Climate adaptation sector review: informing the future direction for the ACT and Region

November 2014
CURF Working Paper 4

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## Glossary

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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>ACR</td>
<td>Australian Capital Region</td>
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<tr>
<td>AP2</td>
<td>AP2: a new <em>Climate Change Strategy and Action Plan for the Australian Capital Territory</em></td>
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<td>BOP</td>
<td>Bushfire Operational Plans</td>
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<td>COAG</td>
<td>Council of Australian Governments</td>
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<td>CURF</td>
<td>Canberra Urban and Regional Futures</td>
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<td>ESA</td>
<td>Emergency Services Authority</td>
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<td>FFDI</td>
<td>Forest Fire Danger Index</td>
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<td>GHG</td>
<td>Green House gas</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<td>NaRCLIM</td>
<td>NSW / ACT Regional Climate Modelling</td>
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<td>NCCARF</td>
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<td>NGOs</td>
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<td>RFMP</td>
<td>Regional Fire Management Plans</td>
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<td>SBMP</td>
<td>Strategic Bushfire Management Plan</td>
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<td>TAMs</td>
<td>Territory and Municipal Services</td>
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<td>WTC</td>
<td>Weathering the Change</td>
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<td>WIC</td>
<td>Wine Innovation Cluster</td>
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Overview

Climate change poses major challenges for all countries, regions and cities. Canberra is no exception, and the imperative to both reduce greenhouse gas emissions and adapt to unavoidable climate changes is becoming stronger.

Climate change adaptation is a relatively new area of policy, practice and research, which has experienced significant and rapid growth in the last 10 years. Government, business and the community have become increasingly engaged and informed of the issues, impacts and consequences that a changing climate will bring in both the short and longer terms. Working collaboratively to ensure a sustainable future for future generations is a goal of many organisations.

The ACT Government is at the forefront of Australian policy and planning in developing a long term and systematic approach to the issues that cities, regions and communities face as they plan for climate change. The Territory’s work on the development of complementary mitigation and adaptation strategies, and the introduction of Directions for the ACT, has provided this background paper with a solid conceptual grounding to undertake its analysis.

This paper is organised as follows:

- A review of the climate science and climate adaptation relevant to both the Australian Capital Territory and the Australian Capital Region (Section 2).
- A review of the ACT’s current policy response and framework in planning for climate change adaptation (Section 3).
- An analysis of emerging leading practice adaptation principles and processes; including the development of seven key principles (Section 4).
- A brief review of the six priority sectors—community health and wellbeing, disaster and emergency management, settlements and infrastructure, water, natural resources and ecosystems, and agriculture—and analysis of leading practices emerging from six case studies, each case study applicable to one priority sector (Section 5).
- A discussion of potential future challenges and opportunities, including research findings (Section 6).

The adoption of a framework based on key principles to assess adaptive practice can be of great assistance to governance and internal reporting mechanisms. We suggest in this study that greater emphasis on integration of policy outcomes and adaptive learning cycles will facilitate the ACT becoming a national leader in climate change adaptation strategy development and implementation.
Executive Summary

This paper aims to provide three objectives for the ACT Government. The first is updating the climate science relevant to the Australian Capital Region; the second is developing leading practice principles for effective climate change adaptation and the third is to provide valuable background material to inform the development of an ACT adaptation strategy in the context of the Australian Capital Region (ACR).

In framing this substantive body of work for these three objectives, we undertook a synthesis of (i) the most recent climate science and projected impacts for the region, and (ii) leading climate adaptation principles. We then utilised the six priority sectors identified in Adapting to a changing climate: Directions for the ACT to frame the case study analysis of leading practice and principles for climate adaptation.

The climate science and implications

The climate science detailed in this paper(Section 2.1) details the expected climatic changes for the Australian Capital Region (ACR) with an emphasis on expected changes in the frequency and intensity of extreme weather events. In particular, it notes that changes to heat-related extreme events and changes in the water cycle are the two central climate concerns for the region.

The changes in hot weather across the Australian Capital Region are already occurring and are dramatic. The number of heatwave days is increasing; heatwaves are occurring more frequently, the duration of the longest yearly heatwave is increasing, the first heatwave of the season is occurring earlier, and the hottest day of a heatwave is becoming hotter. The number of hot days, warm nights and heatwaves is virtually certain to increase through the 21st century across south-eastern Australia. By mid-century an extreme hot day that currently occurs once every 20 years is expected to occur every 2-5 years.

The Forest Fire Danger Index (FFDI), an indicator of extreme fire weather, showed an increase at 16 of 38 weather stations across Australia over the 1973-2010 period, with most of the stations showing an increase in southeast Australia including the ACR. The projected increases in hot days and in consecutive dry days and droughts in the southeast will very likely lead to increased frequencies of days with extreme fire danger in the ACR.

Projections for future changes in rainfall patterns, including drought, for Canberra and the ACR carry significant uncertainties. While most simulations of future climate suggest that the cooler months of the year will be drier than the long-term average, there is no consensus on how summer rainfall will change, implying that the direction of change in total annual rainfall—increase or decrease—cannot be projected with any confidence. However, it does appear likely the long-term pattern of rainfall, particularly seasonality, in the ACR will change, with a suggestion that droughts will become more frequent by the end of the century.
The risks of a changing climate are pervasive and impact all sectors, either directly or indirectly, and sometimes both, with economic, social and environmental consequences. A broad overview of the nature of these impacts and the range of potential responses readily demonstrates the many interdependencies across sectors (Section 2.2).

**Leading climate adaptation principles**

To help address climate change adaptation within and across the six priority sectors identified by the ACT Government the paper identifies, from both the literature and case studies, a set of seven ‘leading adaptation principles’ for consideration in the ACT adaptation assessment and planning.

1. Adopting an integrated approach that spans consideration of social, economic, environmental and cultural factors and their interdependencies, builds robustness and sustainability into city and regional planning.

2. Applying the precautionary principle to decision making on the location of new and redeveloped urban settlement and infrastructure (and other long-life decisions) is particularly important where environmental risk currently or potentially exists. Open space should be a key consideration to allow for adaptation (heat absorption, green infrastructure, coastal retreat).

3. Incorporating risk management and scenario approaches into strategies for economic and sectoral development, and natural resource management, enhances the resilience of Canberra and the region. The best science on climate change, socio-economic trends and community vulnerability and preferences would underpin these approaches.

4. Establishing forums, institutional arrangements, and governance mechanisms that drive collaboration and intergovernmental agreement will facilitate a shared vision for adaptation and efficiency in implementation. This should include regional approaches that better connect regional planning with climate change science.

5. Ongoing stakeholder and community engagement will facilitate community and decision-maker support for adaptation action. This needs to be informed by the latest science, and real opportunities to engage with and influence plans and strategies for adaptation.

6. Growing the adaptation skills and capacity of Canberra and regional communities through long-term interdisciplinary research, engaged agency and iterative monitoring, will build capability to align with the changing climate of the future.

7. Utilising iterative monitoring, adaptive management and robust decision-making processes will ensure ‘learning by doing’ and limit mal-adaptation. The impacts of climate change will require more attention over time including in evaluating adaptation measures and updating risk management profiles.
Subsequent development of an ACT adaptation strategy, including consideration of other relevant case studies, could be expected to enliven these principles for the ACT and region.

Learnings from literature and the case studies

The learnings from the literature and the case study exemplars (Section 5) emphasise the importance of integration of responses and strategies in effectively adapting to a changing climate. While the paper discusses these learnings with reference to each of the priority sectors, the interdependency of each is acknowledged and at the core of the development of the leading climate adaptation principles discussed above. The more detailed and substantive analysis of each exemplar and our findings can be found in Section 5.

Community health and wellbeing

The analysis of this priority sector utilises the Australian National Environmental Health Strategy of 2007-2012 to frame the key learnings. We consider this to be an exemplar as it includes the integration of health goals across a number of key areas and across sectors. Our analysis recognises the import of both the direct and indirect impacts of climate variability. We consider that both aspects ought to feed into health vulnerability assessments but moreover, that the impacts of strategies and actions of other sectors is crucial in a holistic adaptive response. Addressing cross agency communication and potential barriers is crucial for both the implementation of longer term adaptation strategies and for the assessment of the impact of such strategy.

Disaster and emergency management

Disaster and emergency management responses are most often those that address acute risks imposed on communities as a result of severe, short term, impacts. To properly respond to such risk, the important learnings from the vulnerability literature in terms of understanding and mitigating as far as is possible against such risks is explored with particular reference to the expected scale of risks to the ACT and region. This paper utilises the Strategic Bushfire Management Plan for the ACT as the case study exemplar from which leading practice principles are distilled. This includes (but is not limited to) integrative frameworks that allow for community preparedness and consultation and that are local context and local engagement specific; an emphasis on regional collaboration and communication particularly with respect to management responses; and ensuring disaster and emergency management responses are part of a broader adaptation strategy.

Settlements and infrastructure

The case study exemplar for this report is the City of Melbourne Climate Change Adaptation Strategy. It was chosen due to the many similar climate variations expected for both Melbourne and for Canberra and the ACR. The City of Melbourne Strategy focussed on four climate variation impacts in how it framed its adaptation response. Leading practice principles were drawn from the case study to take account the importance of planning processes and the avoidance of maladaptation in long term strategies for urban settlements and related infrastructure in the implementation of an iterative risk management framework. As with the other case study exemplars, the central importance of true
integration across sectors is highlighted and discussed in detail in preparing the leading practice principles which included, but is not limited to, the importance of mainstreaming climate change adaptation into broader planning processes to mitigate against future and expected costs of future adaptation, and to avoid maladaptation.

**Water**
With the combined increased heat projections for the ACT and the increased uncertainty around rainfall predictions for the region, leading climate adaptation principles to redress expected water vulnerability is assessed against the Climate Change Adaptation Strategies for California’s Water. We consider it an exemplar because of the integrated response they have adopted across multiple jurisdictions to improve resiliency, reduce risk and increase sustainability of water, as well as appropriate manage their flood preparation systems and the natural ecosystems. Water, as with the other priority sectors, highlights the core need for integration of climate adaptation responses across sectors, jurisdictions and risk management frameworks. Distilled leading practice principles includes the shift towards an adaptive management approach to water resource management, a holistic and more integrated planning regime for water that effectively integrates with urban and regional planning approaches and strategies that are relevant to the local and regional scale to ensure the complexity of the issue and the facilitation of the community and political investment.

**Natural resources and ecosystems**
The importance of the eco system as a function of a holistic and integrated approach to effective long term planning for climate change adaptation is well recognised and the benefits of eco-system based adaptation well noted in the literature as this approach underpins adaptive management frameworks, which in turn feed back into cross sector integration. This paper draws on the Lower Danube Green Corridor: Floodplain Restoration for Flood Protection (2012) as a case study exemplar which highlights the advantages an adaptive management framework can offer. Leading climate adaptation principles includes, but is not limited to, the achievement of a holistic and comprehensive understanding of ecosystem services at a landscape scale, the nexus between urban and rural ecosystems and eco system management strategies and deeper understanding of land management practices.

**Agriculture**
Utilising South Australia’s Wine Innovation Cluster’s Climate Change Initiative, this case study is considered an exemplar as it highlights the cross fertilisation of issues faced by the agricultural sector, including technological advancements, farm production practice and government programs. Leading climate change principles include the recognition that this sector is already suffering the effects of a changing climate, that this has flow on effects for land management processes and frameworks and that focussing on building adaptive capacity over prescriptive responses will have more positive and long term impact provided that such responses are well integrated across other sectors.
Conclusion

This working paper is designed to provide useful background material that can inform the development of a climate change adaptation strategy for the ACT and the Australian Capital Region. The case studies highlight examples of current practice by sectors and the seven principles provide a platform for community discussion. In summary this working paper is the first step in an 18 month process to be led by the ACT Government during 2014/2015.
1 Introduction

Canberra Urban and Regional Futures (CURF) has been commissioned to provide both theoretical and applied research support and outcomes for the period 2014-2015 as part of an ongoing contribution to the ACT Government’s climate change adaptation agenda. This report is the first output from CURF for the ACT Government’s long term (to year 2025) climate change strategy, focussing particularly on the climate change adaptation aspects.

CURF, based at the University of Canberra, had its origins in the realisation that the urbanisation, population pressures, the impacts of climate change and an awareness of the environmental and social impacts of urban growth were driving an increasing interest in research for evidence based decision making for cities and regions. The overall objective of our research is to find new pathways and implementation strategies for sustainable futures for cities and regions. CURF provides an international collaborative platform for the creation and dissemination of research and knowledge across four key research themes: health and wellbeing, settlements and infrastructure, green growth, and climate change and sustainability.

The policies underpinning this research include Weathering the Change: The ACT Climate Change Strategy 2007-2025 (ACT Government, 2007a) and the subsequent AP2: A new climate change strategy and action plan for the Australian Capital Territory (ACT Government, 2012c). AP2 provides a comprehensive framework within which the ACT Government has outlined its vulnerabilities and risks to climate change. The risk management strategy targets community health, agriculture, water, the natural environment and urban planning (ACT Government 2007a, p7).

In furthering the Australian Capital Territory’s strategy, on 21 May 2014 the Minister for Environment and Sustainable Development, Mr Simon Corbell, MLA launched the ACT Climate Change Adaptation Statement, Adapting to a changing climate: Directions for the ACT. It outlines the priority sectors for the ACT Government’s Climate Change Adaptation Strategy, namely, community health and wellbeing, disaster and emergency management, settlements and infrastructure, water, natural resources and ecosystems, and agriculture. Building on this document, the ACT Government is providing community leadership with the collaborative pathways required to enable the community to adapt to a changing climate.

1.1 The brief and scope of this paper

CURF has prepared this background paper regarding Australian and relevant international best practice on the current climate science and risk, strategies and planning innovations. This research paper highlights areas of progress and opportunity for strategy development by providing analysis of case study exemplars that are aligned with the Government’s six priority sectors. This analysis demonstrates how the leading climate adaptation principles in this paper were identified and operate.
2 Climate change in Canberra, with reference to the region

2.1 The climate science

Our understanding of the climate system has strengthened considerably over the past decade. Observations show unequivocally that the climate is undergoing rapid, directional change towards a warmer state (IPCC, 2013). The earth’s surface air temperature has risen about 1°C above the pre-industrial level, the oceans are warming, Arctic sea-ice is melting, the sea level is rising, atmospheric circulation is changing, and many species of plants and animals are changing their distributions and behaviours in response to a warming planet. Scientists are more confident than ever that human activities, mainly the burning of fossil fuels, are the primary cause for the climate changes we are experiencing.

As the climate shifts, the risks to human prosperity and wellbeing, and to the rest of the biosphere, are increasing. The most recent assessment of the IPCC (2014) shows that the impacts of climate change are now apparent on all continents and across the oceans. Many of the impacts are associated with the influence of climate change on extreme weather events (IPCC, 2012). As knowledge accumulates, it is clear that more serious impacts are expected from more modest increases in global average temperature, and that the risks of severe impacts increase sharply beyond the 2°C temperature rise target that guides current international climate policy development.

In summary, climate change poses major challenges for all countries, regions and cities. Canberra is no exception, and the imperative to both reduce greenhouse gas emissions and adapt to unavoidable climate changes is becoming stronger.

2.2 Implications for Canberra and the Australian Capital Region

Many of the risks of climate change for Canberra and the Australian Capital Region (ACR) are related to the changes in the frequency and intensity of extreme weather events in our region. The most important of these are increases in extreme heat and related events (e.g. bushfires) and in changes to the water cycle.

Extreme heat

The incidence of heatwaves and hot days is already increasing in southeast Australia. The changes in hot weather across the Australian Capital Region are already occurring and are dramatic. The number of heatwave days is increasing; heatwaves are occurring more frequently, the duration of the longest yearly heatwave is increasing, the first heatwave of the season is occurring earlier, and the hottest day of a heatwave is becoming hotter (Perkins and Alexander, 2013). In fact, through the 2000-2009 decade, Canberra experienced an average of 9.4 days per year over 35°C, compared to the long-term average of 5.2 days per year, already reaching the increase in hot weather projected for 2030 (Climate Council, 2014).

The number of hot days, warm nights and heatwaves is virtually certain to increase through the 21st century across south-eastern Australia. By mid-century an extreme hot day that currently occurs once every 20 years is expected to occur every 2-5 years. If current greenhouse gas
emission trends continue, today’s record-breaking hot weather will become commonplace. Projections for Canberra for 2070 are dependent on the rate at which greenhouse gases, especially carbon dioxide, are emitted. Under a low emissions scenario, Canberra is projected to experience about 10 days per year above 35°C (the number already recorded for the 2000-2009), but under a high emissions scenario (i.e. business-as-usual), the number could rise to 18 per year (CSIRO and BoM, 2007).

**Extreme bushfire weather**

The most direct link between climate change and bushfires is through the increasing incidence of high fire danger weather. More hot weather has led to increases in the Forest Fire Danger Index (FFDI), an indicator of extreme fire weather, measured at 16 of 38 weather stations across Australia over the 1973-2010 period; none of the stations showed a decrease. Most of the stations showing an increase are in southeast Australia and include the ACR. The effect of extreme heat was an important factor in recent serious bushfires, including those in Canberra in 2003, the Black Saturday bushfires in Victoria in 2009 and the 2013 fires in Tasmania (Karoly, 2009; Climate Council, 2013).

The projected increases in hot days across the country, and in consecutive dry days and droughts in the southwest and southeast, will very likely lead to increased frequencies of days with extreme fire danger in those regions. The FFDI is projected to increase strongly in regions with uniform rainfall through the year and in the winter rainfall regions, which mainly occupy southeast Australia (Hennessy, 2007). These regions include the Australian Capital Region, implying that the bushfire risk in the ACT and surrounding region is likely to increase significantly through the coming decades.

**Heavy rainfall**

In general, climate change is intensifying the water cycle, leading to an increasing risk of heavy rainfall events and flooding. In most regions of the world, increases in heavy precipitation events have been observed. It is likely that the frequency of heavy rainfall events will increase over many areas of the globe through the 21st century. Across Australia as a whole, it is more likely than not heavy rainfall events will become more frequent as the temperature increases. However, in southeast Australia there has been a slight decrease in the number of heavy rainfall events over the past several decades, consistent with the changing pattern of rainfall where the southeast, including the Australian Capital Region, is experiencing a decrease in total annual rainfall (Griggs et al., 2012).

Looking ahead for the ACR, the situation is less clear as there is considerable uncertainty about changes in total rainfall. If average annual rainfall declines, increases in heavy rainfall are expected to be less evident.

**Droughts and dry periods**

Rainfall over Australia as a whole has increased since 1990. However, from 1970 to the present, the period over which climate change has had the most influence, much of the eastern part of Australia has become drier. Focusing on the 1997-2012 period, which encompasses both the millennium drought and the recent very wet period, southeast Australia, with the ACR at the
northern rim of that region, stands out as being consistently dry. Seasonality of rainfall is also changing; in the far southeast of the continent, rainfall declines have occurred primarily in the cooler months of the year. Canberra and the ACR lie at the northern edge of this region, making observations more difficult to interpret than for Victoria and southern South Australia (Climate Commission, 2013).

Projections for future changes in rainfall patterns, including drought, for Canberra and the ACR carry significant uncertainties. While most simulations of future climate suggest that the cooler months of the year will be drier than the long-term average, there is no consensus on how summer rainfall will change, implying that the direction of change in total annual rainfall—increase or decrease—cannot be projected with any confidence. However, it does appear likely the long-term pattern of rainfall, particularly seasonality, will change. The IPCC (2012) projections, as measured by the number of consecutive dry days, suggest that droughts will become more frequent in southeast Australia by the end of the century. When droughts do occur, the increase in very hot days and heatwaves will likely increase the severity of droughts in terms of their impacts on plants and animals.

Use of climate projections

Given the above it is important that adaptation assessments and decisions for the ACT take account of these overall directions of likely change, with consistent usage across agencies and issues; and that they take account of the levels of uncertainty, including assessing sensitivity and robustness to a range of plausible climate outcomes.

The authors are aware that new climate change projections are currently being developed by CSIRO and the Bureau of Meteorology for the Australian Government. These projections take into account new global modelling of climate change undertaken to support analysis for the Intergovernmental Panel on Climate Change Fifth Assessment Report, as well as recent studies in Australia. There may be new results from these regionally-based national projections that need further consideration by the ACT Government.

2.3 Analysis of impacts

The climate variability and change drivers summarised above have significant impacts on the ACT and surrounding region. Some of the main impact and risk areas are summarised in Figure 1 below, using the recent ACT ‘Adaptation Directions’ identification of sectors as a useful framework (ACT Government, 2014a). This representation demonstrates that:

- The climate related risks are pervasive, impacting all sectors.
- Some impacts are direct (i.e. the climate has a direct primary impact on the sector—see pink boxes), and others are indirect (i.e. the direct or primary climate impact triggers secondary impacts in other sectors—see brown and red boxes).
- When indirect or secondary impacts are taken into account the range of sectors affected can be even more extensive than shown (e.g. tourism, businesses in all sectors potentially impacted by infrastructure vulnerabilities, etc.). This also demonstrates that climate risk and adaptation is an economic as well as a social and environmental issue.
Community health and wellbeing, especially adopting the broader concept of wellbeing, is impacted by nearly all the other sectors, and provides a natural integrating view. This integrating sector view thus also provides the opportunity to focus on the community outcomes sought, and on the most vulnerable communities.

A full risk analysis requires understanding of adaptive capacity to be combined with potential impacts, in order to assess the most vulnerable communities and assets (built and natural). Some components of this have already been investigated for the ACT, but not yet been linked together.

This analysis does not show other (non-climate) drivers of change (e.g. population and urban growth and intensification; other natural environmental pressures such as weeds or pests), but these will also often interact with the possible climate risks consequences and likelihood, unless actively planned for and managed.
3 Current policy response and framework

3.1 National context

Adaptation to climate change is a relatively new concern in policy circles in Australia. In 2007, the National Adaptation Framework was established through the Council of Australian Governments (COAG). The framework and the establishment of the National Climate Change Adaptation Research Facility (NCCARF) (NCCARF, 2008) provided the impetus for expanded research into how Australia may adapt to the various impacts of climate change (NCCARF, 2014). The last five years have seen the generation of a broader range of knowledge and insight regarding adaptation in Australia. The lessons learnt regarding challenges to and opportunities for good adaptation practice come from national to local levels of government and across a variety of sectors. However, while there is now a broad range of literature on adaptation in Australia, significant challenge remains translating that into a practical use for policy makers, including moving from assessment to decision-making and action (Webb et al., 2013).

The Australian Government has developed a number of key policy and guidance documents which have relevant insights for the ACT and the Region. These include the Australian Government’s (2010) Adapting to Climate Change in Australia report which details the importance of collaboration and shared responsibility for climate adaptation across business, government and community sectors (p 7) as well as identifying national adaptation priorities (p11). A number of these priorities are also reflected in the ACT Government’s Directions document. On the back of the Productivity Commission’s 2013 report Barriers to Effective Climate Change Adaptation, the Australian Government Climate Adaptation Outlook report (2013) details an approach for developing a national assessment framework from which useful learnings for the ACT can be drawn. This report utilises three pillars for assessing good adaptation: Drivers, Activities and Outcomes. Additional relevant federal documents include The Role of Regulation in Facilitation or Constraining Adaptation to Climate Change for Australian Infrastructure (Australian Government, 2011) which provides an assessment of regulation frameworks and details principles for adaptive regulation in a changing climate. Finally, the Economic Framework for Analysis of Climate Change Options (AECOM, 2012) provides options for a framework for an economic model for cost benefit analysis of adaptation set against two case studies areas being coastal settlements and water.

As outlined in the previous section, the impacts of climate change vary significantly across the Australian continent and thus responses to those impacts must be tailored to the local context. As such, it is important to develop approaches that are relevant to local and regional circumstances (Granberg and Elander, 2007). With respect to this challenge of making adaptation literature useful for policy makers, and following the scope of this paper, this section outlines the current status of climate change adaptation in the ACT to establish a foundation for exploring best practice lessons.
3.2 Understanding adaptation in the ACT and region

The importance of adaptation for the ACT government is increasing. Reflecting broader responses to climate change, the emphasis in the ACT to date has largely been focused on mitigation. For example, while the *Weathering the Change: ACT Climate Change Strategy 2007-2025* (ACT Government, 2012c) noted the importance of adaptation, the emphasis in *Weathering the Change: Action Plan 1 (2007-2011)* (ACT Government, 2012c) was firmly on mitigation actions. Following this, while *Climate Change and Greenhouse Gas Reduction Act 2010* (ACT Government, 2010a) notes adaptation as an issue, the Act is clearly focused on legislating mitigation actions for the Territory. However, a greater emphasis is placed on adaptation in *Weathering the Change: Action Plan 2* (ACT Government, 2012c), with three actions clearly identified (see Appendix 1 for brief of Actions and Implementation to date). The recently published *Adapting to a changing climate: Directions for the ACT* (ACT Government, 2014a) provides further guidance for the development of future policy for the ACT and region.

3.3 The ACT adaptation policy framework

The policy response framing the ACT Government’s response to adaptation is understood to be derived from two key documents: *Weathering the Change: Action Plan 2 (AP2)* (ACT Government, 2012c) and *Adapting to a changing climate: Directions for the ACT* (ACT Government, 2014a). These documents identify the key issues of concern for the ACT as well as processes through which the policy will be implemented.

While AP2 identifies a range of issues of concern, *Adapting to a changing climate: Directions for the ACT* identifies six priority sectors for the ACT and the region to address in adapting to climate change. Specifically, these are:

- Community health and wellbeing—focused on public health, and linked to the *ACT Population Health Strategic Framework* (ACT Government, 2013b).
- Disaster and emergency management—based on an expected increasing intensity and frequency of extreme weather and natural disasters, and linked to the ACT Emergency Plan (ACT Government, 2012a).
- Settlements and infrastructure—linked to the ACT Planning Strategy (ACT Government, 2012b).
- Water—linked to the ACT Water Strategy (ACT Government, 2014c).
- Natural resources and ecosystems—linked to the ACT Nature Conservation Strategy (ACT Government, 2013a).
- Agriculture—to be further considered in the proposed ACT Climate Adaptation Strategy.

While all are important sectors in themselves, in reality they are inter-connected to form the social, economic and environmental basis for the ACT and regional community, its economic success and sustainability over time. Following the scope of this study, the focus of this section is on the ACT, while acknowledging that links with the broader Australian Capital Region are crucial.

The transition to a whole-of-government approach to governing the ACT, following the implementation of the Hawke Report on ACT governance (ACT Government, 2011), may well provide opportunities for further integration of adaptation initiatives across the government, and between the government and Canberra and regional stakeholders, including NGOs.
business and the community. There may be a number of ways to facilitate this, such as further work to embed adaptation measures in mainstream planning and operational procedures (see section 6 of this report), and explicit sustainability/climate change impact reviews for relevant major policy decisions.

The implementation of adaptation actions within the policy framework is embedded in the broad processes outlined in AP2. AP2 emphasises an adaptive policy cycle (see Figure 2), which allows for policy learning over time and flexibility in the implementation process to reflect changes in technology, economic and community circumstances.

![Figure 2. Evolution of the Adaptive Policy Cycle](source)

It is recognised that policy development in climate change is an evolving process. In this context it is suggested that “environment” be included in the above policy implementation cycle. It is also recognised that the ACT Government has commenced an 18 month community engagement process which will allow the further development of Figure 2 in the process.

Following the importance of local circumstances emphasised in the broad climate literature, this framework is used to guide the exploration of relevant literature and ‘leading practice’ in Section 4.
4 Climate change adaptation – practice and principles

4.1 The adaptation context

Effective climate adaptation responses need to be informed by the options and actions that have been found most useful in addressing climate risks and opportunities. Assessing this and the context specific relevance can be difficult due to the following:

- Context is important when determining suitable adaptation options and responses, e.g. which types of risks/opportunities are relevant to the sponsoring and decision making organisations and their location; the values and objectives of the key stakeholders;
- The relative youth of climate change adaptation research analysis and outcomes and the time delay of tangible and measurable results means that many options and responses and the circumstances in which they apply are not robustly proven; and
- The diversity of work being undertaken, usually across a variety of disciplines and scales (temporal, spatial and hierarchical) and in the context of multiple drivers, policy areas and organisations requires an innovative and formative approach to risk assessment, with difficulties in attribution of success or failure of the interventions.

Typical groups of potentially useful adaptation options are starting to be identified for various categories of risks (e.g. sea level rise; disaster risk management; urban heat islands; agriculture impacts etc.) and their characteristics better understood and documented (e.g. SMEC, 2010 for local governments in general). Leading practice in this context would involve considering such ‘potentially useful’ responses in the specific context under investigation.

In this paper some sources of potential responses have been identified from the literature and case studies, in order to assist in establishing which adaptation responses are effectively already covered in current ACT responses, and which are not; and to ensure that any responses are valid across as well as within sectors, to identify synergies and avoid maladaptation.

4.2 Types of adaptation

Identified by Fankhouser et al (1999), a typology of adaptation measures is an important basis from which to frame appropriate policy responses that ensure the diversity of responses required is conceptualised while providing an analytical framework against which to assess the effectiveness of the implementation of adaptation policy. This typology is discussed below.

4.2.1 Reactive and anticipatory adaptation

Reactive adaptation refers to adaptation that is implemented purely in response to a climatic event or change, after the fact of that change, while anticipatory adaptation requires foresight and planning (Fankhouser et al., 1999, p69). The importance of distinguishing between these two features lies in the fact that most adaptation is reactive due to the relative uncertainty of climate risk (Smit et al, 2000), but the benefit of utilising learnings from other areas including via case studies is to build up a repertoire of anticipatory measures for the variety of risks that may occur in the future.
An example of this is the response to major natural disasters. The governmental response to the Queensland Floods of 2012 meant that a variety of anticipatory measures including the dam were already in place to assist the community in such an event. Unforeseen measures meant that some processes were also reactionary. The merit or otherwise of this aside, the linking of reactive and anticipatory measures is of fundamental importance to the framing of adaptation policy.

4.2.2 Planned and autonomous adaptation

The climate of the past will not be the climate of the future and the built environment, stressed ecosystems and natural resources may not have the adaptive capacity to respond (Bierbaum et al. 2012). Taking proactive steps to prepare for such future changes can reduce the harmful impacts of climate change and encourage a more rapid and effective response to changes as they happen (Bierbaum et al., 2012). Operating in a similar dichotomy to reactive and anticipatory adaptation, planned and autonomous adaptation has its origins in both conscious intervention and ‘natural or spontaneous adjustments’ (Carter et al., 1994 in Fankhauser et al., 1999) respectively.

Fankhauser et al (1999) make the point that while each of these four typologies of adaptation may appear instinctively clear, in practice the lines are often blurred. This may be due to the seemingly similarities of each typology. However, each operates independently. The recognition of this is an important step to consider prior to connecting them together to form an adaptation framing.

We envisage that a useful framework needs to consider both leading practice in adaptation processes (i.e. the approaches used to carry out assessments of climate risks, opportunities and adaptation options, and the progressive delivery, monitoring and review of selected responses); and leading practice in adaptation responses (i.e. assessment of how beneficial or otherwise specific adaptation response strategies and actions have proven to be in particular contexts).

With the above framework in mind, the case studies in section five provide an overview of the basis for an assessment of good practice along with relevant exemplars. These exemplars elucidate leading climate adaptation applicable to the priority sectors.

4.3 Types of barriers

The Productivity Commission Report Barriers to Effective Climate Change Adaptation (2012) classified barriers to climate adaptation as follows:

- Market failures.
- Policy and regulatory barriers.
- Governance.
- Institutional barriers.

Each of these factors can, often interdependently, restrict the adaptive capacity for people and communities to ‘identify, evaluate or manage climate risks’ in such a way that prevents the use of resources in the best way to respond to the effects and impacts of climate change (p74).
4.4 The importance of risk management

4.4.1 Framing and scoping of adaptation

Adaptation can be framed narrowly or broadly. There are not intrinsically right or wrong framings, but it is important to overtly choose the appropriate framing and scoping for the issue at hand. This should typically be done up front with the flexibility to modify if necessary as new insights are generated. An integrated adaptation strategy for a whole jurisdiction with extension into the region (Norman & Steffen, 2014) demands a relatively broad framing.

Examples of framing choices can include:

- Identification of opportunities as well as threats;
- Addressing indirect as well direct impacts and risks, within and across sectors;
- Addressing socio-economic as well as biophysical impacts and outcomes;
- Addressing a range of spatial scopes and scales (local through to regional);
- Addressing a range of temporal scopes and scale (current and short/medium/longer term risks and opportunities);
- Considering hard (e.g. engineering) and soft (e.g. social adaptive capacity) response options;
- Considering transformational as well as incremental response options;
- Taking an integrated approach (with other change drivers, policy areas) as opposed to stand alone (climate focused only); and
- Taking an individual organisational (e.g. government owned assets and services only) and/or broader community perspective.

As is evident from this list, there are real choices to be made and they will have a significant impact on the assessment approach and outcomes. Hence the importance of being overt and agreeing these choices up front and progressively, as necessary.

4.4.2 Iterative processes

In identifying adaptation principles, there are a number of parameters identified in the research and from practice which provide a basis from which to guide the development of leading practice principles—in turn, enabling a useful assessment of adaptive outcomes (Australian Government, 2013). Much adaptation research has been focussed on both the development of conceptual approaches to adaptation (Webb et al., 2013, p321) and the investigation of policy in action (Henstra and Vogal, 2014), particularly at the local or regional level (Susskind, 2010). It has produced a knowledge gap especially in the assessment of adaptation planning to action (Henstra and Vogal, 2014; Webb et al., 2013). Work in adaptation has been developing in a robust and comprehensive manner in the last decade, more certainly in the last five years. The importance of assessing the impact of policy is an ongoing and iterative activity (Pelling, 2011).

Due to the uncertainty surrounding the pace and magnitude of these climatic changes, Parson and Karwat (2011, p744) argue that proactive steps “require a process of sequential, or iterative, decision making, whereby policies and other decisions are revised repeatedly over
multiple decades in response to changes in scientific knowledge, technological capabilities, or other conditions”.

This approach is characteristic of adaptive management—an iterative decision-making process that involves choosing a strategy based on the best available information, but one that is flexible enough to be revised as new knowledge is generated (Jacobson et al., 2009).

A typical and useful adaptive process framework is the risk management cycle (Commonwealth of Australia, 2006, p19; see further ISO 31000:2009 Risk Management – Principles and Guidelines, reviewed and extended upon in 2013). This has often been extended for use in the context of adaptation with an emphasis on incorporating iterative and longer-term adaptive approaches (see for example Webb et al., 2013; HCCREMS, 2013; Cane et al., 2013). An example is also shown at Figure 3. Mapping climate adaptation processes to the risk management cycle is also consistent with the ACT Climate Change Vulnerability Assessment Framework for Infrastructure: Discussion Paper (ACT Government, 2012d).

![ISO 31000:2009 Process Overview](image)

**Figure 3.** The standard risk management process

### 4.4.3 Challenges

Challenges to adaptation are numerous, complex and cross a number of boundaries including economic, social and institutional (Shove, 2010). In addition, they operate at multiple scales (Adger et al., 2009; Norman, 2009). Webb et al.’s (2013) analysis of 20 Australian regional and local adaptation initiatives identifies systemic challenges, many of which align with findings of international studies (e.g. Moser and Eskstom, 2010). Integration and governance challenges are highlighted by the South East Coastal Adaptation study (SECA) (Norman et al., 2013).

Identifying such likely challenges up front means they can be addressed early and preferably collectively providing a strong foundation for understanding the problem, planning appropriate action and then delivering the implementation of the selected action(s). Such challenges are
common across sectors, jurisdictions and issues. Adding to this is the uncertainty and longer term timeframe commitments required for climate adaptation.

4.4.4 ACT legislative framework

The primary legislative framework with respect to the mitigation of climate change in the ACT is the Climate Change and Greenhouse Gas Reduction Act 2010 (the CCGGR ACT). The purpose of the CCGGR ACT is to “promote the development of policies and practices to address climate change, set targets to reduce greenhouse gas emissions and to provide for the monitoring and reporting in relation to the targets” (long title). To achieve this, the GGCCR Act sets out a framework for the reduction of greenhouse gas emissions within the Territory.

In addition to this, the Planning and Development Act 2007 defines the meaning of sustainable development as follows:

Section 9: Meaning of sustainable development

For this Act:

sustainable development means the effective integration of social, economic and environmental considerations in decision-making processes, achievable through implementation of the following principles:

(a) The precautionary principle;
(b) The inter-generational equity principle;
(c) Conservation of biological diversity and ecological integrity;
(d) appropriate valuation and pricing of environmental resources.

The inter-generational equity principle means that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

The precautionary principle means that, if there is a threat of serious or irreversible environmental damage, a lack of full scientific certainty should not be used as a reason for postponing the measures to prevent environmental degradation (Planning & Development Act 2007).

Taken together, this legislative framework offers a platform from which adaptation measures can be implemented and assessed.

Below is an analysis of the current ACT adaptation status assessed against the legislative and policy framework. It is aligned with the challenges outlined above and demonstrates the overall positive position of the ACT in its suite of climate adaptation responses.

4.4.5 ACT challenges and adaptation status

The following table outlines a preliminary assessment of some of the key challenges for the ACT Government and the community in developing a climate change adaptation strategy for the future. Column 1 identifies the challenges and column 2 privies some commentary on the nature of that challenge in the current context. It draws upon the literature review and is
designed to help crystalize some of the key barriers and opportunities that lies ahead with implementation of adaptation.

<table>
<thead>
<tr>
<th>Challenges</th>
<th>ACT adaptation status (and future challenges - preliminary assessment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenge Number 1: Leadership and sponsorship — framing, scoping and resourcing</td>
<td>The ACT Government has shown sustained leadership in climate change, especially in GHG reduction strategies (AP2). The recent commitment to prepare a Climate Change Adaptation Strategy adds to this leadership role. Part of the challenge ahead is to gain broader bipartisan, private sector and community leadership and commitment to develop and support adaptation measures. Good practice indicates that, more than most issues, adaptation requires continuing and shared commitment over time.</td>
</tr>
<tr>
<td>Challenge Number 2: Establishing integrated goals and outcome — mainstreaming</td>
<td>The ACT Government’s framing of adaptation (AP2, and more especially the recent Adapting Directions paper) is quite broad. It addresses climate threats to most relevant sectors, requiring both short and long term responses; expresses the intent to cover several spatial scales including challenges at the regional scale; and the intent to relate climate adaptation directly to other policy areas and responses. While not excluded it would be helpful to be explicit about other framing choices (e.g. including direct and indirect impacts including the links to broader economic health of the ACT and region; including opportunity and not just risk; linkages to other change drivers and policy areas; taking a community outcome and not just government asset perspective; and how adaptation can support positive transformational change and development).</td>
</tr>
</tbody>
</table>
| Challenge Number 3: Addressing institutional issues and responses         | Within the ACT Government: cross-agency interaction has mostly been informal to date on adaptation issues. However the proposed Adaptation Strategy and presentations to the most senior cross government leadership forums provide the opportunity to strengthen and confirm the whole of Government approach. The acid test will be the incorporation of cross agency climate change perspectives into individual policy, investment and operational decisions and implementation.  
External to the ACT Government: the links to the NSW Government are crucial to extend into a regional perspective, and the recent MOU on Regional Collaboration includes sustainable economic growth and land-use/ infrastructure planning as |
priorities. The challenge will be to give this practical effect including in the adaptation context, recognising that the range of institutions and spatial scale depends on the issue/sector under consideration. Follow up to the joint NaRClIM (NSW / ACT Regional Climate Modelling) project also provides a potential vehicle for further strengthening collaboration. The other important institutional and decision making links to be strengthened on adaptation issues include those with the private sector and civil society/ NGOs (see also items 1 above, and 6 below).

The ACT Government has various knowledge development and access platforms. However the adaptation related data used by various agencies appears at the moment to be somewhat fragmented. It would be helpful to position and consolidate climate, adaptation and related data more clearly and consistently across those platforms; and to facilitate consistent use and interpretation of the data across agencies.

<table>
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<tr>
<th>Challenge Number 4: Learning from similar projects and regions</th>
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<tbody>
<tr>
<td>The initial Weathering the Change document (ACT Government 2007) set out high-level objectives. However these need to be further developed in the context of AP2 and the proposed Adaptation Strategy. Given the pervasiveness of climate impacts this could include translation of the Commonwealth’s Climate Outlook goals to the ACT context, and drawing a line of sight from these to broader ACT vision statements and triple bottom line goals (e.g. Time To Talk vision statement; other ACT strategic documents).</td>
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<tr>
<th>Challenge Number 5: Stakeholder engagement and understanding</th>
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<tr>
<td>The Time to Talk Canberra 2030 community engagement initiative (2010) raised many issues relevant to adaptation, and a recent survey of ACT community attitudes to climate issues indicated significant support for government action. The Government has indicated an intention to engage with the community specifically on adaptation and this is an opportunity to gain better, broader and multi-way understanding. The Government also has opportunities for ongoing close collaborative relationships with experts including through the ACT Climate Council and linkages with local tertiary institutions and consultants.</td>
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<tr>
<th>Challenge Number 6: Frameworks, methodologies, toolsets and disciplines to support decision-making</th>
</tr>
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<tbody>
<tr>
<td>The ACT has not yet adopted a consistent approach and methodology to climate adaptation assessment and decision-making, though it does have several</td>
</tr>
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</table>
making potentially compatible component frameworks, mostly drawing on risk management approaches. The delivery of NaRCLIM outputs, and parallel national guidance and data currently being developed by the Commonwealth, all in the next 6-12 months, provides the opportunity to consolidate and promulgate best practice approaches and data across the ACT.

Challenge Number 7: Identifying, developing and managing data and knowledge

The ACT Government is generally well networked with other states and territories and some other regions/cities. However, especially for specific sector issues, it would be helpful to crystallise some of the learning from other regions and initiatives. This CURF project is one step in that direction.

Challenge Number 8: Taking an iterative and adaptive management approach

The ACT Government has been active in researching and responding to climate risks in some priority sectors (e.g. water security, bushfire, spatial planning) and a stated aim of the proposed Adaptation Strategy is to allow an integrated whole-of-government approach. Consistency across issues, policy areas and responses may often be addressed behind the scenes, but is not overtly and publicly demonstrated. This will be essential to demonstrate that the types of interdependencies shown in Figures 1 and 2 of this report are addressed.

4.5 Identified principles

4.5.1 Methodology of selection

Extending on the SECA principles (Norman et al., 2013), the below principles have been developed to build on the review undertaken for NCCARF (Rissik et al., 2013) which reviewed a number of Australian adaptation projects to identify leading adaptation practices. Additional examples of early attempts to move beyond identifying barriers and challenges in order to distil good adaptation principles and practices from the literature and experience to date also includes examples of the work of Webb and Beh (2013) and West and Brereton (2013).

4.5.2 Seven principles

1. Adopting an integrated approach that spans consideration of social, economic, environmental and cultural factors and their interdependencies, builds robustness and sustainability into city and regional planning.

2. Applying the precautionary principle to decision making on the location of new and redeveloped urban settlement and infrastructure (and other long-life decisions) is particularly important where environmental risk currently or potentially exists. Open space
should be a key consideration to allow for adaptation (heat absorption, green infrastructure, coastal retreat).

3. Incorporating risk management and scenario approaches into strategies for economic and sectoral development, and natural resource management, enhances the resilience of Canberra and the region. The best science on climate change, socio-economic trends and community vulnerability and preferences would underpin these approaches.

4. Establishing forums, institutional arrangements, and governance mechanisms that drive collaboration and intergovernmental agreement will facilitate a shared vision for adaptation and efficiency in implementation. This should include regional approaches that better connect regional planning with climate change science.

5. Ongoing stakeholder and community engagement will facilitate community and decision-maker support for adaptation action. This needs to be informed by the latest science, and real opportunities to engage with and influence plans and strategies for adaptation.

6. Growing the adaptation skills and capacity of Canberra and regional communities through long-term interdisciplinary research, engaged agency and iterative monitoring, will build capability to align with the changing climate of the future.

7. Utilising iterative monitoring, adaptive management and robust decision-making processes will ensure ‘learning by doing’ and limit mal-adaptation. The impacts of climate change will require more attention over time including in evaluating adaptation measures and updating risk management profiles.

The above principles are formative and designed to facilitate wider discussion as part of the process of developing a climate change adaptation strategy for the ACT and the Australian Capital Region.
5 Priority Sector Review and Case Studies

This section provides a brief review of adaptation experiences regarding the adaptation processes and responses relevant to the priority sectors outlined in Section 3.3 (community health and wellbeing, disaster and emergency management, settlements and infrastructure, water, natural resources and ecosystems, and agriculture). These experiences are drawn from both domestic and international contexts. Here the focus is on understanding what constitutes leading practice across the sectors and how success can be measured regarding policy interventions to enhance adaptation. The intent is to present a brief review of each priority sector as it emerges in the literature. Following this, a case study is explored that demonstrates good adaptation practice, with lessons regarding the process and response identified and highlighted as relevant to the ACT.

5.1 Priority Sector 1: Community health and well being

5.1.1 Sector review

Climate change presents a range of challenges to community health and wellbeing and, ultimately, the liveability for both urban and rural populations. It is now well established that climate change will have significant impacts on public health (IPCC, 2014) and the way in which people live in future urban environments (Bai et al., 2012; da Silva et al., 2012). Although climate change is a global issue, exposure to risks and the capacity to respond will be dependent on local and regional contexts (Spickett et al., 2011). Emphasising the importance of local factors is, therefore, considered essential in the planning and implementation of any effective adaptation strategy (Mehrotra et al., 2014). In the local context, vulnerability to the impacts of climate change is a product of a range of factors beyond just exposure. While exposure is important, sensitivity to those effects and the capacity of the affected community to respond are fundamental components of effective adaptation strategies (Spickett et al., 2011). The capacity of the community to respond and effectiveness of adaptation strategies will be influenced by the institutions, networks, policies and implementation capacity of the area.

In determining impacts to community health and well being, it is important to acknowledge both direct and indirect factors will influence community health and wellbeing. The direct impacts of climate change are those experienced acutely and have an immediate impact based on the event, e.g. these include such impacts as flooding, fire and heatwaves (Spickett et al., 2011). The extent of the direct impacts can be impacted by other sectors, e.g. the severity of heatwaves will be influenced by the urban design and the degree to which urban heat island effect can be mitigated (as discussed in Priority Sector 3—Settlements and infrastructure). Other strategies responding to direct impacts, such as floods and fire, are embedded with various emergency management plans, such as the ACT Government’s Emergency Plan (as discussed in Priority Sector 2—Disaster and emergency management).

The indirect impacts of climate change are those where any new conditions under climate change influence other environmental parameters, which in turn impact social systems, e.g. these might include impacts of food production (Spickett et al., 2011). Again this highlights the
cross-sectoral nature of climate impacts with strong connections between public health and the urban environment. These indirect impacts, such as prolonged drought, will also impact other sectors, such as agriculture and the ability to achieve food security in a region as well as the well-documented mental health impacts of an extreme and variable climate on rural populations (Morrissey, 2007; Steffen et al., 2014).

Although it is now broadly considered that public health adaptation is inevitable, there are considerable barriers to effective adaptation practices. Huang et al. (2011) note that public health adaptation largely operates at two levels: adaptive capacity building and implementation of specific adaptation action. There is currently a broad range of barriers preventing effective implementation of adaptation strategies. They also note that uncertainties of future climate and socioeconomic conditions limit the ability to make certain interventions. Similarly, competing short-term priorities can undermine consistent and sufficient financial investment in long term capacity building projects. A significant underlying challenge is that current institutional structures—such policy specialised silos, policy fragmentation and contradiction and significant issues across all scales of government—are unlikely to result in successful adaptation. Employing a flexible planning and adaptive management approach, which draws on a broad range of stakeholders from the appropriate local context, can assist in overcoming these challenges.

Public health and well-being is a product of a broad range of factors. As such, in developing an adaptation plan, it requires the active participation of a broad spectrum of actors from within and across public and private spheres. This is crucial as a means of generating broad understanding of cross-cutting nature of health (Spickett et al., 2011; Younger et al., 2008). Huang et al. (2011, p187) advocate the use of comprehensive Health Impact Assessments as a means of providing practitioners with a decision support tool to “take into account the full set of implications of any policy options on climate change that could affect health”. Central to this is the importance of understanding the local circumstances, so that the exposure to direct and indirect risks can be matched with the institutional capacity and support structures (Younger et al., 2008).

In summary the review indicates that current leading practice in adaptation responses for this sector may include:

- Incorporating both direct and indirect climate impacts in health vulnerability assessments;
- Recognising that strategies and actions in other sectors can have a significant impact (positive and negative) on health and well-being vulnerabilities and adaptation, and that cross sector planning and stakeholder engagement is therefore also crucial;
- Addressing cross-agency institutional barriers to avoid policy silos and fragmentation;
- Using public and community health strategies, planning and engagement as key vehicles for adaptation;
- Focusing on building broader adaptive capacity (e.g. the socioeconomic circumstances of the poor) as well as specific adaptation actions (e.g. access to services through transport infrastructure); and
- Potential for use of Health Impact Assessments for significant policy proposals.
5.1.2 Case study lessons

The good quality of life in Australia is based on access to “clean water and air, safe food and housing, protection from pollutants and a program to intervene in the environment to prevent and control disease” (Commonwealth of Australia, 2007). Within this context, the National Environmental Health Strategy 2007-2012 (Commonwealth of Australia, 2007) serves a good practice case study for community health and wellbeing.

The National Environmental Health Strategy 2007–2012 extend the initial framework conceived by the National Environmental Health Strategy 1999 to “identify the Australian environmental health sector’s role in developing and supporting infrastructure for health protection” (Commonwealth of Australia, 1999). The strategy adopts the widely accepted World Health Organisation (2014) definition of environmental health and wellbeing, which forms the basis of the best practice assessment:

> Environmental health addresses all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that can potentially affect health. It is targeted towards preventing disease and creating health-supportive environments. This definition excludes behaviour not related to environment, as well as behaviour related to the social and cultural environment, and genetics.

The adaptation processes adopted by the policy include the integration of goals and outcomes across a number of key areas including climate and water and infrastructure. Stakeholder engagement plays a strong role in the adaptation process, with a notable focus placed on Aboriginal and Torres Strait Islander communities (Commonwealth of Australia, 2007). This highlights how health impacts represent different risks for different social groups, depending on their health status, perceptions of risk, and capacity to take measures to reduce exposure (Gurran et al., 2008, WHO & WMO, 2012). Through representation and partnership, the National Environmental Health Strategy 2007–2012 ensures health is protected through institutional responses. It places an emphasis on a strong and effective internal and external communications capacity, and the need to integrate the considerations of vulnerable communities in the face of extreme climatic changes.

It is important to note, that similar strategies have been adopted on a territory level, with the ACT’s 2010-2015 strategic framework for health, ‘Towards a Healthier Australian Capital Territory’, including a section on the response to the health impacts of climate change. The ACT’s Health Directorate also aims ensure that climate change impacts are considered in population health policy strategies.
5.2 Priority Sector 2: Disaster and emergency management

5.2.1 Sector review

Adaptation to climate change is often discussed as a gradual process of change in response to the impacts of climate change (Woolf et al., 2013). However, as indicated in a previous section, the impacts can be both slow-onset as well as acute. These latter impacts pose potential severe short-term impacts to communities at risk. Disaster and emergency management responses to these acute risks are an important part of an adaptation strategy to address some of the particularly acute direct impacts of climate change (outlined in Priority Sector 1).

It is broadly established that the capacity to respond to climate risks is complex and multifaceted. In conceptualising vulnerability, it is important to understand that risk is a product of exposure and sensitivity to the hazard as well as capacity to respond. The occurrence of hazards cannot be avoided and in and of themselves they do not produce a disaster (Eburch and Dovers, 2013; O’Brien et al., 2006). Their impact, and the potential of them causing a disaster, is tempered by the way in which the effected community can prevent and prepare as well as respond to the actual impact (O’Brien et al., 2006). When understanding the capacity of a community to respond to the risk, it is important to consider both the immediate response and the post-event recovery (Jabareen, 2013). Within each community, vulnerability is not evenly distributed—those who are currently the poorest and most marginalised likely to be the worst affected and have least capacity to respond (Gurran et al., 2008). Reflecting the broad impact of climate change, and the need for adaptation, there are core social justice and equity concerns that need to be acknowledged when designing response and recovery strategies.

The literature regarding disaster and emergency management provides a range of important lessons that can be learnt to inform climate change adaptation good practice. In understanding and then operationalising risk mitigation efforts, Wamsler et al. (2013, p70) note four key actions measures that can be taken. Specifically, this can be to: reduce or avoid hazards (i.e. hazard reduction, avoidance or prevention); reduce the susceptibility of the affected location to withstand hazards (i.e. vulnerability reduction or disaster mitigation); improve post-disaster response mechanisms and structures (i.e. preparedness for response); and, improve post-disaster recovery mechanisms and structures (i.e. preparedness for recovery). Underlining each of these components are good risk assessment measures, however such assessments do not reduce risk in isolation from these other measures.

In formulating a response to the acute impacts of climate change, it is important to draw on a broad range of relevant actors across different scales. In framing a response to disasters, at the national scale, COAG explicitly draws on such a broad range of actors from across society in order to manage the risk. The emphasis is on a regional collaboration and coordination which acknowledges that specific communities are not isolated from one another—i.e. hazards, for example a bush fire, will cross jurisdictional boundaries. In this respect, a network that can coordinate between jurisdictions is important. However, care must be taken to ensure that it is also appropriate for the local context and work in practice. Huang et al. (2011) note that sound policy does not necessarily result in good implementation of that policy in terms of responding to a particular threat. For example, in 2009, although Melbourne had a sound emergency
management response there were significant issues in implementing it, to the extent that 172 people died.

In responding to these challenges, it is important to employ a management plan that is responsive to the local context, able to adapt to changing circumstances and which can be embraced by local users. In regards to planning, Wamsler et al. (2013) highlight that there has been a tendency to employ top-down approaches to emergency planning, with governments often drawing on discipline experts and other government authorities to inform policy and planning. However, Jabareen (2013) notes that this risks missing the intricacies of urban systems, and a participatory and multidisciplinary approach is important. Similarly, da Silve et al. (2012) note that an approach that draws purely on climate projects and spatial analysis will develop an insufficient understanding on cities response capacity and rather there is a need to understand the urban dynamics and range of other social factors that contribute to the relative risk. In this respect, there is an emphasis for learning frameworks to be built into disaster management through the planning, response and recovery stages.

In summary the review indicates that current leading practice in adaptation responses for this sector may include:

- Specific disaster and emergency management strategies as part of an adaptation strategy to respond to the acute impacts of climate change (e.g. more frequent/intense fire, drought, heat waves) are required;
- Acknowledgement that although hazards are inevitable, their impact is tempered by capacity for the effected community to respond and that, further, vulnerability is not evenly distributed with those who are the poorest and most marginalised likely to be the worst effected and have least capacity to respond;
- The incorporation of both the immediate and the post-event recovery responses when assessing the vulnerability of a community;
- Risk assessment measures that recognize that risk will change over time, for example with climate change and development patterns. These could include actions to: reduce or avoid hazards; reduce the susceptibility of the affected location to withstand hazards; improve post-disaster response mechanisms and structures; and, improve post-disaster recovery mechanisms and structures;
- Regional communication and collaboration regarding of disaster and emergency management responses;
- Management plans that are relevant to the local context and engage local stakeholders; and
- Learning frameworks integrated into the planning, response and recovery stages as a means of continual improvement of disaster and emergency management strategies.

The ACT has experienced major bushfires in the last 15 years which caused significant economic, social and environmental damage. Key lessons from this experience are critical to capture and draw on, and they have informed the ACT’s Strategic Bushfire Management Plan.
5.2.2 Case study lessons

Living in the ACT, means living with bushfire (ACT Government, 2009a). The ACT’s Strategic Bushfire Management Plan (ACT Government, 2009a) demonstrates good practice for disaster and emergency management. The aim of the management plan is to encourage collaboration between government and community, where objectives are set for both parties in order to “suppress bushfires and reduce their consequences on human life, property and the environment” (ACT Government, 2009a, p2). This site specific and locally developed approach allows for effective leadership and clear framing.

The structure of the ACT’s Strategic Bushfire Management plan adopts main elements of contemporary bushfire management: Research, Information and Analysis; Preparedness; Prevention; Response; and Recovery (ACT Government, 2009b). These components address the treatment, monitoring and communication of bushfires.

Of particular significance to the good practice discourse, is the statutory and planning framework for bushfire management that illustrates how decision-making is being supported. The framework allows for stakeholders to engage in bushfire planning, in turn allowing for the policy to develop from an iterative approach that builds on past experience. The key elements and relations of the statutory and planning framework for bushfire management in the ACT are identified in Figure 4.

The ACT’s own Strategic Bushfire Management Plan, with its site specific and locally developed characteristics serves as a best practice framework for disaster and emergency management. Of particular significance to the good practice discourse, is the statutory and planning framework for bushfire management that illustrates how decision-making is being supported. The key elements and relations of the statutory and planning framework for bushfire management in the ACT are identified in Figure 4.
Figure 4. Key elements and relations in the ACT’s statutory and planning framework.
5.3 Priority Sector 3: Settlements and infrastructure

5.3.1 Sector review

Urban environments shape the liveability of the cities for the people who function within them (Jabareen, 2013). Cities are dynamic and multi-dimensional entities and, in regards to climate change, they are similarly complex. While the city has been an area of significant research regarding the production of GHG emissions (Dodman, 2009) and strategies to mitigate emissions (Bulkeley, 2010), cities are under researched regarding adaptation (da Silva et al., 2012; Hunt and Watkiss, 2011). Urban settlements and their related infrastructure have significant cross-sectoral impacts. For example, Bai et al. (2012) note that health is impacted by a range of factors beyond the direct health care system, including planning and city structure. The way in which urban environments are designed contributes significantly to the health of urban communities. Given the dynamic nature of cities as living and fluid entities, and that their urban fabric influences across other sectors, an integrative approach to planning is essential (Bai et al., 2012; Jabareen, 2013).

Current planning processes must be made with an eye to the future as a means of mitigating the cost of future adaptation planning and avoiding maladaptive practices. Although the long-term impacts of climate change are shrouded in uncertainty, urban planning decisions have long legacies. In other words, decisions made in 2014 will shape future urban living, with the future retrofitting of the built environmental a more expensive endeavor than forward planning (Bai et al., 2012). The temporal scale associated with climate change presents additional challenges in that decisions are socially and politically shaped by current concerns but for future benefits (Bai et al., 2010). In future planning for settlements and urban infrastructure, there is a need for adaptation plans to be embedded within the current urban context (Huang et al., 2011). One avenue for this is to identify potential co-benefits for urban design that reflect other community concerns — i.e. pursuing ‘no-regrets’ options (Younger, 2008). These could include health, well-being and other socio-economic factors, as well as mitigation actions. This reflects the need for adaptation concerns to be mainstreamed into other planning strategies and policy platforms (Bai et al. 2012). However, to pursue such an agenda the urban system needs to be understood in a holistic way, including an engaged decision making process.

A holistic understanding of the city context is important for effective adaptation planning and the acceptance of that plan. Give the cross-sectoral nature of adaptation, a significant part of this is a need for coordination across different sectors of government (Mehrotra et al., 2013). As noted in Priority Sector 1, there is a risk of contradictory policy measures which undermine each other (Huang et al., 2011). There is a requirement to be aware of maladaptation and circumstances where addressing one issue has adverse effects on another sector. High-level policy discussion is required to identify co-benefits across sectors—e.g. transport systems which promote active transport can provide health benefits, reduce congestion, mitigate GHG emissions and, if done well, can allow for better access to services for the poor. Addressing co-benefits can present opportunities to build capacity and simultaneously improve the situation of those who are most vulnerable (Bambrick et al., 2011).

Long life assets such as infrastructure which are critical for economic productivity also need particular consideration when planning for the future. Infrastructure assets which support
transport systems, energy generation, distribution and transmission, water supply and telecommunications are all exposed to climate change impacts, particularly those from extreme events (IPCC, 2014; Wang et al., 2013).

In summary the review indicates that current leading practice in adaptation responses for this sector may include:

- Acknowledgement that the urban form of a city has significant cross-sectoral impacts (e.g. city design can contribute significantly to the health of urban communities);
- An integrative approach to planning to reflect the dynamic nature and evolution of cities;
- The mainstreaming of climate change adaptation into broader planning processes to mitigate the cost of future adaptation actions and avoid maladaptation, and into infrastructure siting, design and investment processes, noting that this may require new approaches to take into account changing risks for long-life assets or in the context of irreversibility; and
- Strategies for adaptation that are embedded within the current urban context. The identification of co-benefits and ‘no-regrets’ options provides an opportunity for adaptation actions to be linked to other community concerns (e.g. mitigation, health, well-being and other socio-economic factors).

Coordination across different sectors of government is critical to avoid inconsistent policy measures and to identify opportunities to achieve multiple cross-sectoral objectives simultaneously, particularly in the context of high cost investment and irreversible decisions.

5.3.2 Case study lessons

Like the ACT, by 2030, Melbourne is likely to be significantly affected by warmer temperatures and heatwaves though Melbourne will experience this to a greater extent. The ACT will also experience changes in rainfall patterns and frequency, which may result in lower rainfall, intense storm events and flash flooding. In response to these climate change risks, the metropolitan Melbourne area has adopted proactive measures in identifying and monitoring climate change impacts and planning for climate change adaptation. The City of Melbourne’s policy papers *Climate Change Adaptation Strategy* and *Zero Net Emissions by 2020* strategy are exemplars of how municipalities can comprehensively respond to climate change. However, as the scope of this report is specifically climate change adaptation, only Melbourne’s *Climate Change Adaptation Strategy* will be referred to as a case study for good management.

To minimise or avoid the effects of climatic impacts, effective and prompt adaptation is imperative. To achieve this, the City of Melbourne adopts an iterative risk management approach (Figure 5) to help in identifying the most effective adaptation responses and use of resources to reduce the impacts of these events requires an understanding of how they unfold. Note that this is consistent with the risk management approaches discussed in Section 4.4.2.
Figure 5. The City of Melbourne’s Climate Change Adaptation Strategy iterative risk management process

Phase 1: Risk Identification
- Establish the context
- Identify Risks
- Analyse Risks
- Evaluate Risks
- Accept Risks
- Treat Risks (Adaptation)

Phase 2: Risk Assessment

Phase 3: Adaptation Action Plan

Communicate and Consult

Risk and Review
- Monitoring and Review
- Response
- Resilience
5.4 Priority Sector 4: Water

5.4.1 Sector review

Water in southeastern Australia is a scarce resource, with a history of regular and prolonged drought across the country (van Dijk et al., 2013). Although climate change is expected to significantly exacerbate current challenges, water scarcity under climate change should not be treated in isolation from other pressures. These include but are not limited to: unsustainable agricultural management practices, population growth and land use change (Short et al., 2012). As a crucial, multi-use resource, water has cross-cutting impacts across social, economic and environmental spheres (van Dijk et al., 2013). For example, it is a fundamental component of ecosystem health and is crucial in agricultural production in Australia. Given that 90% of Australians live in urban environments, the maintenance of effective water supply systems for cities is also crucial (Hunt and Watkiss, 2011). However, all these water uses will become stressed with future climate predictions, with current water management regimes deemed inappropriate for dealing with these changes (Hunt and Watkiss, 2011).

Conventional means of water management in Australia are unlikely to be sufficient in a climate change affected future. Short et al. (2012) note that, conventionally, there is a tendency for water management to be framed by predict and control based approaches. Such approaches are based on models whereby fixed amounts of water, calculated on historical precipitation levels and inflow patterns, are allocated among different priorities. However, given the impacts of climate change in intensifying the hydrological cycle—characterised by increased intensity of rainfall events but decreased overall rainfall patterns—along with the uncertain and largely unpredictable nature of other impacts, the assumptions underlying such an approach are being questioned (Short et al., 2012). Reflecting the approach advocated within climate change adaptation literature, an adaptive management approach is argued as an important component of an adaptation water resource management strategy.

In shifting away from a linear conceptualisation of water management under climate change, Short et al. (2012) advocate an adaptive management approach with two caveats. First, that given climate change adaptation has broader socio-economic impacts that conventional water planning does not, being informed by and integrating strategies with other urban planning approaches is important. Second, in employing an adaptive management approach it needs to be done in a way that is relevant to the planning processes of major public authorities (Short et al., 2012). Short et al. (2012) suggest such an approach should fulfil a number of requirements. Adaptation concerns should be easily incorporated and mainstreamed into conventional management and operation practices, including both strategic and business planning. Given the need for a multi-disciplinary approach to future risk management and planning, as well as the broad range of actors that must be involved with not only water planning but also more broadly, methods to identify, quantify, communicate and incorporate adaptation concerns must be clear and straightforward. Finally, water resource management must avoid a blinkered approach to dealing with such complex systems by both acknowledging and making integrative inter-linkages between the different components of the water system in their water management regimes (Short et al., 2012, p1957).
Designing an appropriate climate change adaptation strategy for water resource systems requires that it be integrated with the current operations of the utility service provider and that it be dealt with at a strategic management level. In summarising this view, Short et al. (2012, p1975) contend that, “An adaptive strategic plan should have adequate flexibility, promptness and responsiveness to allow itself to adapt to new information and realities as they emerge—sustaining itself and remaining relevant to the changing environment”. In doing this, it must be reiterated that acknowledging the local context and circumstances will be crucial, both in understanding the complexity of the issue and in facilitating the broad technical, community and political acceptance of planning and decision making.

In summary the review indicates that current leading practice in adaptation responses for this sector may include:

- An acknowledgement that water, as a multi-use resource, has cross-cutting impacts across social, economic and environmental spheres in both rural and urban contexts;
- An understanding that water scarcity under climate change should not be treated in isolation from other pressures, particularly in the short term;
- An adaptive management approach to water resource management and a shift away from management strategies informed by models with assumptions based on fixed amounts of water, calculated on historical precipitation levels and inflow patterns;
- An integration of water planning with its broader socio-economic impacts and development of strategies that match with other urban planning approaches;
- Strategies that are relevant to current planning processes of major public authorities;
- The integration of multi-disciplinary approach to future risk management and planning, which draws on a broad range of actors beyond water industry and recognises that risks are not static; and
- Strategies that are relevant to the local context and circumstances regarding an understanding the complexity of the issue and in facilitating broad technical, community and political acceptance of planning and decision making.

The ACT has had recent experience in managing constrained water resources, for example from the severe drought that ended in 2009 and the disruption to supply of potable water from contamination to reservoirs from the 2003 bushfires (White et al., 2006). There are lessons that can be drawn from the experience gained that will contribute to building resilience to likely climate change impacts. It can be noted that the ACT Water Strategy 2014-44 identifies climate change as one of the key factors that will impact upon water supply and sustainability, and consideration of climate change is incorporated in strategies for planning for catchment and flood risk management, and for long term water security.

5.4.2 Case study lessons

Australia’s water sector has already been exposed to the extreme variability (Pittock, 2013; van Dijk et al., 2013). This variability is likely to increase in extremity. The ACT is predicted to be warmer and overall drier with increased incidents of extreme weather-related events like fires, which will demand the storage and supply of water across the region. Such events have had enormous impact on the water industry across Australia and the way it does business.
Services Association of Australia, 2012). In such a highly sensitive climate, the water industry is facing an unprecedented challenge, with implications for all facets of the urban water cycle from water supply, sewerage transfer and treatment and infrastructure, to river health, drainage and flood management (Water Services Association of Australia, 2012).

A number of these aspects of the water supply have been engaged with in the Climate Change Adaptation Strategies for California’s Water (2008), which has led to its selection as a case study. The Californian strategies encourage both increased infrastructure investment and a strengthened decision-making capacity, at regional and state scales (California Department of Water Resources, 2008). In addition, the policy endeavours to provide policy makers with the tools to be able to govern the use of water in the landscape into the future (California Department of Water Resources, 2008).

Although California’s water strategy allows for an increased learning from similar projects and regions as well as identifying and developing more knowledge on water related issues, there is an inherent challenge in this approach (Water Services Association of Australia, 2012). Investment in larger scale water project may have costly implications for current and future generations, with risks arising from potentially wrong decisions and poor allocation of capital (Water Services Association of Australia, 2012). However, some long-term investment decisions are necessary to secure water supplies in areas that are likely to experience drought (Water Services Association of Australia, 2012).
5.5 Priority Sector 5: Natural resources and ecosystems

5.5.1 Sector review

The services humans derive from healthy and functioning ecosystems are extensive, spanning from direct consumable raw material through to sequestering carbon dioxide from the atmosphere (Millennium Ecosystem Assessment, 2005). However, climate change is predicted to have significant negative impacts on biodiversity and ecosystem functionality (Maru et al., 2012). While these impacts will also be fundamentally influenced by other land management practices (Millennium Ecosystem Assessment, 2005), the future impacts of climate change are expected to occur at a rate faster than most systems are able to naturally adapt to (Mawdsley et al., 2009). These ecosystem impacts will influence services that societies rely on across a broad range of sectors. For example, ecosystem health influences water run off, will influence how fire prone environments are, and directly impact productivity of agricultural systems (Hobday and Midgley, 2013).

There is a range of approaches employed for ecosystem adaptation. As Hobday and Midgley (2013) note, ecosystems adapt autonomously to changing environmental conditions constantly. However, in circumstances where change occurs at such a rather that ecosystems will struggle adapt direct human intervention will be needed to maintain their functionality (Hobday and Midgley, 2013). Much attention has been paid to the vulnerability and conservation of specific species, with an emphasis on strategies such as translocation (Mawdsley et al., 2009). While there is undoubted value in species conservation, such a narrow approach has practical limits, given the number of species that will need to be moved. Further, it risks obscuring a more holistic understanding of how ecosystems might function and adapt to future environmental change (Hobday and Midgley, 2013). Employing an ecosystem-based approach to adaptation can help with a more comprehensive approach to managing ecosystems at a landscape scale.

Ecosystem-based adaptation can be understood as an approach that considers the role of ecosystem services in mitigating societies’ vulnerability to climate change (Hobday and Midgley, 2013). Cowan (2013: 269) notes that the approach “seeks to proactively manage ecosystems in order to deliver adaptation benefits, such as flood protection, temperature management or protecting water quality”. Such an approach can be under-pinned by adaptive management (Cowan, 2013; Hobday and Midgley, 2013) in that, while the potential future impacts and responses of various ecosystems are unknown (Maru et al., 2012) this uncertainty is not sufficient to prevent action. As Hobday and Midgley (2013, p259) note, waiting for a complete understanding of the impact of climate change “is illogical, given the rate of climate change, and the generally low risk nature of ecosystem-based adaptive management” and further that “initiating adaptation responses that enhance ecosystem resilience is therefore sensible”. In regards to process, Hobday and Midgley (2013, p260) note it “involves national and regional governments, local communities, private companies and NGOs in addressing the different pressures on ecosystem services, including land use change and climate change, and managing ecosystems to increase the resilience of people and economic sectors to climate change”. They further emphasise the importance of effective monitoring and evaluation regimes, as well as flexible implementation arrangements, that allow for policy learning and improvement of governance structures.
The ecosystem-based adaptation approach is still developing, however there are a range of positive examples regarding success application of the approach and achievement of outcomes. For example, Cowan (2013) highlights the effective application ecosystem-based adaptation in the EU context regarding flood management. However, it is important to note that such an approach is not just relevant to rural areas, with research undertaken in Manchester, the United Kingdom, identifying that enhancing ecosystem functionality in urban environments was predicted to be able to offset a four-degree temperature rise (Cowan, 2013). Whether this outcome can be replicated elsewhere is unclear. This would provide co-benefits of reducing reliance on air-conditioning as well as providing green areas that can promote health benefits. In this respect, Cowan (2013, p272) notes “ecosystem-based adaptation has the potential to offer win-win outcomes in a cost-effective and equitable way and should therefore be considered as part of a portfolio of adaptation responses”. The ACT with its planning focus on incorporating green bush paces in the city may well have significant opportunities to explore ecosystem-based opportunities.

In summary the review indicates that current leading practice in adaptation responses for this sector may include:

- An acknowledgement that the impacts of climate change are expected to occur at a rate faster many ecosystems can naturally adapt, and that these impacts will also be fundamentally influenced by other land management practices;
- An acknowledgement that ecosystem impacts will influence services that societies rely on across a broad range of sectors;
- Strategies that go beyond a focus on translocating or preserving specific species to emphasising a more holistic understanding of how ecosystems might function and adapt to future environmental change (Hobday and Midgley, 2013);
- An ecosystem-based approach to management as to achieve a more comprehensive and holistic understanding of ecosystem services at a landscape scale;
- The development of ecosystem management strategies in both urban and rural areas, and recognition that there are close links with other land and water management objectives and strategies;
- The inclusion of a broad range of stakeholders and communities actors in the planning process; and
- Learning frameworks that are integrated into the approach as a means of employing effective monitoring and evaluation regimes. To complement this, flexible implementation arrangements should be encouraged that allow for policy learning and improvement of governance structures.

5.5.2 Case study lessons

There are a number of strategies that can increase an ecosystem’s adaptive capacity: the most fundamental activities are those that preserve landscape function and diversify habitats (Webb, 2011). Such strategies are successfully underway in the ACT’s nature parks and reserves (Webb, 2011). However, ecosystems as a priority sector have challenged policy makers over the attribution of objectives for the adaptation process (Cowan, 2013). This issue can result from the contrast between the expansive and interactive nature of eco-systems, and the silo and
sometimes rigid structure of governments. Consequently, as explained by Cowan (2013), “those responsible for such projects may not be aware of the potential for wider benefits which may lead to missed opportunities and the failure to accurately assess the benefits that such projects might deliver”.

The case study of the Lower Danube Green Corridor is an example where such opportunities have not been missed on a larger scale. In 2000, in accordance with the World Wildlife Fund (WWF), the governments of Bulgaria, Romania, Ukraine and Moldova became signatories to the Lower Danube Green Corridor Agreement. The agreement was to establish a green corridor along the entire length of the Lower Danube River. The aim of the corridor was to ‘reduce flooding, improve water quality, restore biodiversity and enhance local livelihoods’ (World Bank, 2009). Although the project was recognised as delivering significant adaptation benefits for the eco-system, the primary objective moved beyond this scope, and focused more on the local communities’ abilities to deal with the uncertainties surrounding climate change in what was now a protected ecosystem.

This case study is of particular relevance to the ACT in how it views the eco-system as a whole and inclusive of human activities, rather than the management of ecosystems as a form of conservation, on a larger scale to what is currently occurring in the Territory. It successfully demonstrates the importance of establishing integrated goals and outcomes, as well as effective stakeholder engagement and understanding.
5.6 Priority Sector 6: Agriculture

5.6.1 Sector review

Agriculture as an industry is inherently connected with the surrounding environment and climate conditions (Hayman et al., 2012). In Australia, the agricultural industry has developed over time in response to significant climatic variation. However, it is well established that climate change is going to present significant adverse impacts, which will require changes in current practices (Rickards and Howden, 2012). In this respect, Smit and Skinner (2002) note the vulnerability of the agricultural sector to the impacts of climate change and further contend the importance of integrating agricultural concerns within any adaptation response. Most agricultural sub-sectors in Australia have been subject to some degree of impact and adaptation strategy assessment (Howden and Stokes, 2009).

Agricultural adaptation strategies span a broad range of activities. Smit and Skinner (2002, p85) note there has been a tendency to view them across four core categories: technological developments; government programs and insurance; farm production practice and farm financial management. Within these categories, attention has been given to direct adaptation responses based on technical fixes. Smit and Skinner contend that such direct and prescriptive adaptation approaches at the farm level are not necessarily a useful way to promote adaptation. Rather, a focus on building adaptive capacity is crucial. In this respect, Rickards and Howden (2012) note the importance of understanding agricultural systems within the broad social, political and cultural systems within which they are embedded.

In building adaptive capacity for the region, a more integrative approach is required (Hayman et al., 2012). Such an approach needs to understand context and interactions between relevant actor groups. In this context, relevant actors to agricultural adaptation are broad ranging, spanning from producers, industries and governments (Smit and Skinner, 2002). Strategies for adaptation need to be understood in terms of both potential climate risk and also the socio-economic, political and institutional context in which decisions are made (Rickards and Howden, 2012). As Smith and Skinner (2002) observe, “the place-specificity and context-specificity of agricultural adaptations, means that most climate change adaptations are unlikely to be undertaken independently of related risk-management initiatives”. This reflects the re-occurring theme of the need to have integrated and inclusive approaches that are mainstreamed into existing government strategies.

More recently it has been appreciated that individual agricultural adaptation strategies can be considered along a spectrum from incremental, through systems adaptation to transformational adaptation and change; and that especially in respect of more transformational adaptation “we need to understand its position within the landscape, rural communities, and broader social, political and cultural environment” (Rickards and Howden 2012, p247).

In summary the review indicates that current leading practice in adaptation responses for this sector may include:
• Acknowledgement that most sub-sectors of Australian agriculture have suffered some degree of impact of climate change and that current conventional approaches to land management may need to be altered;
• A focus on adaptive capacity building as well as targeted measures to diversify production systems which take into account likely future risk;
• Strategies that integrate agricultural adaptation practices with other objectives concerned with land and water management and biodiversity conservation;
• An emphasis on developing strategies for adaptation appropriate to the specific context and circumstances of the area being explored, recognizing the broader industry, cross-disciplinary and transformational opportunities provided in the sector;
• The inclusion of a broad range of local stakeholders within the planning process; and
• Learning frameworks that ensure that lessons gained from coping with recent changes in the climate are identified and shared, including limits to coping capacity.

5.6.2 Case study lessons

The Australian wine industries contributes approximately $2.5 billion to agricultural exports (Australian Bureau of Statistics, 2010) making wine the third largest agricultural export with 8.1 per cent of the market share (DFAT, 2009). However, the wine industry is under pressure from the early effects of climate change. The Garnaut report (2008) indicated that the South Australian wine sector was particularly vulnerable to climate, with a predicted 44 per cent reduction by 2050 in land suitable for growing wine grapes.

The Garnaut Report (2008) also explains that, as it is the first sector likely to be adversely affected, the wine industry acts as a forward indicator for all Australian agricultural sectors regarding the impacts of climate change. This is because wine grapes and wine industry, are highly susceptible to and heavily impacted by incident of extreme weather events—heat, drought, frost, wind, hail, bush fires—in addition to higher temperatures which bring a premature harvest. Consequently, the wine sector has been selected as a focal point for discussion regarding the ACT’s agricultural priority sectors.

As the sector is highly sensitive to a changing climate, the industry has strong interests in designing its own responses and reaching efficient results. This is demonstrated by the case study of the Wine Innovation Cluster (WIC) in South Australia. The WIC is an alliance of five major research and development organisations in Adelaide: the Australian Wine Research Institute, CSIRO, the South Australian Research and Development Institute (SARDI), the University of Adelaide and Provisor Pty Ltd (Wine Innovation Cluster, 2014).

To address some of the agricultural issues associated with climate change in the wine industry, the WIC provides capabilities for integrated grape and wine research across the production value chain (Wine Innovation Cluster, 2014). The culmination of the knowledge across the supply chain, by nature, demands a whole of systems management approach: within the vineyard, at the winery and the region. The cross-institutional alignment and support between the partners assists in the development and delivery of solutions across the supply chain, including mainstreaming their delivery. Further to “fast track the development, validation and adoption of innovative solutions” the WIC partners collaborate with other agencies on a program and project basis, in order to learning from the experience and activities of other
regions and initiatives (Wine Innovation Cluster, 2014). As a result of the WIC’s demonstrated good practice with regards to institutional responses, learning and knowledge management, the case study poses possible interested areas for the ACT’s agricultural sector.

5.6.3 Insights from case studies and sector reviews

All case studies addressed the explicit and agreed framing, scoping and resourcing, including spatial and temporal choices criteria for good practice. Most case studies also addressed the criteria of cumulative data and knowledge management. Only the case study of the Lower Danube Green Corridor was perceived as partially addressing these criteria because it had a greater focus on the generation of informed decision making for effective stakeholder engagement.

The criteria of ‘sustained and effective leadership and sponsorship’ was also mostly successfully addressed in the case studies, with only two case studies viewed as partially addressing the criteria. These two case studies were Australia’s National Environmental Health Strategy and California’s Water Strategy. The former placed a greater focus on using existing cross-institutional support, whereas the latter focused more on the dissemination of decision making rather than sustained leadership.

Similarly, only two case studies were viewed as partially achieving the criteria of clear goals, incorporating social, economic and environmental objectives. These were California’s Water Strategy and South Australia’s climate change initiative for the wine industry. In these cases, the climate change adaptations outlined were in their formative stages and, consequently, were more focused on the initial explicit and agreed framing, scoping and resourcing components of the climate adaptation strategies, as well as the management of cumulative data and knowledge.

Interestingly, the same two case studies were also viewed as either partially or not addressing the criteria of effective stakeholder engagement. In both instances, the stakeholder engagement was centred on those who were most likely to influence decision making, rather than also including those who were likely to be impacted by the policies. With South Australia’s Wine Innovation Cluster, those stakeholders engaged were dominantly the partners from industry and research.

Of the emerging criteria considered to constitute good practice, the criterion of learning from others’ experiences was viewed as the least addressed component of the adaptation process, with half of the case studies shown to not address it—these case studies being Melbourne Climate Change Adaptation Strategy, California’s Water Strategies for Climate Change Adaptation and the Lower Danube Green Corridor. However, these case studies were more likely to be viewed as showing leadership and engaging in context decision making. The criteria cross-institutional alignment and support, including mainstreaming of development and delivery was also viewed as being less successfully addressed with half of the case studies viewed as only partially addressing these criteria.

Due to the interrelated and interdependent nature of climate change adaptation, and as further evidenced in the above sector reviews and case studies, there are significant interdependencies between sectors. This was referred to in Section 2 (Figure 1) and is depicted more
generally in Figure 6. Natural resources and ecosystems and water, as well as being important in their own right, also underpin all other sectors. There are also overlapping issues between settlements and infrastructure, agriculture and emergency management. And community health and wellbeing is impacted by all the other sectors.

Figure 6. Overlapping priority sectors

This section has presented information on each priority sector, outlining relevant issues for understanding how that sector may emerge in the ACT. Each case study provides an example of how good adaptation practice might be said to have emerged within each of those priority sectors, with the analytical use of adaptive process principles assisting to identify key lessons that could be usefully applied to the ACT context.

This report highlights that the long-term nature of climate change, and associated adaptations, presents potential challenges.

A common theme across each of the case studies was that adaptation strategies need to be relevant to the day-to-day functioning of the communities they are seeking to influence. Business as usual will not be sufficient. While systems need to change, there still needs to be integration with current institutions for it to work (for example, regarding water).

Integration and mainstreaming emerged as core components of the policy process, along with recognition that at times adaptation will necessitate new approaches that may be transformative. This was reflected both within each case study as well as the broader literature. There is a strong contention that climate change adaptation strategies need to be situated within their local or regional context and also need to be responsive to factors relevant to that community and priorities in short-term. For example, urban infrastructure and health/wellbeing concerns can be potentially addressed through changes to planning and direct interventions that will also enhance adaptation capacity.
Throughout the different sectors, an emphasis was placed on transparent and inclusive engagement processes. In building a comprehensive and integrated approach, there emerged a need to engage in meaningful consultation and collaboration with a broad range of relevant actors, as a means of developing a holistic understanding of the sector and of the broad range of connections it had with other sectors. For example, the need to go beyond government to best understand how planning will influence health and environmental outcomes in urban environments.

A critical part of adaptive management approach is the process of knowledge building, and regular review against new learning and knowledge. There is a need to incorporate knowledge building in the processes and structures of implementation by government agencies in partnership with academic institutions and research organisations and communities.
6 Informing future directions

The ACT Government is in many ways leading the way in developing policy responses to climate change at the state, regional and local level. This work is occurring in the context of the Australian Capital Region recognising that many of the issues involved cross state and local government boundaries.

A number of the challenges and opportunities ahead have been identified. These include mainstreaming action on climate change across government, learning from similar regions experiencing climate change, leading practice in community engagement, and ‘learning by doing’ as part of an adaptive management cycle. To further explore these issues the working paper undertakes a deeper sectoral analysis to gain insight into some of the particular barriers and opportunities that can be found in community health and wellbeing, disaster and emergency management, settlements and infrastructure, water, natural resources and ecosystems and agriculture. From the above, a formative set of guiding adaptation principles have been developed to facilitate wider discussion by government and the community during the process of developing an ACT Climate Change Adaptation strategy.

Climate change is here and now with much of the science settled through the processes of the Intergovernmental Panel on Climate Change. The focus is now on appropriate policy responses and government, industry and community involvement in implementing a zero carbon economy and preparing communities for inevitable change. The suggested principles cover key considerations for the future: adapting an integrated approach, applying the precautionary principle, incorporating a risk management and scenario planning, establishing appropriate governance arrangements, community engagement, capacity building on adaptation and ‘learning by doing’.

The ACT Government is well positioned to build upon leading research and practice in climate change adaptation outlined in this working paper and to take the next step forward with the Canberra and regional community in responding to the impacts of climate change.
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