment Report. Projections of gradual changes are presented for both ‘strong mitigation’ and ‘no mitigation’ scenarios. The former reflects the IPCC’s ‘B1’ scenario based on an economically integrated world successfully pursuing a global agreement to reduce greenhouse gas emissions. The latter reflects the IPCC’s ‘A1FI’ scenario based on a world categorised by fossil-fuels intensive rapid economic growth.

**Figure 2.1 Projected temperature increase to 2070<sup>a</sup>**

Annual average temperature increase relative to 1990



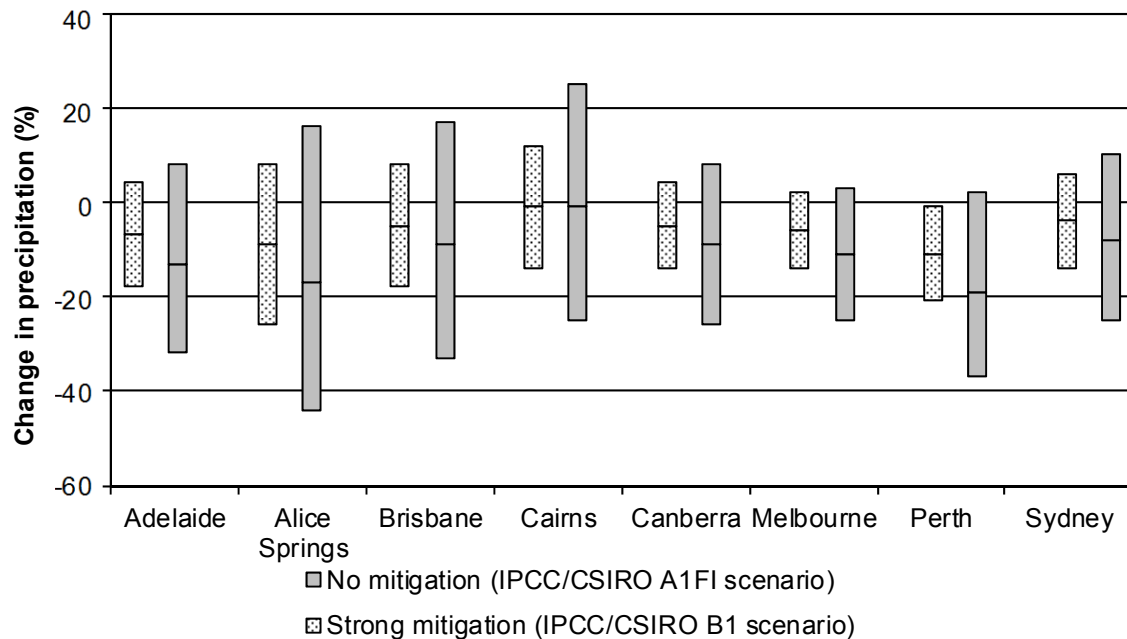
<sup>a</sup> 'Low emissions' refers to the IPCC/CSIRO B1 scenario. 'High emissions' refers to the IPCC/CSIRO A1FI scenario. The 10th and 90th percentile refer to the lowest 10 per cent and highest 10 per cent of the spread of model results.

Source: Adapted from CSIRO and BOM (2012).

Projected changes in average annual precipitation vary widely across Australia. In general, best estimates suggest little change in precipitation in the far north and decreases in precipitation across the rest of the country over the coming decades. The largest decreases in precipitation are projected for central and southern Australia regardless of the emissions scenario (figure 2.2). However, the range of estimates under each scenario is wide, and it is not possible to rule out an increase in precipitation due to climate change in many locations. For example, in Cairns, the CSIRO and BOM project that the impact of climate change on precipitation could range from an increase of 25 per cent to a decrease of 25 per cent by 2070 under a no mitigation scenario (CSIRO and BOM 2007)



**Figure 2.2 Projected change in precipitation to 2070<sup>a</sup>**  
Change in average annual precipitation relative to 1990 in selected cities



<sup>a</sup> Each band represents the projected likely range of precipitation change for the given location and scenario. The midpoint of each band represents the best estimate of change in precipitation.

Source: CSIRO and BOM (2007).

### Sea level

Sea levels are projected to rise significantly over the twenty-first century. In the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report (2007c), average global sea-level rise over the period from 1990 to 2100 was projected to be between 18 cm and 38 cm under a strong mitigation scenario and between 26 cm and 59 cm under a no mitigation scenario. Sea-level rise around Australia's coastline is expected to be in line with global average projections, though the rise along Australia's east coast may be higher (CSIRO and BOM 2007).

There is, however, significant uncertainty about future global sea-level rise, particularly with regard to the contribution of melting ice sheets. In the Fourth Assessment Report, the IPCC noted that accelerated ice flow in Greenland and the West Antarctic could significantly increase the contribution of ice sheets to sea-level rise, increasing the upper bounds of the scenario ranges given above by 10–20 cm. Several studies conducted after the release of the Fourth Assessment Report have also suggested significantly higher upper values for sea-level rise when a larger contribution from ice sheets is considered (CAWCR 2011). For example,

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Katsman et al. (2011) estimated that under a no mitigation scenario, global average sea-level rise could be between 55 and 115 cm by 2100.<sup>2</sup>

## **Extreme weather events**

### *Drought*

Climate change is likely to affect the frequency of drought differently across regions. Using a soil-moisture measure of drought<sup>3</sup> which reflects rainfall and evaporation, Mpelasoka et al. (2008) estimated the impact of climate change on drought using a range of climate models. Results suggest changes in the frequency of drought ranging from negative 20 per cent to positive 80 per cent by 2070 relative to present conditions depending on location and the trajectory of future emissions. The largest increases in drought frequency were projected to take place in south-western Australia.

### *Bushfire weather*

As much of Australia becomes hotter and drier, the risk of bushfire is projected to increase. A common measure of the risk of bushfire is the McArthur Forest Fire Danger Index. The index takes into account factors such as temperature, wind speed, humidity and fire fuel availability, and is commonly represented as a fire danger rating ranging from ‘low’ to ‘extreme’. Analysis by Lucas et al. (2007) suggests the number of very high or extreme fire danger days is likely to increase significantly in most locations across south-eastern Australia. For example, in Melbourne the number of these days is expected to increase from the current average (1973–2007) of 9.0 per year to between 9.8 and 11.1 by 2020 and between 10.8 and 14.7 by 2050.

### *Hailstorms*

The impact of climate change on hailstorms is difficult to forecast as storms are not captured by most global and regional climate models. However, analysis of

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<sup>2</sup> Katsman et al. (2011) assumes a global average temperature rise of 2–6°C by 2100. This range is roughly in line with, but slightly wider than, the IPCC A1FI scenario range.

<sup>3</sup> Soil moisture is just one of many possible measures of drought. Soil-moisture deficiency is most closely related to ‘agricultural’ and ‘hydrological’ definitions of drought. Drought may also be defined and measured solely in terms of rainfall (‘meteorological’ drought) or in terms of the effects of elements of drought on human wellbeing (‘socio-economic’ drought) (Hennessy et al. 2008).

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conditions known to be favourable to hailstorms indicates that the frequency of hail is likely to decrease (perhaps by 1 to 2 days per year) along the southern coast of Australia and increase (perhaps by 4 to 6 days per year) along the eastern coast of Australia by 2070 relative to 1990 (CSIRO and BOM 2007).

The intensity of hailstorms may also be affected by climate change. Modelling of hailstorms over Sydney suggests that the frequency of storms with large hail could significantly increase. For example, using a moderate scenario for future emissions, the likelihood of hail with a diameter of 6 cm or more could increase from once every eight years to a once every five years by 2050 (Leslie, Leplastrier and Buckley 2008).

### *Storm surge and coastal flooding*

A storm surge refers to a temporary elevation of sea level in a particular region due to a combination of strong winds and falling atmospheric pressure (CSIRO and BOM 2007). Coastal flooding due to storm surge is likely to increase with climate change as sea levels rise, because increases in average sea level have a ‘multiplier effect’ on the frequency of high sea-level events including those due to storm surge. While future sea-level rise is highly uncertain, given a sea-level rise of 50 cm, sea-level heights that have historically occurred once every ten years could occur roughly once every ten days on average (Church et al. 2008).

### *Extreme precipitation*

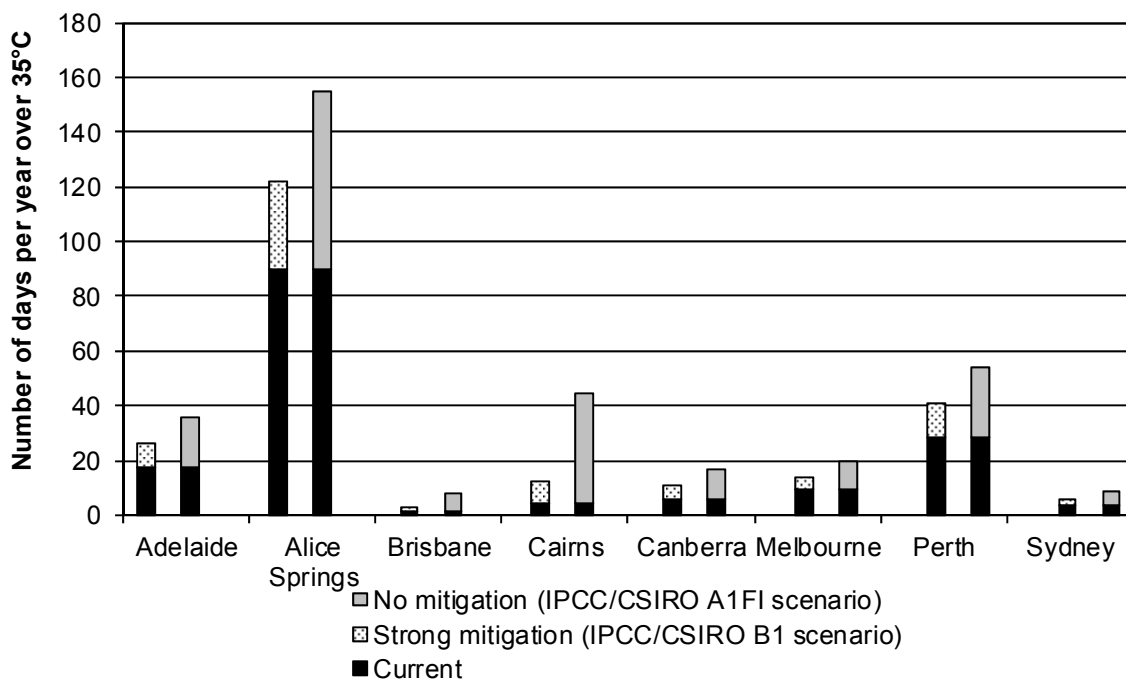
In general, future precipitation is projected to be characterised by ‘longer dry spells interrupted by heavier precipitation events’ (CSIRO and BOM 2007, p. 73). However, precise projections of extreme rainfall are difficult due to the indirect relationships between climate change and precipitation. Projected changes in the intensity of extreme precipitation events also vary by location and season. Using a moderate estimate of future emissions, projections by the CSIRO and BOM (2007) suggest increases in annual extreme precipitation to 2050 are greatest in the far north of Australia, where average precipitation is little changed. However, the intensity of extreme precipitation also increases over Tasmania and parts of Victoria and central Australia, while average precipitation is projected to decline in these areas.

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## Extreme heat

The frequency of hot days (over 35°C) is projected to increase substantially, though the size of the increase varies greatly by location (figure 2.3). The duration of heatwaves is also projected to increase (Alexander and Arblaster 2009).

**Figure 2.3 Projected frequency of days over 35°C per year in 2070<sup>a</sup>**  
Selected cities



<sup>a</sup> Columns show the best estimate for the average number of hot days per year under each scenario.

Source: CSIRO and BOM (2007).

## Cyclones

Projections for tropical cyclones vary, reflecting a range of uncertainties about regional climate change and the tropical cyclone response (Grossmann and Morgan 2011). Studies generally agree that an increase in the intensity of cyclones is likely, but that the overall impact on cyclone frequency is less clear (Abbs 2009; Leslie et al. 2007; McGregor, Walsh and Nguyen 2004). Simulations by Abbs (2009) suggest a substantial decrease in the frequency of tropical cyclones, a slight decrease in the duration of cyclones and a southward shift of cyclone activity across Australia by 2070. However, earlier studies focused on the east coast of Australia project little to no change in cyclone frequency during the first half of this century (Leslie et al. 2007; McGregor, Walsh and Nguyen 2004).

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## 2.2 Challenges of climate change

Studies have suggested that the economic impacts of unmitigated climate change are likely to be significant (box 2.1) In addition, the expected impacts of climate change are diverse, complex, changing over time, subject to long timeframes, often highly uncertain and differ by individual, region and industry. Each of these characteristics poses challenges to adaptation decision making and policy making.

### Box 2.1 Modelling the economic impacts of climate change

A number of studies have attempted to model the economic impacts of climate change globally. Estimated impacts in 2100 vary from a 1 per cent decrease in GDP to an 11 per cent decrease, depending on the assumptions used in the models.

For Australia, studies such as Garnaut (2008b) and Gunasekera (2008) have estimated the impact of climate change in 2100 to be around a 5–6 per cent fall in GDP.

Garnaut (2008b) also provides estimates for the expected impact by industry and state. While output is expected to fall for most industries, the modelling suggests that the two most heavily affected industries are likely to be agriculture (a 20 per cent fall in output by 2100) and mining (a 13 per cent fall in output by 2100).

The most heavily affected states and territories in 2100 were estimated to be Queensland, the Northern Territory and Western Australia (with 9–10 per cent falls in gross state product). The timing of the impacts also varies by state — for example, impacts were estimated to be minimal for Western Australia in the early part of the century, due to its large wheat sector (which is expected to benefit from climate change initially).

Source: Appendix D.

### Diversity and complexity of impacts

The consequences of climate change for life in Australia are likely to be numerous and diverse. For example, Garnaut (2008b) noted a wide range of resource-based industries which could be directly impacted by climate change including dryland and irrigated cropping, livestock production, fisheries, forestry, mining, horticulture, alpine tourism and winemaking.

The impacts of climate change will also vary by location and over time. For instance, the wheat industry is sensitive to a range of climatic factors including carbon dioxide concentration, temperature and rainfall patterns, and the overall impact on yields is a function of the interaction of these factors. Analysis by the CSIRO and the Queensland DPIF (2008) suggests that wheat yields can be expected

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to increase in most regions over the medium term (2030) due to increased carbon dioxide availability. However, over the longer term (2100) the projected impacts vary widely from region to region. Localised changes in temperatures and rainfall patterns over the longer term mean that in some regions yields are projected to be significantly increased and in others significantly reduced.

The impacts of climate change present opportunities as well as threats. For example, changes in current flows off the east coast of Australia may increase the availability of a number of fish species, such as tropical tuna, potentially providing new revenue sources for the fisheries industry (Hobday, Poloczanska and Matear 2008).

The potential impacts of climate change are not limited to the economic sphere. For instance, a variety of potential health impacts have been noted including increased fatalities from natural hazards such as bushfires, increased incidence of heat-related illness and death, and increased transmission risk for mosquito-borne infectious diseases such as dengue fever (Bambrick et al. 2008). Climate change is also likely to significantly impact ecosystems (box 2.2).

### **Box 2.2    The impacts of climate change on ecosystems**

Climate change entails a wide variety of threats to ecosystems, often exacerbating existing environmental problems. Direct and indirect threats include extended droughts, invasive weeds and pests, altered fire regimes, direct temperature effects, increases in salinity and other water quality issues, and changes in water availability (CAWCR 2011). Areas of the greatest biodiversity such as south-west Western Australia and the wet tropics of far north Queensland are expected to be the most severely affected.

Marine ecosystems are also particularly vulnerable to climate change. For example, mass coral bleaching events at the Great Barrier Reef are likely to occur more frequently than in the past even if strong mitigation proceeds. If climate change continues unabated, the Great Barrier Reef is likely to be altered markedly as coral reefs deteriorate and many fish species decline (GBRMPA 2009).

*Sources:* Australian Centre for Biodiversity (2008); CAWCR (2011); GBRMPA (2009).

The potential impacts of climate change are not just diverse but also complex. A vast array of interdependencies exist between different sectors of the economy, society and the natural environment. This complexity means that some of the indirect effects of any given climate change impact may be difficult to predict in advance. The interdependencies of critical infrastructure (many elements of which may be potentially impacted by climate change — box 2.3) illustrate this point. For example, an extreme weather event causing a large-scale disruption to electricity supply could have knock-on effects for telecommunications infrastructure and transportation systems (including trains). In turn, these secondary impacts could

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limit communications and transportation access, making it more difficult for emergency services to respond to the original extreme weather event and for victims to access hospitals.

There are also many interdependencies between adaptation and mitigation activities. For instance, adaptation to higher temperatures could result in increased energy demand for cooling, increasing greenhouse gas emissions and making the future adaptation task more difficult. On the other hand, urban planning measures that reduce the heat island effect and building designs that incorporate passive cooling techniques may act as both adaptation and mitigation measures (IPCC 2007b).

### **Box 2.3    The impacts of climate change on critical infrastructure**

Infrastructure for a wide range of critical services may be affected by climate change via increases in the frequency and/or intensity of extreme weather events, higher sea levels, higher temperatures and decreased rainfall. Critical services potentially affected include electricity, water supply, sewage treatment, telecommunications, water management and transportation. Facilities for various public services such as parks, hospitals and defence buildings may also be impacted.

Over the long term, sea-level rise coupled with high sea-level events such as storm surges could also have particularly significant implications for coastal settlements. At the extreme, the Department of Climate Change and Energy Efficiency has estimated that a very high sea-level rise of 1.1 metres coupled with a high sea-level event<sup>4</sup> could place more than 100 000 residential, commercial and industrial buildings at risk of inundation or erosion.

*Sources:* DCC (2009b); DCCEE (2011); Maunsell Australia (2008a, 2008b, 2008c).

## **Timing and uncertainty**

Some aspects of climate change will be experienced gradually over time, but others may be felt more suddenly. This is because small changes in averages can translate into large changes in the probability of extreme values. Hence, small changes in the averages of climate variables are sometimes projected to lead to significant increases in the frequency of extreme weather events (IPCC 2007c; Katz and Brown 1992). For example, while individual heatwave events cannot be easily attributed to climate change, increases in the frequency and intensity of heatwaves may be more noticeable than gradual changes to average temperatures.

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<sup>4</sup> For Tasmania, Victoria and New South Wales a 1-in-100 year event, for all other states and territories a 'very high tide'.

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## Box 2.4 What is uncertainty?

Uncertainty means different things to different people. Many academic disciplines have developed their own meanings and systems of classification for uncertainty (Thunnissen 2003). Consequently, the way in which estimates of uncertainty are presented in the inter-disciplinary field of climate change is the subject of much debate (Dessai and Hulme 2004). As the IPCC (2007a, p. 131) has noted:

Communicating about risk and uncertainty is difficult because uncertainty is multi-dimensional and there are different practical and philosophical approaches to it.

Economists commonly draw a distinction between 'risk', to define a situation where an outcome is unknown but the likelihood of different outcomes can be quantified, and 'true uncertainty' where an outcome is unknown and the likelihood of different outcomes is not measurable (Dr Leo Dobes, sub. 63; Knight 2002). Many of the uncertainties in climate change fall somewhere in between these two definitions. Climate models can often be used to estimate the likelihood of different outcomes, but estimates from different models do not always agree due to differences in underlying data or assumptions. Hence, the likelihood of different outcomes can often be estimated, but the estimates of likelihood are themselves subject to uncertainty.

Some researchers also distinguish between reducible uncertainty that results from incomplete knowledge about the processes that influence events ('epistemic uncertainty') and irreducible uncertainty that results from the inherently unpredictable nature of human and natural systems ('stochastic and reflexive uncertainty'). Many climate change uncertainties arguably fall into the latter category including future greenhouse gas emissions which are dependent on human behaviour, and aspects of the climate system which are chaotic in nature (Dessai and Hulme 2004; Walker et al. 2003). In other words, some aspects of climate change uncertainty may be reduced over time through further scientific research and observation, but others may be unknowable and hence irreducible.

*Sources:* Dessai and Hulme (2004); Dr Leo Dobes (sub. 63); IPCC (2007a); Knight (2002); Thunnissen (2003); Walker et al. (2003).

The timing and magnitude of future climate change impacts, whether sudden or gradual, is difficult to predict (box 2.4). And the further into the future that impacts are projected, the greater the uncertainty. Key sources of uncertainty include the future trajectory of greenhouse gas emissions (which will be affected by the degree to which global mitigation is effective); the impact of feedback loops on the carbon cycle;<sup>5</sup> the sensitivity of the global climate to greenhouse gas emissions; how global

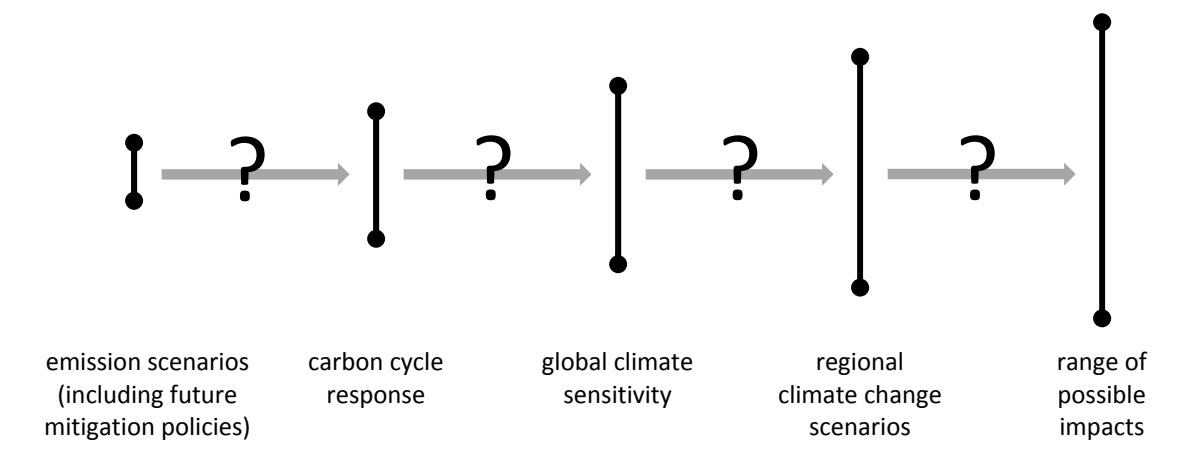
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<sup>5</sup> The carbon cycle refers to the continual exchange and recycling of carbon through different parts of the Earth system including the atmosphere, the oceans, vegetation, and the organic matter in soil and sediments (including fossil fuels) (NOAA 2009). Carbon uptake by land and oceans is driven by physical and chemical processes, such as photosynthesis and oceanic circulation, which are affected by changes in climate and atmospheric carbon dioxide, creating a range of feedback loops (Field and Raupach 2004).



climate change will translate to regional climates; and how regional climate change will affect individuals, firms and governments taking into account their ability to respond and adapt. Each of these uncertainties builds on the last, leading to what Schneider (2004) describes as a ‘cascade’ of uncertainties (figure 2.4).

**Figure 2.4 The cascade of climate change uncertainties**



*Sources:* Based on IPCC (2007a) and Schneider (2004).

This cascade of uncertainties means that the impacts of climate change on a given ecosystem, community or industry are seldom clear. In some cases it may not even be obvious whether the net impacts of climate change are positive or negative. For example, in the forestry sector different aspects of climate change are likely to have both positive and negative effects and the net result is uncertain (box 2.5).

Climate change is also subject to a special category of uncertainty — the surprise. Surprises refer to unanticipated outcomes. Surprises are distinguishable from regular uncertainty because they refer not just to a lack of certainty about an outcome but to a lack of knowledge about the existence of an outcome (Stirling 2003). Climate change is susceptible to surprise because of the complexity and non-linearity of the climate system, incomplete understanding of that system and the rapid rate of climate ‘forcing’ (that is, the increasing concentration of greenhouse gases) (Schneider 2004).

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### **Box 2.5    The impacts of climate change on the forestry sector**

Climate change is likely to have a range of effects on the forestry sector, some beneficial and others detrimental. Most directly, higher carbon dioxide levels may increase the areas where forestry is viable and have positive impacts for productivity, particularly for plantations with short rotations. However, the beneficial impact of carbon dioxide availability is highly uncertain and may be constrained by reduced water availability and the poor nutrient status of Australia's soils.

Changes in temperature and precipitation could also influence forestry sector productivity, but the effects are mixed. While higher temperatures may reduce the incidence of frost and expand growing seasons in cooler areas, higher evaporation rates may also reduce water supply, and the increased frequency of very hot weather may lead to heat stress in some species. Furthermore, reduced precipitation in the southern areas of Australia where plantations are concentrated is likely to reduce productivity and increase tree mortality.

Changes in the frequency and intensity of extreme weather events and related natural hazards such as cyclones, storms, droughts and bushfires are also likely to have significant effects. For example, increases in the frequency and intensity of bushfires may cause more regular loss of plantations, alter the composition of native forests and exacerbate soil erosion. Trees subjected to drought or water logging also tend to be more susceptible to pests and diseases.

Given the mix of possible effects and uncertainty with regard to both the magnitude of future climate change and the sensitivity of the forestry sector to specific changes, the net impact of climate change on forestry is unclear.

*Source:* ABARE (2008).

## **2.3    Responding to climate change impacts**

Climate change poses significant and unique challenges. How individuals, firms, governments and other organisations respond to these challenges will have important implications for community wellbeing. Drawing on research from the natural sciences, climate change researchers refer to the collective response to the impacts of climate change as 'adaptation' (chapter 1). Applying this terminology, responding to climate change can take two related forms: building the capacity to adapt and taking actions to adapt.

From the perspective of economics, climate change adaptation may also be considered an example of a 'structural adjustment' to the economy, akin to the information technology revolution or trade liberalisation. That is, climate change adaptation is the sum of numerous decisions made by individuals, firms and other organisations in response to the incentives created by an external change.

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## **Building adaptive capacity**

Adaptive capacity refers to the ability of individuals, firms, governments and communities to adjust to new ways of doing things in the face of climate change (chapter 1). As such, it is a function of the availability of resources. In particular, Ellis (2000) highlights five forms of capital that underlie the capacity to adapt (figure 2.5). These resources tend not to be evenly distributed within and between communities and consequently not all individuals and communities are equally capable of adapting at any given point in time. However, these resources can also be accumulated over time (some by individuals and some by communities) and converted from one form to another. The adaptive capacity of an individual or community is therefore subject to change.

Adaptive capacity is also a function of resource use. In particular, the degree of flexibility in resource use, the capacity to organise resources and the capacity to learn from experience about the best use of resources (Cinner, Fuentes and Randriamahazo 2009; Stokes and Howden 2010). For example, the adaptive capacity of a community to respond to a bushfire depends on the ease with which people, vehicles and water can be deployed to different locations, how well people are organised to fight a fire and how well they have learnt from recent experience about the best ways to prepare to fight or escape a fire.

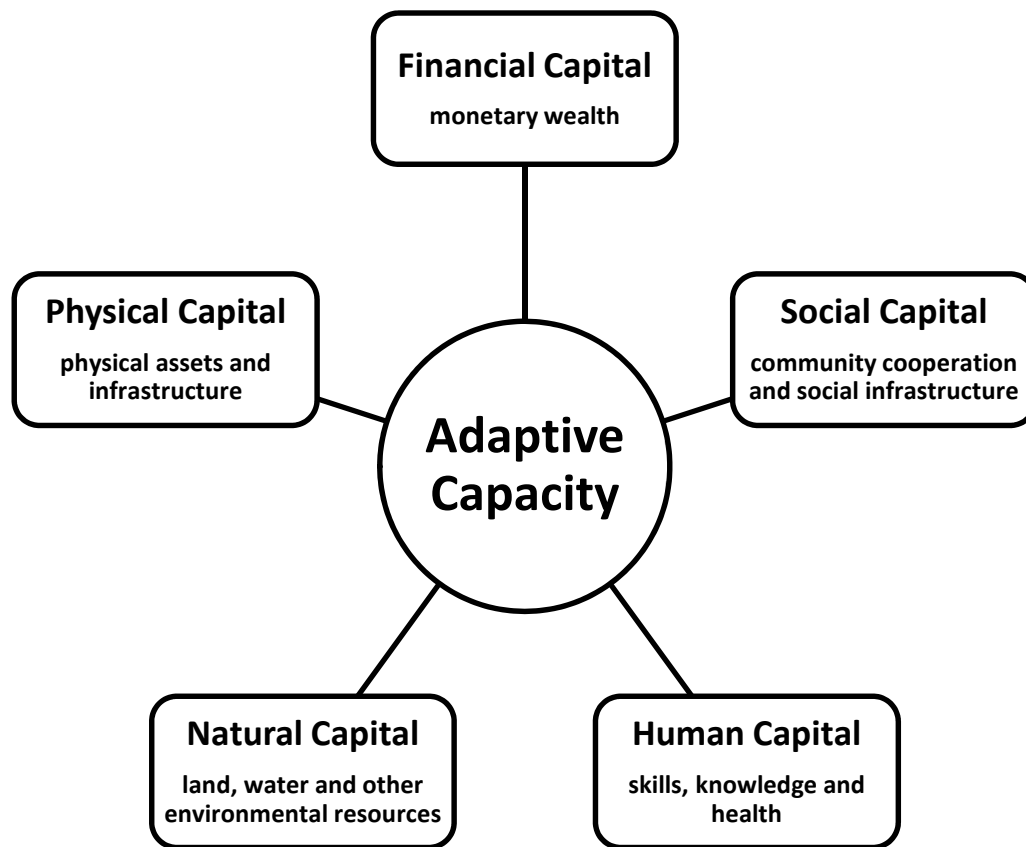
Efforts to build adaptive capacity can take place in a variety of ways. Individuals and firms can improve their adaptive capacity by learning more about the potential impacts of climate change and how they may be affected, by developing risk management strategies, and by ensuring they have resources adequate to undertake any necessary adaptation.

Governments can improve the adaptive capacity of communities by implementing measures that enhance economic growth and improve economic and regulatory flexibility. Such measures can increase the economic resources available to communities to adapt, improve the ability of the economy to handle climate change related shocks, and help to ensure that economic resources are allocated in the best possible way to undertake adaptation (chapter 5). Governments can also enhance adaptive capacity by improving aspects of the provision of climate change information (chapter 6) and other public goods such as infrastructure and services (chapters 9, 10 and 11), and by strengthening institutions and governance arrangements to better manage climate change (chapter 7).

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Figure 2.5 Five forms of capital underpinning adaptive capacity

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### Taking actions to adapt

The range of potential actions able to be taken by individuals, communities, firms, governments and other organisations to adapt is as diverse as the potential impacts of climate change. Actions can be as simple as an individual buying an air-conditioner in response to warmer weather. They can also be as complex as an insurance firm changing the way it forecasts the likelihood of extreme weather events (chapter 12) or a local government changing planning regulations in response to expected future sea-level rise (chapter 8).

#### *Anticipatory and reactive actions*

A distinction can be made between anticipatory and reactive actions to adapt. Anticipatory actions occur in advance to reduce one's exposure to potential climate change impacts whereas reactive actions occur after a climate change impact to reduce its consequences (Fankhauser, Smith and Tol 1999). However, anticipatory and reactive actions are not always easily distinguishable. For example, if building repairs after a storm include structural changes that make the building less

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susceptible to future climate change then this action could be considered anticipatory as well as reactive.

In response to any given climate change risk, the actions of individuals may differ depending on each individual's perceptions of the future, preferences for time and risk, and adaptive capacity. Given these differences, neither anticipatory or reactive actions may necessarily always be preferable, particularly given uncertainty about the magnitude and timing of potential impacts.

### *Incremental and transformational actions*

Actions to adapt may also be classified as 'incremental' or 'transformational' depending on the extent of change involved. Incremental adaptation involves actions to 'maintain the essence and integrity of an incumbent system or process' whereas transformational adaptation involves a 'change in the ... components of a system from one form, function or location to another' (Park et al. 2012, p. 119). In other words, incremental actions are minor adjustments that essentially allow an individual, firm or community to continue doing what they are doing. Transformational actions involve a fundamental shift in how, where or what things are done.

For example, the agriculture sector may be able to incrementally adjust to the impacts of climate change by changing crop management processes and planting times. However, more significant climate change could have significant effects on crop productivity in some regions. This may mean farmers need to take transformational actions, such as relocating the farm, or using the land for other purposes such as other crops, grazing or plantation forestry (CSIRO 2008).

Whether an adaptation action is considered incremental or transformational depends on perspective and timescale. A transformational change by one individual may appear incremental from a community-wide perspective. On the other hand, incremental changes pursued by a large number of individuals over an extended period could give the impression of profound transformational adaptation.

The Commission recognises the need for economic and regulatory flexibility to accommodate both incremental and transformational actions to adapt to climate change. However, the Commission has not identified any cases where transformational actions require fundamental changes to regulation or policy frameworks.

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### *Limits to adaptation*

Not all climate change impacts are amenable to adaptation. Biological, ecological, physical, economic, technological and social thresholds may limit the range of adaptation options available for human and natural systems (IPCC 2007a). For example, though actions can be taken to reduce some environmental stresses on the Great Barrier Reef, if climate change were to continue unabated, it is likely that no adaptation could prevent the decline of the Reef's ecosystem in its current location.

### **Managing the distribution of impacts**

The impacts of climate change will not be evenly spread across the economy. First, as noted above, some industries and regions will suffer more severe climate change impacts. For example, Garnaut (2008b) estimated that agriculture would be among the hardest hit industries as a result of climate change (box 2.1). Individuals and regions that rely on such industries may be more adversely affected than others.

Second, disadvantaged individuals may have less capacity to adapt to, or recover from, climate change impacts. For example, some people may retro-fit houses to cope with climate change impacts, and others may relocate to other regions. However, the financially disadvantaged may be unable to afford such options. In relation to natural disasters, governments have a role in prevention and preparedness, which may assist the financially disadvantaged to cope with such hazards (chapter 10).

Finally, the structural adjustment brought about by adaptation to climate change will itself have distributional impacts. Adaptation and the associated reallocation of resources across the economy may affect the costs of certain goods and services, change the returns to firms or workers, or shift the location of economic activity and employment opportunities. This adjustment could include, for example, increases in the prices of basic goods and services, such as electricity, which would have implications for disadvantaged members of society.

However, the impacts of climate change (and the associated adaptation) are just one of many challenges that disadvantaged individuals and communities may face. For example, prices for basic goods and services are responsive to other factors such as resource prices, exchange rates and government policies. In addition, there may be a range of other structural adjustments that the economy will face in the future.

Therefore, policy responses to equity concerns need to reflect broader distributional concerns, rather than a singular focus on climate change. In general, the existing social security and tax systems and other standard adjustment measures (such as job

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search, placement and training services) will be the most appropriate means of assisting the adjustment process and moderating adverse distributional impacts (PC 2001b). However, in some cases there may be scope for targeted assistance to manage the impacts of extreme events.

### **Adaptation as structural adjustment**

In addressing the challenges posed by climate change, Australia can draw on experience from the major structural adjustments and economic shocks of the past. These include market-induced changes such as the information technology revolution and the emergence of the Chinese economy, as well as policy-induced changes such as trade liberalisation and the float of the Australian dollar. The impacts of these changes have been diverse, complex, uncertain and have involved the wholesale transformation of industries, yet these changes have ultimately proven manageable.

As with other structural adjustments, adaptation to climate change by any individual or firm is not likely to involve a single action but rather a ‘continuous stream of activities, actions, decisions and attitudes’ (Adger, Arnell and Tompkins 2005, p. 78). These are not formed in a vacuum but rather in the context of ongoing economic, political, social and technological change. Consequently, for many individuals, firms or other organisations, climate change may not be the major source of change or uncertainty at any given point in time. As such, it is not always possible for an outsider to distinguish climate change adaptation from actions motivated by other unrelated forces.





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## 3 Barriers to effective adaptation

### Key points

- A barrier to effective adaptation prevents the community from using its resources in the most advantageous way to respond to climate change impacts.
  - The existence of a barrier means there is the potential for resources to be reallocated in ways that make better adaptation actions possible and in turn improve the wellbeing of the community as a whole.
- A barrier could mean that adaptation actions:
  - are the wrong sort of adaptation actions
  - are insufficient or are over and above what is needed
  - do not occur at the right time.
- A range of market failures may constitute barriers. For example:
  - goods or services that improve adaptive capacity but have ‘public good’ characteristics may be undersupplied by the private sector (or not provided at all)
  - where activities have impacts on others in the community (beyond those directly involved) and there is too much of those activities which negatively affect adaptation efforts or not enough of those activities that facilitate adaptation.
- Government regulation has the potential to impact on the adaptation decisions of individuals, businesses, organisations and other levels of government and could impose a barrier where the costs of regulation outweigh the benefits.
- Adaptation to climate change poses governance challenges. Arrangements inconsistent with good governance principles may create a barrier.
- Behavioural barriers could arise in respect to the extent to which individuals and communities identify the need to adapt and the adaptation responses they choose. This could lead to sub-optimal adaptation choices or delay adaptation decisions.
- It is not always the case that there will only be one type of barrier impeding effective adaptation. In some circumstances, there may be multiple barriers interacting.
- Barriers to effective adaptation may not be easy to identify — it is difficult to know what the ‘right’ adaptation response should be in any given situation.
  - Adaptation decisions that do not appear effective (from the perspective of an outsider) may reflect differing preferences, circumstances or attitudes to risk.
- The existence of a barrier only suggests the *potential* for government intervention to improve the wellbeing of the community as a whole. However in some cases intervention by governments could leave the community worse off.

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### 3.1 What is the policy problem?

A barrier to effective climate change adaptation prevents households, communities, businesses and governments from undertaking adaptation activities that would deliver net benefits to the community. A barrier can be anything that prevents the community from using its resources — natural, financial, human, social and physical capital — in the most advantageous way to respond to climate change impacts.

Barriers to effective adaptation can manifest in a range of ways. A barrier could impede effective adaptation by leading to a poor appreciation by individuals of the need to adapt, inappropriate incentives for adaptation, or insufficient capabilities of individuals to adapt effectively (in the form of inadequate resources, knowledge and skills). Further, a barrier could prevent effective adaptation to current climate variability in addition to future variability.

The existence of a barrier will mean that adaptation actions:

- are the wrong sort of actions
- are insufficient or are over and above what is needed
- do not occur at the right time.

Irrespective of the way in which the barrier impedes adaptation, the existence of a barrier signifies a *potential* for resources to be reallocated in ways that improve how we adapt.

The presence of barriers to effective adaptation may not be immediately apparent. The adaptive capacity of individuals, communities, firms, governments and natural systems (and their willingness and capacity to tolerate climate change impacts) will vary markedly and these differences will be reflected in the diversity in climate change adaptation responses. Consequently, from the perspective of an observer, it is difficult to determine whether a *seemingly* effective adaptation option is not being pursued because of the existence of a ‘barrier’ or because it would not lead to a net benefit.

A determination regarding the existence of a policy or regulatory barrier will require a consideration of the welfare of the community as a whole. This inquiry will take an economic approach to identifying and assessing potential barriers, for example by assessing possible market failures. An analysis of the current policy and regulatory frameworks, behavioural characteristics and the effectiveness of governance arrangements will also be necessary.

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## 3.2 Barriers to adaptation

There is a range of potential barriers to effective adaptation, including market failures, policy and regulatory barriers, governance and institutional barriers, and behavioural barriers. It is not always the case, that there will only be one type of barrier impeding effective adaptation. In some circumstances, there may be multiple barriers interacting.

### Market failures

For resources to be allocated to their highest value use, a range of conditions must be met. For example, an efficient market requires competition, access to information and market prices that reflect the value we place on goods and services. Where these conditions are not fulfilled, markets can fail to allocate resources efficiently.

In this context, market failure has a very specific meaning. It does not refer to situations where markets do not deliver the outcomes that a given individual or firm would desire. Rather, it requires a set of circumstances where the market, left to itself, is not delivering the best possible outcome for the community as a whole, suggesting the existence of barriers to effective adaptation. One element of the Commission's task is identifying these market failures.

### *Public goods*

Public goods are goods and services which once provided to one person, are then available to all people at no additional cost. This occurs where a good or service can be consumed by one person without diminishing consumption by others and where it is difficult or infeasible to exclude anyone from benefiting from the good.

A barrier to adaptation could occur where goods or services that improve adaptive capacity are undersupplied by the market (or not provided at all) due to their public good characteristics. Where governments do not recognise this and ensure provision of these goods and services, the welfare of the community may be less than it would be otherwise. A specific application could be in the area of emergency management services, for instance early-warning systems for natural hazards have public good characteristics and are generally provided or funded by governments. Where climate change leads to an increase in the frequency or intensity of natural hazards, community wellbeing may be improved by enhancing early-warning systems.

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While the nature of public goods makes it difficult to determine the optimal level of provision, this market failure can be addressed by governments making judgments about the type and quantity of public goods to fund.

### *Imperfect information*

Imperfect information can lead to market failure where there is inadequate information for consumers, the community and the public and private sectors to make well-informed decisions. Information may be imperfect because of its public good characteristics or because one party to a transaction has more or better information than the other party ('asymmetric information').

In some instances, markets can address problems of imperfect information through intermediary products — for example, consumers purchasing advisory services. However, where the information has considerable public good characteristics, the government may commit to provide the information itself or alternatively to complement or verify market-supplied information.

### *Asymmetric information*

Asymmetric information occurs when one party to a transaction has more or better information than the other party. One example of how asymmetric information could impede effective adaptation is where insurers, and those they insure, have differing information about the extent of risks faced or any actions taken to manage risks. This can lead to a situation where those at higher risk purchase insurance and the greater frequency of payouts leads to an increase in premiums ('adverse selection'). It can also lead to buyers of insurance not having strong incentives to manage their risks, as insurers cannot observe all actions that they take ('moral hazard'). In both cases, premiums may increase and deter individuals or organisations from buying insurance. This limits the range of risk management options and could reduce the effectiveness of adaptation efforts.

### *Split incentives*

Split incentives arise where adaptation decisions involve multiple parties with differing incentives. As a result of these differences, adaptation may not maximise the wellbeing of all parties. For example, some apartment buildings do not have individual water meters and consequently water-use fees are divided equally between residents or landlords. This provides little incentive for residents to minimise their water use.

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## *Spillovers*

Some activities or transactions can involve ‘spillovers’ (also known as externalities) of positive or negative impacts on other individuals in the community which are not taken into account by the parties to that activity. Both negative and positive spillovers could impede effective climate change adaptation by resulting in too much of an activity that negatively impacts on the community’s adaptation efforts and not enough of an activity that improves adaptive capacity. For example, where a coastal council constructs a seawall in order to protect coastal properties in its jurisdiction, a ‘negative spillover’ could occur where erosion in an adjacent local government area is increased as a result. The cost of increased erosion on other properties is not reflected in the price of the seawall nor is it borne by the local council which constructs the seawall. As a result, the council may not take these external costs into account when making a decision about how best to respond to climate change.

Governments often subsidise activities that positively impact others in the community (beyond those individuals directly involved in the activity). For example, governments subsidise disease immunisation, which protects the individual, but also lowers the general risk of disease for everyone. Conversely, governments can use legal restrictions and/or pricing mechanisms in order to address activities that generate negative impacts on others. For example, planning and development regulations may restrict the type of buildings in a given area in order to maintain the amenity of existing residents (for example, restricting the construction of large buildings that block sunlight to their neighbours or factories that produce noise and air pollution). The intention of government intervention in these cases is not necessarily to prevent all activities that generate negative spillovers, rather it is to ensure that resources are allocated taking into account the external benefits and costs of activities.

## *Market power*

The existence of market power could impede effective adaptation where a product or service that improves adaptive capacity is consumed less than would be the case in a perfectly competitive market. Further, there could be potential for a barrier to adaptation where firms which hold market power choose not to undertake adaptation actions that would be undertaken in a competitive market (as the monopolist does not have the same incentive to do so) and as a result the community bears increased costs.

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Governments promote competition in markets through a range of policies, including regulation. However, it is possible that these regulatory and policy frameworks are not currently addressing issues of market power in the context of adaptation.

## **Policy and regulatory barriers**

Government policy and regulation impacts on the adaptation decisions of individuals, communities, businesses and non-government organisations in many ways. For example, coastal planning and development can influence where people live and the type of protective measures they purchase for their properties, and regulation of monopoly infrastructure (such as electricity and water) can affect the investments these businesses undertake to protect infrastructure from the impacts of climate change. Government policy and regulation may impact adaptation decisions deliberately or coincidentally (as a byproduct of pursuing a different policy objective).

While government policy and regulation can deliver economic, social and environmental benefits, it can also entail costs (box 3.1). The focus in this inquiry is on policy and regulation that imposes costs that impede effective adaptation. For example, regulations that restrict the removal of vegetation on private property may mean that landholders are not able to create buffer zones around their dwellings to provide protection from bushfire. Where climate change leads to more frequent bushfires, these land-clearing regulations could impose significant costs in the form of damage to life and property.

In many cases, such costs may be a byproduct of pursuing policy objectives unrelated to adaptation policy. However, in other cases, policy or regulation may be creating barriers for adaptation while not effectively meeting their stated objectives. In either instance, there may be a *prima facie* case for exploring alternate policy and regulatory tools that deliver similar benefits without impeding effective adaptation.

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### **Box 3.1 The costs of regulation**

The costs of regulation include:

- Regulatory charges — direct charges that must be paid to the government under regulatory arrangements, such as fees and levies.
- Substantive compliance costs — costs borne by households and businesses to meet regulations. For example, the prohibition of certain activities that individuals or businesses may wish to undertake otherwise, such as building coastal protection works on private properties.
- Administrative costs — costs borne by government in administering the regulation.
- Indirect/market costs and economic impacts — costs imposed where regulations create barriers to entry in markets, limit competition, or impose delays on business and individuals. For example, where land-use and development approval processes for hazard-prone areas are time consuming and delay the commencement of development of a site.

*Source:* NSW Department of Premier and Cabinet Better Regulation Office (2008).

## **Governance and institutional barriers**

Due to the nature of the federal system, Australian governments are pursuing adaptation policy in varying ways (appendix B). Further, the pervasive nature of adaptation means that it is likely to interact with a broad range of government policies.

Governance refers to the use of institutions, structures of authority and other bodies to establish policies and rules, to allocate resources for implementation, and to coordinate and control the resulting activities (PC 2011f). This can encompass a broad range of activities and processes, including policy processes, legislative settings, organisational arrangements and administrative procedures. Thus, governance arrangements can refer to the mechanics of how public servants make day-to-day decisions in councils to the separation of Commonwealth and state government powers in the Constitution.

The appropriateness of governance and institutional arrangements can affect the way governments and the community respond to climate change. Addressing barriers to climate change adaptation will therefore involve a continuous emphasis on good governance. However, there is no single ‘good governance’ approach that can be universally applied to minimise any negative impacts of governance arrangements on adaptation decisions. There are generally accepted principles for good governance and it is a common practice for a principles-based approach to be

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adopted to strengthen governance arrangements. There are a number of different formulations of good governance principles, and these principles generally encompass similar elements. For example:

- **Accountability and transparency** — Where responsibility for decisions and actions is not clearly allocated or prioritised or where these decision-making responsibilities are not adequately supported, adaptation could be impeded. For example, the current legal liability of councils when making planning decisions, is uncertain. In some cases, councils may not make appropriate decisions as they are uncertain about the legal implications of their decisions. Ensuring that government agencies undertake appropriate and transparent monitoring and evaluation of policies is also an important element of accountability.
- **Coordination and interaction** — Adaptation could be impeded where adaptation issues and policies are not well coordinated across different government bodies. For example, a range of bodies have responsibilities for providing emergency management services in each state and territory. Where these bodies do not work together and coordinate service provision this could impede the ability of providers of emergency services to respond effectively to the expected increase in extreme weather events.
- **Flexibility** — Society's understanding of the likely impacts of climate change is incomplete and uncertain, but constantly improving. Consequently, governance systems will need to provide for flexibility in order to accommodate this uncertainty. For example, inflexible planning systems that assume that land boundaries do not alter over time may lead to ineffective adaptation to climate change.
- **Community involvement** — Where opportunities to participate in and influence decision-making processes are not widely available to the community, adaptation policy and options may not match the community's views on risk, nor may these policies protect highly valued community assets.
- **Capability** — Local governments are responsible for a raft of policies that will influence adaptation, including local land-use planning systems, management of local infrastructure and information provision. Where local councils have insufficient resources to effectively meet their responsibilities and deliver appropriate policy outcomes, this could impede adaptation.

Governance arrangements tend to be complex, dynamic and inherently imperfect — consequently there is always room for improvement. Further, due to the subjective nature of 'good governance', there may be differing views on the importance of strengthening arrangements and how they should be improved.



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In some cases, there may be well-defined ways to strengthen governance arrangements to remove a barrier to adaptation and improve the wellbeing of the community. However, this may not always be the case and a consideration of the feasibility of improving arrangements is necessary, as is an assessment of the expected costs and benefits of any improvement.

## **Behavioural barriers**

Adaptation involves individuals, communities, businesses and governments processing information about climate change, assessing risks and selecting adaptation responses. Consequently, there is a significant behavioural component to adaptation and behavioural barriers can arise in respect to the extent to which individuals and communities identify the need to adapt and the adaptation responses they choose.

### *Cognitive constraints on decision making*

Effective adaption requires individuals to absorb complex scientific evidence on the impacts of climate change and to choose between different adaptation options based on their perceptions of the costs and benefits. This will necessitate individuals incorporating the uncertainties of climate change into these decisions. However, research has shown that people can struggle to gather and process complex information and as a result take short cuts in order to make decisions, either consciously or subconsciously (Crowle and Turner 2010). This could result in sub-optimal adaptation decisions that are chosen out of habit.

Further, in some circumstances people can find it difficult to assimilate multiple sources of information and consequently additional information on climate change impacts or adaptation options may not improve matters (Nicholls 1999). Shafir (2008) noted that the existence of multiple choices may reduce the likelihood of a rational decision, and may lead to the decision maker delaying a decision indefinitely.

Behavioural factors could also have implications for the timing and likelihood of individual adaptation actions. For example, individuals can exhibit time-inconsistent preferences and may have trouble weighing up costs and benefits that occur over long timeframes. That is, one year from now can seem much further into the future than one year in ten years' time. This can lead to individuals placing priority on short-term gains and making decisions contrary to their longer-term interests (Crowle and Turner 2010; Kahneman 2011). This can also mean that more tangible and immediate impacts can take precedence over distant, yet more serious,

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outcomes (Shafir 2008). As a result, some individuals may respond to the long timeframes and uncertain impacts of climate change by procrastinating and deferring adaptation decisions that would be in their own best interest.

### *Social and cultural influences on decision making*

Adaptation decisions do not take place in a vacuum and the decisions we make are likely to be influenced by the information we have, how we interpret this information and our perceptions of how others in the community are responding. Studies have shown that the behaviour and attitudes of family members and friends can have a strong impact on the decisions and actions of individuals. For example, Ajzen and Fishbein (2005) find that individuals have difficulty maintaining an attitude that differs from that of those around them. Further, the way in which people process information is strongly influenced by existing attitudes (Gardner et al. 2009). People tend to ignore, and not seek out, information that is inconsistent with their current views, and additional information can tend to cement their pre-existing views (Kahneman 2011; Nicholls 1999).

### *Identifying behavioural barriers*

Behavioural factors can help explain how people make the decisions that they make. However, how these factors affect decisions, and to what extent, is uncertain. While these decisions may not always be ideal, they still could be as economically efficient as possible given the costs of seeking and processing information and thus may not constitute a barrier to adaptation.

Further, even where such barriers are identified, it is not immediately clear if there is much that governments can or should do to address them. Introducing regulation to address behavioural barriers assumes that regulators are capable of making decisions that are in the best interests of the community. However, this may not always be the case.

Understanding the behavioural factors that influence decision making may nevertheless be useful in regard to how information is provided by governments and to whom it is targeted. Community wellbeing may be improved where governments ensure that the information they provide is easy to use and understand (chapter 6).

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### 3.3 How should we respond to barriers?

The existence of barriers to effective adaptation suggests that there is potential for government to improve outcomes by removing these barriers. However, this will not always be the case. A barrier may not be significant and any government policy response may be more costly than the barrier itself. Reforms should only be pursued where they deal with genuine barriers to adaptation and where the chosen reform improves the wellbeing of the community as a whole.

All potential impacts of removing a barrier should be considered at the outset. While using government policy to address a barrier may assist adaptation efforts, it may have other economic, social or environmental consequences that are not related to climate change adaptation. Any distortions that would be created through addressing the barrier should be taken into account.

Further, in some cases, there may be little that governments can or should do to address identified barriers. Thus, a consideration of the likely effectiveness of government intervention is required. This is particularly relevant in the case of addressing behavioural barriers, but could also apply in other contexts.

#### How do we determine if a barrier exists?

It is not necessarily the case that where an individual or organisation chooses to adapt in a way that others consider ineffective that there is a ‘barrier’. Adaptation to climate change can include a wide variety of responses and will be highly specific to an individual and their personal circumstances. Where an individual *appears* not to be adapting effectively (from the perspective of an observer) this may simply reflect this individual’s differing preferences, circumstances or attitudes to risk.

As noted previously, it can be very difficult for government to determine whether a barrier to adaptation exists. Adaptation is ongoing and will involve countless actions and decisions taken at the individual, business or organisational level in response to specific impacts. These individuals, businesses and organisations will also be responding to a range of other factors and adaptation will only be one in a range of considerations.



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## 4 Assessing reforms and setting priorities

### Key points

- Reforms to address barriers to effective climate change adaptation should be assessed to identify options that are most likely to increase the wellbeing of the community (broadly defined). There is an established approach to assessing policy reforms that is well suited to the issue of climate change adaptation.
  - The approach involves defining the problem, identifying options to address it and considering the positive and negative impacts of reform.
- The long time frames involved and uncertainty about the impacts of climate change mean that it can be difficult to quantify the benefits and costs of reforms to address barriers to adaptation. As a result, formal cost–benefit analysis of reform options may not always be feasible. However, policies should still be analysed in a systematic, transparent way.
- Uncertainty about the impacts of reforms should not lead to inaction.
  - The ‘precautionary principle’ suggests that where there is a threat of serious or irreversible damage, uncertainty should not be used to justify postponing cost-effective measures to prevent damage.
  - The ‘real options’ approach can help to identify reform options that are likely to increase the wellbeing of the community. This approach recognises that if uncertainty about the benefits of climate change adaptation is likely to reduce over time, there can be benefits in deferring costly or irreversible actions until there is confidence that the benefits will exceed the costs. In the meantime, the priority should be to identify low-cost measures to address immediate concerns.
- Priority should be given to reforms to address barriers that reduce the ability of the community to deal with current climate variability and extreme weather events.
- Reforms to address barriers to adaptation to possible future climate trends should only proceed if there is a high degree of confidence that they will deliver net benefits.
  - These could include reforms that have relatively low costs, and potentially large benefits, but a relatively long period between the costs being incurred and receiving the benefits. Net benefits are more likely if reforms would deliver benefits under a range of climate scenarios.

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## 4.1 Assessing reform options

A range of policy mechanisms exists to address barriers to climate adaptation (box 4.1). Some options would make the community better off, while other policy responses might have negative impacts that outweigh the benefits. The challenge for policymakers is to identify and implement the reforms that would make the community better off, while avoiding the options that would do more harm than good.

### Box 4.1 **Some policy responses to address barriers to adaptation**

Several instruments could be used to address barriers to climate change adaptation.

#### **Taxes**

Reforms to tax systems could reduce or abolish taxes that act as barriers to adaptation (such as state taxes and levies on insurance premiums).

#### **Transfers**

Government transfers could address some types of barriers to adaptation. For example, transfers from state and territory governments to local governments could help them to address barriers related to local government capability.

#### **Regulations**

Governments could directly regulate to address barriers to adaptation. This could include regulations in areas such as building, planning, insurance and infrastructure.

#### **Government provision of goods and services**

Some barriers to effective adaptation could be addressed through government provision of goods and services, such as information about the impacts of climate change and advice on how to use that information to aid adaptation.

Agencies including the Productivity Commission and the Office of Best Practice Regulation have developed an approach to policy assessment to identify options that are likely to increase community wellbeing. This involves clearly stating the problem, setting out the reform options and using a cost–benefit framework to assess the effects on the wellbeing of the community (box 4.2).

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#### **Box 4.2      General principles for policy assessment**

1. *Clearly specify the problem* — Detail the nature of the problem, the size of the impacts and the risks and consequences of failing to address the problem.
2. *Consider whether there is a need for government intervention* — Government intervention is not costless, and should only proceed if the government has the capacity to deal with the problem and a sound justification for doing so. Justifications for policy intervention could include market failures, regulatory barriers, behavioural barriers or equity and distributional concerns.
3. *Clearly describe the objectives of reform* — The objectives of reform should be specified in a broad way, to enable consideration of all possible options.
4. *Identify any regulation or policy that is currently in place to address the problem* — If the existing regulations are not addressing the problem, is it because the regulation is flawed, or is it a failure in compliance?
5. *Identify the feasible options* — Identify the options that could feasibly achieve the objectives of the reform. This could include different types of instruments (from market-based instruments and information campaigns through to legislation and regulation), and also the option of making no change to the status quo.
6. *Assess the impacts of the options* — Impacts include the direct effects of the reforms, and any indirect ‘flow-on’ effects (including unintended consequences). This should include an assessment of the distribution of the benefits and costs to enable consideration of the equity impacts of the reform. Impacts do not always have to be assessed through a full quantitative analysis — a detailed qualitative analysis (augmented where possible with quantitative data) can suffice.
7. *Consider implementation and enforcement, and establish a review strategy* — It is important to consider practical implementation issues, and to establish a process for evaluating the effects of the reform after it has been in place for some time.

*Sources:* Australian Government (2010a); PC (2005).

In the case of reforms to address barriers to climate change adaptation, many of the impacts will be difficult to quantify, so a formal, mathematical approach to cost–benefit analysis will often not be feasible (box 4.3). However, the principles of cost–benefit analysis still provide valuable guidance on how reforms should be assessed. These principles include:

- identifying as many of the impacts of reforms as possible, including flow-on effects and unintended consequences
- quantifying impacts where possible, and clearly explaining in qualitative terms those that cannot be quantified
- considering causal relationships (how the reform leads to the impacts)
- clearly stating any assumptions that have been made

- considering the distribution of the benefits and costs (both within and between generations) to allow consideration of the equity implications of reforms
- explaining the decision to pursue or not pursue a reform.

Even if formal cost–benefit analysis is not feasible, a systematic approach to assessing the impacts of policy changes improves the process of decision making. Following this approach can help to identify high-cost features of reform options, and to identify and develop lower-cost approaches. It makes the analysis more transparent, and can reduce the likelihood that decision makers will give preference to the interests of favoured groups.

#### Box 4.3 Cost–benefit analysis for adaptation reforms

Fankhauser et al. (1999) set out a formal approach to comparing the benefits and costs of ‘adaptation investments’ — investments that reduce the damage caused by climate change. If an adaptation investment costing  $C^N$  is undertaken in period 0, there is unmitigated damage of  $d_0^N$  in that period, and partially mitigated damages of  $d_t^N$  in subsequent periods ( $t$ ). Future benefits and costs are ‘discounted’ — adjusted to reflect people’s preferences to accrue benefits sooner and incur costs later — with a discount rate ( $r$ ). Calculating the ‘net present value’ of the cost of the damage is a way to express the value of the future stream of costs in current dollars. It is given by:

$$NPV D^N = C^N + d_0^N + \frac{d_1^N}{(1+r)} + \frac{d_2^N}{(1+r)^2} + \dots + \frac{d_{2t}^N}{(1+r)^t}$$

Postponing the adaptation investment for one period (making an investment of  $C^L$ ) would lead to unmitigated damages in period 0 and in period 1. From then, the damages in each period would be  $d_t^L$ . The benefits of delay would exceed the costs if:

$$C^N - \frac{C^L}{(1+r)} > (d_0^L - d_0^N) + \frac{(d_1^L - d_1^N)}{(1+r)} + \frac{(d_2^L - d_2^N)}{(1+r)^2} + \dots + \frac{(d_t^L - d_t^N)}{(1+r)^t}$$

Whether the benefits of delaying the adaptation investment exceed the costs depends on the discount rate, the costs of making the investment in the current period or one period later, and the costs of mitigated damage compared to unmitigated damage. The calculation could be repeated as new information comes to light, and this could lead to different conclusions. For example, an investment that would not deliver a net benefit this year might be shown to deliver a net benefit if undertaken next year.

Reforms to address barriers to adaptation have a flow of costs and benefits over time, so if the positive and negative impacts could be quantified (or estimated), reforms could be analysed using Fankhauser et al’s (1999) framework. In practice, it will not always be feasible to quantify all of the impacts of reforms to address barriers to climate change adaptation. In these situations, a pragmatic approach is to consider qualitative evidence in any cost–benefit analysis of adaptation.

Source: Fankhauser et al. (1999).



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## 4.2 Challenges with evaluating the impacts of climate change adaptation reforms

The characteristics of climate change mean that formal cost–benefit analysis will not always be feasible when considering reforms to address barriers to adaptation. Some of the main challenges are described below.

### Valuing non-market impacts

Reforms to address barriers to effective adaptation could have impacts that are difficult to value, such as effects on ecosystems and health, and intangible benefits that people gain from measures that reduce the amount of risk they face. These types of impacts pose a challenge for the cost–benefit framework because it can be difficult to compare them to other impacts that can be more accurately expressed in monetary terms. One option is to estimate the value that people place on these non-market impacts by observing their actions or asking them how they value non-market goods and services. (Appendix J of the Commission’s recent report on *Identifying and Evaluating Regulation Reforms* (PC 2011c) sets out more detail on approaches to quantify benefits and costs that are difficult to measure.)

Even if it proves impossible to estimate the value of non-market impacts, they can still be considered within a broad cost–benefit framework. The expected impacts of reforms should be explicitly stated and preferably quantified (for example, the number of hectares of land conserved, or the number of cases of heat-related illness expected to be avoided). With this information, policymakers can at least make a judgment about how they weigh up the positive and negative impacts of reforms.

### The timing of climate change impacts

Because the impacts of climate change will arise over a long period, reforms to address barriers to adaptation might not deliver material benefits for many years. In general, people prefer to receive benefits sooner and face costs later. In formal cost–benefit analysis, future impacts are ‘discounted’ to express the degree to which people are prepared to trade off current and future benefits and costs. The future benefits and costs are estimated, and a ‘discount rate’ is applied to estimate the value that people today place on impacts that will arise in the future. The higher the discount rate, the lower the weight placed on future benefits and costs.

Private investors making decisions about whether to pursue a project typically apply discount rates that are based on their cost of capital with a premium added to reflect

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the risk attached to the project. For governments, choosing a discount rate has proven to be more controversial.

Harrison (2010) described two approaches to selecting the ‘social’ discount rate: the ‘descriptive’ approach and the ‘prescriptive’ approach. The descriptive approach involves selecting a discount rate based on the opportunity cost of capital — the return the community would receive if it chose to invest the capital it devotes to adaptation in an alternative activity. Harrison favoured using a descriptive approach to select discount rates for government projects, and recommended calculating the present value of future benefits and costs using three rates: 3, 8 and 11 per cent (in real terms). Using several discount rates clearly illustrates how changes to the discount rate affect the analysis.

The prescriptive approach involves selecting the discount rate that society ‘should’ use to value the future, based on ethical considerations and value judgments. There is no ‘right’ answer when using this approach: ultimately the decision rests on the values of the decision maker. In some cases, the prescriptive approach has been used to justify discount rates set at low levels. In particular, where benefits of current investment will occur in the distant future (say, in more than 100 years) some authors have advocated using very low discount rates. For example, the Stern Review (Stern 2007) used discount rates of around 1.4 per cent (in real terms). This led Stern to conclude that the current generation should expend resources reducing greenhouse gas emissions, even if the majority of the benefits of mitigation would not arise for many decades (or even centuries). More recently, Maddocks (2011, p. 127) stated:

Given the long life of infrastructure and the potential impact of climate change on future generations, a significantly lower discount rate [than 7 per cent] may be appropriate.

Selecting a prescriptive discount rate at a low level gives greater weight to the interests of future generations. This attention to the interests of people in the (possibly distant) future comes at a cost to the current generation. Reforms that impose a net cost on the current generation could pass a cost–benefit test with a very low discount rate, when they would not pass with a rate based on the opportunity cost of capital. Given that future generations are likely to be substantially wealthier than the current generation, this intergenerational transfer of wealth could be seen to have negative implications that might outweigh the altruistic considerations that would lead to the prescriptive adoption of a low discount rate.

In general, the approach of the Productivity Commission has been to use a range of discount rates in its analysis. For example, in its analysis of emissions-reduction

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policies in key economies (PC 2011b), the Commission used rates of 3, 7 and 11 per cent (in real terms). Using this range of rates shows the effects of using relatively high and relatively low discount rates. If a project only passes a cost–benefit test with a relatively low discount rate, this can tell the decision maker something about the characteristics of the project and encourage deeper consideration of the intergenerational equity issues involved.

The Australian Government recommended that when considering the risks of climate change, governments and businesses should adopt a planning horizon of 25 years ‘in the first instance’ (AGO 2006, p. 9), but this could be extended to 50 or even 100 years. Again, using a range of values can give a better insight into the nature of the benefits and costs of a reform.

Although a quantitative cost–benefit analysis of adaptation reforms will not always be feasible, the analysis should include a thorough and systematic consideration of the issues arising from the long time frames involved in climate change. This should include setting out:

- the expected impacts of the reform (positive and negative)
- the expected timing of the impacts
- the expected distribution of the effects (who will experience the positive and negative impacts).

Decision makers should then explain how these issues have influenced their decisions.

## **Decision making under uncertainty**

If an action has a range of possible outcomes, and these are known and understood with confidence, the ‘expected value’ of the action can be estimated. This is calculated using the size of the possible impacts and the probability that they will arise. This makes it possible to estimate the benefits, costs and net impact of a reform (box 4.4).

The uncertainty around many of the impacts of climate change means that this approach is unlikely to be feasible for many reforms to address barriers to adaptation. While uncertainty poses challenges for decision makers, it should not lead to inaction. A range of tools can be applied to support the decision-making process in a way that remains broadly consistent with the overall objective of maximising the wellbeing of the community as a whole.

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#### Box 4.4     **Calculating expected values for cost–benefit analysis**

A homeowner is considering investing in flood protection works. Based on the available information, the homeowner's assessment is that there are three outcomes that could happen next year.

- No flood — 95 per cent probability, \$0 of damage.
- A minor flood — 4 per cent probability, \$15 000 of damage.
- A major flood — 1 per cent probability, \$200 000 of damage.

The expected value of flood damage next year is equal to the damage bill from each outcome, multiplied by the probability that it arises:

$$(0.95 \times \$0) + (0.04 \times \$15\,000) + (0.01 \times \$200\,000) = \$2600$$

If the homeowner makes the investment in flood protection, they will incur no damage under any flood. If the cost of the investment this year (say, the cost of repayments on a loan to undertake the works — the opportunity cost of capital) is less than \$2600, the expected benefits will exceed the expected costs, and the homeowner would be sensible to undertake the works (assuming that the homeowner has a 'neutral' risk preference.)

The homeowner could also take the more sophisticated approach of Fankhauser et al. (1999) (box 4.3) to decide on the optimal timing of the investment. In this approach, the damages incurred with and without the investment in each period ( $d_t^N$  and  $d_t^L$ ) would be estimated using the expected values approach.

#### *Real options*

Although there is uncertainty about the timing and magnitude of climate change impacts (and hence the benefits of reforms to address barriers to adaptation), it is reasonable to expect that some of the uncertainty will be resolved over time. This could happen through observations of changes in the climate, and through improvements to climate modelling. The 'real options' approach has been developed to help make decisions about investment under uncertainty, and can help to identify reform options that are likely to increase the wellbeing of the community. This approach recognises that where there is uncertainty about the future, there can be value in deferring investment until better information becomes available, while retaining the option to take action as the need arises.

An example of the 'real options' approach in a climate change adaptation context is the idea of land-use permits with climate 'trigger point' restrictions. Consider the case of a resident who applies to build a house on a block of land next to a beach. The local government, based on state government planning benchmarks, considers that the property will be adversely affected by sea-level rise by 2100. As a result,

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the council might choose to deny planning permission. This would have benefits (avoided future damage), but also costs (the resident would miss out on the benefits of living in the house for the years before the damage occurs, and the council would miss out on rate revenue).

The ‘real options’ approach would encourage the parties to look for a low-cost ‘option’ that would enable the resident to take advantage of present conditions, while responding to information that becomes available in the future. One way to do this would be for the council to permit development on the land, but with an ‘option’ built into the planning permission that would give the council the right to impose restrictions on the use of the land once certain ‘trigger points’ (such as an agreed sea-level rise) were reached.

This option would have a relatively low cost in the current period and the resident would benefit from living in the property for several years. Over time, better information about sea-level rise would become available. Once the council is confident that the impacts of sea-level rise are material, it can exercise its option to impose restrictions on the use of the land. This would minimise the prospect that the resident would be harmed by rising seas. Compared to the approach of not permitting development, this approach would likely have larger benefits for the resident, and little additional downside for the council. In net terms, it would be likely to lead to an overall improvement in wellbeing.

While the real options approach is intuitively easiest to apply to tangible examples, it can help to inform decisions about reforms to address barriers to effective climate change adaptation. In some cases, the benefits of reforms to address barriers to effective adaptation will be clear. In others, the benefits will be uncertain, but might become less uncertain in the future. In these cases, the real options approach would suggest taking into account the benefits of delaying action until there is reasonable confidence that the policy will deliver net benefits. Where these benefits exist, they should be taken into account in the decision-making process.

A real options approach to adaptation policy would emphasise implementing reforms today to address barriers that limit people’s capacity to deal with the current climate. This could include reforms to address specific market failures, regulatory barriers or behavioural barriers, as well as reforms to improve the governance arrangements of institutions with responsibilities in climate change adaptation. Reforms that would impose large costs now, with low benefits now and uncertain payoffs in the future, would be deferred until there is better understanding of the impacts. Where the up-front costs are lower and there is the possibility of large benefits in the future, there could be a case for taking some preparatory action today

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that leaves flexibility for effective responses in the future as better information becomes available.

### *Minimising regret*

If barriers to adaptation are identified today, but reforms to address them are not implemented (for example, because they are considered too costly) future generations might regret the lack of action. Likewise, if reforms to address barriers are implemented, but it turns out that they were not necessary (perhaps because climate change is not as severe as was forecast), future generations might regret the cost incurred for little benefit.

The potential for regret is a valid consideration in determining whether or not a reform to address a barrier to adaptation would deliver a net benefit to the community. In deciding whether to implement a reform, decision makers should consider whether they (or their successors) might regret doing so (or not doing so), and the weight they place on the future regret. This could be influenced by:

- *the likelihood that the decision will be regretted* — This is likely to depend on the extent of future climate change. For example, if climate change proves to be more severe than current forecasts, or occurs sooner, people might regret a lack of action to address barriers to adaptation.
- *the timing of regret* — Current generations might not be concerned if decisions they make today are regretted in the distant future. (The present value of discounted future regret might be small.) But if decisions made today could lead to regret in the near future, the potential for future regret would weigh more heavily on decision makers.
- *attitudes to risk* — Some decision makers will be more concerned about future regret than others. For example, some might seek to minimise the damage incurred under ‘worst case scenarios’, while others might choose to implement reforms that are expected to deliver the largest net benefits under ‘central’ estimates of future climate change.

The potential for decisions made today to be regretted in the future should be considered when deciding which reforms should be implemented to address barriers to adaptation. However, potential regret does not imply any particular course of action. Instead, it strengthens the case for thorough analysis of the full range of options to address barriers to adaptation. This should include setting out the implications of different climate change scenarios and different discount rates for the analysis.

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### *The precautionary principle*

The ‘precautionary principle’ was developed as a response to the inherent difficulties that uncertain outcomes present to decision makers (Weier and Loke 2007). The most commonly cited definition comes from the 1992 United Nations Conference on Environment and Development.

Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. (UN 1992a)

The precautionary principle is incorporated into many nature conservation and resource management policies in Australia. Definitions are generally similar to the United Nations’ definition, which allows for a relatively flexible application of the principle. However, there are other definitions that are more prescriptive. These definitions of the principle would limit decision makers’ flexibility to take into account non-environmental impacts of actions (such as social and economic impacts) (Weier and Loke 2007).

There are many ways to exercise precaution, ranging from research through to regulation and outright bans of activities. The real options approach of taking action to respond to new information is part of the spectrum of precautionary measures (Weier and Loke 2007).

In some cases where there is the potential for environmental damage, the more prescriptive definitions of the precautionary principle would require action that is stronger and occurs sooner than would be recommended by a real options approach. For example, scientists have hypothesised that there could be ‘threshold’ effects in the way ecosystems adapt to climate change. A real options approach might recommend taking some action today to prepare for the possibility of threshold effects. A prescriptive precautionary approach might require immediate strong action to safeguard against the possibility of threshold effects. And whereas the real options approach (or a flexible precautionary approach) would take into account the costs of action, a prescriptive precautionary approach might suggest proceeding regardless of the costs in order to prevent environmental damage.

Ultimately, the prescriptive definitions of the precautionary principle involve giving a greater weight to concerns about environmental damage than any other factor. In the case of reforms to address barriers to climate change adaptation, an approach based on strong versions of the precautionary principle might recommend implementing reforms today, even if there is uncertainty about whether they will deliver net benefits. This is unlikely to maximise the wellbeing of the community as

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a whole. The real options approach is more likely to lead to decisions that are consistent with the objective of increasing general community wellbeing.

### **Implications for policy**

Non-market impacts, long timeframes and uncertainty about the impacts of climate change all complicate the task of identifying barriers to effective climate change adaptation, as well as of assessing reforms to address them. However, these characteristics of climate change should not lead to decision paralysis. Nor do they alter the overriding objective for policymakers: to identify and implement reforms that can be confidently expected to increase the wellbeing of the community as a whole. In fact, these characteristics strengthen the case for thorough analysis of reform options, including:

- considering a full range of policy options
- examining the effects of different discount rates
- testing the effects of policies under a range of climate scenarios
- considering whether there is a need for reforms to proceed today, or if there are likely to be benefits in delaying action until better information becomes available
- setting out the distributional impacts of reforms.

Finally, in many cases, assessments of reform options involve a degree of judgment. Decisions should always be clearly explained, including an explanation of how the factors above, and any assumptions, have influenced decisions.

## **4.3 Setting reform priorities**

If it were possible to quantify all of the benefits and costs of reforms to address barriers to adaptation, reforms could be prioritised in order of their expected net benefits. However, the characteristics of climate change mean that this is not feasible. Instead, a number of policy areas where reform efforts should be focused have been identified.

### **Identifying priority areas**

Because the impacts of climate change will be pervasive, there is potential for barriers to arise in any area of public policy. The first step in setting reform priorities was to identify areas where the case for reform was likely to be strongest.



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The Commission's recent research report on *Identifying and Evaluating Regulation Reforms* (PC 2011c) set out criteria that can be used to identify areas where the benefits of reform are likely to be highest.

- *Breadth of reform* — does the problem affect a large share of the community? The more widespread the benefits, the more likely the return from the reform will be higher.
- *Depth of reform* — does the reform address a problem that causes a large distortion in the allocation of resources? The larger the distortion, the greater the potential benefits of reform.
- *Cost of reform* — the costs of reform can include the costs to government of developing and implementing a reform, and the costs to business and the community of dealing with the changes. The higher the costs, the greater the payoff necessary to warrant pursuing the reform.

Based on research, consultation with stakeholders and evidence received in submissions, the Commission identified a number of areas where reforms to address barriers could have broad effects. One is broad economic reform (chapter 5), which would increase the flexibility of the economy to adapt to the current climate and build capacity to adapt to future climate change. While such reforms would increase overall adaptive capacity, barriers exist in other areas that justify targeted reforms. These areas include the provision of information (chapter 6), local government (chapter 7), planning and building regulation (chapter 8), emergency management (chapter 10) and insurance (chapter 12).

There are some areas where the most material barriers to climate change adaptation could be addressed through broad reforms, without the need for sector-specific reforms. For example, the Commission did not identify any material barriers to adaptation that are specific to the transport, forestry or tourism sectors. Other reforms with cross-cutting effects (such as in land-use planning, hazard information provision and disaster recovery arrangements) would facilitate adaptation in these sectors.

## **Addressing barriers to risk management in the current climate**

Current climate variability and extreme weather events are imposing costs on people today. Climate change is expected to lead to greater variability and potentially more frequent or intense extreme weather events, although there is significant uncertainty around these projections. This implies that there are almost certain to be benefits from reforms that address barriers to managing the risks people face in the current climate. Provided the costs are proportionate, it is highly

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likely that such reforms would deliver net benefits, leading to an overall increase in the wellbeing of the community. They could also provide a base for effective adaptation to future climate change.

The United Kingdom Adaptation Sub-Committee assessed progress in adaptation to climate change and made recommendations for steps that the United Kingdom should be taking now (appendix C). One recommendation was that:

... the UK should focus early adaptation efforts on decisions ... that are sensitive to present-day climate variability and therefore where preparing for climate change will provide both immediate and future benefits. (Adaptation Sub-Committee 2010, p. 8)

The Commission has identified a number of reforms across the priority areas that would address barriers to dealing with the current climate. These reforms would provide a basis for dealing with changes that emerge in the future.

## **Addressing barriers to future adaptation**

Some barriers to adaptation are not having material effects today, but could prevent effective adaptation to the long-term effects of climate change (such as sea-level rise). In some cases, reforms to address these barriers would have benefits in the short term that exceed the costs, and the case for action is clear. In others, reforms would not be expected to deliver benefits for many years, and the case to proceed is weaker. Where there is a relatively long period between the costs being incurred and the benefits being received, it might be worthwhile to delay the reform until there is greater certainty that the benefits will exceed the costs. It is more likely that the benefits will exceed the costs if:

- the up-front costs are relatively low, and the potential benefits are large
- the reform is expected to deliver benefits under a range of climate scenarios.

## **Ongoing review**

Reforms to address barriers to adaptation should be subject to ongoing review. This is part of the standard approach to good-practice policy making, and it assumes additional importance in the case of climate change adaptation.

Individual policies should be evaluated once they have been in operation for long enough to draw conclusions about their effectiveness and efficiency. Such reviews can lead to improvements to individual policies, and can also help to identify leading practices and future reform priorities.

*Reforms to address barriers to effective risk management in the current climate should be implemented without delay, where they are likely to deliver net benefits.*

*In relation to barriers to adaptation to uncertain future climate trends, the case is less clear.*

- *Where a reform has low up-front costs and potentially large benefits, albeit with long time periods between the costs being incurred and the benefits being received, there could be a case for preparatory action. The case is likely to be stronger if the reform will deliver benefits under a range of climate change scenarios.*
- *Where measures have high up-front costs, the community is likely to benefit by deferring high-cost options until better information becomes available.*



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## 5 Building adaptive capacity

### Key points

- Policy options that would help the community both deal with the current climate and build capacity to adapt to future climate change include a broad range of economic reforms. These reforms are aimed at addressing market failures and improving existing policies and regulations.
- These reforms enhance the capacity of the community to respond to climate change.
  - They increase the prosperity of the community, providing the means to better respond to changes.
  - They encourage a more efficient allocation of resources — land, labour, and capital — which will support many kinds of adaptation decisions.
- Poorly designed government policies can also affect the capacity of the community to respond to both the current climate and future climate change.
  - Taxes can impede effective climate change adaptation if they limit or delay adaptation decisions.
  - Government transfers can reduce incentives to adapt to change over the longer term.
  - Regulations can increase the costs of adaptation, impede the mobility of workers and businesses, limit the efficiency of markets, and distort resource allocation.

### 5.1 Economic reform and adaptation

Specific policy reforms could address barriers to climate change adaptation but would also increase the wellbeing of the community in the current climate. These are sometimes referred to as ‘no regrets’ or ‘win win’ policy measures. They include economic reform in a broad range of areas (box 5.1). While these reforms are justifiable in their own right, they also offer benefits for climate change adaptation as they enhance the adaptive capacity of the economy and enable the community to more effectively respond to future climate change. Climate change therefore strengthens the case for such reform.

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### Box 5.1     **Objectives and benefits of economic reform**

Economic reform involves changes in government policies and institutional arrangements that affect the incentives and economic behaviour of governments, firms, individuals and households. The objective of microeconomic reform — and economic policy generally — is to improve community living standards. The scope for reform is therefore very wide. It can be applied to the processes of production, distribution and consumption in all areas of the economy.

Microeconomic reform often entails the use of market-oriented approaches to delivering outcomes. These approaches can improve the allocation of resources, enhance consumer choice, and reinforce incentives for firms and individuals to be more productive.

Microeconomic reform that strengthens incentives for resources to move to activities and areas where they are most valued is particularly relevant to climate change adaptation. This is because climate change can be expected to change the economic value of certain activities and resources, such as water, tourism, and land. Thus, policy settings that enable resources to move flexibly through the economy are likely to improve adaptive capacity and enhance the wellbeing of the community.

While market-based mechanisms can play an important role in increasing efficiency and productivity, and ultimately raising the living standards of Australians, they may not be appropriate in all circumstances. This is particularly the case where there are trade-offs between efficiency and equity outcomes, or when markets cannot adequately reflect all values, such as the cultural or amenity value of the environment. This is important for climate change adaptation as climate change is likely to affect a broad range of environmental assets and ecosystems that are valued by Australians.

In these cases, the challenge is to implement reforms that are efficient yet also recognise other equity objectives and community values. Thus, there is a role for governments to intervene where markets fail and where intervention can improve market outcomes.

*Sources:* PC (1996, 1999b).

Economic reforms that improve the operation of the economy enhance the adaptive capacity of the community by enabling continual adjustment to change — including but not limited to climate change. These reforms increase the productivity and flexibility of the economy and ultimately increase the prosperity and wellbeing of the community, thereby providing the means to better respond to shocks (such as extreme weather events). They also facilitate the reallocation of resources that will occur in response to long-run changes in climate trends (such as temperature and rainfall). This will be important for adaptation because, for the most part, adaptation will occur autonomously through market exchanges of goods and services (chapter 2).

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Governments sometimes initiate economic reform to address a market failure or in response to equity considerations, for example, to moderate the distributional impacts of policies or market outcomes. Reforms are also often initiated to address the unintended outcomes of poorly designed or implemented policies, for example, where regulations or taxes have perverse effects on behaviour this could affect some adaptation decisions. Regardless of the motivation for economic reform, the ultimate objective is to improve the wellbeing of the community through a more efficient and equitable allocation of resources.

Reforms that increase prosperity could in some circumstances increase exposure to climate change impacts, for example, if higher incomes raise the demand for larger more expensive houses located in high climate risk areas. This reinforces the case to address specific policy barriers to adaptation in addition to implementing broad-based economic reform.

Governments have a number of policy levers available to achieve reform objectives, including taxes, transfers, and regulations (chapter 4). This chapter focuses on broad-based economic reform in these areas, drawing on specific examples where the case for reform has already been well established. While these should be a high priority there are also other reforms that would address more specific barriers to adaptation and that would also improve the adaptive capacity of the community in the current climate. These are discussed in the following chapters on information, local government, planning and building, infrastructure, emergency management, environmental and health services, and insurance.

DRAFT RECOMMENDATION 5.1

***Australian governments should implement policies that help the community deal with the current climate by improving the flexibility of the economy. This would also build adaptive capacity for dealing with future climate change. This includes reforms to:***

- taxes that influence the way resources are used, such as land tax exemptions and conveyancing duty, which could inhibit the mobility of labour, capital, or both***
- government transfers that reduce incentives to adjust to changing circumstances, such as the reforms recommended in the Commission's 2009 inquiry into drought support***
- regulations that impose unnecessary costs or inhibit competition or flexibility and could impede climate change adaptation by reducing the ability of firms, households or other organisations to respond to changing circumstances, such as restrictions to water trading.***

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## 5.2 Taxation

Some taxes can distort the way people use resources and can result in an allocation of resources that does not maximise the welfare of the community. They can therefore also be a barrier to effective adaptation to climate change if they influence the adaptation decisions or actions of households, firms or consumers. A number of existing taxes have the potential to do this, notably, state-based property taxes. Replacing these taxes with less distortionary taxes would benefit the community and also facilitate adaptation by enabling resources to be used where they provide the greatest value.

### **Example: property taxes**

There are two property taxes in particular that, in their current form, have a distortionary effect on property decisions and as a consequence could impede climate change adaptation. These are conveyancing duty on property (imposed on the transfer of property ownership) and land tax exemptions (land tax is imposed annually on the value of land).

#### *Conveyancing duty*

Conveyancing duty imposes additional costs on property transactions. Duty is applied at a progressive rate scale and thresholds and rates differ between property types and states and territories. For example, on a \$300 000 residential property conveyancing duty can range from around \$7000 to \$11 000 compared to around \$38 000 to \$55 000 for a \$1 million property. This results in a lower level of property exchanges than would occur in the absence of the tax, which could affect climate change adaptation in a number of ways. By making housing transactions more expensive, conveyancing duty could cause some property owners to remain living in a property for longer than they otherwise would — the so called ‘lock in’ effect (PC 2004a).

For example, homeowners who desire to move out of areas at greater risk from extreme weather events may be discouraged from doing so due to conveyancing duty. This view was supported by the Council of Capital City Lord Mayors who stated that ‘state government transfer duty on land limits the mobility of communities to adapt to our changing climate by increasing the cost of any relocation’ (sub. 67, p. 5).

The ‘lock-in’ effect could also affect labour and capital mobility if it inhibits people from moving and changing jobs, or businesses from changing locations. This may



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be important for some types of adaptation strategies. Businesses also tend to be more mobile than consumers and face incentives to minimise their costs, including costs associated with transactions and investment in property (Treasury 2010a). Therefore, the ‘lock-in’ effect could prevent them from adjusting to market conditions and result in land being retained in less productive uses.

As conveyancing duty applies to the value of the whole property (land and buildings) it also taxes buildings and other capital improvements (SBTRC 2001; Treasury 2010a). This could affect adaptation if it deters property owners from undertaking improvements that protect their property from the effects of climate change.

While it is difficult to determine the precise influence conveyancing duty has on decisions it is clear that, in principle, conveyancing duty acts as an impediment to the mobility of labour and capital as well as the efficient use of land. This suggests that conveyancing duty could constitute a barrier to effective climate change adaptation.

### *Potential reform areas*

The distortionary effects of conveyancing duty have led the Commission and others to urge state and territory governments to consider their removal, or significant reduction, with greater reliance on more efficient taxes, such as broad-based land taxes (discussed below) (Gabbitas and Eldridge 1998; IPART 2008; PC 2004a; SBTRC 2001; Treasury 2010a). Depending on the precise changes, such an approach could maintain the revenue base of the states and territories and have little effect on housing prices in the short term. This is because the increase in prices from the removal of conveyancing duty could be offset by increased obligations to pay ongoing land tax (PC 2004a).

### *Land tax exemptions*

In comparison to conveyancing duty, land tax is efficient as it does not affect decisions on how land is used or how much land is used — land is immobile and in fixed supply. However, this depends on a broad taxation base, with no or few exemptions.

States and territories provide various land tax exemptions, most importantly for land used for owner-occupied housing and agricultural purposes (NSW Treasury 2011). These exemptions are often provided due to concerns about cash-flow difficulties for the ‘asset-rich income-poor’.

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Exemptions can encourage land to be devoted to exempt activities (Gabbitas and Eldridge 1998; IPART 2008; Treasury 2010a). These activities may not be as highly valued from a national perspective, and as such, the community overall may be worse off. Exemptions could potentially impede climate change adaptation. For example, exemptions for agricultural land could encourage marginal farming businesses to continue using land (and associated labour and capital resources) for agricultural purposes rather than for more productive, non tax-exempt, activities. This is an inefficient use of land and is contrary to facilitating structural adjustment to climate change. Exemptions may also pose an impediment to biodiversity conservation if the exemption is lost when the land is converted to conservation (PC 2004b). (Other impediments to biodiversity conservation are discussed in chapter 10.)

The existence of tax-free thresholds may also encourage smaller holdings of land (Gabbitas and Eldridge 1998), as could higher taxes on aggregate land holdings (Treasury 2010a). (Tax-free thresholds range from \$25 000 in Tasmania to \$600 000 in Queensland. Tax rates range from 0.2 per cent to 2.25 per cent in Victoria and 0.5 per cent to 3.7 per cent in South Australia (NSW Treasury 2011).) This could restrain economies of scale and scope, and could potentially impede diversification that might be important for some adaptation decisions.

### *Potential reform areas*

Reforms to land tax could improve incentives for efficient land use and at the same time be beneficial for adaptation. For instance, broadening the land tax base, combined with a lowering of the land tax rate, would improve the overall efficiency of the tax (Gabbitas and Eldridge 1998; IPART 2008; PC 2004a; SBTRC 2001). This would help facilitate adaptation as it would remove a potential impediment to structural change in the agricultural sector.

The extension of land tax to owner-occupied land, and to a lesser extent agricultural land, is a highly contentious area. The Commission's 2004 inquiry into first home ownership discussed some of these issues at length. These principally related to payment difficulties for landowners who have high-value landholdings but limited cash flows (the 'asset-rich income-poor') but also included a number of implications for tax administration and compliance (PC 2004a). Australia's Future Tax System Review outlined a number of instruments that could be used to address these issues, including loans, deferred tax liabilities, or reverse mortgage facilities.

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## 5.3 Government transfers

Governments often use transfers (financial assistance) to achieve equity objectives, or to address the adverse effects of adjustment on particular groups — these effects can originate from market-related influences, or as a consequence of changes in government policy (for example, climate change mitigation policy). Assistance to ameliorate adverse effects is sometimes warranted, particularly for economically or socially disadvantaged individuals or communities (chapter 2). However, if not provided appropriately, transfers can reduce incentives to adjust to changing circumstances, such as climate change. Reform to transfers — so as to ensure incentives for adjustment and innovation are maintained — has the potential to increase the wellbeing of the community. These reforms would also help to facilitate adjustment to climate change, strengthening the general case for reform.

### Example: drought assistance

Climate change is expected to increase the frequency of drought in Australia (chapter 2). This will place pressure on many farming businesses. While the agriculture sector has a strong record of coping with drought and other changes, Australian governments have for many decades provided support to farmers in severely drought-affected regions. The existing structure of drought support reduces the incentives for agricultural businesses to adapt to both the current climate and future climate.

In 2009, the Commission undertook an economic assessment of drought support measures as part of the National Drought Policy Review. This analysis found that government support was diminishing incentives for farmers to manage and prepare for drought (PC 2009). The Commission's recommendations concentrated on refocussing drought policy on risk management and climate change adaptation more broadly, so that support could be better directed at improving farmers' self-reliance and preparedness (box 5.2).

In coming to these recommendations, the Commission found that long-term government support encourages dependency. This reduces incentives for self-reliance and preparedness, perpetuates many of the social problems associated with drought, and generally impedes adjustment in the sector (PC 2009). This clearly influences farming businesses' capacity to adapt to the effects of climate change.

Following the release of the Commission's draft report and other reports of the National Drought Policy Review, ministers with responsibility for primary

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industries agreed to a number of principles for national drought assistance reform. These principles included abolition of the ‘exceptional circumstance’ trigger for drought assistance (box 5.2) and the development of farm income support on the basis of mutual responsibility (PIMF 2008). While the Australian Government has not yet terminated the exceptional circumstances declaration process, or associated assistance measures, it has recently conducted a pilot of drought-reform measures in parts of Western Australia in conjunction with the Western Australian Government. The pilot is due to be completed on 30 June 2012.

### **Box 5.2 The Commission’s inquiry into drought support**

The Commission’s inquiry into drought support measures was conducted as part of a trio of assessments for the National Drought Policy Review in 2009. In addition to the Commission’s inquiry, the review included a climatic assessment and an assessment of the social impacts of drought on farm families and rural communities. The inquiry delivered a number of findings and recommendations, including that:

- the National Drought Policy’s Exceptional Circumstance declarations and related drought assistance programs do not help farmers improve their self-reliance, preparedness and climate change management
- a number of Exceptional Circumstances associated programs should be terminated, including interest rate subsidies, farm exit support packages, and small business income support, as should state-based transport subsidies in drought declared areas
- all farm households in hardship — regardless of cause or location — should have access to an income support scheme that is designed for farming circumstances, available on a time-limited basis, and involves a ‘mutual responsibility contract’ — specifying actions to be taken to improve self-reliance. In most cases, this would involve a household or farm financial plan
- significant public funding be directed to training and advice to assist farmers prepare for, manage and recover from the impacts of climate variability and change.

*Source:* PC (2009).

The Western Australian pilot adopted many of the recommendations in the National Drought Policy Review and is aimed at moving towards a ‘risk management’ approach to managing drought. The reform measures are therefore highly relevant to promoting climate change adaptation in the agricultural sector. A recent review of the pilot program was generally supportive of the reforms but made a number of recommendations for change, some of which echo the Commission’s recommendations in its 2009 inquiry (Keogh, Granger and Middleton 2011).

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## 5.4 Regulation

Regulations are necessary to ensure a properly functioning society and economy. However, in some cases, regulations can impose costs where they fail to achieve their objectives or achieve objectives at greater than the minimum cost. Reforms to such regulations would increase the wellbeing of the community by improving the allocation of resources and by reducing compliance costs for households and businesses.

### **Example: water sector regulation**

Climate change will place further pressure on Australia's water resources. There will be changes in the availability of water as well as changes in the demand for water. Thus, adaptation to climate change reinforces the imperative to ensure that scarce water resources are used efficiently and that water supply augmentation options are undertaken in the most cost-effective way.

Australian governments have come a long way in improving the flexibility and efficiency of water markets. The 2004 National Water Initiative, and its predecessor the 1994 Council of Australian Governments (COAG) Water Reform Framework, succeeded in achieving reforms in many areas, including the establishment of secure and tradable water rights and agreement on the removal of barriers to water trading in the rural water sector. There have also been various other pricing and institutional reforms in the urban water sector. These reforms, although yet to be fully implemented, have enabled users to respond to dramatic changes in water availability, and helped to mitigate the impact of drought on agricultural production (NWC 2011b). They have therefore been highly beneficial in responding to climatic variability and are likely to be valuable for adaptation to future climate change.

### *Potential reform areas*

Despite substantial progress there is still scope for further water policy reform, and climate change strengthens the case for reform. Potential areas of reform include the removal of remaining barriers to trade in the Murray–Darling Basin, the establishment of new water markets, more cost-reflective water pricing, and improvements in the way water supply is procured and allocated in the urban water sector (box 5.3). These reforms would facilitate climate change adaptation by enabling water resources to be allocated to their highest value use.

The establishment of new water markets provides additional water sources for farmers and other water-dependent businesses during times of drought and low

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water availability, thus enabling them to adapt to the effects of climate change on water. Reforms to make water prices better reflect the costs of supplying water can signal the need for investment in new supply capacity during times of high demand and low water availability. More cost-reflective pricing also provides a signal to consumers about the cost of their consumption decisions. This can guide behaviour and choice and results in a more efficient allocation of scarce water resources.

### **Box 5.3 Further reforms to Australia's water sector**

The Commission has previously considered the case for economic reform in Australia's urban and rural water sectors (PC 2010b, 2011a). Several of the high priority reforms identified in these reports are discussed below.

#### **Urban water sector reforms**

- *Policy, governance and institutions* — there is a need to establish clear objectives, clarify the roles and responsibilities of water-related institutions and to ensure that best-practice institutional and governance processes are adopted to make regulators, utilities and policymakers responsible and accountable for their actions.
- *Procurement of supply and water allocation* — water-supply security at a lower expected cost could be achieved by governments removing 'policy bans' on supply augmentation from certain sources, such as rural–urban trade and water recycling. Employing a real options approach to selecting supply options would also assist in reducing costs to the community.
- *Water restrictions and pricing* — water restrictions are costly to the community and should only be used in emergency situations. Consumers should be offered a range of tariff/service options (based on the marginal opportunity cost of supply) that allow consumers to express preferences on security of supply and price stability.

#### **Rural water sector reforms**

- *Removal of barriers to trade in the Murray–Darling Basin* — annual caps on the trade of water entitlements out of an irrigation district distort trade and should be eliminated. In this context, the Commission endorses the trading rules set out in the proposed Murray–Darling Basin plan that allows water to be traded free of any restrictions.

A number of these reforms have been supported by the National Water Commission (for example NWC (2011b)). In addition, the National Water Commission has outlined several other areas of reform. These include improvements to the efficiency of existing markets, such as improving price information for water trades in the Murray–Darling Basin, and the facilitation of new water markets for both surface water and ground water in areas outside the Murray–Darling Basin (NWC 2011a). These reforms also offer benefits for climate change adaptation.

Sources: PC (2010b, 2011a); NWC (2011a, 2011b).

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There are a number of challenges associated with implementing these remaining reforms. Not least is the need for political commitment to promoting the use of water resources and water infrastructure that maximises the net benefit to the community. There is also a need to address the tension between providing water for consumptive uses versus environmental uses. Nevertheless, the case for continuing reforms is made stronger by climate change. It is opportune to implement reform while there is less concern currently about water-supply security in most parts of Australia than there has been in recent years (PC 2011a).

### **Example: regulations affecting business**

A broad range of regulatory reform priorities have been identified in the COAG *National Partnership Agreement to Deliver a Seamless National Economy* (box 5.4). These reforms are intended to provide businesses with greater flexibility in shifting resources between jurisdictions, provide smaller firms with greater access to interstate markets, and ultimately reduce the cost of doing business (PC 2011e). While such reforms are beneficial in their own right they could also facilitate climate change adaptation. Businesses that are flexible, less bound by regulation and more competitive should be better able to respond to current and future changes in the environment in which they operate, including climate change.

More broadly, appropriate regulatory reform facilitates adaptation by improving the efficiency and competitiveness of the economy and by reducing the costs of goods and services. For example, streamlining and harmonising construction codes for building and plumbing, combined with a more flexible compliance regime, could lower the cost of compliance for construction businesses operating across jurisdictions and could therefore lower the cost of construction (PC 2011e). This could potentially have flow-on benefits for building owners who wish to undertake construction works to protect their property from the effects of climate change. (Chapter 8 discusses planning and building issues in more detail.)

Another example is national licensing of occupations — this could make it easier for workers to take advantage of employment opportunities in other states and territories. Similarly, a national system for registering business names could make it easier for businesses to trade in different jurisdictions. Such flexibility may be important for climate change adaptation.

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### Box 5.4 COAG competition and regulatory reform

The *National Partnership Agreement to Deliver a Seamless National Economy* outlines 27 priorities for deregulation, 8 areas for competition reform and ongoing reforms to improve processes for regulation making and review. The reforms focus on addressing regulatory and other barriers that impede competition and economic efficiency and add to costs. Many reforms are aimed at reducing the regulatory burden imposed on businesses which operate in multiple jurisdictions.

The 27 areas identified for deregulation involve:

- developing national regulatory systems (for example, trade licensing, registration of business names and construction codes)
- establishing nationally uniform occupational health and safety systems
- establishing nationally consistent systems (for example, payroll tax administration, mine safety and directors' liability)
- improving and/or reducing the burden that regulation places on business (for example, development-assessment processes, food regulation, oil and gas regulation and standard business reporting).

Competition reforms include:

- rationalisation of occupational licensing
- changes to the national access regime for infrastructure
- implementing previously agreed reforms in the areas of energy, transport and infrastructure.

Timetables for implementing the reforms are outlined in the implementation plan attached to the National Partnership. The Commission has assessed the costs and benefits of 17 of the Seamless National Economy Reforms. Preliminary modelling suggests that, if full implementation of reforms ultimately occurs and business and consumers respond in accordance with expectations, the reforms assessed could increase GDP by around 0.4 per cent in the longer run (over \$6 billion) (PC 2011d).

Sources: PC (2010a, 2011d, 2011e).



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## 6 Information provision

### Key points

- Information is essential for effective climate change adaptation. Individuals, firms, governments and community organisations require information to raise awareness of the need to adapt and to enable the appropriate management of climate risks.
- Basic information on current climate risks and climate change tends to be funded by governments because it is necessary for governments to undertake their own functions such as the maintenance of assets and the provision of public goods and services.
  - Unless there are overriding reasons for non-disclosure, such as privacy concerns or national security, such information should be made publicly available.
- Where market failures lead to the underprovision of information, governments may also fund information for the wider community provided the benefits exceed the costs.
  - In the absence of market failures, specific or customised information should be acquired privately.
- There is a number of areas where there may be scope to improve the provision of information by government. These include improving the capacity to forecast extreme weather events, better aligning adaptation research with the needs of users and providing more local climate change information.
- There is also a need to improve the consistency, quality and dissemination of risk information related to natural hazards in the current climate. The Australian Government initiative to improve the quality, coordination and sharing of flood risk information is an important first step. Over time it should be expanded to encompass other natural hazards and take into account climate change.
- In other areas, existing arrangements are in place to facilitate the sharing of information by governments. While there could be room to extend the depth and breadth of information provided under these arrangements, a national repository of climate change information is unlikely to be effective.
- Even if information is produced and shared effectively, individuals may lack the capacity to make fully effective use of information. In addition to making government information publicly available, there may be circumstances where further tailoring or wider communication of information by governments would support adaptation by the community. Before undertaking such activities governments should carefully consider the costs and benefits.

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## 6.1 Information for adaptation

Information is crucial both to manage risks in the current climate and to effectively adapt to climate change. Information can increase awareness of climate risks and recognition of the need to adapt. It can also inform risk management decisions about when and how to best adapt, and allow adaptation actions to be prioritised.

Individuals, businesses, governments and the wider community may be affected by climate change in a variety of ways. Consequently, demands for climate change information are considerable and diverse. Individuals need information to help ensure their personal safety, to protect their property and their livelihoods, and to maintain their wellbeing; businesses need information to make investments, to develop new products, to manage their assets and to protect their employees; and governments need information to provide public goods and services, to protect public assets and to make decisions about planning and land use.

### Who should provide information to support adaptation?

Effective adaptation to climate change requires a mix of publicly and privately funded information. Generally, the provision of basic climate information (and underlying research), such as national and regional projections of climate change, is funded by governments because it is necessary to maintain or improve their own ability to discharge their functions. In addition, governments may fund the provision of information specifically for other audiences where market failures lead to information being underprovided by the private market, so long as the benefits of doing so exceed the costs (box 6.1). However, in the absence of market failures, more specific or customised information should be purchased privately.

As the costs and benefits of all possible uses of government expenditure are not known, public funding decisions for adaptation information and research will need to be made on a case-by-case basis and informed by the best available evidence (qualitative or quantitative) of the costs and benefits of each project. In assessing the costs and benefits of projects and determining priorities for funding, it is important to take account of the long time frames and uncertainties related to climate change impacts (chapter 4). In many instances, the information with the largest net benefits to the community may relate to current, rather than future, climate-related risks. For example, information on bushfire preparedness may foster effective adaptation by better equipping households to cope with the risk of bushfire under the current climate.

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## Box 6.1    **Why do governments produce adaptation information?**

### **Improving government functioning**

Governments undertake a range of functions pursuing equity and social objectives as well as the provision of goods and services. Climate change has the potential to affect a wide variety of these functions including the maintenance of assets, the provision of healthcare and emergency services, and the protection of the environment. Governments may fund the production of a range of climate change related information to assist in carrying out these functions. For example, to inform decisions about the protection of public assets, the Australian Government has commissioned vulnerability assessments of Australia's national parks, nature reserves and World Heritage properties (DCCEE 2012c).

### **Correcting market failures**

Governments may also provide information to the public to address underprovision by the private market. In relation to information for climate change adaptation, market underprovision mainly occurs because information has public good characteristics. However, there may also be cases where government provision could be justified on the basis of significant positive spillovers (when the benefits of information use to the community exceed the benefits to the individual user) or information asymmetry (chapter 3).

#### *Public good information*

Information can be considered a public good when the same piece of information can be used by more than one person and it is difficult to exclude others from using the information. A wide range of climate change adaptation related information may be produced by governments as public goods. For example, the Climate Commission, established by the Australian Government, has produced a number of reports which provide synthesised evidence of the expected regional impacts of climate change on Australia (Climate Commission 2011).

*Sources:* Climate Commission (2011); DCCEE (2012c).

## **Current arrangements for government information provision**

A wide variety of information is already provided by governments to manage current climate risks and support adaptation (box 6.2). In some cases, information is produced directly by government departments and agencies. In other cases, governments fund other organisations and businesses to produce climate change information on their behalf.

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## Box 6.2 Examples of information provided by governments

### Climate trends

The Bureau of Meteorology produces a range of information on climate trends including monthly, seasonal and annual climate statements. Together with the CSIRO, the Bureau has also released *State of the Climate* publications to outline long-term trends in Australia's climate and analyse the factors that influence it.

### Climate change projections

The CSIRO and the Bureau of Meteorology have produced national and regional climate change projections covering a wide range of variables (including temperature, precipitation, humidity, snowfall and wind intensity).

### Climate change impacts and vulnerability assessments

The Department of Climate Change and Energy Efficiency has commissioned vulnerability assessments across a range of areas including investigation of climate change impacts on Australia's coasts, biodiversity and World Heritage properties.

ABARES has produced publications on the impacts of climate change on agriculture, fisheries and forestry, and the Great Barrier Reef Marine Park Authority has produced a Great Barrier Reef vulnerability assessment and a report on the Reef's outlook.

Government-funded research through universities, the CSIRO, the National Climate Change Adaptation Research Facility and other research bodies also produces a range of information on climate change impacts and options for adaptation.

At a high level, the Climate Commission also provides information on climate trends, projections and impacts to raise public awareness of climate change (box 6.8).

### Natural hazard risk information

State and local governments produce maps of natural hazard risks (such as floods and bushfires) to inform land-use planning and emergency management. For example, as recommended by the Victorian Bushfires Royal Commission, the Victorian Government is producing a statewide bushfire hazard map (Victorian Department of Sustainability and Environment 2011).

Geoscience Australia also develops models, methods, information and tools to analyse natural hazard risk and impacts.

### Natural hazard advice and guidance

A range of government agencies involved in emergency management produce information on preparation for natural hazards. For example, the Victorian Country Fire Authority provides Fire Ready Kits with information on how to prepare for a bushfire, and operates the Victorian Bushfire Information Line to provide advice on reducing bushfire risks as well as information on current bushfire incidents (CFA 2012).

*Sources:* ABARES (2012); BOM (2012a); CFA (2012); CSIRO (2007); DCCEE (2012d); GBRMPA (2012); Geosciences Australia (2011); Victorian Department of Sustainability and Environment (2011).

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Frequently, information is an outcome of government-funded research. For example, projections of climate change produced by the CSIRO and Bureau of Meteorology (2007) build on a large body of research funded through government programs such as the Australian Climate Change Science Program. In other cases, governments may rely on research indirectly, for example, synthesising research findings to produce information suitable for a specific task or to make it accessible to the general public.

Governments also sometimes partner with private sector organisations to fund the provision of research and information jointly where some, but not all, of the benefits can be captured privately. For example, the Australian Government and the agricultural industry jointly fund the Managing Climate Variability program which undertakes research to improve climate forecasting and provides farmers with tools and information to manage climate risks (GRDC 2011b).

## **6.2 Barriers to information provision**

Despite the wide variety of climate change related information produced by governments, a lack of information is one of the most commonly cited barriers to adaptation. The view expressed by the Australian Local Government Association (sub. 25, p. 5) is typical:

... the greatest barrier to market based solutions in the area of adaptation is a lack of information and consistent and reliable knowledge.

In some cases there may be good reasons for a lack of information. First, there is a range of scientific uncertainties which limit our understanding of the impacts of climate change. Second, acquiring information is costly. When considering acquiring information, users need to trade off the benefits of more complete information against the costs of acquisition.

A lack of information can only be considered a barrier to effective climate change adaptation when the quantity or quality of information available is less than that required to generate the greatest net benefit to the community as a whole. This may occur when governments fail to fund the provision of information needed to undertake government functions or fail to share this information publicly. Additionally, a lack of information may pose a barrier if markets underprovide certain kinds of information and governments do not provide information sufficient to address the shortfall.

The remainder of this section highlights areas where there appears to be scope to improve the provision of information by government, primarily to improve

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government functioning (particularly at the local government level), but also to support adaptation by the wider community.

## **Forecasting extreme weather events**

Recent natural disasters such as the 2010-11 Queensland Floods and Cyclone Yasi have highlighted the importance of weather forecasting in providing early warning of extreme weather events. Timely and accurate forecasts can reduce the costs of natural disasters in a variety of ways, including by providing residents with time to evacuate and allowing emergency management agencies to effectively deploy resources. As climate change is expected to increase the frequency and intensity of many extreme weather events, the value of forecasts that provide early warning of these events is likely to increase with time.

There may be instances where relatively modest investments to improve the technical capacity of weather forecasting may provide governments and the wider community with better warning information about extreme weather events (Professor Neville Nicholls, sub. 9). For example, a recent inquiry into seasonal forecasting heard evidence that Australia's supercomputing capability has not kept up with advances in comparable countries and that improved computing resources would enable higher resolution weather forecasting (SCISI 2009). Higher resolution forecasting would allow for more accurate local forecasts with longer lead times (in particular, better and more timely forecasts of flash floods).

A review of the capacity of the Bureau of Meteorology to respond to future extreme weather events and provide accurate and timely forecasting services was recently completed (DSEWPC 2011). Findings were presented to the Australian Government in November 2011. However, the review is not yet publicly available and the Government is yet to provide a response to the review's findings.

## **Adaptation research**

Numerous government bodies and other organisations receive public funding to undertake research related to climate change adaptation (appendix B). In general, the research undertaken by these bodies is directed towards furthering understanding in areas where governments have a direct interest and to improving the ability of governments to undertake their own functions.

Adaptation-related research includes basic climate science such as climate observation and projections of future climate change (primarily the domain of universities and government research bodies such as the CSIRO and the Bureau of

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Meteorology) as well as applied adaptation research (mainly undertaken by the CSIRO Climate Adaptation Flagship (box 6.3) and the National Climate Change Adaptation Research Facility (NCCARF) (box 6.4)).

### **Box 6.3 CSIRO Climate Adaptation Flagship**

The CSIRO Climate Adaptation Flagship is a multidisciplinary research partnership between the CSIRO and other research institutions (Australian and international). The focus of the Flagship is on practical research in national priority areas across four themes:

- *Pathways to Adaptation* — supporting decision making by improving vulnerability assessment, delivery of climate change projections and understanding of interactions between climate change and other future drivers of change.
- *Sustainable Cities and Coasts* — developing practical options for urban and coastal communities to adapt to climate change through new planning, design, infrastructure management and governance solutions.
- *Managing Species and Natural Ecosystems* — improving knowledge of climate change impacts on species and ecosystems and developing adaptation options.
- *Adaptive Primary Industries, Enterprises and Communities* — assessing vulnerability and adaptation options, developing adaptation technologies and practices, and assessing adaptation-mitigation interactions for mining, agriculture, fisheries and forestry industries.

Source: CSIRO (2011a).

Other bodies also undertake adaptation research, sometimes incidentally, including:

- the Queensland Climate Change Centre of Excellence
- the Victorian Centre for Climate Change Adaptation Research
- other CSIRO National Research Flagships (particularly the Water for a Healthy Country Flagship and the Wealth from Oceans Flagship)
- several Cooperative Research Centres (such as the Bushfire Cooperative Research Centre)
- Rural Research and Development Corporations (for example, through the Managing Climate Variability Research and Development program)
- some Australian Research Council Centres of Excellence (such as the Coral Reef Studies centre).

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#### **Box 6.4    The National Climate Change Adaptation Research Facility**

The National Climate Change Adaptation Research Facility (NCCARF) was established under the National Climate Change Adaptation Framework agreed to by the Council of Australian Governments in 2007. NCCARF is a partnership between the Department of Climate Change and Energy Efficiency and Griffith University with a consortium of other Australian universities as funding partners.

NCCARF's mission is to generate the 'information needed by decision makers in government, and in vulnerable sectors and communities, to manage the risks of climate change impacts, by leading the research community in a national interdisciplinary effort' (2011, p. 1).

NCCARF has developed National Adaptation Research Plans that identify critical gaps in the information available to decision makers. These plans have been developed around nine priority themes covering biodiversity, health, settlements and infrastructure, emergency management, primary industries, indigenous communities and 'social, economic and institutional dimensions'. Funding for research in accordance with these plans is provided by NCCARF under the Adaptation Research Grants Program.

NCCARF has also set up Adaptation Research Networks across these priority research themes. These Networks are designed to facilitate collaborative climate change adaptation research, the open exchange of information and sharing of climate change adaptation resources.

NCCARF is also responsible for a program of research, conducted with consortium partners, that synthesises and integrates existing and emerging international climate change adaptation knowledge.

*Sources:* NCCARF (sub. 49; 2011).

#### *Improving arrangements for research*

Some submissions questioned whether the current arrangements for applied adaptation research are the most appropriate to support effective adaptation and whether changes could be made to better align research with the information needs of users. For example, the Australian Local Government Association (sub. 25, p. 5) noted that:

... research projects ... while generally worthy appeared too often to be researcher driven, with an imperative for international publication in order to attract Australian research grants, and not necessarily designed to address practical issues of priority concern to councils and the diverse communities and stakeholders they seek to serve.



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Similar concerns were raised by the Queensland Farmers Federation (sub. 55, p. 5):

Despite considerable investment in climate change research for primary industries, the major research programs do not produce information that is relevant for a large number of industries.

Reflecting these concerns, Dr Peat Leith and Dr Sarah Jennings (sub. 22, p. 5) argue that there is a case for greater partnership between industries, governments and researchers to encourage the development of information that spans ‘boundaries between science, policy and research’.

### *Coordination of adaptation research*

Concerns about the effectiveness of adaptation research may reflect poor coordination between the proliferation of organisations and funding sources involved in applied adaptation research. Greater coordination could perhaps be achieved by amalgamating organisations or funding sources. However, diversity in research funding can also have advantages. Selecting the best research is difficult. Consequently, having multiple funding sources reduces the risk of rejecting research projects that would facilitate effective adaptation.

Furthermore, while centralisation of decision making can allow for breadth of perspective and tradeoffs between different research projects, decentralised decision makers may have more expertise in specific fields and better information about the merits of individual research projects (PC 2007). Moreover, some degree of diversity in funding and research management is difficult to avoid given the wide variety of economic sectors and communities affected by climate change.

### *Aligning research with user needs*

Generally, major adaptation research organisations such as the CSIRO Climate Adaptation Flagship and NCCARF appear well aware of the need for consultation, collaboration and partnership with relevant stakeholders. For example, drafting of the research plan for the NCCARF Settlements and Infrastructure Adaptation Research Network involved over 100 participants and three national one and a half day workshops with a wide range of stakeholders and researchers including state and local government agencies, water authorities, engineers, insurers and property developers (NCCARF 2010a).

Concerns about research not meeting stakeholder needs are particularly relevant for NCCARF. NCCARF and its Adaptation Research Networks were specifically designed to serve as a bridge between researchers and stakeholders and ‘to generate

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the information decision makers need to manage the risks of climate change' (DCCEE 2010a, p. 15). To the extent that the needs of decision makers are not currently being met, this may reflect the fact that NCCARF and its Adaptation Research Networks are still in their infancy (implementation plans for research by these Networks were only developed in early 2011). Alternatively, incentives for publication may mean that the needs of users identified in research plans are not flowing through to the research actually undertaken, preventing research from generating information with tangible benefits to end users.

The Australian Government's Climate Change Adaptation Program, from which NCCARF receives funding, will be subject to review at the end of the current funding period (2012). The review should consider whether the current funding arrangements for NCCARF are the most effective way to support adaptation research, with a focus on the information needs of governments (including local governments). Where adaptation research has an industry focus (such as agricultural adaptation), it should also consider whether this research is better undertaken by industry-specific bodies (such as Rural Research and Development Corporations).

## **Local climate change information**

Just as better weather forecasting could improve the ability of the community to manage current climate risks, better information about climate change could improve the community's ability to plan for future climate risks. Concerns about a lack of information raised in submissions often highlighted the limited availability of information on climate change and its impacts at a local level.

The lack of local climate information is an issue for both the private sector and governments. For example, buildingSMART Australasia (sub. 78) and the Investor Group on Climate Change (sub. 73) noted that a lack of appropriately scaled information prevents climate change impacts being taken into account in infrastructure planning and property development investment decisions. Similarly, the Municipal Association of Victoria (sub. 10, p. 10) noted that:

... local government climate change adaptation plans often include actions for councils to review existing arrangements (such as ... preparation for emergencies and heatwaves ...). While the available climate projections are usually sufficient to undertake high-level, broad scope risk assessments, there is rarely sufficient detail to accurately assess the inappropriateness of existing plans, to develop alternative plans or to quantify the impacts of climate change on assets.

In some instances, the scarcity of fine-scale information on climate change may reflect the degree of scientific uncertainty surrounding that information. More

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locally specific information is not necessarily useful if there is already a high degree of uncertainty at a regional or national level.

Businesses may also choose not to acquire locally appropriate information about climate change and its impacts because the costs are prohibitive. This in itself is not a barrier to climate change adaptation. In general, the more specific information is (either contextually or geographically), the more likely the benefits will be concentrated and that the information will be privately provided if sufficiently valued.

Nonetheless, there may be cases where government funding of the provision of more locally appropriate information is warranted. In particular, more fine-scale projections of climate change via a process known as ‘downscaling’ may be worthy of funding as they can sometimes improve the ability of governments and the wider community to plan for climate change at a local level.

### *Downscaling climate change projections*

At a national and regional level, a great deal of information is publicly available about projections of Australia’s future climate. In 2007, the CSIRO and the Bureau of Meteorology (2007) developed regional projections covering a wide range of climate variables including temperature, precipitation, humidity, snowfall, wind and solar radiation. The projections were developed using a range of climate models, based on six scenarios for future emissions developed by the Intergovernmental Panel on Climate Change, and extend out until 2100. The results of these projections are publicly available on the *Climate Change in Australia* website. Through the *OzClim* website, users can also freely explore regional climate change projections using different emissions scenarios and climate models.

However, these large scale projections (with grid spaces of around 200 km by 200 km) may not always provide sufficient detail to inform adaptation decisions. For example, there is significant small-scale spatial variability in rainfall due to factors such as topography which large-scale projections do not capture (Frost 2007). Reflecting this, in some areas efforts have been made at regional levels to ‘downscale’ high-level climate change projections.

A prominent recent example is the Climate Futures for Tasmania project managed by the Antarctic Climate and Ecosystems Cooperative Research Centre and jointly funded by the Australian and Tasmania Governments, and private sector partners (Tasmanian DPaC 2011a). The Climate Futures for Tasmania project used dynamic downscaling (box 6.5) to produce fine-scale projections (with grid spaces of approximately 10 km by 10 km) for the whole of Tasmania. Projected variables

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included average daily minimum and maximum temperatures, total annual and seasonal rainfall, average wind speed, cloud cover, relative humidity, and the frequency and intensity of extreme weather events (such as heatwaves and extreme rainfall).

The results of these projections were used for a variety of purposes including:

- generating new flood inundation maps that take into account possible changes in extreme rainfall due to climate change
- providing detailed analysis of potential impacts of climate change on agriculture
- projecting changes to river flows and inflows to catchments
- assessing the potential impacts of climate change on infrastructure for local governments.

#### **Box 6.5     Downscaling climate change projections**

‘Downscaling’ refers to generating locally-relevant data from global climate models. There are two main approaches: statistical downscaling and dynamic downscaling. Each approach has drawbacks and the potential to introduce biases into results.

##### **Statistical downscaling**

Statistical downscaling involves the use of statistical methods to develop relationships between factors that drive the climate at large scales and local climate conditions to project climate changes at scales of kilometres. The drawbacks of statistical techniques for downscaling are that they assume relationships between local climate conditions and the wider climate are unchanged when the wider climate is altered, they cannot take into account regional feedbacks, and they require historical data over long time periods for testing and adjustment.

##### **Dynamic downscaling**

Dynamic downscaling involves fitting output from global climate models to regional climate models so as to make high resolution regional projections with scales of tens of kilometres. Drawbacks of dynamic models include the high costs involved (doubling the resolution equates to an eightfold increase in computation and storage requirements (Corney et al. 2010)) and the lack of regional feedback.

*Sources:* Corney et al. (2010); IPCC (2007c); Wilby et al. (2009).

With notable exceptions (for example, the South Eastern Australian Climate Initiative), most other regions of Australia have not undertaken exercises in dynamic downscaling of climate change projections of similar scope. In some cases, not undertaking these exercises may be justified as the benefits of downscaling depend on a range of factors including local topography and the purpose of the

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projections. Downscaling may not necessarily produce more accurate or useful information than regional-level projections. Nonetheless, where circumstances are appropriate, the broader use of downscaling of climate change projections could usefully expand the information available for effective climate change adaptation by both governments and the private sector.

## **Sharing and disseminating climate information**

Information produced primarily for government use is frequently of value to the wider community. For example, governments may produce information about bushfire risk in a particular region to inform emergency management and land-use planning decisions. But this information could also be useful to individuals to inform preventative measures to protect their homes against fire and to inform investment decisions by businesses (for instance, whether to invest in a timber plantation). The sharing and dissemination of government-funded climate information is therefore a crucial aspect of effective adaptation.

While the costs of producing information can be high, the costs of reproducing and disseminating information to an additional user tend to be low (and approaching zero for internet publication) (PC 2001a). Where governments have produced adaptation-related information to satisfy government functions, such information should be made publicly available unless there are overriding reasons for non-disclosure (such as privacy concerns or national security). Furthermore, unless there are significant costs involved in dissemination, analysis or other incremental activities, such information should be available to the public free of charge.

### *A national repository of information*

Several submissions suggested some form of national repository of adaptation-related information and research to improve government information dissemination and sharing (Australian Coastal Society, sub. 15; Australian Industry Greenhouse Network, sub. 29; NSW Young Lawyers, sub. 72; Property Council of Australia, sub. 48). Submissions varied considerably on what form a repository should take, what information it should contain and to whom it should be accessible. Some submissions called for a generic national repository of data, research and information; others for a concentration on coastal information, information for local governments, or information on natural hazards.

Given the wide variety of audiences and applications for climate change information, and the ease with which information from different sources can be found on the internet, it is not clear that a generic national repository of information

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would necessarily provide significant benefits over present arrangements. To raise public awareness, the Climate Commission already disseminates high-level information on climate change science, impacts and policy. With regard to coastal, agricultural and local government adaptation there are also arrangements in place.

- The *Climate Kelpie* website, hosted by the Grains Research and Development Corporation, disseminates climate change and adaptation information for farmers.
- The *OzCoasts* website, hosted by Geosciences Australia, disseminates information on Australia's coast including the impacts of climate change.
- The *Coastal Research Web Portal*, hosted by the CSIRO, provides a user friendly means of access to current and past coastal research projects.
- The *Local Government Portal*, hosted by NCCARF, disseminates information on research relevant to local government adaptation.

Further, NCCARF (2010b, 2011) conducts an ongoing program to synthesise and integrate national and international climate change research and plans to further develop its website to become the 'first-stop shop' for climate change adaptation research. There may be room to extend the depth and breadth of information available from these existing sources, but no obvious need for their replacement.

### *Improving coordination and sharing of hazard risk information*

One area where there is scope for improvement is information on natural hazards. Ensuring adequate information is available to deal with risks related to the current climate is the first step to providing adequate information for climate change adaptation. Current climate risks are often conveyed using hazard maps (box 6.6). However, concerns have been raised about the quality and consistency of hazard mapping. For example, the Victorian Bushfires Royal Commission (2010, pp. 215–17) noted that:

There are deficiencies in the mapping of bushfire risk throughout Victoria ... mapping and [bushfire risk] designation processes differ between the building and planning systems ... the 2009 fires burnt across large areas that were not designated [bushfire prone areas for planning or building control purposes].

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Similarly, the Queensland Floods Commission of Inquiry (2012, p. 62) noted that:

There is currently a lack of flood mapping in Queensland planning schemes. A recent report ... established that 80 out of the 127 [local government] planning schemes reviewed (63 per cent) contained no flood-related mapping. Of the remaining 47 planning schemes with maps, only 23.6 per cent were completed in accordance with [state planning policy guidelines].

The quality and extent of hazard mapping tends to improve following such inquiries. For example, the Victorian Government is now producing a statewide bushfire hazard map (Victorian Department of Sustainability and Environment 2011). However, it would be preferable if each state and territory did not have to experience a major natural disaster and subsequent inquiry for hazard mapping to advance.

#### **Box 6.6    What is hazard mapping?**

Hazard mapping is used to produce and convey information about the potential risk posed to a particular location from a given type of natural hazard (such as floods (inland and coastal), bushfires, cyclones, earthquakes and landslides). Hazard maps are typically produced by state or local governments to inform land-use planning, building regulations and emergency management. The exact information they convey varies by natural hazard and the purpose of the mapping.

Hazard mapping (or risk information gained from hazard mapping exercises) may also inform risk management decisions by households such as where to live and what insurance products to purchase. Hazard maps can also affect the price and availability of natural hazard related insurance products (chapter 12).

Reflecting concerns about the extent, quality and consistency of flood mapping across the country, the Australian Government recently accepted a recommendation of the Natural Disaster Insurance Review (chapter 12) for national coordination and dissemination:

The Government will establish a flood risk information portal, hosted by Geosciences Australia, to provide a single access point to flood mapping data. Initially, this will serve as a repository for existing flood mapping data ... the portal will be complemented by the development of guidelines for the collection, comparability and reporting of flood risk information. The guidelines will contribute to an improvement of the quality and consistency of flood data over time. (Attorney-General's Department, sub. 64, p. 19)

This is an important initiative. Better coordination of flood mapping across Australia will allow for improved management of flood risk in the present climate.

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It will also provide a stronger basis for future measures to adapt to potential changes in flood risk due to climate change.

As similar concerns about quality and consistency have been expressed about bushfire hazard mapping, the Commission considers that this initiative should also be expanded over time to encompass other natural hazards (particularly bushfires). A single source for natural hazard information would make it easier to assess the quality and consistency of existing information and identify improvements.

The importance of consistent and up-to-date hazard mapping will only increase over time as climate change alters (and in many cases increases) the intensity and frequency of natural hazards. Consequently, climate change will also reduce the reliability of information based on historical experience alone. It will be important that the guidelines developed take into account climate change where feasible and that they are regularly reviewed and updated.

#### DRAFT RECOMMENDATION 6.1

*The Australian Government initiative to improve the coordination and dissemination of flood-risk information should be expanded over time to encompass other natural hazards. Guidelines to improve the quality and consistency of risk information should be regularly updated and take climate change into account where feasible.*

## 6.3 Barriers to information use

Not all information-related barriers to effective adaptation relate to the provision of information. Even if information is produced, coordinated and shared appropriately, individuals may lack the capacity to use the information in a way that supports effective adaptation. This could be due to external capacity constraints (a lack of skills or resources) or internal ‘cognitive’ constraints.

### External capacity constraints

External factors that constrain the ability of an individual, community or organisation to make use of adaptation information are the same as those that limit the capacity to adapt more broadly (chapter 2). For example, information on options for adaptation is unlikely to be useful if implementing those options requires skills or financial resources that are deficient.



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In the case of vulnerable groups, governments recognise an obligation to provide support. The capacity to make use of climate change information is likely to be lowest among these groups. Consequently, the Commission agrees with the Australian Government that:

A strong social safety net is essential to assist those who may otherwise have difficulty in adapting, for example, vulnerable groups, such as the aged, the poor and Indigenous communities. It is envisaged that any support to these groups would be delivered through the existing social welfare system. (DCCEE 2010a, p. 9)

External capacity constraints apply to governments as well as individuals. Several submissions highlighted a lack of guidance provided to local governments that do not have the capacity to interpret or use information on climate change impacts and adaptation options (Australian Local Government Association, sub. 25; Ku-ring-gai Council, sub. 1; Mornington Peninsula Shire, sub. 16). Local government capacity constraints are discussed in chapter 7.

## **Cognitive constraints**

Making decisions is a costly process. It takes time and effort to gather, process and analyse information. Psychologists and behavioural economists have demonstrated that often, to reduce the costs of mental processing, people apply heuristics. Heuristics are mental shortcuts, such as rules of thumb, which make decision making faster and less effortful while resulting in decisions that are ‘good enough’ rather than ‘optimal’. In other words, people trade off the best possible decision to save on the mental processing costs of fully evaluating a decision (Reeson and Dunstall 2009).

Using heuristics often produces good results. When decisions are highly complex, optimising costs and benefits can be ‘simply impractical’ (Reeson and Dunstall 2009, p. 11). However, choices between using heuristics and carefully weighing costs and benefits tend to be made unconsciously. Consequently, using heuristics can lead to biases and anomalies in decision making. A wide range of cognitive biases and anomalies have been identified and some common examples are provided in box 6.7.

Submissions noted that cognitive biases may inhibit the use of information and pose barriers to effective climate change adaptation (Australian Psychological Society, sub. 35). For example, status quo bias may lead people to adapt less than they would otherwise prefer; present bias may lead people to unduly discount the future benefits of adaptation; and choice overload may cause people to avoid adapting due to the large number of complex adaptation choices.

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## Box 6.7 Examples of cognitive biases and anomalies

**Availability bias** — people tend to estimate the likelihood of an event based on the ease with which past examples come to mind. For example, one may overestimate the rate of divorce in a population by recalling the large number of acquaintances who have recently divorced (Tversky and Kahneman 1973).

**Anchoring** — people tend to make estimates by ‘anchoring’ to an initial reference point and then adjusting. These adjustments are often insufficient (especially in novel situations) so the anchor value influences the final estimate even when it is completely irrelevant (Tversky and Kahneman 1974). For example, comparing two equally valued properties, one may be inclined to offer a higher price for the property with the higher asking price.

**Choice overload** — people tend to be more inclined to put off making decisions when the number of available choices is very large. For example, in one experiment, people were more inclined to purchase jam when 6 varieties were presented than when 24 or 30 were presented (Iyengar and Lepper 2000).

**Dealing with low probability events** — people have difficulty making rational decisions where low probability events are involved. For example, people tend to buy insurance only when the probability of a risk exceeds a certain threshold, even when the insurance is heavily subsidised (Camerer and Kunreuther 1989).

**Framing** — people’s decisions can be influenced by the way a choice is framed (Tversky and Kahneman 1986). For example, people may be more inclined to undergo surgery if the risk of death is framed as a ‘95 per cent survival rate’ rather than a ‘5 per cent mortality rate’.

**Present bias (hyperbolic discounting)** — people tend to prefer a small reward now to a large reward later, but will tend to wait for the large reward if both the small and large rewards are far into the future (Thaler 1981). For example, one may prefer \$10 today to \$12 next week, but \$12 in 52 weeks to \$10 in 51 weeks.

**Loss aversion and status quo bias** — people tend to prefer avoiding losses to making gains, consequently people can be reluctant to change the status quo because the disadvantages of changing loom larger than the advantages (Kahneman, Knetsch and Thaler 1991). For example, rates of volunteering for organ donation tend to be substantially higher in countries where donation is ‘opt-out’ rather than ‘opt-in’ (Johnson and Goldstein 2004).

*Sources:* Camerer and Kunreuther (1989); Iyengar and Lepper (2000); Johnson and Goldstein (2004); Kahneman, Knetsch and Thaler (1991); PC (2008b); Thaler (1981); Tversky and Kahneman (1973, 1974, 1986).

However, heuristics are not necessarily invariable across a population or over time. While many of the biases noted in box 6.7 have been shown to affect wide cross-sections of the community, not everyone experiences every cognitive bias and, those that do, do so to varying degrees. Furthermore, people can (to some extent) adapt and change heuristics over time in response to feedback (Reeson and

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Dunstall 2009), and reliance on heuristics can vary based on experience and circumstance. For example, List (2003) has demonstrated that the status quo bias tends to disappear in markets as traders gain experience.

Moreover, critics question whether evidence from laboratory experiments and surveys can be legitimately generalised to everyday experience (PC 2008b). Some economists argue that, over time, the behaviour of markets can compensate for individual biases. Where individuals are aware of their biases, firms can profit by helping individuals to correct them because biases lead to benefits forgone (Ergas 2007; PC 2008b). Furthermore, in many instances, markets may lead to close to optimal outcomes even in the presence of biases due to the potential for arbitrage and the possibility that offsetting biases cancel out (Epstein 2006).

Heavy-handed approaches that attempt to overcome cognitive biases by mandating or regulating the way individuals adapt are unlikely to be successful and may do more harm than good. But there are certain circumstances where targeted interventions may improve outcomes. Some non-regulatory interventions can change the way choices are presented in order to overcome biases without restricting individual choice — for instance, requiring drivers to make a choice about organ donation when renewing their licence rather than having to ‘opt-in’ (Thaler and Sunstein 2008). Furthermore, governments may prioritise messages and tailor the presentation of information in ways that take cognitive constraints into account.

## **6.4 Tailoring information provision to public needs**

In addition to making government information freely and publicly available, there may be circumstances where further tailoring or wider communication of information by governments would support effective adaptation by the community. However, these measures should only be pursued where it can be demonstrated that there are benefits that clearly exceed the costs.

In many cases, the long time frames of climate change mean individuals and firms have opportunities to learn from others and adjust their responses over time without relying heavily on government-funded information. Governments should therefore prioritise the wider dissemination of information on current climate risks, and information to inform adaptation related decisions that are costly to reverse or not regularly repeated (chapter 4), that is, where opportunities for learning from experience are limited.

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In communicating such information, governments need to ensure it is accurate, timely, relevant and explicit about uncertainties, but also tempered by the public desire for simple messages. If information is too complex it may be misinterpreted or lead to decision paralysis due to ‘choice overload’. However, if information is too simple, it may gloss over important complexities (DEFRA 2011c). In either case, there is a risk of poor decision making by users, and users consequently losing trust in governments and ignoring further advice (Suarez and Patt 2004). To limit these risks, governments may be best advised to present information simply, while providing links to further information for more sophisticated or motivated users (Reeson and Dunstall 2009).

## **Providing natural hazard risk information for properties**

At the level of individual properties, there may be a case for improving the delivery of basic information about the risks currently posed by natural hazards such as flooding and bushfires, and projected changes to those risks over time (for example, changes in the frequency of coastal inundation due to sea-level rise). The Queensland Floods Commission of Inquiry (2012), for instance, noted that property buyers often do not consider the risk of flood when making purchasing decisions.

Potential measures include providing hazard risk information on property title documents, property certificates, rates notices and rental contracts (Insurance Council of Australia, sub. 42; Queensland Floods Commission of Inquiry 2012; Victorian Coastal Council, sub. 70). However, these measures may also impose costs on state and local governments (particularly if high-quality hazard mapping is not already available) and may raise legal liability concerns. Further, there is limited information available with regard to the effectiveness of these measures. Issues of land use and risk management are discussed further in chapter 8.

### **INFORMATION REQUEST 6.1**

*How useful are property title documents, property certificates, rates notices and rental contracts as means for communicating natural hazard risk information to households and businesses? What alternatives are available? What costs and risks would state and local governments incur in providing such information?*

## **Improving public awareness of climate change**

A crucial aspect of adaptation is improving basic community understanding of climate change. As highlighted in several submissions, adaptation may be inhibited by a failure to appreciate the basic threats posed by climate change (Australian

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Psychological Society, sub. 35; CSIRO Climate Adaptation Flagship, sub. 40). A range of measures is already in place to inform the wider community about climate change risks, including the formation in 2011 of the Climate Commission (box 6.8).

#### **Box 6.8    The Climate Commission**

The Climate Commission was established by the Australian Government as an independent body to provide expert advice and information to the community on the science of climate change, climate change impacts and climate change mitigation policy. The Commission has produced a range of reports to raise awareness about climate change including summaries of the impacts of climate change for a range of regions across Australia. The Commission also holds public outreach events across the country to explain these impacts.

*Source:* Climate Commission (2011).

With regard to the effects of climate change on specific regions or sectors a ‘report card’ may be a useful device for conveying information in a manner that is easy to understand and can be regularly updated. This approach is used in Queensland to convey information about the health of waterways and the Great Barrier Reef but could be applied more broadly (Healthy Waterways 2009; Queensland Government 2011a).

### **Providing adaptation options and decision support tools**

In order to take adaptation actions, decision makers may need more than just information on climate change impacts. They may also need information on options to adapt and tools to help inform their decisions and choose between options. An example is the *Climate Kelpie* website, hosted by the Grains Research and Development Corporation, which provides links to a range of tools to support climate-related decisions by farmers organised by region and commodity (GRDC 2011a).

Providing decision makers with adaptation options and decision support tools may be particularly fruitful for motivating adaptation, as behavioural research has shown that information provision tends to be more effective when accompanied by details on how to take action. For example, a communications campaign to encourage vaccination was significantly more successful when combined with a map with directions to a health centre and its opening hours (Reeson and Dunstall 2009).

However, it is also important to recognise that there are fundamental limits to the scope of information on adaptation options that governments can and should

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provide. The most appropriate approach to adaptation could vary significantly from one individual or business to the next reflecting differences in circumstances and personal preferences. Governments are unlikely to be able to provide highly customised information, and should not attempt to. Precisely because such information is specific, the benefits are likely to accrue privately and should be purchased privately.

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## 7 Local government

### Key points

- Climate change has implications for a broad range of local government functions.
  - These functions include the provision of local public infrastructure and the delivery of local services, such as recreational facilities. They also include regulatory roles in the areas of development and planning, public health, and environmental management.
- Some local governments have undertaken climate change risk assessments, developed adaptation action plans and implemented adaptation measures. Others have not undertaken any adaptation planning.
  - The identification by the Australian or state and territory governments of good practice examples of risk assessments and adaptation options could help to provide guidance and reduce costs for councils.
- A number of potential barriers exist that could be limiting local governments' ability to plan for and implement adaptation measures. These are not unique to adaptation and are barriers to effective service delivery by local government in the current climate.
  - There is a lack of clarity regarding the roles and responsibilities for adaptation of councils, including in the areas of land-use planning and emergency management.
  - Legal liability concerns appear to be hindering adaptation for many councils. There is a case for state governments to clarify the legal liability of councils and the processes required to manage that liability.
  - Many councils do not have the capacity to effectively plan for and implement adaptation responses — some face financial constraints and shortages of professional and technical expertise.
- Coordination and collaboration among local governments can address some of the capacity constraints they face. This can occur through the establishment of regional organisations of councils or alliances to undertake common activities, or joint activities such as resource sharing.
- More broadly, state and territory governments need to ensure that local governments have the capacity to effectively carry out their responsibilities, including but not limited to, climate change adaptation.

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## 7.1 Adaptation at the local government level

Local governments are established through state and territory government legislation and are responsible for a diverse range of community services, such as infrastructure, recreational facilities, and local economic development (including tourism).<sup>6</sup> They also have a range of regulatory responsibilities conferred on them by state and territory governments, which broadly include development and planning, public health, and environmental management (PC 2012).

Climate change has the potential to affect many of these functions. For example, increased incidence and severity of storm activity and storm surge could damage coastal assets, such as jetties and marinas, and render some services inoperable, including ferries and barges. It could also result in flash flooding, which could increase the demand for emergency services and also threaten wetlands and creeks.

Given the diverse nature of local governments, the effects of climate change will be experienced differently. Councils in coastal areas face a different set of climate risks (including sea-level rise and storm surge) to inland councils (such as bushfires and riverine flooding). The diversity of local governments was outlined in the Commission's recent draft regulation benchmarking report on *The Role of Local Government as Regulator* (PC 2012). Each local community is characterised by a unique set of geographic, environmental, economic and social circumstances. This is reflected in differences in the population of local governments (ranging from 57 people to 1.1 million people), land area (ranging from just over 1 km<sup>2</sup> to over 370 000 km<sup>2</sup>), and the median average income of residents (ranging from around \$27 000 to \$105 000 per year) (PC 2012).

Climate change is just one of the many risks that local governments need to manage. Other factors, such as demographic changes and economic growth and development also present challenges for councils. It is therefore important that climate change adaptation is incorporated into councils' broader risk management strategies.

When developing strategies to manage climate change risks, councils will need to consult with their local communities about how risks should be managed and the level of risk the community is willing to bear. This includes a consideration of whether and how to protect existing settlements at risk from climate change (chapter 8). These decisions will often need to take into account diverse community opinions and preferences, for example, about protecting the environmental and recreational aspects of some areas and protecting private and public assets at risk.

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<sup>6</sup> The ACT does not have a system of local government.



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## **Barriers to local government adaptation**

In order to manage the risks of climate change on local government services, councils need to identify risks, develop options to mitigate those risks, and then implement adaptation options that provide a net benefit to the local community. A range of potential barriers to managing risks were cited in submissions, including:

- poorly defined roles and responsibilities for adaptation
- local government capacity constraints, including financial constraints, lack of information and guidance, and skill shortages
- legal liability concerns of local governments.

These barriers can apply to all stages of climate change risk management — these are the identification of climate risks, the development of adaptation options, and the implementation of adaptation measures. However, for many councils they mainly affect the implementation of adaptation options.

### ***Barriers to identifying climate change risks and adaptation options***

Climate change risk assessment involves defining how the climate is projected to change in the future, assessing how this will affect local government assets and services, and developing options to manage these risks. A number of councils have undertaken climate change risk assessments and developed adaptation action plans as a first step to managing the risks of climate change. For example, several councils provided submissions to the Commission with details of risk assessments or adaptation strategies developed for their areas (Clarence City Council, sub. 10; Mornington Peninsula Shire, sub. 16; Redland City Council, sub. 36) (box 7.1).

However, many other councils have not undertaken any adaptation planning. If councils are unable to develop risk assessments or adaptation plans due to capacity constraints or other reasons, such as behavioural barriers or councillors' attitudes to climate change (chapter 3), then a barrier to adaptation may exist. (Capacity constraints are discussed further in section 7.3.)

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### Box 7.1     **Case study: Redland City Council risk assessment and adaptation plan**

In 2009, Redland City Council (south-east Queensland) engaged consultants to undertake a climate change risk assessment to explore the ways in which climate change may impact on Council assets and services. The risk assessment was based on the Australian Government's *Climate Change and Risk Management* guide for business and government (AGO 2006). A total of 31 council services were considered subject to climate change risks, including the provision of infrastructure (such as coastal infrastructure, transport, and buildings), planning and development, environmental management, community and social planning (such as aged care, emergency services and recreation services), and corporate services (such as workplace health and safety, and legal and financial services).

Risks were assessed over three time periods (current to 2010, 2030, and 2070) using scales for consequences (insignificant to catastrophic) and likelihood (rare to almost certain), and a matrix for risk evaluation encompassing all 31 services at potential risk. Risks were assessed against climate change scenarios based on CSIRO projections for coastal regions of south-east Queensland using a range of climate variables, including temperature, rainfall, wind speed, sea-level rise and storm surge.

A total of 48 risks were identified, of which 21 were classified as 'high priority'. None were considered extreme, though almost all risks in the medium to high category were associated with infrastructure, such as low-lying public infrastructure susceptible to flooding. A substantial number of risks to environmental management were also identified, such as increased algal blooms, and harm to animal or plant populations, habitats, or ecosystem health from storms and flooding. Risks to community and social planning included threats to public safety from increased storms and flooding.

To address these risks, the Redland City Council developed a *Climate Change and Energy Action Plan 2010-2015*, which identifies adaptation and mitigation actions to be taken in the five-year period. These include:

- further research and analysis of risks, such as determining the location of infrastructure and assets at risk by comparing spatial data on storm tides and flooding with data on location of roads and coastal structures
- reviews and updates of existing plans, such as Bushfire Management Plans and Bushfire Risk Mapping, every five years
- investigating cost-effective options to manage risks, including for defending or retreating from sea-level rise impacts and conducting a cost-benefit analysis of major design-criteria changes for new buildings.

*Sources:* Marsden Jacob Associates and Broadleaf Capital International (2009); Redland City Council (2010).

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The Australian Government has provided financial assistance and guidance to some local governments to undertake climate change risk assessments and to develop adaptation options. The main Australian Government programs in this area are:

- the *Local Adaptation Pathways Program* (LAPP) (now closed). The LAPP provided \$2.4 million in funding from 2008 to 2010 for 39 projects covering 94 councils (DCCEE 2012h)
- the *Coastal Adaptation Decisions Pathways Program* (CAPP). The CAPP has provided \$4.5 million to councils and alliances of councils for research and development funding to demonstrate effective approaches to adaptation in the coastal zone (DCCEE 2012e)
- guidance for identifying risks and incorporating these into local government operations, including the *Climate Change Impacts and Risk Management* guide for business and government (AGO 2006) (appendix B).

Some state governments and local government associations have also provided assistance for councils to undertake adaptation planning in the form of grants and guidance material (appendix B).

While many councils have been supportive of these programs, some expressed concern that risk assessments and adaptation plans developed under the LAPP have been generic and not detailed enough to result in concrete action (Pillora 2010). Others suggested that the LAPP has not involved a coordinated or strategic approach to developing local government adaptation responses across Australia. For example, due to the one-off and competitive nature of the LAPP, it was thought to disadvantage smaller, less well-resourced councils with fewer professional staff to prepare grant applications and to implement adaptation programs (Local Government Association of Queensland, sub. 41; Sunshine Coast Council, sub. 53).

#### *Identification of 'good practice' adaptation risk assessments and options*

One way to build on the experience of the LAPP and the CAPP would be to identify 'good practice' examples of risk assessments and adaptation plans. This would help councils to draw on the experience and work of others when developing their own responses, especially those councils that have not yet undertaken any adaptation planning. Indeed, one of the objectives of the CAPP is to develop leading-practice approaches to managing climate change risks in the coastal zone (DCCEE 2012e).

Good practice examples are those that follow good-practice risk management and regulatory principles and that appropriately take into account the uncertainty posed by climate change (chapters 4 and 10).

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One option could be for state and territory governments to draw on the risk assessments and adaptation plans that have been developed to date and to identify best practice examples that can be distributed to other local governments. While this may help to provide guidance and reduce the costs of planning for some councils, it may not overcome persistent capacity constraints, particularly where these constraints limit councils' ability to interpret or adopt good planning approaches demonstrated by other councils (section 7.3).

Local government associations and regional organisations of councils can also play a role in identifying good practice examples and disseminating these to councils in their jurisdictions. Some already appear to be taking action in this area, including the Municipal Association of Victoria (sub. 79) and the Local Government and Shires Association of New South Wales through its *Climate Change Action Pack* (appendix B). (The role of collaboration and coordination between councils is discussed later in this chapter.)

The Australian, state and territory governments also have a responsibility for evaluating the outcomes of programs they fund, which could help to identify good practice risk management approaches and adaptation plans. In this regard, some of the recommendations outlined in the evaluation of the LAPP could facilitate this. These recommendations include: the development of a range of case studies that illustrate climate change risk assessments and adaptation strategies that can be presented to local governments; the development of networks of council officers involved in adaptation planning; and forums to provide opportunities for councils to learn from the LAPP experience (DCCEE 2012h).

The evaluation also includes a number of recommendations focused on improving any future rounds of the LAPP. These include: the development of a standardised list of climate change risks; the development of more detailed guidance to consultants on definitions and terminology, the risk assessment process, the focus and format of reports, and adaptation strategies for local government; and greater consideration of state and territory government requirements for local governments in adaptation (DCCEE 2012h).

While there has been no formal response to the evaluation by the Department of Climate Change and Energy Efficiency, the Commission understands that the Department has commissioned a report that analyses and synthesises the outcomes of the LAPP. This report is intended to be used as a resource by councils that are considering the risks of climate change for their activities.

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## 7.2 Roles and responsibilities

Clearly defined roles and responsibilities are necessary to ensure that the most appropriate level of government or the community is responsible for managing the risks of climate change. Without appropriately defined roles and responsibilities for adaptation, some local governments may fail to take action to manage the risks of climate change due to uncertainty about whether and how they should act. Councils reported that roles and responsibilities are not well defined in respect to climate change adaptation in general, and also in relation to some specific areas.

- *Coastal management* — councils reported uncertainty about roles and responsibilities relating to a number of coastal issues, including:
  - who has responsibility for funding and managing coastal protection works (state or local governments, or private or public land owners) (Clarence City Council, sub. 10; Municipal Association of Victoria, sub. 79; Sunshine Coast Council, sub. 53)
  - the appropriate balance between protecting property and protecting the environmental and amenity aspects of coastal areas (Victorian Local Governance Association, sub. 3) (chapters 9 and 11)
  - whether and how councils should manage the risks of climate change in high-risk coastal areas, both for new developments (Local Government Association of Queensland, sub. 41) and existing settlements (Sunshine Coast Council, sub. 53). These issues also extend to inland areas, where other hazards can pose high risks, such as bushfires or riverine floods (chapter 8).
- *Emergency management* — there is uncertainty about the roles and responsibilities between the Australian, state and territory and local governments in responding to natural disasters (chapter 10).

Some of the uncertainty about roles and responsibilities appears to partly stem from a lack of clarity about the policy and regulatory frameworks within which councils operate, particularly regarding land-use planning (chapter 8), as well as legal liability concerns (discussed later). Clarification of these matters may address some of councils' concerns. Nonetheless, there is scope to clarify the roles and responsibilities for adaptation by local government in some areas, particularly those relating to coastal protection (chapter 9).

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### *When should local government be responsible for adaptation?*

The principle of subsidiarity — that responsibility for a particular function should reside with the lowest level of government competent to deal with the issue — can help guide the assignment of responsibilities. Local governments have specific knowledge and expertise relevant to their local communities. Thus, where council actions are confined to their local area they are likely to be the most appropriate level of government to manage the risks of climate change.

When determining whether local government is the most appropriate level of government to be responsible for adaptation, it is important to consider whether the local government has the capacity to effectively deliver outcomes. This includes access to financial resources, suitably qualified staff, and appropriate information and guidance from state and territory governments (section 7.3).

Local government may not be the most appropriate level of government to undertake adaptation in cases where:

- local government actions have positive or negative impacts on other jurisdictions. For example, a local government may invest in a seawall that protects properties within its jurisdiction, but creates erosion in a neighbouring local government area. Alternatively, a local government may decide not to protect a beach or area of national environmental significance from the effects of climate change
- there are areas of shared interest or there are economies of scale from a more centralised or coordinated provision of services. For example, it may be more efficient to undertake climate change modelling at a national, state or territory level. Similarly, it may be more efficient to undertake risk assessments at a regional scale through groups of councils, rather than by each individual council
- diversity in local government approaches to adaptation may impose costs that exceed the benefits. For example, there is a tension between allowing local governments to tailor responses to their own circumstances and minimising costs for businesses that operate across jurisdictions, such as property development.

In these instances, regional, state or territory, or national approaches may be more appropriate. The South Australian Government's proposed regional agreements and regional integrated vulnerability assessments are examples of a regional approach that involves natural resource management boards, local governments, and regional development boards (SA Government 2010a). Where regional approaches are considered suitable, it may be necessary for state and territory governments to facilitate these.

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Given the diversity of local government functions, it will be necessary to assess roles, responsibilities and resourcing on a case-by-case basis — a one size fits all approach will not be appropriate. In examining this issue in a recent report into the role of local governments as regulators, the Commission found that state governments should consider the spread of costs and benefits for any given policy area or regulatory activity and determine which level of government is best positioned to undertake that activity (PC 2012).

Poor definition of the roles and responsibilities of local governments appear to be a systemic issue and is not specific to climate change adaptation *per se*. There is scope to improve the transparency and accountability of local government regulation. Across all jurisdictions, numerous state and territory Acts and associated legislation delegate regulatory responsibilities to local government. However, no jurisdiction has a comprehensive list of laws that delegate a regulatory role to local government. Further, only New South Wales and the Northern Territory have a legislative requirement for local policies and laws to be published on local government websites (PC 2012). Consequently, there is uncertainty as to exactly what functions local governments undertake and what they are required to do under state and territory law.

Development and maintenance by each state and the Northern Territory government of a list or register of the laws which require local governments to play a role would:

- provide clarity to state, territory and local governments
- assist state, territory and local governments in discussing and setting priorities
- assist state, territory and local governments in assessing whether local governments are adequately resourced to fulfil their regulatory roles (PC 2012).

While this may not entirely clarify roles and responsibilities for adaptation (further guidance and clarification of legal liability is also required), it is likely to be a low-cost and necessary first step in the process.

DRAFT RECOMMENDATION 7.1

***There is uncertainty about the roles and responsibilities for adaptation by local governments, including in the areas of land-use planning, coastal management, and emergency management. As a first step to clarifying these roles and responsibilities, state and Northern Territory governments should publish a comprehensive list of laws which delegate regulatory roles to local governments. This would assist state, territory and local governments to assess whether local governments have the capacity to effectively discharge their roles.***

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## 7.3 Local government capacity

The capacity of local governments to implement adaptation options is limited by financial constraints, access to information and guidance to support adaptation decisions, and the knowledge and expertise of staff. As noted by the Australian Local Government Association (sub. 25, p. 3):

... the capacity to address these [climate change] impacts will also vary, reflecting differences in the availability of information, expertise, and resources available at the local government organisation level.

The capacity constraints facing local governments are not unique to climate change adaptation. As outlined in PC (2008a), local governments face resourcing constraints in relation to the broad range of areas in which they have regulatory responsibilities. It is therefore beyond the scope of this inquiry to comprehensively consider local government capacity constraints. Nonetheless, some specific constraints have been identified that are limiting councils' ability to undertake adaptation.

### Financial constraints

The most common capacity issue raised by stakeholders related to councils having insufficient financial resources to implement climate change adaptation actions (for example, Barry Pullen, sub. 27; Council of Capital City Lord Mayors, sub. 67; NCCARF Adaptation College, sub. 21; Redland City Council, sub. 36; Sunshine Coast Council, sub. 53). Specific financial constraints were cited for funding capital works to protect against the effects of sea-level rise or severe weather events, the potential acquisition of property in high-risk areas, and to prepare for and respond to natural disasters.

The implementation of identified adaptation options often requires considerable financial resources and expertise. For example, the Sunshine Coast Council (sub. 53) has identified 150 adaptation options across a broad range of areas, from preparing for the potential health impacts of changes in vector-, food- and water-borne diseases to developing guidelines relating to the provision of new, and retrofitting existing, infrastructure.

In the Commission's 2008 inquiry into the revenue raising capacity of local governments, councils indicated that their levels of revenue were inadequate to meet many local government functions, including for maintaining and upgrading infrastructure assets and funding additional services provided to their communities



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on behalf of other spheres of government (PC 2008a). This clearly has implications for adaptation.

Funding infrastructure construction and maintenance is already a major financial challenge for local government, requiring long-term planning and resourcing. Climate change is likely to reduce the lifespan of infrastructure and increase maintenance costs and repair costs ... since many councils struggle to finance baseline capital expenditure requirements, the additional cost of climate-proofing infrastructure is too much. (Municipal Association of Victoria, sub. 79, pp. 18–19)

Local governments' capacity to access revenue will affect their ability to take adaptation actions. As noted by the Victorian Local Governance Association (sub. 3, pp. 10–11):

Local governments are often expected to respond to many of the immediate, locally felt climate impacts on communities without having the capacity to do so. Many of the most disadvantaged rural and regional communities are also the most vulnerable to climate change impacts ... These exacerbate other vulnerabilities, such as declines in agricultural yields ... The rural local governments in these areas are the most exposed to a combination of high cost-to-revenue ratios due to large road lengths to maintain an ageing built infrastructure, combined with a diminished capacity for rate-based revenue increase and (often) declining populations.

### *Local government revenue sources*

Local governments receive revenue from a range of sources, including own sources (municipal rates, user fees and charges, fines, and developer contributions) and recurrent grants from the Australian, state and territory governments. Grants from the Australian Government are generally passed through the state and territory governments and include financial assistance grants (general purpose payments and local roads grants) and specific purpose grants, including natural disaster-mitigation funding (chapter 9). State and territory government grants are directed to a wide variety of purposes, including housing and community services, transport, public order and safety, and recreation and culture (DITRDLG 2010).

There is considerable variation in the proportion of revenue each local government receives from own sources, which reflects population density and demographics, natural endowments, and economic activity (PC 2012). Councils have a choice about which revenue source they use to fund council services (with the exception of government grants that are tied to specific purposes). In making this decision, councils need to determine whether the service or activity is a public good, private good, or likely to result in costs or benefits to others in the community (box 7.2).

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## Box 7.2     **Funding council services**

*Municipal rates* – are generally levied on land (and in some cases capital improved) values and therefore do not influence how land is used. They represent an appropriate means of financing local public goods, where those that benefit from the service cannot be identified or excluded. Rates are also an appropriate means of funding services that provide wider community or ‘flow-on’ benefits, where those that receive the benefits cannot be identified.

*User fees and charges* – if the local government service provides benefits to identifiable individuals or groups, then the costs of that service should be allocated to those that receive the benefit. Examples include developer charges or contributions from property owners.

*Borrowings* – if the council service provides benefits to the community over a considerable period of time (as is the case for some infrastructure), then it may be appropriate to finance the service through borrowing with the cost of debt serviced through rates or user charges. This enables the cost of the asset to be matched with the benefit from the consumption of the service over the life of the asset, promoting intergenerational equity.

It may also be appropriate to use a combination of rates, user fees and charges, and borrowing. For some councils, concerns about ability to pay may result in prices for some services being subsidised from rates revenues or higher prices for some groups. Where this is the case, transparency in the level of any subsidy is important to enhance accountability. The exact mix of cost recovery mechanisms is a choice for individual councils depending on their circumstances.

*Source:* PC (2008a).

There is scope for some councils to raise additional revenue through own sources, particularly municipal rates, though this varies between councils. However, some rural and remote councils are highly dependent on grant money, and have limited capacity to raise additional own-source revenue (PC 2008a).

User charges, such as developer charges or infrastructure levies, could also be used to fund adaptation where local governments provide adaption responses (such as seawalls) that deliver private benefits. Indeed, some councils have used special levies to fund coastal protection measures (chapter 9). Some councils have also enacted policies or laws that require binding agreements to be put in place with property owners to cover the future costs of protection measures (chapter 8).

Local government funding is an issue that goes beyond the scope of this inquiry — councils have competing funding priorities for the broad range of services they deliver and climate change is only one of the risks that must be managed.

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Nonetheless, funding has clear implications for adaptation. As noted by the Mornington Peninsula Shire in Victoria (sub. 16, p. 9):

... a barrier to adaptation will be the ability of local government to access funding in a timely and affordable manner. Consideration should be given to examining the regulatory tools available to local governments to raise finance in an economical and equitable way. For example, it may be appropriate to consider how developer contribution schemes are formulated and implemented and how government expenditure in coastal (and flooding) protection works can be recovered from the beneficiaries of any public works.

In some cases, there are legislated restrictions on the fees that local governments can charge for the provision of goods and services (PC 2012). This includes developer charges, which in the case of New South Wales and Queensland, are capped by state governments, though in New South Wales councils can apply to the Independent Pricing and Regulatory Tribunal for a contribution above the capped amount. This could affect the ability of councils to raise revenue to fund some adaptation responses, especially if charges are set at a level below the cost of service provision (PC 2008a).

In addition to own sources of revenue and recurrent grants from the Australian, state and territory governments, local governments can access funding from a number of competitive grant programs. Some of these are adaptation specific though they have mostly focused on planning for adaptation. Other grants could potentially be used to fund adaptation responses (box 7.3).

Given the diversity in revenue-raising sources, revenue-raising capacity, and the adaptation requirements of individual councils, it is likely that financial constraints will vary substantially across local governments. Moreover, as outlined in section 7.2, there may be instances where local governments are providing adaptation responses that have costs or benefits to the community more broadly, or are provided on behalf of other levels of government. In these instances, it will be necessary for state and territory governments, or the Australian Government, to assess whether local governments have appropriate access to financial resources.

## **Inadequate guidance and information**

### *Inadequate guidance*

There is currently a large volume of guidance material available to local governments relating to adaptation (annex 1, appendix B). However, this does not appear to be meeting the requirements of councils. This is particularly the case with respect to state government guidance to support land-use planning and development

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decisions, but also extends to implementing adaptation options in a range of areas. For instance, the Mornington Peninsula Shire (sub. 16, p. 8) stated that:

There is an urgent need to provide guidance on when and how to conduct a reliable assessment of coastal vulnerability when decision makers are being asked to determine development applications on a given site along the coast.

The Municipal Association of Victoria (sub. 79) recommended that coastal adaptation guidance be developed specifically to meet local governments' needs.

### **Box 7.3      Funding available to local governments for adaptation**

Adaptation-specific funding has been provided to local governments from the Australian Government to undertake climate change adaptation risk assessments and adaptation plans, primarily through the *Local Adaptation Pathways Program*, the *Coastal Adaptation Decisions Pathways Program* and the *Integrated Assessment Human Settlements* sub-program. This latter sub-program funded five projects aimed at building the capacity of local governments to identify climate change challenges and responses (DCCEE 2012f). Some adaptation-specific funding is also available from state and territory governments. For example, the Tasmanian Government's *ClimateConnect* program offers grants of up to \$20 000 for councils to develop and implement adaptation options (Tasmanian Climate Change Office 2012).

Local governments can also access other funding that could potentially be used for adaptation. From the Australian Government, these include the *Regional Development Australia Fund*, the *Local Government Reform Fund*, and *Caring for Our Country* grants. One project being considered under the Regional Development Australia Fund includes funding for coastal protection infrastructure for the Torres Strait Islands Regional Council (DRALGAS 2012b). At the state level, examples include:

- in Victoria, the *Local Government Infrastructure Program*, which provides funding to councils to build, or renew, infrastructure, including roads, bridges and new community assets (Victorian Government 2012a)
- in Queensland, the *Local Government Grants and Subsidies Program*, which provides financial support to local governments that demonstrate limited capacity to self-fund an identified priority project (Queensland DLGP 2012). This program incorporates the *Climate Ready Infrastructure* initiative, which requires councils to consider climate change adaptation in applications for state government grants for new infrastructure (Queensland Government 2010a)
- the *South Australian Local Government Research and Development Scheme*, which provided financial support to the South Australian Local Government Association to develop a financial model and tool to guide decision makers about the financial implications of climate change impacts on asset management and investment (LGASA 2012).

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More broadly, the Local Government Association of Queensland (sub. 41, p. 2) suggested that councils need clearer guidance across most activities, ranging from:

understanding social and economic vulnerability, determining acceptable levels of risk and how and when to respond to reduce these risks within their communities, to the particularities of determining when a development application should be refused without exposing their organisations to legal and financial risks.

Some councils also suggested that a profusion of adaptation planning tools, approaches and methodologies is leading to confusion and uncertainty about what adaptation actions should be taken (Environmental Defenders Office 2011; Northern Alliance for Greenhouse Action, sub. 6).

It is not clear to what extent local governments' concerns relate to inadequate clarity of their roles and responsibilities and legal liability, or to a lack of appropriately targeted guidance, or a combination of these. It may be that councils are seeking guidance on exactly when and how to respond to the potential impacts of climate change, including how to prioritise and implement adaptation actions (Gold Coast City Council, sub. 17; Pillora 2010). Without more specific guidance from higher levels of government some councils appear to be reluctant to take action on climate change (Gippsland Coastal Board, sub. 65). Moreover, it is likely that for some councils, clarification of roles and responsibilities and the legal liability they face, particularly in the area of land-use planning (chapter 8), may address some of their guidance concerns.

Regardless, this reveals a need for different or additional guidance to local governments from state and territory governments and/or local government associations than is currently being provided. This needs to be provided in a manner that allows councils to take their own circumstances and the diversity of services they provide into account in their adaptation decisions. The identification of good-practice risk assessments and adaptation options (section 7.1) may go some way to addressing this at the adaptation planning stage, but this may be insufficient to guide councils with the implementation of specific adaptation responses.

### *Inadequate information*

Information on climate change impacts is often unavailable at an appropriate scale. The Municipal Association of Victoria (sub. 79) reported that climate change projections are usually sufficient to undertake high-level, broad-scope risk assessments, but there is rarely sufficient localised detail to incorporate risks into specific plans (or to develop new plans) or to quantify the impacts on assets.

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While some locally-scaled data are being provided in a number of states, for example as part of the *Tasmanian Climate Futures Project* and Victoria's *Future Coast Program*, it appears that even in these circumstances further data are required to meet the specific needs of councils. The Mornington Peninsula Shire (sub. 16) acknowledged the work carried out for the Western Port Bay under the *Future Coasts Program*, but suggested that similar information is also required for Port Phillip Bay.

To address information gaps, several submissions argued that there needs to be a move to a central data source, in particular to support land-use planning decisions, but more broadly to act as a 'clearing house' for information about adaptation and responses (Redland City Council, sub. 36; Victorian Local Governance Association, sub. 3). Some recent measures have been introduced which attempt to provide a single point of information to councils on particular climate change impacts and adaptation (chapter 6 and appendix B).

If information is not appropriately utilised to make decisions, this could constitute a barrier to effective adaptation. That is, where the Australian, state or territory governments do not have appropriate processes to ensure that local governments understand the information provided to them, or do not have access to the information they need to make decisions and can make that information public, then decisions by councils may not effectively take into account climate change.

In order to make effective adaptation decisions, local governments require data that are at a detailed local level. There could be a case for a base level of information to be provided by the Australian, state or territory governments (incorporating consistent information on scenarios and assumptions to use), which could then be built on or extended by local governments to obtain the finer-grain data that they require. The central coordination and provision of locally-scaled data on hazards is discussed in chapter 6.

## **Skills and knowledge**

Even when climate change information and guidance material are available to local governments, they may not have the professional or technical expertise to determine how these should best be used. The Coasts and Climate Change Council (sub. 30, p. 3) stated that:

At the local level, decision makers have varying capacity to acquire the data they need to understand risks under different climate change scenarios, and can lack the know-how to integrate that information into planning and investment decisions.

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Gaps in expertise may be limited to specific areas. These can be as narrow as skills in geomorphology and coastal processes (South East Councils Climate Change Alliance, sub. 12) or in applying new planning options in an Australian context (such as rolling easements and planned retreat (chapter 8)) (Sunshine Coast Council, sub. 53). Some councils do not have the interdisciplinary skills required to incorporate the complexity and uncertainty of climate change into decision making frameworks across all local government disciplines (Ku-ring-gai Council, sub. 1). Technical expertise to assess climate change impacts or to respond to climate change information provided to them may also be missing (Housing Industry Association, sub. 69; Municipal Association of Victoria, sub. 79).

Some stakeholders indicated that training may be required to apply risk-management techniques (Victorian Centre for Climate Change Adaptation Research, sub. 56) and to develop local and regional adaptation action plans (Australian Climate Change Adaptation Research Network for Settlements and Infrastructure, sub. 19).

More broadly, strong competition for workers from other levels of government, as well as the private sector, has meant that local governments are often subject to a shortage of suitably qualified workers, particularly with respect to development assessment planners, strategic planners, and building inspectors and surveyors (PC 2012). This has implications for councils' ability to consider adaptation issues, particularly with respect to land-use planning decisions. However, a number of options are available to address skill shortages, including contracting out services, training, and assistance from state and territory governments.

There may be circumstances where expertise is available for adaptation, but local governments would have to offer higher wages in order to attract skilled staff to their local area, particularly in remote areas. This may be beyond the resources of some councils, especially if the expertise only needs to be utilised infrequently. One option to address this is for councils to outsource some functions to a private organisation. This would provide flexibility for councils to commission work as required and enable them to access expertise they may not otherwise be able to afford to employ on a permanent basis (PC 2012). In the context of adaptation, the suitability of such arrangements depends on whether private organisations have the required climate change adaptation expertise and knowledge of local issues.

State and territory governments also have a role to play in ensuring an appropriately trained local government workforce, particularly when state or territory governments change or impose additional responsibilities on local governments (PC 2012). In this regard, there have been some initiatives put in place by governments to address workforce shortages within local government. For example,

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the Victorian Government has established the ‘Regional and Rural Planning Flying Squad’, which provides short-term planning assistance to rural and regional councils to undertake their regulatory planning functions. This includes ‘specialist expert and technical assistance on issues such as major projects and developments, long-term land-use issues, strategic plans as well as immediate support with planning permit and amendment work’(Victorian DPCD 2012). While still in its early stages of operation (the program was launched in November 2011), the Regional and Rural Planning Flying Squad could be an example of how to address some of the barriers that arise from skill shortages.

Local government associations also have a role to play in providing training for their members. An example of this is the training package provided by the Municipal Association of Victoria on behalf of the Department of Sustainability and Environment’s *Future Coasts Program*. This training package includes a half-day session for local government councillors and executive staff on climate change and coastal adaptation planning, as well as a more technical full-day session for coastal managers (Municipal Association of Victoria, sub. 79).

Coordination and collaboration with other local councils could also be a means of addressing barriers to adaptation arising from skill shortages. This could include resource sharing and undertaking joint projects with other councils (discussed below).

## **Local government coordination and collaboration**

Coordination and collaboration among local governments can address some of the capacity constraints they face. This can occur through the establishment of regional organisations of councils, alliances, or committees to undertake joint activities such as resource sharing or undertaking projects together. These arrangements allow local governments to benefit from the skills and knowledge within the local government network. They can also reduce costs for councils and minimise inconsistency in approaches to regulatory activities such as land-use planning, and could also help to moderate financial constraints.

Some of these collaborative arrangements have a climate change specific focus (appendix B), including the Northern Alliance for Greenhouse Action (sub. 6), the South East Councils Climate Change Alliance (sub. 12), the Coastal Council’s Adaptation Taskforce (sub. 17) and the National Sea Change Taskforce (sub. 75). Some local government collaborative bodies that have a broader focus also consider climate change adaptation issues, such as the Victorian Local Governance Association and Central NSW Councils (box 7.4).



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Some state and Australian Government assistance is provided to local governments to coordinate or collaborate. For example, the Queensland Government's *Local Government Grants and Subsidies Program* provides funding assistance 'to promote collaboration between neighbouring local governments to deliver regional priorities' (Queensland DLGP 2012).

**Box 7.4    Local government collaboration on adaptation**

- The South East Councils Climate Change Alliance (consisting of eight councils located in the south-east of Melbourne) undertook a project to examine climate change impacts in the Western Port Region and potential adaptation responses by councils. This included involvement from the CSIRO Adaptation Flagship and funding from the Australian and Victorian Governments (South East Councils Climate Change Alliance, sub. 12)
- The Local Government Association of Queensland has formed a Coastal Councils Adaptation Taskforce with 21 Queensland councils. The Taskforce aims to improve the ability of councils to adapt to climate change and provide expert guidance to councils on planning issues (LGAQ 2011). The Association is also working with Townsville City Council and the Queensland Government to develop a coastal adaptation strategy for Townsville (with additional funding from the Australian Government). This project will include an assessment of adaptation options for coastal areas of Townsville, which will be applicable more widely (Queensland Office of Climate Change 2012).
- The Southern Tasmanian Councils Authority (representing 12 councils) undertook the Regional Councils Climate Adaptation Project in partnership with the Local Government Association of Tasmania and the Tasmanian Government (with additional funding from the Australian Government). The project developed climate change scenarios at local scales, adaptation plans for individual councils and a toolkit for adaptation planning (STCA 2012; Tasmanian DPaC 2011b).
- The Western Australian Local Government Association and Western Australian Department of Environment and Conservation have formed the Climate Change in Local Government Partnership Agreement. This aims to improve the capacity of councils to address climate change issues. A Climate Change Management Toolkit and Adaptation Planning Checklist have also been developed to assist councils (WALGA 2012).
- Central NSW Councils (representing 17 central New South Wales councils) undertook a Water Security Study to develop 50-year water demand and supply projections — factoring in potential climate change impacts — and identify options to ensure adequate water availability (water supply is a local government responsibility in parts of New South Wales) (Central NSW Councils 2009).

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The Australian Government's *Local Government Reform Fund* provided financial assistance to the Tasmanian Government and the Southern Tasmanian Councils Authority to develop a regional approach to climate change adaptation (DRALGAS 2012a). Adaptation specific funding through the LAPP and the CAPP was also provided for joint risk assessments and other adaptation projects undertaken by alliances of councils.

## 7.4 Legal liability

An area consistently identified as a barrier to effective climate change adaptation is that of the unclear legal liability of local governments when implementing adaptation policy (box 7.5). This issue has been identified in previous reports (Baker and McKenzie 2011; Blake Dawson 2011) and was also raised in submissions (Clarence City Council, sub. 10; Local Government Association of Queensland, sub. 41; Municipal Association of Victoria, sub. 79; Shire of Busselton, sub. 54). Legal liability is resulting in reluctance on the part of local governments to take action due to concerns of legal challenge, including in instances where:

- councils release or do not release information relating to climate change impacts
- councils approve or refuse applications for development that may be susceptible to climate change risks
- councils make changes to planning instruments to incorporate climate change considerations, which affect existing developments
- councils install protective structures or do not install protective structures (this also incorporates the maintenance and upkeep of these structures).

There is considerable uncertainty about the circumstances in which councils are liable. In particular, there is concern that uncertainty regarding legal liability is affecting local government decisions and the extent to which councils incorporate adaptation considerations into land-use planning and development practices.

Arguably, concerns regarding legal liability partly stem from uncertainty about how councils should manage the risks of climate change and poorly-defined policy and regulatory frameworks (chapter 8). This can manifest in a range of circumstances, including where local councils are unable to sufficiently address adaptation issues because there is no complementary adaptation policy at the state and territory level or where they are potentially taking on responsibilities beyond those traditionally assumed by local government.

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### Box 7.5     **Examples of legal liability concerns in New South Wales and Queensland**

Liability concerns were particularly raised in the context of how changes in planning systems impact on ‘existing use rights’. In particular, Queensland’s ‘injurious affection’ provisions under the *Sustainable Planning Act 2009* (Qld) provide for compensation of owners of interests in land when they are adversely affected by changes to the planning framework. Similar provisions exist in Western Australia and Tasmania, although in these jurisdictions ‘injurious affection’ only applies where the relevant land is set aside for a public purpose under a planning scheme (Blake Dawson 2011). The Sunshine Coast Council (sub. 53) stated that the injurious affection provisions in Queensland have meant that local governments are unwilling to change planning systems to address coastal hazards.

In contrast, in New South Wales under the *Civil Liability Act 2003* (NSW), an authority is only liable if something it does (or fails to do) is found to be so unreasonable that no other authority with the same functions would consider it reasonable (England 2008). Councils in New South Wales are also protected from liability for negligence when acting in ‘good faith’ (under the *Local Government Act 1979* (NSW)), which is widely assumed to mean compliance with the relevant state government planning manual. Currently, New South Wales is the only state with such legal arrangements (SCCCWEA 2009). However, even in states and territories without ‘injurious affection’ provisions (including New South Wales), there have been indications that concerns about legal liability have affected council decision making.

In some cases, it may be *perceptions* about legal liability that are hindering effective adaptation and not simply the legal arrangements themselves. If this is the case, state or Australian government leadership to clarify where legal liability lies and provision of information to councils about this could effectively address this barrier.

Regardless of the governance arrangements between state and local governments and any provisions introduced by state governments to provide local governments with ‘indemnity’, there will always exist a level of uncertainty regarding legal challenge. As noted by McDonald (Clarence City Council, sub. 10, attachment 2), common law evolves as a new case emerges and courts consider how existing principles apply to novel circumstances. Thus:

... protection from liability can never be guaranteed and will only be established after the event. Any path the Council decides to pursue therefore necessarily carries some risk, even though it believes itself to have exercised reasonable care throughout. (Clarence City Council, sub. 10, attachment 2, p. 19)

There is little agreement on an appropriate government response. Some proponents expressed a view that changes to legislation are required to address problems about liability, and there was support in submissions for extension of the arrangements in

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New South Wales (box 7.5) to all jurisdictions. The Commission is yet to form a view on whether this would fully address all legal liability concerns.

DRAFT RECOMMENDATION 7.2

***Uncertainty about the legal liability of local governments is emerging as a barrier to effective climate change adaptation. State and Northern Territory governments should clarify the legal liability of local governments regarding climate change adaptation matters and the processes required to manage that liability.***

INFORMATION REQUEST 7.1

*The Commission notes the current arrangements in New South Wales to limit the legal liability of local governments through the Civil Liability Act 2003 (NSW) and the Local Government Act 1979 (NSW), and seeks further information on whether this approach (or alternatives) could fully address the legal liability issues facing local governments in other jurisdictions when dealing with climate change adaptation.*

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## 8 Planning and building regulation

### Key points

- Planning and building regulation in Australia has been based solely on historical information.
  - As data have become more reliable, some predicted climate change impacts are being considered. However, this is not occurring in a systematic or coordinated way within or across these regulatory frameworks.
- Adaptation can most effectively be incorporated into land-use planning and building regulation by ensuring that regulation moderates activities which negatively impact on adaptation by the community, addresses information failures regarding risks to property and human safety, and facilitates the provision of public goods.
  - However, the benefits of regulation should exceed the costs to the community as a whole.
- In recent years, land-use planning has increasingly taken into account projected changes to coastal processes, including sea-level rise and erosion.
- Further, in revising land-use planning systems to better manage environmental hazards, planners are indirectly responding to the risks of climate change.
- Planning frameworks should be flexible and facilitate a risk management approach to incorporating climate change risks into land-use planning systems.
- The Australian Building Codes Board has reviewed the adequacy of current building code standards under climate change and has recently utilised climate change information in a review of the standards for buildings in cyclone-affected areas.
  - However, this work has not resulted in any changes being made to the Building Code of Australia to take into account climate change impacts.
- A formalised program to incorporate climate change impacts into the Building Code of Australia over time is required.
- Cumbersome and unnecessarily time-consuming processes to incorporate new information into planning and building regulation represent a barrier to adaptation.
- Addressing climate change risks for existing settlements entails a number of complex considerations and it may be necessary to develop national approaches or principles to support strategic management of this issue.
  - The new COAG Select Council on Climate Change should consider appropriate policy responses to manage these risks.

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Planning and building regulation in Australia has in the past been based solely on historical information — for example, ‘1-in-100 year’ events are often used as a benchmark for planning decisions. In recent years, as data have become more reliable, some predicted climate change impacts are being considered. However, this is not occurring in a particularly systematic or coordinated way within or across these regulatory frameworks.

Land-use planning systems are a framework to guide and facilitate the future growth and development of Australian settlements. They are also used to preserve the environment, provide and coordinate community services and facilities, and promote and coordinate the orderly and economic use and development of land (PC 2011f) (box 8.1). Building regulation, on the other hand, relates to how buildings are constructed and places a strong emphasis on the safety of a building’s inhabitants.

## **8.1 Planning and building regulations are based on a static climate**

### **Land-use planning**

There is no well-established approach to incorporating climate change into land-use planning decisions (box 8.2). Even where states and territories have explicit frameworks for incorporating climate change into land-use planning, local governments must still make difficult decisions regarding how to implement and enforce planning systems on the ground. Many local governments have raised concerns about their role in this context. A commonly identified barrier to climate change adaptation is insufficient guidance and information from state and territory governments on how to incorporate climate change into land-use planning. A compounding issue is that local governments can have insufficient financial and human capital resources to undertake this role. While these concerns are often specific to land-use planning, they can also relate to local government functions more broadly (chapter 7).

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### Box 8.1    **Why do governments regulate planning and building?**

Government intervention in both private property markets and the building industry is justified as private markets fail to maximise social welfare in the absence of suitable regulation. There are several types of market failure.

- Externalities
  - For example, where an area is cleared for development, biodiversity may be affected, or the natural beauty of an area may be diminished.
  - The co-location of different types of developments can introduce problems or create benefits. Where industrial facilities are placed close to residential areas, residents can be negatively affected by noise or pollution. Conversely, it may be advantageous for complementary retail businesses to be co-located.
  - Buildings, or the construction of buildings, can have negative impacts on inhabitants and the surrounding community through excessive construction noise, inadequate ventilation or poor drainage.
- Public goods
  - For example, governments can ensure the coordination and provision of community services and facilities such as parks in land-use planning.
- Information asymmetries
  - Many characteristics of a building are hidden by the time it is completed, leading to a situation where knowledge about the health, safety and sustainability of a building is known to the builder but is not readily available to the buyer. This is compounded by the nature of building information. The building process is complex, involving tradeoffs between costs, skills, materials, building designs and processes which impact on the characteristics of the finished building.
- Split incentives
  - Where differing incentives between parties mean that investments or decisions that would make everyone better off are not undertaken. For example, where the benefits of a building characteristic do not accrue to the party that designs or builds the structure it may not be incorporated in the building.

Equity considerations that guarantee some minimum standards relating to building use are a further rationale for government regulation of the building industry.

Sources: PC (2004c, 2011f).

All states and territories have overarching land-use planning legislation, for example, the Victorian *Planning and Environment Act 1987*. Generally, these Acts do not contain specific requirements to take climate change into account in planning decisions. In some cases, other legislation may indirectly impose climate change requirements, for example the Victorian *Climate Change Act 2010* requires decision makers, including planners, to have regard to climate change.

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## Box 8.2    **How planning systems should respond to climate change risks**

It is not immediately clear how planning systems should respond to threats of climate change. While some submissions stated that planning systems do not effectively incorporate climate change considerations, there was little detail provided regarding how current planning schemes should manage climate change risks.

The Australian Climate Change Adaptation Research Network for Settlements and Infrastructure expressed concern that state planning policies were not effective or ‘strong enough’ (sub. 19, p. 4). For example, they cite the Victorian State Planning Policy as being unable to prevent development occurring in vulnerable coastal areas, despite the inclusion of an ‘erosion-prone-areas’ policy.

The Council of Capital City Lord Mayors (sub. 67, p. 4) argued that ‘currently developments and buildings are not always durable and adaptable to changes over time’. They advocated a focus on ensuring longer life-spans for developments. In particular, they noted that site cover and setback requirements need to be reviewed in order to ensure that neighbourhoods have adequate tree cover and sufficient space between buildings.

The Gippsland Coastal Board (Victoria) suggested that ‘numerous state and local government planning policies may need to be reconsidered in light of climate change’ (sub. 65, p. 7). It provided an example of ‘activity centres’ which promote growth and development in particular areas — which may be inappropriate where these areas are susceptible to climate change impacts.

For land-use planning systems to facilitate effective adaptation, ideally governments would be required to utilise just the right amount of regulation to address any activities which have positive or negative ‘spillover’ impacts on adaptation by the community, address information failures regarding the risks to property created by climate change and facilitate the provision of public goods (box 8.1). This would need to be done such that the benefits of land-use planning regulation exceed the costs.

*Sources:* Australian Climate Change Adaptation Research Network for Settlements and Infrastructure (sub. 19); Council of Capital City Lord Mayors (sub. 67); Gippsland Coastal Board (sub. 65).

### *Coastal management*

Most jurisdictions have specific coastal management legislation which establishes a policy framework in coastal areas that also covers land-use planning. In some cases, these Acts (such as the *Coastal Protection Act 1979* (NSW)) explicitly identify climate change induced sea-level rise as an environmental hazard to be considered.

Coastal management is also addressed in state planning policies which generally specify high-level principles for managing coastal erosion and inundation in local planning schemes. For example, Victoria and New South Wales require the use of



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the precautionary principle in local government planning decisions, and most states recommend that development in inundation and erosion prone areas should be avoided where possible (box 8.3).

**Box 8.3 Principles in statutory coastal planning policies — examples**

**Victoria**

Victoria's State Planning Provisions (section 13.01) outline principles for managing coastal inundation and erosion. These include planning for a sea-level rise of at least 0.8 metres by 2100, applying the precautionary principle to planning decisions when considering climate change risks, ensuring that new development is located and designed to take into account the impacts of climate change on coastal hazards, ensuring that land subject to coastal hazards is identified, and avoiding development in areas subject to inundation and erosion.

**New South Wales**

New South Wales' Coastal Policy 1997 recommends that the precautionary principle be used when planning for climate change risks. In addition, the NSW Coastal Planning Guideline outlines six principles for coastal planning: assess and evaluate coastal risks, taking into account the NSW sea-level rise benchmark (as set out in the NSW sea-level rise statement 2009); advise the public of coastal risks; avoid intensifying land use in coastal risk areas; consider options to reduce land use in coastal areas; minimise the exposure of developments to coastal risks; and implement appropriate management responses and adaptation strategies.

**Queensland**

Queensland's State Planning Policy for Coastal Protection specifies that areas prone to coastal hazards are to be identified based on a benchmark of a sea-level rise of 0.8 metres and an increase in cyclone intensity of 10 per cent by 2100. The policy restricts development in these areas unless it is temporary or relocatable, or is development that cannot be easily located elsewhere. The policy also notes that beach nourishment is the preferred option for controlling erosion. Coastal protection works should only be considered where retreat from the location is not a feasible option.

Finally, section 5.1 of the *Sustainable Planning Act 2009* (Qld) requires local governments to apply the precautionary principle in planning decisions.

*Sources:* NSW DECCW (2009); NSW Department of Planning (2010); NSW Government (1997); Queensland DERM (2012).

Most states (except Tasmania) also set a benchmark for the expected sea-level rise by 2100 (table 8.1; box 8.3). These benchmarks are to be used by local governments when making planning decisions, and in assessing whether an area is at risk of coastal hazards, including inundation and erosion. In addition, Queensland's benchmark also specifies an increase in cyclone intensity that must be considered.

**Table 8.1 Sea-level rise benchmarks<sup>a</sup>**

<i>State/territory</i>	<i>2050 benchmark</i>	<i>2100 benchmark</i>
	cm	cm
New South Wales	40	90
Victoria	..	80
Queensland <sup>b</sup>	..	80
South Australia	30	100
Western Australia	..	38
Tasmania	..	..
Northern Territory	..	..

<sup>a</sup> The base year for the benchmarks is 1990, except for Western Australia, which uses 2000 as its base year.

<sup>b</sup> The Queensland State Planning Policy Coastal Management also includes a benchmark of a 10 per cent increase in cyclone intensity by 2100. .. Not applicable.

*Sources:* NSW DECCW (2009); Queensland DERM (2012); SA DPLG (2011); Victorian Government (2008); WA Planning Commission (2003).

States and territories provide some guidance on how to apply state planning principles and sea-level rise benchmarks. These may impose regulatory requirements that local governments should include in their planning schemes. For example, for developments in specified coastal areas:

- New South Wales' State Environmental Policy No. 71 (coastal protection) requires a development plan approved by the minister, which includes consideration of coastal processes and hazards
- Western Australia regulates mandated setbacks for buildings, which comprises components to account for erosion and sea-level rise (WA Planning Commission 2003). These setbacks are based on sea-level rise benchmarks, and the expected erosion caused by a 1-in-100 year storm event
- South Australia and the Northern Territory impose minimum floor heights for buildings (NT Government nd; SA DPLG 2011).

### *Other environmental hazards*

Local governments are required to consider specific environmental hazards — such as floods, bushfires, cyclones and landslides — in local planning processes. In particular, state planning policies often incorporate requirements or restrictions on

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development in areas that are classed as at risk of environmental hazards. For example, Victoria requires a permit for development in bushfire prone areas, which includes conditions on water access and defensible space.

State and territory planning frameworks and associated policy generally do not mention management of these hazards in the context of climate change. Some exceptions to this include:

- Western Australian planning policy (State Planning Policy 3.4 Natural Hazards and Disasters) notes that changes in risk driven by climate change should be taken into account by local governments
- The Queensland Government provides advice on identifying climate change impacts in its planning framework (though the guidance notes that incorporating climate change into bushfire risk assessments would be impractical). Further, the Queensland Inland Flood Review (Queensland Government 2010b) recommended that a climate change factor be taken into account for flood planning
- The NSW Government provides guidance on taking climate change into account when identifying flood risks (NSW DECC 2007).

A number of state and territory policies for managing environmental hazards are currently under review. In addition, recent inquiries into natural disasters, such as the Victorian Bushfires Royal Commission and the Queensland Floods Commission of Inquiry, have considered planning frameworks. While these reviews do not generally focus on climate change, to the extent that they improve planning frameworks for natural hazards they would have climate change adaptation benefits.

Some states are also undertaking research to better integrate climate change into natural hazard planning frameworks. For example, the NSW Government is currently undertaking work to update data on the impact of climate change on flood and bushfire risks (Roger and Dunford 2011). Adjusting planning maps for climate change impacts is discussed further in chapter 6.

### *Principles for managing climate change risks within land-use planning*

Where planning systems are modified to take into account for climate change, regulations should:

- facilitate a risk management approach
- incorporate transparent and rigorous community consultation processes and take into account the community's acceptable levels of risk for different types of land use

- 
- consider the full costs and benefits of land use from a communitywide perspective.

### *Risk management approach*

A risk management approach to land-use planning requires flexible planning frameworks at the state and territory level, that enable local government to use a range of planning instruments to manage risks in their local area (box 8.4). This could include ‘real options’ and regular monitoring of risks and responses. Such an approach would facilitate timely adaptation responses that deliver the best possible outcomes to the community.

Some state planning policies advocate risk management approaches, for example the NSW sea-level rise policy (NSW DECCW 2009). Further, a number of local governments have identified ‘risk management’ as an important approach in their adaptation plans. For example, Clarence City Council in Tasmania (sub. 10, attachment 1, p. 36) states that ‘risk management responses should be flexible and allow creative solutions to local circumstances’ (box 8.5). However, it is not clear to what extent risk management approaches are being implemented by local governments more broadly, and in practice.

A key element of adopting a risk management approach for land-use planning is to match the timeframe of the relevant land use and its associated potential risks. In this context, time-limited development approvals or the use of ‘triggers’ could provide a useful tool for councils to manage the risks of climate change. Both Clarence City Council and Wellington Shire Council (Victoria) have proposed to utilise ‘triggers’ in their land-use planning schemes (boxes 8.5 and 8.6). The intention is to take action that manages climate change risks as they develop. Consequently, land subject to potential hazards may be utilised for many years before further adaptation responses are required.

In contrast, depending on interpretation and application, the use of sea-level rise benchmarks could result in planning decisions being based on impacts unlikely to occur until some future time (usually 2100). Such benchmarks can substantially exceed usual safety margins for the majority of the life-span of a structure (Clarence City Council, sub. 10, attachment 1, p. 32). However, the practical application of these benchmarks can differ — in its Coastal Planning Guideline, the NSW Department of Planning (2010, p. 4) notes that ‘the sea-level rise planning benchmarks are not intended to be used as a blanket prohibition on development of land projected to be affected by sea-level rise’. Rather, this document emphasises mitigating and managing climate change risks in land-use planning systems over time.

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#### Box 8.4 Planning scheme instruments

A range of instruments could be used to manage climate change risks in land-use planning. Some of the instruments detailed below are already in use in some jurisdictions in Australia, while others, such as rolling easements, have only been used in other countries.

**Zones** — describe the types of land use that will be encouraged in particular areas and establish permit requirements for both land use and development. These can be used to restrict development in high risk areas.

**Overlays** — set other area-specific requirements that regulate the development of land, but do not usually control the use of land, which is managed under the zones.

**Rolling easements** — are a type of easement placed along the shoreline to prevent property owners from holding back the sea through engineering works, but allow any other type of use and activity on the land. As the sea advances, the easement automatically moves or ‘rolls’ landward (NOAA 2012). These policies do not require a particular line to be drawn on the map and allow landowners to decide how best to use their property up to the point where the land finally erodes (Titus 1998).

**Setbacks** — require dwellings to be set back a minimum distance from specified areas (such as roads or the line of permanent vegetation or shoreline) or at a minimum elevation above sea level. Elevation setbacks are used to manage coastal flooding, while lateral setbacks address coastal erosion risks.

**Time-bound or trigger-bound approvals** — approval for development can be given for a specified time period, or until an identified event occurs (a ‘trigger’).

**Information** — could involve requirements to conduct risk management plans or provide ‘risk disclosure certificates’ that set out information on risks and hazards.

**Indemnity statements** — approval is dependent on the developer formally acknowledging the climate change risks associated with the property and ‘indemnifying’ the council against future legal actions arising from the effects of climate change.

**Adaptation response plans** — approval is dependent on the preparation of an adaptation response plan that may include a description of climate change impacts on the land and details of adaptive actions to be taken.

*Sources:* NOAA (2012); Titus (1998).

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### Box 8.5 Risk management and Clarence City Council

In 2007, the Clarence City Council (Tasmania) commissioned a study into climate change impacts in the Clarence coastal area. The report recommended that the emphasis for new development should be on 'performance based responses that maintain acceptable levels of risk over the life of the structure' (sub. 10, attachment 1, p. 32). In this way, areas subject to potential hazards may be used for many years before further adaptation responses are required. Under a performance-based approach, a range of responses could be considered when facing a particular risk as long as they meet the particular performance requirement.

For existing settlements subject to increasing risks (or new property approved in areas subject to climate change risks), the council proposes to use 'triggers', such that an adaptation response is only required to maintain risk at acceptable agreed levels. In this way the community will respond to actual changes in risk as the sea level rises or erosion progresses, not to events forecast for the distant future. Different triggers would be required for different risks (the council has identified high water tables, inundation and erosion in its report) and hazard maps will be required to monitor each trigger point.

*Source:* Clarence City Council (sub. 10, attachment 1).

Some local governments argued that state and territory planning frameworks are not sufficiently flexible and impede local governments' management of climate change risks. For example, the Gold Coast City Council (Queensland) (sub. 17, p. 2) noted that 'it appears that the existing legislative and legal framework may restrict LGAs [Local Government Authorities] in developing an adequate planning response potentially leaving the community vulnerable to future risk'. A key concern was that legislative frameworks within which local governments operate planning systems do not incorporate policy for all climate change risks (Mornington Peninsula Shire, sub. 16; South East Councils Climate Change Alliance, sub. 12). Further, there is some evidence that there are barriers to councils using more sophisticated and complex planning instruments within state frameworks (Giles and Stevens 2011).

#### INFORMATION REQUEST 8.1

*To what extent do current state and territory land-use planning frameworks facilitate or impede the use of different land-use planning tools, such as time-limited development approvals or 'triggers'? What changes are required to state and territory planning frameworks to address any impediments?*

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**Box 8.6 Wellington Shire Council — climate change response plans**

The Wellington Planning Scheme identifies sea-level rise and coastal inundation caused by climate change as potential threats to coastal communities. Research is underway to better define the risks in specific locations. This information will be used to develop future planning and development regulations.

In the interim, the council uses climate change response plans to regulate development on land identified as vulnerable to sea-level rise and inundation. A response plan must be prepared by the proponent of a development and include:

- the climate change impacts on the land. Impacts may include short-term inundation caused by storm surges or longer-term inundation caused by sea-level rises
- risks to people, property and the environment. Risks may include drowning, water damage to buildings, pollution, loss of access to a property, and permanent loss of use of a property
- adaptive action to manage the risks. Adaptive action may be incorporated into the design of the development by raising floor heights, using building materials that are not susceptible to water damage, or building removable structures. Alternatively, adaptation action such as evacuating or permanently abandoning the site in certain circumstances may be contingent on future triggers
- triggers for adaptive action. An evacuation trigger can include flood warnings from emergency or weather services. Where the council determines that a risk indicator exceeds a given level, such as where the annual event probability of a severe flood deeper than 300 mm exceeds 10 per cent, abandonment may be triggered.

If the climate change response plan is approved and the development proceeds, the owner of the land is required to enter into an agreement with the council to abide by the plan and register it on the title of the land. Land owners are also required to review and reregister the plan at least every ten years, or sooner if required by the council.

*Source:* Wellington Shire Council (nd).

### *Understanding risk at the community level*

Determining acceptable levels of risk (box 8.7) for different types of land uses involves recognising that some damage to buildings and assets may not pose significant problems (for example, flooding of a road for a few days each year may not cause significant disruptions or damage). In other cases, even minor impacts may be highly undesirable (for example, impacts on hospitals that lead to power outages or require evacuation of staff and patients).

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### **Box 8.7     Acceptable levels of risk**

The international standard for risk management states that risk evaluation is the ‘process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude is acceptable or tolerable’ (International Organization for Standardization 2009, p. 6). This is also reflected in the draft Australian Standard on climate change adaptation for settlements and infrastructure, which explicitly incorporates identifying ‘acceptable risks’ through stakeholder consultation as part of the risk assessment process (Standards Australia 2011, p. 46).

*Sources:* International Organization for Standardization (2009); Standards Australia (2011).

Rigorous and transparent community consultation processes are required in order to establish the community’s ‘acceptable levels of risk’ and ensure this risk profile is incorporated into local government planning schemes. In all states and territories, amendments to land-use planning schemes are required to undergo community consultation processes. However, in some cases, specific studies to gauge community views may be required. One example of this is the work conducted by Lake Macquarie City Council in New South Wales, which used a range of consultation methods to canvas how best to manage flood risks in the Lake Macquarie area (box 8.8). Clarence City Council (sub. 10) is another example of a local government that consulted constituents to determine their views on managing climate change risks.

Such a process requires an understanding among the community of the risks posed by climate change. A common first step to assessing climate change risks within local government areas is to undertake vulnerability assessments (chapter 7) and then make these publicly available. Local governments have also explored a range of options to convey information about climate change risks at the property level. This can include placing notices on property contracts — for example, Lake Macquarie City Council has both flooding and sea-level rise notifications on contracts for sale (box 8.8). Another approach adopted by Wellington Shire Council, is to require property owners themselves to conduct risk assessments and identify potential adaptation options before development approval is given (box 8.6).



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### **Box 8.8 Lake Macquarie City Council — Flood Risk Management**

Lake Macquarie City Council is currently updating its *Waterway Flood Study*, *Flood Risk Management Study* and *Flood Risk Management Plan* to incorporate recent flood events and the implications of climate change (all of which are required under the NSW Government's flood policy) (WMA Water 2011).

The Council has embarked on a community consultation process before adopting a finalised Management Plan, which has included:

- correspondence with all affected property owners (approximately 7000)
- six community workshops with potentially flood-affected residents
- a survey of residents' views relating to attributes of Lake Macquarie
- a survey of residents' views on proposed flood risk management options
- other opportunities to provide feedback through online surveys and written submissions.

Through the Flood Risk Management Plan, the Council has identified three categories of flood risk. Proposed development restrictions in these areas include requirements for floor heights and setbacks from the lake. In the survey of residents' views of flood management options, 94 per cent of respondents supported imposing development conditions such as raised floor heights and foreshore setbacks (Molino Stewart 2011).

Property certificates (section 149 certificates) are also utilised in Lake Macquarie and the intention is for these to continue to include a 'lake flooding' notation on foreshore properties below 3.0 metres Australian Height Datum, and a 'sea-level rise' notation on properties below 1.0 metre Australian Height Datum (Lake Macquarie City Council 2011). 83 per cent of survey respondents agreed with using section 149 certificates to notify owners about the risk of flooding and sea-level rise (Molino Stewart 2011).

*Sources:* Giles and Stevens (2011); Lake Macquarie City Council (2011); Molino Stewart (2011); WMA Water (2011).

'Indemnity statements' could be used to ensure awareness of climate change risks and to clarify liability for land-use planning decisions. These statements have been recommended [by Professor. Jan McDonald] in a research report conducted for Clarence City Council (sub. 10, attachment 2). The Commission is only aware of one example of a local government using such a tool. In June 2011, the Lockyer Valley Council in Queensland endorsed an interim measure which required owners reconstructing a dwelling on flooded land to provide an 'indemnity statement' to the council confirming that they are aware of the current minimum habitable floor levels recommended by the council and that they are aware of the risk of rebuilding at a lower level (Lockyer Regional Council 2011). However, this was rescinded in September 2011 (Queensland Floods Commission of Inquiry 2012).

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Thus, establishing ‘acceptable levels of risk’ also requires an elucidation of private and public responsibilities in managing these risks (box 8.9). Community agreement on this, and land-use planning regulation that clearly allocates risk, may also address legal liability issues faced by local governments (chapter 8). However, the effectiveness of such approaches is yet to be tested and is likely to depend on governments’ commitment.

**Box 8.9      Establishing private and public responsibility for climate change risk**

To emphasise that land owners must accept private responsibility for risks where they continue to live in hazard areas, some state and local governments have released policy statements that attempt to define public and private responsibility for risks for both new and existing settlements. For example, in its Sea Level Rise Policy Statement, the NSW Government states:

Coastal hazards and flooding are natural processes and the Government considers that the risks to properties from these processes appropriately rest with the property owners, whether they be public or private. This will continue where these risks are increased by sea level rise. Under both statute and common law, the Government does not have nor does it accept specific future obligations to reduce the impacts of coastal hazards and flooding caused by sea level rise on private property. (NSW DECCW 2009, p. 5)

The Port Adelaide Enfield Council (South Australia) development plan states that coastal development that requires protection measures against particular environmental hazards at the time of development, or in the future, should only be undertaken if: ‘the measures do not nor will not require community resources, including land, to be committed’ and ‘binding agreements are in place to cover future construction, operation, maintenance and management of the protection measures’ (Port Adelaide Enfield Council 2012, pp. 30–1).

Clarence City Council (sub. 10, attachment 1, p. vi) states in its report into climate change impacts:

As existing owners were not aware of the developing risk and are not in control of the causes of this developing risk, it is proposed that for a period of 25 years, risk reduction and management measures be borne by the wider community. After that time, the cost of further risk management measures would be the responsibility of those that benefit from coastal use or occupation. Risk management works undertaken by the Council could be paid for by a special coastal risk reduction rate in affected areas. Funding assistance from higher levels of government would be required during the 25 year transition period.

*Sources:* Clarence City Council (sub. 10, attachment 1); NSW DECCW (2009); Port Adelaide Enfield Council (2012).

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### *Consistency in planning regulation across different jurisdictions*

Australia's land-use planning system is intended to provide local governments with flexibility to take into account local circumstances when making planning decisions. In this context, it is appropriate that local governments incorporate climate change into their planning systems. Further, it may also be appropriate that state and territory governments adopt different planning frameworks, or use different benchmarks to respond to climate change risks.

However, in order for local governments to effectively implement land-use planning systems, a supporting framework with guiding principles is required at the state and territory level. Further, it is important that councils have the appropriate guidance and capacity to implement planning policies such that information failures or externalities of land use in association with climate change are addressed (chapter 7). Focusing on these key challenges is likely to provide significant benefits in terms of strengthening the consideration of climate change risks within land-use planning systems.

Inquiry participants raised concerns that climate change risks are not being consistently managed or monitored in land-use planning schemes (Coasts and Climate Change Council, sub. 30; Housing Industry Association, sub. 69; Mornington Peninsula Shire, sub. 16), particularly in the context of different sea-level rise benchmarks developed by the Australian Government and some state governments (Clarence City Council, sub. 10; Council of Capital City Lord Mayors, sub. 67) (table 8.1). For example, the Sunshine Coast Council (sub. 53) felt that the existence of different sea-level rise benchmarks across jurisdictions divided opinions within local governments, led to significant time and effort being expended to develop local government policy responses and impeded the process of adaptation to coastal hazards.

This issue was addressed in the House of Representatives Inquiry 'Managing our Coastal Zone in a Changing Climate', which recommended that governments consider the benefits of adopting a nationally consistent sea-level rise planning benchmark and a National Coastal Zone Policy and Strategy with principles, objectives and actions for integrated coastal zone management (SCCCWEA 2009). A national approach to coastal adaptation has subsequently been proposed (DCCEE 2010c), but no formal policy approaches have been agreed.

*As a priority, land-use planning systems should be revised to ensure that they are sufficiently flexible to enable a risk management approach to incorporating climate change risks into planning decisions. In doing this, consideration should be given to:*

- *transparent and rigorous community consultation processes that enable an understanding of the community's acceptable levels of risk for different types of land use*
- *the timeframe of risks and the expected life time of proposed land use*
- *the costs and benefits of different types of land use.*

## **Building**

As the climate changes, the location, intensity and frequency of environmental hazards faced by buildings in Australia is expected to change also. However, in developing the Building Code of Australia (BCA) and referenced minimum standards (box 8.10), the Australian Building Codes Board (ABCB) and other standard-setting bodies have traditionally relied on historical climate and weather data to determine the intensity and geographical location of environmental hazards that the built environment may face, and the stringency of standards needed to manage those hazards (ABCB 2010).

The ABCB has received direction on incorporating climate change impacts into the BCA from a number of sources.

- A 2007 Australian Government report on the need to adapt buildings to climate change identified probable impacts on buildings from various environmental hazards, and recommended reviewing the building code and standards, and areas where standards apply, using projected climate impacts (BRANZ 2007).
- The COAG National Adaptation Framework recommended that 'the Australian Building Codes Board consider climate change as part of periodic reviews' of the building code, and that 'information used to determine vulnerability of settlements to climate-related hazards (such as floods, bushfires, cyclones and coastal inundation)' should be reviewed (COAG 2007b, p. 18).
- A 2009 review for the Australian Government of the intergovernmental agreement which established the ABCB, found that 'standards for building design and construction do not currently reflect the potential impact of climate change' (ACG 2009, p. iv). The review recommended that 'governments and industry be open to the potential to reflect climate change adaptation risks within

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the National Construction Code, where such inclusion can be justified in RIS [regulation impact statement] analysis’ (ACG 2009, p. iv).

- The 2011 COAG National Strategy for Disaster Resilience established a priority outcome that ‘building standards and their implementation are regularly reviewed to ensure they are appropriate for the risk environment’, where risks include ‘the predicted impact of climate change on sea level and the frequency and intensity of extreme weather events’ (COAG 2011, p. 12).

#### **Box 8.10 The National Construction Code and the Australian Building Codes Board**

The National Construction Code is intended to incorporate all on-site construction requirements into a single code. Currently, the Code comprises the BCA and the Plumbing Code of Australia. A reform program is underway to expand the National Construction Code to also incorporate electrical and telecommunications standards. The ABCB is the national regulatory body responsible for the National Construction Code.

The BCA covers new commercial, residential and public buildings, but excludes ‘non-buildings’ or engineering constructions (such as roads and bridges). Existing buildings are not covered unless undergoing alterations or changes of use. The code establishes national minimal standards (typically developed by Standards Australia) to ensure buildings in Australia are designed and constructed to withstand a range of hazards, including environmental-related hazards such as cyclones and extreme winds, intense rains, bushfires and to some extent floods. The BCA itself is not legally binding — constitutionally, state and territory governments are responsible for the statutory framework for building regulation. Requirements under the BCA only become mandatory once referenced in state and territory legislation.

Information about environmental hazards feeds into two stages of the BCA’s standard setting process. First, these data are used to estimate the intensity and frequency of weather hazards a building may face in a given location which determines geographical coverage and the stringency of building standards. Second, data on environmental hazards are used in regulatory impact analyses to estimate the costs and benefits of proposed amendments to the BCA and inform determinations regarding changes to the Code.

*Source:* ABCB (2012).

#### ***The objectives of the Building Code of Australia***

Under the BCA’s current objectives — health, safety, amenity and sustainability — buildings are primarily designed and built to reduce risks to human life, rather than to minimise damage to the building. While a focus on life preservation is likely to

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also achieve some degree of protection to the building, ‘building durability’ is not a primary objective (ABCB, pers. comm., 25 January 2012).

Several inquiry participants argued that the lack of a ‘building durability’ objective in the BCA poses a barrier to adaptation. The Insurance Council of Australia (sub. 42, p. 5) noted that:

... unlike the building codes of some other developed nations, the BCA does not include a specific principle for property durability. The BCA therefore permits the construction of buildings (at a minimum standard) that include no element of durability (property protection), creating a stock of buildings that whilst ‘safe’ are increasingly brittle to extreme weather events ...

The current objectives of the BCA do not restrict building regulators incorporating climate change risks into the code. The ABCB has recognised that ‘the role of the Building Code of Australia is critical in ensuring that communities are resilient to climate change impacts’ (ABCB 2011d, p. 5). Further, the review for the Australian Government of the intergovernmental agreement which established the ABCB (and which sets out the objectives of the BCA), found that ‘future climate change risks can be accounted for through the current regulatory principles and objectives of the BCA’ (ACG 2009, p. iv).

#### *The extent to which standards in the Building Code of Australia take into account climate change*

In its submission, the Department of Climate Change and Energy Efficiency (sub. 57, p. 10) noted that the BCA is generally applied through ‘prescriptive technical standards that assume an unchanging climate’ and that ‘without regular review, standards for a particular region could become obsolete over time as the climate changes’. Further, some submissions have suggested that a strict application of the COAG regulation impact statement (RIS) process (box 8.11) by the ABCB has limited the scope for climate change data to be considered when assessing changes to the BCA. For example:

Practically applying principle 3 of the Guide, ‘adopting the option that generates the greatest net benefit for the community’, has required historical data and demonstrable building failures before any regulatory proposal designed to prevent harm can be justified. (Tasmanian Government, sub. 51, p. 7)

Climate change impacts need to be appropriately incorporated into the BCA and referenced standards. Use of historical data or inaccurate predictions that do not accurately reflect future environmental hazards may lead to poor regulatory decisions that impose costs on society. For example, if the impacts of climate change are not reflected in the standards in the BCA, the market failures that the

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building code is intended to address (box 8.1) may not be addressed and costs may be imposed on building owners and users, and the wider community, when climate change impacts are experienced.

**Box 8.11 COAG best practice regulation guidelines**

Under the intergovernmental agreement which established the ABCB, amendments to the BCA must meet COAG best practice regulatory principles. These include that potential amendments generate ‘the greatest net benefit for the community’ and be ‘proportional to the issue being addressed’ (COAG 2007a, p. 4). The COAG best practice regulation guide states that a cost–benefit analysis should ‘assess the costs and benefits of all the options supported by an acceptable level of evidence’ (COAG 2007a, p. 11). The intergovernmental agreement imposes the additional requirement that an amendment must be the ‘minimum necessary’ to achieve ... [the BCA’s] objectives efficiently’ (COAG 2006).

*Sources:* COAG (2006, 2007a).

*Towards an appropriate process for incorporating climate change impacts*

While the ABCB has undertaken some work to consider the incorporation of climate change impacts in the BCA, this has not resulted in any formal changes. In 2010, the ABCB conducted a review to assess how well the existing code could address potential environmental hazards under climate change using both low and high greenhouse gas emissions scenarios. The review identified possible adaptation options for the BCA to better manage these hazards and proposed areas where further research was needed (box 8.12). The Commission is unaware of any government response to the ABCB’s review.

The ABCB has indicated it faces difficulties in amending the BCA to incorporate climate change impacts while still meeting COAG best practice principles (that is, demonstrating a clear net benefit from the amendment) (box 8.11). The ABCB argued that the uncertainty of climate change predictions is seen as incompatible with an evidence-based approach to the review and development of the BCA (ABCB, pers. comm., 25 January 2012, 8 March 2012). This finding is also demonstrated in the recent review of wind standards for construction in cyclone-affected areas — the first review of building code standards to utilise climate change projections — which found that none of the amendments considered in the final regulation impact statement would likely deliver net benefits compared with the existing standards (box 8.13).

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### **Box 8.12 ABCB review of the BCA under climate change**

In 2010, the ABCB reviewed the potential impacts of climate change (including higher temperatures, higher wind speeds, more intense but overall less rainfall, and greater risks of floods and bushfires) on buildings designed and constructed to the existing building code, and identified options to adapt the building code to meet future changes in environmental hazards.

The review found that buildings designed and constructed in accordance with the current standards under the BCA are likely to be 'reasonably adequate' under a 'low-emissions' scenario for the next 50 years. However, if the climate were to change in accordance with a 'high-emissions' scenario, the current BCA is likely to be deficient. The report noted that the latest climate science indicates a high-emissions scenario is likely in the medium to long term (2050 and 2100) and in this case the BCA will need to adapt in response.

*Source:* ABCB (pers. comm., 25 January 2012).

The ABCB has indicated to the Productivity Commission that work to incorporate climate change impacts into the BCA must generally be set by COAG through direction from the Building Ministers' Forum<sup>7</sup> (as a condition of the intergovernmental agreement under which the ABCB operates) (ABCB, pers. comm., 13 March 2012).

Reforms to the BCA to better reflect the likely changes in location, intensity and frequency of environmental hazards faced by buildings in Australia should be considered. While the existence of uncertainty regarding these impacts will complicate the analysis, this does not alter the overriding goal for the ABCB to identify and implement reforms to the code that can be confidently expected to increase the wellbeing of the community as a whole. Further, the COAG best practice guidelines are an appropriate tool to ensure that proposed reforms achieve net benefits. The Commission does not consider that adherence to these guidelines should preclude consideration of climate change impacts or would lead to the development of overly stringent regulations that would not be justified by cost-benefit analysis (chapter 4).

### *The Building Code of Australia and minimum standards*

The BCA is a performance-based code and imposes minimum acceptable standards. This provides flexibility as there is no obligation to adopt any particular material, component, design factor or construction method (ABCB 2011b) (box 8.14).

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<sup>7</sup> The Building Ministers' Forum is an ad hoc COAG body composed of Australian, state and territory ministers responsible for building regulation.



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### **Box 8.13    Reviewing wind standards for climate change impacts**

The ABCB is currently reviewing the existing Australian wind standards (AS/NZS 1170.2 and AS/NZS 4055) to determine if cyclone regions and standards for construction should be amended to allow for possible increases in cyclone intensity and shifts in cyclonic activity due to climate change.

As part of the initial regulatory assessment impact process, a range of scientific information was reviewed (including historical wind data, studies of recent extreme cyclones, and climate change literature on cyclone activity). Five changes to existing wind standards were proposed to manage the evolving risk from cyclonic activity.

In an initial Regulation Impact Statement (RIS), the five proposed changes were subject to cost–benefit analysis. Benefits were calculated as ‘avoided damages’ using an estimate of the ‘annual average cyclone related insured losses’ over the period from the mid-1960s to 2006 (ABCB 2010, p. 13). Benefits (avoided damage) were adjusted for a predicted increase in cyclone peak winds of 5 to 10 per cent by 2070, and southward movement of category 3 intensity cyclones by up to 3 degrees of latitude as a consequence of climate change. Under these conditions, when taking into account costs, all five proposed changes were found likely to deliver a net benefit compared to existing wind standards.

After a consultation period, and as part of the final RIS process, additional literature on cyclone activity and climate change impacts was reviewed and a revised set of changes to wind standards was proposed. Only two (of the original five) proposed changes were retained for consideration ‘based on an analysis of current climatic conditions’ (ABCB 2011c, p. 39). It was recommended consideration of a third change ‘be put “on hold” until further evidence and improved climate change simulations become available’ (ABCB 2011c, p. 39).

The methodology used in the initial cost–benefit analysis to calculate the benefits of the proposed changes was also revised for the final RIS (for consistency, all five original changes were still assessed). Benefits (avoided damage) were recalculated using estimates of the likelihood of a cyclone affecting a house (based on historical data on cyclones making landfall in a given area), and the damage to a new house per cyclone event (based on damage reports from Cyclones Yasi and Larry). These data were then adjusted to account for a 25 per cent reduction in the likelihood of cyclones by 2100, and a 30 per cent increase in damage (arising from a 5 to 10 per cent increase in cyclone intensity and wind speed by 2100). In contrast with the initial RIS, the final RIS found that the five proposed changes to wind standards were likely to deliver an overall net cost.

*Sources:* ABCB (2010, 2011c).

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### Box 8.14 Performance requirements under the BCA

The BCA is a performance-based code; a building must meet certain performance requirements (which outline a minimum level of building function which must be met in terms of building materials, components, design factors, and construction methods) but there is flexibility as to how these requirements are met. Compliance with performance requirements may be achieved through either of two means:

- *deemed-to-satisfy provisions* — prescriptive examples of materials, components, design factors, and construction methods which would result in compliance with the performance requirement.
- *alternative solutions* — non-prescribed approaches that would also result in compliance with the performance requirement. These solutions may include the use of alternative materials, components, design factors or construction methods to those specified in the deem-to-satisfy provisions. Users of alternative solutions must demonstrate to an approval authority that their alternative approach will meet the relevant performance requirement. There are four assessment methods allowed for under the BCA to do this.

Source: ABCB (2011b).

However, Bluescope Steel (sub. 8, p. 14) argued that ‘to design and build beyond the minimum standard introduces bureaucracy, which discourages best practice and encourages a default to the minimum standards’. The implication seems to be that adaptation could be impeded where the ‘alternative solutions’ route is excessively costly or time consuming. This leads to a disincentive to make buildings more resilient to climate change where this is not provided for under the deemed-to-satisfy provisions.

In its 2004 inquiry into building regulation, the Productivity Commission found that performance-based regulation and alternative solutions have led to significant cost savings and more modern and innovative designs (PC 2004c). However, it did recommend that the ABCB establish a national repository or database of approved alternative solutions to reduce the costliness and time impost in utilising ‘alternative solutions’. In its submission to the Productivity Commission, the ABCB indicated agreement with this recommendation. However, it is yet to be implemented (ABCB, pers. comm., 29 February 2012).

## 8.2 The timeliness of regulation review

Planning and building systems are regularly updated to incorporate new information. However, the processes for reviewing and updating planning legislation and policy frameworks can be ‘cumbersome, time consuming and open

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to challenge’ (Mornington Peninsula Shire, sub. 16, p. 11). This process is complicated by the fact that updates to planning schemes can affect land values. The Water Services Association of Australia (sub. 52) also raised concerns regarding the length of time that it takes to update standards under the BCA.

Robust amendment processes that incorporate up-to-date information and canvass community views are essential to ensure that regulatory processes are transparent and reflect community values. However, such processes are likely to take time, particularly where consensus decision making across different levels of government is required. In some cases, a lack of access to up-to-date climate change information may be due to capacity constraints of local governments (chapter 7) or simply reflect the high level of uncertainty surrounding some climate change impacts (chapter 6).

In some cases, excessively long government review processes could result in inefficient decisions and create a barrier to adaptation. Several reviews have examined this issue in the context of both land-use planning and building regulation. For example, the Victorian Bushfires Royal Commission (2010) found serious deficiencies with the mapping of bushfire risk throughout Victoria (which was used in land-use planning and building schemes). Its report shows that the 2009 fires covered large areas that were not designated as ‘at risk’ of fire by either the building or planning system (which had separate mapping processes). The Victorian Bushfires Royal Commission also raised concerns that while a project to align mapping of bushfire risks across the planning and building schemes in Victoria commenced in 2002, progress was very slow and was still ongoing in 2009.

The Productivity Commission’s 2004 report into building regulation received submissions raising similar concerns. The inquiry found that:

To some extent, delays are an inevitable consequence of the need to achieve agreement between nine jurisdictions and the need for rigorous and transparent consultation and impact assessment processes. Further, the recent agenda for the [ABCB] has included reform issues for which acceptable resolutions are inherently more difficult to achieve (eg energy efficiency). (PC 2004c, p. 279)

The Commission’s 2004 inquiry also received testimony from the ABCB indicating that the Board recognised the problems of delays and had taken steps to address the issue. However, the Victorian Bushfires Royal Commission also examined this issue and reported significant delays in the ABCB and Standards Australia developing new bushfire standards, and noted that this was partly a factor of insufficient resourcing of these processes (box 8.15). The Victorian Bushfires Royal Commission (2010) made two recommendations specifically relating to future development of bushfire standards by Standards Australia. However, the

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Productivity Commission considers that these recommendations should be extended more broadly.

DRAFT RECOMMENDATION 8.2

*As a priority, the Building Ministers' Forum should ensure that the National Construction Code and associated standards (including those developed by Standards Australia) take climate change impacts into account. As soon as practicable:*

- the Building Ministers' Forum should provide a formal response to the Australian Building Codes Board's 2010 review of the Building Code of Australia under climate change*
- the Australian Building Codes Board should develop a formal work program that outlines its approach to incorporating climate change in the National Construction Code over time. This work program should reflect any formal government response to the 2010 review of the Building Code of Australia.*

*The Australian Government should give consideration to the public funding requirements for the Australian Building Codes Board and Standards Australia to undertake this work.*

### **8.3 Managing climate change risks for existing settlements**

In most jurisdictions, planning instruments and building regulation cannot control existing uses of land and structures.<sup>8</sup> Development approval through planning schemes effectively confers a property right or 'interest' such that existing use may continue irrespective of future changes in planning instruments. Similarly, building regulation applies to all new buildings in Australia and existing buildings are not generally required to meet amendments to the code, unless undergoing major alterations or additions, changes of use, or subdivision. In consequence, there is no regulatory framework to ensure that private property owners undertake actions to mitigate climate change risks to existing property.

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<sup>8</sup> An exception to this is the ACT, where the ability to use land is controlled through leasing provisions (Maddocks 2011).

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### **Box 8.15 Timeliness of revisions to the bushfire standard**

The Victorian Bushfires Royal Commission — established to investigate the Victorian bushfires on 7 February 2009 — reviewed the length of time required to complete the most recent revision of the bushfire standard AS/NZS 3959: Construction of buildings in bushfire-prone areas.

The Royal Commission noted that the development of the new bushfire standard (AS 3959-2009) took nearly eight years. It found that this was primarily due to the management of the review processes by the ABCB and Standards Australia, and insufficient resourcing of those processes. The Royal Commission noted that:

The lengthy history of the revision of AS 3959-1999 and the eventual publication of AS 3959-2009 reflect poorly on both Standards Australia and building regulators, in particular the ABCB. It is unfortunate that regulation of a matter of public safety should have been allowed to drift for nearly eight years ... (Victorian Bushfires Royal Commission 2010, p. 255)

The Royal Commission recommended a number of reforms to improve the timeliness of future revisions of standards, including:

- a greater commitment of public resources to the review and development of AS 3959 and other bushfire-related standards
- that future proposals for revision and development of bushfire-related standards by Standards Australia specify the scope of the review and include clear project management specifications.

*Source:* Victorian Bushfires Royal Commission (2010).

Property owners have a private incentive to adopt measures to manage environmental risks to their personal safety and property. Further, insurance premiums for existing property act as both a signal and an incentive for owners to consider private adaptation action (chapter 12). Thus, the lack of application of planning or building regulation to existing settlements does not prevent existing owners from undertaking their own adaptation. However, governments may wish to introduce policy for existing development in order to address problems of imperfect information (where property owners do not have access to information on the potential impacts of climate change) or where a public good may be useful in protecting settlements.

Addressing climate change risks for existing settlements entails a number of complex considerations, including whether and how governments should relocate existing settlements from high hazard risk areas (box 8.16), particularly in the coastal zone. Currently, there is no established policy response to this issue (Australian Academy of Technological Sciences and Engineering, sub. 18; Mornington Peninsula Shire, sub. 16; Suncorp Group, sub. 28). It may be necessary to develop national approaches or principles to support strategic management of

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climate change risks for existing settlements. Following this inquiry into barriers to effective climate change adaptation, the COAG Select Council on Climate Change should consider these issues when it is developing national adaptation priorities and work plans.

#### **Box 8.16 Categories of adaptation planning approaches**

There are three major categories of adaptation planning approaches that local governments can pursue — protection, accommodation and retreat. Where:

- **protection** involves construction of ‘hard’ engineering infrastructure such as seawalls, groynes and revetment walls in order to maintain development in its current location. This can also incorporate ‘soft’ protective works such as replenishment of beaches (where sand lost through longshore drift or erosion is replaced from sources outside the eroding beach)
- **accommodation** entails requirements to modify existing or proposed structures to take into account potential climate change impacts (for example, by requiring buildings to have floor levels above a defined height)
- **retreat** provides for the relocation of built assets or abandonment from a high risk area to a lower-risk site.

*Source:* DCC (2009b).

### ***Protect***

Whether and how to protect existing settlements are key issues facing local governments. These decisions largely relate to whether to invest in protective infrastructure, such as ‘hard’ and ‘soft’ engineering works (box 8.16). This in turn entails a determination of who is responsible for this public infrastructure and who pays (chapter 9). Further, a range of community assets, not just private property, are likely to be affected. For example, governments may also consider protection measures for the natural environment (chapter 11) and local infrastructure (chapter 9). While local governments are largely responsible for making these decisions, they can have implications beyond local government jurisdictions and in this context there can also be a role for state, territory and Australian governments (chapter 7). Decisions regarding ‘protect’ strategies will also need to take into account ‘acceptable levels of risk’ for both new and existing settlements (see earlier discussion).

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## *Accommodate*

Where property owners have access to appropriate information — about climate change risks and options to manage these risks — they can make their own decisions as to the type of adaptation options they wish to pursue based on their individual risk preferences and the costs and benefits of specific measures.

The Victorian Bushfires Royal Commission (2010) examined this issue in the context of retrofitting houses to meet contemporary building standards in bushfire-prone areas. While it noted that there is some precedent for mandatory application of new regulations to existing buildings (for example, for pool and spa fencing and some smoke alarms), they also recognised the substantial costs involved in modifying existing houses to meet current building standards. As a result the Commission did not recommend mandatory retrofitting of houses in bushfire-prone areas. Instead, it recommended greater information provision about ways in which existing buildings in bushfire-prone areas can be modified to incorporate bushfire safety measures.

In 2010, a Senate Select Committee inquiry into bushfires in Australia recommended a house loss-risk index for households in Australia's highest-risk bushfire areas (SSCARI 2010). The Australian Government supported this recommendation in principle and noted that in Victoria, in response to the Victorian Bushfires Royal Commission, the government has created a 'Household Bushfire Self-Assessment Tool' to assist residents in their bushfire survival planning. Other jurisdictions also have similar bushfire assessment tools.

However, there may be a barrier to private adaptation for existing settlements where the information provided regarding changes to building or planning regulations is too complex for owners to make an informed decision regarding the implications for their property. For example, the BCA is a technical document outlining detailed standards for new buildings and consists of several volumes — it is unlikely to provide easy-to-access information about climate change risks, and risk management responses for established buildings. Further, the code is not available at a 'reasonable' cost. The Victorian Bushfires Royal Commission recommended free online provision of all bushfire-related standards (COAG 2007a).

Another potential barrier to private adaptation for existing property is where 'split incentives' occur between property owners and tenants. This involves a divergence in incentives faced by tenants and landlords. For example, both landlord and tenant could benefit from installing insulation in a building, if they could agree on a rent adjustment that makes both better off. Yet frequently this does not happen because of difficulties and risks in negotiating the rental adjustment (PC 2005). However,

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the importance of split incentives as a market failure needs to be kept in perspective. To the extent that the costs of damage to a building are important, it will become worthwhile for both parties to agree to a new contract.

### *Retreat*

The third type of strategy available in hazard-prone areas is retreat. Retreat from a location may be considered where the cost of protect or accommodate strategies outweighs the value of the land protected.

A ‘managed retreat’ policy involves active intervention by the government in the retreat process (Mornington Peninsula Shire, sub. 16). This may involve setting aside land for retreat or allowing developments in an area on the condition that they be removed once the sea level reaches a specified point. The Byron Shire Council (NSW) approach is an example of a managed retreat policy, and Port Macquarie-Hastings Council in New South Wales is considering the use of such a policy (box 8.17). The UK Government has also implemented a number of managed retreat policies, which generally involve the deliberate breaching of flood defences, with some defences rebuilt further back from the coast line.

Managed retreat could also be facilitated through the acquisition of land by governments, either voluntarily or through compulsory measures (though legal issues may arise in the compulsory acquisition of land) (Maddocks 2011). Historically, compulsory acquisition has been used to acquire land for significant new infrastructure. However, governments could choose to exercise these powers in the context of climate change, where the increased severity or frequency of natural hazards means that development in a specific area faces very high risks.

A managed approach to retreat may offer some benefits. For example, retreat from a coastline may allow space for natural ecosystems, such as salt marshes, and a managed approach may enhance these benefits. Managed retreat could also be used to enhance defences in surrounding regions, for example by, using vacated land as firebreaks.

However, managed retreat is also likely to have significant costs. These include the dislocation of landowners (who may otherwise choose not to retreat — and may cause significant community anger), and administrative and infrastructure costs. These costs need to be carefully considered against the benefits before embarking on a retreat scheme. In particular, the timing of retreat is important — governments should not embark on costly retreat schemes before the benefits and costs of the scheme are apparent.



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## Box 8.17 Examples of planned retreat

### Byron Bay

In response to concern about coastal erosion and the potential impacts of climate change, Byron Shire Council in northern New South Wales has adopted a 'planned retreat' policy. Local planning regulations require that development must be relocated or removed once the erosion escarpment (the most landward limit of erosion) encroaches within a set distance of the development (Byron Shire Council 2010a). When this happens development consent lapses, though coastal land may be occupied and used until that time. In addition, new dwellings must meet several criteria, including being single storey, modular and able to be removed within 12 hours, if necessary.

In addition, property owners are largely prohibited from constructing protective structures against the erosion of their land and impacts of other coastal processes. The Council's Development Control Plan specifies that such structures must 'not cause adverse impacts on other lands or on coastal processes' (Byron Shire Council 2010a, p. J7). Where beach protection works are permitted, rock, concrete and other hard material must not be used.

### Port Macquarie-Hastings

In response to concerns regarding erosion in the Lake Cathie region (NSW), Port Macquarie-Hastings Council commissioned a study investigating various adaptation options. These options included building a revetment wall, groyne, beach replenishment and planned retreat (both voluntary and compulsory).

The preferred option recommended in the study was a voluntary planned retreat scheme. Under this scheme, the council would buy affected properties as they were placed on the market, or as landowners voluntarily offered to sell the properties to the council. This would require purchase of properties at market value — though if compulsory acquisition was used, the council would be required under NSW law to pay compensation including the market value of the property, and relocation expenses.

The costs to the council of both voluntary or compulsory acquisition would be high. The study estimated the costs at between \$8 million to \$12 million to purchase 17 affected properties.

*Sources:* Byron Shire Council (2010a, 2010b, nd); McDonald (2007); Moore (2010); Munro (2011); SMEC (2012).

An alternative is an 'unmanaged' approach to retreat. This primarily involves non-intervention by government in an area. In these cases, there may be a gradual reduction in the provision of government services, including the provision of disaster-mitigation infrastructure (Australian Climate Change Adaptation Research Network for Settlements and Infrastructure, sub. 19; Gippsland Coastal Board, sub. 65). Landowners would have the options of vacating the land ('retreating'), or

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undertaking their own accommodation or defence strategies (where these do not have impacts on others or the environment).

An issue in retreat schemes is whether compensation should be offered to affected landowners. For example, the Victorian Bushfires Royal Commission (2010) noted that land owners in bushfire-prone locations may be unable to sell their land. Therefore, the Royal Commission recommended that the Victorian Government develop and implement a retreat and resettlement strategy for existing developments in areas of unacceptable bushfire risk, including a scheme for non-compulsory acquisition of land by the Victorian Government in these areas. This land could then be used as firebreaks to protect nearby properties (COAG 2007a).

In international managed retreat schemes, some limited compensation has generally been granted. For example, in the United Kingdom, the Department for Environment, Food and Rural Affairs suggests that compensation should generally only be provided to landowners where the land is purchased by government to enhance defences (such as through the creation of salt marshes and firebreaks).

Claims for compensation need to be carefully considered on a case-by-case basis. In particular, there is little case for compensation to landowners where property was purchased with full knowledge of the potential risks. Extending compensation to affected landholders is likely to be prohibitively expensive. For example, Redland City Council in Queensland (sub. 36, p. 3), which has a history of managing voluntary land buyback schemes in the Southern Moreton Bay Islands, argues that ‘local government and its communities will not be able to afford to buy back inundated land’.

#### INFORMATION REQUEST 8.2

*The Commission seeks views on individual, business and community preferences for managing the risks of climate change for existing settlements.*

- *What levels of climate change risk are appropriate for existing settlements? Does this differ for private and public assets?*
- *What approaches should governments take to ensure these levels of ‘acceptable’ risk are maintained?*
- *In what circumstances should governments use ‘protect’, ‘accommodate’ or ‘retreat’ options for managing climate change risks to existing settlements?*

*The Council of Australian Governments' Select Council on Climate Change should consider, as part of its adaptation work plan, appropriate responses to managing the risks of climate change to existing settlements in high-hazard risk areas.*

## 8.4 Interactions between land-use planning and building regulation

In some cases the vulnerability of people and buildings to climate change impacts will depend on how well building standards (which generally control how to build) and planning regulations (which generally control where to build) are integrated to manage environmental hazards. For example, where planning schemes can identify areas that are bushfire prone and the level of bushfire hazard, the BCA can then specify a construction standard for a building in a given area to better manage bushfire risk. The importance of this crossover is recognised in the National Strategy for Disaster Resilience which states that:

... the predicted impact of climate change on sea level and the frequency and intensity of extreme weather events must be considered in an integrated approach to natural hazards in land use planning schemes, building code standards, and state and territory based regulations. (COAG 2011, p. 12)

Under the strategy, a range of work is underway to examine how current planning and building frameworks interact to manage environmental hazards to settlements.

In some cases, the building code may not apply standards for buildings to withstand certain hazards — for example, the current BCA does not contain standards for building in flood prone areas (although work has commenced on this) or for storm surge (ABCB 2011a). This may not be a problem if planning decisions ensure that buildings are not located on flood plains or in areas at risk of storm surge, or are protected by suitable engineering structures (BRANZ 2007). However, it may lead to gaps in the overall regulatory framework where neither system addresses the hazard.

Where both planning and building frameworks must address a common environmental hazard, it can be important they both use the best available information to determine the location and level of hazard. Inconsistent use of data may lead to gaps in overall hazard management. For example, the Victorian Bushfires Royal Commission noted that that building code bushfire-prone area maps did not match bushfire hazard maps used in the planning system — meaning

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that houses could be located in a bushfire hazard area under the planning system without meeting the bushfire standards under the building code (COAG 2007a).

In some cases the distinction between building and planning regulation can be blurred, for example where local governments impose building regulation through their local planning instruments. This may lead to duplication and overlap in regulation (Housing Industry Association, sub 69). In 2004, the Productivity Commission found that ‘local governments, through their planning approval processes, are imposing regulations on building. While this may offer benefits, there are concerns about the resulting regulatory inconsistencies across Australia and a lack of rigorous regulatory assessment’ (PC 2004c, p. xlv).

#### INFORMATION REQUEST 8.3

*The Commission is seeking submissions on gaps or overlaps between land-use planning and building regulations that may act as barriers to adaptation.*

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## 9 Provision and regulation of infrastructure

### Key points

- The impacts of climate change on the infrastructure sector are significant because:
  - infrastructure is interconnected — impacts on one infrastructure sector are likely to have impacts on other infrastructure sectors
  - some infrastructure is critical — if it were rendered unavailable for an extended period, there would be a significant impact on the wellbeing of the community
  - infrastructure assets tend to be long lived.
- While there do not appear to be many policy and regulatory barriers that inhibit the infrastructure sector from adapting to climate change, there may be ways to facilitate or encourage adaptation (for example, through enhancing the provision of information).
- In general, owners and operators of infrastructure are best placed to consider and respond to climate change risks. Government intervention is appropriate to correct market failures (for example, the provision of public goods such as disaster-mitigation infrastructure) where the benefits to the community exceed the costs.
- Local governments will generally be responsible for providing disaster-mitigation infrastructure, such as seawalls.
  - Such infrastructure should be considered as part of broader local government strategies. It should be subject to cost-benefit analysis, which includes impacts on external parties, such as environmental impacts.
  - Given the financial constraints on local governments, there may be scope for them to use special levies to fund this infrastructure where there are mainly private benefits.
- Energy networks and water services are subject to price regulation. Regulators and regulated entities need to consider the long-term impacts of climate change when making pricing proposals and decisions.
  - There may be scope in some cases to move to light handed forms of pricing regulation, such as price monitoring.

Infrastructure refers to the system of structures that exist to support human settlements. This includes transport, electricity, water and telecommunications.

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Climate change may have a number of impacts on Australia's infrastructure network. These may include damage to infrastructure caused by natural disasters and coastal inundation, reduced reliability of electricity transmission and distribution networks due to higher temperatures, and the impacts of variable rainfall on the water sector (chapter 2).

Climate change is of particular significance for the infrastructure sector for three reasons.

- Infrastructure tends to be interconnected. As a result, the impact of climate change on one infrastructure asset may be felt across many sectors. For example, the impacts of reduced rainfall would be felt in the water sector, but may also have impacts on the electricity sector (which uses water in the generation process). This may in turn have impacts on transport and telecommunications.
- Some infrastructure, including electricity and water networks, is classed as 'critical infrastructure', which 'if destroyed, degraded or rendered unavailable for an extended period, would significantly impact on the social or economic wellbeing of the nation or affect Australia's ability to conduct national defence and ensure national security' (Australian Government 2010b, p. 8).
- Infrastructure investment tends to be in long-lived assets. For example, electricity generators are generally designed with operational lives in excess of 30 years. Major bridges have a design life of up to 100 years. Infrastructure investment decisions therefore need to consider the climate over an extended time period.

Addressing barriers to effective climate change adaptation within the infrastructure sector is therefore important.

## **9.1 Provision of infrastructure**

### **How is infrastructure provided?**

Either directly, or through public corporations, governments at all levels provide a range of infrastructure — including transport, electricity, telecommunications and water and sewerage. Much of the responsibility for infrastructure provision lies at the state, territory and local government level — the Australian Government's responsibilities lie primarily in the provision of national road, rail and telecommunications networks and postal and aviation services (table 9.1).

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**Table 9.1 Responsibilities for infrastructure provision**

<i>Australian Government</i>	<i>State and territory governments</i>	<i>Local governments</i>
National roads (shared)	Urban, rural and local roads (shared)	Local roads (shared)
Local roads (shared)	Railways (shared)	Public transport (buses)
Railways (shared)	Ports and sea navigation	
Aviation services (national and international)	Aviation (some regional)	Aviation (regional)
Telecommunications	Electricity supply	Electricity supply
Postal services	Sewerage treatment, water, dams and drainage	Sewerage treatment, water, dams and drainage
	Public transport (trains, buses)	

Source: Webb (2008).

Historically, infrastructure has been provided by governments for two reasons. First, infrastructure often exhibits public good characteristics (where one person's use of a good does not detract from others' use of the good, and where people who do not pay for it cannot be prevented from using the good), and thus would be underprovided by the private market. Second, infrastructure networks may be a natural monopoly — the service can be supplied by one provider at a much lower unit cost than by two or more providers.

However, a growing proportion of infrastructure is being provided by the private sector, or through public private partnerships — including electricity generation and distribution assets, water infrastructure and toll roads. In these cases, governments plan for and monitor the provision of infrastructure, but may leave the construction and operation of the infrastructure to the private sector. In addition, because infrastructure often displays natural monopoly characteristics, privately owned infrastructure is often subject to government regulation (section 9.2).

### **Current practices for infrastructure decision making**

Responsibility for providing of infrastructure primarily lies with the states and territories. Further, where governments provide electricity, water and urban transport, this is largely through government trading enterprises (Webb 2008).

Most state and territory governments have infrastructure plans, which identify key projects and priorities for the state infrastructure networks. Examples include the *Queensland Infrastructure Plan* (Queensland Government 2011b) and New South Wales' *State Infrastructure Strategy 2008–2018* (NSW Government 2008).

At the national level, the primary bodies responsible for infrastructure decision making are the Department of Infrastructure and Transport, and Infrastructure

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Australia. The Department is responsible for the implementation of Australian Government infrastructure programs, such as the Nation Building Program. Infrastructure Australia is a statutory body that provides advice to the Australian Government on Australia's infrastructure needs, and evaluates proposals for investment in nationally significant infrastructure.

Guidelines are available to assist with infrastructure decision making.

- Infrastructure Australia has issued guidelines for infrastructure funding proposals. This requires robust cost–benefit analysis that monetises as many costs and benefits as possible, and also considers non-monetised costs and benefits. In addition, these proposals must consider risk and uncertainty through, for example, sensitivity analysis (Infrastructure Australia 2011).
- State and territory governments often have guidelines for investment decisions. One example is the New South Wales Government's guidelines for economic appraisal (NSW Treasury 2007).

Infrastructure decision-making frameworks do not generally require explicit consideration of climate change impacts. However, environmental impact statements can require consideration of climate change risks through project-specific determinations (for example, the assessment of mining projects in Queensland requires consideration of climate change impacts (Queensland Environmental Protection Agency 2008)). In addition, both Queensland and Tasmania have requirements to consider climate change risks in cabinet submissions for government projects. The Queensland *Climate Ready Infrastructure* initiative requires local governments to consider climate change adaptation when applying for Queensland Government grants for infrastructure (Queensland Government 2010a). Further, New South Wales' guidelines state that climate change impacts on infrastructure should be considered in existing risk management frameworks (NSW Treasury 2010).

In addition, COAG requires state and territory governments to have strategic plans for capital cities. These plans must cover a range of criteria, including climate change adaptation. Infrastructure funding will be linked to meeting these criteria (COAG 2009a).

Climate change risks are only considered in a limited number of guidelines for infrastructure.

- Standards Australia has released a draft standard on considering climate change adaptation for infrastructure and buildings. This standard sets out a series of guidelines for managing risk, based on the international standard for risk management (Standards Australia 2011).



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- The Australian Green Infrastructure Council has issued guidelines on managing climate change risks for infrastructure (AGIC 2011). This guidance forms the basis of the adaptation component of the Infrastructure Sustainability rating tool, which rates the sustainability of infrastructure investments.

In general, climate change features in state and territory government infrastructure strategies. For example, managing the impacts of climate change, including enhancing the resilience of infrastructure networks, is one of the principles behind Queensland's infrastructure strategy (Queensland Government 2011b).

Finally, the Australian Government has a strategy in place for managing risks to critical infrastructure, including those posed by climate change (box 9.1). This strategy contains a range of programs aimed at improving the adaptive capacity of Australia's critical infrastructure.

### **How can these practices be improved?**

The Commission has investigated infrastructure investment frameworks in a number of previous studies and inquiries, and noted areas for potential improvement (box 9.2). These suggestions are typically 'no regrets' measures — they would be beneficial regardless of the impacts of climate change. In addition, by enhancing decision-making frameworks, they would facilitate effective adaptation to climate change, and thus climate change strengthens the case for reform.

#### *Principles for considering climate change in infrastructure investment decisions*

There are several general principles that should be followed by government and the private sector when making adaptation decisions for infrastructure.

- The operator of infrastructure is likely to be best placed to consider adaptation investments.
- Adaptation investments should be subject to cost–benefit analysis.
- All investment options should be considered.
- The timeframes associated with adapting infrastructure should be taken into account.

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### Box 9.1     **Australian Government's strategy for critical infrastructure**

The Australian Government's *Critical Infrastructure Resilience Strategy* is aimed at improving the capacity of critical infrastructure, both publicly and privately owned, to deal with disasters, including those due to climate change. The strategy endorses a non-regulatory approach, recognising that in most cases, '... the owners and operators of critical infrastructure are best placed to manage risks to their operations and determine the most appropriate mitigation strategies' (Australian Government 2010b, p. 14).

As part of this strategy, the Trusted Information Sharing Network (TISN) has been established. The TISN is a forum through which owners and operators of critical infrastructure can work together, share risks and solutions, and bring issues to government that are seen as barriers to critical infrastructure 'resilience'. The TISN consists of seven critical infrastructure sectors (banking and finance, health, food chains, transport, communications, water services and energy), and two expert advisory groups (IT security and resilience). TISN members include owners and operators of critical infrastructure, government representatives and peak bodies.

A second major component of the strategy is the Critical Infrastructure Program for Modelling and Analysis (CIPMA). CIPMA attempts to model the behaviour and dependencies of critical infrastructure networks in response to disasters and threats. This information is provided to owners and operators of critical infrastructure to help them prepare for a range of disasters. It aims to address a market failure relating to interdependencies between critical infrastructure networks.

CIPMA includes a series of 'impact models' which assess the flow-on impacts of disruptions to a critical infrastructure service. The modelling work can provide insights into:

- how the economy and population will be affected
- how long the disruption will last
- the area affected
- how the various systems will behave (CSIRO 2011b).

Five TISN sectors are currently involved in CIPMA (health and food chains are not). The Attorney-General's Department has noted that it is looking to expand the coverage of CIPMA by enhancing the geographic and sectoral coverage, developing the transport sector coverage, and developing a national critical infrastructure geospatial database (Attorney-General's Department, sub. 64).

*Sources:* Australian Government (2010b); Attorney-General's Department (sub. 64) CSIRO (2011b).

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*The operator of infrastructure is likely to be best placed to consider adaptation*

In general, owners and operators of infrastructure assets, whether they be a government-owned enterprise or the private sector, are best placed to manage climate change risks to their business within existing frameworks. The owner and operator is likely to have a greater knowledge of its business — and the risks it faces — than government, and will generally face a commercial incentive to manage these risks. Indeed, there is evidence that private sector infrastructure providers are considering climate change risks in their investments (box 9.3).

**Box 9.2 Previous Commission reports on infrastructure investment**

**Urban water**

The Commission's inquiry into urban water outlined a number of shortcomings with the urban water infrastructure decision-making process. First, jurisdictions were not considering supply-side (such as building desalination plants) and demand-side (such as water restrictions) options together. Second, jurisdictions were not considering all options when making investment decisions — for example, there were restrictions on purchasing rural water for urban use, and prohibitions on indirect potable reuse and aquifers. Australian Government subsidies may lead jurisdictions to prefer one option over another. Third, there may be barriers to using real options approaches, including institutional and governance arrangements that lead to an undue level of risk aversion, and potential impediments imposed by economic regulators.

**Road and rail pricing**

In its inquiry to road and rail pricing, the Commission endorsed the 'Auslink' (now replaced by the Nation Building Program) approach to road and rail funding. This approach included detailed guidelines, with merit tests and detailed cost-benefit analysis of projects. However, the Commission noted that the success of the approach would depend on how rigorously it was applied, in particular whether decision making was undertaken in 'a transparent and consultative way, with full engagement of interested parties' (PC 2006, p. 266).

*Sources:* PC (2006, 2011a).

However, government intervention may be necessary to address market failures. This may include the provision of information (chapter 6), or to account for the external impacts on other parties associated with some adaptation investments — for example, the environmental and erosion impacts of seawalls may necessitate government regulation of such infrastructure. In addition, governments need to ensure that regulation (or lack of it) is not imposing an unnecessary barrier to climate change adaptation (section 9.2).

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Finally, given the strong interconnection between infrastructure networks, coordination within and between certain infrastructure sectors is necessary. This is currently facilitated through the Australian Government's Trusted Information Sharing Network (box 9.1).

### **Box 9.3      Adaptation and private infrastructure investments**

A number of submissions noted that private infrastructure providers are considering climate change adaptation in their investments. For instance, the Australian Petroleum Production and Exploration Association Limited (sub. 59, p. 2) noted that:

The industry already, in some cases, considers climate-related issues in project and facility design. For example, the Environmental Impact Statement for the Queensland Curtis [liquefied natural gas] Project assesses climate change and climate change related issues ...

Further, the Australian Industry Greenhouse Network (sub. 29, p. 2) noted that:

... commensurate with the commercial self-interest that accompanies large capital investment, companies are already factoring in adaptation.

An example of climate change risks being considered in a project is the Brisbane Airport Parallel Runway development. The site for the runway is currently subject to inundation during flood events, which may become more severe as a result of climate change. The development contains a number of adaptation measures, including building a number of tidal channels, building a new seawall along the northern boundary of the airport, and bringing in sand from Middle Banks to elevate the site.

Transurban has a climate change strategy that considers and responds to climate change risks faced by the business. Transurban has undertaken climate change risk assessments for the Citylink road network, and intends to do the same for its Sydney assets in 2011-12.

Sources: Brisbane Airport Corporation (2007); Transurban (2011).

### *Adaptation investments should be subject to cost–benefit analysis*

As with all investments, investments to enhance the ability of infrastructure systems to adapt to a changing climate should be subject to cost–benefit analysis (chapter 4). Investments to improve the preparedness and reduce the vulnerability of infrastructure networks to climate change should only proceed if they generate net benefits to the community as a whole.

### *All investment options should be considered*

When making infrastructure investments, the costs and benefits of a range of options should be considered (including the option of not making the investment at

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all). The Commission has previously noted that in the urban water sector, some investments have not considered all options, which has led to inefficient outcomes (box 9.2).

In the context of adaptation within infrastructure, options that could be considered include where to locate the infrastructure and the design of the infrastructure (such as whether the infrastructure needs to be designed to a higher standard to manage climate change risks). Due to the uncertainty associated with climate change, a real options approach should be considered — which involves deferring the bulk of an investment, but maintaining the option to undertake the investment later at a lower cost than otherwise. For example, this may involve setting aside land to build a seawall once sea levels rise beyond a certain point, rather than building the seawall now (PMSEIC Independent Working Group 2007).

One example of the use of a real options approach is the case of the Thames Barrier in the United Kingdom. The present barrier may not be able to provide adequate flood protection in the case of projected sea-level rise. Rather than undertaking an upgrade of the barrier now, the UK Government has proposed an approach where upgrades to the barrier will occur once the sea level reaches prescribed thresholds. Land will be safeguarded, in case it is required for new flood defences in the future (Reeder and Ranger nd).

#### *Consider the timeframes of the investment*

Infrastructure investments tend to be in long-lived assets, with some infrastructure having design lives of up to 100 years. Therefore, infrastructure investment decisions should consider potential climate change scenarios, and the impact these may have on the asset.

A useful approach to dealing with these long timeframes may be that proposed by Ron Ben-David (2010). Under this approach, risk-based investment plans would be established by infrastructure investors (or government departments) for 30–50 years into the future. These plans would then be tested against shorter-term investment plans. Such an approach would allow infrastructure investors to examine how short-term investments relate to longer-term investment goals, and whether these investments are influencing potential future investment options for adapting to climate change.

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### *Barriers to effective climate change adaptation*

Participants to the inquiry have suggested a number of potential barriers that may limit the ability of infrastructure planning to adapt to climate change. These include:

- barriers to using real options approaches
- a lack of guidance on adaptation within infrastructure
- a lack of information on climate change risks
- limited provision of disaster-mitigation infrastructure
- the Australian Government's arrangements for disaster recovery
- risk allocation and valuation of public private partnerships.

### *Barriers to using real options*

'Real options' is a tool that can be used to manage the uncertainty surrounding climate change (chapter 4). A number of participants have advocated the use of such a framework to manage climate change risks, including Dr Leo Dobes (sub. 63), the Tasmanian Government (sub. 51), and the Water Services Association of Australia (sub. 52).

The Commission considers that a real options approach is a useful tool for managing the uncertainty surrounding climate change, and can be incorporated into existing cost-benefit frameworks. However, there may be barriers to the use of real options by governments. For example, in the urban water sector, the use of real options has been limited due to:

- unclear roles of ministers, government departments and water utilities
- inappropriate political involvement in decision making that can lead to an undue level of risk aversion — it may be difficult to convince people that money needs to be spent that does not lead to an output at the time of the investment (PC 2011a).

The institutional and governance reforms recommended in the Commission's 2011 inquiry into the urban water sector — such as clearly outlining the roles and responsibilities between elected representative, water utilities and regulatory agencies — would help overcome some of these impediments and enable more efficient water supply augmentation decisions to be made (PC 2011a).

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### *Lack of guidance on adaptation by infrastructure*

Some inquiry participants suggested that a lack of guidance from governments regarding how adaptation should be taken into account in infrastructure decisions may be leading to a fragmented approach to dealing with climate change adaptation (Australian Green Infrastructure Council, sub. 13; Investor Group on Climate Change, sub. 73; NSW Young Lawyers, sub. 72).

It is unclear whether a lack of guidance represents a barrier to infrastructure owners and operators considering climate change risks. There already appears to be considerable guidance on climate change risks to infrastructure that is available or in development (such as by Standards Australia and the Australian Green Infrastructure Council), and programs are in place to assist operators of critical infrastructure to manage climate change risks. Given the financial and human resources of many infrastructure operators, in most cases a shortage of relevant advice is unlikely to prevent them from considering climate change risks in their investments.

Nonetheless, there may be scope to improve the guidance available to local governments, who may not have the resources to manage climate change risks to the infrastructure they operate (chapter 7).

### *Lack of information on climate change risks*

Information on climate change risks is important for the infrastructure sector. The extent to which information is available on climate change risks for specific locations will influence infrastructure decisions, including the provision of disaster-mitigation infrastructure such as seawalls.

Several participants suggested that a shortage of appropriate information is a barrier to climate change adaptation. For example, the Water Services Association of Australia (sub. 52, pp. 20–1) noted that:

There is a lack of information regarding climate change scenarios of design events that are permissible or the methodologies to apply them, and as a result organisations are going it alone. This risks inconsistent, and possibly inadequate, adaptation responses.

There is a role for governments to provide information on the risks associated with climate change. However, the provision of information is not costless, and therefore the costs and benefits of providing information need to be considered. In addition, information needs to be provided in a manner that is useful to infrastructure providers. The provision of information is considered further in chapter 6.

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### *Provision of disaster-mitigation infrastructure*

Disaster-mitigation infrastructure refers to a range of infrastructure that can be used to limit the impacts of natural hazards, such as bushfires and floods. This infrastructure can include seawalls, levees and firebreaks.

Disaster-mitigation infrastructure is often provided by governments and, due to the localised impacts of disasters, most commonly by local governments. In general, this infrastructure is provided by governments due to its public good characteristics. There may also be some negative impacts on external parties resulting from this infrastructure — for example, seawalls may simply shift flood risks to neighbouring locations that are unprotected by the seawall.

There is evidence that some local governments and local government associations are considering the need for such infrastructure in the context of climate change.

- Clarence City Council (Tasmania) has commissioned a report which considers risks to coastal areas, and the cost and benefits of a range of measures, such as seawalls and beach replenishment (Clarence City Council 2008). (Clarence City Council (sub. 10) has noted that the cost of implementing the measures outlined in the report go beyond their financial capacity, and that they have received limited assistance from the Tasmanian Government.)
- The Sydney Coastal Councils Group is undertaking a study which aims to provide guidance to local governments on the effectiveness of coastal protection measures, and provide guidance for upgrading structures to accommodate future sea-level rise (SCCG 2011b).
- Local governments used temporary and permanent levees to protect towns, including Nathalia, Wagga Wagga and Lismore, from flooding (ABC News 2012a, 2012b; McClelland 2011).

However, participants to the inquiry have suggested that the level of disaster-mitigation infrastructure in Australia is inappropriate. For example, Suncorp Group (sub. 28) noted the difference in Australian Government spending between disaster mitigation (\$27 million in 2010-11 under the National Partnership Agreement on Natural Disaster Resilience) and relief (\$5.6 billion in 2010-11).

The Commission does not have sufficient evidence to determine whether the amount of disaster-mitigation infrastructure provided by governments is appropriate. However, there are some general principles that should be followed when making investment decisions in such infrastructure. A cost–benefit approach should be applied to assessing the need for disaster-mitigation infrastructure. This should take into account all potentially significant impacts, including the cost of



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maintaining the infrastructure over the long term, and those impacts on external parties, such as:

- environmental impacts
- beach access and amenity
- damages to properties in other local government areas.

All options should be considered for addressing the impacts of climate change — which may include building the infrastructure differently, delaying it, not building it at all, or taking other approaches to managing relevant risks, such as restoring the natural environment to provide protection from hazards.

Further, it is important that decisions regarding disaster-mitigation infrastructure be incorporated into broader strategic plans for local governments, including infrastructure plans and general land-use planning and zoning. This should include considering disaster-mitigation measures in the context of the appropriate levels of risk for the local government, and setting priorities for the protection of assets.

There may be barriers that are limiting the provision of disaster-mitigation infrastructure. Participants noted that there is some confusion over the level of government responsible for funding and providing disaster-mitigation infrastructure (Gold Coast City Council, sub. 17; Mornington Peninsula Shire, sub. 16). For example, the Gold Coast City Council (sub. 17, p. 3) stated that:

... the State Government has also posed that if Council constructs a seawall on public land, it should own it and be responsible for its maintenance into perpetuity. Ideally, the State Government should agree to a location for the boulder seawall on public land, provide public funding for the construction of the wall and maintain it for a period of time.

Given this confusion, there is scope for state and territory governments to clarify the roles and responsibilities of local governments. In many cases, given the localised impact of climate change, local governments may be best placed to provide disaster-mitigation infrastructure. However, in some cases, external impacts or wide-spread impacts may require state or territory government involvement.

In addition, in some cases local governments may have limited capacity or be financially constrained, which restricts their ability to provide disaster-mitigation infrastructure and may constitute a barrier to adaptation. One option that could be considered to assist with the financial constraints on local governments is to require those who benefit from the provision of disaster-mitigation infrastructure to pay for its construction and maintenance. The *Australia's Future Tax System Review* noted that user charges are an appropriate funding mechanism for local governments to

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deliver services (Treasury 2010a). There are some examples of local governments that have used or proposed this approach:

- Mackay Regional Council (2009) has a policy of applying a special levy to cover the costs of seawall construction that would have largely private benefits.
- Pittwater Council (2012) has applied a special levy to cover the costs of infrastructure upgrades, including emergency management infrastructure.

Requiring private landowners to pay at least some of the costs associated with constructing and maintaining disaster-mitigation infrastructure (or, alternatively, requiring the landowner to take responsibility for providing and maintaining the infrastructure) will encourage effective climate change adaptation. This would ensure that those receiving a benefit from the investment are paying for it. This would lead to private landholders factoring in the costs of protection measures when making investment decisions — it may be more beneficial for the landholder to not build, or relocate, rather than paying the cost of the mitigation infrastructure.

Where special levies and charges are not an option for a local government, there may be a case for state and territory governments to provide financial assistance for the provision of disaster-mitigation infrastructure (chapter 7).

A further issue that may be limiting the provision of disaster-mitigation infrastructure is the legal liability of local governments in relation to such structures (Clarence City Council, sub. 10). For example, the construction of a seawall provides an expectation that this structure will provide adequate protection against flood. If the seawall fails, or has unintended consequences for neighbouring properties, the local government may be liable (Clarence City Council, sub. 10, attachment 2). Legal liability issues for local governments are discussed further in chapter 7.

### *Australian Government arrangements for disaster recovery*

As state, territory and local governments are responsible for a large proportion of Australia's infrastructure, natural disasters can impose a significant burden on these governments. For significant disasters, the Australian Government acts as an insurer of last resort by reimbursing state and territory governments a certain percentage of expenditure on relevant infrastructure through the Natural Disaster Relief and Recovery Arrangements. In the case of infrastructure, relief is provided to cover costs relating to the restoration or replacement of essential public assets to its pre-disaster standard. In some cases, payment may be available to restore the asset to a more disaster-resilient standard, though these provisions appear to have been rarely used.

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There are concerns that the Natural Disaster Relief and Recovery Arrangements may be leading to ‘moral hazard’ — that is, the arrangements may lead to state, territory or local governments not appropriately considering disaster mitigation in infrastructure investment, or not insuring their assets. This would constitute a barrier to climate change adaptation, and is considered further in chapter 10.

*Risk allocation and valuation of public private partnerships*

According to the *National Public Private Partnership Guidelines* (Infrastructure Australia 2008, p. 3), a public private partnerships is:

A long-term contract between the public and private sectors where the government pays the private sector to deliver infrastructure and related services on behalf, or in support, of government’s broader service responsibilities. [Public private partnerships] typically make the private sector parties who build infrastructure responsible for its condition and performance on a whole-of-life basis.

Of key relevance for this inquiry is the risk allocation between private and public parties in public private partnership contracts, in particular for damage caused by extreme events. In principle, these risks should lie with the party best able to manage these risks, and should ensure that the incentives to appropriately manage the risk are not reduced.

In general, the private sector is seen as a better manager of financial risk, whereas the government is seen as a better manager of regulatory risk (Sharp and Tinsley 2005). The *National Public Private Partnership Guidelines* apply in all states and territories, and contain guidance on the allocation of the risk of extreme events between the public and private parties. The guidelines state that:

- the private party must use all reasonable endeavours to minimise the impact of the extreme event
- no financial relief is to be granted as a result of extreme events (that is, the private party bears the financial risk)
- the government bears the risk of not being provided with services (Infrastructure Australia 2008).

This appears to be consistent with the principle that risk is allocated to the party best able to manage it.

A further issue how governments assess whether to proceed with a public private partnership contract. The *National Public Private Partnership Guidelines* suggest that the costs and revenues be forecast over the life of a project. This excludes the costs and revenues incurred after the contract has been completed and control of the

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asset has been handed back to the government. Using this approach, features of the project that may be aimed at managing climate change risks that occur after the duration of the partnership contract cannot be accounted for in the valuation of the project (Department of Climate Change and Energy Efficiency, sub. 57; Maddocks 2011).

It is not clear that this is a significant issue. Governments should consider the climate change risks for the life of the asset. Where governments consider that there are climate change risks that occur after the project is handed back to governments, they have the option of requesting modifications to the infrastructure to manage these risks (and therefore would need to pay the private provider more in the contract).

## **9.2 Regulation of infrastructure**

The provision of infrastructure is subject to a range of regulation. For example, infrastructure can be subject to pricing regulation, environmental impact statements, and planning regulation. This section considers whether these regulations (or lack of regulation) impede effective climate change adaptation.

### **Price regulation of natural monopolies**

Infrastructure such as electricity networks and water are often subject to pricing regulation as they are often natural monopolies. The predominant model used to regulate prices in Australia is a building block model. This model bases prices on projections of operating costs, capital investment and the required return on capital over a regulatory period (box 9.4).

Regulators also monitor investment and operating expenses to ensure that market objectives are met at the lowest cost possible. This is because regulating prices based on a rate of return on assets:

- provides no incentive for the regulated firm to operate efficiently — increases in costs will be recovered
- may provide an incentive for the regulated entity to overinvest in capital if the regulator overestimates the required rate of return on the assets.

Regulated companies must submit proposals for forecast capital and operating expenditure over a regulatory period. If the regulator does not deem these expenses to be appropriate, they can prevent these expenses from being considered in the pricing decision.

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#### Box 9.4 Regulation of natural monopolies

Natural monopolies in Australia are regulated in various ways.

- **Electricity transmission and distribution** is regulated by the Australian Energy Regulator. The regulator limits the amount of revenue a transmission or distribution company can receive. The revenue cap is based on the provider's weighted average cost of capital for its existing assets, and the expected investments and operating costs over a five year period. The regulator can refuse to allow network companies to pass through capital or operating costs if it is not deemed to be the most efficient way to meet network objectives.
  - Some states also regulate **electricity retail prices**. For example, the Independent Pricing and Regulatory Tribunal in New South Wales regulates the retail prices for small retail consumers.
- **Water** prices are regulated by the states and territories. For example:
  - in Victoria, the Essential Services Commission regulates water prices, based on the utility earning a reasonable rate of return on its assets, and being able to recover operational and investment expenditure. The Water Industry Regulatory Order 2003 notes that expenditure forecasts must represent the efficient delivery of the service, and must take into account a planning horizon that extends beyond the period of the water plan
  - in New South Wales, the Independent Pricing and Regulatory Tribunal uses a building block model to calculate tariffs for water retailers.
- The Australian Competition and Consumer Commission has the power to make access determinations for parts of the **telecommunication network**, and sets the default price for access to a network. For example, in July 2011 the Australian Competition and Consumer Commission released the access determination for fixed line services, with prices for the network based on similar principles to those used to regulate electricity distribution and transmission.

Participants in the inquiry have raised concerns that current price setting arrangements may represent a barrier to adaptation investments (Attorney-General's Department, sub. 64, Water Services Association of Australia, sub. 52). It was suggested that regulators are not allowing some adaptation investment costs to be factored into prices, partially because regulators only consider a five-year timeframe when making pricing decisions. For example, a proposal to include climate change investments into prices for Victorian distribution companies in 2011–15 was partially rejected by the regulator (box 9.5).

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**Box 9.5 Australian Energy Regulator decision on Victorian distribution networks**

In July 2010, the Australian Energy Regulator (AER) published its draft findings on the expenditure pools for Victorian electricity distributors over the 2011–15 period. The distribution companies were proposing a substantial increase over their 2005–2010 budgets, partially on climate change grounds.

Victorian distributors proposed a forecast capital expenditure of \$5.4 billion — 66 per cent higher than the 2006–10 period. Part of this increased capital expenditure proposal was based on a climate change report by AECOM. However, the AER suggested that the ‘reports do not demonstrate any material shifts in asset ageing or deterioration nor in operating condition sufficient to materially alter the expected future demand or power system capability in the forthcoming regulatory control period’ (AER 2010, p. 293). The AER considered that the impacts of climate change will emerge progressively over time, and as such the large proposed step-change increase in capital expenditures was unjustified. Due to a range of factors, including the AER’s view of the climate change related investments, the capital allowance approved in the draft findings was \$3.4 billion — a 38 per cent reduction on the proposal.

In addition, the distributors proposed an operating and maintenance expenditure of around \$3 billion, a 38 per cent increase over the previous period. Of this increase, \$47 million was related to the projected impacts of climate change. These impacts included more hot days, bushfire risks, increased termite damage, and the need for reviews of climate change risk.

In order to be satisfied that the proposed operating expenditures were needed, AER required evidence that the impact of climate change was likely to be more significant than for the 2009 base year. However, the AER noted that consultant projections for the number of extreme heat and wind days in 2015 were less than the actual number of extreme heat and wind days in 2009. As such, the AER did not allow the proposed increase in climate change related operating expenditure.

*Source:* AER (2010).

While the regulatory framework generally specifies that regulators determine prices over a set timeframe, this does not prevent regulators from approving climate change adaptation-related investments. Given the long-lived nature of infrastructure assets, regulators need to consider the costs and benefits of investments over the lives of the assets when determining whether a capital investment made during the regulatory period can be reflected in higher prices. The same holds true for climate change adaptation-related investments.

In general, the onus is on the infrastructure operator to provide evidence that an investment is necessary. The regulator is required to consider the evidence, and determine whether the expenditure is consistent with the objectives of regulation. If an infrastructure operator can provide evidence as to why a climate change

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adaptation investment is required to meet the objectives of the market (for example, in the national electricity market, the investment would need to improve the efficiency, security or reliability of supply), the regulatory framework appears able to accommodate this investment.

While regulators should guard against the ‘gold plating’ of infrastructure networks, they should also give consideration to the most cost-effective time to commence climate change investments. In some cases it may be cost effective to delay the investment, whereas in others, early preventative adaptation measures may be appropriate.

INFORMATION REQUEST 9.1

*Are there any examples where the economic regulation of infrastructure has impeded investments to facilitate adaptation?*

However, price-based regulation of infrastructure services is costly. Costs include administrative costs, lobbying and appeal costs, and information costs for the regulator. In addition, by limiting the returns infrastructure investors can receive, price-based regulation may curtail infrastructure investment. Finally, while in theory price-setting regulation can allow innovative approaches to managing climate change, such as real options, in practice incorporating such approaches into the regulatory framework may be difficult (PC 2011a).

The Commission has previously advocated moves to a price monitoring regime in the airport, urban water and gas sectors (box 9.6). Under a price monitoring approach, the regulator would collect data, with strict price controls only applied if these data suggest that market power is resulting in prices being set higher than would otherwise be the case. This approach is now applied in the aviation sector. Price monitoring is likely to be more appropriate than price setting where ‘the scope for abuse of market power is fairly limited, but where some concerns still remain about potential monopoly pricing’ (PC 2011a, p. 319).

In the case of urban water, the Commission considered that:

- there are significant costs associated with price setting regulation. In particular, lobbying and compliance costs are high, and regulators do not have perfect information about the regulated business
- the governance of the water sector (including the Commission’s governance recommendations in its Urban Water Inquiry) is such that, while monopoly pricing is a concern, it is not an overly significant one
- the benefits of price-setting regulation would be unlikely to exceed the costs

- price monitoring has greater flexibility than price setting, may be more compatible with real options approaches, and would have lower costs (PC 2011a).

Where the benefits of a more light-handed approach to the economic regulation exceed the costs, this approach may facilitate effective adaptation to climate change. This framework would allow infrastructure providers to implement climate change adaptation-related investments where they deem it necessary to do so, without requiring approval from a regulator. In addition, as noted above, such a framework may better facilitate options to manage the uncertainty associated with climate change, such as real options approaches. However, there would still be incentives for the company to avoid unnecessary adaptation investments — over-investing, as revealed through monitoring, may lead to them becoming subject to stricter regulatory controls.

#### **Box 9.6 Economic regulation of infrastructure — previous Commission inquiries**

##### **Urban water**

The Commission considered that, while urban water utilities have some degree of market power, the benefits of price-setting regulation would be unlikely to exceed the costs (including administrative, lobbying and information costs). The Commission recommended a move to more light-handed price monitoring, which would involve gathering information to assist with a determination as to whether market power is likely to be a concern.

##### **Gas-access regime**

The Commission's 2004 inquiry into the gas-access regime considered that, in some cases, price-based regulation was used where it was doubtful that it would lead to net economic benefits. The Commission recommended that the option for price monitoring regulation should be added into the regime. This would apply in situations where the case for price-based regulation is not as strong.

##### **Airports**

The Commission's 2002 report into the price regulation of airports noted that, while airports had market power in the provision of aeronautical services, the scope for them to use this power was constrained by their substantial non-aeronautical income. Given this, the Commission recommended price monitoring as a less costly method of regulating the prices charged by airports. This recommendation was accepted by the Government.

*Sources:* PC (2002, 2004d, 2011a).



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## Should there be an explicit requirement to consider adaptation?

As noted in section 9.1, most jurisdictions do not impose an explicit requirement on infrastructure providers (government or private) to consider climate change risks in their investment. Some participants have suggested that this is a potential barrier to effective climate change adaptation. For example, the Australian Green Infrastructure Council (sub. 13) recommended expanding the Queensland requirement to consider adaptation in cabinet decisions to all jurisdictions. In addition, Redland City Council (sub. 36) suggested that legislation may be needed to ensure that infrastructure providers publicly plan for climate change. Internationally, the United Kingdom has some requirements to consider adaptation in infrastructure decisions (box 9.7).

### Box 9.7 UK approaches to considering adaptation

The United Kingdom has some requirements that climate change be taken into account in infrastructure decision making and management.

- Government agencies must develop adaptation plans. This includes identifying risks to infrastructure, and implementing strategies to manage these risks.
- Some government-owned companies (and some private companies) must report on the impact of climate change on their business. This includes utilities and infrastructure operators.
- Major projects must undergo an economic assessment, following the ‘Green Book’. The Green Book contains guidance for dealing with the effects of climate change.

Source: Appendix C.

The Commission does not consider that the absence of a requirement to consider adaptation is a barrier to adaptation. Infrastructure decision makers and investors already have incentives to consider climate change adaptation in their decisions — as with any other risk that investors face. A legislated requirement to consider these risks would not enhance these incentives, and could result in perverse outcomes such as costly ‘box ticking’.

Therefore, on balance the Commission does not support the use of such a requirement.

## Inconsistent regulation across jurisdictions

The Investor Group on Climate Change (sub. 73), and Maddocks (2011) considered that inconsistent regulation across and within jurisdictions is a barrier to climate

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change adaptation within the infrastructure sector. For example, each state has its own approaches for managing the impacts of sea-level rise, and local governments incorporate these approaches into their frameworks in differing ways.

The Investor Group on Climate Change (sub. 73, p. 4) suggested as a result of this regulatory framework:

... property investors and developers are faced with understanding a variety of different approaches to managing sea-level rise and erosion, with variance across both state and local government jurisdictions. There is also uncertainty as to the status of existing property and infrastructure, particularly in relation to any obligation on councils to protect existing assets.

It is appropriate that local governments are able to take into account their varying exposure to climate change risks when making regulatory decisions. Therefore, it is not clear that there is a strong case for regulating planning approvals for infrastructure, and other regulation, in a nationally consistent manner. The role of sea-level rise benchmarks and other planning requirements is considered further in chapter 8.

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## 10 Emergency management

### Key points

- Climate change is expected to increase the frequency or severity of some extreme weather events, increasing demand for emergency services.
- Following recent disasters in many states, governments have commenced processes to reform emergency management arrangements.
- However, some problems still remain and these may constitute barriers to effective adaptation to climate change.
  - Providers of emergency services are not always well coordinated, or may have poorly-defined or overlapping roles and responsibilities.
  - Some local governments lack the capacity to adequately meet emergency management responsibilities that have been assigned to them.
- Reforms to emergency management arrangements would help the community deal with current climate variability and extreme weather events. These will deliver immediate benefits and facilitate effective adaptation to climate change.
- Good processes of risk management, including consideration of all available options to manage risks, can help improve the balance between emergency prevention, preparedness, response and recovery.
- The Natural Disaster Relief and Recovery Arrangements may be distorting infrastructure and insurance decisions by state and territory governments. An independent review should investigate the extent to which this is the case and examine alternative arrangements.

Emergencies are situations that endanger life, property and the environment. They include natural disasters, such as bushfires, cyclones, droughts, floods, storms and heatwaves. While these emergencies can cause significant damage to the community in the current climate, some are expected to become more intense and/or frequent due to climate change. This would increase the demand for emergency services and have wide-ranging impacts — for example, more frequent heatwaves could increase pressures on hospitals; more intense cyclones could significantly damage essential transport, communications and energy infrastructure; and larger floods could cause significant economic and social damage.

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Emergency management includes:

- prevention — actions taken before an emergency to reduce the potential impacts on the community or the environment. For example, flood-mitigation infrastructure, Total Fire Ban days and cyclone standards in building codes
- preparedness — actions taken to ensure that the community is able to respond to, and cope with, an emergency if it occurs. For example, public education programs, evacuation procedures, cyclone shelters, removal of vegetation to reduce bushfire risk, and backup electricity systems
- response — actions taken immediately before, during and after an emergency to reduce the impacts on the community and provide immediate relief and support. For example, ambulance and fire-fighting services, search and rescue operations, and evacuating people from disaster-affected areas
- recovery — actions taken to support affected communities to restore damaged property and economic activity, as well as physical, social and emotional health. For example, restoration of damaged infrastructure, counselling programs, and providing temporary housing (Australian Government 2009; SCRGSP 2012).

Governments, individuals, businesses and community groups have important roles to play over all four aspects of emergency management.

## 10.1 Current arrangements

The whole community has a role to play in managing emergencies (box 10.1). For example, many households take measures to prepare for bushfires or floods, and members of local communities often help each other out when natural disasters occur. Governments are also expected to provide support in many cases. For example, they provide ‘public goods’ such as early-warning systems and disaster-mitigation infrastructure which provide benefits to the broader community and will only be adequately provided with government intervention. These can also reduce losses to economic activity or calls on government expenditure to fund recovery. Governments also fund emergency-response services (such as fire fighting) that can prevent an emergency from spreading, and assist people that may not have the capacity to respond to, or recover from, emergencies on their own.

The emergency management sector encompasses a large number of organisations. These include agencies of the Australian, state, territory and local governments, along with emergency response organisations (such as fire, police and ambulance services, and State Emergency Services), the military, self-organised community groups and other volunteer organisations (such as the Red Cross) (figure 10.1).

**Figure 10.1 Major agencies involved in emergency management**

Commonwealth level	State and territory level	Local level
<ul style="list-style-type: none"> <li>• Air Services Australia</li> <li>• Australian Defence Force</li> <li>• Australian Maritime Safety Authority</li> <li>• Attorney-General's Department               <ul style="list-style-type: none"> <li>• Emergency Management Australia</li> </ul> </li> <li>• Centrelink</li> <li>• Department of Agriculture, Fisheries and Forestry</li> <li>• Department of Human Services</li> <li>• Department of Sustainability, Environment, Water, Population and Communities</li> </ul>	<ul style="list-style-type: none"> <li>• Ambulance services</li> <li>• Department of Premier and Cabinet</li> <li>• Department of Primary Industries</li> <li>• Environmental agencies</li> <li>• Fire services</li> <li>• Health services</li> <li>• Police force</li> <li>• Providers and regulators of essential services</li> <li>• State coroner</li> <li>• Volunteer organisations               <ul style="list-style-type: none"> <li>• State Fire Authority</li> <li>• State Emergency Service</li> </ul> </li> <li>• Road management and transport authorities</li> </ul>	<ul style="list-style-type: none"> <li>• Natural Resource Management bodies</li> <li>• Community groups</li> <li>• Municipal councils</li> <li>• Regional organisations of councils</li> </ul>

*Sources:* Australian Government (2009); Emergency Management Australia (2004); OESC (2012); Pearce et al. (2009).

Roles and responsibilities for emergency management vary across levels of government, and there are a range of measures that have been implemented at each level to address the impacts of climate change (appendix B). These are generally based on high-level principles and objectives that have been defined for emergency management (box 10.1). Broadly speaking, the role of the Australian Government is to help coordinate national efforts in disaster research, provide important information relevant to emergency services, and provide general assistance in all four aspects of emergency management (Australian Government 2009). Each state and territory government has primary responsibility within its jurisdiction for emergency management and has its own emergency management arrangements. Finally, local governments work in partnership with states and territories to prepare for and respond to local emergencies.

Numerous funding arrangements are in place to support these roles. For example:

- the Australian Government funds risk assessments undertaken by some local governments, funds climate-related research and provides relief payments to individuals and businesses affected by disasters
  - the Australian Government also funds disaster-mitigation projects by state and territory governments through the Natural Disaster Resilience Program and funds the restoration of essential infrastructure after a disaster through the Natural Disaster Relief and Recovery Arrangements (section 10.4)
- state and territory governments provide disaster assistance as well as grants to emergency services organisations and councils
- local governments fund risk assessments and early-warning systems. They also fund disaster-mitigation infrastructure, such as flood embankments and firebreaks.

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### Box 10.1 Objectives of emergency management

In 2009, the Australian, state and territory governments agreed to the National Disaster Resilience Statement (COAG 2009b), followed by a National Disaster Resilience Strategy in 2011 (COAG 2011). These set out the roles of governments and others.

- All levels of government are responsible for implementing measures to reduce exposure to hazards, including risk-based land management and planning, clear processes for informing people about risks, supporting preparation by individuals and communities, and ensuring that emergency services are well-coordinated.
- Businesses are responsible for understanding the risks they face and ensuring they are able to provide services during or after a disaster.
- Individuals have a role to play in preventing, preparing for, responding to and recovering from disasters, including through active planning and preparation for protecting life and property.
- Non-government organisations and volunteers help the community cope with, and recover from, disasters.

The Australian Government's overall approach to emergency management has been set out by Emergency Management Australia (1998, 2004). The broad aims are to ensure that emergency management measures:

- are comprehensive — emergency management operations are organised across the aspects of prevention, preparedness, response and recovery
- include all hazards — the same set of arrangements are used to manage all types of emergencies, including natural disasters
- involve all agencies — collaborative approaches are used to manage emergencies, involving all levels of governments, volunteers and community organisations
- prepare the community — emergency management arrangements allow the community to manage emergencies effectively at the local level.

Sources: COAG (2009b, 2011); Emergency Management Australia (1998, 2004).

## Reviews of natural disasters

In the aftermath of recent natural disasters around Australia, state governments have commissioned a number of reviews. These reviews investigated the causes of these disasters and the appropriateness of the response to them, as well as the adequacy of emergency management arrangements in preparing for and responding to these events. All these reviews concluded that providers of emergency services did not operate as well as they could have and made a broad range of recommendations to improve emergency management (box 10.2). The prospect of greater climate

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variability as a result of climate change strengthens the need for improving these arrangements (Victorian Government 2011a).

Following these reviews, many state and territory governments have initiated changes to their emergency management structures. For example:

- the Victorian Government appointed a Fire Services Commissioner to improve bushfire planning and preparedness and manage the response to major fires in Victoria
- the Victorian Government provided funding to strengthen emergency management capacity of local governments, including fire intelligence management and early-warning systems
- the Queensland Government developed ‘Get Ready Queensland’ to provide information on storms, floods and cyclones, and also made a number of improvements to flood mapping, early-warning systems, dam management and floodplain management programs
- through the Council of Australian Governments, most states and territories implemented a telephone-based emergency-warning system (Centre for Risk and Community Safety 2011).

Many reforms are still underway. Overall, some of these may improve the community’s ability to manage disasters — for example, through clarifying roles and responsibilities (section 10.2) or improving the balance between prevention, preparedness, response and recovery (section 10.3). This will facilitate effective adaptation to climate change by ensuring that appropriate arrangements are in place to manage risks and deal effectively with emergencies when they occur.

These recent reviews demonstrate that some state governments have adopted transparent processes to investigate the impacts of disasters and help the community and governments to learn from them. Ongoing transparent review processes will be an important part of incremental reforms to emergency management arrangements as the climate changes.

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## **Box 10.2 Recent inquiries into natural disasters**

State governments have commissioned a number of reviews following large-scale natural disasters that caused significant damage. These investigated the causes of the disasters and responses to them, including the role of emergency management. Reviews include:

- the Victorian Bushfires Royal Commission (2010)
- the Review of the 2010–11 Flood Warnings and Response (2011)
- the Queensland Floods Commission of Inquiry (2012)
- the Perth Hills Bushfire Review (2011).

These inquiries found inadequacies in the delivery of emergency services during disasters, and made numerous recommendations for improving emergency management arrangements.

### **Clarifying roles and responsibilities and improving coordination**

All the reviews supported measures to clarify roles and responsibilities, and coordination and leadership arrangements in all phases of emergency management. These measures could take the form of reviews and/or changes in existing emergency management procedures and legislation.

The consensus is that leadership and control arrangements can be improved through the appointment of a suitable individual with overall responsibility for disaster response. For example, the Review of the 2010–11 Flood Warnings and Response recommended the appointment of a state emergency controller who is ultimately accountable for all major emergencies.

Measures to clarify the roles and responsibilities of those involved in emergency management can include: training of disaster-management personnel to ensure they clearly understand their roles during an event; practice exercises among emergency service organisations; or amendments to existing emergency manuals and procedures to clearly define rescue roles, responsibilities and arrangements.

### **Improving preparedness**

Numerous recommendations related to improving the preparedness of communities, by helping them better understand the risks they face. These include putting in place adequate early-warning systems and ensuring that communities can access and understand relevant information.

For example, the Perth Hills Bushfire Review recommended that the Fire and Emergency Services Authority collaborate with the Real Estate Institute of Western Australia to provide a package of information to new residents moving into bushfire-prone areas. In a further example, both the Queensland Floods Commission of Inquiry and the Perth Hills Bushfire Review call for the provision of education programs to make communities better prepared for future emergencies.

(Continued next page)



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## Box 10.2 (continued)

### **Building capability and capacity**

All of the reviews were in favour of measures to ensure that providers of emergency services have the ability and the resources to operate effectively during an emergency. Recommendations included revising emergency management training procedures to improve capacity, making better information available to emergency response agencies (for example, mapping data), providing emergency services with appropriate equipment, and implementing measures to attract more volunteers.

### **Sharing responsibility**

Another key message from the reviews was the importance of sharing responsibility for hazard preparedness. This requires the involvement of all tiers of government, emergency service providers and the broader community. Communities need to recognise, understand and manage their own hazard risks and not rely solely on the assistance of emergency service organisations and governments. The Review of the 2010–11 Flood Warnings and Response pointed to research which suggests that flood damage can be cut by up to 80 per cent if a community is well prepared for a flood. Measures implemented to promote this notion of ‘shared responsibility’ include guidance manuals and websites to provide communities with relevant information.

Broadly similar recommendations were made in a number of other reviews such as the Victorian Government’s green paper ‘Towards A More Disaster Resilient and Safer Victoria’ (2011c) and ‘A Review of Disaster Management Legislation and Policy in Queensland’ (2009).

*Sources:* O’Sullivan and the Consultancy Bureau Pty Ltd (2009); Queensland Floods Commission of Inquiry (2012); Victorian Bushfires Royal Commission (2010); Victorian Government (2011b, 2011c); WA Government (2011).

## **10.2 Roles and responsibilities**

Recent reviews have found that inadequate definition of roles and responsibilities contributed to shortcomings in emergency management that affected the community’s response to natural disasters (section 10.1). Improving arrangements in this area will improve risk management in the current climate and facilitate effective adaptation to climate change.

Poorly-defined roles and responsibilities and inadequate coordination in emergency management may arise from existing institutional arrangements. Providers of emergency services generally have different roles, responsibilities and objectives, reflecting differences in the overarching structures governing each entity. For example, local governments are primarily responsible for managing disasters in their local government area, while other agencies such as the police and State

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Emergency Service perform emergency management activities on a larger scale under command structures determined at the state or territory level.

Furthermore, each emergency service organisation has its own legislation, organisational hierarchy, training programs, operational processes and resources — which may result in an isolated (or ‘silo’) approach to emergency management. This can cause a number of issues when managing a disaster. For example, on ‘Black Saturday’, staff from the Victorian Country Fire Authority and the Victorian Department of Sustainability and Environment did not always work cooperatively, leading to weaknesses in bushfire warnings and contributing to some warnings being issued too late or not at all (Victorian Bushfires Royal Commission 2010). In a further example, the Victorian Review of the 2010–11 Flood Warnings and Response (Victorian Government 2011b) argued that the siloed approach followed by emergency service providers prevented them from readily communicating and sharing information, due to separate and incompatible information management and communication systems.

Inquiry participants submitted that there is a lack of consistency and clarity in emergency management arrangements, leading to uncoordinated provision of emergency services. For example, the Attorney-General’s Department (sub. 64, p. 2) argued that:

... traditional government portfolio areas and service providers, with different and unconnected policy interests may be attempting to achieve the right [prevention, preparedness, response and recovery] balance individually. This has resulted in gaps and overlaps, which may hamper effective action and coordination at all levels and across all sectors.

The Northern Alliance for Greenhouse Action (sub. 6, p. 2) also stated that ‘there is continuing uncertainty about the scope of roles and responsibilities of different levels of government’, and argued that better coordination between local governments, particularly at the regional scale, would improve the delivery of emergency services. In a further example, the Municipal Association of Victoria (2011, p. 7) noted that:

Under the current system, each council and [the Municipal Emergency Management Planning Committee] spends considerable effort undertaking similar risk assessment processes. But a lack of consistency means the same hazard is identified in multiple municipal districts, with an absence of coordination of treatment leading to different treatment measures being applied across the state.

Experience from recent natural disasters has also shown that unclear roles and responsibilities of emergency service providers can reduce the effectiveness of emergency services. Inquiries into the 2009 ‘Black Saturday’ bushfires and the 2010–11 floods in Queensland and Victoria suggest that the chain of command

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across agencies is sometimes confused and contested in preparing for, responding to and recovering from disaster events (box 10.3).

Given that climate change is likely to increase demand for emergency services, improving coordination arrangements and clarifying roles and responsibilities of those involved in emergency management can not only help in managing current climate risks, but also facilitate adaptation to future climate impacts.

For example, a number of people volunteer to help out other members of the community even if they are not part of an official emergency management organisation (for example, assisting a neighbour after a flood or storm). While it would not be feasible to set out formal responsibilities or arrangements for every member of the community willing to assist during a disaster, providing general information about emergency management procedures and having processes in place to inform volunteers about how to assist most effectively may lead to improved disaster response.

Following recent reviews, state and territory governments are already implementing reforms to improve emergency management arrangements relating to roles and responsibilities, coordination and flexibility. There have also been agreements through the Council of Australian Governments to set out roles and responsibilities for disaster resilience (for example, COAG 2011). Clearer and more predictable emergency management arrangements within and across governments at all levels can enhance the support available to local governments in managing disasters (Victorian Local Governance Association, sub. 3).

## **Local government capacity**

Inquiry participants submitted that many local governments lack the capacity to meet their existing emergency management obligations. For example, Redland City Council (sub. 36) argued that limited resources makes it hard for them to maintain an Emergency Coordination Centre and guarantee uninterrupted communication in an emergency. The Mornington Peninsula Shire (sub. 16, p. 14) is a further example. It argued that:

Little funding has been directed towards local council officer resources, yet local councils carry a lot of responsibility. In most councils, the emergency services co-ordinator is an addition to a person's primary role, due to lack of funding. There also needs to be a greater emphasis and resourcing for the long term impacts of recovery as this is often overlooked.

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### **Box 10.3    Unclear roles and responsibilities and poor coordination in emergency management**

#### **Review of the 2010–11 Flood Warnings and Response (Victoria)**

The absence of any overarching coordination framework can result in a siloed, uncoordinated management structure where each agency focuses on legislated obligations to address specific hazards. Such a structure usually performs poorly in the face of a significant emergency. Citing the example of the 2010–11 Victorian floods, the Review argued that the lack of effective coordination and command and control arrangements led to an ad hoc response to the floods.

For example, under current arrangements, a dam breach and its resulting impacts would require the involvement of several agencies such as the State Emergency Service, Department of Sustainability and Environment, police force, VicRoads and Department of Primary Industries where each agency is responsible for different things. However, ultimate responsibility for such an emergency does not sit with any particular agency, meaning that nobody is effectively in charge of managing the situation. In another example, many councils were not aware of their specific responsibilities with respect to issuing flash-flood warnings, or lacked the technical and financial capacity to assess the likely local impacts of flash flooding and issue adequate warnings.

#### **Victorian Bushfires Royal Commission**

The Royal Commission found that confusion about roles and responsibilities resulted in inadequate management of several fires on ‘Black Saturday’. For example, the operational chain of command in different stages of the fires was unclear and no single person was in charge of operational planning, tasking and accountability on that day. Responsibilities were shared between the Country Fire Authority, Department of Sustainability and Environment, the Chief Commissioner of Police, and the Emergency Services Commissioner. There was consequently no cohesive and unambiguous leadership structure. In a further example, one of the leaders with ultimate responsibility for operational response is the Chief Officer of the Country Fire Authority. However, under the CFA Act 1958 (Vic), responsibility for operational matters over which the Chief Fire Officer has control is not clear.

#### **Queensland Floods Commission of Inquiry (Final Report)**

The Commission of Inquiry indicated that the disaster management system that was in place during the 2010–2011 floods was deficient in that local government, Queensland police and other disaster agencies were not fully aware of their roles and responsibilities. For example, there was confusion about Emergency Management Queensland’s role in directing versus supporting State Emergency Services when responding to the floods.

*Sources:* Queensland Floods Commission of Inquiry (2012); Victorian Bushfires Royal Commission (2010); Victorian Government (2011b).

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Recent inquiries into natural disasters have also found that resourcing constraints can lead to poor coordination across councils. This impacts on the provision of emergency services. For example, the Queensland Floods Commission of Inquiry (2011) suggested that less well-resourced councils have struggled to respond to the 2011 floods due to a shortage of staff trained in emergency management, lack of coordination among council staff and no contingency planning included in councils' disaster management plans.

Emergency management is just part of a broad range of local government functions that will be affected by climate change, and climate change is only one of the many risks that councils have to manage. A thorough consideration of the risks, benefits, costs and alternative priorities for scarce local government resources is therefore required before committing additional funding and resources to emergency management at the expense of other priority areas. Coordination and collaboration among councils and improved guidance from state and territory governments could help councils reduce the costs of managing the risks of climate change in different areas, including emergency management (chapter 7).

### **10.3 Getting the balance right**

All aspects of emergency management — prevention, preparedness, response and recovery — have a role to play in helping the community to deal with the impact of extreme weather events and other emergencies. For example, the Attorney-General's Department (sub. 64, p. 2) emphasised that:

In the context of emergency management, effective adaptation to climate change means getting the [prevention, preparedness, response and recovery] balance right in order to minimise the harm done by natural disasters.

Some inquiry participants submitted that current arrangements do not achieve the right balance. For example, Clarence City Council (sub. 10, p. 4) submitted that:

It would seem logical in many circumstances to implement preventative measures where appropriate rather than to rely on emergency response and management when events occur. At present there appears to be no understanding of the economic benefits of protect versus recover in relation to coastal processes.

However, it is difficult to say what the balance between prevention, preparedness, response and recovery should be to best facilitate effective adaptation to climate change. For example, whether a preventive measure such as a flood barrier is appropriate will depend on specific local circumstances, other options available to manage emergencies, and the preferences of the community. More broadly, all government-funding decisions involve making tradeoffs between alternatives that

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have different costs and benefits for the broader community. For example, local governments could construct permanent flood levees to protect some towns located near rivers, or purchase low-cost temporary levees — as was done by Moira Shire Council in Victoria and which protected the town of Nathalia from flooding in early 2012 (ABC News 2012b). The choice may depend on the likelihood of flooding and other spending priorities.

Expenditure on emergency prevention or preparedness could be too low — leaving the community facing high levels of risk — or it could be too high and resources could be better used to meet other policy objectives. While disaster-mitigation infrastructure can reduce damage if a disaster occurs, sometimes it could be more efficient to use limited funds to strengthen response arrangements (such as fire services) or provide recovery assistance after an emergency. This may be the case where disasters are difficult to predict, the potential damage is low, or preventive infrastructure is very costly.

The Commission is not in a position to assess the adequacy of specific arrangements that are in place across Australia, or whether spending on measures that can prevent damage in a disaster is too low (see below). However, while it is difficult to say what the right balance between prevention, preparedness, response and recovery would be in specific cases, there are principles that can guide government decision making.

A key part of this is identifying risks and considering all options available to manage these risks. This can be done through a risk management framework (box 10.4) that evaluates risks and their consequences, and sets out options to reduce the impacts on the community. Taking this approach, governments can help to inform the community of the range of risks they face and consider tradeoffs between ways of dealing with those risks — whether through prevention, preparedness, response or recovery. This can be further facilitated by ongoing consultation with the community to ensure that all risks and interests are considered, supported by transparent decision making and clearly defined roles and responsibilities (section 10.2).

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#### **Box 10.4 Risk management**

The Australian Government has published guidance for managing climate-related risks, based on the Australian and New Zealand Standard for Risk Management (currently AS/NZS ISO 31000). This process involves:

- establishing the context — identifying relevant stakeholders, clarifying objectives, and setting criteria against which risks to these objectives can be evaluated
- identifying the risks — assessing the range of risks that could affect the community
- analysing the risks — reviewing existing risk management processes, assessing the consequences of each risk and forming a judgment of its likelihood
- evaluating the risks — identifying the most severe risks and those for which more detailed analysis is required
- treating the risks — identifying options to manage risks or adapt to their consequences, and adopting the best options (this can include developing strategies to deal with a range of possible scenarios).

Each stage of the process should involve communication and consultation with all stakeholders in the community, along with ongoing monitoring and evaluation to adjust to changing circumstances.

*Source:* AGO (2006).

Governments can also work towards achieving a good balance between prevention, preparedness, response and recovery by assessing the costs and benefits of each option available, and selecting the options that are likely to most improve the wellbeing of the wider community. In each case, the costs and benefits will depend on the specific circumstances — for example, the extent of flood or bushfire risk in a local area, or the costs of specific infrastructure projects or increasing the capacity of local fire services. This assessment of costs and benefits should also consider the implications that investment in one aspect of emergency management may have on others — for example, whether increased preparedness can reduce the cost of providing emergency response services (section 10.4), or whether recovery payments create disincentives for good risk management (chapter 12).

In addition, given high uncertainty about the impacts of climate change — and the effects of extreme weather events more generally — ‘real options’ approaches may be most appropriate in some circumstances (chapter 4). This means taking actions that have relatively low costs today but leave options open for further measures to be taken in the future as information improves. For example, if flooding is expected to increase in the future due to climate change, one option may be to buy a relatively low-cost portable or temporary flood levee. This could allow decisions about whether to invest in more permanent or expensive levees to be deferred until

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the need becomes clearer (for example, as projections of future flooding due to climate change improve).

Using these principles, governments and communities can work towards an appropriate balance between prevention, preparedness, response and recovery. These principles can also help to allocate scarce resources to uses that best improve the wellbeing of the overall community. Even though extreme weather events and the impacts of climate change can be highly uncertain, these principles provide a framework to identify and manage risks, deal with emergencies and facilitate effective adaptation to climate change.

## **Disaster-mitigation infrastructure**

Some inquiry participants suggested that governments are not adequately investing in measures to prevent and prepare for disasters. For example, Suncorp Group (sub. 28) pointed out the Australian Government funding for disaster recovery and rebuilding in 2011 was significantly greater than funding for disaster-mitigation works, citing figures of \$5.6 billion and \$27 million respectively (excluding expenditures by state, territory and local governments). Insurance Australia Group (sub. 39) noted that increased investment on disaster-mitigation infrastructure can reduce the total economic impact of disasters.

To the extent that too little mitigation infrastructure is provided, this could increase pressures on the response and recovery phases of emergency management. In some cases, this may represent a barrier to effective climate change adaptation when decisions are made without regard to whether prevention or preparedness measures would be more appropriate.

However, disaster-mitigation infrastructure can be costly and these costs need to be weighed up against the benefits (reduced risk of damage) to the community, as well as against the broader range of competing priorities for government funds. The appropriateness of a given disaster-mitigation investment will depend on the specific circumstances (chapter 9).

Figures for the total amount of Australian Government funding tied to disaster-mitigation infrastructure and to restoring damaged infrastructure cannot be used, on their own, to determine whether there is an appropriate balance between preparing for and recovering from disasters. For example, recovery spending was unusually high in 2011 (mainly due to extreme weather events in Queensland and Victoria) and spending in previous years has been substantially less (table 10.1). While disaster-resilience funding from the Australian Government has generally been less than that for recovery, these figures do not capture spending by state and



local governments out of other funding sources (for example, state and territory governments often match disaster-mitigation funding from the Australian Government on a one-for-one basis (SCFFR 2012)). In addition, these figures do not indicate whether the benefits of the projects that received funding outweighed their costs, or whether there are further investments that should be made.

**Table 10.1 Australian Government funding for disaster prevention and recovery, 2005-06 to 2010-11**

	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
	\$m	\$m	\$m	\$m	\$m	\$m
Disaster mitigation or resilience <sup>a</sup>	31	24	30	37	34	26
Natural Disaster Relief and Recovery Arrangements	69	104	18	292	106	6 116 <sup>b</sup>

<sup>a</sup> Specific Purpose Payments made to states for natural disaster mitigation or resilience, plus payments for bushfire mitigation. <sup>b</sup> This figure includes expected future costs for natural disasters that occurred in 2010-11.

Sources: Treasury (2006, 2007, 2008, 2009, 2010b, 2011a).

## 10.4 Natural Disaster Relief and Recovery Arrangements

Natural disasters can impose large costs on the community. To facilitate recovery after major disasters, the Australian Government provides assistance through the Natural Disaster Relief and Recovery Arrangements (NDRRA). These fund a proportion of the recovery costs incurred by state and territory governments after a natural disaster, including:

- one-off payments and other assistance for individuals and businesses
- the cost of restoring essential publicly-owned infrastructure (such as roads, bridges and schools), including recovery funding provided to local governments (figure 10.2).

The amount that the Australian Government reimburses a disaster-affected state or territory depends on expenditure thresholds and criteria for eligible spending (Attorney-General's Department 2011). Remaining costs are paid by the states, although these costs are often spread among all states through GST allocations (ERC 2011).

**Figure 10.2 Natural Disaster Relief and Recovery Arrangements**

Coverage: bushfire, earthquake, flood, storm, cyclone, storm surge, landslide, meteorite strike, tornado.			
<p><b>Category A</b></p> <p>Emergency assistance to alleviate hardship or the distress of individuals.</p> <p><i>Includes:</i></p> <ul style="list-style-type: none"> <li>• emergency accommodation</li> <li>• repairs to housing</li> <li>• removal of debris</li> <li>• counselling.</li> </ul>	<p><b>Category B</b></p> <p>Restoration or replacement of damaged essential public assets; loans and grants; counter-disaster operations to ensure public health and safety.</p> <p><i>Includes:</i></p> <ul style="list-style-type: none"> <li>• concessional-rate loans or interest rate subsidies for small businesses and primary producers</li> <li>• freight subsidies for primary producers</li> <li>• grants to non-profit organisations.</li> </ul>	<p><b>Category C</b></p> <p>Community recovery packages to support the recovery of regions, communities and sectors.</p> <p><i>Includes:</i></p> <ul style="list-style-type: none"> <li>• community recovery funds to restore social networks and community facilities</li> <li>• recovery grants for small businesses and primary producers.</li> </ul>	<p><b>Category D</b></p> <p>Acts of relief or recovery in circumstances deemed to be exceptional by the Attorney-General.</p>
<p><b>Assistance thresholds for state and territory governments</b></p> <ul style="list-style-type: none"> <li>• First threshold: 0.225 per cent of total state government revenue and grants in the previous two financial years.</li> <li>• Second threshold: 1.75 times the first threshold.</li> </ul> <p><b>Reimbursement</b></p> <ul style="list-style-type: none"> <li>• Expenditure below the first threshold: 50 per cent for categories A and C.</li> <li>• Expenditure between the first and second thresholds: 50 per cent for categories A, B and C.</li> <li>• Expenditure above the second threshold: 75 per cent for categories A, B and C.</li> </ul>			

Source: Attorney-General's Department (2011).

In 2010-11, Australian Government expenditure on the NDRRA has been estimated at \$6.1 billion (including expected future costs for disasters in that year) (Treasury 2011a). In Queensland, most state recovery expenditure after the flooding and cyclone that is eligible under the NDRRA has been used to replace state roads and local government assets (table 10.2).

**Table 10.2 Estimated NDRRA-eligible expenditures**

Queensland floods and Cyclone Yasi, 2010–11

<i>Item</i>	<i>Expenditure</i>
	\$m
State roads	2 894
Local government assets	3 114
Other state assets	150
Support services and other payments	496
Loans	230
<b>Total</b>	<b>6 884</b>

Source: Queensland Government (2012c).

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The NDRRA mean that state and territory governments do not bear the full cost of rebuilding infrastructure after a disaster. This has led to concerns that they have less incentive to adequately maintain infrastructure and manage climate-related risks — a form of ‘moral hazard’ — which can lead to a poor balance of disaster prevention, preparedness, response and recovery (Attorney-General’s Department, sub. 64; ERC 2011; Mortimer, Bergin and Carter 2011). Some inquiry participants also suggested that relief payments to individuals (including NDRRA assistance) can reduce incentives to take out adequate insurance, although there is little evidence available to support this (chapter 12). More broadly, there are concerns that there could be large fiscal burdens on the Australian Government if extreme weather events become more frequent or severe due to climate change (Department of Climate Change and Energy Efficiency, sub. 57).

In their current form, the NDRRA may give rise to a barrier to effective adaptation to climate change by distorting the incentives that state and territory governments have to reduce their risks through disaster-mitigation measures. They may also reduce incentives to manage their residual risks by adopting adequate insurance arrangements (whether through self-insurance, commercial insurance or decisions not to insure). This may be because NDRRA payments to states are made net of any insurance payouts they may receive (ERC 2011). In particular, a large proportion of NDRRA expenditure is used to rebuild roads, which are not insured by most state and territory governments (with the exception of Victoria and the ACT) (Department of Finance and Deregulation 2012).

The NDRRA also encourage damaged infrastructure to be rebuilt without requiring an assessment of the costs and benefits to the community. This may also be a barrier to effective adaptation. Under current arrangements, funding is provided on the condition that essential public assets are restored or replaced to their pre-disaster standard. A cost-effectiveness test is imposed only when additional funding is requested to build more disaster-resilient infrastructure under the ‘betterment’ provisions of the NDRRA. However, some inquiry participants suggested that these provisions are rarely used because some proposals may not pass this test, or construction could be delayed. As a result, states may be discouraged from changing the design, location or objectives of infrastructure.

Only limited evidence is available to the Commission on the extent to which the NDRRA have distorted infrastructure and insurance decisions by state and territory governments. The absence of insurance arrangements for some state-owned assets does not necessarily imply a barrier to effective adaptation — in some cases, it can be more efficient for states to bear risks and costs themselves. New clauses in the 2011 NDRRA determination require states to implement ‘disaster-mitigation strategies’ and report on their insurance arrangements to the Australian

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Government, which may reduce funding if it deems these to be inadequate (Attorney-General's Department 2011). But it is not clear whether these clauses will be sufficient to ensure an appropriate balance between disaster prevention, preparedness, response and recovery.

In the Commission's view, an independent review of the NDRRA should be undertaken to examine whether current arrangements result in inappropriate infrastructure investment, insurance, disaster recovery or other risk-management decisions by state and territory governments (as well as by individuals, businesses and local governments that receive assistance funded by the NDRRA). This review should also consider alternative arrangements or funding models that may reduce any distortions. These could include, for example:

- requirements for all infrastructure for which NDRRA funding is provided to undergo a cost-benefit assessment in accordance with the Best Practice Regulation Handbook (Australian Government 2010a)
- the use of lump-sum funding grants that are not tied to actual rebuilding or restoration costs (giving states an incentive to consider all available options for using these funds, including modifying the design and location of infrastructure)
- requirements for states to develop and update disaster plans for infrastructure that set out how essential infrastructure will be rebuilt after damage occurs
- transparent disclosure of project types and funding amounts under the NDRRA.

The review should commence immediately and produce a preliminary report by the end of October 2012. This would give governments the opportunity to consider any preliminary recommendations for the next bushfire and flood season.

DRAFT RECOMMENDATION 10.1

***The Australian Government should commission an independent public review of the Natural Disaster Relief and Recovery Arrangements. This review should commence as soon as possible and desirably produce a preliminary report by the end of October 2012. The review should consider whether the arrangements lead to inadequate infrastructure investments or insurance decisions, or reduce the incentives of state and territory governments to appropriately manage their risks. It should also examine alternative arrangements or funding models.***

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# 11 Environmental and health services

## Key points

### Environmental services

- Climate change may exacerbate existing pressures on ecosystems, habitats and biodiversity, as well as giving rise to new pressures.
- Reducing environmental pressures generally can improve the adaptive capacity of ecosystems and species.
- Good environmental information can facilitate effective adaptation by allowing decision makers to consider how the community values environmental resources.
- Flexible environmental management can facilitate effective adaptation. This could include the use of conservation reserves and wildlife corridors.

### Health services

- Health services could be affected by extreme weather events (such as heatwaves) as well as by more gradual climatic changes (such as changes in the geographic distribution of vector-borne diseases).
- These may add to the pressures faced by governments in providing health services. An appropriately-resourced and flexible health system would be well placed to respond effectively to climate change impacts.

Climate change could have a number of impacts on human and environmental health — for example, it could threaten the survival of some species and habitats, exacerbate pressures on ecosystems, or create health problems as a result of heatwaves or changes in the distribution of some diseases. While many of these impacts are uncertain, climate change may exacerbate pressures on governments as they manage environmental resources and provide health services. In response, more flexible policy approaches may be required to facilitate effective adaptation and ensure that policy objectives are being met.

## 11.1 Environmental services

Climate change could exacerbate current pressures on many natural environments, such as habitat and biodiversity loss, pollution, fire, and the spread of weeds and

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introduced animal species. Climate change could also introduce new pressures on some ecosystems. This could occur directly — through higher temperatures and sea levels, changed rainfall patterns or increasingly severe weather events — or indirectly, as settlement patterns and economic activities adapt to climate change. Many of these impacts are highly uncertain (box 11.1).

### **Box 11.1 Uncertain environmental impacts of climate change**

The impacts of climate change on the natural environment are uncertain. As a result it can be difficult to predict the likely impacts on a given ecosystem, habitat or species. For example, there is uncertainty about:

- the impacts of changes in temperature, rainfall and water availability
- changes in the frequency and severity of fires, cyclones and storm surges
- the extent of changes in the geographic range of species (both native and introduced)
- which species are most likely to face increased threat of extinction due to climate change impacts
- changes in life-cycle events and migration patterns
- the future effectiveness of various environmental management strategies
- future impacts from human activities (such as agriculture, urban development and tourism) that arise from adaptation to climate change.

Interactions could occur between these factors, increasing the uncertainty.

*Sources:* Australian Conservation Foundation (sub. 47); Director of National Parks (sub. 60); State of the Environment 2011 Committee (2011); Steffen et al. (2009).

Some species and ecosystems may be unable to adapt successfully to longer-term climate changes (IPCC 2007a). While many are able to adapt to external pressures and short-term climate variability, climate change could occur faster than some species and ecosystems are able to adjust through evolutionary processes (Director of National Parks, sub. 60), and could result in the collapse of ecosystems that are already damaged or vulnerable (Department of Sustainability, Environment, Water, Population and Communities, sub. 77). The 2011 State of the Environment report identified climate change as the most serious environmental challenge facing Australia (State of the Environment 2011 Committee 2011).

These impacts on natural environments will also affect human activities. For example, climate change could have an adverse impact on valuable environmental services, such as the regulation of soil and water quality, crop pollination and

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biodiversity. In turn, this may affect the viability of some agricultural activities, tourism and recreation.

Environmental impacts of climate change have implications for communities and individuals, as well as the range of policies that are in place across all levels of government to manage environmental resources (box 11.2). The impacts of climate change may mean that some policies need to be reviewed or changed to address barriers to adaptation by natural environments. This could involve reducing pressures on ecosystems generally, improving environmental information and enhancing the flexibility of environmental management.

### **Reducing pressures on ecosystems**

Many ecosystems currently face a range of pressures that can damage or fragment habitats, disturb species or reduce biodiversity. These include:

- human settlement and activities, including urban development, animal grazing, cropping, fertiliser use, fire management, water extraction and mining
- pollution from chemicals and waste products (soil, water or air pollution)
- salination of waterways, ground water and soils
- invasive plant and animal species
- overexploitation of natural resources (such as overfishing)
- extreme weather events, including fire, flood and storm surge (State of the Environment 2011 Committee 2011).

Reducing the pressures that ecosystems and habitats currently face — known as ‘baseline’ pressures — can help to reduce the extent to which these pressures are exacerbated by climate change (Council of Australian Biological Collections, sub. 23; Kylie Jones, sub. 11; State of the Environment 2011 Committee 2011; Steffen et al. 2009). More generally, broader actions that improve the general health of ecosystems, habitats and species can increase their resilience to the range of pressures they face and maintain the capacity to adapt to climate-related changes (Director of National Parks, sub. 60).

Environmental management in Australia generally follows this approach. For example, improving ecosystem resilience has been identified as a key priority for dealing with climate change in the intergovernmental *Australia’s Biodiversity Conservation Strategy 2010–30* (NRMMC 2010). Further, management strategies for most national parks and reserves focus on reducing current pressures. For example, environmental management of the Great Barrier Reef includes a major

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program to reduce water contamination and protect vulnerable ecosystems from physical damage and human disturbance (GBRMPA 2007).

### Box 11.2 Environmental management policy in Australia

The **Australian Government** manages ecosystems of 'national significance' through the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth). Under this Act, the Government lists threatened species and ecosystems; develops recovery plans for threatened species; and protects heritage, wetland and marine areas. This includes World Heritage areas of cultural or natural significance and wetlands listed under the Convention on Wetlands of International Importance ('Ramsar Convention'). Climate change has been identified as a 'key threatening process' under the Act.

Parks Australia manages reserves that have been proclaimed under the Environment Protection and Biodiversity Conservation Act, including the Kakadu, Uluru-Kata Tjuta, Norfolk Island and Christmas Island national parks. Other authorities have been established by the Australian Government to manage water resources in the Murray-Darling Basin and to manage the Great Barrier Reef.

In addition, the Government funds environmental conservation through the Caring for our Country scheme, which covers the National Reserve System, biodiversity, coastal environments, sustainable land practices, natural resource management and community engagement. The Government also provides funding through the Biodiversity Fund for farmers and other land managers to protect or enhance native vegetation and control invasive pests and weeds.

**State and territory governments** have primary responsibility for managing most national parks, providing large infrastructure, monitoring pollution and undertaking land-use planning (where not delegated to their local governments).

In addition, agreements between the Australian, state and territory governments have established 56 natural resource management regions (mostly based on catchment areas). Management bodies in each region have responsibilities that cover land-use planning, waterway protection and vegetation management.

**Local governments** perform a number of functions that can impact the environment, including land-use zoning, infrastructure provision and the management of open spaces and coastal environments. Local governments also apply some Commonwealth, state and territory environmental legislation.

**Voluntary and other community-based groups** also play an important role. For example, a large number of Landcare and Coastcare groups have been established to manage local environments, undertake environmental protection activities and share resources. These groups sometimes receive government funding.

*Sources:* Caring for our Country (2011a, 2011b); Department of Agriculture, Fisheries and Forestry (sub. 68); DSEWPC (2012a); Landcare Australia (2012).



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Parks Australia has adopted this approach in its management of conservation reserves.

In the absence of greater certainty regarding its particular impacts, Parks Australia considers the best overall approach of addressing climate change is to build the resilience of natural environments so they are in the best position to withstand those existing impacts which may be exacerbated by climate change. (Director of National Parks, sub. 60, p. 5)

Participants in the inquiry identified several options for improving the adaptive capacity of ecosystems. These include:

- controlling and reducing invasive species, especially those that may pose increased threats to biodiversity in a changed climate — for example, through increased regulatory controls on the importation or sale of potentially invasive plant species (Invasive Species Council, sub. 37)
- improving fire management practices to better align with natural fire patterns (Department of Sustainability, Environment, Water, Population and Communities, sub. 77; Director of National Parks, sub. 60)
- improving the connectivity of conservation reserves and wildlife corridors (discussed below).

Some actions to reduce existing pressures on ecosystems may have environmental and economic benefits, even in the current climate — such as improvements in the quality or availability of ecosystem services, biodiversity conservation and tourism opportunities (State of the Environment 2011 Committee 2011). When the benefits to the wider community exceed the costs, governments (and other environmental managers) should prioritise these actions. This may involve market-based, regulatory or voluntary measures to manage environmental resources, supported by a good understanding of natural environments (including their vulnerability to climate change) and flexible management approaches (discussed below).

## **Environmental monitoring and information**

Environmental management involves making decisions about how to conserve or use natural resources. Trade-offs are inherent in many of these decisions — for example, whether to protect a habitat by creating a national park or allowing development on that land where there is a high economic value to the community. Further, some activities have adverse impacts on the environment that may not always be fully accounted for in decisions by households or businesses — for example, a land owner may benefit from a seawall even though it exacerbates environmental damage elsewhere.

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Better understanding of environmental conditions and changes can help decision makers to weigh up these impacts and implement policy responses that reflect the values the community attaches to ecosystems and environmental services (PC 1999a). An important part of this is information on how the community values the environment — including economic, natural, amenity and leisure values. These can be difficult to quantify as many environmental features and services (such as clean air and biodiversity) are not traded on markets. However, there are techniques available to estimate these values, such as stated and revealed preference methods (Land and Water Australia 2005). It may also be possible to collect qualitative information on the value that people place on environmental services and resources, and use this information as an input to decision making.

Several submissions expressed concern that some environmental services are not being appropriately valued at present. For example, the Director of National Parks (sub. 60, p. 9) contended that:

Failure to properly value ecosystem services can distort conservation investment, with a tendency to focus on ‘symptoms’ rather than ‘causes’ of biodiversity decline being an obvious result. Improved valuation of ecosystem services (including their capacity to ameliorate the socio-economic impacts of climate change) and better understanding of the vulnerability of ecosystem services to climate change would encourage more informed and better targeted decision-making ...

Similarly, the Department of Sustainability, Environment, Water, Population and Communities (sub. 77, p. 13) noted that:

Policy interventions to facilitate adaptation could be enhanced by improved recognition and inclusion of the value of ecosystem services ... and further understanding of the vulnerability of ecosystem services to climate change.

More broadly, environmental information can provide a starting point for protecting the most valuable environments and minimising the costs of environmental damage — including damage that could occur due to climate change (Australian Conservation Foundation, sub. 47; Council of Australian Biological Collections, sub. 23; Ian Rae, sub. 2; Queensland Seafood Industry Association et al, sub. 24; South East Forest Rescue, sub. 45). This could include indicators of environmental health and patterns of change, or projections of the impacts of climate change and the vulnerability of ecosystems to those impacts (chapter 6).

Good environmental information can facilitate effective adaptation by enabling decision makers to consider the implications their decisions have on the environment. This can also improve the transparency of decision-making processes and allow for better evaluation of policies and environmental management approaches to ensure that these are meeting their objectives.

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For example, some local governments may need to make decisions about coastal land that could be affected by climate change — such as whether to allow private development, construct physical measures to protect the shoreline, or set the area aside for environmental conservation. Good information on local environmental conditions and biodiversity — along with an understanding of how such development will affect the value the local community places on the amenity of beaches, wetlands and development — can help to ensure that appropriate decisions and trade-offs are made. This could be further supported by clear reporting to the community — for example, through regular ‘report cards’ that indicate coastal environmental conditions and preparedness for climate change impacts.

Governments have recently taken steps to improve the collection and distribution of environmental information, including information on climate change. For example:

- ‘State of the Environment’ reports are prepared by the Australian, state and territory governments (along with some local governments) on a regular basis
- environmental indicators for some regions and ecosystems are provided in a clear and accessible form — for example, report cards on the Great Barrier Reef (Queensland Government 2011a) and on projected climate change impacts for marine areas (CSIRO and NCCARF 2009)
- the Australian Government has commissioned assessments of the vulnerability of national reserves, World Heritage areas and biodiversity to climate change impacts (ANU 2009; Dunlop and Brown 2008; Steffen et al. 2009)
- a National Plan for Environmental Information is being developed by the Australian Government to improve the quality and coverage of environmental information — including bringing together information from multiple sources, establishing information standards and providing information services (BOM 2012b; Department of Sustainability, Environment, Water, Population and Communities, sub. 77)
- a system of environmental and economic accounts is being developed by the Australian Bureau of Statistics (based on the United Nations System of Integrated Environmental and Economic Accounting.) that will include measures of natural resources, environmental services and waste products over time (ABS 2010).

These will supplement a range of environmental information that is already collected.

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## Flexible environmental management

The impacts of climate change on ecosystems, habitats and species are highly uncertain (box 11.1). While improvements in research and information can reduce some of this uncertainty, in many cases it will be difficult to predict all the direct and indirect effects that climate change may have.

Flexibility can be an important way of dealing with uncertainty — whether of climate change impacts or other pressures that environments face — by responding to changes as they occur and managing the risks of unanticipated outcomes. Changing approaches that are currently inflexible and do not achieve environmental policy objectives effectively can improve outcomes in the current climate as well as reduce barriers to effective climate change adaptation.

Submissions to the inquiry supported flexible approaches. For example:

We need to prepare for these [climate change] impacts by ensuring policies, institutions and management approaches are flexible and able to deal with the uncertainty posed by a changing climate. (Wentworth Group of Concerned Scientists, sub. 4, p. 1)

In the absence of robust, definitive and location-specific research, a risk management approach needs to be taken supporting dynamic and adaptive reserve management. (Director of National Parks, sub. 60, p. 8)

There are several types of policy instrument that can be used to support flexible environmental management (box 11.3). For example, market-based approaches can be used to allocate environmental resources to their most valuable uses, and where these are not feasible, regulatory and voluntary approaches can help to protect important ecosystems and habitats.

A more specific approach is the use of ‘adaptive management’, where research is used to reduce uncertainty and environmental conditions are monitored over time to evaluate the impact of management decisions (Allan and Stankey 2009). In some cases, this may involve trialling a range of approaches, conserving natural resources when their biodiversity value is unclear, or protecting multiple habitat types when it is uncertain how particular species will adapt to climate change.

Such an approach has been supported by an intergovernmental agreement on biodiversity, *Australia’s Biodiversity Conservation Strategy 2010–30*.

Traditional approaches to biodiversity conservation need to be rethought. Planning approaches that include managing for uncertainty will be critical, with greater emphasis on risk management and adaptive management approaches. These must be based on high-quality information, monitoring and experimentation. (NRMMC 2010, p. 30)

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## **Box 11.3 Policy instruments for environmental management**

### **Market-based instruments**

Defining property rights or providing financial incentives (such as taxes and subsidies) can help to ensure that environmental impacts are factored into decisions. This can facilitate effective adaptation to climate change by signalling changes in the scarcity and economic value of natural resources (Agrawala and Fankhauser 2008). As people respond to these signals, resources can be allocated to their most highly valued uses.

Water markets in Australia provide a good example. Limits are set on the total amount of water that can be extracted from the Murray-Darling river system for irrigation. These are enforced through a system of water rights that can be traded, ensuring that water is allocated to its most productive uses (chapter 5). These arrangements can also be used to retain water in the river system for environmental purposes.

However, market-based approaches may not be viable in all cases — for example, where property rights are difficult to define or enforce, or where outcomes are difficult to measure. These problems have impeded the development of markets for biodiversity ‘offsets’ (Murtough, Aretino and Matysek 2002).

### **Regulation**

In some cases, regulations can be used to prohibit or limit activities that have negative impacts on the environment. This can be efficient when there is a significant risk that those impacts will cause irreversible damage. For example, regulations are used to control the clearing of native vegetation, the use of pesticides and herbicides that may run off into the Great Barrier Reef, and the uses of different parcels of land.

### **Voluntary approaches**

Voluntary and community-based approaches are sometimes used to manage natural resources or undertake conservation activities. For example, many individual farmers have made voluntary efforts to regenerate native vegetation or control invasive species, and a number of Landcare and Coastcare groups (involving landowners, farmers, government agencies and volunteers) work to improve environmental outcomes. Further, regional Natural Resource Management bodies in all states draw on community input and participation to undertake floodplain and water management.

In general, voluntary and community-based arrangements can be flexible ways to address local environmental problems by drawing on community resources. They can also lead to a diversity of approaches between local areas that can encourage innovation and allow groups to learn from each other. In some cases, local governance can be a more effective way to manage natural resources than market-based or regulatory approaches imposed by governments (Dietz, Ostrom and Stern 2003). By supporting such arrangements — whether through funding, information provision or legislation — governments can facilitate flexible environmental management.

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There may be scope to improve flexibility in a range of environmental management activities. This could include the creation of natural reserves and species refuges, the use of buffers between sensitive habitats and human activities, maintaining seed banks and captive populations, new fire management practices, or changes in ways that invasive species are controlled. Improving flexibility could also involve changes to management objectives — for example, broadly focusing on maintaining ecosystem functions or improving ecosystem services, rather than focusing more narrowly on conserving individual species in a given location (Steffen et al. 2009).

### *Conservation reserves and wildlife corridors*

Conservation reserves and wildlife corridors can assist animal and plant species to adapt to climate change. As the impacts of climate change occur, some species may seek to migrate to new, more suitable habitats — for example, in response to changes in average temperatures and rainfall, or because of increased pressures from invasive species or fire.

A large amount of land has been set aside for environmental conservation, including national parks, Indigenous reserves and local conservation areas — many of which are part of the National Reserve System (box 11.4). Other landholdings also support habitats and species, including privately owned farmland, remnant forests and land owned by the Department of Defence. Natural connections between these areas, such as wildlife corridors, can also facilitate the movement of species (box 11.5).

#### **Box 11.4 The National Reserve System**

The National Reserve System consists of over 9400 land parcels covering around 14 per cent of the Australian land mass. It includes national parks, Indigenous Protected Areas and some privately-owned land (where the landowner has entered a voluntary agreement with the relevant state or territory government). It is based on an overall objective of achieving the long-term conservation of nature with associated ecosystem services and cultural values. In addition, reserves must contribute to the system's overall:

- comprehensiveness — by including examples of regional-scale ecosystems
- adequacy — by including ecosystems in ways that ensure ecological viability and maintain the integrity of populations and species
- representativeness — by conserving genetic diversity and habitat variability.

*Sources:* Director of National Parks (sub. 60); DSEWPC (2012b, 2012c).

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The importance of conservation reserves and wildlife corridors was recognised by submissions to the inquiry. For example, the Department of Sustainability, Environment, Water, Population and Communities (sub. 77) noted that reserves can help species adapt to climate change by protecting water resources, regenerating vegetation, providing new habitats and reducing pressures caused by invasive species.

#### **Box 11.5 Wildlife corridors**

Wildlife corridors can facilitate the movement of species and their adaptation to climate change. These can consist of forms of natural connection across landscapes, including remnant forests, waterways, reserves and patches of vegetation. By allowing landscapes to maintain ecological functions and natural connections, these corridors can improve the resilience of ecosystems to emerging threats, including climate change.

The Australian Government is considering ways to strengthen wildlife corridors in Australia, following the release of a draft plan by the National Wildlife Corridors Plan Advisory Group. This plan proposes a national corridor system, based on existing corridors established by state governments and others, that includes:

- connectivity between landscapes at continental, regional and local scales
- government, Indigenous and privately owned land
- collaboration between government agencies, regional bodies, Indigenous groups, community groups and landowners, supported by clearly defined roles and responsibilities
- ongoing monitoring and evaluation of the effectiveness of wildlife corridors
- Australian Government grants to establish new wildlife corridors.

*Source:* National Wildlife Corridors Plan Advisory Group (2012).

However, conservation reserves are often based on fixed land boundaries that may not always be effective for conserving ecosystems and species in a changing climate. If climate change means that some ecosystems need to shift, or some species seek to move to new habitats, current reserves may not be the most appropriate way to conserve biodiversity and meet policy objectives.

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For example, the Director of National Parks (sub. 60) submitted that the current National Reserve System may not contain sufficient flexibility to allow some animal and plant species to adequately adapt to climate change. As such, some adjoining land may need to be included in the reserve system, or some land that is currently included may no longer be required to meet conservation objectives.

As climate change impacts become more pronounced, protected area managers will face some potentially contentious issues. There may be pressures to relinquish reserves which are no longer effective in conserving the biodiversity they were designed to protect; areas of currently low conservation significance adjoining existing protected areas may need to be rehabilitated in order to allow for migration of species and communities; and the values for which protected areas were declared may no longer exist. Meeting future challenges such as these will require flexible and innovative approaches ... (Director of National Parks, sub. 60, p. 7)

As such, there may be scope for the Australian Government — along with state and territory governments, Indigenous groups and private landowners — to consider more flexible arrangements for the National Reserve System. There are several alternatives that could be used to meet the system's objectives (box 11.4) more effectively. These could include:

- expanding the National Reserve System
- amending the boundaries of some reserve areas
- ongoing research and monitoring of species changes and movements
- changing specific management objectives or strategies for some areas
- considering other uses for land that is no longer required to meet the objectives
- using wildlife corridors more often to connect conservation reserves and other habitats to allow species movement (box 11.5).

Such approaches could allow natural environments to adjust to current pressures and adapt to future climate change. The most effective approach is likely to vary on a case-by-case basis — for example, in some instances, amending boundaries may be the most appropriate strategy, but in others this may be expensive or impractical because the reserve area borders a settlement or faces a natural boundary (such as the ocean or a mountain range). More broadly, ongoing monitoring and evaluation of environmental outcomes can help to ensure that the National Reserve System is meeting its objectives, or could be used to reassess these objectives if an appropriate level of conservation is not being achieved.



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## 11.2 Health services

Climate change could have a number of effects on human health, arising from extreme weather events and gradual changes in temperature, rainfall and other climatic factors (box 11.6). This might include, for example, an increase in the number of heat-related deaths, greater incidence of vector-borne diseases in some parts of Australia, or increased mental health problems as people cope with droughts or floods. The effects would be felt disproportionately by some groups — children, the elderly, people that already have an illness, people of low socio-economic status, those living in rural or remote areas, and Indigenous people (Bambrick et al. 2011; Bi et al. 2011).

### Box 11.6 Climate change and human health

Changing patterns of temperature and rainfall in Australia — along with changes in weather variability and the frequency or severity of extreme weather events — could affect human health. Impacts could arise directly (such as injury or death from a bushfire or flood), or indirectly (such as changes in patterns of disease due to climatic impacts on ecological, biological or social systems) (NCCARF 2009). Impacts could also vary depending on the characteristics of different regions and populations (Bell 2011).

There are several potential impacts.

- Extreme weather events — such as heatwaves, droughts, bushfires, cyclones and flash floods — could lead to increased injury, death or mental health problems. In particular, heat-related deaths could significantly increase (well in excess of any reduction in cold-related deaths). Extreme weather events could also exacerbate existing health conditions, such as cardiovascular and respiratory problems.
- Gradual changes could occur in the incidence, geographic range, seasonality and/or timing of disease and illness. For example, there could be a southwards extension (or longer seasons) of suitable conditions for vector-borne diseases — such as the Ross River, dengue or Barmah forest viruses — as breeding patterns and distributions of vector species (such as mosquitos) change.
- Patterns of gastrointestinal diseases could also change as a result of increased food contamination (due to warmer temperatures) or water contamination (for example, due to increased algal growth or flooding and runoff). In addition, respiratory problems could be exacerbated by changes in air quality — for example, due to increased smog on hot days, changed distributions of plant allergens, or higher levels of wind-borne particulates during bushfires or droughts.

*Sources:* Bambrick et al. (2008); Bell (2011); Bi et al. (2011); Blashki et al. (2011); Harley et al. (2011); McMichael et al. (2003); NCCARF (2009); PWC (2011); WA Department of Health (2008).

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Governments provide and fund many health services, to meet objectives such as equitable access to healthcare and reducing the impacts that disease in one person can have on others. Climate change adds to the pressures that governments face in providing the majority of health services (for example, pressures that arise from managing disease, disability and increasing medical costs). Climate change impacts may increase demand for ambulance services, doctors, hospitals, disease prevention, pharmaceuticals and mental health services. The impacts could affect all levels of government — for example, the Australian Government in the provision and/or funding of aged care and medical research; state and territory governments in the provision of public hospitals; and local governments in the provision of some healthcare facilities and management of water supplies.

In particular, more prevalent heatwaves in a changing climate could increase pressures on emergency services, hospitals, local governments and early-warning systems (Bi et al. 2011; PWC 2011). To ensure these are dealt with appropriately, there may be a need to review the heatwave plans that have been implemented by some state (and local) governments, such as New South Wales, Victoria and Queensland (NSW Government 2011; Queensland Health 2004; Victorian Department of Health 2011). This may help to ensure that public health objectives are being met effectively without imposing excessive burdens on the community.

Similarly, strategies to manage vector-borne and infectious diseases may require ongoing evaluation. Climate change could affect patterns of these diseases and increase pressures on existing monitoring activities and early warning systems (including the National Notifiable Diseases Surveillance Scheme), or on vector-control activities (such as mosquito eradication by local governments). These activities can be strengthened through flexible responses to changes in disease patterns to minimise the health risks to the community (Blashki et al. 2011; Harley et al. 2011). The provision of information and guidance to facilitate disease prevention efforts by households can further support these activities.

## **Maintaining a flexible and appropriately resourced health system**

The ability to prepare for and respond to the health impacts of climate change will depend on the quality and flexibility of existing health services. While there may be specific changes to health service provision that could be warranted to deal with climate change, the Commission has received little information on specific barriers to adaptation by health services. As many of the climate change impacts on health are uncertain and some are likely to be gradual (Blashki et al. 2011; Harley et al. 2011), the Commission considers that the best overall response is to ensure that health services are appropriately resourced and meet the community's needs

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efficiently and flexibly. This can allow health services to deal with new challenges as they arise.

It will be important to appropriately evaluate and review health service provision, funding levels and prevention strategies to ensure that health services are meeting policy objectives and can facilitate adaptation to climate change. Policy decisions affecting other government activities may also need to consider climate change related impacts on human health — for example, emergency management, water distribution, land-use planning, building regulation and transport.

More broadly, governments can also facilitate adaptation by appropriately funding and/or providing research and information that have widespread benefits for the community (chapter 6). This includes undertaking research on the impacts of climate change on human health, and providing the community with information on these impacts and options for responding to them.



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## 12 The role of insurance

### Key points

- Insurance is an important tool for managing risk. The price and availability of insurance create incentives to reduce exposure to risk and adapt to climate change.
- However, climate change may affect how insurance is provided and lead to higher premiums, or reduced availability of insurance, for some types of hazard.
- Concerns have arisen about the take up of insurance by households, its affordability, and its availability for some types of hazard (such as flood and gradual processes of erosion and sea-level rise). Increased risk of extreme weather events due to climate change may escalate these concerns.
- Overall, there appear to be few barriers to the Australian insurance market facilitating effective adaptation to climate change.
  - However, state insurance taxes and levies are inefficient. These should be phased out and replaced with less distortionary taxes.
- Other regulations or government policies may have implications for the cost, take up and provision of insurance.
  - There can be a role for governments to provide information on natural hazards and disaster-mitigation infrastructure where the benefits to the community exceed the costs.
  - Planning and building regulations affect the degree of risk to which the community is exposed and how insurers price that risk.
  - Government assistance after disasters may affect the take up of insurance, although there is insufficient evidence to support or counter such claims.
- Reforms to address barriers to adaptation in these areas could improve the take up of insurance, reduce the cost of insurance to some households and strengthen its role in facilitating effective adaptation to climate change.
- The Australian Government has proposed several reforms to insurance regulations.
  - Insurers could be required to offer flood cover to all households, while allowing consumers to 'opt out'. This reform should only proceed if it can be demonstrated that the benefits to the wider community would exceed the costs.
  - Subsidies for insurance premiums would distort risk management decisions and impose costs on the wider community, and should not be pursued.
  - Other proposed reforms to improve disclosure in insurance contracts may have some benefits and modest costs. Reviews should be scheduled to occur after their implementation to assess whether policy objectives are being met.

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## 12.1 Insurance in a changing climate

Insurance can help households, businesses and governments manage risk. It offers financial protection from a number of hazards — such as fire, wind, hail and flood — that can be costly for the community and may become more frequent and/or severe due to climate change. Insurance markets do this by pooling risks and paying policyholders when they suffer a loss (box 12.1).

Insurance provides incentives that can facilitate adaptation to climate change. In principle, the premium that a policyholder pays is proportional to the chance of the policyholder experiencing a loss and the expected size of any loss. This premium gives the policyholder an incentive to reduce their exposure to risk. For example, they might invest in measures to make their house more resistant to wind damage, or relocate to an area less prone to bushfire. In addition, insurance can be difficult to obtain for some kinds of risks. This creates a different incentive to reduce exposure to those risks.

In responding to these incentives, households, businesses and governments can make decisions that reduce their exposure to risks and adapt to climate change. While these responses can be costly, they can reduce insurance premiums and the overall costs of disasters. Many remaining or ‘residual’ risks that cannot be avoided can then be pooled and managed through insurance.

### Box 12.1 Key principles of insurance

#### Insurance is the pooling of risks

An insurance contract generally involves a policyholder making a payment (premium) to an insurer. In return, the insurer covers the policyholder for losses that occur following an agreed event (such as theft or storm damage). This benefits policyholders that prefer to pay a small, certain cost (the premium) to avoid a large, uncertain loss. When insurers can accumulate a larger pool of premiums from many customers facing unrelated risks, claims on the pool can become more manageable.

#### Premiums are based on risk

Insurance premiums are generally set in line with the degree of risk that a policyholder faces. This involves calculating an ‘actuarially fair’ base premium — essentially, the expected size of a loss multiplied by the probability of it occurring over the length of the insurance contract. This gives the policyholder an incentive to reduce the risks that they face. (A margin is also added to the base premium to cover administrative, capital and tax-related costs.)

(Continued next page)

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## Box 12.1 (continued)

### **Only some risks are insurable**

Insurance is generally only offered if the insurer can reasonably estimate the probability of a loss, there is a degree of randomness or chance, the risk can be diversified by the insurer (by offsetting it against unrelated risks faced by other policyholders), and the policyholder is willing to pay the premium charged (Berliner 1982; Charpentier 2008; Faure 1995). As few risks meet these criteria perfectly, whether insurance is provided for a given risk will depend on the circumstances. For example, when there is a chance of widespread losses across many policyholders from a single event (such as a cyclone or flood), insurers may not be willing to offer insurance if they might suffer significant losses themselves. However, an insurer may be able to offer cover if they can set aside extra capital, pool the risks with enough other unrelated risks (say, risks in a different region or those unrelated to environmental hazards), or purchase their own insurance cover through 'reinsurance' arrangements.

### **Information is essential for properly pricing risks**

Setting premiums that accurately reflect the true risks requires reliable information (such as historical data, projections of future hazards or details of policyholders' property). In some cases, problems with information can lead to market failures and insurance not being provided. If an insurer cannot distinguish between high and low risk customers and charges both the same premium, low-risk customers may choose not to insure, leaving the insurer with high-risk customers and potentially large claims — a problem of 'adverse selection' (Faure 1995). 'Moral hazard' arises when policyholders are less inclined to reduce their risks because they have insurance, but the insurer cannot observe their actions and increase the premium to reflect the higher risk the insurer faces as a result.

### **Insurance markets can overcome information problems**

Insurance markets have developed ways to address problems that arise when policyholders have better information than the insurer. For example, insurers might distinguish between high and low risk policyholders by offering discounts to those that do not make claims ('no claim bonuses') or limiting the amount they will pay out following some types of event, such as flood ('sub-limits'). In addition, insurers can improve policyholders' incentives to reduce risks by setting an 'excess' or 'deductible' amount that the policyholder must bear themselves when making a claim.

*Sources:* Berliner (1982); Charpentier (2008); Faure (1995).

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## Climate change could affect how insurance is provided

Climate change could have a number of effects on insurance markets. For example:

- changes in the types of natural hazards or level of risk faced by the community could increase demand for insurance
- more frequent or severe extreme weather events could lead to larger, and more variable, insurance payouts
- losses might become more correlated across geographic areas, or affect a larger portion of policyholders, making it more difficult for insurers to diversify risks
- changes in climatic trends could mean that historical data become less useful for estimating the risks that policyholders face, and insurers may need to rely more on climate projections and models (Charpentier 2008; Hecht 2008; Mills 2005; Mills, Roth and Lecomte 2005).

These factors could affect the provision and cost of insurance. If losses become larger — or more volatile, frequent or uncertain — insurers may need to set aside more capital or purchase more reinsurance to ensure they can pay claims and remain solvent (Hecht 2008; Kunreuther and Michel-Kerjan 2009). Even for a given underlying level of risk, greater uncertainty or less reliable information can make it more difficult for insurers to estimate that level of risk (Agrawala and Fankhauser 2008; Tooth 2011). This could also raise the cost of insurance.

As these pressures build over time, insurers could respond in several ways. For example, they might charge higher premiums in particular areas that face increasing risks of bushfire or cyclone. Alternatively, they might set higher excess amounts in insurance contracts to limit their exposure to some hazards. It is also possible that some insurers could withdraw cover for particular hazards (or in some high-risk geographic areas) if capital and reinsurance costs become too high (Kunreuther and Michel-Kerjan 2009). Further, opportunities could arise for insurers to expand cover in some markets, provide different insurance products (box 12.2), or educate the community about preventing and preparing for extreme weather events.

Many of these changes may be extensions of how insurers deal with the current climate. Climate variability across geographic areas means that insurers already set different premiums depending on the level of risk and types of hazards a property is exposed to. After a large disaster, insurers sometimes re-assess their estimates of the underlying risks. When this happens, premiums charged to some policyholders can significantly increase. There is evidence that this has occurred following recent floods and cyclones, and that global reinsurers have increased their ‘risk ratings’ for Australia, leading to higher reinsurance costs (Institute of Actuaries of Australia 2011b; Insurance Council of Australia 2012b; SCSPLA 2012b).



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## **Box 12.2 Insurance products for climate-related risks**

### **Parametric and index-based insurance**

Under a parametric or index-based insurance contract, the policyholder pays a premium and the insurer agrees to make a pre-defined payout when a ‘trigger’ is reached (such as a set level of rainfall or the number of days exceeding a given temperature) (IMF 2008). The trigger is not based directly on actions or losses of the policyholder. This can reduce information problems and transaction costs by making it relatively easy to determine when a payout should be made and the size of the payout (Economics of Climate Adaptation Working Group 2009). However, the policyholder will not be covered if the trigger is not reached, and thus may have to bear more risk (or loss) themselves. Parametric insurance products such as ‘weather derivatives’ are being increasingly used in some parts of the world to insure agricultural activities where information problems have been significant (Agrawala and Fankhauser 2008).

### **Catastrophe bonds**

Catastrophe bonds are a financial product where a purchaser (such as a large investor) provides capital and an issuer (such as an insurer or reinsurer) pays interest. Should a pre-defined event occur — such as a large cyclone or earthquake — the purchaser forfeits some or all of the capital and/or interest to the issuer (Agrawala and Fankhauser 2008). Catastrophe bonds can draw on the resources of capital markets once a disaster occurs (Michel-Kerjan and Morlaye 2008), and can be provided in several forms, such as indemnity insurance (based on actual losses), parametric insurance (based on an independent trigger), or linked to total insurance industry losses (OECD 2011b). While catastrophe bonds have not yet been issued in Australia, their use has been increasing globally (IMF 2008; OECD 2011b). Well-known examples include the Caribbean Catastrophe Risk Insurance Facility run by several Caribbean governments, and US insurers’ use of catastrophe bonds to cover cyclones.

### **Multi-peril crop insurance**

Insurance products could be developed to insure against hazards that have historically been difficult to cover. For example, most Australian insurers have never offered ‘multi-peril’ crop insurance (insurance that covers all or most weather-related events that could damage crop yields, usually provided on an indemnity basis). This has been due to information problems, highly correlated risks and the way governments have provided drought support (Keogh, Granger and Middleton 2011; PC 2009). At present, a related product is being trialled in Western Australia (Western Australian Farmers Federation, sub. 26), through a mutual agreement that is exempt from some insurance regulations (Keogh, Granger and Middleton 2011). In other cases, multi-peril crop insurance may not be viable without government subsidies (National Farmers’ Federation, sub. 76).

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## The Australian insurance market

The insurance products most directly related to climate change adaptation are building and contents insurance (although other kinds of insurance might also facilitate adaptation, such as business interruption cover or liability insurance). Historically, the most expensive insurance claims in Australia have been weather-related — mainly from cyclones, hail, storms, floods and bushfires (Attorney-General's Department 2012). For example, insurance payouts (across all types of insurance product) were around \$1.1 billion for the Victorian bushfires in 2009 and amount to \$2.4 billion to date for the 2011 Queensland floods (Insurance Council of Australia 2012a). Further, it has been estimated that around half of all property insurance payouts are for weather-related events (Institute of Actuaries of Australia 2011b).

Most building and contents policies provide cover for several kinds of hazard, including theft and damage from fire, wind, hail and stormwater inundation. Only some policies provide cover for riverine flooding and most exclude landslide and 'actions of the sea' (usually meaning storm surge and gradual processes such as erosion and sea-level rise). Further, not all households have building or contents insurance, or may not have insurance that covers all the hazards that they potentially face or the full cost of replacing their assets (box 12.3).

Concerns about household and small business insurance in Australia and government assistance after disasters have been raised in recent inquiries (box 12.4), with similar concerns raised by some participants in this inquiry (Australian Sea Level Rise Partnership, sub. 44; Ecological Water Solutions, sub. 66; Insurance Australia Group, sub. 39; Insurance Council of Australia, sub. 42; Institute of Actuaries of Australia, sub. 43; Suncorp Group, sub. 28). (Insurance of government assets is examined separately in chapter 10.) These concerns have mainly centred on riverine flooding, including the availability, cost and take up of flood insurance and difficulties that consumers face in understanding insurance contracts. Flood is excluded from some household insurance policies (unlike bushfire and storm damage), even though flood cover has increased significantly in recent years — inclusion of flood cover has risen from around 3 per cent of policies taken out in 2006 to 54 per cent in 2010, and it is expected to rise to 84 per cent by 2013 (Insurance Council of Australia 2011). Further, premiums for flood cover can be very high — sometimes in excess of \$5000 annually — for the estimated 7 per cent of residential properties that are 'exposed to predictable and repetitive flooding' (Insurance Council of Australia 2011, p. 2).

In response to these concerns, the Australian Government has proposed several reforms and is consulting on ways to implement these (section 12.3).

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### Box 12.3 Non-insurance and under-insurance for natural hazards

There have been few Australian studies of non-insurance (where insurance is not taken out, or does not cover a relevant hazard such as flooding) and under-insurance (where an insurance policy provides cover for less than the cost of replacing property). There are no regularly reported data and most studies have drawn on surveys.

- In 2001, an estimated two per cent of owner-occupied households had neither building nor contents insurance, and around 39 per cent of households that rent lacked contents insurance (MJ Powling Research Consulting 2001).
- In 2005, it was reported that between 27 and 81 per cent of households were underinsured by 10 per cent or more (compared to rebuilding costs), and that structures destroyed in the 2003 Canberra bushfires were underinsured by an average of 40 per cent of the replacement cost (ASIC 2005).
- In 2007, it was reported that around four per cent of owner-occupied households lacked building insurance. Further, 12 per cent of owner-occupied and 67 per cent of rental households did not have contents insurance. Non-insurance was found to be greatest for households with lower incomes or few savings, and among people that were younger, born in non-Western countries, not in full-time employment, retired, or of lower levels of education (Tooth and Barker 2007).
- More recently, it has been estimated that 52 per cent of renters have not insured their contents against theft, fire, flood or other damage (GIO Insurance 2010), and that low-income groups (especially those living in rented or public housing) are less likely to have contents insurance (Collins 2011).

These studies have identified the cost of insurance relative to household income and other expenditure as the major reason for non-insurance and under-insurance. Other factors include:

- decisions to self-insure, or not considering insurance to be worthwhile (given the risks faced and potential impact of a loss)
- assumptions that government-provided infrastructure (such as flood barriers) will always prevent damage from natural disasters
- expectations that governments will provide compensation following a disaster
- a lack of trusted information or advice
- difficulty understanding or comparing insurance products
- difficulty estimating the cost of replacing assets
- negative past experiences with insurance claims.

*Sources:* ASIC (2005); Collins (2011); GIO Insurance (2010); Insurance Council of Australia (2011); MJ Powling Research Consulting (2001); NDIR (2011); Sheehan and Renouf (2006); Tooth and Barker (2007).

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#### Box 12.4 Recent inquiries covering insurance for natural hazards

The *Victorian Bushfires Royal Commission* (completed July 2010) investigated the cause of the Victorian bushfires of February 2009 and made recommendations on preventing, preparing for and responding to bushfires. In relation to insurance, it recommended that the Fire Services Levy charged on building insurance be removed because it is inequitable and reduces the take up of insurance.

The *Natural Disaster Insurance Review* (completed September 2011) investigated the extent of flood insurance in Australia and problems with claims processing and dispute handling following the Queensland floods of late 2010 and early 2011. It recommended that flood insurance be mandatory in all home building, contents and strata title policies, and that flood premiums for existing properties that exceed an 'affordability threshold' be discounted by a government-backed reinsurance scheme.

The *Queensland Floods Commission of Inquiry* (completed March 2012) also investigated the Queensland floods. Its recommendations covered flood-risk management, land-use planning, emergency response and the performance of insurers. In particular, it recommended that insurers communicate with policyholders more clearly after a disaster to explain why a claim was accepted or rejected.

The *House of Representatives Standing Committee on Social Policy and Legal Affairs* recently investigated claims processing, dispute resolution and strata-title insurance.

- Volume 1 (completed February 2012) recommended amendments to the General Insurance Code of Practice to change claims-handling and dispute-resolution processes, and recommended that insurers be required to offer 'standard cover' policies (that cover flood and 'actions of the sea', and base payouts on the replacement value of assets).
- Volume 2 (completed March 2012) recommended a 12-month moratorium on stamp duty charged by the Queensland Government on strata-title insurance north of the tropic of Capricorn, as well as a review of competition in the strata-title insurance market and a review of factors that have increased premiums recently.

*Sources:* NDIR (2011); Queensland Floods Commission of Inquiry (2012); SCSPLA (2012a, 2012b); Victorian Bushfires Royal Commission (2010).

## 12.2 Factors affecting insurance costs and provision

There are several factors that could affect how insurance markets set and adjust premiums in line with risks — including taxes, regulations and government-provided goods. These factors can also influence how households, businesses and governments respond to the incentives that insurance premiums and the availability of insurance give them. Where reforms in these areas are justified in the current climate, climate change strengthens the case for such reforms.

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## Insurance taxes

Taxes make up a significant portion of the cost of insurance to policyholders. Aside from the Goods and Services Tax, insurance is subject to specific state and territory taxes and levies. General insurance tax (stamp duty) ranges from 7.5 to 11 per cent across jurisdictions (NSW Treasury 2011). In addition, New South Wales, Victoria and Tasmania impose Fire Services Levies to partly fund fire-fighting services (levied only on commercial property insurance in Tasmania). In total, these taxes and levies amounted to \$5.0 billion in revenue for state and territory governments in 2010-11 (ABS 2012).

The cost to policyholders can be substantial. For example, Suncorp Group (sub. 28) estimated that insurance taxes and levies add around 44 per cent to base premiums paid by NSW households for building and contents insurance (including Goods and Services Tax). Taxes and levies on insurance for small businesses can be even higher.

State and territory insurance taxes and levies can distort the ways that households and businesses manage the risks that they face. Some inquiry participants argued that, by raising the cost of insurance, these taxes and levies can discourage people from taking out adequate insurance, or from insuring their assets at all (Insurance Australia Group, sub. 39; Insurance Council of Australia, sub. 42; Suncorp Group, sub. 28; Water Services Association of Australia, sub. 52). To the extent that taxes and levies raise the final cost to consumers, it could be reasonably expected that the take up of insurance would be reduced.

There is growing support for phasing out insurance taxes and levies. While there have been few empirical studies, one found that states with higher insurance taxes tend to have higher rates of non-insurance (for building and contents), and that the removal of the Fire Services Levy in Western Australia was associated with reduced levels of non-insurance (Tooth and Barker 2007). In addition, the *Australia's Future Tax System* review (the 'Henry Review') argued that specific taxes and levies on insurance can raise levels of non-insurance and under-insurance. It recommended removing these taxes and levies and subjecting insurance only to a broad-based consumption tax, such as the Goods and Services Tax (Treasury 2010a). A House of Representatives inquiry found that state insurance taxes have exacerbated premium rises for strata-title insurance in some parts of Queensland (SCSPLA 2012b). Further, the Victorian Bushfires Royal Commission (2010) criticised insurance levies on equity grounds, arguing that the Victorian Fire Services Levy meant that households that chose not to insure (or that under-insured) did not make a fair contribution to the cost of fire services.

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Removing state and territory taxes and levies on general insurance would facilitate effective adaptation to climate change. This reform would improve the affordability of insurance for some households and ensure that insurance premiums more closely reflect the level of risk that households and businesses face. This may also reduce levels of non-insurance and under-insurance.

Some states and territories have already begun to phase out particular insurance taxes or levies. For example, Queensland, Western Australia, South Australia and the ACT have already phased out fire services levies and replaced them with charges added to rates notices. Victoria has committed to do likewise by July 2013 (Victorian Department of Treasury and Finance 2011). Other state-level taxes, such as property-based charges or land taxes, can be a more efficient revenue base for state governments (chapter 5), and would not discourage the take up of insurance.

#### DRAFT RECOMMENDATION 12.1

***State and territory taxes and levies on general insurance constitute a barrier to effective adaptation to climate change. State and territory governments should phase out these taxes and replace them with less distortionary taxes.***

## Information

Information plays a key role in insurance provision. Reliable estimates of the frequency of natural hazards and the damage caused are essential for accurately assessing and pricing risks. For example, flood insurance has not been widely available in Australia until recently in part because flood maps and elevation modelling were not available to a sufficient degree of accuracy (Handmer 2002; Mason 2011). In addition, storm surge and coastal erosion are excluded from most insurance policies because the localised impacts are not understood well enough (Mortimer, Bergin and Carter 2011).

Improvements in the quality, extent or availability of information can make insurers more willing to provide cover. By reducing uncertainty, this can lower the cost of doing so. Reliable information — provided in a suitable form — can also facilitate good risk management and adaptation decisions by households and businesses. For example, households that are aware of their exposure to particular risks can make decisions about where they live, how they prepare for (or adapt to) hazards, and which insurance products they purchase.

Many insurers collect (or purchase) information that they need to set premiums and provide cover. For example, the insurance industry has developed a National Flood Information Database that overlays property addresses with known flood risks

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according to government flood maps (Insurance Council of Australia 2011). Further, the Insurance Council of Australia is developing a ‘resilience rating system’ that insurers can use to assess the durability of buildings to natural hazards, which may allow insurers to match premiums more closely to the risks faced by individual properties (Climate Risk, sub. 38; Insurance Council of Australia, sub. 42). Some insurers also undertake their own detailed modelling of natural hazards and the potential impacts on properties.

In some cases, information can have additional ‘public good’ benefits. For example, data on natural hazards such as floods, bushfires, cyclones and storm surges can benefit households, businesses and local governments, as well as insurers. There can be a role for governments to provide information in these cases (chapter 6).

Several participants in the inquiry submitted that governments should provide more information and natural hazard mapping (for example, Insurance Australia Group, sub. 39; Municipal Association of Victoria, sub. 79; Suncorp Group, sub. 28). Some participants also favoured greater consistency in the way that risk information is provided to households, along with mandatory disclosure by local governments (Insurance Council of Australia, sub. 42). Recently, the Australian Government has proposed to collate flood maps from all levels of government and make these available to consumers, insurers, local governments and others through a single portal, managed by Geoscience Australia (Treasury 2011c). Chapter 6 examines the scope for further information provision by governments.

## **Planning and building regulation**

Planning and building regulation can reduce losses that occur from weather-related events and help insurers to quantify risks more accurately (for example, by locating settlements away from flood or bushfire-prone areas). This may then be reflected in lower insurance premiums.

Some submissions from the insurance sector put forward a case for stronger land-use planning and building regulation. For example, there were concerns that insurance can be expensive for properties that were built when some natural hazards may not have been well understood, either by governments or households (Insurance Council of Australia, sub. 42). There was also support for stronger building codes to improve the ‘durability’ of buildings and prevent or reduce damage during cyclones, bushfires, floods and other events (Insurance Australia Group, sub. 39; Insurance Council of Australia, sub. 42).

Building owners already have an incentive to ensure that their properties are appropriately constructed and can withstand extreme weather events. To the extent

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that stronger planning and building regulations further reduce insurance claims (or reduce uncertainty faced by insurers), they could lead to lower premiums. On the other hand, any benefits must be weighed against the costs that regulations can impose on the community — such as increased construction costs or the costs of potentially limiting other ways of adapting to natural hazards. Chapter 8 examines the case for reforming planning and building regulations to address barriers to adaptation.

## **Disaster-mitigation infrastructure**

Governments construct and maintain a range of infrastructure that can prevent or mitigate the impact of extreme weather events — for example, flood barriers, dikes, dams, firebreaks and seawalls. This is mostly done by state, territory and local governments, with some funding contributed by the Australian Government. In many cases, this infrastructure has widespread benefits for the community and public good characteristics. Its presence or absence can also be used by insurers to assess risks to properties and set premiums accordingly (Insurance Council of Australia, sub. 42).

Some inquiry participants argued that increased government spending on disaster-mitigation infrastructure could reduce insurance premiums as well as the total economic impact of disasters. In general, the appropriateness of this infrastructure will depend on local circumstances and other options available to manage risks or meet policy objectives (such as land-use planning). Governments' investment decisions are best made through a cost-benefit approach, taking into account all monetary and non-monetary costs and benefits to the community, as well as a thorough assessment of risks. However, the Commission is not in a position to assess the merits of individual investments in disaster mitigation. Chapters 9 and 10 further examine the role of government-provided infrastructure in facilitating adaptation to climate change.

## **Consumer understanding of insurance contracts**

The role of insurance in facilitating adaptation to climate change will depend on the ability of consumers to use insurance to manage their risks. In turn, this will be influenced by how well they understand insurance products and the risks they face. Cognitive constraints on decision making or other behavioural barriers (chapter 3), for example, could affect how consumers make decisions about insurance.

Issues relating to insurance contracts, consumer understanding and insurers' assessments of claims have been a focus of recent inquiries (box 12.4). In particular,



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riverine flooding is not covered in all insurance contracts. Consumers are not always aware when it is excluded — in part because contracts are lengthy or confusing, or simply not read (Connolly 2011; NDIR 2011). As a result, some consumers who believed their insurance policy would cover flooding have discovered, after a flood, that it did not. There have also been lengthy disputes with insurers about whether water damage was caused by flood (which may not be covered) or stormwater (which is usually covered) (NDIR 2011; Queensland Floods Commission of Inquiry 2012).

Another issue is the ability of insurers to provide personal advice to policyholders about which insurance products are best suited to their needs (that is, in addition to information about specific products). For example, Suncorp Group (sub. 28) submitted that current financial advice regulations are difficult and costly for insurers to comply with, and generally discourage insurers from offering personalised advice to households that could help them adapt to climate-related risks.

Reforms are already underway in these areas, including a standard definition of ‘flood’ and requirements for a ‘key fact sheet’ that sets out which hazards are covered in a household insurance policy and which are not (Treasury 2011d, 2012). Reforms are also underway to reduce regulatory requirements for providing ‘scaled’ advice (Australian Government 2011a) and to extend legislation covering ‘unfair’ contract terms to insurance (which is currently exempt) (Treasury 2011f). Section 12.3 further discusses these proposed reforms.

## **Government as ‘insurer of last resort’**

Governments at all levels provide financial and other assistance to households and small businesses following large disasters, with charities providing further assistance to households in some cases. This is an important component of emergency management (chapter 10). (The Australian Government also provides assistance to the states and territories through the Natural Disaster Relief and Recovery Arrangements, discussed in chapter 10.) In addition, governments have sometimes encouraged insurance companies to process claims faster or interpret insurance policies more leniently after a disaster.

In most cases, assistance payments are modest compared to the size of insurance payouts — for example, a Disaster Recovery Payment of \$1000 per adult and \$400 per child is paid to welfare recipients affected by a declared natural disaster (Centrelink 2009). However, significantly higher payments (over \$100 000 in some cases) have been made to some households following large disasters — such as the

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Victorian bushfires in 2009 and Queensland floods in 2011 — drawing on state government funds and private donations (NDIR 2011).

While this assistance can meet important equity objectives and generally has broad support within the community, some concerns have been raised that recovery assistance can reduce incentives to privately manage risks (a form of ‘moral hazard’). For example:

... individuals electing not to insure their assets place a burden on the community when governments, in the absence of private insurance, are faced with the position of taking on the responsibility of insurer of ‘last resort’. While there may be an equity argument for individuals who are financially disadvantaged to access government assistance, open-ended assistance is inequitable when it is provided to individuals who are able to responsibly insure, but choose not to do so. (Insurance Australia Group, sub. 39, p. 22)

Similar concerns have also been expressed more widely (for example, Mortimer, Bergin and Carter 2011; NDIR 2011).

In contrast, some participants suggested that government assistance is unlikely to have a material impact on insurance. For example:

The Tasmanian Government considers that existing disaster recovery policies ... do not impede the efficient operation of the Australian insurance market, or reduce incentives to take up insurance. (Tasmanian Government, sub. 51, p. 8)

Conceivably, the expectation of a payment from governments (or charities) after a natural disaster could lead to some households reducing the amount of insurance cover they take out, or taking fewer measures to reduce their exposure to hazards. Government support could also ‘crowd out’ the development or provision of some insurance products. This could give rise to barriers to effective adaptation.

While there appears to be a *prima facie* case for claims that assistance payments can affect the take up of private insurance, the Commission is not aware of detailed evidence either in support of, or counter to, such claims. Some amount of assistance can help communities recover quickly after a disaster and support vulnerable people. In cases where large payments have been made, these have been mostly funded by voluntary donations. Nevertheless, concerns about governments acting as ‘insurers of last resort’ and reducing incentives for private risk management are likely to remain.

## Reform priorities

Phasing out state and territory taxes and levies on general insurance would have net benefits for the wider community even in the current climate, and should be

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prioritised. Reforms to address barriers to adaptation in other areas — including information provision, land-use planning, building regulation, infrastructure and emergency management (chapters 6–10) — could further improve how insurance markets price risks and how the community manages the risks that it faces. This could address concerns about the cost and provision of insurance (for example, by making insurance premiums more affordable for some households) and strengthen the role of insurance in facilitating effective adaptation to climate change.

More generally, clarification of the roles and responsibilities of households, businesses, other organisations and each level of government for managing risks can improve how effectively these risks are managed. This may also go some way towards addressing concerns about governments acting as insurers of last resort following disasters.

## **12.3 Reforms to insurance regulations**

There could be scope for changes to insurance market regulations to address market failures that affect the cost, availability or take up of insurance, or to meet specific equity objectives. It is important that any reform is based on clear evidence of a policy-relevant problem (box 12.5), rigorous assessment of the likely costs and benefits for the community, and consideration of alternative options — including making no changes to current arrangements. A reform would only be justified when there are clear benefits to the community that outweigh the costs.

Poorly designed regulatory intervention in insurance markets can create barriers to effective adaptation to climate change. For example, if insurers are prevented from setting premiums in line with underlying risks, this could distort the incentives that premiums give households and businesses to manage their risks efficiently. Alternatively, costs can arise by restricting the options available to households and businesses to manage their own risks and allocate resources in ways best suited to their individual circumstances. In these cases, regulatory intervention may have costs to the wider community that exceed any benefits (such as broader insurance policy coverage or lower premiums).

### **The Government's proposals**

The Australian Government is consulting on several reforms to insurance regulations. These reforms will require insurers to:

- provide cover for riverine flooding in all household building and contents policies, while allowing consumers to ‘opt out’ of flood cover when taking out

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or renewing a policy (Treasury 2011c) (this would be in addition to other hazards, such as bushfire and storm, that are already included in most policies)

- adopt the following standard definition of ‘flood’ in household, small business and strata-title insurance contracts: ‘the covering of normally dry land by water that has escaped or been released from the normal confines of: A. any lake, or any river, creek or other natural watercourse, whether or not altered or modified; or B. any reservoir, canal, or dam’ (Treasury 2011d, p. 5)
- provide a one-page ‘key fact sheet’ that clearly lists which hazards are covered in a household building or contents policy, and which are not (Treasury 2012).

### **Box 12.5 Identifying the objectives for reform**

It is important to clearly identify the objective targeted by any policy reform.

#### **Market failures**

One objective could be to address a market failure. However, in the case of insurance, not all observed levels of insurance premiums and the take up of insurance necessarily reflect market failures. For example:

- the presence of non-insurance and under-insurance (box 12.3) does not, in and of itself, indicate a market failure. This may largely reflect decisions that households have made about the value of insurance and which economic risks they prefer to bear themselves
- insurance may be unavailable in some cases because the underlying risks are difficult to insure. If no insurer is willing to provide cover for commercial reasons, this does not necessarily indicate a market failure.

#### **Equity objectives**

Another objective could be to meet a well-defined equity outcome. For example:

- some low-income households may struggle to pay insurance premiums, along with other household expenditures
- some disadvantaged households may need assistance to adequately protect themselves from extreme weather events.

There are various options available to governments to meet equity objectives without creating costly distortions to insurance markets. These options include direct payments, made through the existing social safety net, to the most vulnerable households. Alternatively, governments could invest in disaster-mitigation infrastructure (such as dikes or firebreaks) in areas where this has net benefits for the community, or improve the information they provide to households on natural disasters. Implemented appropriately, such options can also improve the adaptive capacity of disadvantaged members of the community.

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As noted in section 12.2, the Australian Government has also committed to collate flood maps in a publicly accessible portal (Treasury 2011c), extend legislation covering unfair contract terms to general insurance (Treasury 2011f), and reform regulations for providing ‘scaled’ advice (Australian Government 2011a).

In addition, the Government has stated that it will consider introducing flood insurance premium discounts and establishing a flood reinsurance pool, following a consultation process in 2012 (Australian Government 2011b).

### **Mandating flood cover**

The proposed regulations to require insurers to cover riverine flooding, while allowing consumers to opt out of flood cover in their insurance policies, have several potential benefits and costs.

This reform could benefit some consumers. For example, it would allow consumers to more easily compare insurance quotes with and without flood cover. This would allow them to assess the extent of their flood risk (as estimated by the insurer and reflected in the premium). In some cases, the reform could also reduce scope for confusion or disputes with insurers after water damage occurs — for example, whether damage is due to stormwater or riverine flooding (Treasury 2011c).

However, the reform would also impose costs on the community. While many insurers already offer flood cover in most areas (and some have made it a standard inclusion in their policies), some do not. In many cases, this is because they lack suitable data with which they can price flood risks (Insurance Council of Australia, sub. 39; Tooth 2011). Requiring all insurers to offer flood cover could increase some insurers’ capital and operating costs — for example, the costs of obtaining reinsurance or more accurate flood data. These higher costs may be passed through to the premiums charged to policyholders.

Alternatively, some insurers may choose to withdraw all household cover in areas where they are not willing to cover flood. To the extent that this reduces competition in the insurance market, it would also reduce consumer choice and could lead to higher premiums — thereby impeding effective adaptation to climate change. Such outcomes could be exacerbated if the proposed regulations place restrictions on how insurers apply sub-limits to flood payouts or set flood-specific excess amounts for policyholders.

More generally, the benefits of the reform are likely to be small for households that already take out flood cover. Many households face very low flood risks and a growing proportion have flood cover in their insurance policies (for example, the

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Insurance Council of Australia (2011) has estimated that 84 per cent of household policies will cover flood by 2013, even in the absence of new regulations). Of the relatively small number of households in the highest-risk areas for flooding, some may choose to ‘opt out’ of flood cover when faced with potentially very high premiums (in line with the risks they face). Thus, take up of flood cover among this group as a result of the reform may be limited. More broadly, provided that they are well informed of the level of risk they face, decisions by these households not to purchase flood cover or otherwise reduce their exposure to flood risks would generally not warrant government intervention.

In the Commission’s view, a more appropriate initial policy response to concerns about the extent of flood cover would be to address barriers to effective adaptation in other policy areas (section 12.2). This could include improved disclosure of risk information to households so that they are more aware of their exposure to natural hazards (chapter 6), or increased investment in flood-mitigation infrastructure where this has net benefits for the wider community (chapter 10).

After that, there may be scope to examine changes to insurance regulations to target a clearly-defined market failure or equity problem for which there is sufficient evidence. A reform should proceed only if there are clear benefits for the wider community that exceed the costs. These should be assessed prior to implementation using the Regulation Impact Statement process, in accordance with the Best Practice Regulation Handbook (Australian Government 2010a). Further, a review should be scheduled to occur after any reform is implemented to assess whether policy objectives are being met effectively.

#### DRAFT RECOMMENDATION 12.2

***The Australian Government should only proceed with reforms that require all household insurers to offer flood cover if it can be demonstrated that the benefits to the wider community would exceed the costs. These benefits and costs should be assessed, and any reforms implemented, after barriers to effective climate change adaptation in other policy areas are addressed.***

### Other changes to insurance regulations

As noted above, the Australian Government has proposed other changes to insurance regulations. These consist of the ‘key fact sheet’, standard definition of ‘flood’, application of unfair contract terms legislation to general insurance, and reforms to financial advice regulations.

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These reforms could improve outcomes for consumers with generally modest costs for insurers. The Australian Government has already prepared Regulation Impact Statements for the key fact sheet and standard definition of flood, and enabling legislation has passed each house of parliament, although in both cases the Government noted that sufficient data were not available to empirically assess the costs and benefits (Treasury 2011b, 2011e).

It will be important to schedule reviews to occur after each of these reforms is implemented, to evaluate the impacts on the wider community. These reviews should be supported by empirical evidence where feasible, and be completed before further reforms to insurance regulations are considered.

### **Subsidising insurance premiums**

Subsidising insurance premiums means that the premiums paid by policyholders do not fully reflect the level of risk that they face. This would reduce their incentives to mitigate their risks and thereby impede effective adaptation to climate change.

Such subsidies have been put forward as a policy option to assist the relatively small number of households that live in very high flood-risk areas. In response to concerns about the affordability of insurance and levels of non-insurance in the community, the Natural Disaster Insurance Review recommended that flood insurance premium discounts be provided for some existing flood-exposed properties (that meet an ‘affordability threshold’), and that these discounts be funded by a reinsurance facility backed by the Australian Government — which would essentially involve the Government underwriting and taking on private risks (NDIR 2011). In response, the Government stated that it will consider these options in 2012, following a consultation process (Australian Government 2011b; Treasury 2011c).

This echoes proposals put forward by others, where governments would fund subsidies for insurance premiums — either directly or by backing a reinsurance pool — to reduce the cost of insurance for the small number of properties facing very high flood risks (Institute of Actuaries of Australia 2011a; Insurance Council of Australia 2011). This could give governments greater incentives to reduce those risks through land-use planning decisions and disaster-mitigation infrastructure.

While such subsidies may reduce the cost of taking out insurance for those households that receive them, the underlying policy objectives to be met are not clear. As noted in box 12.5, high insurance premiums and observed levels of non-insurance do not in themselves clearly indicate a market failure. Moreover, the impacts of the availability and cost of insurance vary across households and it is not

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clear that premium subsidies would direct assistance to those households that are most in need (in an overall sense). For example, if subsidies were based on the size of insurance premiums — which generally reflect the level of risk faced — the benefits could flow to households that would have purchased insurance anyway, rather than to low-income households that struggle to pay their insurance premiums.

Without clear evidence of market failures or the distribution of outcomes across households, it would be difficult to design or justify intervention in insurance markets that would improve the overall wellbeing of the community. In particular, subsidies for insurance premiums can be costly.

- Subsidies reduce the incentives that insurance premiums give households to reduce their exposure to risks. This would likely impede any structural adjustment required to adapt to climate change.
  - Subsidies could also encourage excessive development in hazard-prone areas if not restricted to existing properties. This could further impede adaptation.
- Risk management decisions by households more broadly — including those that do not directly benefit from subsidies — could be distorted if subsidies are funded through cross-subsidisation by lower-risk policyholders.
- There could be potentially large budgetary costs if governments fund subsidies or underwrite risks, such as by insuring households directly or by backing a reinsurance pool (for example, the government-backed National Flood Insurance Program in the United States has required large funding injections from the US Government in recent years (Michel-Kerjan 2010)).
- Government expenditure on insurance subsidies could be used for other purposes that have greater net benefits for the community. This could include spending that targets equity objectives more directly (chapter 2).

In effect, the result would be that governments take on private risks and become an ‘insurer of last resort’.

In the Commission’s view, the costs to the community as a whole of subsidising insurance premiums are likely to exceed any benefits. Any government intervention would be more effective when clearly targeted at a well-defined market failure or equity objective, supported by clear evidence of a policy-relevant problem. As such, alternative options may be more appropriate for meeting policy objectives.

#### DRAFT RECOMMENDATION 12.3

***Governments should not subsidise premiums for household or business property insurance, whether directly or by underwriting risks. This would impose a barrier to effective adaptation to climate change.***



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## 13 Reform priorities

### Key points

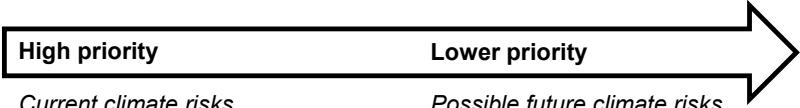
- Reforms to help the community to manage the risks of current climate variability and extreme weather events should be prioritised.
- For reforms to address barriers to adaptation to uncertain future climate trends the case is less clear.
- Australian Government agencies will have a role to play in climate change adaptation policy.
  - Climate change adaptation should be part of agencies' normal risk management processes.
  - Some Australian Government agencies will have specific responsibilities, such as research, information provision and emergency management.
  - There is a limited role for the Australian Government in policy coordination and oversight.
- The Council of Australian Governments' Select Council on Climate Change (and any successor beyond March 2013) is the appropriate body for coordinating adaptation policies that require a national response.
- At this time, a systematic review of legislation and regulation to identify impediments to adaptation would not be justified.
- The proposal of requiring insurers to offer flood cover in all household policies should not proceed unless it can be demonstrated that the benefits to the wider community would exceed the costs.

This chapter sets out high-priority reforms to address barriers to effective adaptation, some lower-priority reforms and some policy options that should not be pursued.

### 13.1 High- and lower-priority reforms

Reforms to help people and governments deal with *current* climate variability and extreme weather events should be prioritised. The case for implementing reforms to address barriers to adaptation to future climate trends is less clear (figure 13.1).

Figure 13.1 Reform priorities by level of government

		
<b>Risks</b>	<i>Current climate risks</i>	<i>Possible future climate risks</i>
<b>Characteristics</b>	High degree of certainty	Significant uncertainty
<b>Effective adaptation</b>	Take action today to improve risk management and build adaptive capacity	Take preparatory actions that are low cost and reversible
<b>Australian Government</b>	<ul style="list-style-type: none"> <li>Review natural disaster recovery arrangements</li> <li>Improve hazard mapping</li> <li>Ensure the National Construction Code takes climate change into account</li> <li>Reform transfers that impede adaptation (such as drought support)</li> </ul>	<ul style="list-style-type: none"> <li>Provide downscaled climate projections</li> </ul>
<b>State and territory governments</b>	<ul style="list-style-type: none"> <li>Clarify the roles, responsibilities and legal liability of local governments</li> <li>Better align building and planning regulation</li> <li>Phase out inefficient taxes (such as taxes on insurance and property transfers)</li> </ul>	<ul style="list-style-type: none"> <li>Make changes to land-use planning regulations to respond to uncertain future climate change impacts</li> </ul>
<b>Local governments</b>	<ul style="list-style-type: none"> <li>Improve communication of hazard information to residents</li> </ul>	<ul style="list-style-type: none"> <li>Consider new planning instruments</li> </ul>
<b>National coordination (possibly through COAG)</b>	<ul style="list-style-type: none"> <li>Clarify roles and responsibilities in emergency management</li> <li>Pursue ongoing economic reforms to enhance flexibility and adaptive capacity</li> </ul>	<ul style="list-style-type: none"> <li>Establish guidelines for managing climate change risks to existing settlements</li> </ul>

## High priority: improve risk management in the current climate

The current climate poses numerous risks that are known and are causing damage. There are barriers that reduce the community's ability to manage those risks, and reform options exist that could address those barriers. These reforms would most likely involve incremental changes to existing institutions, regulations and practices. The reforms identified below (and discussed in detail in chapters 5–12) would be likely to have relatively low costs, and benefits that exceed their costs, and should be given high priority.

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Some reforms would help households, businesses, governments and community groups to identify the risks they face. Examples include:

- ensuring that hazard maps are consistent, comprehensive, publicly available, updated regularly and provided in a way that delivers clear messages to people who face risks
- encouraging research into the impacts of climate change that is responsive to the needs of the community.

Some reforms would strengthen people's incentives to manage risks and adapt to climate change (or address regulatory barriers that create disincentives), including:

- clarifying the roles and responsibilities of local governments in climate change adaptation
- reforms to the Natural Disaster Relief and Recovery Arrangements to reduce moral hazard and promote disaster preparedness
- improving flexibility in land-use planning
- ensuring that building codes take climate change into account
- ongoing reforms to tax and transfer systems to phase out measures that weaken incentives to adapt.

A third set of reforms would address barriers that are related to the capacity of governments, households, businesses and the community to adapt. They include:

- ensuring that local governments have resources that are commensurate with the responsibilities they are tasked with by state and territory governments
- clarifying the legal liability of local governments in relation to land-use planning decisions that are related to climate change adaptation
- phasing out taxes specifically levied on insurance that raise the cost to consumers.

### **Lower priority: address barriers to adaptation to uncertain future climate trends**

Some barriers to adaptation are not having material effects today, but could prevent effective adaptation to the long-term effects of climate change (such as sea-level rise). Because the impacts of climate change would arise over a long period, such reforms might only deliver material benefits many years into the future and could have material costs now. In these cases, the rationale for an immediate government response is weaker, although there could be a case for taking some low-cost

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preparatory actions. The case is stronger if the benefits of reforms are likely to be realised under a range of climate scenarios. Examples of lower-priority reforms include:

- ‘down-scaled’ projections of climate change impacts at a local level
- changes to land-use planning regulations to respond to uncertain future climate change impacts
- developing approaches to managing climate change risks in existing settlements.

## 13.2 National policy coordination

Effective climate change adaptation will involve policy responses from all levels of government, and will need to be incorporated into risk management across a range of portfolios. Most policies related to climate change adaptation will be the responsibility of local, state and territory governments. However, Australian Government agencies will have to deal with climate change adaptation as part of their normal risk management processes. For example:

- Emergency management — The Attorney-General’s Department is responsible for maintaining and improving the national emergency management system.
- Research and information provision — Geoscience Australia, the CSIRO, the Bureau of Meteorology and the Climate Commission have roles in conducting research and providing information on climate, weather and risks. Other agencies with specialised responsibilities (such as the Australian Institute of Marine Science and the Great Barrier Reef Marine Park Authority) will need to conduct and implement research into climate change adaptation in their areas of responsibility.
- Synthesising research — The National Climate Change Adaptation Research Facility is responsible for synthesising existing research on the impacts of climate change and identifying critical gaps in the information that is available to decision makers.

Some climate change adaptation policy issues will require cooperation between several levels of government. In these cases, the Council of Australian Governments’ (COAG) Select Council on Climate Change (box 13.1) and any successor is the appropriate forum for coordinating national responses. One possible role for the Select Council on Climate Change could be consideration of appropriate responses to managing the risks of climate change for existing settlements in high hazard risk areas (chapter 8).

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The Commission does not see any specific role for the Department of Climate Change and Energy Efficiency in climate change adaptation.

#### **Box 13.1 The COAG Select Council on Climate Change**

In 2007, COAG agreed to a National Climate Change Adaptation Framework. Under this framework, an implementation plan was to be developed in 2007, with biennial reports on implementation and a full review in the fourth year. Neither the biennial reports nor the fourth-year review were undertaken.

As part of the new system of ministerial councils established by COAG, a new Select Council on Climate Change was announced on 13 February 2011. The terms of reference for the Select Council were published in March 2012, and the Select Committee is due to provide a final report to COAG on 31 March 2013 that details the Committee's achievement against its objectives. The Select Council has a number of responsibilities, most of them related to greenhouse gas emissions reduction policies. However, it also has a role in adaptation:

Developing national adaptation priorities for agreement by COAG and work plans for these priorities, by building on intergovernmental work already undertaken, in liaison with other ministerial bodies as required, and including, where necessary, recommendations to COAG on matters requiring broader cross-portfolio reform. (Australian Government 2012, p. 2)

DRAFT RECOMMENDATION 13.1

*The Australian Government should focus on national policy responses in areas such as emergency management, research and information provision. Existing agencies will have a role in managing policy responses in these areas.*

*The Council of Australian Governments' Select Council on Climate Change, and any successor, should coordinate policy responses in areas where cooperation between levels of government is required.*

### **13.3 Reform options that should not be pursued**

There are several reform proposals where there is insufficient evidence that the benefits would exceed the costs. The proposal that would require insurers to provide flood cover in household policies (with an 'opt out' provision) should not proceed unless it can be demonstrated through a Regulation Impact Statement that the benefits would exceed the costs. Proposals for government subsidies for household insurance would be costly, reduce incentives for adaptation and risk management and should also not be pursued (chapter 12).

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## A systematic review of legislation

The Department of Climate Change and Energy Efficiency suggested that one way to identify barriers to adaptation could be to undertake a systematic review of regulation ‘to assess whether and to what extent adaptation is supported or constrained’ (sub. 57, p. 13). It then referred to the example of the Legislative Review Program (LRP) conducted as part of the National Competition Policy reforms. Under the LRP, legislation and regulation were systematically reviewed to determine the effects they had on competition. If the regulation had an adverse effect on competition, the onus of proof was on those who wanted to retain the regulation to demonstrate that it delivered a net benefit.

The Commission’s recent report on *Identifying and Evaluating Regulation Reforms* found that ‘principles-based’ reviews (such as the LRP) ‘have considerable potential to identify and achieve significant reforms’ (PC 2011c, p. 84). However, this type of review tends to have high costs:

The LRP demonstrated the enormity of the effort required to undertake such a comprehensive review of regulation across the economy ... The program ran five years longer than initially envisaged. Resources were often stretched thin and the quality of some of the reviews was inevitably poor. For smaller jurisdictions the gains from some of their review effort may not have justified the costs involved. A few high profile regulations managed to avoid review and/or reform. (PC 2011c, p. 81)

A systematic review to identify legislation and regulation that constrains adaptation would be likely to have high costs. Through this inquiry process the Commission has identified a number of regulatory barriers to effective adaptation, and has proposed reforms to address them. Stakeholders have an opportunity to identify further barriers in response to this draft report. Beyond that, it is not clear that a full review of legislation would identify many more significant barriers to adaptation. As such, the case for such a review process is weak.

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## A Public consultation

In keeping with its standard practice, the Commission has actively encouraged public participation in this inquiry.

- Following receipt of the terms of reference on 20 September 2011, it advertised the inquiry in major metropolitan newspapers and sent a circular to likely interested parties.
- In late October 2011, it released an issues paper to assist those wishing to make written submissions. Some 79 written submissions were subsequently received (table A.1). These submissions are available online at [www.pc.gov.au/projects/inquiry/climate-change-adaptation](http://www.pc.gov.au/projects/inquiry/climate-change-adaptation)
- It met informally with a wide range of stakeholders across Australia and New Zealand (table A.2) and held several roundtables (table A.3).

The Commission thanks all those who have contributed to this inquiry and now seeks additional input. It welcomes further submissions to discuss the substance of the draft report. The Commission also invites participation in public hearings to be held in early July 2012.

**Table A.1 Submissions received<sup>a</sup>**

<i>Participant</i>	<i>Submission number</i>
Adaptive Futures	31*
Attorney-General's Department	64
Australian Academy of Technological Sciences and Engineering	18
Australian Climate Change Adaptation Research Network for Settlements and Infrastructure	19
Australian Coastal Society	15#
Australian Conservation Foundation	47
Australian Green Infrastructure Council	13
Australian Industry Greenhouse Network	29
Australian Institute of Aboriginal and Torres Strait Islander Studies	62
Australian Local Government Association	25#
Australian Petroleum Production and Exploration Association Limited	59#
Australian Psychological Society	35
Australian Sea Level Rise Partnership	44

(Continued next page)

**Table A.1** (continued)

<i>Participant</i>	<i>Submission number</i>
Australian Sustainable Built Environment Council Climate Change Task Group	5
Bluescope Steel	8
Brotherhood of St Laurence	74
buildingSMART Australasia	78#
Carruthers, Ian	33
Cement Concrete and Aggregates Australia	7
Clarence City Council	10#
Climate Risk	38#*
Coasts and Climate Change Council	30*
Consult Australia	71
Council of Australian Biological Collections	23
Council of Capital City Lord Mayors	67
CSIRO Adaptation Flagship	40
Department of Agriculture, Fisheries and Forestry	68
Department of Climate Change and Energy Efficiency	57
Department of Sustainability, Environment, Water, Population and Communities	77
Director of National Parks	60
Dobes, Dr Leo	63
Ecological Water Solutions	66
Edge Environment	54
Gippsland Coastal Board	65
Gold Coast City Council	17
Good Shepherd Australia New Zealand	20
Green Building Council Australia	61#
Housing Industry Association	69
Institute of Actuaries of Australia	43
Insurance Australia Group	39
Insurance Council of Australia	42
Invasive Species Council	37#*
Investor Group of Climate Change	73
Jones, Kylie	11
Ku-ring-gai Council	1
Leith, Dr Peat and Jennings, Dr Sarah	22
Local Government Association of Queensland	41#
Mornington Peninsula Ratepayers' and Residents' Association	34
Mornington Peninsula Shire	16
Municipal Association of Victoria	79
National Climate Change Adaptation Research Facility	49
National Farmers' Federation	76
National Sea Change Taskforce	75#*
NCCARF Adaptation College	21
NCCARF Water Governance Research Initiative	32#
Nicholls, Prof Neville	9

(Continued next page)



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**Table A.1** (continued)

<i>Participant</i>	<i>Submission number</i>
Northern Alliance for Greenhouse Action	6
NSW Young Lawyers	72
Pittock, Dr Barrie	46#
Property Council of Australia	48
Pullen, Barry	27
Queensland Farmers Federation	55
Queensland Seafood Industry Association, Australian Prawn Farmers Association, Oceanwatch Australia and Pro-vision Reef	24
Rae, Ian	2
Redland City Council	36
Shire of Busselton	50
South East Councils Climate Change Alliance	12
South East Forest Rescue	45
Spatial Industries Business Association	58
Suncorp Group	28
Sunshine Coast Council	53
Surf Life Saving Australia	14#
Tasmanian Government	51
Victorian Centre for Climate Change Adaptation Research	56
Victorian Coastal Council	70
Victorian Local Governance Association	3
Water Services Association of Australia	52
Wentworth Group of Concerned Scientists	4#
Western Australian Farmers Federation	26

<sup>a</sup> A hash (#) indicates that the submission includes attachments. An asterisk (\*) indicates that the submission contains confidential material NOT available to the public.

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**Table A.2 Meetings**

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***Participant***

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**Australian Capital Territory**

Attorney-General's Department

AusAID

Australian Building Codes Board

Australian Industry Greenhouse Network

Australian Local Government Association

Australian Property Institute

Bureau of Meteorology

CSIRO Climate Adaptation Flagship

Department of Agriculture, Forestry and Fisheries

Department of Climate Change and Energy Efficiency

Department of Defence

Department of Immigration and Citizenship

Department of Infrastructure and Transport (via phone)

Department of Resources, Energy and Tourism

Department of Sustainability, Environment, Water, Population and Communities

Department of the Prime Minister and Cabinet

Geosciences Australia

The Treasury

**Tasmania**

Antarctic Climate and Ecosystems Cooperative Research Centre

Clarence City Council

Forestry Tasmania

Tasmanian Government (inter-departmental meeting)

**New South Wales**

Infrastructure Partnerships Australia

Institute of Actuaries of Australia

Insurance Council of Australia

Investor Group on Climate Change

National Sea Change Taskforce

Lake Macquarie Council (via phone)

NSW Farmers' Association

NSW Government (inter-departmental meeting)

Professor Bruce Thom

Swiss Re

Sydney Coastal Councils Group

**South Australia**South Australian Local Government Association (via phone)

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(Continued next page)

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**Table A.2** (continued)

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*Participant*

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**Victoria**

Australian Conservation Foundation  
Australian Energy Regulator  
Business Council of Australia (via phone)  
Municipal Association of Victoria  
Victorian Coastal Council  
Victorian Government (inter-departmental meeting)  
Victorian Local Governance Association (via phone)  
Wellington Shire Council (via phone)

**Western Australia**

Adaptive Futures  
Local Government Insurance Services  
Pastoralists and Graziers Association  
Western Australian Farmers Federation  
Western Australian Government (inter-departmental meeting)  
Western Australian Local Government Association (via phone)

**Queensland**

Brisbane Airport  
CSIRO Climate Adaptation Flagship  
Gold Coast City Council  
Local Government Association of Queensland  
National Climate Change Adaptation Research Facility  
Queensland Office of Climate Change  
South East Queensland Council of Mayors

**New Zealand**

Canterbury Earthquake Recovery Authority  
Christchurch City Council  
Earthquake Commission  
Environment Canterbury  
Local Government New Zealand  
New Zealand Ministry of Civil Defence and Emergency Management  
New Zealand Ministry for the Environment  
New Zealand Treasury

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**Table A.3 Roundtables**

<i>Participant</i>	<i>Organisation</i>
<b>Sydney — 7 February 2012</b>	
Nicholas Scofield	Allianz
Duncan Anderson	Attorney-General's Department
John Trowbridge	Centre for International Finance and Regulation
Andy Kollmorgen	Choice
Tim Andrews	Institute of Actuaries of Australia
Peter McCarthy	Institute of Actuaries of Australia
George Karagiannakis	Insurance Australia Group
David Wellfare	Insurance Australia Group
Karl Sullivan	Insurance Council of Australia
Cameron Hick	Munich Re
Anthea McClintock	NSW Department of Trade and Investment
Richard Tooth	Sapere Research Group
Annabelle Butler	Suncorp
Nicole Gameraov	Swiss Re
Jerome Davidson	The Treasury
<b>Melbourne — 14 February 2012</b>	
Adrian Beresford-Wylie	Australian Local Government Association
Jennifer Bennett	Central NSW Councils
Rosa Gagetti	City of Port Adelaide Enfield
Andrew Paul	Clarence City Council
Bruce Thom	Coasts and Climate Change Council
Shelley Franklyn	Darwin City Council
Lalage Cherry	Department of Climate Change and Energy Efficiency
David Corkill	Gold Coast City Council
Tracy Taylor	Goulburn Broken Greenhouse Alliance
Jennifer Scott	Ku-ring-gai Council
Doreen Erhart	Local Government Association Queensland
Sally Rice	Moiria Shire Council
Jarrod Filosa	Mornington Peninsula Shire Council
Ben Morris	Municipal Association of Victoria
Bob Savage	North Burnett Regional Council
Kent Boyd	Parkes Shire Council
Joanne Ludbrook	Peron Naturaliste Partnership
Melanie Bainbridge	Western Australian Local Government Association
<b>Melbourne — 15 February 2012</b>	
David Prestipino	Attorney General's Department
Sugi Sivarajan	Australian Energy Regulator
Terry Rossitto	Brisbane Airport Corporation
Mark Rogers	Colonial First State
Jo Mummery	Department of Climate Change and Energy Efficiency
David Mitchell	Department of Infrastructure and Planning (NSW)
Debra Robertson	Department of Infrastructure and Transport
Tom Garrish	Department of Transport (Victoria)

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**Table A.3** (continued)

<i>Participant</i>	<i>Organisation</i>
Garth Crawford	Energy Networks Association
Anna Brakey	Independent Pricing and Regulatory Tribunal (NSW)
Jonathan Kennedy	Infrastructure Partnerships Australia
Ilya Zak	Infrastructure Partnerships Australia
David O'Toole	Office of Environment and Heritage (NSW)
Claudio Battilana	Victoria Managed Insurance Authority



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## References

- ABARE (Australian Bureau of Agricultural and Resource Economics) 2008, *The Potential Impacts of Climate Change on the Forest and Wood Products Manufacturing Sector in Australia*, Report commissioned for the Garnaut Climate Change Review, <http://www.garnautreview.org.au/CA25734E0016A131/pages/all-reports--resources-commissioned-reports.html> (accessed 6 September 2011).
- ABARES (Australian Bureau of Agricultural and Resource Economics and Sciences) 2012, *Climate Change Publications*, [http://www.daff.gov.au/abares/publications\\_remote\\_content/publication\\_topics/climate2](http://www.daff.gov.au/abares/publications_remote_content/publication_topics/climate2) (accessed 16 March 2012).
- Abbs, D. 2009, *The Impact of Climate Change on the Climatology of Tropical Cyclones in the Australian Region*, CAWCR Technical Report: 16 pp.
- ABC News 2012a, 'Flood threat spreads but Wagga levee holds', March, <http://www.abc.net.au/news/2012-03-07/flood-threat-spreads-but-wagga-levee-holds/3873218> (accessed 10 March 2012).
- 2012b, 'Nathalia levee to stay in place for now', Sydney, <http://www.abc.net.au/news/2012-03-15/nathalia-levee-to-stay-in-place-for-now/3891300?section=vic> (accessed 20 March 2012).
- ABCB (Australian Building Codes Board) 2010, *Proposal to Revise Building Code of Australia Requirements for Construction in Cyclone Affected Regions*, Consultation Regulation Impact Statement, March, RIS 2010-01, Canberra.
- 2011a, *Building in Flood Prone Areas*, <http://www.abcb.gov.au/en/major-initiatives/building-in-flood-prone-areas> (accessed 28 March 2012).
- 2011b, *Hierarchy of the Performance-Based BCA*, <http://www.abcb.gov.au/about-the-national-construction-code/the-building-code-of-australia/hierarchy-of-the-performance-based-bca> (accessed 10 April 2012).
- 2011c, *Proposal to Revise the National Construction Code Requirements for Construction in Cyclone Regions*, Regulation Impact Statement for final decision, September, Canberra.
- 2011d, *The Australian Building Codes Board Response to 'Our Cities – Building a Productive, Sustainable and Liveable Future' Discussion Paper*, Submission to the Department of Infrastructure and Transport, 28 February,

- 
- <http://www.infrastructure.gov.au/infrastructure/mcu/urbanpolicy/files/AustralianBuildingCodesBoard.pdf> (accessed 29 March 2012).
- 2012, *Australian Building Codes Board*, <http://www.abcb.gov.au/en/about-the-australian-building-codes-board> (accessed 23 January 2012).
- ABS (Australian Bureau of Statistics) 2010, *Linking the Environment and Economy: Towards an Integrated Environmental-Economic Account for Australia*, Cat. no. 4655.0.55.001, Canberra.
- 2012, *Taxation Revenue, Australia, 2010-11*, Cat. no. 5506.0, ABS, Canberra.
- ACG (Allen Consulting Group) 2009, *Review of the Intergovernmental Agreement for the Australian Building Codes Board*, Final Report, March, Canberra.
- ACT Government 2007, *Weathering the Change: The ACT Climate Change Strategy — Action Plan 2007–2011*, Department of Territory and Municipal Services, Canberra.
- 2012, *ACT Climate Change Council*, [http://www.environment.act.gov.au/climate\\_change/climate\\_change\\_council](http://www.environment.act.gov.au/climate_change/climate_change_council) (accessed 21 March 2012).
- Adaptation Fund 2010, *Accessing Resources from the Adaptation Fund: The Handbook*, Adaptation Fund Board Secretariat, Washington DC.
- Adaptation Sub-Committee 2009, *Preparing for Climate Change: Adaptation Sub-Committee Work Programme*, Committee on Climate Change, London.
- 2010, *How Well is the UK Prepared for Climate Change?*, London.
- 2011, *Adapting to Climate Change in the UK: Measuring Progress*, Committee on Climate Change, London.
- Adger, W., Arnell, N. and Tompkins, E. 2005, 'Successful adaptation to climate change across scales', *Global Environmental Change*, vol. 15, pp. 77–86.
- AECOM 2009, *Coastal Inundation at Narrabeen Lagoon: Optimising Adaptation Investment*, Canberra.
- AER (Australian Energy Regulator) 2010, *Victorian Electricity Distribution Network Service Providers Distribution Determination 2011-2015: Draft Decision*, June, Melbourne.
- AGIC (Australian Green Infrastructure Council) 2011, *AGIC Guideline for Climate Change Adaptation*, October, Brisbane.
- AGO (Australian Greenhouse Office) 2006, *Climate Change Impacts & Risk Management: A Guide for Business and Government*, Canberra.
- Agrawala, S., Bosello, F., Carroro, C., de Bruin, K., de Cian, E., Dellink, R. and Lanzi, E. 2010a, *Plan or React? Analysis of Adaptation Costs and Benefits*



- 
- Using Integrated Assessment Models*, August, OECD Publishing, <http://ideas.repec.org/p/oec/envaaa/23-en.html> (accessed 7 December 2011).
- , Carraro, M., Kingsmill, N., Lanzi, E., Mullan, M. and Prudent-Richard, G. 2011, *Private Sector Engagement in Adaptation to Climate Change*, OECD Environment Working Paper no. 39, Organisation for Economic Co-operation and Development, Paris.
- and Fankhauser, S. 2008, *Economic Aspects of Adaptation to Climate Change: Costs, Benefits and Policy Instruments*, Organisation for Economic Co-operation and Development, Paris.
- , Kramer, A., Prudent-Richard, G. and Sainsbury, M. 2010b, *Incorporating Climate Change Impacts and Adaptation in Environmental Impact Assessments: Opportunities and Challenges*, OECD Environmental Working Paper No. 24, OECD, Paris.
- Ajzen, I. and Fishbein, M. 2005, 'The influence of attitudes on behavior', *The Handbook of Attitudes*, vol. 173, pp. 173–221.
- Alaska Department of Environmental Conservation 2010, *Alaska's Climate Change Strategy: Addressing Impacts in Alaska*, Final report submitted by the Adaptation Advisory Group to the Alaska Climate Change Sub-Cabinet, Juneau.
- Alexander, L.V. and Arblaster, J.M. 2009, 'Assessing trends in observed and modelled climate extremes over Australia in relation to future projections', *International Journal of Climatology*, vol. 29, no. 3, pp. 417–435.
- ALGA (Australian Local Government Association) 2010, *Climate Change: ALGA Position Paper & Discussion Document*, Canberra.
- Allan, C. and Stankey, G.H. (eds) 2009, *Adaptive Environmental Management: A Practitioner's Guide*, CSIRO Publishing, Melbourne.
- ANU (Australian National University) 2009, *Implications of Climate Change for Australia's World Heritage Properties: A Preliminary Assessment*, Department of Climate Change and Department of the Environment, Water, Heritage and the Arts, Canberra.
- ASIC (Australian Securities and Investments Commission) 2005, *Getting Home Insurance Right: A Report on Home Building Underinsurance*, Canberra.
- Attorney-General's Department 2011, *National Disaster Relief and Recovery Arrangements: Determination 2011*, Canberra.
- 2012, *Disasters Database*, Canberra, <http://www.disasters.ema.gov.au/Browse/Titles.aspx> (accessed 11 January 2012).
- AusAID 2011a, *Annual Report 2010-2011*, Canberra.

- 
- 2011b, *International Climate Change Adaptation Initiative*, [http://www. ausaid.gov.au/keyaid/adaptation\\_initiative.cfm](http://www. ausaid.gov.au/keyaid/adaptation_initiative.cfm) (accessed 3 April 2012).
- Australian Centre for Biodiversity 2008, *Biodiversity and Climate Change*, Report commissioned for the Garnaut Climate Change Review, <http://www.garnaut review.org.au/CA25734E0016A131/pages/all-reports--resources-commissioned-reports.html> (accessed 6 September 2011).
- Australian Government 2009, *Australian Emergency Management Arrangements*, Attorney-General's Department, Canberra.
- 2010a, *Best Practice Regulation Handbook*, Canberra.
- 2010b, *Critical Infrastructure Resilience Strategy*, Canberra.
- 2011a, *Future of Financial Advice 2011: Information Pack 28 April 2011*, Canberra.
- 2011b, *Government's Response to NDIR Recommendations*, Treasury, Canberra.
- 2012, *Council of Australian Governments' Select Council on Climate Change Terms of Reference*, <http://www.climatechange.gov.au/government/initiatives/sccc/tor.aspx> (accessed 10 April 2012).
- Baker and McKenzie 2011, *Local Councils' Risk of Liability in the Face of Climate Change - Resolving Uncertainties. A Report for the Australian Local Government Association*, <http://www.climatechange.gov.au/publications/local-govt/resolving-uncertainties.aspx> (accessed 19 March 2012).
- Baker, R., Barker, A., Johnston, A. and Kohlhaas, M. 2008, *The Stern Review: an Assessment of its Methodology*, Productivity Commission Staff Working Paper, January, Melbourne.
- Bambrick, H., Capon, A., Barnett, G., Beaty, R. and Burton, A. 2011, 'Climate change and health in the urban environment: Adaptation opportunities in Australian cities', *Asia-Pacific Journal of Public Health Supplement*, vol. 23, no. 2, pp. 67S–79S.
- , Dear, K., Woodruff, R., Hanigan, I. and McMichael, A. 2008, *The Impacts of Climate Change on Three Health Outcomes: Temperature-Related Mortality and Hospitalisations, Salmonellosis and Other Bacterial Gastroenteritis, and Population and Risk of Dengue*, Report to the Garnaut Climate Change Review, Melbourne.
- Barker, A., Murray, T. and Salerian, J. 2010, *Developing a Partial Equilibrium Model of an Urban Water System*, Productivity Commission Staff Working Paper, March, Melbourne.

- 
- Bell, E. 2011, 'Readying health services for climate change: A policy framework for regional development', *American Journal of Public Health*, vol. 101, no. 5, pp. 804–813.
- Ben-David, R. 2010, *Convincing Regulators of the Need for Climate Change Adaptation. Really?*, October, Melbourne.
- Berliner, B. 1982, *Limits of Insurability of Risks*, Prentice-Hall, Upper Saddle River, New Jersey, United States.
- Berrittella, M., Bigano, A., Roson, R. and Tol, R. 2006, 'A general equilibrium analysis of climate change impacts on tourism', *Tourism Management*, vol. 27, no. 5, pp. 913–924.
- Bi, P., Williams, S., Loughnan, M., Lloyd, G., Hansen, A., Kjellstrom, T., Dear, K. and Saniotis, A. 2011, 'The effects of extreme heat on human mortality and morbidity in Australia: Implications for public health', *Asia-Pacific Journal of Public Health Supplement*, vol. 23, no. 2, pp. 27S–36S.
- Blake Dawson 2011, *Coastal Climate Change Risk - Legal and Policy Responses in Australia*, Melbourne, <http://www.climatechange.gov.au/en/publications/coastal-climate-change-risk/legal-policy-response.aspx> (accessed 27 March 2012).
- Blashki, G., Armstrong, G., Berry, H.L., Weaver, H.J., Hanna, E.G., Bi, P., Harley, D. and Spickett, J.T. 2011, 'Preparing health services for climate change in Australia', *Asia-Pacific Journal of Public Health Supplement*, vol. 23, no. 2, pp. 135S–143S.
- BOM (Bureau of Meteorology) 2010, *Long-Term Rainfall Variations in Australia*, <http://www.bom.gov.au/lam/climate/levelthree/climch/clichv4.htm> (accessed 29 February 2012).
- 2012a, *Climate and Past Weather Information*, <http://www.bom.gov.au/climate/> (accessed 9 March 2012).
- 2012b, *The National Plan for Environmental Information*, Canberra, [http://www.bom.gov.au/environment/NPEI\\_info\\_sheet.pdf](http://www.bom.gov.au/environment/NPEI_info_sheet.pdf) (accessed 14 March 2012).
- Bosello, F., Roson, R. and Tol, R. 2006, 'Economy-wide estimates of the implications of climate change: Human health', *Ecological Economics*, vol. 58, no. 3, pp. 579–591.
- , ——— and ——— 2007, 'Economy-wide estimates of the implications of climate change: Sea level rise', *Environmental and Resource Economics*, vol. 37, no. 3, pp. 549–571.
- and Zhang, J. 2005, *Assessing Climate Change Impacts: Agriculture*, July, Fondazione Eni Enrico Mattei, Venice.

- 
- Botterill, L.C. and Fisher, M. 2003, *Beyond Drought: People, Policy and Perspectives*, CSIRO Publishing.
- BRANZ 2007, *An Assessment of the Need to Adapt Buildings for the Unavoidable Consequences of Climate Change*, Final Report, August, Canberra.
- Brisbane Airport Corporation 2007, *New Parallel Runway Draft EIS/MDP*, <http://bne.com.au/projects-and-development/new-parallel-runway-project/related-materials> (accessed 19 January 2012).
- de Bruin, K., Dellink, R. and Agrawala, S. 2009, *Economic Aspects of Adaptation to Climate Change: Integrated Assessment Modelling of Adaptation Costs and Benefits*, March, OECD Publishing, <http://ideas.repec.org/p/oec/envaaa/6-en.html> (accessed 7 December 2011).
- Byron Shire Council 2010a, *Development Control Plan 2010*, Mullumbimby, NSW.
- 2010b, *Draft Coastal Zone Management Plan for Byron Shire Coastline: Part A.*, Mullumbimby, NSW.
- nd, *Planned Retreat in Byron Shire*, Mullumbimby, NSW, [http://www.byron.nsw.gov.au/files/publications/Planned\\_Retreat\\_fact\\_sheet.pdf](http://www.byron.nsw.gov.au/files/publications/Planned_Retreat_fact_sheet.pdf) (accessed 19 August 2011).
- California Energy Commission 2011, *Cal-Adapt*, State of California, Sacramento, <http://www.cal-adapt.org> (accessed 14 December 2011).
- California Natural Resources Agency 2009, *2009 California Climate Adaptation Strategy*, Sacramento.
- Calzadilla, A., Zhu, T., Rehdanz, K., Tol, R. and Ringler, C. 2009, *Economy-Wide Impacts of Climate Change on Agriculture in Sub-Saharan Africa*, International Food Policy Research Institute, <http://www.ifpri.org/publication/economywide-impacts-climate-change-agriculture-sub-saharan-africa> (accessed 12 December 2011).
- Camerer, C.F. and Kunreuther, H. 1989, 'Decision processes for low probability events: Policy implications', *Journal of Policy Analysis and Management*, vol. 8, no. 4, pp. 565–592.
- Caring for our Country 2011a, *Caring for our Country*, Canberra, <http://www.nrm.gov.au/about/caring/index.html> (accessed 16 April 2012).
- 2011b, *NRM Regions*, Canberra, <http://www.nrm.gov.au/about/nrm/regions/index.html> (accessed 16 April 2012).
- Carroro, C., Bosello, F. and de Cian, E. 2009, *An Analysis of Adaptation as a Response to Climate Change*, Department of Economics, University of Venice, [http://ideas.repec.org/p/ven/wpaper/2009\\_26.html](http://ideas.repec.org/p/ven/wpaper/2009_26.html) (accessed 7 December 2011).

- 
- CAWCR (Centre for Australian Weather and Climate Research) 2011, *Climate Science Update: A Report to the 2011 Garnaut Review*, CSIRO, Canberra, <http://www.garnautreview.org.au/update-2011/commissioned-work.html> (accessed 7 September 2011).
- CC DARE (Climate Change Adaptation and Development Initiative) nd, *Supporting Sub-Saharan Africa including Small Island Countries with Climate Change Adaptation*, United Nations Environment Programme and United Nations Development Programme, Nairobi.
- CCCSN (Canadian Climate Change Scenarios Network) 2011, *About Us*, Toronto, <http://cccsn.ca/?page=aboutus> (accessed 19 December 2011).
- CCES (Center for Climate and Energy Solutions) 2011, *State Adaptation Plans*, Arlington, Virginia, [http://www.c2es.org/what\\_s\\_being\\_done/in\\_the\\_states/adaptation\\_map.cfm](http://www.c2es.org/what_s_being_done/in_the_states/adaptation_map.cfm) (accessed 14 December 2011).
- Central NSW Councils 2009, *Centroc Water Security Study Component 2: Options Paper Final*, MWH Global, Bathurst.
- Centre for Risk and Community Safety 2011, *Systematic Review of Reports on Emergency Alert*, Melbourne.
- Centrelink 2009, *Payment Rates*, Canberra, [http://www.centrelink.gov.au/internet/internet.nsf/payments/disaster\\_rates.htm](http://www.centrelink.gov.au/internet/internet.nsf/payments/disaster_rates.htm) (accessed 13 February 2012).
- CFA (Country Fire Authority) 2012, *Fire Ready Kit*, <http://www.cfa.vic.gov.au/firesafety/bushfire/firereadykit.htm> (accessed 16 March 2012).
- CGIAR (Consultative Group on International Agricultural Research) 2012, *Who We Are*, Washington DC, <http://www.cgiar.org/who/index.html> (accessed 20 January 2012).
- Charpentier, A. 2008, 'Insurability of climate risks', *The Geneva Papers on Risk and Insurance*, vol. 33, pp. 91–109.
- Church, J. , Hunter, J., Cowell, P., O'Farrell, S. and White, N. 2008, 'Sea-level Rise', in Newton, P. (ed), *Transitions: Pathways Towards Sustainable Urban Development in Australia*, CSIRO Publishing, Melbourne, pp. 191–210.
- , ——, McInnes, K.L. and White, N.J. 2006, 'Sea-level rise around the Australian coastline and the changing frequency of extreme sea-level events', *Australian Meteorological Magazine*, vol. 55, no. 4, pp. 253–260.
- Cinner, J., Fuentes, M. and Randriamahazo, H. 2009, 'Exploring social resilience in Madagascar's marine protected areas', *Ecology and Society*, vol. 14, no. 1, pp. 41–61.

- 
- Clarence City Council 2008, *Climate Change Impacts On Clarence Coastal Areas*, December, Clarence.
- Climate Commission 2011, *About the Commission*, <http://climatecommission.gov.au/about/> (accessed 6 February 2012).
- COAG (Council of Australian Governments) 2006, *An Agreement Between the Governments of the Commonwealth of Australia, the States and the Territories to Continue in Existence and Provide for the Operation of the Australian Building Codes Board*, April, Canberra.
- 2007a, *Best Practice Regulation: A Guide for Ministerial Councils and National Standard Setting Bodies*, October, Canberra.
- 2007b, *National Climate Change Adaptation Framework*, Canberra.
- 2009a, *Council of Australian Governments' Meeting 7 December 2009*, Communique, [http://www.coag.gov.au/coag\\_meeting\\_outcomes/2009-12-07/index.cfm](http://www.coag.gov.au/coag_meeting_outcomes/2009-12-07/index.cfm) (accessed 19 January 2012).
- 2009b, *National Disaster Resilience Statement*, Canberra.
- 2011, *National Strategy for Disaster Resilience: Building Our Nation's Resilience to Disasters*, Canberra.
- Coast Protection Board 2004, *Policy Document*, Adelaide.
- Collins, D. 2011, *Reducing the Risks: Improving Access to Home Contents and Vehicle Insurance for Low-Income Australians*, Brotherhood of St. Laurence, Melbourne.
- Connolly, C. 2011, *Natural Disaster Insurance Review: A Consumer Perspective on the NDIR Issues Paper*, Transia Pty Ltd, Sydney.
- Corney, S., Katzfey, J., McGregor, J., Grose, M., Bennett, J., White, C., Holz, G., Gaynor, S. and Bindoff, N. 2010, *Climate Futures for Tasmania Technical Report - Climate Modelling*, Antarctic Climate and Ecosystems Cooperative Research Centre, [http://www.dpac.tas.gov.au/\\_\\_data/assets/pdf\\_file/0015/151125/CFT\\_-\\_Climate\\_Modelling\\_Technical\\_Report.pdf](http://www.dpac.tas.gov.au/__data/assets/pdf_file/0015/151125/CFT_-_Climate_Modelling_Technical_Report.pdf) (accessed 16 March 2012).
- Crowle, J. and Turner, E. 2010, *Childhood Obesity: an Economic Perspective*, Staff Working Paper, 25 October, Productivity Commission, Melbourne.
- CSIRO (Commonwealth Scientific and Industrial Research Organisation) 2008, *An Overview of Climate Change Adaptation in Australian Primary Industries — Impacts, Options and Priorities*, CSIRO, Canberra, <http://www.csiro.au/resources/AgricultureAdaptationReport2008.html> (accessed 6 September 2011).

- 
- 2011a, *Climate Adaptation Flagship*, <http://www.csiro.au/Organisation-Structure/Flagships/Climate-Adaptation-Flagship/ClimateAdaptationFlagshipOverview.aspx> (accessed 3 April 2012).
- 2011b, *Protecting Australia's Critical Infrastructure with CIPMA*, <http://www.csiro.au/Organisation-Structure/Divisions/Mathematics-Informatics-and-Statistics/CIPMA.aspx> (accessed 3 February 2012).
- and BOM (Bureau of Meteorology) 2007, *Climate Change in Australia*, CSIRO, [http://climatechangeinaustralia.com.au/technical\\_report.php](http://climatechangeinaustralia.com.au/technical_report.php) (accessed 6 September 2011).
- and —— 2010, *State of the Climate*, Canberra, <http://csiro.au/resources/State-of-the-Climate.html> (accessed 8 December 2011).
- and —— 2012, *Climate Change in Australia - National Temperature Change*, <http://www.climatechangeinaustralia.gov.au/nattemp15.php> (accessed 3 April 2012).
- and NCCARF (National Climate Change Adaptation Research Facility) 2009, *Marine Climate Change in Australia: Impacts and Adaptation Responses 2009 Report Card*, Cleveland, Queensland.
- and Queensland DPIF (Department of Primary Industries and Fisheries) 2008, *Global Climate Change Impacts on Australia's Wheat Crops*, Report commissioned for the Garnaut Climate Change Review, <http://www.garnautreview.org.au/CA25734E0016A131/pages/all-reports--resources-commissioned-reports.html> (accessed 6 September 2011).
- DAFF (Department of Agriculture, Fisheries and Forestry) 2011, *Australia's Farming Future*, <http://www.daff.gov.au/climatechange/australias-farming-future> (accessed 3 April 2012).
- Darwin City Council 2011, *Climate Change Action Plan 2011-2020*, Darwin.
- DCC (Department of Climate Change) 2009a, *Australian Climate Change Science: A National Framework*, Canberra.
- 2009b, *Climate Change Risks to Australia's Coast: A First Pass National Assessment*, Department of Climate Change, Canberra, <http://www.climatechange.gov.au/publications/coastline/climate-change-risks-to-australias-coasts.aspx> (accessed 7 September 2011).
- 2009c, *Local Adaptation Pathways Program*, <http://www.climatechange.gov.au/government/initiatives/lapp/lapp-round-two.aspx> (accessed 13 April 2012).
- DCCEE (Department of Climate Change and Energy Efficiency) 2010a, *Adapting to Climate Change in Australia*, Commonwealth of Australia, <http://www>.

- 
- climatechange.gov.au/publications/adaptation/position-paper.aspx (accessed 18 January 2012).
- 2010b, *Climate Change Adaptation Actions for Local Government*, Canberra.
- 2010c, *Developing a National Coastal Adaptation Agenda*, A report on the National Climate Change Forum, 18 February, Adelaide.
- 2011, *Climate Change Risks to Coastal Buildings and Infrastructure: A Supplement to the First Pass National Assessment*, Canberra, <http://www.climatechange.gov.au/publications/coastline/climate-change-risks-to-coastal.aspx> (accessed 7 September 2011).
- 2012a, *Adapting to Climate Change*, <http://climatechange.gov.au/government/adapt.aspx> (accessed 3 April 2012).
- 2012b, *Caring for Our Coasts*, <http://www.climatechange.gov.au/government/initiatives/caring-for-coasts.aspx> (accessed 3 April 2012).
- 2012c, *Climate Change Adaptation Program*, <http://www.climatechange.gov.au/government/initiatives/climate-change-adaptation-program.aspx> (accessed 6 February 2012).
- 2012d, *Climate Change Publications*, <http://www.climatechange.gov.au/publications.aspx> (accessed 16 March 2012).
- 2012e, *Coastal Adaptation Decision Pathways projects*, Australian Government, <http://www.climatechange.gov.au/government/initiatives/coastal-adaptation-decision-pathways.aspx> (accessed 28 February 2012).
- 2012f, *Integrated Assessment of Human Settlements Sub-Program*, Australian Government, <http://www.climatechange.gov.au/government/initiatives/climate-change-adaptation-program/lapp-ia.aspx> (accessed 28 February 2012).
- 2012g, *National Coastal Risk Assessment*, <http://www.climatechange.gov.au/climate-change/australias-coasts-and-climate-change/adapting/national-coastal-risk-assessment.aspx> (accessed 21 March 2012).
- 2012h, *Review of the Local Adaptation Pathways Program. Report by Walter Turnbull*, Canberra.
- 2012i, *Select Council on Climate Change - Think Change*, <http://www.climatechange.gov.au/government/initiatives/sccc.aspx> (accessed 3 April 2012).
- 2012j, *What the Government is Doing*, <http://www.climatechange.gov.au/en/government.aspx> (accessed 3 April 2012).
- DEFRA (Department of Environment, Food and Rural Affairs) 2011a, *Adapting to Climate Change Evidence Plan 2011/12*, London.



- 
- 2011b, *Advice for Reporting Authorities*, London, <http://www.defra.gov.uk/environment/climate/sectors/reporting-authorities> (accessed 19 December 2011).
- 2011c, *Managing Adaptation: Linking Theory and Practice*, [http://www.ukcip.org.uk/wordpress/wp.../UKCIP\\_Managing\\_adaptation.pdf](http://www.ukcip.org.uk/wordpress/wp.../UKCIP_Managing_adaptation.pdf) (accessed 10 February 2012).
- 2011d, *May 2011 — Departmental Adaptation Plan Updates*, London, <http://www.defra.gov.uk/environment/climate/government/departamental-adaptation-plans> (accessed 19 December 2011).
- 2011e, *What is Government Doing?*, London, <http://www.defra.gov.uk/environment/climate/government> (accessed 14 December 2011).
- 2011f, *What is UKCP09?*, UK Climate Projections, London, <http://ukclimateprojections.defra.gov.uk/content/view/868/531> (accessed 15 December 2011).
- 2012, *The UK Climate Change Risk Assessment 2012 Evidence Report*, London.
- Department of Finance and Deregulation 2012, *Review of the Insurance Arrangements of State and Territory Governments under the Natural Disaster Relief and Recovery Arrangements Determination 2011*, Phase 1 Report, Canberra.
- Dessai, S. and Hulme, M. 2004, 'Does climate adaptation policy need probabilities?', *Climate Policy*, vol. 4, no. 2, pp. 107–128.
- Dietz, T., Ostrom, E. and Stern, P. 2003, 'The struggle to govern the commons', *Science*, vol. 302, pp. 1907–1912.
- DITRDLG (Department of Infrastructure, Transport, Regional Development and Local Government) 2010, *2007-08 Local Government National Report*, Canberra, [http://www.regional.gov.au/local/publications/pdf/LGNR\\_2007-08.pdf](http://www.regional.gov.au/local/publications/pdf/LGNR_2007-08.pdf) (accessed 23 March 2012).
- DRALGAS (Department of Regional Australia, Local Government, Art and Sport) 2012a, *Local Government Reform Fund*, <http://www.regional.gov.au/local/LGRF.aspx> (accessed 4 April 2012).
- 2012b, *Regional Development Australia Fund Round Two*, Canberra, [http://www.regional.gov.au/regional/programs/files/RDAF\\_Rd\\_2\\_EOIs\\_Application20120214.pdf](http://www.regional.gov.au/regional/programs/files/RDAF_Rd_2_EOIs_Application20120214.pdf) (accessed 22 March 2012).
- DSEWPC (Department of Sustainability, Environment, Water, Population and Communities) 2011, *Review of the Bureau of Meteorology 2011*, <http://www.environment.gov.au/about/bom/index.html> (accessed 4 April 2012).

- 
- 2012a, *Environment Protection and Biodiversity Conservation Act*, Canberra, <http://www.environment.gov.au/epbc/index.html> (accessed 16 April 2012).
- 2012b, *National Reserve System Protected Area Requirements*, Canberra, <http://www.environment.gov.au/parks/nrs/about/management.html> (accessed 15 March 2012).
- 2012c, *Scientific Framework*, Canberra, <http://www.environment.gov.au/parks/nrs/science/scientific-framework.html> (accessed 15 March 2012).
- Dunlop, M. and Brown, P. 2008, *Implications of Climate Change for Australia's National Reserve System: A Preliminary Assessment*, Department of Climate Change and Department of the Environment, Water, Heritage and the Arts, Canberra.
- Eboli, F., Parrado, R. and Roson, R. 2010, 'Climate-change feedback on economic growth: Explorations with a dynamic general equilibrium model', *Environment and Development Economics*, vol. 15, no. 5, pp. 515–533.
- EC (European Commission) 2009, *Adapting to Climate Change: Towards a European Framework for Action*, white paper, COM(2009) 147, Brussels.
- 2010, *Adaptation to Climate Change: Strategies, Projects, Links*, Brussels, [http://ec.europa.eu/clima/sites/change/strategies\\_project\\_links/index\\_en.htm](http://ec.europa.eu/clima/sites/change/strategies_project_links/index_en.htm) (accessed 20 December 2011).
- Economics of Climate Adaptation Working Group 2009, *Shaping Climate-Resilient Development: A Framework for Decision-Making*, [http://ec.europa.eu/development/icenter/repository/ECA\\_Shaping\\_Climate\\_Resilient\\_Development.pdf](http://ec.europa.eu/development/icenter/repository/ECA_Shaping_Climate_Resilient_Development.pdf) (accessed 10 April 2012).
- Ellis, F. 2000, *Rural Livelihoods and Diversity in Developing Countries*, Oxford University Press, Oxford.
- Emergency Management Australia 1998, *Australian Emergency Management Glossary*, Attorney-General's Department, Canberra.
- 2004, *Emergency Management in Australia: Concepts and Principles*, Attorney-General's Department, Canberra.
- England, P. 2008, 'Heating up: Climate change law and the evolving responsibilities of local government', *Local Government Law Journal*, vol. 13, pp. 209–223.
- Environmental Defenders Office 2011, *Audit of Sea Level Rise, Coastal Erosion and Inundation Legislation and Policy. Report prepared by the Environmental Defender's Office of New South Wales for the Sydney Coastal Councils Group*.

- 
- Epstein, R.A. 2006, 'Behavioral economics: Human errors and market corrections', *The University of Chicago Law Review*, vol. 73, no. 1, pp. 111–132.
- ERC (Expenditure Review Committee) 2011, *The Asset Insurance Arrangements of Australian State Governments*, Canberra.
- Ergas, H. 2007, 'Policy implications of behavioural economics: The case of consumer protection', presented at Productivity Commission's roundtable on Behavioural Economics and Public Policy, Melbourne, 9 August.
- Fankhauser, S., Smith, J. and Tol, R. 1999, 'Weathering climate change: some simple rules to guide adaptation decisions', *Ecological Economics*, vol. 30, no. 1, pp. 67–78.
- Faure, M.G. 1995, 'The limits to insurability from a law and economics perspective', *The Geneva Papers on Risk and Insurance*, vol. 20, no. 76, pp. 454–462.
- Field, C.B. and Raupach, M.R. 2004, *The Global Carbon Cycle: Integrating Humans, Climate, and the Natural World*, Island Press, Washington DC.
- Frost, A. 2007, 'Australian application of a statistical downscaling technique for multi-site daily rainfall: GLIMCLIM', *MODSIM*.
- Gabbitas, O. and Eldridge, D. 1998, *Directions for State Tax Reform*, Productivity Commission Staff Research Paper, Canberra.
- Gardner, J., Dowd, A., Mason, C. and Ashworth, P. 2009, *A Framework for Stakeholder Engagement on Climate Adaptation*, Working paper no. 3, CSIRO Climate Adaptation Flagship Working Paper Series, CSIRO.
- Garnaut, R. 2008a, *Introduction and Overview of Approach to Economic Modelling*, Garnaut Review Technical Paper no. 1, Melbourne.
- 2008b, *The Garnaut Climate Change Review: Final Report*, Cambridge University Press, Melbourne.
- GATECC (Governor's Action Team on Energy and Climate Change) 2008, *Florida's Energy and Climate Change Action Plan*, Center for Climate Strategies, Washington DC.
- GBRMPA (Great Barrier Reef Marine Park Authority) 2007, *Great Barrier Reef Climate Change Action Plan 2007-2012*, Townsville.
- 2009, *Great Barrier Reef Outlook Report 2009*, July, Townsville.
- 2012, *Outlook for the Reef*, <http://www.gbrmpa.gov.au/outlook-for-the-reef> (accessed 16 March 2012).
- Geoscience Australia 2011, *Hazards Information*, <http://www.ga.gov.au/hazards.html> (accessed 10 April 2012).

- 
- GFDRR (Global Facility for Disaster Reduction and Recovery) 2011, *About GFDRR*, Washington DC, <http://www.gfdr.org/gfdr/node/1> (accessed 8 December 2011).
- Giles, G. and Stevens, H. 2011, 'Sometimes I wonder how we keep from going under: Planning for sea level rise in established communities', presented at New South Wales Coastal Conference, Tweed Heads, NSW, November.
- GIO Insurance 2010, *Renters Feather Nests but don't Protect their Property*, Sydney, <http://www.gio.com.au/news/renters-feather-nests-dont-protect-their-property> (accessed 30 November 2011).
- Global Environment Facility 2011, *Adaptation*, Washington DC, <http://www.thegef.org/gef/adaptation> (accessed 7 December 2011).
- GRDC (Grains Research and Development Corporation) 2011a, *Climate Kelpie - Rounding up Climate Tools for Australian Farmers*, <http://www.climatekelpie.com.au/> (accessed 19 March 2012).
- 2011b, *Managing Climate Variability Research and Development Program - About Us*, <http://www.managingclimate.gov.au/about-us/> (accessed 27 March 2012).
- Grossmann, I. and Morgan, M. 2011, 'Tropical cyclones, climate change, and scientific uncertainty: what do we know, what does it mean, and what should be done?', *Climatic Change*, vol. 108, no. 3, pp. 543–579.
- Gunasekera, D., Ford, M., Heyhoe, E., Ahammad, H., Phipps, S., Harman, I., Finnigan, J. and Brede, M. 2008, 'Global integrated assessment model: A new analytical tool for assessing climate change risks and policies', *Australian Commodities*, vol. 15, no. 1, pp. 195–216.
- , Kim, Y., Tulloh, C. and Ford, M. 2007, 'Climate change: Impacts on Australian agriculture', *Australian Commodities*, vol. 14, no. 4, pp. 657–676.
- Gurran, G., Hamin, E. and Norman, B. 2008, *Planning for Climate Change: Leading Practice Principles and Models for Sea Change Communities in Coastal Australia*, University of Sydney, Sydney.
- Handmer, J. 2002, 'Flood insurance: A backward glance and some current issues', in Smith, D.I. and Handmer, J. (eds), *Residential Flood Insurance: The Implications for Floodplain Management Policy*, Water Research Foundation of Australia, Canberra, pp. 59–72.
- Harley, D., Bi, P., Hall, G., Swaminathan, A., Tong, S. and Williams, C. 2011, 'Climate change and infectious diseases in Australia: Future prospects, adaptation options, and research priorities', *Asia-Pacific Journal of Public Health Supplement*, vol. 23, no. 2, pp. 54S–66S.

- 
- Harrison, M. 2010, *Valuing the Future: The Social Discount Rate in Cost-Benefit Analysis*, Visiting Researcher Paper, Productivity Commission, Canberra.
- Healthy Waterways 2009, *Healthy-e-Waterways Report Cards*, <http://www.health-e-waterways.org/reportcard> (accessed 19 March 2012).
- Hecht, S.B. 2008, 'Climate change and the transformation of risk: Insurance matters', *UCLA Law Review*, vol. 55, pp. 1559–1620.
- Hennessy, K., Fawcett, R., Kirono, D., Mpelasoka, F., Jones, D., Bathols, J., Whetton, P., Stafford Smith, M., Howden, M., Mitchell, C. and Plummer, N. 2008, *An Assessment of the Impact of Climate Change on the Nature and Frequency of Exceptional Climatic Events*, Bureau of Meteorology and CSIRO, Aspendale.
- HM Government 2012, *UK Climate Change Risk Assessment: Government Report*, London.
- HM Treasury 2009, *Accounting for the Effects of Climate Change: Supplementary Green Book Guidance*, London.
- Hobday, A., Poloczanska, E. and Matear, R. 2008, *Climate Impacts on Australian Fisheries and Aquaculture: Implications for the Effects of Climate Change*, Draft report to the Australian Government Department of Climate Change, Canberra.
- Hope, C. 2009, 'The costs and benefits of adaptation', *Assessing the Costs of Adaptation to Climate Change: A Review of UNFCCC and Other Recent Estimates*, International Institute for the Environment and Development, London.
- , Anderson, J. and Wenman, P. 1993, 'Policy analysis of the greenhouse effect: An application of the PAGE model', *Energy Policy*, vol. 21, no. 3, pp. 327–338.
- ICCATF (Interagency Climate Change Adaptation Task Force) 2011, *Federal Actions for a Climate Resilient Nation: Progress Report of the Interagency Climate Change Adaptation Task Force*, United States Government, Washington DC.
- IMF (International Monetary Fund) 2008, *World Economic Outlook, April 2008: Housing and the Business Cycle*, Washington DC.
- Infrastructure Australia 2008, *National Public Private Partnership Guidelines*, December, [http://www.infrastructureaustralia.gov.au/public\\_private/ppp\\_policy\\_guidelines.aspx](http://www.infrastructureaustralia.gov.au/public_private/ppp_policy_guidelines.aspx) (accessed 19 January 2012).
- 2011, *Better Infrastructure Decision-Making: Guidelines for Making Submissions to Infrastructure Australia's Infrastructure Planning Process, Through Infrastructure Australia's Reform and Investment Framework*,

- 
- [http://www.infrastructureaustralia.gov.au/reform\\_investment/files/Better\\_Infrast\\_ructure\\_Decision\\_Making\\_Guidelines\\_v4.pdf](http://www.infrastructureaustralia.gov.au/reform_investment/files/Better_Infrast_ructure_Decision_Making_Guidelines_v4.pdf) (accessed 10 January 2012).
- Institute of Actuaries of Australia 2011a, *Response to the Natural Disaster Insurance Review Issues Paper*, Sydney.
- 2011b, *Submission to the Garnaut Climate Change Review — Update 2011*, Sydney.
- Insurance Council of Australia 2011, *Insurance Council of Australia Response to Natural Disaster Insurance Review*, Sydney.
- 2012a, *Historical Disaster Statistics*, Sydney.
- 2012b, *Inquiry into Residential Strata Insurance*, Submission to the House of Representatives Standing Committee on Social Policy and Legal Affairs, Sydney.
- International Organization for Standardization 2009, *Risk Management - Principles and Guidelines*, 15 November, ISO31000, Geneva.
- IPART (Independent Pricing and Regulatory Tribunal) 2008, *Review of State Taxation: Report to the Treasurer. Final Report.*, New South Wales.
- IPCC (Intergovernmental Panel on Climate Change) 2007a, *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge and New York.
- 2007b, *Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge and New York.
- 2007c, *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge and New York.
- Iyengar, S.S. and Lepper, M.R. 2000, 'When choice is demotivating: Can one desire too much of a good thing?', *Journal of Personality and Social Psychology*, vol. 79, no. 6, pp. 995–1006.
- Johnson, E.J. and Goldstein, D.G. 2004, 'Defaults and donation decisions', *Transplantation*, vol. 78, no. 12, pp. 1713–1716.
- Jotzo, F. 2010, *Prerequisites and Limits for Economic Modelling of Climate Change Impacts and Adaptation*, Environmental Economics Research Hub Research Reports, Environmental Economics Research Hub, Crawford School,

---

Australian National University, <http://ideas.repec.org/p/een/eenhrr/1055.html> (accessed 13 December 2011).

Kahneman, D. 2011, *Thinking, Fast and Slow*, Allen Lane, New York.

——, Knetsch, J.L. and Thaler, R.H. 1991, ‘Anomalies: The endowment effect, loss aversion, and status quo bias’, *Journal of Economic Perspectives*, vol. 5, no. 1, pp. 193–206.

Katsman, C., Sterl, A., Beersma, J., van den Brink, H., Church, J., Hazeleger, W., Kopp, R., Kroon, D., Kwadijk, J., Lammersen, R., Lowe, J., Oppenheimer, M., Plag, H., Ridley, J., von Storch, H., Vaughan, D., Vellinga, P., Vermeersen, L., van de Wal, R. and Weisse, R. 2011, ‘Exploring high-end scenarios for local sea level rise to develop flood protection strategies for a low-lying delta: The Netherlands as an example’, *Climatic Change*, vol. 109, pp. 617–645.

Katz, R. and Brown, B. 1992, ‘Extreme events in a changing climate: Variability is more important than averages’, *Climatic Change*, vol. 21, no. 3, pp. 289–302.

Kemfert, C. 2002, ‘An integrated assessment model of economy-energy-climate: The model Wiagem’, *Integrated Assessment*, vol. 3, no. 4, [http://journals.sfu.ca/int\\_assess/index.php/iaj/article/viewArticle/21](http://journals.sfu.ca/int_assess/index.php/iaj/article/viewArticle/21) (accessed 7 December 2011).

Keogh, M., Granger, R. and Middleton, S. 2011, *Drought Pilot Review Panel: A Review of the Pilot of Drought Reform Measures in Western Australia*, Canberra.

Knight, F.H. 2002 (1921), *Risk, Uncertainty and Profit*, Beard Books, Washington.

Kunreuther, H. and Michel-Kerjan, E. 2009, *At War with the Weather: Managing Large-Scale Risks in a New Era of Catastrophes*, MIT Press, Cambridge, Massachusetts.

Lake Macquarie City Council 2011, *Draft Lake Macquarie Waterway Flood Study and Flood Risk Management Plan Exhibition Notice*, <http://www.lakemac.com.au/downloads/Flood%20Study%20and%20Plan%20Summary.pdf> (accessed 14 March 2012).

Land and Water Australia 2005, *Making Economic Valuation Work for Biodiversity Conservation*, Department of the Environment and Heritage, Canberra.

Landcare Australia 2012, *What is Landcare?*, Sydney, <http://www.landcareonline.com.au/about/what-is-landcare> (accessed 16 April 2012).

Lemmen, D.S., Warren, F.J., Lacroix, J. and Bush, E. (eds) 2008, *From Impacts to Adaptation: Canada in a Changing Climate 2007*, Government of Canada, Ottawa.

- 
- Leslie, L.M., Karoly, D.J., Leplastrier, M. and Buckley, B.W. 2007, 'Variability of tropical cyclones over the southwest Pacific Ocean using a high-resolution climate model', *Meteorology and Atmospheric Physics*, vol. 97, no. 1–4, pp. 171–180.
- , Leplastrier, M. and Buckley, B.W. 2008, 'Estimating future trends in severe hailstorms over the Sydney Basin: A climate modelling study', *Atmospheric Research*, vol. 87, no. 1, pp. 37–51.
- LGAQ (Local Government Association of Queensland) 2011, *Taskforce to Help Councils Deal with Risk of Climate Change*, Brisbane, [http://www.lgaq.asn.au/web/guest/news/-/asset\\_publisher/pG32/content/taskforce-to-help-councils-deal-with-risk-of-climate-change?redirect=%2Fweb%2Fguest%2Fnews](http://www.lgaq.asn.au/web/guest/news/-/asset_publisher/pG32/content/taskforce-to-help-councils-deal-with-risk-of-climate-change?redirect=%2Fweb%2Fguest%2Fnews) (accessed 9 March 2012).
- LGASA (Local Government Association of South Australia) 2012, *Local Government Research and Development Scheme Projects*, Government, Local Government Association of South Australia, <http://www.lga.sa.gov.au/site/page.cfm?u=562> (accessed 8 March 2012).
- List, J. 2003, 'Does market experience eliminate market anomalies?', *The Quarterly Journal of Economics*, vol. 118, no. 1, pp. 41–71.
- Lockyer Regional Council 2011, *Lockyer Valley Regional Council Ordinary Meeting of Council Minutes*, [http://www.lockyervalley.qld.gov.au/images/PDF/about\\_council/meetings/minutes/oc\\_29062011\\_min\\_at.pdf](http://www.lockyervalley.qld.gov.au/images/PDF/about_council/meetings/minutes/oc_29062011_min_at.pdf) (accessed 27 March 2011).
- Lucas, C., Hennessy, K., Mills, G. and Bathols, J. 2007, *Bushfire Weather in Southeast Australia: Recent Trends and Projected Climate Change Impacts*, Consultancy report prepared for the Climate Institute of Australia by the Bushfire CRC and CSIRO.
- LWEC (Living With Environmental Change) 2011, *About*, Swindon, United Kingdom, <http://www.lwec.org.uk/about> (accessed 19 December 2011).
- Mackay Regional Council 2009, *Final Minutes*, June, [http://www.mackay.qld.gov.au/\\_\\_data/assets/pdf\\_file/0005/54392/090603\\_-\\_Ordinary\\_Minutes.pdf](http://www.mackay.qld.gov.au/__data/assets/pdf_file/0005/54392/090603_-_Ordinary_Minutes.pdf) (accessed 6 February 2012).
- Mackellar, D. 2010 (1908), *My Country*, Scholastic Australia, Sydney.
- Maddocks 2011, *The Role of Regulation in Facilitating or Constraining Adaptation to Climate Change for Australian Infrastructure*, Report for the Department of Climate Change and Energy Efficiency, Canberra.
- Marsden Jacob Associates and Broadleaf Capital International 2009, *Redland City Council Climate Change Risk Assessment and Adaptation Plan*, Redland City



- 
- Council, [http://www.redland.qld.gov.au/SiteCollectionDocuments/Plans\\_Report s/Management\\_Plans/ClimateChangeRiskAssessmentAdaptationPlan.pdf](http://www.redland.qld.gov.au/SiteCollectionDocuments/Plans_Report s/Management_Plans/ClimateChangeRiskAssessmentAdaptationPlan.pdf) (accessed 13 March 2012).
- Mason, A. 2011, *The History of Flood Insurance in Australia*, Natural Disaster Insurance Review, Canberra.
- Maunsell Australia 2008a, *Impact of Climate Change on Australia's Road and Bridge Infrastructure*, Report commissioned for the Garnaut Climate Change Review, <http://www.garnautreview.org.au/CA25734E0016A131/pages/all-reports--resources-commissioned-reports.html> (accessed 6 September 2011).
- 2008b, *Impact of Climate Change on Australia's Telecommunications Infrastructure*, Report commissioned for the Garnaut Climate Change Review, <http://www.garnautreview.org.au/CA25734E0016A131/pages/all-reports--resources-commissioned-reports.html> (accessed 6 September 2011).
- 2008c, *Impact of Climate Change on Infrastructure in Australia and CGE Model Inputs*, Report commissioned for the Garnaut Climate Change Review, <http://www.garnautreview.org.au/CA25734E0016A131/pages/all-reports--resources-commissioned-reports.html> (accessed 6 September 2011).
- McClelland, R. 2011, *Mayo Lecture*, 6 October 2011, James Cook University, Townsville.
- McDonald, J. 2007, 'The adaptation imperative: managing the legal risks of climate change impacts', *Climate Law in Australia*, Federation Press, Sydney.
- McGregor, J.L., Walsh, K.J.E. and Nguyen, K.C. 2004, 'Fine-resolution regional climate model simulations of the impact of climate change on tropical cyclones near Australia', *Climate Dynamics*, vol. 22, no. 1, pp. 47–56.
- McMichael, A., Woodruff, R., Whetton, P., Hennessy, K., Nicholls, N., Hales, S., Woodward, A. and Kjellstrom, T. 2003, *Human Health and Climate Change in Oceania: A Risk Assessment 2002*, Department of Health and Ageing, Canberra.
- Michel-Kerjan, E. 2010, 'Catastrophe economics: The National Flood Insurance Program', *Journal of Economic Perspectives*, vol. 24, no. 4, pp. 165–186.
- and Morlaye, F. 2008, 'Extreme events, global warming, and insurance-linked securities: How to trigger the "tipping point"', *The Geneva Papers on Risk and Insurance*, vol. 33, pp. 153–176.
- Mills, E. 2005, 'Insurance in a climate of change', *Science*, vol. 309, pp. 1040–1044.
- , Roth, R.J. and Lecomte, E. 2005, *Availability and Affordability of Insurance under Climate Change: A Growing Challenge for the U.S.*, Ceres, Boston.

- 
- MJ Powling Research Consulting 2001, *Home and Motor Vehicle Insurance: A Survey of Australian Households*, NRMA Insurance Ltd, Sydney.
- Molino Stewart 2011, *Community and Stakeholder Consultation Program for Lake Macquarie Waterway Flood Management Plan*, December, <http://www.lakemac.com.au/downloads/Community%20survey%20and%20workshop%20results%20-%20final%20report%20%282012%29.pdf> (accessed 14 March 2012).
- Moore, M. 2010, 'Beachfront landowners win sandbag decision', *Sydney Morning Herald*, 3 February.
- Mortimer, E., Bergin, A. and Carter, R. 2011, *Sharing Risk: Financing Australia's Disaster Resilience*, Australian Strategic Policy Institute, Canberra.
- Mpelasoka, F., Hennessy, K., Jones, R. and Bates, B. 2008, 'Comparison of suitable drought indices for climate change impacts assessment over Australia towards resource management', *International Journal of Climatology*, vol. 28, no. 10, pp. 1283–1292.
- Municipal Association of Victoria 2011, *The Role of Local Government in Emergency Management*, <http://www.mav.asn.au/news/Pages/Role-of-Local-Government-in-Emergency-Management-7-Dec.aspx> (accessed 10 April 2012).
- Munro, K. 2011, 'Residents step up action against Byron council and sue over beachfront property dispute', *Sydney Morning Herald*, 11 January.
- Murtough, G., Aretino, B. and Matysek, A. 2002, *Creating Markets for Ecosystem Services*, Productivity Commission Staff Research Paper, Canberra.
- NASA (National Aeronautics and Space Administration) 2011, *NASA's Role: Taking a Global Perspective on Earth's Climate*, United States, Pasadena, California, <http://climate.nasa.gov/NasaRole> (accessed 19 December 2011).
- National Wildlife Corridors Plan Advisory Group 2012, *Draft National Wildlife Corridors Plan*, Department of Sustainability, Environment, Water, Population and Communities, Canberra.
- Natural Resources Canada 2011a, *Climate Change Impacts and Adaptation: What We Do*, Government of Canada, Ottawa, [http://adaptation.nrcan.gc.ca/whaquo\\_e.php](http://adaptation.nrcan.gc.ca/whaquo_e.php) (accessed 12 December 2011).
- 2011b, *Tools for Adaptation*, Government of Canada, Ottawa, [http://adaptation.nrcan.gc.ca/tools/abosuj\\_e.php](http://adaptation.nrcan.gc.ca/tools/abosuj_e.php) (accessed 12 December 2011).
- NCCARF (National Climate Change Adaptation Research Facility) 2009, *National Climate Change Adaptation Research Plan for Human Health*, Gold Coast.

- 
- 2010a, *National Climate Change Adaptation Research Plan - Settlements and Infrastructure*, <http://www.nccarf.edu.au/sites/default/files/NCCARF%20Settlement%20Book%20FINAL.pdf> (accessed 8 February 2012).
- 2010b, *Phase 1: Establishment Phase May 2008 - May 2010 Report*, [http://www.nccarf.edu.au/sites/default/files/3328-NCC-NCCARF-Report%5B11%5D\(1\).pdf](http://www.nccarf.edu.au/sites/default/files/3328-NCC-NCCARF-Report%5B11%5D(1).pdf) (accessed 19 March 2012).
- 2011, *NCCARF Strategy 2010-2013 Summary*, Queensland.
- NDIR (Natural Disaster Insurance Review) 2011, *Natural Disaster Insurance Review: Inquiry into Flood Insurance and Related Matters*, Treasury, Canberra.
- Nelson, G., Rosegrant, M., Koo, J., Robertson, R., Sulser, T., Zhu, T., Ringler, C., Msangi, S., Palazzo, A., Batka, M., Maghalhaes, M., Valmonte-Santos, R., Ewing, M. and Lee, D. 2009, *Climate Change: Impact on Agriculture and Costs of Adaptation*, International Food Policy Research Institute, Washington DC.
- Nicholls, N. 1999, 'Cognitive illusions, heuristics, and climate prediction', *Bulletin-American Meteorological Society*, vol. 80, pp. 1385–1398.
- , Drosowsky, W. and Lavery, B. 1997, 'Australian rainfall variability and change', *Weather*, vol. 52, pp. 66–72.
- NOAA (National Oceanic and Atmospheric Administration) 2009, *Basics of the Carbon Cycle and the Greenhouse Effect*, [http://www.esrl.noaa.gov/gmd/outreach/carbon\\_toolkit/basics.html](http://www.esrl.noaa.gov/gmd/outreach/carbon_toolkit/basics.html) (accessed 22 December 2011).
- 2011, *Climate Program Office: Program Activities*, United States Department of Commerce, Silver Spring, Maryland, [http://www.climate.noaa.gov/index.jsp?pg=/.cpo\\_pa/cpo\\_pa\\_index.jsp&pa=all](http://www.climate.noaa.gov/index.jsp?pg=/.cpo_pa/cpo_pa_index.jsp&pa=all) (accessed 13 December 2011).
- 2012, *Erosion Control Easements*, Ocean and Coastal Resource Management, [http://coastalmanagement.noaa.gov/initiatives/shoreline\\_ppr\\_easements.html](http://coastalmanagement.noaa.gov/initiatives/shoreline_ppr_easements.html) (accessed 14 March 2012).
- Nordhaus, W. 1998, *New estimates of the economic impacts of climate change*, <http://www.sc-eco.univ-nantes.fr/~tvallee/memoire/model-DICE/nordhaus/impact%20text%20122998a.pdf> (accessed 5 December 2010).
- NRMMC (Natural Resource Management Ministerial Council) 2010, *Australia's Biodiversity Conservation Strategy 2010-2030*, Canberra.
- NRTEE (National Roundtable on the Environment and the Economy) 2009, *True North: Adapting Infrastructure to Climate Change in Northern Canada*, Government of Canada, Ottawa.

- 
- NSW DECC (Department of the Environment and Climate Change) 2007, *Practical Consideration of Climate Change*, Floodplain Risk Management Guideline, October, Sydney, <http://www.environment.nsw.gov.au/resources/floodplains/FRMGuidelinePracticalConsiderationClimateChange.pdf> (accessed 23 March 2012).
- NSW DECCW (Department of the Environment, Climate Change and Water) 2009, *NSW Sea Level Rise Policy Statement*, October, Sydney, <http://www.planning.nsw.gov.au/LinkClick.aspx?fileticket=ukmXcVJesYA%3D&tabid=177> (accessed 23 March 2012).
- NSW Department of Planning 2010, *NSW Coastal Planning Guidelines: Adapting to Sea Level Rise*, August, Sydney, <http://www.planning.nsw.gov.au/LinkClick.aspx?fileticket=VYjmQirQlAk%3d&tabid=177&language=en-US> (accessed 23 March 2012).
- NSW Department of Premier and Cabinet Better Regulation Office 2008, *Measuring the Costs of Regulation*, June, Sydney.
- NSW Government 1997, *NSW Coastal Policy 1997*, October, Sydney, <http://www.planning.nsw.gov.au/plansforaction/pdf/CPPARTA.PDF> (accessed 23 March 2012).
- 2008, *State Infrastructure Strategy 2008-09 to 2017-18*, June, [http://www.treasury.nsw.gov.au/\\_\\_data/assets/pdf\\_file/0017/11717/sis2008\\_1\\_introduction.pdf](http://www.treasury.nsw.gov.au/__data/assets/pdf_file/0017/11717/sis2008_1_introduction.pdf) (accessed 19 January 2012).
- 2010a, *2010 Metropolitan Water Plan*, Sydney.
- 2010b, *Metropolitan Plan for Sydney 2036*, Sydney.
- 2011, *State Heatwave Sub Plan*, Sydney.
- 2012, *Adapting to Climate Change*, <http://www.environment.nsw.gov.au/climatechange/adaptation.htm> (accessed 3 April 2012).
- NSW Treasury 2007, *NSW Government Guidelines for Economic Appraisal*, Sydney.
- 2010, *Economic Appraisal Guidelines - Guidance on Climate Change for Asset and Infrastructure Assessments*, Treasury Circular 10/12, September, Sydney.
- 2011, *Interstate Comparison of Taxes 2011-12*, Research and Information Paper, Office of Financial Management, Sydney.
- NT Government 2009, *Northern Territory Climate Change Policy*, Darwin.
- nd, *Northern Territory Planning Scheme*, Darwin.

- 
- NWC (National Water Commission) 2011a, *Strengthening Australia's Water Markets*, <http://nwc-web01.squiz.net/publications/bookshop/june-2011/strengthening-australias-water-markets> (accessed 23 December 2011).
- 2011b, *The National Water Initiative - Securing Australia's Water Future: 2011 Assessment*, <http://www.nwc.gov.au/water-reform/assessing-progress/biennial-assessments/the-national-water-initiative-securing-australias-water-future-2011-assessment> (accessed 23 December 2011).
- NZ Ministry for the Environment 2008a, *Climate Change Effects and Impacts Assessment: A Guidance Manual for Local Government in New Zealand*, second edn, Wellington.
- 2008b, *Coastal Hazards and Climate Change: A Guidance Manual for Local Government in New Zealand*, second edn, Wellington.
- 2010, *Preparing for Future Flooding: A Guide for Local Government in New Zealand*, Wellington.
- NZ Ministry of Agriculture and Forestry 2010, *Adaptation Toolbox*, Wellington, <http://www.maf.govt.nz/environment-natural-resources/climate-change/resources-and-tools/adaptation-toolbox> (accessed 19 December 2011).
- O'Sullivan, J. and The Consultancy Bureau Pty Ltd 2009, *A Review of Disaster Management Legislation and Policy in Queensland*, <http://www.emergency.qld.gov.au/publications/pdf/Consultants%20DM%20Report%20FINAL.pdf> (accessed 19 January 2012).
- OECD (Organisation for Economic Cooperation and Development) 2009, *Integrating Climate Change Adaptation into Development Co-operation: Policy Guidance*, Paris.
- 2011a, *Adaptation to Climate Change*, Paris, <http://www.oecd.org/env/cc/adaptation> (accessed 7 December 2011).
- 2011b, *Risk Awareness, Capital Markets and Catastrophic Risks*, Policy Issues in Insurance No. 14, Paris.
- OESC (Office of the Emergency Services Commissioner) 2012, *Emergency Management Manual Victoria*.
- OGC (Office of Governance and Commerce) and DEFRA (Department for the Environment, Food and Rural Affairs) 2010, *Adapting Your Procurement*, United Kingdom, London.
- PARC (Prairie Adaptation Research Collaborative) nd, *Home*, Regina, Saskatchewan, Canada, <http://www.parc.ca/rac/index.php?page=home> (accessed 12 December 2011).

- 
- Park, S.E., Marshall, N.A., Jakku, E., Dowd, A.M., Howden, S.M., Mendham, E. and Fleming, A. 2012, 'Informing adaptation responses to climate change through theories of transformation', *Global Environmental Change*, vol. 22, no. 1, pp. 115–126.
- PC (Productivity Commission) 1996, *Stocktake of Progress in Microeconomic Reform*, Research Report, Canberra.
- 1999a, *Implementation of Ecologically Sustainable Development by Commonwealth Departments and Agencies*, Report no. 5, Canberra.
- 1999b, *Microeconomic Reform and Australian Productivity: Exploring the Links*, Research Report, Canberra.
- 2001a, *Cost Recovery by Government Agencies*, Report no. 15, Melbourne.
- 2001b, *Structural Adjustment - Key Policy Issues*, Melbourne, <http://www.pc.gov.au/research/commissionresearch/sakpi> (accessed 13 December 2011).
- 2002, *Price Regulation of Airport Services*, Report no. 19, Canberra.
- 2004a, *First Home Ownership*, Report no. 28, Melbourne.
- 2004b, *Impacts of Native Vegetation and Biodiversity Regulations*, Report no. 29, Melbourne.
- 2004c, *Reform of Building Regulation*, Research Report, Canberra.
- 2004d, *Review of the Gas Access Regime*, Report no. 31, Canberra.
- 2005, *The Private Cost Effectiveness of Improving Energy Efficiency*, Report no. 36, Canberra.
- 2006, *Road and Rail Freight Infrastructure Pricing*, December, Report no. 41, Canberra.
- 2007, *Public Support for Science and Innovation*, Research Report, Canberra.
- 2008a, *Assessing Local Government Revenue Raising Capacity*, Research Report, Canberra.
- 2008b, *Review of Australia's Consumer Policy Framework*, Report no. 45, Canberra.
- 2009, *Government Drought Support*, Final Inquiry Report, Report no. 46, Melbourne.
- 2010a, *Catalogue of COAG Reforms and Initiatives. Impacts and Benefits of COAG Reforms: Annex to the Research Report*, Canberra.

- 
- 2010b, *Market Mechanisms for Recovering Water in the Murray-Darling Basin*, Research Report, Melbourne.
- 2011a, *Australia's Urban Water Sector*, Report no. 55, Melbourne.
- 2011b, *Carbon Emission Policies in Key Economies*, Research Report, Canberra.
- 2011c, *Identifying and Evaluating Regulation Reforms*, Research Report, Canberra.
- 2011d, *Impacts of COAG Reforms: Business Regulation and VET - Overview*, Discussion Draft, Canberra, [http://www.pc.gov.au/\\_\\_data/assets/pdf\\_file/0019/114346/coag-reform-business-regulation-vet-overview.pdf](http://www.pc.gov.au/__data/assets/pdf_file/0019/114346/coag-reform-business-regulation-vet-overview.pdf) (accessed 28 February 2012).
- 2011e, *Impacts of COAG Reforms: Business Regulation, and VET: Part A Business Regulation*, Discussion Draft, Canberra, [http://www.pc.gov.au/\\_\\_data/assets/pdf\\_file/0003/114348/coag-reform-business-regulation.pdf](http://www.pc.gov.au/__data/assets/pdf_file/0003/114348/coag-reform-business-regulation.pdf) (accessed 28 February 2012).
- 2011f, *Performance Benchmarking of Australian Business Regulation: Planning, Zoning and Development Assessments.*, Research Report, Canberra.
- 2012, *Performance Benchmarking of Australian Business Regulation: The Role of Local Government as Regulator*, Draft Research Report, Canberra.
- Pearce, T., Handmer, J., Higgins, J., King, D., McDonald, J., Pagano, F., Schneider, J. and Whetton, P. 2009, *National Climate Change Adaptation Research Plan for Emergency Management*, National Climate Change Adaptation Research Facility, Gold Coast.
- Pillora, S. 2010, *Australian Local Government and Climate Change*, Working Paper no. 1, Australian Centre of Excellence for Local Government, University of Technology, Sydney, [http://www.acelg.org.au/upload/documents/1279693805\\_ACELG\\_ClimateChangeReport\\_July10.pdf](http://www.acelg.org.au/upload/documents/1279693805_ACELG_ClimateChangeReport_July10.pdf) (accessed 13 March 2012).
- PIMF (Primary Industries Ministerial Forum) 2008, *Communique, 12 November 2008*, [http://www.daff.gov.au/agriculture-food/drought/national\\_review\\_of\\_drought\\_policy/communiques/primary\\_industries\\_ministerial\\_forum\\_-\\_12\\_november\\_2008](http://www.daff.gov.au/agriculture-food/drought/national_review_of_drought_policy/communiques/primary_industries_ministerial_forum_-_12_november_2008) (accessed 23 December 2012).
- Pittwater Council 2012, *The Special Rate Variation Explained*, <http://www.pittwater.nsw.gov.au/council/specialratevariation/explained> (accessed 6 February 2012).
- PMSEIC (Prime Minister's Science, Engineering and Innovation Council) Independent Working Group 2007, *Climate Change in Australia: Regional*

---

*Impacts and Adaptation: Managing the Risk for Australia*, Report prepared for the Prime Minister's Science, Engineering and Innovation Council, Canberra.

Port Adelaide Enfield Council 2012, *Port Adelaide Enfield Council Development Plan*, Development Plan, 16 February, [http://www.sa.gov.au/upload/franchise/Housing,%20property%20and%20land/PLG/Online%20DPs/Greater%20metropolitan/Port\\_Adelaide\\_Enfield\\_Council\\_Development\\_Plan.pdf](http://www.sa.gov.au/upload/franchise/Housing,%20property%20and%20land/PLG/Online%20DPs/Greater%20metropolitan/Port_Adelaide_Enfield_Council_Development_Plan.pdf) (accessed 27 March 2012).

Poverty-Environment Initiative 2011, *Mainstreaming Climate Change Adaptation into Development Planning: A Guide for Practitioners*, United Nations Environment Programme and United Nations Development Programme, Nairobi.

Purdon Associates and AECOM 2010, *East Lake Electrical Infrastructure: Final Environmental Impact Statement*, July, Canberra.

PWC (Pricewaterhouse Coopers) 2011, *Protecting Human Health and Safety During Severe and Extreme Heat Events: A National Framework*, Canberra.

Queensland DERM (Department of Environment and Resource Management) 2012, *Queensland Coastal Plan*, January, Brisbane, <http://www.derm.qld.gov.au/coastalplan/pdf/qcp-web.pdf> (accessed 23 March 2012).

Queensland DLGP (Department of Local Government and Planning) 2012, *Local Government Grants and Subsidies Program*, <http://www.dlgp.qld.gov.au/grants-and-funding/local-government-grants-and-subsidies-program.html> (accessed 22 March 2012).

Queensland Environmental Protection Agency 2008, *Guidelines for Preparing a Climate Change Impact Statement (CCIS)*, Brisbane.

Queensland Floods Commission of Inquiry 2011, *Interim Report*, Brisbane.

— 2012, *Final Report*, Brisbane.

Queensland Government 2007, *ClimateSmart Adaptation 2007–12*, Brisbane.

— 2010a, *Climate Ready Infrastructure Initiative Fact Sheet*, <http://www.climatechange.qld.gov.au/pdf/factsheets/8govlship-n3.pdf> (accessed 22 March 2012).

— 2010b, *Increasing Queensland's Resilience to Inland Flooding in a Changing Climate: Final Report on the Inland Flooding Study*, Brisbane.

— 2011a, *Great Barrier Reef First Report Card: 2009 Baseline*, Brisbane.

— 2011b, *Queensland Infrastructure Plan: Building Tomorrow's Queensland*, November, <http://www.dlgp.qld.gov.au/resources/plan/qip/queensland-infrastructure-plan.pdf> (accessed 19 January 2012).



- 
- 2012a, *Office of Climate Change*, <http://www.climatechange.qld.gov.au/whatsbeingdone/queensland/officeofclimatechange.html> (accessed 21 March 2012).
- 2012b, *Premier's Council on Climate Change*, <http://www.climatechange.qld.gov.au/whatsbeingdone/queensland/premierscouncil/index.html> (accessed 21 March 2012).
- 2012c, *State Budget 2011-12 Mid Year Fiscal and Economic Review*, Brisbane.
- Queensland Health 2004, *Queensland Heatwave Response Plan*, Brisbane.
- Queensland Office of Climate Change 2012, *Townsville Coastal Hazard Adaptation Strategy Pilot Project*, Brisbane, <http://www.climatechange.qld.gov.au/whatsbeingdone/townsville-strategy-pilot-program.html> (accessed 9 March 2012).
- Redland City Council 2010, *Confronting Our Climate Future, A Strategy to 2030 for Redland City to Reduce Greenhouse Gas Emissions, Respond to Climate Change, Achieve Energy Transition*, [http://www.redland.qld.gov.au/SiteCollectionDocuments/Plans\\_Reports/Environment\\_plans/Confronting\\_our\\_climate\\_future.pdf](http://www.redland.qld.gov.au/SiteCollectionDocuments/Plans_Reports/Environment_plans/Confronting_our_climate_future.pdf) (accessed 26 March 2012).
- Reeder, T. and Ranger, N. nd, *How do you Adapt in an Uncertain World? Lessons from the Thames Estuary 2100 Project*, World Resources Report Uncertainty Series, Washington DC.
- Reeson, A. and Dunstall, S. 2009, *Behavioural Economics and Complex Decision-Making: Implications for the Australian Tax and Transfer System*, CSIRO, [http://taxreview.treasury.gov.au/content/html/commissioned\\_work/downloads/CSIRO\\_AFTS\\_Behavioural\\_economics\\_paper.pdf](http://taxreview.treasury.gov.au/content/html/commissioned_work/downloads/CSIRO_AFTS_Behavioural_economics_paper.pdf) (accessed 30 January 2012).
- Rive, N., Aaheim, H. and Hauge, K. 2005, 'Adaptation and world market effects of climate change on forestry and forestry products', presented at the 8th Annual Conference on Global Economic Analysis, Lübeck, Germany.
- Roger, E. and Dunford, S. 2011, *Delivering Improved Climate Change Projections for NSW Councils*, Office of Environment and Heritage, <http://www.ancelg.org.au/upload/Delivering%20improved%20climate%20change%20projections%20Erin%20Roger.pdf> (accessed 28 March 2012).
- SA DPLG (Department of Planning and Local Government) 2011, *South Australian Planning Policy Library: Version 6*, September, Adelaide, [http://www.sa.gov.au/upload/franchise/Housing,%20property%20and%20land/PLG/SA\\_Planning\\_Policy\\_Library\\_version\\_6.pdf](http://www.sa.gov.au/upload/franchise/Housing,%20property%20and%20land/PLG/SA_Planning_Policy_Library_version_6.pdf) (accessed 23 March 2012).

---

SA Government 2010a, *Prospering in a Changing Climate - A Draft Climate Change Adaptation Framework for South Australia*, [http://www.sa.gov.au/upload/franchise/Water,%20energy%20and%20environment/climate\\_change/documents/adaptation/Draft\\_Climate\\_Change\\_Adaptation\\_Framework.pdf](http://www.sa.gov.au/upload/franchise/Water,%20energy%20and%20environment/climate_change/documents/adaptation/Draft_Climate_Change_Adaptation_Framework.pdf) (accessed 18 March 2012).

—— 2010b, *Water for Good*, <http://www.waterforgood.sa.gov.au/wp-content/uploads/2009/06/complete-water-for-good-plan.pdf> (accessed 21 March 2012).

—— 2012a, *Premier's Climate Change Council*, <http://www.sa.gov.au/subject/Water,+energy+and+environment/Climate+change/Tackling+climate+change/Premier's+Climate+Change+Council> (accessed 21 March 2012).

—— 2012b, *South Australia's Climate Change Legislation*, <http://www.sa.gov.au/subject/Water%2C+energy+and+environment/Climate+change/Tackling+climate+change/South+Australia's+climate+change+legislation> (accessed 21 March 2012).

SBTRC (State Business Tax Revenue Committee) 2001, *Review of State Business Taxes*, Victorian Department of Treasury and Finance, Melbourne.

SCCCWEA (Standing Committee on Climate Change, Water, Environment and the Arts) 2009, *Managing Our Coastal Zone in a Changing Climate*, House of Representatives Inquiry, Canberra, [http://www.aph.gov.au/Parliamentary\\_Business/Committees/House\\_of\\_Representatives\\_Committees?url=ccwea/coastalzone/report.htm](http://www.aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=ccwea/coastalzone/report.htm) (accessed 27 March 2012).

SCCG (Sydney Coastal Councils Group) 2011a, *About the Sydney Coastal Councils Group*, [http://www.sydneycoastalcouncils.com.au/About\\_SCCG](http://www.sydneycoastalcouncils.com.au/About_SCCG) (accessed 3 April 2012).

—— 2011b, *Assessment and Decision Frameworks for Seawall Structures Project*, [http://www.sydneycoastalcouncils.com.au/Project/assessment\\_and\\_decision\\_frameworks\\_for\\_seawall\\_structures\\_project](http://www.sydneycoastalcouncils.com.au/Project/assessment_and_decision_frameworks_for_seawall_structures_project) (accessed 29 February 2012).

SCFFR (Standing Council on Federal Financial Relations) 2012, *National Partnerships - Environment*, Canberra, [http://www.federalfinancialrelations.gov.au/content/national\\_partnership\\_agreements/environment.aspx](http://www.federalfinancialrelations.gov.au/content/national_partnership_agreements/environment.aspx) (accessed 10 April 2012).

Schneider, S.H. 2004, 'Abrupt non-linear climate change, irreversibility and surprise', *Global Environmental Change Part A*, vol. 14, no. 3, pp. 245–258.

SCISI (Standing Committee on Industry, Science and Innovation) 2009, *Seasonal Forecasting in Australia: Report of the Inquiry into Long-Term Meteorological Forecasting in Australia*, Parliamentary paper 409/2009, House of

- 
- Representatives, Canberra, [http://www.aph.gov.au/Parliamentary\\_Business/Committees/House\\_of\\_Representatives\\_Committees?url=ccea/ccbio/tor.htm](http://www.aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=ccea/ccbio/tor.htm) (accessed 14 March 2012).
- SCRGSP (Standing Committee for the Review of Government Services Provision) 2012, *Report on Government Services 2012*, Productivity Commission, Canberra.
- SCSPLA (Standing Committee on Social Policy and Legal Affairs) 2012a, *In the Wake of Disasters Volume One: The Operation of the Insurance Industry During Disaster Events*, House of Representatives, Canberra.
- 2012b, *In the Wake of Disasters Volume Two: The Affordability of Residential Strata Title Insurance*, House of Representatives, Canberra.
- Shafir, E. 2008, 'A behavioural background for economic policy', *Behavioural Economics and Public Policy: Roundtable Proceeding*, Productivity Commission, Canberra.
- Sharp, L. and Tinsley, F. 2005, 'PPP policies throughout Australia: A comparative analysis of public private partnerships', *Public Infrastructure Bulletin*, vol. 1, no. 5, pp. 21–34.
- Sheehan, G. and Renouf, G. 2006, *Risk and Reality: Access to General Insurance for People on Low Incomes*, Brotherhood of St. Laurence, Melbourne.
- SMEC 2012, *Lake Cathie Coastline Management Study - Stage 2*, February, Newcastle.
- SSCARI (Senate Select Committee on Agriculture and Related Impacts) 2010, *The Incidence and Severity of Bushfires Across Australia*, August, [http://www.aph.gov.au/Parliamentary\\_Business/Committees/Custom\\_Contents/SenateCommittees/agricctte/bushfires/report](http://www.aph.gov.au/Parliamentary_Business/Committees/Custom_Contents/SenateCommittees/agricctte/bushfires/report) (accessed 2 April 2012).
- Standards Australia 2011, *Climate Change Adaptation for Settlements and Infrastructure*, Draft Standard DR AS 5334.
- State of the Environment 2011 Committee 2011, *Australia State of the Environment 2011: In Brief*, Department of Sustainability, Environment, Water, Population and Communities, Canberra.
- STCA (Southern Tasmanian Councils Authority) 2012, *RCCAP — Regional Councils Climate Adaptation Project*, Hobart, <http://stca.tas.gov.au/cc/rccap—regional-councils-climate-adaptation-project/> (accessed 9 March 2012).
- Steffen, W., Burbidge, A., Hughes, L., Kitching, R., Lindenmayer, D., Musgrave, W., Smith, M.S. and Werner, P. 2009, *Australia's Biodiversity and Climate Change: Summary for Policy Makers*, Department of Climate Change, Canberra.

- 
- Stern, N. 2007, *The Economics of Climate Change*, Cambridge University Press, Cambridge.
- Stirling, A. 2003, 'Risk, uncertainty and precaution: some instrumental implications from the social sciences', in Berkhout, F., Leach, M. and Scoones, I. (eds), *Negotiating Environmental Change*, Edward Elgar, Cheltenham, UK, pp. 33–76.
- Stokes, C. and Howden, M. 2010, *Adapting Agriculture to Climate Change: Preparing Australian Agriculture, Forestry and Fisheries for the Future*, CSIRO Publishing, Collingwood, Victoria.
- Suarez, P. and Patt, A. 2004, 'Cognition, caution, and credibility: the risks of climate forecast application', *Risk Decision and Policy*, vol. 9, no. 1, pp. 75–89.
- Sydney Water 2010, *Climate Change Adaptation Program Summary*, Sydney.
- Tasmanian Climate Action Council 2010, *Acting on Climate Change: Progress in Tasmania in 2008-10. Inaugural Biennial Report to the Minister for Climate Change.*,  
[http://www.dpac.tas.gov.au/\\_data/assets/pdf\\_file/0011/154568/Tasmanian\\_Climate\\_Action\\_Council\\_Biennial\\_Report\\_2008-10.pdf](http://www.dpac.tas.gov.au/_data/assets/pdf_file/0011/154568/Tasmanian_Climate_Action_Council_Biennial_Report_2008-10.pdf) (accessed 21 March 2012).
- Tasmanian Climate Change Office 2012, *Climate Connect Grants*, [http://www.climatechange.tas.gov.au/grants/climateconnect\\_grants](http://www.climatechange.tas.gov.au/grants/climateconnect_grants) (accessed 14 March 2012).
- Tasmanian DPaC (Department of Premier and Cabinet) 2011a, *Climate Futures for Tasmania*, [http://www.dpac.tas.gov.au/divisions/climatechange/adapting/climate\\_futures](http://www.dpac.tas.gov.au/divisions/climatechange/adapting/climate_futures) (accessed 16 March 2012).
- 2011b, *Regional Councils Climate Adaptation Project Update*, Hobart, [http://www.dpac.tas.gov.au/divisions/climatechange/news/regional\\_councils\\_climate\\_adaptation\\_project\\_update](http://www.dpac.tas.gov.au/divisions/climatechange/news/regional_councils_climate_adaptation_project_update) (accessed 9 March 2012).
- Tasmanian Government 2008, *Tasmanian Framework for Action on Climate Change*, Hobart.
- 2012a, *Tasmanian Climate Action Council*, [http://www.dpac.tas.gov.au/divisions/climatechange/action\\_council](http://www.dpac.tas.gov.au/divisions/climatechange/action_council) (accessed 21 March 2012).
- 2012b, *Tasmanian Climate Change Office*, <http://www.dpac.tas.gov.au/divisions/climatechange> (accessed 21 March 2012).
- Thaler, R. 1981, 'Some empirical evidence on dynamic inconsistency', *Economics Letters*, vol. 8, no. 3, pp. 201–207.
- and Sunstein, C. 2008, *Nudge: improving decisions about health, wealth, and happiness*, Yale University Press, London.

- 
- Thunnissen, D.P. 2003, 'Uncertainty classification for the design and development of complex systems', presented at the 3rd Annual Predictive Methods Conference, Newport Beach, California.
- Titus, J.G. 1998, 'Rising seas, coastal erosion, and the takings clause: how to save wetlands and beaches without hurting property owners', *Maryland Law Review*, vol. 57, pp. 1279–1502.
- Tol, R. 2007, 'The double trade-off between adaptation and mitigation for sea level rise: an application of FUND', *Mitigation and Adaptation Strategies for Global Change*, vol. 12, no. 5, pp. 741–753.
- Tooth, R. 2011, *Flood Insurance: Economics and Issues*, Sapere Research Group, Sydney.
- and Barker, G. 2007, *The Non-Insured: Who, Why and Trends*, Insurance Council of Australia, Sydney.
- Transurban 2011, *Sustainability Report 2011*, <http://www.transurban.com/sr11/interactive/> (accessed 29 February 2012).
- Treasury 2006, *Final Budget Outcome 2005-06*, Canberra.
- 2007, *Final Budget Outcome 2006-07*, Canberra.
- 2008, *Final Budget Outcome 2007-08*, Canberra.
- 2009, *Final Budget Outcome 2008-09*, Canberra.
- 2010a, *Australia's Future Tax System: Report to the Treasurer*, detailed analysis, vol. 2, Canberra.
- 2010b, *Final Budget Outcome 2009-10*, Canberra.
- 2011a, *Final Budget Outcome 2010-11*, Canberra.
- 2011b, *Key Fact Sheet for Home Building and Home Contents Insurance Policies*, Regulation Impact Statement, Canberra.
- 2011c, *Reforming Flood Insurance: A Proposal to Improve Availability and Transparency*, Consultation Paper, Canberra.
- 2011d, *Reforming Flood Insurance: Clearing the Waters*, Consultation Paper, Canberra.
- 2011e, *Reforming Flood Insurance: Standard Definition of Flood*, Regulation Impact Statement, Canberra.
- 2011f, *Unfair Terms in Insurance Contracts: Draft Regulation Impact Statement for Consultation*, Canberra.

- 
- 2012, *Key Facts Sheet: Home Building and Contents Insurance Policies*, Discussion Paper, Canberra.
- Tversky, A. and Kahneman, D. 1973, 'Availability: A heuristic for judging frequency and probability', *Cognitive Psychology*, vol. 5, no. 2, pp. 207–232.
- and —— 1974, 'Judgment under uncertainty: Heuristics and biases', *Science*, vol. 185, no. 4157, pp. 1124–1131.
- and —— 1986, 'Rational choice and the framing of decisions', *The Journal of Business*, vol. 59, no. 4, pp. S251–S278.
- UK Environment Agency 2011, *A New Adapting to Climate Change Programme*, United Kingdom, London.
- UKCIP 2011, *Tools*, Oxford, <http://www.ukcip.org.uk/tools> (accessed 14 December 2011).
- UN (United Nations) 1992, *United Nations Framework Convention on Climate Change*, New York.
- UNDP (United Nations Development Programme) 2004, *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures*, Cambridge University Press, Cambridge.
- 2007, *Adaptation to Climate Change: Doing Development Differently*, UNDP Briefing Note, New York.
- 2011a, *Adaptation to Climate Change*, New York, <http://www.undp.org/climatechange/adapt> (accessed 7 December 2011).
- 2011b, *Climate Change Adaptation*, United Nations Development Programme – Global Environment Facility, New York, [http://www.undp.org/gef/do\\_cc\\_adaptation.shtml](http://www.undp.org/gef/do_cc_adaptation.shtml) (accessed 20 December 2011).
- 2011c, *UNDP Projects that Contribute to Green LECDs*, [http://www.beta.undp.org/undp/en/home/ourwork/environmentandenergy/focus\\_areas/climate\\_strategies/undp\\_projects\\_thatcontributetogreenlecds.html](http://www.beta.undp.org/undp/en/home/ourwork/environmentandenergy/focus_areas/climate_strategies/undp_projects_thatcontributetogreenlecds.html) (accessed 12 December 2011).
- and GEF (Global Environment Facility) 2010, *Adapting to Climate Change: UNDP-GEF Initiatives Financed by the Least Developed Countries Fund, Special Climate Change Fund and Strategic Priority on Adaptation*, New York.
- UNEP (United Nations Development Programme) 2012, *Knowledge Support and Policy Integration*, Nairobi, <http://www.unep.org/climatechange/adaptation/KnowledgeandPolicy/tabid/29577/Default.aspx> (accessed 19 January 2012).

- 
- UNFCCC (United Nations Framework Convention on Climate Change) 2007, *Investment and Financial Flows to Address Climate Change*, October, <http://unfccc.int/resource/docs/2008/tp/07.pdf> (accessed 10 December 2012).
- 2011a, *Decisions Adopted by the Conference of the Parties*, Report of the Conference of the Parties on its sixteenth session, held in Cancun from 29 November to 10 December 2010, Bonn.
- 2011b, *Green Climate Fund: Report of the Transitional Committee*, Draft decision CP.17, Bonn.
- 2011c, *Nairobi Work Programme on Impacts, Vulnerability and Adaptation to Climate Change (NWP)*, Bonn, [http://unfccc.int/adaptation/nairobi\\_work\\_programme/items/3633.php](http://unfccc.int/adaptation/nairobi_work_programme/items/3633.php) (accessed 12 December 2011).
- UNISDR (United Nations International Strategy for Disaster Reduction) 2007, *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*, Geneva.
- 2011, *Strategic Framework 2025, Work Programme 2012-2015*, Geneva.
- 2012, *What We Do*, Geneva, <http://www.unisdr.org/we> (accessed 16 February 2012).
- USGCRP (United Nations Global Change Research Program) 2011, *Overview*, United States Government, Washington DC, [http://www.globalchange.gov/index.php?option=com\\_content&view=article&id=417&Itemid=401](http://www.globalchange.gov/index.php?option=com_content&view=article&id=417&Itemid=401) (accessed 13 December 2011).
- Victorian Bushfires Royal Commission 2010, *2009 Victorian Bushfires Royal Commission Final Report*, vol. 2, Melbourne.
- Victorian Department of Health 2011, *Heatwave Plan for Victoria: Protecting Health and Reducing Harm from Heatwaves*, Melbourne.
- Victorian Department of Sustainability and Environment 2011, *Bushfire Hazard and Biodiversity Mapping Project*, <http://www.dse.vic.gov.au/land-management/land/native-vegetation-home/bushfire-hazard-and-biodiversity-mapping-project> (accessed 16 March 2012).
- Victorian Department of Treasury and Finance 2011, *Victorian Fire Services Property Levy*, Options Paper, Melbourne.
- Victorian DPCD (Department of Planning and Community Development) 2012, *Regional and Rural Planning Flying Squad*, <http://www.dpcd.vic.gov.au/planning/projects-and-programs/rural-planning-flying-squad> (accessed 15 March 2012).

- 
- Victorian Government 2008, *Victorian Coastal Strategy 2008*, Melbourne, <http://www.vcc.vic.gov.au/2008vcs/VCCCoastalStrategyfinal.pdf> (accessed 23 March 2012).
- 2011a, *Implementing the Government's Response to the 2009 Victorian Bushfires Royal Commission*, Melbourne.
- 2011b, *Review of the 2010-11 Flood Warnings and Response*, Final Report, Melbourne.
- 2011c, *Towards A More Disaster Resilient and Safer Victoria*, Melbourne.
- 2012a, *Regional Growth Fund*, [http://www.rdv.vic.gov.au/\\_\\_data/assets/pdf\\_file/0005/67973/RGF-6295\\_12pp-BOOKLET\\_web.pdf](http://www.rdv.vic.gov.au/__data/assets/pdf_file/0005/67973/RGF-6295_12pp-BOOKLET_web.pdf) (accessed 9 March 2012).
- 2012b, *Review of the Climate Change Act*, <http://www.climatechange.vic.gov.au/home/review-of-climate-change-act> (accessed 21 March 2012).
- WA Department of Health 2008, *Health Impacts of Climate Change: Adaptation Strategies for Western Australia*, Perth.
- WA Government 2011, *Perth Hills Bushfire February 2011 Review*, Perth.
- WA Planning Commission 2003, *State Coastal Planning Policy*, Statement of Planning Policy No. 2.6, June, Perth, [http://www.planning.wa.gov.au/dop\\_pub\\_pdf/SPP\\_2\\_6.pdf](http://www.planning.wa.gov.au/dop_pub_pdf/SPP_2_6.pdf) (accessed 23 March 2012).
- WALGA (Western Australian Local Government Association) 2012, *About Us*, Perth, <http://www.walgaclimatechange.com.au/about-us.htm> (accessed 9 March 2012).
- Walker, W.E., Harremoes, P., Rotmans, J., van der Sluijs, J., van Asselt, M., Janssen, P. and von Krauss, M.P.K. 2003, 'Defining uncertainty: a conceptual basis for uncertainty management in model-based decision support', *Integrated Assessment*, vol. 4, no. 1, pp. 5–17.
- Webb, R. 2008, *Infrastructure Australia Bill 2008*, Bills Digest, 5 March, no. 69, Department of Parliamentary Services, Parliament of Australia, Canberra.
- Weier, A. and Loke, P. 2007, *Precaution and the Precautionary Principle: Two Australian Case Studies*, Productivity Commission Staff Working Paper, Melbourne.
- Weitzman, M. 2009, 'On modelling and interpreting the economics of catastrophic climate change', *Review of Economics and Statistics*, vol. 91, no. 1, pp. 1–19.
- Wellington Shire Council 2011, *Wellington Planning Scheme Amendment C33*, Victoria.



- 
- nd, *Guidelines for Preparation of a Climate Change (Sea Level Rise) Response Plan*, [http://www.wellington.vic.gov.au/Files/Climate\\_change\\_response\\_plan\\_guidelines.pdf](http://www.wellington.vic.gov.au/Files/Climate_change_response_plan_guidelines.pdf) (accessed 28 March 2012).
- Wilby, R.L., Troni, J., Biot, Y., Tedd, L., Hewitson, B.C., Smith, D.M. and Sutton, R.T. 2009, 'A review of climate risk information for adaptation and development planning', *International Journal of Climatology*, vol. 29, no. 9, pp. 1193–1215.
- WMA Water 2011, *Lake Macquarie Waterway Flood Risk Management Study and Plan Public Exhibition Copy*, September, New South Wales.
- World Bank 2010a, *Climate Change Adaptation*, Washington DC, <http://climatechange.worldbank.org/overview/climate-change-adaptation> (accessed 8 December 2011).
- 2010b, *Development and Climate Change: Stepping up Support to Developing Countries*, Washington DC.