

Climate Change Adaptation in the Natural Resource Management Sector of Victoria

A literature review and analysis of institutional context
and organisational needs for adaptation

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Disclaimer

The views expressed herein do not represent those of the Victorian Government, VCCCAR or any of the organisations that participated in the study. They are the views and interpretations of the report authors.

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Abbreviations

ACOSS	Australian Council of Social Services
AGO	Australian Greenhouse Office (Federal)
BoM	Bureau of Meteorology
CAHA	Climate And Health Alliance
CEFP	Clean Energy Futures Package
CFA	Country Fire Authority
CMA	Catchment Management Authority
COAG	Commonwealth Of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSO	Community Service Organisation
DEPI	Department of Environment & Primary Industries (VIC) – (Formally DSE and DPI)
DCC	Department of Climate Change (Federal)
DCCEE	Department of Climate Change and Energy Efficiency (Federal)
DoH	Department of Health (VIC)
DoHA	Department of Health & Ageing (Federal)
DHS	Department of Human Services (VIC)
DIICCSRTE	Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (Federal)
DPI	Department of Primary Industries
DSE	Department of Sustainability & Environment (VIC)
EDO	Environmental Defender’s Office
EO	Executive Officer
GP	General Practitioner
IPCC	Intergovernmental Panel on Climate Change
LGA	Local Government Area
MPHWP	Municipal Public Health and Wellbeing Plan
ML	Medicare Local
NDIS	National Disability Insurance Scheme
NCCARF	National Climate Change Adaptation Research Facility
NGO	Non-Government Organisation
NHHN	National Health & Hospitals Network
NHR	National Health Reform
NRM	Natural Resource Management
PC	Productivity Commission
PCP	Primary Care Partnership
SECCCA	South East Councils Climate Change Alliance
VCCCAR	Victorian Centre for Climate Change Adaptation Research
VCOSS	Victorian Council of Social Services
WHO	World Health Organisation

Executive summary

This report is a major output of a research project entitled 'Implementing tools to increase adaptive capacity in the community and natural resource management sectors'; funded by the Victorian Government through the Victorian Centre for Climate Change Adaptation Research (VCCCAR). The project consists of several phases of desktop, empirical and action research. The main goal of the research phase leading to this report was a better understanding of the climate change adaptation planning capabilities and needs of three types of service providers funded by the Victorian Government: Catchment Management Authorities (CMAs); Community Service Organisations (CSOs); and Primary Care Partnerships (PCPs).

This document focuses on the Natural Resource Management (NRM) sector, in particular Victoria's Catchment Management Authorities (CMAs). It **reviews existing academic and grey literatures on climate change adaptation** in the context of NRM and **analyses the institutional context of CMAs in relation to climate change adaptation**. It includes a review of international, Australian and Victorian published material on adaptation in NRM, with a view to appreciating the status of planning for and responding to climate change impacts. The analysis of interviews conducted among Victoria's CMAs identified **a range of sectoral and organisational adaptation barriers, needs and capacities**.

Key points from the literature review

- Like many public policy issues, NRM planning is governed by a complex set of legislation and policies, operating at various levels of government. In the state of Victoria, the history of catchment management dates back to the 1880s, and more recently into the 1980s where river health and salinity issues required a whole-of-catchment approach. The *Catchment and Land Protection Act 1994* and the *Water Act 1989* form the two main legislative instruments related to catchment management, but beyond this, a much broader set of legislation and policies at both state and federal level also influence the role and mandate of CMAs. The primary statutory responsibility of each CMA is to develop and implement a five-year Regional Catchment Strategy (RCS) that identifies priorities and targets for managing the region's natural assets. CMAs are also responsible for waterway management¹, regional drainage, and are the custodians of the Environmental Water Reserve².
- Nationally, the formal institutionalisation of NRM planning began with the establishment of the 56 NRM regions, based on water catchments or bioregions³. These regions were formed under phase 2 of the Natural Heritage Trust (2002/3 to 2007/8), later replaced with a new national NRM funding scheme called Caring for Our Country. These initiatives have provided funding to local, state and territory governments as well as farmers and Landcare groups to improve biodiversity and sustainable farming practices in a changing climate
- Climate change will have profound impacts on Victoria's catchments. Consequently, the state's CMAs will have to adapt their planning and management strategies as the catchments continue to

¹ Except the Port Phillip and Westernport CMA region, where waterway management is led by Melbourne Water

² The Victorian Environmental Water Reserve is water allocated for maintaining the health of water ecosystems.

³ A bioregion is a landscape that is similar in terms of biodiversity, environmental processes and climate.

face the challenges of a changing climate. Indeed, the 2012 *Catchment Condition and Management Report* by the Victorian Catchment Management Council (VCMC) states that climate variability and change will be the 'most confronting' of current pressures on Victorian land and water resources. The most severe, direct physical impacts of climate change on catchments are projected to be: reduced runoff into Victoria's waterways of between 5 and 45% by 2030 and 50% by 2070 (VCES 2008 cited in VCMC, 2012:15); changes in the distribution and frequency of extreme weather events; and the extent and frequency of droughts. There will also be many other indirect physical impacts that, together with the direct impacts, will create resource dilemmas such as competing claims on water, land and biodiversity

- One of the most difficult challenges for natural resource managers is the uncertainties inherent in the projected impacts of climate change; particularly their intersections with each other and existing pressures. Nonetheless, there are convincing arguments that it would be shortsighted to postpone adaptive actions until our ability to project climate change and its impacts are more certain. This is because attainment of such certainty is unlikely to occur, and a better understanding of scientific information does not necessarily lead to greater adaptive capacity. To make progress, climate change risks need to be incorporated into regional NRM planning and policies. However, effectively integrating climate change projections and the more complex, interactions of climate change impacts into regional NRM planning is challenging
- Social and institutional factors are key influencers upon adaptation planning, including in the NRM sector. Evidence from Europe and Australia shows how approaches such as social learning, institutional learning, and adaptive governance can facilitate institutional change to enable adaptation at the organisational level, despite complexity and uncertainty (Brunner, 2005; Voss, 2006; Pelling, 2010). Evidence also suggests that such learning-based approaches need to be co-owned by a wide range of stakeholders in order that adaptation options outside the existing paradigm are explored and adaptation is successful (Füssel, 2007).

Key points from the analysis of interviews

- Victoria's ten CMAs are well-placed to lead climate change adaptation in the state's NRM sector. During their 16 year existence, Victoria's CMAs have managed to successfully adapt to changing circumstances of funding, the physical climate, and political dynamics. However, current under-resourcing in funding and staffing capacity dedicated to this issue limits that potential.
- The NRM sector has a challenging set of starting conditions, in terms of land use patterns, and, as funded authorities, CMAs are constrained somewhat in the flexibility of their governance through relevant legislation. Nonetheless, the ethos of community-led NRM and the 'bridging' nature of CMAs place them in a good position for facilitating adaptation action in Victoria's catchments. New federal funding for climate change adaptation research and action over the next four years via the *Clean Energy Future* package may go some way to addressing this challenge.
- CMAs are largely aware of the potential for climate change to impact on the biophysical environment of the catchments they manage, and are building this into their Regional Catchment Strategies. However, they are unsure of how climate change will impact on the organisations themselves and individual staff, as well their stakeholders in the regions. From a CMA perspective, it is not sufficient for external agencies (e.g. research organisations, other government agencies) to just supply information on climate change, even if it is considered accurate, trustworthy and

credible. An interpretation of the information is also necessary, along with the facilitation of using the information to make more informed adaptation decisions.

- NRM practitioners revealed several examples of innovation and change in the sector. The use of a resilience approach⁴ in classifying sub-regions as social-ecological systems goes one step towards reconceptualising impacts and potential actions from a more systemic perspective. The development of an online platform for presenting a Regional Catchment Strategy may enable a more flexible and adaptive approach to managing based on the best available information, as it can be updated more frequently than every 5 years. Market-based instruments are being employed to allocate scarce funding to its perceived best use. CMAs are (variously) integrating climate change into other catchment management activities, collaborating with external agencies, or pooling resources with other CMAs to manage a lack of specific resources for adaptation.

The preliminary analysis presented in this report points to an opportunity to engage in further research into the NRM situation in Victoria, including the multi-level governance structure that involves State and Commonwealth government departments. In particular, further research regarding the ways that CMAs have used planning and information tools in the past can inform use of those tools for climate change adaptation planning.

In concluding the report, we identify three 'possibilities' for NRM sector adaptation:

- Fostering innovation in regional governance
- Supporting regional facilitators
- Adopting an adaptation lens for investment and planning

These are ideas, based on the peer-reviewed literature and our interpretation of the interviews and document analysis, for advancing adaptation in Victoria's NRM sector.

⁴ The 'resilience approach' to catchment management refers to the connections between people and nature, how these connections change, and what can be done to achieve desired, balanced goals for resilience.

1 Introduction

This document constitutes a key deliverable of the research project: 'Implementing tools to increase adaptive capacity in the community and natural resource management sectors' funded by the Victorian Government through VCCCAR. It contains a review of institutional context and literature on climate change adaptation needs and capacities for NRM in Victoria.

1.1 About the project

The project entitled 'Implementing tools to increase adaptive capacity in the community and natural resource management sectors' (hereafter referred to as Implementing Adaptation) runs from 31 August 2012 until 30 November 2013. Researchers from RMIT and Monash Universities are conducting the research. The project is governed by a Project Management Group, a Project Advisory Committee, and the Research Team (VCCCAR, 2013).

The main goal of this research project is to gain a better understanding of the adaptation capabilities and needs of three types of government service providers and funded agencies across three groups from two sectors: CMAs, CSOs and PCPs, and to facilitate the implementation and testing of tools and methodologies for climate change adaptation planning.

This project explores three key research themes, designed to analyse individual, organisational and sectoral contexts, test adaptation tools, and build capacity for future adaptation success.

Theme 1: Exploring the organisational context for adaptation in government agencies and service providers

- How are the three types of organisations (CMAs, CSOs, PCPs) and broader sectors currently planning for climate change adaptation and what enables or constrains their status?
- Who are the key stakeholders within and outside of the organisations influencing adaptation?
- How do individuals within these organisations see how climate change adaptation ought to happen?

Theme 2: Testing of tools and support mechanisms for climate change adaptability

- How can adaptation planning tools assist organisations in planning for climate change adaptation?
- What evidence is there of changes in adaptation planning practice or learning as a consequence of using these tools?
- Can/should it be assumed that existing tools and support mechanism are the best fit for the identified needs, or are customised, individual support mechanisms more meaningful?

Theme 3: Building organisational capacity for participation in adaptation

- What competencies need to be built within government service providers/funded agencies to successfully adapt to climate change?
- What are the elements of a program that would effectively engage and support the community and natural resource management sectors in climate change adaptation?

The research approach is action-research oriented and is designed in three phases:

Phase 1: The purpose of the first phase of the research was to scope the scale and purpose of the whole project. This was achieved through a cross-sector workshop for stakeholders to contribute initial ideas for the project and reflections on the state of climate change adaptation in their sectors. The outcomes of the first phase are published in a workshop discussion paper (Fünfgeld *et al.*, 2012a) and a workshop summary report (Fünfgeld *et al.*, 2012b).

Phase 2: The purpose of the second phase of the research was to achieve a better understanding of the adaptation situation in each sector, including perceived adaptation needs and opportunities, as well as barriers or constraints. This involved conducting semi-structured interviews with individuals and groups from organisations in each sector, as well as a review of the peer-reviewed literature and document analysis of relevant publications.

Phase 3: The third phase of the research is intended to involve a series of action-research inquiries with specific organisations (or clusters of organisations) from each sector. The general purpose is to engage in cycles of participatory action-led learning and reflection around climate change adaptation 'tools', in order to learn more about each organisation's individual context and identify further options for adaptation action. It is envisaged that this will result in practical adaptation outcomes for the participants and their organisations, an increase in adaptive learning capacity, and valuable research insights for the researchers involved; potentially in a co-research mode with project participants.

This report presents findings from the literature and document reviews as well as analysis and interpretation of qualitative data, regarding NRM and climate change adaptation in Victoria.

The project has established an information-sharing relationship with two projects funded by the National Climate Change Adaptation Research Facility (NCCARF; see Section 2.1 below): 'Leading Adaptation Practices and Support Strategies for Australia: An International and Australian Review of Products and Tools' (NCCARF, 2012; Webb & Beh, 2013) and 'Adapting the Community Sector for Climate Extremes' (NCCARF, 2011; Mallon *et al.*, 2013).

1.2 Overview of this document

This report consists of seven sections and three appendices. Section 1 (this section) provides background information on the project. Section 2 outlines the current institutional and governance context of the NRM sector in Victoria and relevant national policy. Section 3 sets out the research framework and methodology utilised to undertake both the literature review and data collection through interviews across the NRM sector in Victoria.

Section 4 reports the key themes interpreted from the peer-reviewed literature on adaptation in the NRM sector, and Section 5 contains a preliminary analysis of the research data, focusing on key themes from the interviews.

Drawing on the literature and research data, Section 6 focuses on adaptation possibilities for the NRM sector in Victoria and Section 7 draws conclusions by synthesising the key themes from the literature and the interviews. A full list of references cited throughout the report is provided as well as Appendices outlining the interview structure (Appendix 1: Outline used for semi-structured interviews), a de-identified record of respondents (Appendix 2: De-Identified record of respondents) and the data analysis coding framework (Appendix 3: VCCCAR IA NVivo Coding Framework).

1.3 Definitions

For the purpose of this report, **climate change adaptation** is defined as adjustments in ecological, social or economic systems in response to observed or expected changes in climatic parameters, such as temperature, rainfall and humidity (McCarthy *et al.*, 2001; Adger *et al.*, 2005). Seen from this perspective, the main purpose of adaptation is to reduce or alleviate negative impacts of climate change, or to exploit new opportunities arising from such change.

Adaptive capacity refers to a system's ability to reduce its exposure and sensitivity to climate change impacts and adjust to existing impacts (IPCC, 2007).

The term regional **NRM bodies** is used throughout this document to refer collectively to the 56 regional NRM organisations recognised by the Australian Government. These are called Catchment Management Authorities (CMAs) in Victoria and New South Wales (from January 2014, these will be known as 'Local Land Services' in NSW), Regional NRM Boards in South Australia and the Northern Territory, Regional NRM Committees in Tasmania, and Regional NRM Groups in Queensland and Western Australia (Campbell, 2008).

In Victoria, **Catchment Management Authorities** or **CMAs** are the primary bodies responsible for managing catchment resources. CMAs are provided with regional waterway, floodplain, drainage and environmental water reserve management powers under the Water Act 1989. The Victorian Catchment Management Council (VCMC) is the State Government's key advisory body on catchment management, and is an independent, expert body, appointed under the CALP Act. Working with the VCMC, CMAs have responsibility for the co-ordination and management of floodplains, rural drainage (including regional drainage schemes), water quality and nutrient management, water supply catchment protection, wetlands, and restoration of degraded waterways. CMAs are also the caretakers

of river health (Victorian Government, 2013a). A more detailed summary of the role and responsibilities of CMAs is included in section 2.1.6 of this report.

Our review and the associated research focussed on organisational level needs and contexts for enabling or hindering adaptation planning in the NRM sector in Victoria. While we acknowledge the important role that individuals can play in adaptation, we are primarily interested in the relationship between individual action (and individual ability to act) and a given organisational context.

Organisations are defined as “collectives that have agency” (Pelling, *et al.*, 2007) – “groups of actors that work towards a common goal in a coordinated manner” (Berkhout, 2012). “Organisations and their ability to act are shaped by institutions that constitute the formal and informal ‘rules of the game’” (North, 1990). This last distinction is important, as we use the term ‘organisation’ and not ‘institution’ to refer to public sector entities, such as government departments and CMAs. Through this research, we hope to elicit a better understanding about how organisations can ‘learn to adapt’, and how their social and natural environments shape their goals, structure and ways of planning for and adapting to climate change (Berkhout, *et al.*, 2006).

2 Background to the NRM sector in Victoria

A complex set of legislation, policies, and institutions that operate at the national, state and regional levels govern Victoria's NRM planning. In recent years, a number of specific research and policy initiatives have been geared towards facilitating climate change adaptation in the NRM sector. The following summarises the institutional context of climate change adaptation in the NRM sector.

2.1 Victorian policy and institutional context

Legislative and institutional framework

Victoria's NRM statutory authorities are known as Catchment Management Authorities (CMAs). The State is divided into ten catchment regions (Figure 1), each of which is governed by one CMA.

Figure 1: Victoria's Catchment Management Authorities



Source: Department of Environment and Primary Industries (Victorian Government, 2013b).

The history of catchment management in Victoria arguably extends back to the 1880s, as the state gradually established institutions and legislation to 'manage' its rivers and water, along with other land management issues such as forests, soil and rabbits. The VCMC's Victorian Catchment Management Almanac provides detailed documentation of this history. Some key events identified in that document include: establishment of the Melbourne and Metropolitan Board of Works in 1890; the State Rivers and Water Supply Commission in 1905; the Rivers and Streams Fund in 1931; the Soil Conservation Regional Advisory Committees in 1941; the first River Improvement and Land Drainage Trusts in 1949; and the initial Water Act of 1958 (VCMC's Almanac). In 1975, the Drainage of Land Act meant that drainage authorities needed to "act to protect catchments and watercourses in terms of both drainage courses and floodplain areas". In 1978, a Salt Action Liaison team set itself up in the Loddon-Campaspe catchment, establishing revegetation guidelines, and there was widespread recognition that landowners were not 'fully owning' projects (VCMC's Almanac).

The VCMC's Almanac indicates that the concept of Integrated Catchment Management (ICM) was first articulated in 1981: "catchment-stream relationships are dynamic. Without an integrated approach to catchment land use and stream management, the correction of stream problems is unlikely to be achieved". In 1984, NSW announced its 'Total Catchment Management Policy'. In 1988, a National Workshop on Integrated Catchment Management in Melbourne formally recognised the ICM phrase. 1988 saw the advent of the Flora and Fauna Guarantee Act, and 1989 the Water Act; two pieces of legislation that relate directly the responsibilities of present day CMAs.

In recognition of the private ownership of a large proportion of Victoria's catchments, the state's approaches to catchment management have increasingly involved local communities. Consequently, regional NRM in Victoria is targeted towards river catchment management on private land. For example, during the 1980s several community-based conservation programs were established, including Land for Wildlife, Farm Tree Groups (in 1981), the Australian Trust for Conservation Volunteers in 1982, and the Landcare program in 1986.

The main legislative instruments influencing the actions of Victoria's CMAs are the *Water Act 1989* and the *Catchment and Land Protection (CaLP) Act 1994*. The Water Act specifies CMAs obligations for waterway management and river health in separate Statements of Obligations, issued in 2006 (Victorian Government, 2013c). The CALP Act established the Victorian Catchment and Land Protection Council, and the Catchment and Land Protection Boards. In conjunction with the state government, the boards were responsible for producing Regional Catchment Strategies (RCSs). That Act also established the *Victorian Catchment Management Framework* to deliver integrated catchment management (ICM), built around delivery of sustainable NRM outcomes across the State on both public and private land. In 1997, in response to the Catchment Management Structures review, the Catchment and Land Protection Council was replaced with the current Victorian Catchment Management Council (VCMC), the CALP Boards were replaced by the now Catchment Management Authorities (CMAs), and the remaining Water Authorities were also incorporated into the CMAs. The VCMC is the Victorian government's key advisory body on catchment management. It is independent of government agencies and its role is to influence change in catchment management within Victoria. The Council takes a state-wide, rather than regional, catchment view on land, water and biodiversity issues and priorities. The CaLP Act requires the VCMC to report on the condition and management of Victoria's catchments every five years (VCMC, 2012a).

In the Melbourne metropolitan area, working closely with the Port Phillip and Westernport CMA, Melbourne Water has a unique role in managing rivers, creeks and major drainage systems. Many other agencies and groups also play a significant role in managing the catchments, including the Department of Environment and Primary Industries (formerly the Departments of Sustainability and Environment [DSE] and the Department of Primary Industries [DPI], which were combined in April 2013), Parks Victoria and local governments (VCMC, 2012b).

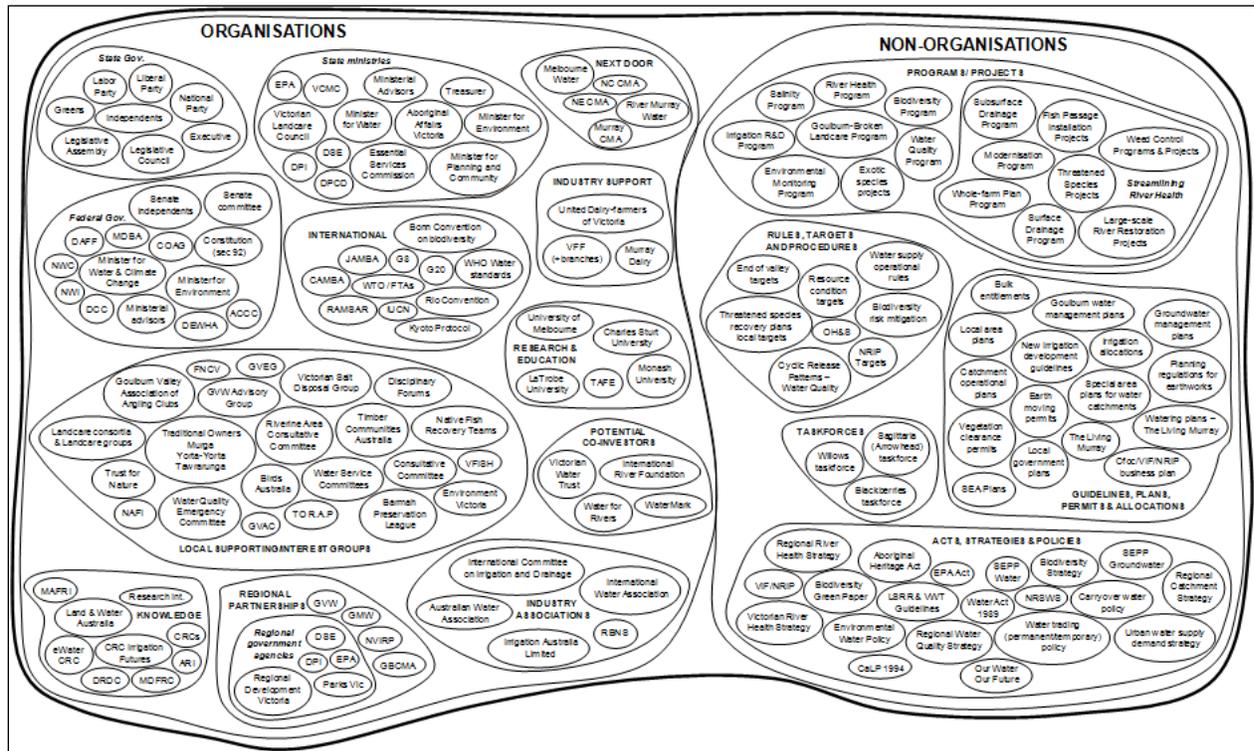
Beyond the CaLP and Water Acts, a broader set of legislation at both state and federal level also influence the role and mandate of CMAs. Table 1 illustrates some of the legislative complexity in which CMAs operate, providing an overview of some Victorian and national legislation influencing key functions of CMAs.

Table 1: Legislation relevant to catchment management (adapted from DEPI, 2013)

Victorian legislation	National legislation
<ul style="list-style-type: none"> • Aboriginal Heritage Act 2006 • Alpine Resorts (Management) Act 1997 • Catchment and Land Protection Act 1994 • Climate Change Act 2010 • Coastal Management Act 1995 • Conservation, Forests and Lands Act 1987 • Crown Land (Reserves) Act 1978 • Environment Protection Act 1970 • Fisheries Act 1995 • Flora and Fauna Guarantee Act 1988 • Forests Act 1958 • Heritage Rivers Act 1992 • Land Act 1958 • National Parks Act 1975 • Parks Victoria Act 1998 • Planning and Environment Act 1987 • Reference Areas Act 1978 • Sustainable Forests (Timber) Act 2004 • Traditional Owner Settlement Act 2010 • Victorian Conservation Trust Act 1972 • Victorian Environmental Assessment Council Act 2001 • Water Act 1989 • Wildlife Act 1975 	<ul style="list-style-type: none"> • Environment Protection and Biodiversity Conservation Act 1999 • Fisheries Management Act 1991 • Native Title Act 1993 • Water Act 2007 • Water Amendment Act 2008

This legislative context is underpinned by a vast array of governmental and non-governmental organisations and other stakeholders with which CMAs typically interact. A systems map of the management system from the perspective of the Goulburn-Broken Catchment (Figure 2) depicts the high degree of institutional complexity that Victorian catchment managers face, both in terms of the number of organisations and the legislation, strategies, policies, programs and guidelines that structure their multi-level governance system (Wallis & Ison, 2011).

Figure 2: System map of a Victorian catchment managing system, prepared in 2009



Source: Wallis & Ison (2011: 4088).

Roles and responsibilities of CMAs in Victoria

Under the Victorian CaLP Act (1994), a CMA's main goal is to contribute to "achieving sustainable management of Victoria's land and water resources" (Victorian Government, 2013c). To this effect, CMAs deal with a wide range of NRM issues, including:

- Sustainable regional development
- Floodplain management
- Protection of native vegetation and fauna
- Management of irrigation and dryland salinity
- Sustainable land management practices, including construction sites
- Pest plant and animal control
- Rural-urban fringe issues
- Waterway management

(Victorian Government, 2013a)

In accordance with the CaLP Act, the primary responsibility of each CMA is to develop and co-ordinate implementation of a five-year Regional Catchment Strategy (RCS) in partnership with its communities. The RCS provides a vision for the future landscape and identifies priorities, objectives and targets for

managing the region's natural assets. It forms the basis for investment decisions to ensure improved natural resource outcomes for the regions. In this sense, CMAs are a major collective advisory body to government regarding funding priorities for natural resource management at the catchment level (Victorian Government, 2013a).

Each CMA has a Statement of Obligations to the State of Victoria (Minister for Water, 2006), which are guided by the following principles⁵:

- a) Facilitate and coordinate the management of catchments in an integrated and sustainable manner;
- b) Take a sustainable approach by balancing environmental, social and economic considerations;
- c) Plan and make decisions within an integrated catchment management context:
 - recognising the integral relationship between rivers, their catchments and coastal systems;
 - using the best available scientific information;
 - targeting resources to address priorities and deliver maximum improvement in resource condition;
- d) Provide opportunities for community engagement in the integrated management of catchments including rivers and related water and land ecosystems;
- e) Develop strategic partnerships with other relevant authorities and government agencies;
- f) Promote and apply a risk management approach for natural assets which seeks to preserve the quality of the natural assets;
- g) Promote and adopt an adaptive approach to integrated catchment management, including continuous review, innovation and improvement;
- h) Manage business operations in a prudent, efficient and responsible manner;
- i) Act as the caretaker of river health and provide regional leadership on issues relating to river health; and
- j) Undertake the operational management of the Environmental Water Reserve as a key component of an integrated program of river, wetland, floodplain and aquifer restoration.

Under the *Water Act*, the other major responsibility of CMAs relates to waterway management, regional drainage and custodianship of the Environmental Water Reserve (Victorian Government, 2013b). The Department of Environment and Primary Industries (DEPI) is in the process of developing a Victorian Waterway Management Strategy (currently available as a draft (Victorian Government, 2012a), which will become the policy for water management in Victoria, replacing the Victorian River Health Strategy (Victorian Government, 2002).

⁵ This is the current statement, as issued under the Water Act 1989. Previously, statements were issued under the CaLP Act 1994, which included reference to climate change as a sub-point to c) "recognising the need to foster the resilience of natural assets – including land, biodiversity and water resources - to climate change".

Fulfilling the above responsibilities makes CMAs important agencies with crucial roles in the management of the state's natural resources, including to:

- Ensure the sustainable development of natural resource based industries
- Maintain and where possible improve the quality of land and water resources
- Conserve natural and cultural heritage
- Involve the community in decisions relating to natural resource management within their Region
- Advise on matters relating to catchment management and land protection and the condition of land and water resources in the Region
- Promote community awareness and understanding of the importance of land and water resources, their suitable use, conservation and rehabilitation (Victorian Government, 2013a).

Each CMA is governed by a CMA board, which sets regional strategic priorities, evaluates the effectiveness of outcomes, monitors external and internal CMA environment, and identifies strategic opportunities. The Boards and CMA staff are responsible for developing detailed work programs and oversight of program delivery and stakeholder engagement. Each CMA has a varying number of staff to develop and implement programs, and to liaise with communities, government and other organisations (Victorian Government, 2013c, 2013d).

Climate Change Act 2010 and Climate Change Adaptation Plan

The Climate Change Act 2010 (Victorian Government, 2010) is a framework for the Victorian Government to respond to climate change (covering both mitigation and adaptation) within the context of national policy. The Act requires the Victorian state government to develop a Climate Change Adaptation Plan, which needs to be updated every four years. The first Plan was released on 19 March 2013. The Act states that the Plan needs to include:

- (1) 'an outline and risk assessment of the potential impacts of climate change on various regions of Victoria', and
- (2) 'a statement of the Government of Victoria's state-wide priorities and strategic responses for adaptation to potential impacts of climate change.'

(Victorian Government, 2010: p.13)

While each update to the Plan must include a report on the implementation and effectiveness of the previous plan, the Act provides no detail about plan implementation.

The Act requires "decision makers to take climate change into account when making specified decisions under the Catchment and Land Protection Act 1994, Coastal Management Act 1995, Environment Protection Act 1970, Flora and Fauna Guarantee Act 1988, Public Health and Wellbeing Act 2008 and Water Act 1989". Clearly, both major pieces of legislation affecting CMA business are captured in these requirements.

Investment in climate change adaptation research

The Victorian State Government established VCCCAR in 2009 with \$5 million in funding over five years, to assist government and other agencies by undertaking climate change adaptation research. The now Department of Environment and Primary Industries (DEPI) oversees the research conducted by VCCCAR's partner universities.

This project exemplifies VCCCAR research, aiming to increase adaptive capacity in the community and natural resource management sectors through the testing and implementation of adaptation planning and decision-making tools (VCCCAR, 2013). DEPI and the VCMC are involved in oversight of the project.

2.2 National policy and institutional context

Establishment of regional NRM planning in Australia

In 1997, the Australia Government established the *Natural Heritage Trust* (NHT) aimed at helping the restoration and conservation of Australia's environment and natural resources (Australian Government, 1997). In the second phase of the NHT, between December 2002 and June 2004, the Government established boundaries for 56 NRM regions covering all of Australia. Creating the 56 regions represented a shift from semi-formal and differentiated institutional origins of NRM, towards a much more formalised and persistent set of institutional and management entities (Robins & Dovers, 2007).

These regions were based on catchments or bioregions and, together with their representing organisations, vary considerably in terms of their origin, form, capacities, and environmental and social contexts (Robins & Kanowski, 2011). For example, the land areas for which they are responsible range in size, from 1,840 km² for the Sydney Metro Catchment Management Authority, NSW, to 1,850,000 km² for Rangelands NRM Co-ordinating Group in Western Australia. Their resourcing and staff capacity is equally diverse, ranging from five to 75 staff members (*ibid*).

Two Federal programs and their associated policy measures, led to development of regional strategic plans for NRM, and to embedding of a regional model of NRM across Australia (Robins & Kanowski, 2011). These were the *Natural Heritage Trust Phase 2* (Australian Government, 2008; from 2002/3 to 2007/8) and the *National Action Plan for Salinity and Water Quality* (Australian Government, 2001 from 2000/01 to 2007/08).

Recent changes to NRM planning in Australia

In 2005, at a Federal level, a joint state, territories and Federal government council - The *Natural Resource Management Ministerial Council* was co-chaired by the Minister for Environment and Heritage and the Minister for Agriculture, Fisheries and Forestry. Council is multi-jurisdictional and comprises of Australian Government, state and territory environment and agriculture ministers. These ministerial links provide a strong mandate for an integrated national approach to natural resource management by the Australian Government in partnership with the states and territories.

After the change in federal government in 2007, the newly elected Labor government created a new national NRM funding scheme called Caring for our Country (CfoC) (Australian Government, 2008b). The five-year initiative has provided funding to local, state and territory governments, as well as farmers and Landcare groups (Campbell, 1994), in order to improve biodiversity and sustainable farming practices in a changing climate (Australian Government, 2012a). The first five-year period of CfoC, from 2008/09 to 2012/13, will be replaced by a second five-year program term, starting in mid-2013 (Australian Government, 2013a). The scheme is being delivered by both the federal Department of Agriculture, Fisheries and Forestry (DAFF) and the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC).

In evaluating the recent state of regional NRM planning in Australia (mainly at a federal level), Robins and Kanowski (2011) argue that CfoC has weakened the regional model of NRM by, amongst other things: narrowing the agenda for NRM; centralising control over NRM issues; increasing transaction costs; and by widening the gap between regional NRM bodies and local groups. This is consistent with a Senate Inquiry (Australian Government, 2010a), which found that CfoC has not built on lessons and achievements of the past but instead “placed this legacy in grave danger” (*ibid*:73).

Federal policy guidance on adaptation

The Australian Government Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (DIICCSRTE, formerly the Department of Climate Change and Energy Efficiency (DCCEE)), is mandated to provide national climate change adaptation policy leadership and coordination at a Federal level. The Department works with partners (including states and territories) and stakeholders in vulnerable sectors and regions to assist decision makers to better manage the risks from climate change impacts. DIICCSRTE funds and delivers a number of key policies and programs intended to assist decision-makers with determining climate change adaptation strategies and actions, including research programs (see below).

In 2006, the Australian Greenhouse Office of the then Department of Environment and heritage (precursor to DCCEE and then DIICCSRTE) published a guide entitled ‘Climate Change Impacts and Risk Management: A Guide for Business and Government’. Modelled on the Australian risk management standard of 2004 (Standards Australia/Standards New Zealand, 2004), the guide recommends a risk management approach to assessing climate change and addressing risks and opportunities. While some NRM bodies incorporate risk management in their adaptation processes (e.g. Bardsley & Sweeney, 2010), it is not clear to what extent the Australian Government guide has been used in NRM climate change adaptation planning processes.

In 2007, the Australian Government, endorsed by the Council of Australian Governments (COAG), released Australia’s first National Climate Change Adaptation Framework, as a guide to jurisdictional action on adaptation. It identified medium-term (5-7 years) strategies for addressing eight sectors or areas of Australia’s vulnerability to climate change. Three of these were directly within the remit of CMAs: water resources; coastal regions; and biodiversity.

In 2008, with the aim to assist NRM practitioners in thinking through the implications of and responses to climate change, the then department of Climate Change and Energy Efficiency (DCCEE) published a

primer on climate change mitigation and adaptation (Campbell, 2008). The document included a summary of climate change science, an assessment of the implications of climate change on regional NRM, and suggestions for integrating climate change considerations into NRM business. It was the first guidance document on climate change issued by the Australian Government specifically targeted at natural resource managers.

In 2010, the then DCC put forward a position paper with a vision for adapting to the impacts of climate change (Australian Government, 2010b). The paper identified six national adaptation priority areas for action, five of which directly intersect with the statutory responsibilities of regional NRM bodies: coastal management, water, natural systems of national significance, preparation for management of natural disasters, and agriculture (p12).

In 2012, DCCEE announced \$43.9 million of funding over four years for the Regional Natural Resource Management Planning for Climate Change Fund (NRM Fund), "to improve regional planning for climate change and help guide the location of carbon and biodiversity activities, including wildlife corridors" (Australian Government, 2012b).

Productivity Commission inquiry

In 2011, the Australian Government requested the Productivity Commission to undertake an inquiry into regulatory and policy barriers to effective climate change adaptation. The objective of the inquiry was to assist the Council of Australian Governments (COAG) to advance climate change adaptation reforms in Australia by identifying the highest priority reforms through examining policy frameworks and costs and benefits of adaptation options (Australian Government, 2011:iv)

The Productivity Commission's final report *Barriers to Effective Climate Change Adaptation* (Australian Government, 2013b), identified four key barriers to effective climate change adaptation: (i) market failures; (ii) policy and regulatory barriers; (iii) governance and institutional barriers; and (iv) behavioural and cognitive barriers.

While the report included an evaluation of the climate change impacts on environmental services, none of the Commission's recommendations highlighted actions that specifically address natural resource management. Yet, the report acknowledges that climate change may exacerbate existing pressures on ecosystems, habitats and biodiversity and concludes that flexible environmental management can remove existing barriers to adaptation and facilitate effective adaptation (Australian Government, 2013b: 283).

National adaptation research

In 2008, the Australian Government established the National Climate Change Adaptation Research Facility (NCCARF) to 'harness and coordinate the capabilities of Australia's researchers, to generate and communicate the knowledge decision-makers need for successful adaptation to climate change" (NCCARF, 2012). This effort is supported by up to \$50 million funding for national climate change adaptation research to build understanding and adaptive capacity to reduce sectoral and regional vulnerability to the impacts of climate change.

NCCARF established nine priority themes for research, each of which is guided by a National Adaptation Research Plan. Two priority areas, Terrestrial Biodiversity and Freshwater Biodiversity, directly intersect with natural resource management questions, while others such as Settlements and Infrastructure, Primary Industries, and Indigenous Communities produce research also relevant to NRM.

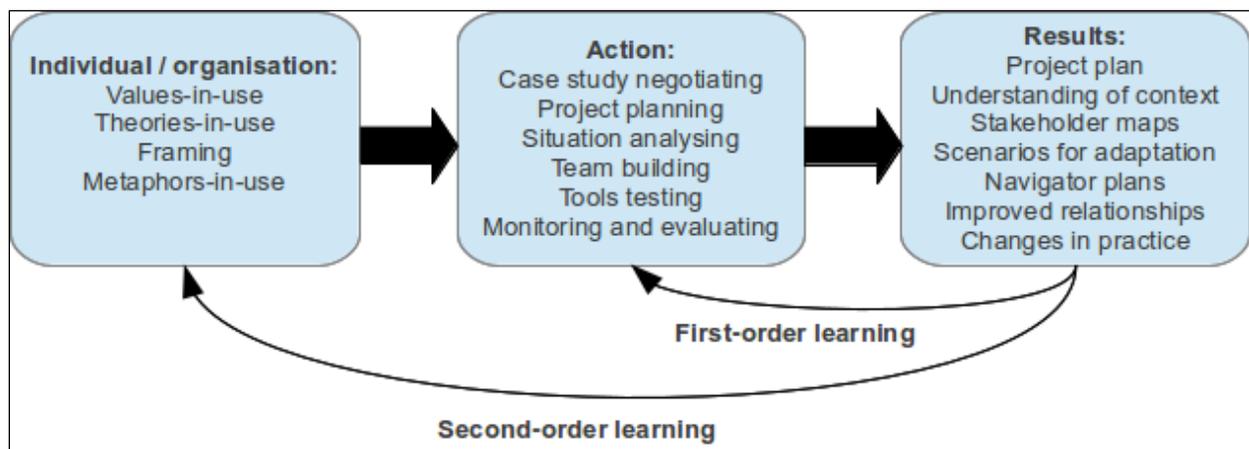
3 Research framework and methodology

3.1 Theoretical framework

The VCCCAR Implementing Adaptation research project is particularly concerned with eliciting an understanding of how organisations in different sectors learn to plan for climate change adaptation. To do this, a number of theoretical concepts were drawn upon; with the concept of social learning being central. Learning approaches are particularly suitable for adaptation planning in a climate changing world, where it is impossible to think of an 'end point' when adaptation will be complete or when we are 'adapted' (Adger *et al.*, 2005; Berkhout *et al.*, 2006; Collins & Ison, 2009; Fünfgeld & McEvoy, 2011; Wallis *et al.*, 2013). CCA has many similarities to processes of organisational learning (Berkhout *et al.*, 2006), policy learning, and the ideas of double and triple loop learning found in the works of Argyris and Schön (1978), Senge (1990), Schön and Rein (1995), and particularly Hall's (1993) treatise on policy paradigms and social learning, where he describes the need for three orders of learning.

Adaptation planning is not simply a matter of 'having a plan'. It is a continuous and iterative process of learning, action, monitoring and reflection. Figure 3 below, outlines one interpretation of learning that may be applicable for adaptation planning. In this interpretation, first order learning is conceived as the adjustment of action in response to the results of an action or basic 'learning by doing'. In this model, second order learning is conceived as adjustment of the principles (e.g. values, rules, theories) on which action is based, as well as adjusting the action itself in response to results.

Figure 3: A learning-based model of research and engagement



Source: Adapted from Ison *et al.* (2009).

This interpretation of social learning can provide one theoretical lens from which to analyse the learning, changes in practice, and individual and collective transformations that may take place when adaptation planning processes are undertaken in a given organisational environment. The challenge for both researchers and practitioners is to apply the concept of social learning in practice such that the situation researched and the research itself transform through learning. An aim of this project was to

appreciate the possibility for a social learning approach within NRM CCA planning through qualitative research. Rich data on the needs and capabilities of organisations and individuals were collected through semi-structured interviews and focus groups with CMA personnel.

3.2 Literature review methodology

Guiding questions for the review

The intent of this literature review was to gain an overview of the current knowledge and understanding regarding climate change adaptation in the NRM sector and climate change impacts on NRM issues, to inform the interpretation of the empirical research findings. To be able to adequately reflect the crosscutting nature of climate change adaptation, the approach was deliberately broad in thematic scope. However, four specific questions guided the review:

- *What evidence exists in the academic and non-academic literature about efforts of the NRM sector to plan for and respond to climate change impacts?*
- *How is climate change adaptation framed in key sector publications and studies?*
- *To what extent are climate change impacts and adaptation considerations incorporated in planning and decision-making processes in the Australian NRM sector?*
- *What evidence exists about the adaptive capacity of the sector in Victoria, Australia and elsewhere?*

Review process

It is important to note that this review was predominantly based on the peer-reviewed academic literature, although 'grey literature' such as government documents, have also been consulted. Additional grey literature was included, such as existing organisational publications, literature reviews and other key documents from the NRM sector. In selecting these documents, emphasis was placed on the Australian NRM context and on literature pertaining to CMAs in particular. For the review of current formal institutional context, websites of relevant government departments associated with NRM, at the federal and Victorian state government level, were searched, alongside recent publications from peak organisations in the sector.

For the review of peer-reviewed academic literature, electronic database searches were conducted using the search terms: 'climate change', 'climate change adaptation', 'natural resource management', 'catchment management', 'climate change impacts', and their various combinations.

The focus was on including peer-reviewed journal articles from the past five years, although some older papers considered important were included. The electronic databases used for this search were:

- IngentaConnect (Ingenta)
- ENVIROnetBASE
- ProQuest Science Journals (ProQuest)

- ScienceDirect (Elsevier)
- SpringerLink
- Web of Science (ISI)
- Wiley Online Library
- ProQuest
- Social Services Abstracts (ProQuest)
- GeoRef (ProQuest)
- GeoRef In Process (ProQuest)

3.3 Interview methodology

Sample size and selection

The stakeholder consultation and scoping process for the VCCCAR IA project aimed to give all organisations within each sector an opportunity to participate. For the interview phase of the projects, interview targets were set as outlined in Table 2 below.

Table 2: Interview targets per sector

Sector	Organisation target	Individual interview target
CMA	4	15
CSO	12	25
PCP	8	15

The VCMC and DEPI assisted in making the project known among CMA staff. In addition, the research team contacted CMAs by email to inform them of the project, its objectives and deliverables. The first round of phone calls occurred from August to September 2012, to gauge interest in project participation. Phone calls were made to executive level representatives or their administration support.

Participation in interviews was voluntary, and an opportunistic sampling process was employed. Where CMAs expressed interest in project participation, a Participant Information Sheet and project summary was emailed. A follow-up phone call was made 3-5 days later to confirm participation and interview dates were scheduled, including clarifying the research ethics procedures requirements of the project. Face to Face interviews were preferred, but in some instances, phone interviews were undertaken due to time constraints and the geographic location of the interviewees.

Semi-structured interviews

Between October 2012 and January 2013, a total of 72 interviews were conducted (Table 3). Among CMAs, a total of 18 interviews were conducted covering 6 CMAs.

Table 3: Actual numbers of organisations and individuals interviewed per sector

Sector	Organisations interviewed	Individuals interviewed
CMA	6	18
CSO	27	31
PCP	17	23

Interviews ranged from half an hour to 2 hours. The interviews were semi-structured, to ensure interviews remained focused on the main research questions and to maximise consistency across interviewers whilst enabling a degree of flexibility and allowing for more in-depth answers where appropriate (see outline in Appendix 1).

All interviews were audio recorded with the consent of the participant for data analysis purposes. Participants were given a broad background to the project and asked to discuss their personal history, training, and organisational context.

Interviews that could not be arranged face to face were undertaken over the phone all and followed a similar structure than face-to-face interviews. All phone interviews were audio recorded with the consent of the participant.

To close each interview, participants were asked if they felt like there was anything they wished to add to the interview or if there was anything missed, to provide opportunity for further open discussion.

Where possible, the individual researchers conducting the interviews undertook reflection immediately after each interview. This involved listing five key messages gleaned from an interview and discussing these with other researchers. These reflections were used as an additional data source for analysis.

Rich picturing activity

Semi-structured interviews were structured around a participatory activity called 'rich picturing' or 'drawing rich pictures'. During this activity, participants were asked to draw a simple picture of their situation within the sector with regard to climate change adaptation.

Participants were provided with butchers paper and 20 colour markers and then asked to draw a picture in that capture the answer to the question: "What is happening in your sector with regard to responding to and planning for climate variability and change?" (see question 2, Appendix 1). Participants were prompted to consider what they perceive as problematic or significant in the situation and instructed to draw themselves in the picture and encouraged to minimise the use of text and labels.

Participants were left alone for ten to fifteen minutes to draw their rich picture without interruption or pressure arising from researchers being present in the room. Participants were then asked to describe

what their picture with a series of prompts regarding networks, information support and policy context (see Appendix 1).

Participants were offered to keep the hard copy of their rich picture. All rich pictures were photographed and included in the analysis and imported into NVivo10 (see below).

Spectrum of support activity

A final exercise was utilised to determine what participants perceived to support them in adaptation and what was thought to 'get in the way'. Participants were asked to place themselves on a spectrum line (drawn on flip chart paper) from zero to ten, where zero signified the statement: "I have no support that I need to make progress on adaptation" and ten stood for: "I have all the support I need to make progress on adaptation". A series of questions were asked (Appendix 1) to determine reasons for where participants placed themselves on the spectrum.

Data analysis and interpretation

All interviews were transcribed using a professional transcription service using time-stamping for ease of analysis. All interviews were de-identified, categorised listed with analysis attributes such as regional context (rural, peri-urban and urban) and level of employment (officer, middle management and executive). The complete de-identified participant register with associated attributes can be found in Appendix 2.

All interview audio and transcripts were analysed using the *NVivo10* software. Additional data sources, such as organisational strategic plans, annual reports, brochures and associated information were also included in the software for use in analysis. The following individual and organisational attributes were allocated to each interview and other data sources including:

- Interviewer
- Date of interview
- Location of interview
- Organisation type (PCP, CSO, CMA)
- Geographic context of organisation (rural, peri-urban, urban)
- Length of employment at organisation (<1 year, 1-5 years, 5-10 years >10 years)
- Level of employment (officer, middle management, executive)

These attributes allowed sector-specific analysis and consideration of specific aspects of the interview during the analysis. NVivo data analysis was undertaken using standalone software versions for each researcher. A version control and data coding protocol had to be developed to maintain consistency in approach. A master file with three back-up locations ensured that data was stored securely. Standalone projects were merged with the project master file every fortnight and merge reports retained in each instance for records. All versions of the NVivo project files were password protected.

NVivo relies on users 'coding' research data, i.e. assigning labels about the messages contained to a word, phrase or section of transcribed interview. For this purpose, a coding framework was developed,

based on work by David Ballard's *model of the change process for sustainability* (Ballard, 2005). The framework consists of the overarching codes of: *history, awareness, agency, association, action & reflection, and architecture*. Under each of these headings, several codes were developed and applied to the interview transcripts. A full coding framework, complete with sub-codes and associated descriptions, is available at Appendix 3. To maintain consistency in coding, the research team undertook two parallel interview coding sessions, with different researchers working on identical interviews. Coding comparisons were then undertaken using NVivo statistical analysis tools to ascertain the level of variation in coding by individual researchers. Coding comparisons were undertaken at various stages throughout the analysis process in an attempt to maximise coding consistency. Throughout the coding process, researchers noted emergent themes within NVivo.

Data analysis could occur for such a diverse and multi-sectoral set of interviews in many ways. The aim of the research team was to investigate a range of themes and allow for key messages to emerge from the data. The following report outlines these key themes, supported by direct quotes from participants.

4 Key themes emerging from the literature

4.1 Impacts of climate change on catchments and the NRM sector

South-eastern Australia is experiencing a range of changes to its natural and human systems, induced by anthropogenic climate change. More frequent and prolonged drought, changing rainfall patterns, sea-level rise, and more intense and more frequent extreme weather events can be expected for the remainder of the 21st century (Steffen, 2013).

Climate change impacts for Victoria

A range of climate change impacts can be expected to affect Victoria, its ecosystems, and its people, posing significant risks for the state (Climate Commission, 2012; DSE, 2012). Some of these impacts will result from gradual, slow-onset climate change trends. For example, coastal inundation from sea-level rise and water scarcity due to a long-term drying trend. Other impacts will occur through increased short-lived extreme weather events, such as heat waves, bushfires, hailstorms and heavy rainfall.

Annual average daily mean temperatures in Australia have increased by 0.9°C since 1910 and are projected to continue to increase by 1.0 to 5.0°C into 2070 under future emission scenarios considered by the Intergovernmental Panel on Climate Change (Bureau of Meteorology & CSIRO, 2012). Victoria's average number of hot days above 35°C has already increased, and is projected to increase further, from nine in 1990 to between 15 to 26 days in 2070. The number of cool days and cold nights is projected to decrease (Victorian Government, 2012a). This will lead to more frequent heatwaves and days of very high or extreme fire danger. The increase in temperature extremes is paralleled by a long-term drying trend over southern and eastern Australia, leading to more frequent droughts in Victoria and elsewhere (Bureau of Meteorology & CSIRO, 2012).

In recent history, Victoria has experienced both a 14-year drought and significant water scarcity that, dramatically, culminated in the 2009 heatwave and Black Saturday bushfire disasters, followed by extremely wet years that led to severe flooding and damages to crops, properties and infrastructure. These events "provide Victorians with a window into [a] future" (Climate Commission, 2012) where it can be expected that extreme weather events will increase in frequency and in intensity throughout the 21st century (IPCC, 2012). In addition, with global sea level rise tracking near highest projected levels, coastal communities in Victoria will experience more frequent inundation, stronger storm surges, increased coastal erosion, and increased threats to low-lying housing and properties.

Climate change impacts on natural resource management

Climate change is expected to profoundly affect Victoria's catchments. The pervasiveness of the issue makes it "hard to think of a single NRM issue without significant potential impacts from climate change" (Campbell, 2008:15). The fourth assessment of land and water resources in Victoria, the 2012 Catchment Condition and Management Report (VCMC, 2012a:15) mentions climate variability and change as the most confronting of current pressures on Victorian land and water resources. The report states "the most severe direct physical impacts of climate change on catchments to be reduced runoff into Victoria's waterways of between 5 and 45% by 2030 and 50% by 2070 (VCES, 2008); and changes in the distribution and frequency of extreme weather events; and the extent and frequency of droughts" (VCMC, 2012a). Indirect physical and social impacts of climate change highlighted in the report that the NRM sector will need to address are (VCMC, 2012a: 15):

- Risks to small and fragmented populations of native flora and fauna and those at limits of their range
- Impacts on agricultural production, farming practices and food supply chains
- Intensifying competition between consumptive and environmental uses of scarce water resources

This suggests that CMAs and other regional NRM bodies will be required to respond to an increasing number of resource dilemmas arising from climate change and its impacts, i.e. competing claims on the use of natural resources such as water, land, biodiversity (Blackmore, 2007).

Although the Australian climate has long been characterised by extreme variability, the literature suggests that anthropogenic climate change and exacerbated climate variability will significantly affect overall catchment and waterway health. Serious and lasting impacts may occur, for instance, when different extreme weather events occur concurrently or within short periods. Bushfires followed by floods, as experienced between 2009 and 2010-11 in many parts of Victoria can lead to significant challenges at the catchment level. For example, Mt Lubra in the Grampians: [\[and East Gippsland ...\]](#)

"In 2006, bushfires at Mt Lubra in the Grampians destroyed large tracts of the catchment, but the critical impact on water resources was avoided until the major floods of January 2011 washed large amounts of ash and debris into Lake Bellfield - the principal source of town water for Horsham in the Wimmera. Water quality in the region is still adversely impacted in the Wimmera Mallee region."

(VCES, 2012: 104).

4.2 Adaptation decision-making under uncertainty

Adaptation is challenging because it requires making complex decisions under conditions of uncertainty beyond 'typical' realms of uncertainty in policy-making, and it challenges the status-quo and the value-basis of our decisions. Acknowledging uncertainty and finding ways for making robust decisions that can allow for these uncertainties are important strategies for building the adaptive capacity of the NRM sector.

What to make of uncertainties?

The literature suggests that uncertainty regarding the projected impacts of climate change is perhaps one of the most difficult challenges for natural resource managers needing to respond to climate change - and a key inhibitor for adaptation (Bardsley & Sweeney, 2010; Cross *et al.*, 2013; Lawler *et al.*, 2010). The uncertainty inherent in climate change projections and the timing and location of potential impacts leads to complex questions regarding the when and how of incorporating adaptation into NRM planning (Bardsley & Sweeney, 2010). However, it has long been argued that although climate change impacts at the regional scale remain uncertain, 'it would be short-sighted to postpone adaptive actions until impacts are better understood' (Fankhauser *et al.*, 1999).

To make progress on adaptation, climate change risks need to be incorporated into regional NRM planning policies. Effectively integrating inherently uncertain climate change projections into regional NRM planning processes, however, is challenging (Bardsley & Sweeney, 2010). To some extent, uncertainty can be evaluated using standard stochastic methods, and for some adaptation actions, their most economical timing can be assessed using decision-support tools such as cost-benefit analysis (Fankhauser *et al.*, 1999). However, more detailed studies focused on particular uncertainties may not necessarily provide sufficient justification for adaptation action.

As Bardsley and Sweeney (2010: 1137) note, "much [...] previous research on risk within NRM systems has been reductionist in nature – attempting to better understand sectoral impacts or components of systems by analysing their respective parts". In many ways, climate change can render traditional decision-making processes based on the *predict-then-act* approach impossible, because adaptation involves not only one but many different policy problems, a range of actors, and diverse decision-contexts, geographic scales, and time scales (Lempert *et al.*, 2004 and Dessai *et al.*, 2009).

Similarly, Ison *et al.* (2011) state that, even though concepts such as Integrated Catchment Management (ICM) and Integrated Water Resources Management (IWRM) seemingly embrace a more holistic approach, many NRM bodies continue to view adaptation as 'fitting into' an existing situation, relying on linear, one-way concepts of designing and implementing policies and practices that lead to a situation (or an organisation) being better adapted.

Drawing on case study research conducted in three catchments in the UK, Collins *et al.* (2007) conclude that catchment management remains largely based on a relatively narrow evidence base where catchment modelling science is used to inform policy. In the context of adaptation, this is considered challenging because many issues that require taking adaptive action cannot be sufficiently explored and understood from one perspective alone (Collins *et al.*, 2007).

Certainly CSIRO's work (Dunlop *et al.* 2012), indicates that Australia's biodiversity management still operates within a static framing of biodiversity and landscapes. Anticipated climatic changes will very likely have wide ranging and significant impacts affecting almost all species, ecosystems and landscapes. This significantly challenges a framing of biodiversity conservation as an attempt to preserve biodiversity in its current state (*ibid*). These authors developed three adaptation propositions about managing biodiversity under a changing climate:

- Conservation strategies accommodate large amounts of ecological change and the likelihood of significant climate change–induced loss in biodiversity.
- Strategies remain relevant and feasible under a range of possible future trajectories of ecological change.
- Strategies seek to conserve the multiple different dimensions of biodiversity that are experienced and valued by society.

Such concepts might be expanded within an NRM context, especially when considering another significant challenge represented by the intersections between climate change and other existing societal challenges and system dynamics; particularly as our knowledge and understanding of these systems and their interactions is limited (Haque & Burton, 2005; Schneider, *et al.*, 2003).

Arguing for an approach similar to that of Dunlop *et al.* (2013), Matthews and Wickel (2009), in the freshwater sector, argue for application of a 'natural history approach' to climate change adaptation. This involves moving from 'impacts thinking' guided by climate models from which uncertainty can never be eliminated, towards 'adaptation thinking' that acknowledges dynamic processes instead of stationary, quantifiable ecosystems. Such a shift could lead to successful climate change adaptation, by understanding what qualities enable ecosystems to adapt and be resilient to climate impacts; understanding how NRM institutions can facilitate these processes, in particular at regional levels; and developing capacity at the institutional level to anticipate and detect climate change and to implement responses (*ibid*: 274f.).

Negotiating decisions through empowerment

The literature also points out that better understanding of scientific information does not necessarily lead to successful adaptation (Adger *et al.*, 2005). Rather, that adaptation research and planning needs to begin with an understanding of social and economic vulnerability, as human behaviour, institutional capacity and culture are more important than biophysical impacts (Handmer, Dovers and Downing 1999).

Adaptation has a multitude of definitions and categorisation (Smit, *et al.*, 1999), let alone issues to consider. This inevitably leads to a lack of agreement on best practice, which can hinder effective formulation of climate change adaptation policies (Ison *et al.*, 2011). The complexity of the issues to be considered can make it virtually impossible to ascertain adaptation options using existing decision-making processes, and it can be counterproductive to try to characterise uncertainty as a basis for decision-making (Lempert *et al.*, 2004).

A different starting point for effective decision-making for adaptation may therefore be, as Collins *et al.* (2007:572) suggest, for NRM practices to better acknowledge that catchments “are situations of uncertainty, complexity, and conflict”. Walker *et al.* (2001:96) point out that the main challenge for integrating scientific information into NRM practices is to “develop approaches by which data, knowledge and scientific judgements of that data and knowledge can all be made available for integration into a negotiation process that attempts to deal with the inherent uncertainty through communication of the principles, values and assumptions underlying analyses”. This general observation seems to be particularly relevant in complex decision-making domains, such as climate change adaptation.

Drawing on lessons from a well-documented case study of climate change adaptation in a regional NRM context, Bardsley and Rogers (2010) argue that, due to the persistently uncertain nature of climate science, regional adaptation efforts should focus on empowering of stakeholders to increase the resilience of socio-ecological systems they are involved with. They show that the transfer of information to managers and planners needs to be supported by acceptance and ownership of the concept of change itself. Only once such ownership exists can the actual work of planning and devising regionally appropriate adaptation actions begin. A number of research approaches and decision support tools have shown to be useful in the context of NRM decision-making for adaptation, including: participatory Geographical Information Systems (GIS) modelling; environmental risk analysis; and participatory action learning (Bardsley & Sweeney, 2010).

Similarly, Walker *et al.*'s 2009 study in the Goulburn-Broken Catchment highlighted that “the current state of the system is a consequence of changes in resource use’ and the crossing of identified biophysical, economic, and social thresholds operating at different scales, may result in irreversible changes in goods and services generated by the region. They suggest that “interventions in the system for managing resilience are constrained by current governance, and attention needs to be paid to the roles and capacities of the various institutions”. Moreover, that “maintaining the region in its current basin of attraction may not be either feasible or desirable”, a strategy for promoting transformation should include:

- clear evidence that transformation is needed
- acceptance that change is necessary
- leadership, strong social networks, and trust
- a negotiation process
- strategic disinvestment in infrastructure, subsidies, or incentives that maintain the current regime
- support for those who will lose from the transformation
- political ability to implement structural changes
- strategic new investments in social and human capital, infrastructure, and technology (*ibid.*)

In evaluating a catchment development initiative in the Western Australian wheatbelt, Measham (2009) reflected that stakeholders commonly thought knowledge about managing complex problems like salinity will never be sufficient; however useful learning can be achieved through the process of gathering knowledge itself. Such empowerment may also be necessary because effective adaptation requires making complex and often unpopular decisions that, if not co-owned and supported by all key stakeholders involved, may not get implemented or may get derailed.

Daring to adapt

A recent study that examined preferences and perceived risks associated with adaptation strategies showed that individuals tend to act conservatively when it comes to adaptation, preferring measures that were most similar to the status quo (Tam & McDaniels, 2013). In practice, this suggests that greater acceptability of adaptation measures can be achieved by highlighting how these measures relate to existing techniques and processes and deemphasising their perceived novelty (*ibid*).

Underlying such perceptions are differing value systems held by the stakeholders involved in adaptation processes, which influence how climate change is interpreted; which impacts are deemed significant; and what ought to be done about them (Kemp & Martens, 2007; Voss & Kemp, 2005; Hulme, 2009; Heazle, 2010; O'Brien & Wolf, 2010).

It appears that, to date, only little attention has been given to psycho-social aspects of adaptation, in NRM planning or in other sectors, such as the beliefs and perceptions that underpin the acceptability of particular measures (Tam & McDaniels, 2013; Dunlop *et al.* 2013). It is likely that adaptation requires an expansion and modification of current NRM practices, and it will become more important to better understand individual and collective perceptions, as well as the individual psychological and organisational processes that lead to the acceptance or rejection of new ideas.

4.3 Sector-specific adaptation needs and strategies

To date, limited information exists on how NRM organisations and their stakeholders actually manage to adapt to climate change. Further research and documentation of tested processes and supporting mechanisms for adaptation planning are urgently required. However, a growing number of case studies points to some key ingredients for successful practical adaptation.

Documenting adaptation planning processes

Case studies can provide useful examples and rich accounts of successful and unsuccessful adaptation planning processes – although all too often the ‘failures’ are not documented adequately. Increasingly, rich case studies of climate change adaptation in the NRM sector are being documented. In 2009, a special issue of *Climate and Development* described six case studies from around the world of how adaptation measures have been incorporated into river management (Pittock & Dovers, 2009). The case studies include many examples of successful ecological and social adaptation outcomes, such as better flood retention, increased water security, reduced river pollution and increased institutional capacity (Pittock, 2009). The Social Learning for Integrated Water Managing project, implemented in various European catchments, produced an equally rich source of information on conditions and processes for learning as part of adaptation in the water sector (Keen *et al.* 2005; Blackmore, Ison, & Jiggins, 2007; Blackmore, 2007; Collins *et al.*, 2007).

Halofsky *et al.* (2011) lament that to date, only few literature sources contain information on adaptation that is relevant and directly useable for natural resource managers at an operational level.

Documenting and sharing cases from within the regional NRM sector where actual adaptation

processes are explained in detail, including major decision points and how decisions were taken, appears to be a major strategy to gradually build the sector's capacity to respond.

Planning ahead or merely reacting?

To gain a better understanding of the extent to which NRM organisations are currently preparing themselves to climate change impacts, it can be useful to apply diagnostic tools that evaluate evidence of adaptation planning in organisational strategies and documented practices. Ogden and Innes (2008) propose a typology for classifying adaptation evidence in strategic plans that can be applied to other sectors. They distinguish between four different types of adaptation evidence:

- proactive-direct adaptation
- proactive-indirect adaptation
- reactive-direct adaptation
- reactive-indirect adaptation.

Proactive (or anticipatory) adaptation here refers to acting before a situation becomes a crisis, whereas reactive adaptation represents 'waiting for something to happen before any action is taken' (Ogden & Innes, 2008: 857). Direct adaptation, on the other hand, refers to plans that explicitly acknowledge climate change as a potential driver of systemic changes, while the 'indirect' types of adaptation may incorporate best practices for sustainable resource management, which happens to be consistent with appropriate adaptation responses yet not specifically consider these as a response to climate change. Most adaptation options that have been implemented to date tend to be reactive, short-term solutions to particular climate hazards (Fankhauser *et al.*, 1999).

Ogden and Innes (2008) report on the extent to which strategic forestry planning processes in the Yukon Territory, Canada, incorporate climate change adaptation considerations. Assessing two major regional strategic forestry plans, they found that, while they included some examples of 'best management practices' that are consistent with adaptation goals, most planning processes were struggling to address climate change risks directly – despite relatively high levels of awareness and public interest in climate change issues.

Since the climate will continue to change, many argue that it makes sense to consider adaptation a continuous process rather than a once-off outcome to work towards (Fünfgeld & McEvoy, 2011; Füssel, 2007; Matthews & Wickel, 2009; Pittock, 2009; McEvoy *et al.* 2013). In the context of such continuous adaptation, however, it may be difficult to distinguish between proactive and reactive, and successful adaptation measures often prove to be a mix of both (Fankhauser *et al.*, 1999).

The need for better policy coordination

In a Canadian case study focused on evaluating policy capacity and coordination for adaptation in the extremely decentralised forestry sector (Rayner *et al.*, 2013), it was found that climate change adaptation has led to an expansion of mandates in forest and NRM departments, which requires better coordination of the existing policy capacity. The study found that while some policy capacity for adaptation existed in forestry organisations – in particular at the provincial level – problems of vertical

and horizontal coordination posed significant challenges. A pattern of fragmented, poorly coordinated adaptation policy responses was identified, leading to duplication and policy conflicts at different levels of government.

In Victoria, the VCMC provides an organisational framework for vertical integration of the main CMA issues vis-à-vis the state government, as well as a facility to enhance horizontal collaboration across the sector. Climate change impacts and adaptation are clearly considered important issues by the VCMC in the context of catchment health (2012a). It is not evident from the literature, however, to what extent the guidance and services provided by the Council has resulted in increased adaptation action and improved capacity to address climate change adaptation at the CMA level. The plethora of legislation and policies that may intersect with climate change adaptation planning, indicate that adaptation planning has potential to be addressed in a fairly ad-hoc manner. Consequently, as demanded by numerous complex policy issues, adaptation to climate change also warrants better policy coordination and synergies.

Supporting autonomous adaptation

Adaptation has been variously described as occurring autonomously, reactively, or in a planned, anticipatory manner. Autonomous or reactive adaptation can be defined as adaptation through actions and changes “that do not constitute a conscious response to climate stimuli, but result from changes to meet altered demands, objectives and expectations which, whilst not deliberately designed to cope with climate change, may lessen the consequences of that change” (Bates *et al.*, 2008:48). In contrast to processes of autonomous adaptation, planned adaptation can be understood as “the use of information about present and future climate change to review the suitability of current and planned practices, policies, and infrastructure” (Füssel, 2007:268). The focus of this work is on the planned, anticipatory forms of adaptation, and the different kinds of learning that can facilitate such adaptation.

Pittock (2009) argues that the water sector can learn about climate change adaptation by better understanding the factors that hinder and facilitate autonomous adaptation to climate change. It has been argued that a major role for government in the context of climate change adaptation in the NRM sector is to provide the right legal, regulatory and socio-economic environment to support autonomous adaptation (Fankhauser *et al.*, 1999).

Building on known measures and moving beyond them

Dovers (2009) discusses processes by which adaptation can become ‘normalised’ in institutions. He proposes that in order to adapt effectively and without further delay, it would be better to focus on known and well supported policy proposals and management options that address known issues, without necessarily having been developed to address climate variability and change. Such actions are justifiable on grounds other than adaptation – for example increased community resilience, improved livelihoods, human safety, resource efficiency and ecological conservation. As an example from the water management sector, he argues that if Australia’s National Water Initiative was implemented in detail and as intended, it would significantly enhance the ability to cope with increased climate variability and change (p 4), because it builds on “things we should already have done [...], where there are serious implementation deficits” (p5).

Furthermore, the case studies included in Pittock and Dovers (2009) suggest that adaptation in water management may most effectively be considered in the context of common problems. Pittock (2009) advocates viewing adaptation as a pathway that starts by implementing small-scale, ‘no and low regrets’ measures to respond to known vulnerabilities, which can be scaled up at a later stage. As Bardsley and Rogers (2010) note: “Many issues relevant to climate change adaptation for NRM will be managed effectively in [...] a reactive manner or by applying ‘no regrets’ actions that would create socioeconomic and environmental benefit irrespective of the extent of climate change”.

Incremental improvements to adaptation actions appear to be an effective, yet not often consciously adopted strategy for regional adaptation, that is particularly effective when combined with a reflective process of learning (Bosomworth *et al* in press; Brunner & Lynch, 2010; Jordan and O’Riordan 2005; Berkhout 2004;). As Bardsley and Rogers (2010: 6) put it: “Adaptation responses to climate change will require the development of new ideas that will amount to a great global process of experimentation, with the requirement for ongoing social learning and improvements in actions as more evidence becomes available”.

However, there is a risk that by focusing too much on the 'low hanging fruit' of well-supported adaptation issues and incremental adaptation, more innovative adaptation measures may never be fully explored, leaving organisations with only applying simple solutions to complex problems. Based on their evaluation of an NRM project to foster adaptive management, Allan and Wilson (2009:398) conclude that when adaptation occurs within the conventional paradigm and does not challenge existing assumptions about the issues faced, this will limit adaptation outcomes to "only enable people to do the same thing a little differently".

4.4 Learning and capacity building for adaptation in the NRM sector

Participatory and flexible approaches based on learning are often recommended as effective avenues for adaptation planning. There is increasing discussion in the literature about the role of approaches such as adaptive management and social learning. These are discussed here in detail.

Differences in adaptive capacity

Adaptive capacity is a key determinant to allow organisations and individuals to effectively adapt to climate change. To support NRM bodies and their stakeholders in adaptation, gaining a better understanding of their current adaptive capacity and systematically developing it can be considered a core part of adaptation at the regional scale.

Robins and Dovers (2007) examined capacity-building issues of NRM regions in Australia, in relation to two major NRM programs: the Natural Heritage Trust extension (Australian Government, 2008a) and the National Action Plan for Salinity and Water Quality (Australian Government, 2001). Describing capacity building as "knowledge and awareness-raising activities to support desired change", they found that a significant capacity gap existed between well-resourced, high-capacity regions and those with lower resource and capacity levels, indicating a self-perpetuating effect of well-resourced regions being able to use these resources to increase their capacity, while lower resourced regions remain stagnant (p275). This is in line with an observation made in the Draft Victorian Waterway Management Strategy (Victorian Government, 2012b:236), which in the context of allocating state funding to CMAs states "a fully competitive approach may lead to better-resourced CMAs being inappropriately advantaged over those that are less well resourced".

Adaptive management

In NRM, as well as in the broader environmental governance and management literature, there is appreciation that ecological and social systems do not simply co-exist besides each other. Instead they are increasingly considered as coupled socio-ecological systems (Gallopín, 2006; Turner *et al.*, 2003; Young *et al.*, 2006; Walker 2002; Holling 1973). Discourses about climate change adaptation often involve this concept.

However, it is often unclear how coupled socio-ecological systems can be better understood, and what relevance and consequences a more holistic understanding has for adaptation policy and practice (Walker *et al.* 2002; Ison *et al.*, 2011). Often, traditional management approaches cannot provide the

more holistic information needed to characterise coupled socio-ecological systems and their changing physical and social conditions (Allan & Wilson, 2009).

For these reasons, adaptive management (Holling, 1978; Maciver & Dallmeier, 2000; Allen *et al.*, 2001; Gunderson & Holling, 2002; Habron, 2003; Walker *et al.*, 2004) and systems thinking (Bawden & Pretty, 2007; Collins *et al.*, 2007; Ison *et al.*, 2009) are increasingly suggested in the literature as more flexible approaches to NRM based on learning and continuous improvement. Adaptive management emphasises the role of learning to appreciate and understand the dynamics involved in socio-ecological systems, with the aim to influence the resilience, adaptability and transformability of the system. Allan and Wilson (2009: 388) summarise adaptive management in the following way:

“In its simplest sense, adaptive management is learning from policies and management implementation in order to improve future management and policies”

Systems thinking approaches can provide insights into the interdependencies and complexities that characterise coupled socio-ecological systems such as catchments (Ison *et al.*, 2007). Using systems thinking, catchments can be understood as “an assembly of components interconnected together as if they had a purpose” (Collins *et al.*, 2007:565). In the context of defining adaptation goals, systems thinking can be used to bring to light different and potentially conflicting interpretations of the purposes of a catchment that are based on the interests and worldviews of the stakeholders involved. Catchment purposes may be as different as providing drinking water, providing wildlife habitats, or providing environmental flows to waterways (*ibid.*).

Adaptive management requires participatory planning and decision-making processes that enable organisational and social learning (see below). Often the intention is to introduce and experiment with adaptive management approaches using specific projects. Evidence from the *Meeting in the Middle* project (Allan & Wilson, 2009) suggests however, that it can be difficult to implement experimental projects geared at adaptive management and improving adaptive capacity, because a raft of constraints “force projects back into the mainstream” (*ibid.*: 397). These include institutional constraints such as existing hierarchies of power and the need to devise and adhere to preconceived project management milestones, as well as existing cultural norms (politeness, preference for expected behaviours, role understanding, ideas regarding what constitutes knowledge) and pragmatic issues, such as tight timeframes and working with the willing and those available (Ostrom 2005 & 2008).

Some research findings, however, question the universal suitability of adaptive management for leading a more integrated NRM planning, arguing that adaptive management practices tend to show biases of the group involved in fostering the approach, and outcomes may therefore be unacceptable for groups not involved in the process (Walker *et al.*, 2001).

Social learning approaches

Social learning can be described as the shared enquiry involved in co-management of natural assets (Schulser *et al.*, 2003) or the learning of a social entity as a whole through context specific multiparty collaboration (Pahl-Wostl *et al.*, 2007). Central to the notion of social learning is collaborative participation in activities that lead to learning and practice change (Allan & Wilson, 2009). Ison *et al.* (2011: 3979) describe social learning as 'both an alternative governance mechanism [...] and a process of systemic change and transformation undergone by stakeholders in complex situations'.

In the European project *Social Learning for Integrated Water Managing* (SLIM), social learning was found to be a useful alternative to existing policy instruments (Blackmore *et al.* 2007) that 'draws on creative and adaptive processes among multiple users around environmental problems [...] leading to concerted action at catchment scale' (Blackmore, 2007:519).

Social learning processes can support stakeholders in jointly defining adaptation goals (Blackmore, 2007). Such convergence of goals needs to be underpinned by a joint process of creating knowledge among stakeholders, making assumptions apparent and sharing mutual expectations, which helps build trust and respect – an important prerequisite for concerted action on climate change adaptation (Blackmore, 2007).

In a study evaluating soil management and soil health, conducted by the Murray Catchment Management Authority, (2006 to 2008), Allan and Wilson (2009) highlight key lessons for social learning and adaptive management in the context of climate change responses. They show that, despite a perceived 'participatory turn' in agricultural extension and NRM, traditional practices, grounded in the paradigm of technology transfer, continue to prevail. Social learning, which is based on joint exploration of ideas, power sharing and experimentation, fundamentally clashes with the technology transfer paradigm.

In the same study, the authors question whether social learning or participatory processes should be attempted at all in constraining institutional environments, including, for instance, in environments where hierarchies of power may limit the agency of staff; where time allocations to participate are insufficient; or where expectations about outcomes differ. Allan and Wilson (2009) propose that these constraints do not constitute a good reason for avoiding participatory learning approaches, but should be carefully considered when designing projects that deviate from organisational and cultural norms.

Research – policy – practice collaboration

A key success factor for successful adaptation at the sub-national level mentioned repeatedly in the literature is effective collaboration between researchers, policy makers and NRM managers. A number of scholarly publications suggest that collaboration between research and NRM bodies can help overcome many of the barriers posed by uncertainty and complexity of climate change issues (Allan & Wilson, 2009; Measham, 2009; Halofsky *et al.*, 2011; Bardsley & Rogers, 2010; Cross *et al.*, 2013).

Cross *et al.* (2013) report on their successful implementation of a collaborative adaptation planning framework, called *Adaptation for Conservation Targets*, in the southwest of the United States. The framework was used to facilitate collaborative climate change adaptation planning and was specifically

designed for NRM use. Focused on conservation, it offers a workshop-based process for identifying adaptation actions with regard to conservation features such as species, whole ecosystems, or ecological functions.

Similarly, Halofsky *et al.* (2011) propose a workshop method for promoting two-way learning on climate change adaptation between scientists and forestry resource managers. The workshop format included highly interactive components, including jointly producing a short course video containing lectures and discussions on climate change issues, which was embedded in facilitated discussions about adaptation options.

Measham (2009) identified 'feedback' as a key process for participatory research, in the context of returning information to participants, to facilitate group and individual learning and collectively understand the situation. Also, group deliberation was an important element of social learning, giving participants opportunities to interact and learn from each other (*ibid.*).

5 Key themes emerging from the interviews

5.1 Historical influences

The historical influences of regional land-use and the management of catchments in Victoria play a key role in shaping how the sector functions today. These influences reach back to European settlement and the land-use patterns that evolved around closer settlement and soldier-settlement schemes. More recently, from the 1980s, efforts to deal with salinity problems led to experiments in community-led regional governance that grew into the institution of CMAs as they are known today.

Land-use and settlement patterns in Victoria were recognised as particularly important in shaping the role of CMAs. In essence, CMAs evolved from institutional arrangements designed as a means of managing salinity across large areas of mainly privately-owned land. The following quote portrays one respondent's perspective of this story of settlement and the cultural construction of Victoria's landscapes.

"[E]mbedded in the drawing is the history of land use, and land is very important for every culture historically. As we get more and more urbanised, you know, people forget that, but we actually make the landscape, we take the landscape and we put our future dreams into it. That's what we turn into, so. [W]e still went into this old paradigm that the land's got to be useful, and useful is someone using it, even though if you were rich you could always have your little squattocracy, and you know, a couple of square miles up the back which you just left for kids riding and stuff." (r21)

This quote reflects on what can be understood as a (wrongly thought of) 'nation-building' narrative of Australian history, where settlers encountered an undeveloped and unclaimed land (or *terra nullius*) and have sought to establish sovereignty through its settlement and use. The consequence of this is that the Victorian landscape is a patchwork of land-uses and settlements that reflect not only resource use, but also the deeply held imaginings of what the landscape ought to be. This poses a challenging set of starting conditions for adapting to climate change, as adaptation most likely means a reframing of the landscape's purpose, a reappraisal of the valuing that constructs the landscape, and resultant change in the physical uses of the landscape.

The agriculture and NRM sector has a history of managing uncertainty in relation to climate and environmental impacts. Droughts, floods, salinity and erosion are recurring themes in Victoria's settled history. References to past climatic sequences and future adaptive responses are typically framed by the concept of stationarity, where climate variability is bounded by a range defined by past experiences. This is captured in the following quote.

“[A] lot of landholders and farmers will say, ‘We’ve always had climate variability. We’ve been through droughts. The 1940 drought and the federation drought, they were just as bad as this most recent one.’ They weren’t. The most recent one is by far the worst. Most farmers don’t find it [dealing with adversity] difficult because they are always facing adversity in one way or another and what they term adversity might not be so adverse in a global sense.” (r32)

Several respondents drew attention to the recent prolonged 13-year drought, which occurred from 1997-2009 in Victoria, and which was the longest and most severe drought in recorded history. This drought had many adverse impacts, including a reduction in water resource allocation in the Goulburn-Murray Irrigation District in northern Victoria, and flow-on effects in the form of large-scale bushfires (in 2002/03, 2006/07 and 2009) and reduced breeding of fauna. The drought also had some beneficial aspects, with one respondent (r15) reporting that the drought reduced weed loads substantially, which enabled the quality of native habitat to improve. The drought also caused water tables to fall and thus reduced the threat of salinity in many areas of the state. The quote above reflects on respondent’s understanding that this recent drought is the most severe in recorded history, and challenges the notion of stationarity.

Continuing this theme of climate variability, prior to the drought a major focus for CMAs was responding to salinity. Salinity was long recognised as an issue in Victoria, caused by rising water tables resulting from a variety of reasons including vegetation clearing, irrigation, rainfall and the natural salt content of the landscape. A Salinity Program was instituted across Victoria’s catchments, growing out of a community-led governance model that was trialled in what became known as SPPAC – the Salinity Pilot Program Advisory Committee. Two CMA respondents (r27, r52), who have been in the sector for a long period of time, specifically referred to SPPAC as both an effective way of managing uncertain threats (comparable to climate change) and as a formative influence on the organisational culture of CMAs.

“I feel like we’re at the stage we were at in the mid ‘80s when salinity started to emerge as a real problem. I guess it was perhaps at the very beginning, the late ‘70s that people started to, that science started to recognise the problem. And I’m sure land holders started to recognise the problem too. It was, and then by the mid ‘80s there was starting to be some planning done around it. In exactly the same way, highly speculative, operating on really scant information. By the end of the, by the mid ‘90s, the response to salinity was sort of placed in departments. I remember Joan Kirner, who was the Premier at the time, she moved the salinity response of government...into her own Office of Premier to try and give it a sort of

multidimensional, multidisciplinary approach; a whole of government approach. And by the time the drought took hold, which was when salinity, a lot of land salting started to disappear, just because water tables fell, there was a pretty coherent and well informed response to salinity going on.” (r52)

This leads into the institutional history of CMAs in Victoria, which is somewhat varied. In some areas in the north of the state, salinity groups such as SPACCS operated, but the predecessors to CMAs in many places were the former River Improvement Trusts. During the period of 1988 to about 1995 these Trusts evolved slowly into catchment-based Waterway Management Authorities (E.g. Lake Wellington Rivers Authority, and Upper North East River management Authority). In 1994 they became CaLP (Catchment and Land Protection) Boards in 1994, and finally CMAs in 1997. Although respondents commented little on this institutional history, one did suggest that in five years' time, CMAs would function differently again to how they currently operate. This history of evolving organisations show that CMA operations and the institutional arrangements that structure these activities have previously dealt with change and transformation.

This capacity for change is supported by the reflections of a number of respondents about the proposed CMA mergers of 2009 that appeared in the Land and Biodiversity White Paper (2009) of the then Victorian Department of Sustainability and Environment (DSE) under the previous Labor Government. The idea was to merge fifteen CMAs and Coastal Boards into five 'Natural Resources and Catchment Authorities,. However, following a change of government in late 2010, this plan was reversed and the CMAs and Coastal Boards remained in their prior institutional configuration. Some of the tensions around those proposed mergers are captured in the following quotes.

“[W]e were going to merge in 2009 with Melbourne Water. The government of the day was going to merge us, but there's 700 people in Melbourne Water and we've got 21. And DSE have got however many hundred, 800, 900. And you know, so we don't have much sway in, as far as resources to be able to go.” (r50)

“There's nothing worse for government departments is if you get merged and then the next government comes along and demerges and you're all over the shop.” (r27)

Not all respondents were against the proposed mergers, suggesting that they may have helped progress a climate change adaptation agenda by creating greater staffing levels and the flexibility to take adaptation opportunities (see Section 6.1 for possibilities).

While CMAs are frequently undergoing changes in staffing, sources of funding, and institutional arrangements, their main planning documents – Regional Catchment Strategies (RCS) - are revised on a five-yearly basis. Given they were only established in 1997, most CMAs are now just into their third

Regional Catchment Strategy. One respondent suggested that this does not match the pace of change in the sector.

“The Last Regional Catchment Strategy was a bible; we didn’t change it, and it’s still in existence now, and it was written in 2004 and not a word of it’s been changed, regardless of all the stuff that’s gone on since in the political information and the physical environment. We’re still reporting on what we said we’d do in 2004.” (r51)

Each CMA has taken individual approaches to developing their RCSs, with some attempting to address the issue of currency. One CMA is moving their RCS to an online platform, with the intention that it can be updated as new information becomes available. Another has reconceptualised the landscapes it manages as Social-Ecological Systems (SES) following the model developed by the Resilience Alliance. The RCSs of all ten CMAs don’t exactly align by year (e.g. CCMA 2003-2008, PPWCMA 2004-09, EGCMA 2005-2010), and there exists no state-wide catchment management strategy, although one was proposed in the Land and Biodiversity White Paper.

The reliability of funding programs and the allocation of resources have also fluctuated over the history of Victorian CMAs. The current funding situation relating to climate change adaptation is picked up as a key theme in Section 2.8. Respondents contrasted the nature of fixed and competitive funding, as well as state and federal governments as sources of funds. CMAs receive funding from a combination of federal and state governments, although they are a state authority.

“[H]istorically there’s been two main areas. So one has been what we’ve called our state vote or the Victorian Investment Framework and that’s, it’s a quasi-competitive quasi-allocated funding and that, traditionally, has been a significant proportion of our funding and that comes through DSE. So we prepare an annual investment plan across a number of programs, that goes to DSE, they assess it with all the other CMA bids and then they allocate funds which come to us and we manage those.” (r30)

CMAs have always relied on a mix of state and federal funds. Federal funds come from the Natural Heritage Trust I (in 1997-2002) and II (2002-2008), now called Caring for our Country (2008-current), which includes funds for Regional Landcare Facilitators, some of whom are located in Victorian CMAs. The Land Sector Package part of Clean Energy Future will be a substantial source of funding for NRM in Australia, including funds specifically related to climate change adaptation. Respondents also identified the availability of federal funds from Water for the Future, including opportunities for CMAs to administer the on-farm irrigation efficiency program.

“[T]he other main stay of our funding has been what was NHT, Natural Heritage Trust and National Action Plan for salinity and now is CfoC, so Caring for

our Country 1, soon to be Caring for our Country 2, where we get a base allocation of funding. And then we get, on top of that, we can apply for competitive funds and those rounds are on an annual basis and they fund three, roughly three to five year projects.” (r30)

A key sticking point was the lack of a rateable funding base, which was an original design feature of Victorian CMAs. The CMAs were originally set up to collect a catchment levy, which raised funds from all landholders in the catchment that could be used at the CMA's discretion. This was abolished after the Labor government came to power in 1999. The funding situation means that staffing levels at CMAs fluctuate, as some staff members are recruited with specific program funds. Also, much of the funding CMAs receive is for delivery of programs, so they act as conduits for investment from state and federal government, rather than recipients of the resources themselves.

Over the time that CMAs have been operating, while the institutional arrangements have become very complex, catchment managers have developed a culture of cooperation and communication. The following respondent draws attention to the key element of this, which can be understood as treating the catchment managing situation as dynamic and as a learning experience.

“We've had a lot of stability, really, for a pretty long time, 14 years of pretty good stability, which has allowed us to really entrench some processes and entrench some thinking, like I was saying before, the culture, culture's very strong. The risk is in the long strength in culture is you've got to make sure you keep looking out. Don't think you've got everything perfect because you've been there for a long time. That's the worst thing you can do.” (r27)

To summarise, and to relate the history of Victorian CMAs to the current situation, it can be claimed that these organisations are survivors and have managed to adapt to changing circumstances of funding, the physical climate, and political dynamics. The NRM sector has a challenging set of starting conditions, in terms of land use patterns, and, as funded authorities, CMAs are constrained somewhat in the flexibility of their governance through the relevant legislation. However, the ethos of community-led NRM and the 'bridging' nature of CMAs place them in a good position for facilitating adaptation action in Victoria's catchments.

5.2 Perception of climate change impacts

During interviews, participants were asked to describe or explain what was happening in their sector with regard to responding to and planning for climate variability and change. This question was embedded within a rich picture exercise, which meant there were varied approaches to the way the question was answered, as explained in Section □

A few participants provided comprehensive answers on a range of impacts that the sector has already experienced as well as the pressures and impacts they expect to be affected by in the future. The majority of participants referred to policies or strategies because they are currently involved in the writing and designing of the Regional Catchment Strategy. However, few could address how their sector plans for climate variability and change. This is a reflection on the way the question was asked but is also a good indicator of the progress of the sector with regards to addressing climate change adaptation. There was also a sense of risk in structuring policies around climate change, where it could be perceived by members of the public as misdirected – as indicated in the following quote.

“If you do something about it, or try and do something and you don’t get any climate change impacts happening for five or 10 years, because it may be a 25 year impact, people are going to go, oh what a waste of money that was.”
(r50)

However, some participants were able to clearly identify the climate change impacts that were visible and affecting their region. These impacts varied from nationally threatened species such as the Murray Cod, to the risk of bushfires in densely forested hills and the competition for water between agriculture, environmental needs, such as river flows, and the demand from urban communities. It is clear that while the NRM sector may have a better understanding of what is happening on the ground than other sectors (e.g. CSOs and PCPs), the range of impacts that they are experiencing, operating on the ground in variable environments, appears greater than those sectors. This range seems to apply both within and between the CMAs, as can be seen in the following quotes, which refer to fires, flooding and sea level rise; all issues of concern to the CMA participants interviewed.

“Within those highlands we have water reservoirs, threatened species associated with some of the highland streams, forested hills and also being subject to fire. And both are responses... of climate change and that is (due to) an increase desire or policy of the state government to increase prescribed burning and also the severity of wildfire, especially after prolonged dry periods which, as far as we understand the science, will become more of a feature in the future climate.” (r32)

“We’ve had ... the bush fires go through in the large public land or in the Southern part of the catchment and we’ve had the flooding up in the north.”
(r26)

“In the north-west corner, there’s an island. It’s got a national marine park. Melbourne Water invests quite a lot of money there. And it is massively going to be inundated in the next 100 years.” (r51)

The rich picture exercise provided some useful insights into how individuals within the CMAs looked at climate change and their role in planning for climate change adaptation. Some staff drew holistic and all-encompassing images that showed how they are trying to protect the many environmental assets of the region. Some showed the regional environmental planners atop a tall building to symbolise the responsibility of writing the regional catchment strategy from a whole region point of view. Others showed the existing threat of urban sprawl, population growth, and increasing demand for ecological resources. This highlighted that climate change is just one of the threats that the assets are affected by and for where the CMAs are trying to plan. The illustrations and discussion around the pictures provided a good perspective of how large a role the CMAs play.

“[W]hat else is in my picture? Farmland decline and loss, [...] just decline in quantity of it. And decline in its economic viability as it’s chopped up for all the hobby farming and then speculation and then urban fringe loss...I think I probably would have tried to draw the biodiversity of the region too and how that’s in decline. There’s no question it’s in decline, it’s measurable [...] which adds up to ecological decline and decline in the resilience of ecological systems. So we’re very much concerned about the big picture, this thing we call ecological integrity.” (r52)

Some respondents highlighted the social inequality of climate change impacts, particularly in relation to the location of properties likely to be affected by sea-level rise and flooding. However, they were unsure of how to deal with the social justice implications of climate impacts on their catchment and recognise that, for them, this is not just an environmental issue.

“So it’s actually, it’s probably bigger than just an environmental problem. It’s going to be a really big social issue. And I don’t know how, I’m not sure how the social justice side of it’s all going to work.” (r50)

“Traditionally the lower areas are the poor socio economic areas for people. The rich live on a hill.” (r50)

In relation to reducing the risks of short-term climate impacts, such as flood incidents, CMAs play a role in supporting local governments and emergency services through floodplain mapping, communications and administration.

“Well the flood plain managers, when there’s an incident, a flood incident, there’s an incident control centre so our flood plain managers get [notified] then we provide other support. So whether it’s administration support or IT support or mapping, pegging, communications, if they need it. So yeah, so we

sort of step in as a, you know the organisation steps in as a supportive back up.” (r26)

In summary, CMAs are largely aware of the potential for climate change to impact on the biophysical environment of the catchments they manage, and are building this into their Regional Catchment Strategies. What is less clear is how climate change will impact on the organisations themselves and individual staff, as well as residents of catchments.

5.3 Sources of information and funding

A strong theme in the interviews was the availability and quality of information and funding specifically to assist climate change adaptation in the NRM sector. These are important elements in the ability of the sector to respond to climate change: knowing the severity and locations of climate impacts, and having appropriate resources to embed this knowledge into strategy and planning.

In relation to sources of information, respondents mentioned that if the information was from a government source, it was more trustworthy and more credible than a consultancy report. If the information also had a local focus, it was perceived to be more useable.

“Probably also gives it maybe a little bit more credibility if the government have got it and the government are giving it out.” (r50)

“DSE have provided regional scale qualitative modelling and projections which has been a valuable tool in helping plan at a broad level.” (r63)

However, also apparent from the responses was the lack of consistency between the sources of information accessed. For example, not all the CMA personnel interviewed use the then DSE (now DEPI) climate change projections or specifically refer to them. Each CMA indicated they use a different source of climate change information, some citing the work of climate change networks, others citing research projects or a variety of work produced by the then DSE. This lack of consistency between the sources used could inherently lead to a range of interpretations, especially seeing that the capacity to interpret such information may vary across CMAs. A large number of respondents also referred to a professional contact as their source of information, some internally within their organisation, others in research or in government. This has potential to create inconsistencies and is perhaps not the most streamlined approach for information gathering.

When asked about the adequacy of the information to support adaptation, responses varied between “there not being enough information to be able to plan appropriately and confidently” to the information being there but not knowing either how to interpret it or, more often, not knowing what to do about it (see Section 6.1 for possibilities). There was generally an underlying view that a lot of information was obtained from external sources.

“Probably the gap, but it’s not my area, is the underpinning science and information that tells us what we should be doing and where we should be doing it, I think that’s the great uncertainty.” (r30)

One participant mentioned that they were aware of future projections for sea level rise and the impacts this would have if farms, land and houses were inundated with water, but their CMA did not know what action to take to prepare for future flooding. It is therefore not sufficient to supply accurate, trustworthy and credible information. An interpretation of the information is also necessary, along with facilitation to develop skills in using the information is required to help support more informed adaptation planning decisions (see Section 66.1 for possibilities).

“The information’s there I guess already. But it’s interpreting what to do about, so the sea level’s going to rise in this area, it’s going to become inundated. What does that mean for the animals living there, the people living there? Even if it’s farm land, what’s it going to mean for the price of milk?” (r50)

An example of where this is happening, in an area not directly related to climate change, is in the use of the EnSym environmental simulation modelling platform to support market-based instrument (MBI) schemes such as EcoTender, BushTender, CarbonTender and BushBroker. DEPI has developed the platform, which relates a calculated environmental benefits index (EBI) to the cost to landholders willing to improve their land, and allocates investment on the cost-effectiveness of bids in a reverse auction. Some CMAs have participated in trials of these state government programs, and are even experimenting with running their own regional MBI programs.

This example reflects on a preference among some respondents for information on impacts that can offer some planning options. They felt that if scenarios could be developed, associating a dollar value, then decision makers can make the decision whether, for example, an investment to save an indicator species is worth making or not. As noted above, such tools are available.

Access to sources of relevant information is only one factor in whether it will be used or not; equally important is the capacity of staff to obtain, interpret and make use of it. This capacity varies across the CMAs. In our interviews, we only encountered approximately 0.5 FTE of staff time specifically dedicated to climate change adaptation.

“Internally we don’t have a dedicated project officer to oversee this.” (r63)

“[I]n an ideal world you would actually put someone on to look at the climate change impacts...it would be a really useful thing. [...] Because we’ve done the mapping of assets and we’ve got the predicted sea level rise but it’s pretty hard to work out what to do about that.” (r50)

In most CMAs, responsibility for climate change adaptation is spread across staff members who have key responsibilities in other areas. Climate change advice and expertise is also brought in from external research organisations (e.g. Bureau of Meteorology, CSIRO, universities) or through climate networks.

“Our funding doesn’t stretch as far as having a skilled-up person in climate change. So we all do a little bit where we can, and we try and bring resources in where we can.” (r51)

Our interviews indicate that CMAs currently do not receive any funding specifically related to climate change adaptation (prior to the NRM Climate Change Planning fund in 2013). In addition to the program-based funding sources detailed in Section 5.1 (i.e. NHT I & II, CfoC, CEF), CMAs derive small amounts of discretionary funding for climate change activities through the interest gained on holding funding in bank accounts, from leftover amounts remaining from completed programs or borrowed from other project budgets (r31). Respondents also contested that they have all the information they need, or can get access to it easily, but that the main issue is funding.

“The issue is dollars. [...] If we had more to do more, I think we'd be able to respond better.” (r27)

In summary, these small quantities of funding and the limited staff time available are not adequate for a substantive program of adaptation activities and strategy development in CMAs. For instance, impact identification, analysis and reporting are expensive and resource intensive. In the case of obtaining LIDAR mapping of the coastline, one respondent reflected that the then DSE now DEPI are the “*only ones that can afford it*” (r50). Integrating climate change into other catchment management activities is one way that CMAs manage this lack of specific resources, as is collaborating with external agencies, or pooling resources with other CMAs.

5.4 Strategies for managing uncertainty

As described in Section 5.1, the NRM sector claims to be well adapted to situations of uncertainty, both biophysical climatic uncertainty and political uncertainty. In this section we examine the evidence for this claim and explore the governing processes that enable the navigation of uncertainty.

One CMA is embedding the principles of resilience into their Regional Catchment Strategy, influenced by collaboration with the Resilience Alliance. Some of the features of a resilience approach include conceptualising catchments as coupled social-ecological systems (SESs). This is a departure from previous strategies where landscapes were classified by their biophysical features only. The SES model classifies areas by a combination of their biophysical and social attributes. For example, the ‘Commuting Hills’ SES represents the upland areas of the river catchment, which are largely public land and important areas ecologically, combined with the social status of the community which mostly comprises residents that regularly commute to Melbourne. This SES is clearly different from other nearby SESs that identify with being located *in* the catchment.

“ALL of these areas overlap and they’re clouded, there’s no distinct boundaries so whilst I’ve drawn lines here, there’s no lines to these because some people will probably feel that they’d resonate more with one SES than the other SES, SES being Social Ecological Systems.” (r26)

In essence, this model of social and biophysical classification leads to ways of managing these regions that are more sensitive to context. The resilience approach also emphasises systemic thinking (i.e. a whole-of-system perspective) that lends itself to considering the trajectory of all elements of the catchment and the effects of multiple stressors, climate change impacts and governance.

“...tight targets, or focussing on one asset at the expense of everything else, that doesn’t fit with the CMA. So certainly that systems perspective, how are those relationships between the different parts, what does that mean and is really, sits comfortably with the people and the board and the community.” (r30)

The above quote demonstrates recognition of the consequences of setting targets or focusing on narrowly defined issues in governing catchments. It also highlights the importance of relationships, supposedly between different forms of capital, including social, natural and economic capital. CMAs operate in partnership and collaboration with several other groups and organisations in their regions, including landholders, water authorities, Landcare groups, researchers, networks and climate alliances.

In relation to the purely biophysical uncertainty of climate change, CMAs feel that the “*predictability of the impacts*” is the main issue of uncertainty and that traditional engineering approaches (sea walls or groynes) employed over the last few centuries will not work under these circumstances (r50).

“The problem is, I guess no one really knows, no one knows what will happen if we just let it naturally occur. Will the erosion then turn the cliff, the banks in to sand banks that the birds from Siberia will then, oh, it was there, it’s over here now. So will that just happen, or does it need to be actively managed?” (r50)

One example of a measure that can decrease uncertainty is the modernisation of irrigation infrastructure in the Goulburn-Murray Irrigation District (GMID). Known as NVIRP (Northern Victorian Irrigation Renewal Project), this represents a large investment by both state and federal governments in northern Victoria – taking in the North Central, Goulburn-Broken and North East CMAs. During a group interview with several members of one CMA, they pointed to this investment as an example of climate change adaptation, as it would enable irrigated agriculture to continue in the region, both physically in terms of the ability of the irrigation network to convey water, and economically. There appear to be a number of systemic consequences of NVIRP (e.g. see the Victorian Auditor General report – Frost 2010), which were not mentioned in interviews.

5.5 Support needed for adapting to climate change

The participants that were able to articulate examples of climate change impacts in the NRM sector were also able to clearly identify what they felt was necessary to address adaptation. For example, some felt that the development of regional catchment strategies will aid in adaptation planning if "climate change is treated as another threatening process rather than a chapter on its own". Embedding adaptation in their strategic planning rather than treating it as an independent issue was considered the most appropriate approach (See Section 6 for possibilities).

Some respondents reflected that progress is being made in helping inform them on climate adaptation, undertaken by research institutes with federal government funding and expert collaboration. One respondent had high expectations for the 'NRM Climate Change Impacts and Adaptation Research Grants Program' and was keen for this to start in order to gain commitment to further adaptation work. However, there was a perception that nothing new is being done other than translation of existing work to produce usable, practical information for the sector. Others highlighted that this knowledge-broker role was a traditional domain of CMAs.

"We're getting information from people like DPI and DSE, and on the other side of us are local councils and some of the smaller agencies that are trying to translate that information into what it means for them at a more local scale. And there's us in the middle trying to set strategic environmental direction, and trying to broker the information both ways but struggling." (r51)

CMAs wanted a research agenda developed with them as a group, with DEPI determining what is financially and practically feasible in terms of adaptation for their catchment area. Impacts have been identified, now they need to know what practical actions to take and they want to be involved in the process.

There was some concern about the changing political appetite for climate change mitigation, with one respondent (r61) suggesting that the Victorian state government had moved into climate change adaptation as the Commonwealth government is operating in the mitigation arena. Yet, various Victorian Governments have been working on adaptation and mitigation since the early 2000s. However, there has been a discernible shift away from mitigation activities as the Commonwealth develops various plans. This is a reasonable concern because there are limits to adaptation⁶, and these limits very much depend on our mitigating greenhouse gas emissions (Dow *et al.* 2013; Palutikoff *et al.* 2013; Klein *et al.* 2007).

Some thought that climate change was a politically risky topic because 'the public' may perceive acting on climate change as a long-term problem, as a waste of money compared to more short-term, 'immediate' issues. The quote below reflects a typical political struggle; that of the need for a long-term

⁶ Limits to adaptation are also contingent on ethics, knowledge, attitudes to risk and culture (Adger *et al.* 2009)

view and planning (E.g. biodiversity, social planning, critical infrastructure, and climate change adaptation), versus more short-term electoral cycles, as an obvious limitation on strategic planning to adapt (Meadowcroft 2002). This respondent's suggestion is that, because of the electoral cycle, policies and politicians are limited, unable or unwilling to address these longer timeframes. If this remains true, it imposes a significant barrier for adaptation planning.

"It's hard because I think it's a decision that transcends the four year election cycle... You've got to say, we're trying to do something for 20 year's time or 50 year's time. And it's just not a natural thing for the politicians to be able to do..." "I think everyone's constrained again by the political row over, of the four or five year election / funding cycle." (r50)

The perception of climate change as a risky, political area has led some CMAs to focus on their core obligations, such as river management, or areas of intervention and control that are more certain and measurable.

"We're not quite sure where an analysis of climate change impact would take us. It feels very speculative. It's very speculative compared to other threats that we're dealing with. You know, we can measure the other threats we're dealing with, we've got a history of observing them and we can make some predictions about where they'll go from here." (r52)

In some cases, respondents described climate change as having an impact on what they managed, but suggested that current management approaches were an adaptive measure (see Section 6 for possibilities). For example, several CMAs run programs to improve the quality and connectivity of terrestrial habitat, which they consider to enable movement of threatened species under climate change. Adoption of this approach is likely a reflection of much of the NRM related literature, which argues for such an approach.

"We've got mapping so we know where things are but we haven't really taken things to the next step of what does that mean in a planning capacity for some of those sites that are most vulnerable. [...] We've got to produce this regional catchment strategy that's supposed to address climate change in a meaningful way, but I don't think we've got the tools to take this heap of information and turn it into something meaningful." (r51)

Some respondents grappled with the uncertain and diffuse nature of adapting to climate change. In contrast to (seemingly) measurable targets such as biodiversity, climate change adaptation presents no obvious measures of performance. The availability of climate change projections did not directly guide management objectives, as reflected in the following quote:

“We’ve got the data [...] but not the tools to really convert that into something meaningful for use on the ground and action planning and stuff.”
(r51).

In summary, there is an opportunity to better support CMAs in interpreting and embedding climate change adaptation into their strategies and activities.

6 Possibilities for adaptation in the NRM sector

Here we present some possibilities for climate change adaptation in the NRM sector in Victoria, drawing on key themes from the literature and from our interviews. These are not recommendations, per se rather, possibilities for action in a transformation towards an adaptation-oriented NRM sector.

6.1 Fostering innovation in regional governance

Within the context of NRM planning and decision-making in Victoria, climate change adaptation is an emerging and complex issue, due to both the complexity of existing institutional arrangements and the uncertain nature of climate change and its potential impacts. A number of policy initiatives and funding schemes are in place or in progress that support CMAs and other NRM bodies in taking climate change adaptation considerations into account in their planning.

For example, in the preparation of their Regional Catchment Strategies, CMAs have to address requirements under Victoria's Climate Change Act (2010) and to consider carbon markets with regards to re-vegetation planning. More recently the federal government initiated the NRM planning fund which aims to support development of the information and capacity required to undertake such planning. At this stage, there is no practical guidance to natural resource managers in Victoria on planning for climate change, but it is developing. Nonetheless, NRM bodies have significant responsibilities to show initiative and incorporate adaptation thinking into their planning and operational processes.

Some respondents proposed that the NRM sector could try to achieve, for climate change adaptation, the kind of regional governance performance achieved by the Salinity Pilot Program Advisory Committee (SPPAC) in some northern parts of the state. Wallis *et al.* (2013) described some of the characteristics of SPPAC, suggesting it was an example of social learning in a regional NRM setting focused on concerted action to improve the salinity situation. They argue that SPPAC's institutional arrangements that gave responsibility for the salinity response to a cross-ministerial committee also provided a regional platform for community-led decision-making. However, they also suggest that the governance arrangements giving rise to the social learning were discontinued such that present day arrangements would not enable such learning.

Little research has explored the influence upon social learning and transformation of catchment management of other governance arrangements such as the former River Improvement Trusts that evolved into the Waterway Management Authorities, and eventually the CMAs. Given the institutional complexity of Victoria's rural water management system (Wallis & Ison, 2011), alongside that of NRM, biodiversity and other land management issues, it is unlikely to be ideal to create new institutions, but rather to re-craft or re-design existing institutions to be more fit-for-purpose with respect to climate change (Young, 2002 & 2010). Much can also be offered by international cases such as the EU project HarmoniCOP (Harmonizing Collaborative Planning on the role of social learning and IC-tools in participation with specific emphasis on the European Water Framework Directive) and the Integrated Project NEWATER (New methods for adaptive water management).

The regional NRM sector in Victoria has a record of community-led governance. However, climate change affects more than natural resources, and Victoria's NRM regions represent a milieu of private and public land, with a mix of agricultural, recreational, ecological, industrial and residential land uses. The NRM sector in Victoria (and possibly more broadly) could enter into partnerships or networks to share climate change adaptation resources. Investing in networks of organisations and community groups could also provide a platform for conversations about regional resilience and transformation, for example, the South West Climate Change Forum (SWCCF) in South West Victoria, or the Gippsland Climate Change Network (GCCN) in the East. Fostering networked-based innovation in regional governance, could avoid one-size-fits-all approaches (Ostrom *et al.* 2007; Dunlop *et al.* 2013) and allow adaptive responses to be fit-for-purpose within their regional contexts.

This kind of networked-governance might also assist NRM planners in having access to a broader 'team' of expertise and support in developing and implementing adaptive NRM plans. Moreover, it would, as Olssen *et al.* (2004) suggest, the information flow and social networks for NRM would help facilitate the combination of various sources of information, sense-making for NRM planning in a changing context, and perhaps most importantly, provide arenas of collaborative learning.

6.2 Supporting regional facilitators

As our interviews revealed, in many cases CMAs do not lack for sources of accurate, reliable and trustworthy information, but do not always make use of it. Some propose that the sector would benefit from a form of facilitation or 'knowledge brokering' in utilising such information in adaptation planning. This is not to say that 'knowledge' is a discrete product that can be transferred from one group to another (i.e. the container metaphor of knowledge: Krippendorff, 1993). Rather, there is a need to translate understandings from one community of expertise (e.g. climate adaptation researchers) to another (e.g. regional NRM planners). In the academic literature, this concept is named 'boundary work' (Clark *et al.*, 2011) and presents a possibility for ongoing investment in regional facilitation and knowledge-brokering. For example, the Regional Landcare Facilitator (RLF) initiative funds RLFs in each of Australia's 56 NRM regions. A formal evaluation of this initiative claimed that RLFs have emerged as key actors in regional NRM, by connecting stakeholders and acting as 'conduits' for information (Clear Horizon, 2012).

Again, the federal NRM Planning for Climate Change Fund is a significant development, presenting an opportunity to connect adaptation information to CMAs. This has two main components: Stream 1 involves funding of \$28.9M over 5 years to NRM agencies in order to incorporate adaptation into NRM plans. Stream 2 involves funding of \$15M over 5 years for the development of regional-scale climate projections (Element 1) and, more relevant, a research-oriented capacity building exercise to provide adaptation information and guidance on how to incorporate this into planning (Element 2).

6.3 Adopting an adaptation lens for investment and planning

Our interviews indicated that organisations and individuals in the NRM sector deal with climate change adaptation in a few different ways, most commonly: (i) as a discrete and separate threat to be identified and managed; (ii) as a systemic issue that runs through all other issues; or (iii) not at all, or in a very limited capacity. The academic literature indicates that there are few NRM issues unaffected by climate change (Campbell, 2008; Dunlop *et al.* 2013), therefore the most appropriate strategy would be to treat adaptation as a cross-cutting, systemic issue.

One possibility is to adopt an 'adaptation lens' for all NRM investment and planning in Victoria. Measures of performance that are currently used (e.g. for biodiversity) could continue to be used, and adaptation investment directed to activities as addressing the risk to the asset. There is a possible role for scenario planning (in the context of the two points above), drawing on existing and new climate projections and impacts information.

Equally, climate change has the potential to make many current NRM approaches increasingly difficult and ineffective (e.g. maintaining vegetation community types in their current locations), which is a fundamentally different challenge to that posed by other threats to NRM (adapted from Dunlop *et al.* 2013). Through this adaptation lens, as Dunlop *et al.* (2013) propose, there is a good case for moving away from the 'static' frame of conservation and NRM, toward objectives and actions that: accommodate large amounts of change, including potential losses; remain relevant and feasible under a range of possible future trajectories of change (*cf.* Regan *et al.* 2005; Dessai and Hulme 2007); and seek to conserve the multiple different dimensions of our natural resources and landscapes experienced and valued by society.

Finally, NRM bodies will need to act on the best available information. Natural resource managers who 'dare to adapt' can draw on a growing body of documented NRM adaptation measures that use strategies such as supporting autonomous adaptation, enhancing organisational adaptive capacity, applying adaptive management techniques, and adopting principles of adaptive governance. Considering adaptation as an ongoing process of learning and organisational change, and documenting and sharing progress and setbacks across the sector will also be an important overall strategy for tackling adaptation in an effective manner.

7 Conclusions

This report represents a step towards better understanding climate change adaptation in the NRM sector in Victoria. By combining an analysis of the institutional and governance context, with a detailed literature review and interviews with those in the NRM sector, it provides a good overview of the current state of the sector and possible areas for investment and action.

The review of NRM policy reveals that planning for climate change adaptation is not strongly embedded in the institutional and governance arrangements for NRM in Victoria. In the past, Regional Catchment Strategies have not clearly defined priorities for adaptation. With new resources being provided for this purpose from the federal NRM Planning for Climate Change Fund, adaptation will feature strongly in these strategies in the next couple of years.

A summary of the broad-scale impacts of climate change on Victoria's catchments was presented and a review of the literature highlighted some of the strategies that natural resource managers employ to deal with the inherent uncertainty associated with climate change impacts. These include the use of risk management, adaptive governance, and social learning approaches that point to a need for institutional innovation in regional governance.

Interviews with several CMA staff members and those involved in NRM more generally revealed a number of key themes. Firstly, that history matters in NRM due to settlement patterns, the make-up of private and public land, and in learning from successful experiments in regional governance. Perceptions of climate change adaptation vary across the sector, as do sources of information and funding and strategies for managing uncertainty. A common response was that CMAs had access to all the information they needed, but lacked the resources or support to make sense of it in relation to their catchment strategies and day-to-day work.

Finally, three possibilities for investment and action were identified, based on the literature review and interviews that might improve the way that climate change adaptation planning is approached in Victoria's NRM sector. Firstly, fostering innovation in regional governance, so that one-size-fits-all approaches are avoided and adaptive responses are fit-for-purpose in particular regional contexts. Secondly, a role for regional facilitators in translating or brokering knowledge across research and practice was identified. Thirdly, adopting an adaptation lens for NRM investment and planning into the future was identified as another possibility. These are ideas that require further exploration and research.

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Appendix 1: Outline used for semi-structured interviews

Introduction (10min)	
1.	<ol style="list-style-type: none"> a. Introduce VCCCAR IA Research team, history and roles b. Explain what the research is about (using the PIS): <i>'The project is called 'Implementing tools to increase adaptive capacity in the community and natural resource management sectors'. Its main aim is to better understand if and how government service providers and funded agencies adapt to climate change impacts. The project runs until November 2013 and is funded by the Victorian Government through the Victorian Centre for Climate Change Adaptation Research (VCCCAR).'</i> c. Explain why we are doing these conversations/interviews: <i>to gain a better understanding of the climate change adaptation needs, capacities and context of your organisation.</i> d. Explain how long the conversation will take and how it will be structured e. Explain ethics clearance and consent forms (interview and audio recording) and obtain relevant signatures. Give a copy of each form to each participant. f. Turn audio recorder on if consent was given. g. Ask each interviewee: <ul style="list-style-type: none"> • what their role in their organisation is, • how they got there (training and employment background) • how long they have been with this organisation & in this role. h. Note down the following demographic information: gender, age group (e.g. below 25, 26-35, 36-45, etc.), position title.
Rich picture drawing (15min)	
2.	<p>Rich picture: What is happening in your sector with regard to responding to and planning for climate variability and change</p> <ol style="list-style-type: none"> a. Ask the participant/s to draw what they see happening using pictures to represent the situation. Prompts/instructions: <ul style="list-style-type: none"> • Put yourself in the picture • You can label things and use words • What do you see that is problematic or significant? b. Ask the participant to describe the picture (try not to interrupt initially except for clarification) c. Use the picture as a basis for a discussion on the following themes
Semi-structured interview (up to 45min)	
<i>Take care to avoid leading questions. Only use closed questions for clarification purposes.</i>	
3.	<p>Who is in the picture and why are they in there – what are their roles?</p> <p>Additional questions e.g.:</p> <ul style="list-style-type: none"> • What key people and organisations, networks, partnerships and other entities are in the picture • Who is influential in this situation? Who is affected by or important to the situation but not influential? • Who isn't represented? Why? • What are the relationships between the different people/organisations represented like? Who needs to be talking to whom? Do they? Informally, formally, through what mechanisms?

4. **Where do you get support on how to address these issues from?**

Additional questions e.g.:

- What sources of information do you regularly use? What makes this useful?
- In general, what makes information 'usable' for you?
- Who/what supports you in planning for and responding to climate variability and change?
- What information is missing? What kind of support is lacking?

5. **What laws, policies and rules influence your ability to respond to/plan for climate variability and change?**

Additional questions e.g.:

- Which legislation influences your day-to-day decision-making in this context?
- What policies exist that have an influence here – at various levels of government and at an organisational level?
- What legal duties do you have that are, or might be, affected by climate variability and change

6. **What helps and what gets in the way?**

Draw a spectrum line from '0' to '10' and ask them to mark on where they feel they are in response to the statement:

'I have all/none of the support I need to make progress on adaptation'

e.g.

o _____ x _____ 10 _____

Then you can interrogate this further, e.g.:

Why are you not at zero? (what are the good/supportive things that are happening?)

Why are you not at 10? (what prevents you being at 10, what is missing etc.)

Where would you like to be in 2 years' time? (or one year or five years) – mark on a second x in the spectrum line.

What would it take to get there?

This should prompt a discussion about what would support their progress in responding to adaptation.

If necessary, probe further using the above questions to establish where the main barriers lie, e.g. at the individual, organisational, sectoral level?

Closing the Interview

- 7.
- a. At the end of the interview, ask what else they would like to tell you that hasn't been covered yet. Any questions that we didn't ask but that we should have asked?
 - b. Turn audio recording off
 - c. Ask for permission to take a photo of the rich picture and obtain signature on photo consent form
 - d. Thank participants
 - e. Discuss what will happen with the information they provided
 - f. Discuss how and when you will follow up with them
 - g. Discuss how they can stay involved in the project (further activities, email updates, etc.)

Appendix 2: De-Identified record of respondents

Respondent ID	Geographic Context		Level of Employment	
	Rural (R)	Urban (U)	Officer (O)	Middle Management (MM)
r1		U		MM
r2	R		E	
r3		U		MM
r4		PU		MM
r5		PU	O	
r6		PU	O	
r7		U		MM
r8		U	O	
r9		U	E	
r10		PU	O	
r11	R		E	
r12		PU	E	
r13		U	E	
r14	R		MM	
r15	R		MM	
r16	R		MM	
r17	R		MM	
r18		U		MM
r19		U		MM
r20		U		MM
r21		U		MM
r22		PU	E	
r23		U	O	
r24	R		MM	
r25		U	E	
r26	R		MM	
r27	R		E	
r28	R		MM	
r29	R		O	
r30	R		O	
r31	R		MM	
r32	R		MM	
r33	R		MM	
r34	R		O	
r35	R		O	
r36	R		E	
r37		U	E	
r38		U	E	
r39		U		MM
r40		U	E	
r41		U	E	
r42	R		O	
r43	R		O	
r44		U	E	
r45		U	E	

r46	PU	E
r47	PU	E
r48	R	E
r49	U	E
r50	U	MM
r51	U	O
r52	U	O
r53	PU	MM
r54	PU	E
r55	U	U
r56	PU	E
r57	R	E
r58	R	O
r59	U	MM
r60	U	MM
r61	U	E
r62	PU	O
r63	PU	MM
r64	R	O
r65	R	E
r66	U	E
r67	U	O
r68	U	MM
r69	R	O
r70	R	O
r71	U	MM
r72	U	MM
r73	PU	MM

Appendix 3: VCCCAR IA NVivo Coding Framework

The framework below was used to code and analyse qualitative empirical research material (rich pictures, interview transcripts, organisational publications, and interview notes) using the software NVivo10. Coding occurred at the level of the sub-nodes mentioned in the framework. The coding framework was developed by the VCCCAR IA research team, based on Ballard's 'model of the change process for sustainability' (Ballard, 2005).

Node	Description	Sub nodes	Description of sub nodes
1. History	Aspects of the historical situation that influence the current situation in which organisations are adapting to climate change. These are elements that can influence or even structure (e.g. path dependencies) what can be achieved.	<ul style="list-style-type: none"> 1 Governance history 2 Previous research 3 Organisational history 4 Evolution of organisational culture 5 Individual history 6 Regional history 	<ul style="list-style-type: none"> 1 What is said about previous governance approaches 2 What is said about past research work 3 Background to current organisational practice and structure 4 Background to current organisational identity and culture 5 Link between personal journey and organisational evolution 6 Historical aspects of the geographical region

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<p>2. Awareness</p>	<p>Awareness of what is happening and of what is required, including access to grounded usable information and processes to make sense of how projected climate impacts affect core business for an organisation and awareness of the scale, urgency and structure of the issues – its complexity, multi layeredness, absence of ‘quick fixes’, time dimension for creating effective change etc.</p>	<ol style="list-style-type: none"> 1 CC information availability 2 CC and the organisation 3 CC terminology 4 CC impacts 5 Understanding CC vulnerabilities 6 Organisational priorities and CC 7 Sectoral priorities and CC 8 Local/regional priorities and CC 9 Framing of CC adaptation 	<ol style="list-style-type: none"> 1 Availability of usable (including trustworthy and locally appropriate) information 2 Ability to make the connection between a changing climate and the core purpose and practice of the organisation or on their beneficiaries 3 Understanding climate terminology and language 4 Understanding what the main CC impacts are that affect society/the sector/the organisation 5 Understanding how a changing climate will impact particular vulnerable groups (could have sub nodes of e.g. low income groups, health impacts on certain groups) 6 Understanding of how climate change overlays existing organisational priorities 7 Understanding of how climate change overlays existing sectoral priorities 8 Understanding of how climate change overlays existing local/regional priorities 9 Awareness of how climate change adaptation is framed
<p>3. Agency</p>	<p>The ability to find a response that seems personally (or organisationally) meaningful - knowing what to do, feeling that that action is appropriate and worthwhile, knowing how this fits within an organisation and its existing priorities.</p>	<ol style="list-style-type: none"> 1 Linking CCA with existing agendas 2 Identifying CCA responses 3 Accessing resources for CCA 4 Role of individuals in CCA 5 Organisational role in CCA 6 Leadership in CCA 7 Motivation for CCA 8 Attitude towards CC 	<ol style="list-style-type: none"> 1 Ability to make tangible links to existing political agendas 2 Ability to identify meaningful and worthwhile responses (despite constraints) 3 Availability and access to resources including money, people, skills, expertise 4 Personality and mind set of individuals in relation to CCA 5 The role of the organisation in responding to a changing climate 6 Leadership in relation to responding to a changing climate 7 Motivation for responding to a changing climate (e.g.

			<p>compliance/tick box, nice to have, reduce vulnerability(</p> <p>8 Attitude towards climate change, e.g. supportive, unsure, climate change sceptic etc (could contain sub nodes).</p>
4. Association	<p>Association with other people in groups and networks, e.g. opportunities to learn from others, share experiences, have a common platform to advocate for change, opportunities for dialogue across different groups</p>	<ol style="list-style-type: none"> 1 Network participation 2 Value of networks 3 Research collaboration 4 Peer-to-peer collaboration 5 Other types of collaboration 6 Sharing experiences 	<ol style="list-style-type: none"> 1 Participating in networks by individuals or at the organisational level 2 Statements made about the value of networks (positive and negative) 3 Collaboration with researchers and academics and involvement in research projects 4 Collaboration with peers from other organisations of the same type 5 Collaboration with others (not academics and peer-to-peer) on projects, activities etc. 6 Opportunities to learn/share/discuss ideas and experience relevant to adaptation with others
5. Action and Reflection	<p>Learning cycles (double loop learning– did we reach our objective? Was it the right objective? Does it get us nearer to our goal?) and getting better at the skills and at questioning our assumptions.</p>	<ol style="list-style-type: none"> 1 Organisational learning 2 Individual learning 3 Using local knowledge 4 Monitoring and evaluating CCA 5 Managing organisational risk 6 Strategic planning 	<ol style="list-style-type: none"> 1 Opportunities/activities/experiences of organisational learning and reflection 2 Opportunities/activities/experiences of individual learning and reflection 3 Accessing and using local knowledge and experience for CCA 4 Reporting, monitoring and evaluating processes of CCA 5 Role of organisational risk management in CCA 6 Strategic planning for CCA / integrating CCA into strategic planning at an organisational level
6. Architecture	<p>The container that all this exists in and how supportive it is of change – the organisational culture, politics,</p>	<ol style="list-style-type: none"> 1 Powerful and influential actors 2 Sector architecture 	<ol style="list-style-type: none"> 1 Who is influential in the sector in relation to CCA? 2 The complexity of the sector in relation to CCA 3 Who is affected by and vulnerable to climate

	legislation, media, standards, codes, regulations, technological know how.	<ul style="list-style-type: none"> 3 Vulnerable groups 4 Current organisational culture 5 Political architecture and politics 6 Policy frameworks 7 Federal government 8 State government 9 Local government 	<ul style="list-style-type: none"> impacts? 4 How organisational ways of doing things (culture and identity) affect ability to respond to a changing climate 5 How changing party politics affects ability to respond to a changing climate 6 How changing policy frameworks affect ability to respond to a changing climate 7 What was said about the role of the Federal Government? 8 What was said about the role of the State Government? 9 What was said about the role of local government?
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