

[VCCCAR Project: Framing Adaptation in the Victorian Context](#)

Framing Climate Change Adaptation in Policy and Practice

Hartmut Fünfgeld and Darryn McEvoy

Working Paper 1

April 2011

ISBN 978 0 7340 4417 4
© RMIT University 2011

Partner Universities



Project Sponsor

Department of
Sustainability
and Environment

Table of Contents

| | |
|---|----|
| Acknowledgements | 4 |
| Executive Summary | 5 |
| 1 Introduction..... | 8 |
| 1.1 Scope of this document | 8 |
| 1.2 The VCCCAR <i>Framing Adaptation</i> project..... | 9 |
| 1.3 Framing terminology used in this document | 12 |
| 2 Setting the scene: climate change mitigation and adaptation | 12 |
| 3 The framing of climate change adaptation..... | 15 |
| 3.1 Framing as a social process..... | 15 |
| 3.2 Processes of framing in adaptation policy and practice | 17 |
| 3.3 Conceptual framing | 19 |
| 3.4 Operational framing | 21 |
| 4 Unpacking adaptation framing | 24 |
| 4.1 Adaptation to what?..... | 24 |
| 4.2 Who or what adapts?..... | 28 |
| 4.3 How does adaptation occur?..... | 31 |
| 4.4 What is good adaptation? | 35 |
| 5 Examples of conceptual framing: adaptation approaches..... | 36 |
| 5.1 Hazards approaches..... | 37 |
| 5.1.1 Evolution..... | 37 |
| 5.1.2 Definitions | 37 |
| 5.1.3 Hazard frames in policy and practice..... | 37 |
| 5.2 Risk management approaches | 38 |
| 5.2.1 Evolution..... | 38 |
| 5.2.2 Definitions | 39 |
| 5.2.3 Risk management frames in policy and practice | 39 |
| 5.3 Vulnerability approaches..... | 40 |
| 5.3.1 Evolution..... | 40 |
| 5.3.2 Definitions | 41 |
| 5.3.3 Vulnerability frames in policy and practice | 43 |
| 5.4 The resilience approach..... | 44 |
| 5.4.1 Evolution..... | 44 |
| 5.4.2 Definitions | 44 |
| 5.4.3 Resilience frames in policy and practice | 45 |
| 6 Examples of operational framing: climate change adaptation assessments..... | 45 |
| 6.1 Climate change assessments: purpose and objectives..... | 46 |
| 6.2 Climate impact assessment..... | 47 |
| 6.2.1 Objectives and methods | 47 |
| 6.2.2 Strengths and limitations..... | 50 |
| 6.3 Climate risk assessment..... | 51 |
| 6.3.1 Objectives and methods | 51 |
| 6.3.2 Strengths and limitations..... | 53 |
| 6.4 Vulnerability assessment..... | 54 |
| 6.4.1 Objectives and methods | 54 |
| 6.4.2 Strengths and limitations..... | 56 |
| 7 Discussion: framing implications for policy-makers | 57 |
| 7.1 Adaptation as a learning process | 57 |
| 7.2 Implicit and explicit adaptation framing | 58 |
| 7.3 Choice of adaptation approach..... | 58 |
| 8 Outlook: how to respond to this document..... | 59 |
| References..... | 61 |

Tables

| | |
|--|----|
| Table 1: Objectives and definitions of climate change mitigation and adaptation | 14 |
| Table 2: Three levels of adaptation framing..... | 18 |
| Table 3: Common elements of conceptual framing in adaptation policy and practice | 20 |
| Table 4: Common adaptation challenges relating to operational framing at the local level | 23 |
| Table 5: Overview of climatic stressors and key impacts for Australia..... | 27 |

| | |
|--|----|
| Table 6: Barriers to market-based adaptation..... | 29 |
| Table 7: Comparison of key characteristics of outcome and contextual vulnerability | 43 |
| Table 8: Goals of climate change assessments..... | 46 |
| Table 9: Priority risk rating matrix..... | 51 |
| Table 10: Five-step approach to vulnerability assessment | 55 |

Figures

| | |
|---|----|
| Figure 1: Overview - Structure and content of this scoping paper..... | 9 |
| Figure 2: VCCCAR Framing Adaptation Project – Schematic overview | 11 |
| Figure 3: What is the meaning of adaptation? Framing questions | 24 |
| Figure 4: Adaptation as response to climatic stressors..... | 25 |
| Figure 5: Typical onset and duration of climatic impacts | 26 |
| Figure 6: Adaptation as response to climatic risks..... | 27 |
| Figure 7: Generic process for adaptation policy setting..... | 30 |
| Figure 8: Typology of adaptation measures | 34 |
| Figure 9: Links between climate change and risk..... | 39 |
| Figure 11: Outcome vulnerability | 42 |
| Figure 12: Contextual vulnerability..... | 42 |
| Figure 13: Schematic of the impact approach..... | 48 |
| Figure 14: Schematic of the interaction approach..... | 49 |
| Figure 15: IPCC’s ‘seven steps of climate impact assessment’ | 49 |
| Figure 16: Steps in the risk management process, according to the CCIRM guide | 51 |
| Figure 17: Decision-making matrix for identified risks..... | 53 |
| Figure 18: Eight-step model for global change vulnerability assessment..... | 56 |

Acronyms

| | |
|-----------------|---|
| AR4 | Fourth Assessment Report of the IPCC (see below) |
| DSE | Victorian Government Department of Sustainability and Environment |
| CSIRO | Australian Commonwealth Scientific and Industrial Research Organisation |
| GCM | Global Circulation Model |
| IPCC | InterGovernmental Panel on Climate Change |
| MAV | Municipal Association of Victoria |
| PFWG | Port Fairy Working Group |
| RMIT University | Royal Melbourne Institute of Technology University |
| UNFCCC | United Nations Framework Convention on Climate Change |
| VCCCAR | Victorian Centre for Climate Change Adaptation Research |

Acknowledgements

This document has benefited substantially from the input of peer reviewers based in adaptation research, policy development and local practice. The authors would like to thank the following people for their written comments on draft versions of the document, and for engaging in broader discussions on the topic of the working paper:

Nick Aberle, Office of the Commissioner for Environmental Sustainability
Paula Arcari, RMIT University
Che Biggs, University of Melbourne
Karyn Bosomworth, Climate Change Adaptation Program, RMIT University
Taegen Edwards, University of Melbourne
Ray Ison, Monash University
Roger Jones, Victoria University
Rod Keenan, Victorian Centre for Climate Change Adaptation
Brenda Lin, CSIRO
Kate Lonsdale, UK Climate Impacts Programme
John Martin, LaTrobe University
Halley McCann, Department of Sustainability and Environment
Ryan Meyer, Arizona State University, USA
Ben Morris, Municipal Association of Victoria
Jane Mullett, Climate Change Adaptation Program, RMIT University
Jana-Axinja Paschen, Monash University
Benjamin Preston, Oak Ridge National Laboratory, USA
Izabela Ratajczak-Juszko, Climate Change Adaptation Program, RMIT University
Lauren Rickards, University of Melbourne
Debra Roberts, eThekweni Municipality, South Africa
Nina Rogers, Sustainability Victoria
Iain White, University of Manchester, UK
John Wiseman, University of Melbourne
Emma Yuen, CSIRO

While the working paper has been informed by the feedback provided by these reviewers, the views expressed in the working paper are those of the authors, who are solely responsible for the content.

Executive Summary

Understanding current and future climate change impacts, and how best to respond, are major challenges for Australian communities. Decision-makers need to consider the range of potential impacts climate might have in the future, where and when these may occur and how different industries or parts of the community might respond. Such complex challenges are often labelled as ‘wicked’ and are best addressed using collaborative approaches involving shared learning across institutions.

This working paper described what ‘adapting’ to climate change means by clarifying commonly used terminology and how these different concepts are used in policy development in Australia, and other parts of the world. Framing occurs when people with different knowledge, experiences and personal backgrounds consider an activity or a challenge. Framing is a way of making sense of a topic (like climate change) from an individual perspective but it can also be used to arrive at a shared meaning and sense of purpose in addressing the challenge.

The framing of adaptation can be **explicit** in strategies, policy documents, or procedural guidelines, but is often **implicit** in discussions, choices about planning approaches and processes, and the selection of assessment methodologies. Making framings explicit is important for establishing a collaborative process for adaptation. Explicit consideration of framing is also likely to influence the types of adaptation options and ‘pathways’ considered.

The most commonly used framings of adaptation are:

- 1. A hazards approach.** ‘Hazards’ are closely linked to disaster risk management. This natural disasters frame has been a dominant consideration in policy discussion on climate change. Increasingly broader notions of climatic hazards are being adopted, linked with other socio-economic and environmental trends, for example population expansion into bushfire prone areas in South East Australia or coastal zones likely to be affected by sea level rise or storm surges.
- 2. Risk management approach.** This is the dominant, organisational practice for dealing with many types of uncertainties in local government and the private sector. Central to the notion of risk are uncertainty and perception. Risk is defined as the combined product of hazards, exposure and vulnerability and there is a close connection between hazards and risk management approaches.
- 3. Vulnerability approach.** This focuses on who or what will be affected and in what way. A wide range of possible policy responses to vulnerability are possible. For example, *outcome vulnerability* relates to the residual impacts (e.g. on a habitat, an ecosystem, or a municipality) after all feasible adaptation responses have been taken into account. A *contextual framing* of vulnerability considers vulnerability in the broader context of interactions between climate and society.
- 4. Resilience approach.** The ‘resilience’ concept originated in ecology but is now being translated and applied to human systems. It is defined as the ability of groups or communities to cope with external stresses and disturbances as a result of social, political, or environmental change.

Each of these approaches has been influential in the development of climate change assessment methods. How assessment methods are framed is important given the role assessments play in adaptation planning in government. The framing can determine which departments are involved and which minister is considered to have responsibility for addressing climate impacts. Therefore, clarity of the framing and qualities and limitations of different assessment approaches will inform the methods used to assess impacts and adaptation responses.

The way that different people frame adaptation projects and planning processes is often implicit and may only come to the surface when arguing the business case for adaptation or when choosing a particular assessment approach.

Framing can occur at different stages of the adaptation process, for examples as an agency, local government, business or community considers the following questions:

'Adaptation to what?' What types of climatic changes do we need to adapt to?

'Who or what adapts?' Who or what are being impacted and how will it affect them?

'How do we adapt?' What are the processes and methods we use to devise and implement adaptation measures?

'What is good adaptation?' How do we know we are adapting successfully?

The choice of frame can lead to different types of climate change assessments:

Climate impact assessment. This approach is mainly concerned with analysing the effects of climatic change on natural, social and economic systems. Climate impact assessments can focus on biophysical impacts, socio-economic impacts, or both. Assessment can be conducted at various scales, from national level to regional and local impacts.

This approach uses quantitative data where available, leading to quantifiable estimates that are often sought after by policy and decision makers in order to justify pursuing particular strategies. However, uncertainty is a major problem because climate models are not able to give accurate local and regional scenarios for many climatic variables. The process of downscaling to regions and localities can also be resource intensive and time consuming.

Climate risk assessment. This is linked to the risk management approach and provides a way of dealing with uncertainty inherent in climate impact assessment. Risk can be quantified using various quantitative and qualitative techniques and used to assess the likelihood and expected consequences of a climate change impact under different scenarios, resulting in ratings of 'low', 'medium', 'high' or 'extreme' risk. This indicates the priority with which a risk should be treated. Risk assessment processes are suitable for organisations of various sizes, can fit well with existing organisational procedures and be readily integrated into existing risk management systems. However, the approach can lead government to be focused inwardly, often to the neglect of the interests of other departments or external stakeholders.

Vulnerability assessment. This is increasingly common practice in adaptation. It is implemented in many different ways using various definitions of vulnerability and a range of assessment methods. Vulnerability assessments typically address the characteristics of a vulnerable system, the type and number of stressors, and how these impact on the system. They can add valuable, bottom-up, perspectives for adaptation and be used to build the case for adaptation based on local data and information, thus ensuring that adaptation options are designed in direct response to local needs, enhancing the potential for tangible local adaptation outcomes. The range of vulnerability assessment methods in use means it is difficult to compare the results from different assessments, or understand the spatial variability of vulnerability beyond the scope of the immediate analysis.

In summary, climate change adaptation can be considered a **process of continuous social and institutional learning, adjustment and transformation**. Understanding adaptation as an ongoing process of learning is particularly relevant for local and regional scale decision-making. Understanding local vulnerability and perceived risk using a combination of quantitative and qualitative data can provide a bottom-up perspective of adaptation needs that is specific to a particular location.

In a situation of constrained time and financial resources, the **choice of a particular adaptation approach or a combination of approaches** will be highly influential in establishing a particular dominant framing for an adaptation process. Ideally, policy developers and decision-makers should pause and query why a type of approach or method will be applied to any particular adaptation project and ascertain the relevance of the underlying concepts for the purposes of the activity.

About the project

This is the first working paper produced from the project: 'Framing multi-level and multi-actor adaptation responses in the Victorian context'. This is an 18 month project which aims to develop and test an operational framing of adaptation which will subsequently act as a decision-making 'roadmap' to better inform adaptation policy and practice by Victorian authorities at the local and regional levels. To achieve these aims, the project has been structured into to four work packages:

1. the development of an overarching framework for adaptation (the 'roadmap');
2. preliminary economic analysis of climate change impacts and adaptation;
3. an exploration of local narratives; and
4. testing of these research outputs in three case study locations in Victoria.

This report on *Framing Climate Change Adaptation in Policy and Practice* draws from research carried out as part of work package one. It should be noted that the analysis discussed in the report covers the early stages of thinking about impacts and adaptation – the 'first step' on any adaptation pathway – rather than a comprehensive study of all adaptation processes. Other aspects of adaptation will be the focus of future project work.

1 Introduction

1.1 Scope of this document

This peer-reviewed document is one of the first outputs of the project 'Framing multi-level and multi-actor adaptation responses in the Victorian context' ('Framing Adaptation' in the following). It provides a review of theoretical concepts that are fundamental to framing climate change adaptation and a discussion of how these concepts are commonly applied in adaptation processes. The intentional focus of this review is on an exploration of how adaptation theory is currently being applied in climate change assessment methodologies. In reviewing relevant literature on climate change adaptation theory and assessment methods, the paper therefore aims to:

- a) Clarify the meaning and use of abstract terms commonly used for framing adaptation,
- b) Outline common concepts that can guide policy development for climate change adaptation at sub-national scale,
- c) Evaluate the usefulness and limitations of common approaches to climate change assessments in the context of local and regional adaptation planning and practice.

The chosen focus of the paper does not suggest that a limitation of the debate of adaptation framing to the link between adaptation theory and climate change assessment approaches is imperative. Rather, this document provides a starting point for discussion and shared learning between the researchers, policy-makers and local decision-makers involved in the Framing Adaptation project, as well as a broader audience, based on the assumption that climate change assessment approaches are considered important entry points into adaptation processes.

The paper sets out with an overview of the Framing Adaptation project, followed by an introduction to the debate about the meaning and purpose of climate change adaptation in section 2. Section 3 then provides theoretical reflections on framing and explains why exploring framings in the context of local and regional climate change adaptation is a worthwhile undertaking. This discussion leads into unpacking different dimensions of the (contested) meaning of adaptation (section 4), all of which are often used as part of framing processes. Sections 5 and 6 discuss various approaches and methods commonly used for conceptualising and operationalising climate change adaptation. A concluding discussion in section 7 highlights key questions for researchers, policy developers and decision-makers regarding the framing of adaptation processes at conceptual and operational levels.

Figure 1 provides an overview of the logic of this scoping paper, including key issues raised in each of the sections.

Figure 1: Overview - Structure and content of this scoping paper

| | |
|------------------|--|
| Section 1 | Introduction: What is the VCCCAR Framing Adaptation project about? What is this document about? |
| Section 2 | What are climate change mitigation and adaptation? |
| Section 3 | What is framing, and how does it apply to climate change adaptation? |
| Section 4 | How can the meaning of climate change adaptation be explored? |
| Section 5 | How is climate change adaptation framed conceptually? |
| Section 6 | How does operational framing occur as part of climate change assessments? |
| Section 7 | What are the implications for policy makers? |
| Section 8 | How can I respond to this document? |

1.2 The VCCCAR Framing Adaptation project

The Framing Adaptation project aims to explore how effective adaptation to climate change can be achieved using various approaches and framings. To achieve this aim, the project is working with academic and non-academic partners to develop and test a decision-making ‘roadmap’ to guide and inform adaptation policy and practice by authorities at the local and regional levels¹. This includes exploring different types of framing adaptation commonly used in local and regional adaptation processes and investigating if and how explicit or implicit framings influence adaptation processes and their outcomes.

The Framing Adaptation project is funded by the State Government of Victoria (Australia) through the Victorian Centre for Climate Change Adaptation Research (VCCCAR). VCCCAR projects are designed to facilitate research on climate change adaptation that is immediately relevant to adaptation policy development and practical applications, with a view to help state and local authorities in Victoria address climate change impacts and adaptation in an effective, informed manner. In line with this goal, the Framing Adaptation project aims to help facilitate dialogue on the meaning and purpose of adaptation between adaptation research, policy and practice. The project, therefore, takes a distinctive perspective on climate change adaptation research that is cross-disciplinary yet grounded in social science knowledge.

The project is a collaboration of three Victorian universities (RMIT University, Monash University, and the University of Melbourne), with active involvement from various state government departments, local authorities and local stakeholder groups. The Department of Sustainability and Environment (DSE) is the lead state government partner, with the main collaborating organisations at the local level being the City of Melbourne, the City of Greater Bendigo, and the Port Fairy Working Group. Other partners include the Municipal Association of Victoria (MAV), the Australian Commonwealth Scientific and Research Organization (CSIRO), the Victorian Commissioner for Environmental Sustainability, and Victoria University. There is also a close working relationship with three other

¹ A project summary with further details on the project’s objectives is available online at: www.vcccar.org.au/content/pages/framing-project

projects concurrently funded by VCCCAR². The eight researchers who form the core project team have academic backgrounds in climate change mitigation and adaptation, human geography, systems research, economics, forestry, emergency and risk management, and in the social sciences.

The 18-months research project, which commenced in September 2010, consists of four distinct work packages (Figure 2):

Work package one aims to develop a framework for adaptation planning (an 'adaptation roadmap'), which considers risk and vulnerability assessment, adaptation measures, barriers and opportunities affecting implementation, and how best to build local capacity. The roadmap will be made 'fit for purpose' through iterative engagement in the case studies (see work package three below).

Work package two undertakes an evaluation of existing approaches for economic impact assessment to better understand the strengths and weaknesses of different methodologies and their usefulness for local and regional adaptation. The analysis also produces preliminary estimates of the costs of climate change to vulnerable sectors in Victoria, both in the current context and under future climate change. Consideration is given to how best to frame the complexity associated with costing adaptation responses, to what extent non-market values can be included in economic impact assessments, and how conditions of uncertainty can be addressed. The results provide an economic perspective to adaptation framing that will inform the development of the adaptation roadmap.

Work package three conducts iterative testing of the adaptation framework in the selected case studies by engaging with a range of different state and local government stakeholders. The work package promotes a participatory setting, which informs the development of both context-specific and transferable adaptation guidance through a process of mutual learning and consensus building. Collaborative development and testing of draft guidance materials will be carried out with the City of Melbourne, the City of Greater Bendigo, and the community of Port Fairy (through the Port Fairy Working Group). Issues of mainstreaming and multi-level governance will also be explored in partnership with main case study stakeholders.

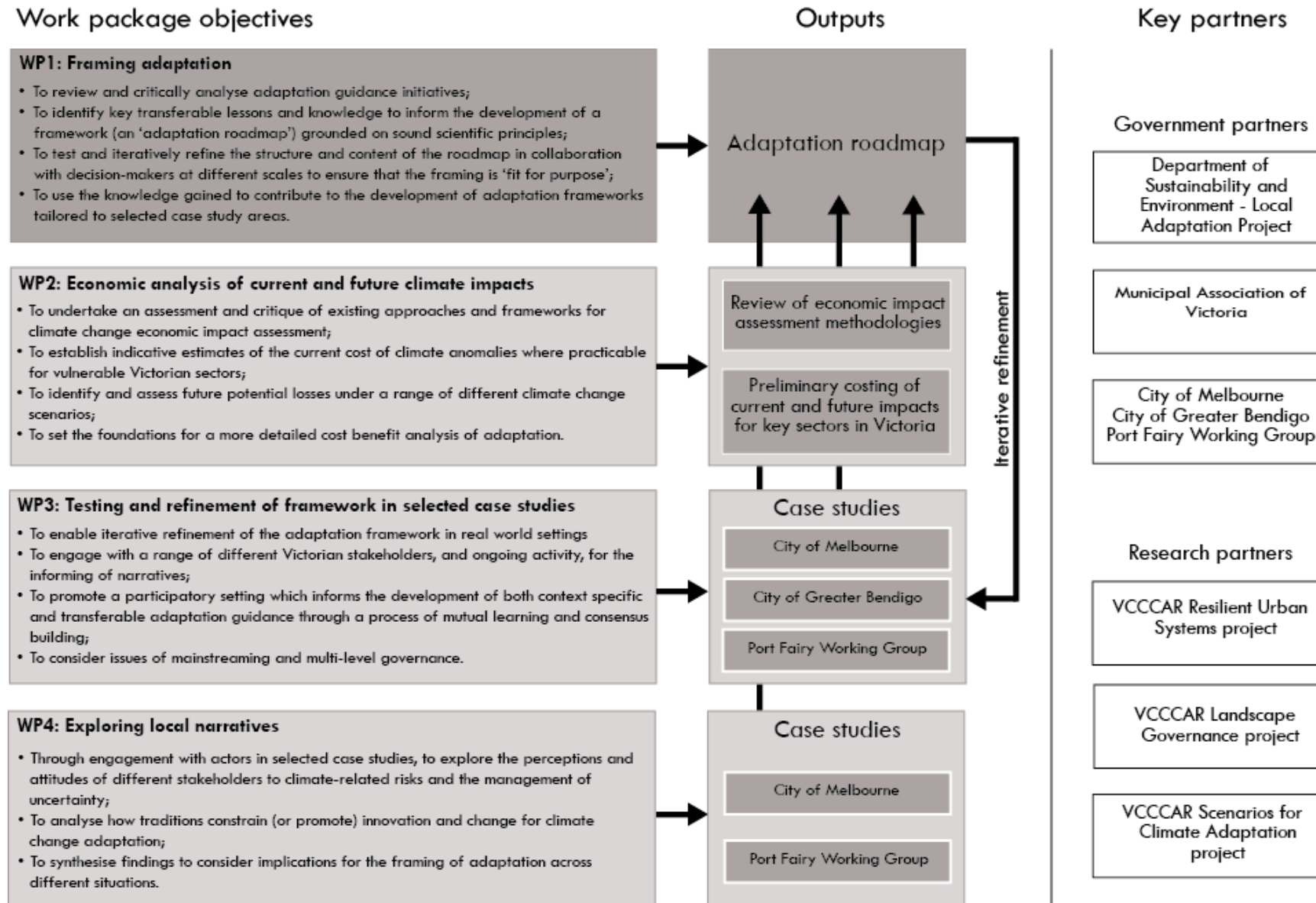
Work package four explores local perceptions and attitudes to climate-related risks and the management of uncertainty through empirical social research and engagement with actors in two case study locations (Port Fairy and Melbourne). A key research question is how traditions constrain or promote innovation and behaviour change for climate change adaptation, and how these inform the framing of adaptation within a given local context. Learnings from this work will be used for refining the adaptation roadmap.

Research undertaken in the four work packages is collaboratively guided by a team of experts, consisting of the core researchers and additional stakeholders from research, policy and local adaptation practice. State and local government staff, as the main direct users of the research outputs, play a centrally important role in this process. Field research conducted as part of work packages three and four will make use of organisational and local knowledge, and research participants will be selected in close consultation with key stakeholders in each location.

Figure 2 below illustrates how the work packages are anchored in the Framing Adaptation project, and how research outputs generated in each work package link up in the development and refinement of the adaptation roadmap.

² The VCCCAR partner projects are: 'Building common understanding of scenario based strategies to inform climate change adaptation' (www.vcccar.org.au/content/pages/scenarios-climate-adaptation); 'Resilient urban systems: a socio-technical study of community scale climate change adaptation initiatives' (www.vcccar.org.au/content/pages/resilient-urban-systems); and 'Understanding policies and governance for integrated landscape management in a changing environment' (www.vcccar.org.au/content/pages/vcccar-project-news).

Figure 2: VCCCAR Framing Adaptation Project – Schematic overview



1.3 Framing terminology used in this document

As will become apparent in the following discussion on adaptation framing, this piece of research, like all research projects, is not free from the implicit 'framing' of climate change adaptation. Such implicit framing has occurred, for example, through the inclusion of some topics in this paper while excluding others, in the selective incorporation of feedback from peer-reviewers, and the use of particular language and examples. While processes of framing will be discussed in context throughout this document, it is important to acknowledge from the outset that:

'...the research exercise itself is a political and institutionalised process shaped by the support for and production of research, questions over the initial 'agenda setting' and framing of the problem, and the final negotiation and implementation'

Vogel et al. (2007: 352)

To minimise the potential for inadvertently framing climate change adaptation in preconceived ways, the following terminology has been adopted throughout this paper when referring to the process of framing:

'Adaptation planning' refers to the collective of processes and steps undertaken to address the impacts of climate change.

'Approach' is used broadly to refer to different ways of going about climate change adaptation that are defined by different overarching adaptation goals, disciplinary traditions, and country-specific decision-making systems and preferences.

'Framework' is used when referring to existing guidance for adaptation planning processes that have been developed in certain sectors, countries or governments and that are accessible as published reference material.

'System' refers to social, ecological, or combined socio-ecological entities with defined spatial or administrative boundaries, which are used to describe the interdependent, multi-faceted setting in which climate change adaptation is nested.

'Method' is used when referring to step-by-step processes used in the course of planning for climate change adaptation. Climate change assessments are considered methods in this regard.

This paper has been written in a style primarily geared towards an expert audience familiar with climate change impacts and responses. An overarching goal of the Framing Adaptation project, however, is to provide recommendations to state and local level policy developers and decision-makers about the goal and process of climate change adaptation and the usefulness of different approaches for planning place-based adaptation. Whereas detailed discussion and precise exploration of definitions and concepts is necessary in order to give robust recommendations, it is challenging to balance an appropriate amount of detail and justification with practical guidance that also considers existing knowledge and time constraints of the target audience. To better suit a local and state government audience, a condensed version of this document will be made available.

2 Setting the scene: climate change mitigation and adaptation

To discuss adaptation framing in context, a brief introduction to the evolution of climate change mitigation and adaptation as multi-scalar societal challenges is warranted. The global phenomenon of climate change can be characterised by (Smit et al., 2000, Adger, 2006):

- An enormous number of diverse actors with a vast array of different values, levels of knowledge and cultural practices;
- Multiple climatic stressors; and

- Multiple time and spatial scales.

Challenges of this complex nature have been labelled as ‘wicked’ (Rittel and Weber, 1973) or ‘super-wicked’ (Bernstein et al., 2007)³, which are best addressed using collaborative approaches and processes that are non-linear, open-ended and based on learning across institutional boundaries, involving a wide range of stakeholders (Roberts, 2010). Responding to climate change therefore necessitates governance arrangements that can facilitate collaboration and integration across different levels of government, different geographic scales, and different sectors and professional backgrounds.

At an international scale, the United Nations Frameworks Convention on Climate Change (UNFCCC) and the InterGovernmental Panel on Climate Change (IPCC) have been influential in shaping the debate on climate change, as have been groups of sceptical scientists and politicians.⁴ The IPCC’s Fourth Assessment Report (AR4), published in 2007, concluded that meteorological observations from around the world suggested that the global climate is undergoing significant change beyond natural variability. Not only was the global climate changing but it was *highly likely* the observed changes could be attributed to human interference through increased concentrations of greenhouse gases (IPCC, 2007).

The publication of these findings marked a decisive point in the history of climate change policy and practice. Since the early 1990s, the reduction of global greenhouse gas emissions had been central to the agenda of decision-makers at all administrative scales, with the objective to mitigate anthropogenic (man-made) climate change. Much of the attention at the international level focused on the UNFCCC’s task of facilitating a binding greenhouse gas reduction agreement among national governments that could come into force once the Kyoto Protocol expired in 2012. The AR4, however, provided scientific evidence that climate change was already occurring and thus provided a strong case for addressing the impacts of climate change through adaptation, whilst simultaneously increasing the efforts towards reducing global greenhouse gas emissions to limit the magnitude of future climate change. In international negotiations on climate change, this paradigm shift has resulted in the UNFCCC expanding its focus to include negotiations on governance regimes for responding to the impacts of climate change ⁵.

Since 2007, climate change mitigation and adaptation have become recognised in the policy and practice communities as complementary strategies for responding to climate change. While mitigation and adaptation are commonly distinguished from each other and usually defined as different responses and requiring different processes, they are inherently linked. Table 1 provides an overview of key objectives and commonly used definitions of climate change mitigation and adaptation.

³ In addition to Rittel and Weber’s (1973) characteristics of wicked problems, ‘super-wicked problems’ are characterised by the fact that time for action is running out; that there is no central governing authority to solve the problem; and that those seeking to solve the problem are also causing it (Bernstein, Cashore et al. 2007).

⁴ Without anticipating any of the discussion that follows in later sections of this document, it is important to acknowledge at the outset that all current discussion on climate change adaptation, including the review presented here, is embedded in the ongoing public discourse on climate change, which is underpinned by differences in knowledge, beliefs and values systems. The views presented here, while thoroughly researched and peer-reviewed, reflect interpretations and viewpoints of the authors.

⁵ The shared vision for long-term cooperative action of the implementation of the Convention now, up to and beyond 2012, addresses mitigation, adaptation, finance, technology development and transfer and capacity building (United Nations 2010: 2).

Table 1: Objectives and definitions of climate change mitigation and adaptation

| | Objectives | Definitions |
|---------------------------|--|---|
| Climate change mitigation | <ul style="list-style-type: none"> Stabilising greenhouse gas concentrations Reducing greenhouse gas emissions Promoting greenhouse gas sinks Halting dangerous anthropogenic climate change | <p>‘Stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system’ (United Nations, 1992).</p> <p>‘An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases’ (McCarthy et al., 2001)</p> <p>‘Technological change and substitution that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce greenhouse gas emissions and enhance sinks’ (IPCC, 2007).</p> |
| Climate change adaptation | <ul style="list-style-type: none"> Reducing climate change related harm to natural and human systems Reducing the vulnerability of natural and human systems to the impacts of climate change | <p>‘Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities’ (McCarthy et al., 2001).</p> <p>‘Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects’ (IPCC, 2007).</p> |

Source: Authors and as cited.

As this comparison of objectives and definitions shows, mitigation and adaptation differ fundamentally in terms of their respective goals and consequently the governance regimes required for achieving these goals. Mitigation has a clear, global goal (primarily the reduction of greenhouse gases emitted), and climate science and observational atmospheric data can play a major role in the process of deciding what levels of greenhouse gas emissions reductions are required to avoid a certain degree of global warming. To achieve greenhouse gas reductions, national legislation can both regulate and incentivise emission cuts through national and sectoral reduction goals, carbon pricing and by encouraging voluntary reductions in households and private businesses. Greenhouse gas reduction is cumulative and fully scalable, and it is irrelevant where the reduction occurs – at large, the benefits of reduced rates of global warming will be shared equally across the globe irrespective of location. Although the implementation of mitigation programs is fraught with practical problems such as non-compliance, free-riding and unresolved questions regarding equity in emissions reduction, mitigation provides an opportunity for government, businesses, and individuals operating at different scales, and in different parts of the world, to cooperate towards achieving a common goal.

Adaptation is a much more diffuse task. Originally a concept developed in evolutionary biology, its definition and goals are largely place-based: they require an understanding not only of the impacts that are going to occur in a given place, but, importantly, also of the local fabric of social, economic and ecological systems. The IPCC definition of adaptation as ‘adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects’ (McCarthy et al., 2001) underlines the context-specific nature of adaptation. The definition does not, however, specify how ‘adjustments’ in systems should (or will) occur, nor what these systems are. If ecological, social or political systems, or combined socio-ecological ‘systems’ are considered the locus for climate change adaptation, a clear understanding of the system under consideration is necessary for defining effective goals and devising actions that will work towards these goals within the limits and opportunities provided by that system.

Systems that bear relevance for responding to climate change can be identified at various scales (e.g. from the international to the local level). Defining the nature of a system under consideration requires specifying the subjects or components that constitute the system (e.g. flora and fauna species, socially diverse groups of human beings, physical components of the natural environment, the

built environment etc.) as well as its boundaries (e.g. geographic, social or administrative boundaries).

Due to its highly contextual nature adaptation differs from mitigation in that it will mainly result in localised benefits, i.e. actual adaptations that take effect right where the investment took place. Although the distribution of adaptation costs across beneficiaries is often contested, the local nature of adaptation benefits can be a significant incentive for individuals, local businesses and local authorities to invest in adaptation measures in their geographic area. For example, tree planting programs in dense urban areas with limited green space lead to a number of direct adaptation benefits in the city, including improved shading on hot days, improved microclimate, and a reduction of the urban heat island effect⁶. Local adaptation approaches that draw on contextual knowledge of socio-economic and ecological conditions can harness this potential, whereas local action on mitigation action is often impeded by concerns about the distribution of benefits and free-riding because localised investment (i.e. reducing local emissions) results in collective global benefits (i.e. reduced rate of global warming).

While significant progress on mitigation can be achieved by central regulation through binding intergovernmental and national agreements, adaptation requires place-based approaches that integrate multiple levels of governance, linking strategic top-down guidance with flexible, context-specific responses to local climate-related hazards. The required flexibility exposes adaptation goals to value-based judgement of all stakeholders involved, and views can differ substantially regarding what is to be protected from harm, which opportunities are to be exploited, and which vulnerabilities are worthwhile addressing.

A success criterion for climate change adaptation therefore is to develop a shared framing of what successful climate change adaptation means in a given context, to enable actors to collaboratively design and implement effective climate change responses. Knowledge of, and agreement on, key conceptual and operational terms relevant to adaptation processes can help establish such shared framing, but due to the 'wickedness' of the problem it can be expected that actions will need to evolve based on flexible and creative thinking. A suitable metaphor depicts this process as that of an 'explorer who has a sense of direction but no clear route' (Clarke and Stewart, 1997), instead of a traveller who knows the exact route to a destination.

3 The framing of climate change adaptation

This section provides an introduction to questions of framing and how different framings lend meaning to place-based adaptation.

3.1 Framing as a social process

'Framing' has been described as a process by which actors construct and represent meaning to understand a particular event, process or occurrence (Goffman, 1974, Gray, 2003)⁷. Any information in the public domain is intentionally or intuitively framed in one way or another, and an indefinite variety of frames can emerge on any given topic, depending on the organisations, actors and academic disciplines involved. In abstract terms, frames can be characterised as 'organising principles that enable a particular interpretation of a phenomenon' (de Boer et al., 2010: 502). They are decisive in knowledge production as part of research, policy development and policy implementation because they are of agenda-setting character. Frames allow certain questions to be asked while others get silenced (O'Brien et al., 2007). Framing thus is an 'unavoidable reality of [...]

⁶ Urban tree planting programs are a good example for measures where action primarily taken on grounds of improved urban amenity and liveability results in significant co-benefits for mitigation (in this case promoting greenhouse gas sinks) and adaptation (cooling and shading effect of trees).

⁷ The process of framing has been examined in detail in a wide range of disciplines, including political science (Tversky and Kahneman 1981; Putnam and Holmer 1992), environmental conflict research (Lewicki, Gray et al. 2003), communication and media studies, anthropology, social and organisational psychology, and management science.

communication processes, especially [in] public affairs and policy' (Nisbet, 2009: 15) and thus critical to the direction any public policy discourse will take.

Critical to the topic of this paper is that framing also occurs whenever individuals with different 'knowledge', experiences and personal backgrounds interact to collaborate on an activity, for example to develop a climate change adaptation strategy. Frames then act as purposeful 'sense-making devices' (Weick, 1995) that enable members of a group to identify and label processes or events they are engaged in, and contextualise them within a particular set of values, ideas or political agendas, in order to arrive at a shared meaning and sense of purpose.

Yet how exactly does framing occur in such groups? Scientific disciplines provide a good entry point for explaining the role (and power) of frames. Scientific disciplines and their associated academic networks can be understood as communities of practice (Lave and Wenger, 1991, Wenger, 1998), which 'make meaning' (Bouwen, 1998) by creating and reinforcing a shared framing vis-à-vis a common area of scientific interest. Frames are apparent in shared values, research methods, key hypotheses, widely accepted assumptions, all of which are expressed in a specific set of expert language. Individuals trained in different disciplines carry these frames into organisations and their operations, where they influence decision-making and take on an agenda-setting character.

For example, if a local authority wants to commission the building of a new public library, it is likely that advice will be sought from a range of in-house and external experts, including engineers and architects, community development workers, and environment or sustainability officers. Let's imagine that the local authority holds a first meeting of key staff to explore the purpose and rationale of the project, i.e. building a new library. Each of the abovementioned experts will come to that discussion with a different focus in mind, which will be guided by factors such as their role in the organisation (i.e. their respective job descriptions), what type of expert advice is expected of them, and, importantly, differing individual perspectives grounded in professional and personal values, knowledge and experience.

The community development worker, for example, may look at the project from the point of view of how the new library can benefit a broad range of users and contribute to a healthy, vibrant community life, which is in line with his overall role within the organisation. His attention may be focused on considering the pros and cons of various proposed locations for the library, on ensuring access for disabled people, and on making sure the new library will have enough funds to run effective community engagement programs that attract large participation. A key concern of the architect, on the other hand, may be to consider various appropriate building designs and to what extent they will match up with the local government's construction budget, and the suitability of different types of building material. The environment officer may come to the library project meeting with a similar design focus, yet pursuing a slightly different interest: she may be mainly concerned about ensuring the building's location doesn't impact negatively on its surroundings; she may further argue for designing the library to highest energy efficiency standards; and she likely would want to ensure the library has excellent public transport. Most of her concerns come from the perspective of minimising the negative environmental impacts and maximising energy efficiency opportunities.

In reality, we can assume that each individual's perspective would be somewhat broader, based on the willingness to cooperate and respect of other's expertise, knowledge and experience, as well as shaped by previous experiences of collaborating on projects across departmental and disciplinary boundaries. The point of this example is, however, to illustrate that although the interests of the different individuals involved may well overlap (e.g. questions of access have social and environmental implications), each of them will come to the table with their preconceived knowledge and value-based priorities that constitute a type of framing, which is likely to impact on the decision-making process and final outcomes of the project. This can be observed directly in meetings during the early stages of projects, where differential framings manifest themselves in the use of differing specialised language and narratives. In successful collaborations, all actors involved gradually come to develop a shared 'frame for purpose' for the project at hand (e.g. the new library needs to meet a set of defined objectives), which incorporates a negotiated number of individual concerns and

objectives and becomes the accepted shared frame. In essence, framing is a truly social process that relates to the way individuals interact in social groups, what preconceived ideas and agendas they bring into a collaborative process, and to what extent they are able to respect and learn from the concerns of their collaborators. Hence paying attention to differing initial framings and the process of developing a shared frame is critical for effective collaboration and, ultimately, for achieving set goals in an efficient manner.

Our example, the construction of a new library, is a relatively straightforward project: a single, shared goal is easy to determine (e.g. building a new library in line with key organisational objectives), the project's beneficiaries can be identified (e.g. local community members, or particular socio-economically disadvantaged groups), financing arrangements can be made through existing budget planning processes, and relevant technical and other information can be obtained at reasonable cost. The scale of the project makes it manageable by a small group of involved decision-makers, and, all going well, it is likely the project can be completed in a relatively short time frame.

Responding to the future impacts of climate change, however, is a project with much larger spatial and time dimensions, and one that is substantially more complex. A highly cross-disciplinary endeavour, climate change adaptation requires the involvement of an immensely diverse set of people – scientific and other type of experts, elected politicians, community leaders, business owners and residents – many of whom will wear more than one 'hat' throughout the process. In addition, adaptation is in many ways a new challenge for individuals and organisations. Such 'emerging organisation contexts' (Bouwen, 1998) require collaborative cross-disciplinary efforts across research, policy and practice. The large number of diverse actors involved makes it very likely that several differing interpretations of the meaning and purpose of 'the adaptation project' co-exist, and arriving at a common framing is not straightforward.

To start with, a farmer, an urban planner, a climate change scientist, and a local journalist are likely to have fundamentally different views about what climate change is; if and why it is happening; and what role adaptation plays in responding to climate change. Likewise, at an operational level views about what the goals of adaptation are or should be, and how adaptation can be facilitated can be expected to differ across individuals, organisations and communities. Here, a shared understanding of underlying concepts, goals and objectives as well as knowledge and acceptance of appropriate methodologies is essential for achieving tangible adaptation outcomes.

Investigating differences in framing by different actors can therefore help understand how adaptation processes can be made more effective (Collins and Ison, 2009) and more time and resource efficient through a process of becoming cognisant of different framing and actively working towards a shared understanding of adaptation in any given context.

3.2 Processes of framing in adaptation policy and practice

As the above discussion has illustrated, adaptation framing occurs through social processes that take place at several levels, from the individual to the collective, drawing on 'multiple reservoirs of knowledge' (Vogel et al., 2007), values and experiences.

To refine our abstract understanding of framing processes in policy and practice contexts, three nested levels can be identified at which framing occurs (Table 2). Firstly, at a meta-level, public discourses on climate change adaptation are drawing on culturally distinct values and beliefs, such as considering the earth and its environment as worth protecting, or maintaining the view that no one, irrespective of social origin or geographic location, should suffer harm induced by climate change if it can be avoided. Framing of climate change adaptation using values and beliefs is often apparent in the mass media, where emotive narratives encapsulate, and reinstate, polarised perceptions of climate change culprits and climate change victims, of global cartels of climate change science and armies of climate change sceptics. Values and questions of power are apparent in all of these framings, and they transpire to, and influence, research, policy development and decision-making at

various scales. As indicated in the introduction, questions of meta-narratives and meta-level framing are not the focus of this document⁸.

Secondly, adaptation framing occurs at the conceptual level, which is largely manifest in theorisations on adaptation processes and outcomes, and in the definition of abstract scientific concepts. Abstract concepts, such as hazard, risk, vulnerability, and resilience are commonly used in research, from where they emerge to guide policy development and adaptation practice. Defining the meaning of these terms in the context of climate change constitutes an important framing process that enables actors involved in adaptation to establish shared goals and meaning.

Thirdly, conceptual-level framings heavily influence the ‘operational’ level of adaptation practice, where decisions are made and actions are taken, embedded in distinct framings. At an operational level, framings are articulated in written and spoken language, for example, in policy documents, public debates, internal meetings, and consultancy reports. For example, a local government may decide to carry out an assessment of expected local climate change impacts that is guided by an understanding, defined one way or another, of notions of risk.

Table 2: Three levels of adaptation framing

| Levels of framing | Determining process of framing | Example |
|-------------------|---|---|
| Meta | Referring to value and belief systems | The value that people are entitled to certain human rights and should not suffer unnecessary harm |
| Conceptual | Theorisation | Defining what vulnerability means in the context of climate change |
| Operational | Day-to-day implementation and decision-making | Applying a certain understanding of vulnerability to the assessment of climate change impacts |

Source: Authors.

At all three levels, the frames that guide climate change adaptation can be explicit, i.e. openly discussed as part of policy or program design, or they can be subconsciously represented without ever being reflected on or discussed. Due to the nature of framing as a social process discussed above, such implicit framing is common and manifests itself by:

- How adaptation is referred to (e.g. as ‘problem’, ‘challenge’, ‘opportunity’, or ‘process for increasing capacity’),
- Who is expected and permitted to make qualifying statements about adaptation (e.g. politicians, government staff, scientists, local residents),
- What questions are considered relevant and important (e.g. ‘what are the key climate change impacts?’; ‘how certain is climate change?’; ‘who and what is going to be affected by climate change?’; or ‘who or what assets do we want to protect?’), and
- The range of answers considered appropriate (e.g. depending on underpinning values, professional traditions, and political risk involved).

(modified from de Boer et al., 2010)

These rather contentious questions expose that adaptation framing, like all framing processes, is highly political and closely associated with questions of values and power. Who ‘drives’ the

⁸ This aspect of framing, however, is central to work package four (WP4) of the Framing Adaptation project, which investigates local narratives of climate change adaptation. Research outputs from WP4 will be incorporated into the adaptation roadmap.

adaptation agenda, in which direction, and who gets to decide which approach to adaptation planning will be used are to a large extent dependent on the values that dominate among powerful decision-makers. For example, in the context of government decision-making in democratic systems, a powerful driver for framing adaptation in a particular way may be concerns of politicians regarding how well value-based adaptation goals resonate with the electorate and political agendas, whether they can generate sufficient public concern, and if they are considered to require urgent action. If policy options are framed in ways that are not supported by the public and political leaders, they may be dropped altogether from policy debates and decision-making processes (Vogel et al., 2007). This is in line with the observation that successfully tackling any ‘wicked problem’ requires engaging the public in value-based debates that lead to behaviour change, and that ‘government cannot simply “deliver” key policy outcomes to a disengaged, passive public’ (Australian Government, 2007: 31).

Because adaptation framing is embedded in, and part of, social and political processes, the decision about which frame(s) to promote throughout an adaptation planning process is influential, since it has the potential to pre-determine certain ‘adaptation pathways’ or even adaptation outcomes, some of which may prove to be ‘maladaptations’ (Barnett and O’Neill, 2010). This is because choosing – explicitly or not – a framing for adaptation comes with an opportunity cost, i.e. a particular framing may elicit knowledge on some climate change impacts and adaptation options while concealing or suppressing others, including adaptation measures that could be equally (or more) effective (Vogel et al., 2007, Barnett and O’Neill, 2010). For these reasons, it is critical that actors involved in adaptation planning and decision-making processes are enabled to reflect on preconceived framings and engage in the development of a shared framing for climate change adaptation, including any implicit framing inherent in the choice of particular approaches and methods for climate change adaptation (de Boer et al., 2010).

In the following we examine processes and determinants of conceptual and operational framing in further detail.

3.3 Conceptual framing

A key aspect to making adaptation framing explicit is to discuss and validate the theories, concepts and approaches used in a particular local context. Lack of clarity on underlying theories and concepts constitutes a common and frequently overlooked form of divergent framing.

A common conceptual problem in framing adaptation lies in the inconsistent use of abstract epistemological terms, such as ‘concept’, ‘approach’, ‘framework’, and ‘method’. Although it is often assumed that shared understanding on the meaning of these terms is a given, discussions with various government agencies has shown that such agreement rarely exists (Fünfgeld et al., 2011). In section 1.3, we defined how we use these terms throughout this document, to avoid confusion and minimise inadvertent framing. Similarly, we argue that all adaptation initiatives can benefit from clarifying the use of such terms, e.g. by agreeing on a set terminology at the outset of an adaptation project or at the beginning of a policy document.

Table 3 suggest a distinctive list of common framing elements used in the context of adaptation, as one of many ways for dealing with the complexity inherent in adaptation framing. The table is by no means intended to be prescriptive but rather included here as an example of how different framing elements can be distinguished by way of explicit and purposeful definition from the outset of an adaptation planning process.

Table 3: Common elements of conceptual framing in adaptation policy and practice

| Type of framing | Framing element | Purpose in the context of adaptation | Implicit / explicit use in policy and practice | Examples |
|--|-------------------------|---|---|--|
| <p>Conceptual Abstract Guidance</p> <p>Practical Technical Instruction</p> | <p><i>Concept</i></p> | To define a constituent component of climate change adaptation | Mostly implicit | <ul style="list-style-type: none"> • Climatic hazard • Social vulnerability • Biophysical vulnerability • Exposure • Sensitivity • Risk |
| | <p><i>Policy</i></p> | To set out legally binding, verifiable adaptation goals and priorities and guide implementation | Explicit | <ul style="list-style-type: none"> • Victorian Climate Change Act 2010 |
| | <p><i>Strategy</i></p> | To give broad direction on organisational objectives and priorities for adaptation | Implicit or explicit | <ul style="list-style-type: none"> • Victorian Climate Change White Paper 2010 |
| | <p><i>Approach</i></p> | To give broad direction to an adaptation planning process, underpinned by selected concepts | Mostly implicit, sometimes explicit but often lack of deep shared understanding across stakeholders | <ul style="list-style-type: none"> • Capacity-building approach • Hazards approach • Vulnerability approach • Ethnographic approach • Risk management • Social learning approach |
| | <p><i>Framework</i></p> | To operationalise adaptation policy; to provide process guidance for adaptation | Mostly explicit | <ul style="list-style-type: none"> • Risk management standard (Standards Australia, 2009) • UNDP Adaptation Policy Frameworks (Lim and Spanger-Siegfried, 2005) |
| | <p><i>Method</i></p> | To provide technical, step-by-step guidance following a particular assessment process | Mostly explicit | <ul style="list-style-type: none"> • Climate impact assessment (Carter et al., 1994, Parry and Carter, 1998) • Vulnerability assessment • Climate risk assessment |

Source: Authors and as cited.

It is important to understand the relationship between the various framing elements. Concepts like vulnerability, exposure and risk and their various definitions are used for different framings of climate change adaptation. They are, however, abstract conceptualisations of complex socio-ecological processes, and hence they often do not lend themselves easily to application in adaptation planning and decision-making. In order to make a theoretical concept such as vulnerability relevant to adaptation practice, it needs to be 'translated' and embedded into adaptation policy, strategy, or an adaptation approach. This process of translating scientific concepts into practical applications is a decisive step in adaptation framing, and one that is often overlooked. Using the example of vulnerability, Nelson et al. (2010) reflect on this process, arguing that there is an important difference between the definition of a theoretical concept and its application in a conceptual framework for decision-making:

'Definitions describe the components of vulnerability, such as exposure, sensitivity and adaptive capacity, whereas conceptual frameworks give meaning to the emergent properties of these concepts so that they can be analysed in ways that are objective and repeatable.'

(Nelson et al., 2010: 11)

3.4 Operational framing

At the scale of local and regional adaptation, these reflections on framing point us to the likelihood that what may be perceived as one shared discourse on 'climate change adaptation' may actually be underpinned by different understandings, misunderstandings and different unspoken assumptions held by the stakeholders involved. Seeing that there is no straightforward and broadly accepted definition of what constitutes 'adaptation', the framing of adaptation can be expected to differ significantly among stakeholders and across different local contexts. If groups of adaptation actors (researchers, government, civil society organisations, households, individuals etc.) persistently lack a shared understanding of what constitutes climate change adaptation, this can lead to inefficiencies in adaptation planning processes, as people talk unknowingly at cross-purposes, in discussions that evolve along existing value dispositions, where biases based on personal beliefs, fiercely held assumptions, political affiliations or professional interests can remain unchallenged. Such discussions tend to be unconstructive and often preclude identifying effective avenues and measures for local adaptation.

Establishing a consistent, widely-accepted operational-level framing for adaptation that is grounded in a shared understanding of theoretical concepts should be considered a critical task during the early stages of adaptation processes. Such purposeful framing will need to be guided by participatory processes of social learning that are able to generate context-specific interpretations of adaptation, its goals and the most suitable approaches to be used, which can then be the basis for effective and empowering 'situated decision-making' (de Boer et al., 2010).

The VCCCAR Framing Adaptation project focuses to a large extent on investigating questions regarding the 'operational framing' of adaptation, acknowledging that developing and implementing local response measures that address climate change impacts necessarily is a highly context-specific process that requires taking local circumstances into account (McEvoy et al., 2010). There is no single template for adaptation planning that can be guaranteed to work for all constituencies. At an operational level, local adaptation needs to be tackled in locally appropriate ways that takes account of the intricacies of the local system under consideration, i.e. the socio-economic, political and environmental context.

The authors contend that an investigation of common ways of framing climate change adaptation by unravelling underlying theories, concepts and approaches, including their proliferation through professional traditions and sectoral approaches, can inform and improve collaborative processes for climate change adaptation. We consider better practical guidance on how to 'make sense' of adaptation critical in order to enable systems and their constituting components (ultimately people and organisations) to adapt effectively, with tangible outcomes. Discussions with local government

actors in Victoria have shown that many councils embark on a climate change assessment process (often a risk assessment) prior to having a clear understanding what it is they expect their adaptation planning process will achieve, which different framings regarding climate change adaptation exist within their stakeholder group, and where major information, capacity and resource gaps are. Such a lack of clarity around the localised meaning and purpose of adaptation makes it very difficult to identify suitable adaptation measures that deliver real outcomes to the community.

Ultimately, developing an explicit framing for adaptation at an operational level (e.g. for local or regional adaptation planning) is as much about the journey as it is about the outcome (i.e. a workable framework for adaptation planning). Framing takes place as a continuous process that facilitates social learning among the actors involved (Bouwen and Taillieu, 2004), including building trust and opportunities for self-reflection and for acknowledging non-explicit assumptions and subjective value-based judgement (Pahl-Wostl, 2002). Since social learning is continuous and ever-evolving, frames can never be static but are subject to dynamic and ongoing modification by all actors involved. In fact, successful social learning will result in a constant re-framing of issues, as stakeholder garner additional information and as the local context continues to change.

In practical terms, adaptation frames can be revealed by posing reflective questions at different stages of an adaptation initiative, which reveal open or hidden framing differences held by the stakeholders involved. Table 4 lists a number of challenges and inherent uncertainties that are typical for the early stages of climate change adaptation processes, and proposes questions that can be asked to reveal underlying adaptation framing.

Table 4: Common adaptation challenges relating to operational framing at the local level

| | Common challenges | Operational framing questions | Inherent uncertainties | Examples |
|-------------------|---|--|---|---|
| Preparatory stage | Developing a robust business case for adaptation | <p>What is climate change?</p> <p>What does climate change mean for our municipality?</p> <p>Do we need to act?</p> | <p>Uncertainty regarding the causal link between global climate change and local impacts</p> <p>Uncertainty of climate model data</p> <p>Uncertainty about political future of organisations/actors/plans</p> | <ul style="list-style-type: none"> • Disbelief in climate change science • Different levels of knowledge on climate change science • Reluctance to trust modelled climate data and reliance on observations • Confusion about climate variability and climate change • Lack of understanding about relationship between average climate parameters (temperature, precipitation) and their extremes • Difficulty in committing to plan now for far-off climatic events • Lack of buy-in due to trade off (e.g. short-term costs versus long-term resilience of built assets to climate hazards). |
| | Obtaining buy-in from key actors | <p>Who is most at risk from climate change impacts?</p> <p>Which assets are most at risk from climate change impacts?</p> | <p>Uncertainty about levels of risk</p> | <ul style="list-style-type: none"> • Disagreement of weighting of financial and economic assets versus intangible assets (community, culture, social cohesion) • ‘Siloed’ sectoral appraisal of assets at risk lacking holistic perspective |
| Planning stage | Facilitating effective collaboration on adaptation planning | <p>What is our responsibility to adapt to climate change?</p> <p>What do we value and seek to protect?</p> <p>Who will bear the cost of adaptation?</p> | <p>Uncertain policy context (e.g. sharing of responsibility)</p> <p>Uncertainty about legal/statutory responsibilities</p> <p>Financial uncertainty (e.g. regarding ongoing maintenance costs)</p> | <ul style="list-style-type: none"> • Different views regarding legitimate thresholds and triggers for adaptation action (disasters, policy triggers, economic incentives) • Disagreement on how responsibility for climate change adaptation should be shared across levels of government • Questioning who should pay for, and who will benefit from, adaptation • Questioning the need for local action in absence of agreed national strategies and goals • Concerns about legal liability of action / inaction • Agreeing on accepting potential trade-offs, including agreeing on whether to maintain the status quo through protecting the most vulnerable system elements or whether to consider what to sacrifice |
| | Agreeing on adaptation goal(s) | <p>Who should be involved in planning for adaptation?</p> <p>What time frame should we use for adaptation planning?</p> <p>What spatial boundaries are best applied to adaptation planning?</p> | <p>Uncertainty about adequate time frames</p> <p>Uncertainty about the stability of governance regimes</p> | <ul style="list-style-type: none"> • Lack of confidence on spatial boundaries for actions (e.g. local government area, catchments, landscape-based regional management) • Lack of experience in effective cross-departmental, collaborative planning • Discrepancy between short-term political cycles and long-term planning for adaptation • Institutional and systemic barriers to adaptive management, adaptive governance, multidisciplinary approaches, and decentralised decision making |
| | Prioritising areas for adaptation action | | | |

Source: Authors.

4 Unpacking adaptation framing

In summary of the above discussion, the framing of local adaptation can be understood as a continuous process of social learning, where an explanation of the meaning of climate change adaptation is contextualised within a particular locality. Such meaning can be explored and unravelled by addressing a set of core framing questions, as outlined on the left in Figure 3.

Figure 3: What is the meaning of adaptation? Framing questions

| | |
|----------------------------|--|
| Adaptation to what? | <p>What climatic stressors exist?</p> <p>What non-climatic stressors exist?</p> <p>What local impacts are likely to result from these stressors (climatic and non-climatic, in what time frame)?</p> |
| Who or what adapts? | <p>What system(s) will need to adapt to climate change impacts?</p> <p>What system elements are at risk of climate change?</p> <p>What are the goals of adaptation?</p> |
| How does adaptation occur? | <p>What is the intended outcome of adaptation?</p> <p>What actors and organisations need to be involved in adaptation?</p> <p>What process will be followed to plan adaptation?</p> <p>What concrete adaptation measures will be taken, by whom?</p> |
| What is good adaptation? | <p>What can be deemed successful and efficient adaptation?</p> <p>How can the success of adaptation be measured?</p> <p>How can measures be adjusted to ensure robust adaptation outcomes?</p> |

Source: Adapted from Smit, Burton et al. (2000).

These framing questions can be disaggregated into subsets of questions that are directly relevant to planning and decision-making for climate change adaptation at an operational level (right column of Figure 3). In the following section, each of these lead questions and their operational counterparts are discussed in the context of local and regional planning and decision-making for adaptation.

4.1 Adaptation to what?

| | |
|---------------------|--|
| Adaptation to what? | <p>What climatic stressors exist?</p> <p>What non-climatic stressors exist?</p> <p>What local impacts are likely to result from these stressors (climatic and non-climatic, in what time frame)?</p> |
|---------------------|--|

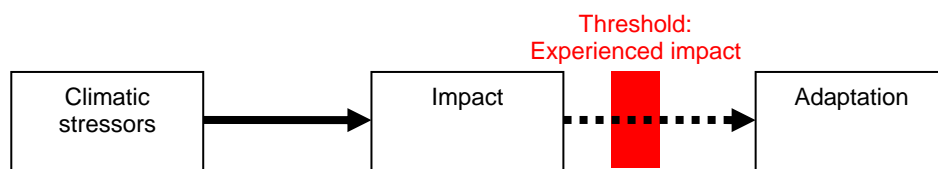
‘Adaptation to what’ refers to gaining a sound understanding as to which climatic stressors a system (or component thereof) needs to adapt to, and how these are projected to change under various climate change scenarios.

Understanding climatic stressors

At its core, planned adaptation is driven by knowledge on climatic and non-climatic stressors, which are expected or perceived to result in impacts on social, economic and ecological systems. It is usually not the presence of the stressor itself but the experience of its impacts, which are the trigger for adaptation. For example, an increase in average global temperature has led to, among other impacts, a rise in global mean sea level by an average of 1.7mm per year (± 0.5 mm) in the 20th century (Parry et al., 2007). According to the AR4, best estimates of global sea level rise for the 21st century range from 28 to 43cm, depending on the greenhouse gas emissions scenario used (*ibid.*). Regional sea level rise may be significantly higher than these projections, and recent Australian

studies project a mean sea level rise of up to 2m by 2100 (CSIRO and Bureau of Meteorology, 2009). While increasing sea level rise has been a known impact of climate change for some time, its consequences on coastal areas have only relatively recently been felt, for example in low-lying island states. In many coastal areas around the world, the currently experienced impacts of sea level rise are not yet considered to have passed a critical threshold that would trigger adaptation planning at the local level (Figure 4). Importantly, this threshold is fluid and differs between individuals, organisations and social groups. Scientific data on the anticipated severity of the impact is only one factor that defines the threshold. More importantly are context-specific factors such as the perception of risk, social norms, and behavioural dimensions, all of which are grounded in an array of individual and collective values. Values in turn underpin the political discourse around climate change adaptation and ultimately determine political will.

Figure 4: Adaptation as response to climatic stressors



Source: Authors.

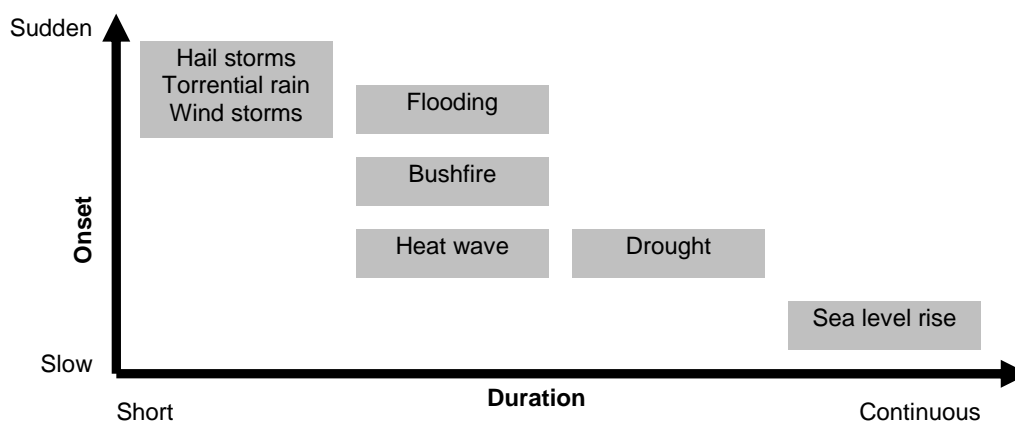
Understanding direct and indirect impacts

Climatic stressors can have a direct or indirect impact on systems (sometimes referred to as ‘primary’ and ‘secondary’ impacts). For example, changing precipitation patterns can directly result in more frequent flash flooding, accelerated soil erosion or destabilisation of riverbanks. Indirectly, they can lead to the disruption of ecosystem services (e.g. flooding of agricultural land) or human processes (e.g. the breakdown of transport infrastructure due to flooding). Similarly, an increase in extreme summer temperatures will manifest itself in more frequent and prolonged summer heatwaves, which may lead to significant indirect impacts on human health/comfort, vegetation, and critical infrastructure such as energy and transport systems (Queensland University of Technology, 2010). Concurrent climatic stressors can have a cascading, compounding effect, as seen in the 2009 Victorian bushfires, where a period of prolonged drought coincided with extreme heat and strong winds, led to widespread damage to infrastructure, natural environment and human health, including the loss of lives (*ibid.*).

Sudden versus slow onset impacts

Climatic impacts can also be distinguished between by those that happen suddenly, such as extreme atmospheric events or consequences thereof, and slow-onset impacts that follow a pattern of gradual change (Figure 5). In the context of adaptation framing, gaining a better understanding of the specific onset and duration of climatic impacts can help clarify the type of adaptation response necessary, as well as point towards the most adequate planning process. For sudden, short-term events such as storms and flooding, adaptation efforts may need to focus on improved disaster prevention, establishing early warning systems, and effective disaster response. For slow-onset, continuous impacts such as sea-level rise, however, strategic forward planning is critical, and existing planning instruments such as land use planning may need to be altered to take gradual changes in climatic stressors into account. Clarification of the onset of impacts is useful at the beginning of an adaptation process, mainly because it helps focus adaptation goal setting and prioritisation activities.

Figure 5: Typical onset and duration of climatic impacts



Source: Authors.

Recognising the role of non-climatic stressors

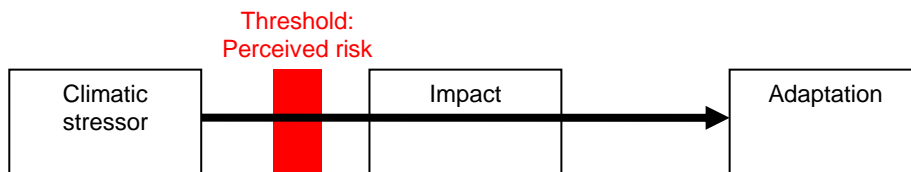
Yet another dimension to consider in adaptation framing is the transformation of climatic stressors into actual impacts influenced by human agency, technology and infrastructure. Using the example of the Victorian bushfires 2009, five out of eleven fires that began on ‘Black Saturday’ (7 February 2009) were caused by electricity infrastructure failing in temperatures over 46 degrees Celsius, combined with strong wind (Parliament of Victoria, 2010). Also, the impact of wind storms is often felt more intensely in high-density urban areas, where tall buildings create corridors that accelerate wind speed, which in turn can cause impacts (damages) that would not have occurred in areas with low-density housing. Similarly, ongoing drought can cause scarcity of drinking water, irrigation water and water for industrial use. This in turn can impact on electricity supply, for example when water used for cooling of power generators becomes scarce. Not only is the severity of impacts to a large extent defined by human agency; man-made hazards such as petrochemical spills, nuclear accidents, leakage from industrial waste etc. can be triggered or exacerbated by climatic hazards. Coastal flooding as a result of storm surges, for example, can lead to petrochemical spills in refineries, which are typically located on the coast, in proximity to ports infrastructure.

These examples show that climatic stressors do not occur in isolation of societal processes. In some situations, broader socio-economic processes may exhibit a range of significant stressors that can compound or alleviate indirect climatic impacts. For example, a national economy going through an economic crisis, with high rates of unemployment, high inflation and contracting economic output, can be assumed to suffer more prolonged economic consequences from a major natural disaster, such as a tropical cyclone, as recovery mechanisms are weakened by structural economic instability affecting all levels of society.

Capturing perceptions of risk

In the context of differing time scales, when dealing with ‘planned’ adaptation it is also important to consider the notion of risk and its perception in human systems: it is not only observed changes in climatic conditions that are likely to trigger adaptation action but also the perceived risk posed by a long-term trend, a projected gradual change in climatic conditions, or an expected future extreme event (Figure 6). Risk perception affects the threshold for adaptive action and may lead to immediate preventative or adaptive action, even though no impact has occurred. Although existing methods for dealing with climate risk will be discussed in section 5.1.3, the notion of risk perception and climate change is a complex issue in itself and falls outside the focus of this particular paper. A large body of literature on this topic exists for the reader to refer to (e.g. Kaspersen et al., 1988, Slovic, 2000, Pidgeon et al., 2003, Kaspersen and Kaspersen, 2005).

Figure 6: Adaptation as response to climatic risks



Source: Authors.

Table 5: Overview of climatic stressors and key impacts for Australia

| Climatic stressor | | Direct impacts | Selected indirect impacts | Onset | Duration |
|-------------------|---|-----------------|---|----------------|---------------------|
| Temperature | Average temperature increase <ul style="list-style-type: none"> • Increase in atmospheric circulation • Increased melting of polar ice • Thermal expansion of sea water • Reduction in frost periods and snow cover | Wind storms | Coastal storm damage due to tropical storms | Sudden | Short |
| | | | Storm damage to built environment and habitats | Sudden | Short |
| | | Sea level rise | Coastal inundation | Slow | Continuous |
| | | | Coastal erosion | Sudden or slow | Continuous |
| | | Heat waves | Heat stress | Sudden | Short |
| | Increase in extreme temperatures | Bushfires | Fire damage to built environment and habitats | Sudden | Short |
| Precipitation | Average precipitation decrease / increase* | Droughts | Drinking water scarcity | Slow | Short to continuous |
| | | | Irrigation water scarcity | Slow | Short to continuous |
| | | | Reduced environmental flows | Slow | Short to continuous |
| | | Torrential rain | Flood damage to built environment and property | Sudden | Short |
| | Increase in extreme precipitation | Hailstorms | Damage to build environment and physical assets | Sudden | Short |
| | | Thunderstorms | Fire damage | Sudden | Short |

* Most but not all parts of Australia are expected to experience a decrease in rainfall.

Sources: Based on CSIRO (2007), CSIRO and Bureau of Meteorology (2009).

4.2 Who or what adapts?

Who or what adapts?

What system(s) will need to adapt to climate change impacts?
What system elements are at risk of climate change?
What are the goals of adaptation?

As discussed above, examining what we are adapting to involves understanding how particular climatic and non-climatic stressors are likely to impact on social and ecological systems, in a particular place and over a given period of time. Gaining greater clarity on stressors and their expected impacts, however, is closely tied with understanding the object of adaptation: Who or what needs to adapt to identified climate change impacts? Which parts of community, of an ecosystem, or the built environment are most at risk of suffering the climate change impacts we have identified?

Defining systems as the objects of adaptation

These questions call for defining the nature of the system within which adaptation is going to occur. For example, are we looking at a natural ecosystem such as a coral reef structure, a primary forest, or a manufactured system such as an urban ecosystem? Or is the focus a human system, e.g. a local economy, a regional emergency management system, or a state-wide system of social services? In the case of strategic local adaptation planning, the 'object' of the adaptation planning efforts is often described as a coupled socio-ecological system, i.e. the complex system that makes up a particular municipality or region, consisting of interacting and closely connected natural and human systems and sub-systems thereof (e.g. the local agriculture sector as a sub-system of the local economic system, which is closely tied to local ecosystems) and the elements within these systems that are at risk from climatic impacts. Without defining system boundaries, its elements at risk, which includes 'things' as well as people, it will be difficult to define adaptation outcomes that are supported by stakeholders, risking the failing of entire adaptation processes (Jones and Preston, 2011).

Framing systems as the object in which adaptation is going to occur involves describing all elements at risk of climate change impacts within the system as accurately as possible, including how they are likely to be affected by climate change. Systems differ in aspects such as their constituent components, their organising principles and the degree of dynamism. For example, a local public health care system may be described as 'vulnerable' to the climate change impact of heat waves due to the large proportion of elderly people with limited mobility; urban parks, gardens and green space corridors may be described as a system with limited adaptive capacity to a reduction in average rainfall and more frequent extreme temperatures, and so on.

Drawing boundaries around the system being investigated and describing the system's elements at risk will point to local drivers for adaptation by framing climate change stressors and their impacts in relation to a local context: a number of public and private buildings in a coastal low-lying town are considered vulnerable to sea-level rise; a light rail network in an inner-city area is highly sensitive to temperature extremes, a wildlife park on the urban fringe is prone to be affected by bushfires and smoke, elderly people are likely to be most affected by heat waves etc.⁹ Identifying and describing the elements most at risk may also include finding evidence on what autonomous adaptation the system is capable of, and how autonomous adaptation can best be supported.

Clarifying roles and responsibilities for adaptation actors

Scoping out the system under consideration also raises the question of which actors are or should be involved in adaptation processes. 'Actors' can refer to individuals or groups of people, to people actively undertaking adaptive action as well as to groups passively benefiting from adaptation

⁹ Typical terms used to describe a system's characteristics are summarised in Smit, Burton et al. 2000: 238.

actions. Identifying obvious as well as less apparent actors as part of adaptation framing is critical for establishing a link between research, policy and practice: without it, adaptation planning runs the risk of remaining theoretical and removed from real life situations.

Gaining a good understanding of adaptation actors and their responsibilities also includes considering what respective roles public and private actors should play. As discussed in section 2, the benefits derived from adaptation actions are immediately available at the location of the investment, as opposed to climate change mitigation, which results in collective benefits that may seem less tangible to individual actors. The immediacy of adaptation benefits may lead policy-makers to the assumption that the private sector and market-based approaches are best suited to facilitate effective adaptation. However, relying solely on private actors for achieving effective adaptation is difficult for a number of reasons, as outlined in Table 6:

Table 6: Barriers to market-based adaptation

| Barrier | Example |
|---|--|
| Uncertainty about climate change impacts affects the assessment of expected climate-related damages and the benefits of adaptation | Cost-benefit assessment results are inconclusive regarding financial and non-financial costs and benefits |
| Individual resource constraints in understanding the nature of impacts on a system require collective action | High cost of developing climate change projections |
| Effective adaptation through market-based processes may be limited for non-traded public assets and goods | Supporting adaptation of biodiversity and jointly consumed ecosystem services |
| Resource constraints regarding implementing adaptation actions, as much adaptation will draw on resources not held by the adapting actors themselves | Local adaptation action plans not being implemented due to resource constraints |
| Adaptation benefits may spill over to beneficiaries other than the actor making the change, which is as a systemic disincentive for private adaptation investment | Reducing agricultural water use from a pooled water resource increases water availability for other actors |
| Individual adaptation action may dislocate climate-related impacts onto other stakeholders unable to take action themselves and put them at increased risk | Protecting a coastal property from erosion by hard infrastructure may dislocate coastal erosion impact to neighbouring properties |
| Some climate change impacts require collective adaptive action in order to be effective but high costs and uncertainty prevent timely private action | A whole-of-catchment approach to reducing water runoff can have a significant effect on flood prevention whereas the effect of action by individual property owners may be limited |
| Climate change impacts are distributed unequally across space and social groups, leading to inequalities that markets and private action are unlikely to address sufficiently without regulatory intervention | Low income groups may suffer disproportionately from an increase in food prices following extreme events (e.g. storms, hail, flooding) |
| Focus on one small part of a system can lead to maladaptation in other parts or systems | Increased use of pesticides to combat an increase in vector-borne diseases may lead to adverse environmental effects |
| Institutional barriers need to be removed before individual action can take place | Unclear governance arrangements over responsibilities for climate change adaptation prevent private action |

Source: Expanded from Aaheim, Berkhout et al. (2008)

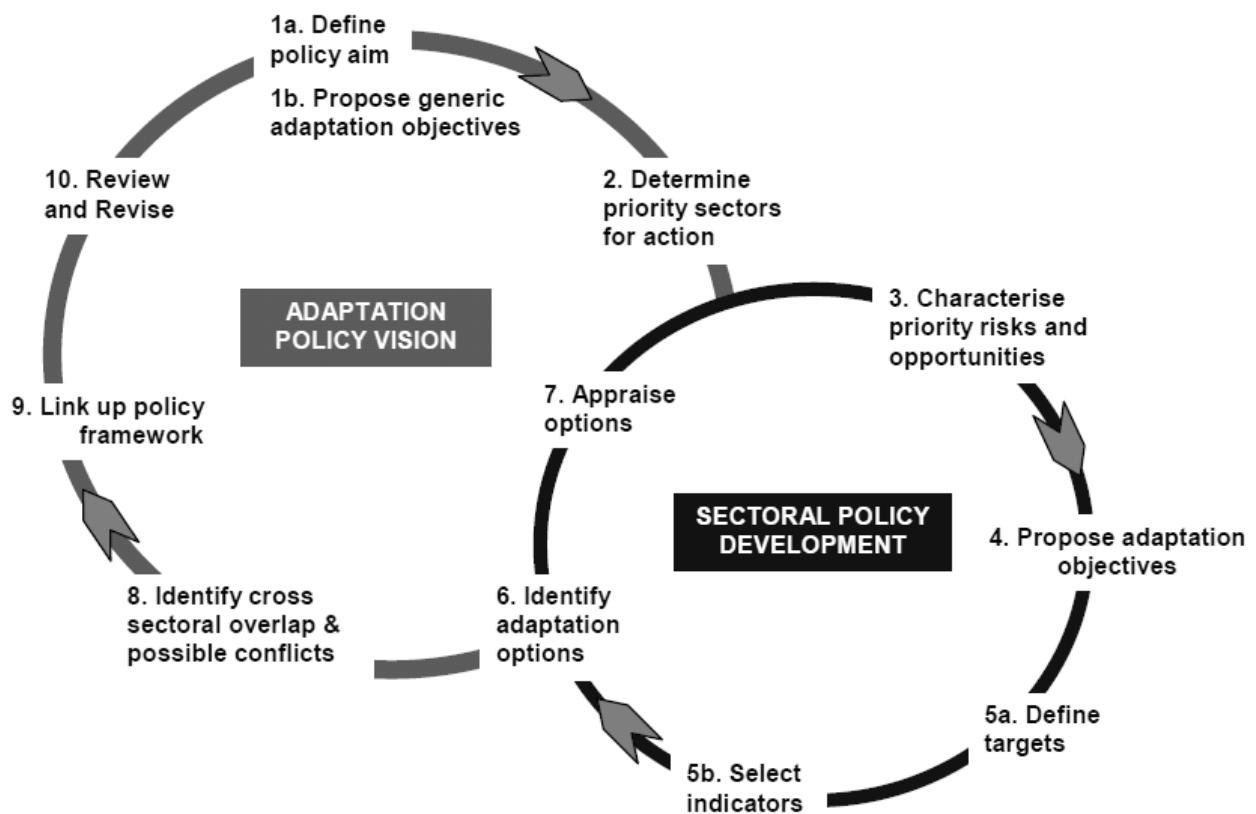
Due to these shortcomings of market processes, governments play a critical role in regulating effective adaptation and closing gaps left by markets. To facilitate adaptation, governments can provide information on climate change impacts to vulnerable groups and assist with disaster relief. Public policy can also provide incentives for adaptation and compensate for the unequal distribution of climate impacts and spillovers, as well as correct through regulatory action existing policies and

practices that have proven to be maladaptive. Moreover, government policies can facilitate mainstreaming climate change adaptation across sectors and plan and regulate long-term investment in infrastructure to ensure future vulnerabilities are reduced.

Setting goals for adaptation

Setting high level aims and subordinate objectives for climate change adaptation needs to be an iterative process so that emerging information on climate change impacts, policy context and stakeholders can be incorporated at regular intervals. Like all goal statements, adaptation objectives need to be achievable and time-bound to be able to effectively drive adaptation processes. However, the definition of aims and objectives needs to take place iteratively, to be able to accommodate changing climatic or local context parameters. While broad visioning and goal setting is needed at the adaptation policy level (e.g. at the level of state government), more detailed, involved sectoral planning is needed to specify sectoral adaptation objectives, define concrete targets and a set of indicators, prior to identifying, implementing and evaluating adaptation options. Figure 7 illustrates how such sectoral planning could interlock with an overarching adaptation policy development process.

Figure 7: Generic process for adaptation policy setting



Source: Horrocks (2007).

Adaptation objectives also need to strike a delicate balance between providing clear guidance on the one hand and allowing for a certain degree of flexibility on the other. Some of the flexibility needed can be offset by revisiting objectives statements more frequently, although this may prove difficult under the constraints of established financial and political processes.

4.3 How does adaptation occur?

How does adaptation occur?

What actors and organisations need to be involved in adaptation?
What process will be followed to plan climate change adaptation?
What concrete adaptation measures will be taken, by whom?

Developing a shared understanding of current and future climatic stressors and their impacts, which ones are critical to a particular location, and what elements of a chosen system are at risk are essential starting points for adaptation processes that are workable at local and regional scale. Even though it may be impossible to achieve a truly shared framing on adaptation (de Boer et al., 2010), making different views explicit paves the way for a discussion about the goals of adaptation and the processes to be used to achieve these goals, including a process for developing a suite of adaptation measures that respond to climate-related impacts in alignment with local needs and capacities.

Arguably, the question of how adaptation is going to occur is the one most critical and contentious for local and regional scale adaptation, as it connects reflections on the purpose of adaptation with decisions on the methodology to be used. For discussing the ‘how-to’ aspect of climate change adaptation, it is useful to note that the term ‘adaptation’ can refer to the process of adapting as well as to the condition of being adapted (Smit et al., 1999). Adaptation as a process can take place through various activities, leading to different types of ‘adaptation outcomes’, and clarity is needed about the intended outcomes as well as the methods, tools and processes used for achieving them. For the purposes of reflecting on different ways of framing adaptation, it is useful to briefly examine these two uses of the term in more detail.

Framing adaptation as an outcome

At the level of international climate negotiations, adaptation is often referred to as a necessary result of dealing with the negative impacts of climate change. This view follows the argument that adaptation is a critical aspect of responding to climate change, because a certain degree of global climate change can no longer be avoided. The amount of adaptation needed, however, will depend on the success of climate change mitigation efforts. Adaptation is framed as an outcome, thereby providing a central argument in negotiations on climate change mitigation, as it emphasises questions of what a desired state of ‘being adapted’ would look like, what degree of adaptation is technologically possible, and who should be held legally responsible for the costs of adaptation. This outcome frame also relates to what has been described as the metaphor of adaptation ‘fitting into’ existing processes and systems (Collins and Ison, 2009), where adaptation is considered to be a known, predetermined addition to a given situation (e.g. incorporating climate change adaptation considerations into existing land use policies). Adaptation is primarily seen as yet another consideration in mostly linear planning and decision-making processes, which, if considered appropriately, will lead to a future state of being more adapted.

Outcome-frame adaptation is often strongly influenced by the need for evidence-based decision-making, which relies on ‘hard data’ generated by modelling climate change impacts, vulnerabilities and adaptive capacities. This ‘impact modelling and decision-analytical’ frame (Hinkel et al., 2010) has dominated research activity as well as some adaptation programs at the local and regional scale in Australia (e.g. HCCREMS, 2009). It is worth noting in this context in the past that decision-makers have tended to understand adaptation outcomes from the perspective of engineering or technological adaptation solutions. In recent years, however, interest in alternative, non-technological measures, such as spatial planning, financial and instruments and incentives for good adaptation practice, has increased (McEvoy et al., 2010).

In the context of local and regional adaptation, the outcome frame also pertains to questions of goal-setting as part of climate change adaptation processes (discussed in more detail below).

Envisaging what 'being adapted' would actually mean in a particular local context is a common and very useful step in the early stages of adaptation processes¹⁰, because it is often unclear what outcomes are being sought. Different actors may strive for different types of outcomes, such as minimising financial losses from climate change impacts versus building a more prosperous, more resilient community for future generations (Rickards, 2010, Adger et al., 2009).

This raises the question about who decides on the objectives for adaptation and about what 'desirable future' should be strived for through adaptation, and hence what adaptation measures will constitute good adaptation practice, pointing to the important role of values and power (O'Brien and Wolf, 2010) that are inherent in all decision-making processes.

While the outcome frame is useful for arguing the case for mitigation and can provide an impetus for agreeing on adaptation goals, its usefulness is limited in regard to working towards adaptation options and devising practical adaptation measures. Questions of 'how to' are usually addressed using conventional planning and technology that can be readily applied to climate change. Typically, technological adaptation options feature prominently in outcome-focused adaptation as measures to reduce or compensate the negative effects of climatic climate. Arguably, a focus on an outcome framing for adaptation is one of the reasons why infrastructure responses, such as building sea walls and flood barriers, are often the first port of call and sometimes favoured over alternative 'soft' adaptation options.

Applying an outcome frame emphasises a static, end-point vision of the future, where systems 'are fitted into' the future situation (Collins and Ison, 2009), which fundamentally contradicts the reality of continuous evolution and change. The validity of an outcome framing to adaptation lies in developing a better understanding of what different futures may look like, e.g. as part of scenario planning exercises.

Framing adaptation as a process

Adaptation framing which focuses on 'process' aspects tends to place greater emphasis on adapting to climate change impacts by adopting a systemic perspective, where changing the way a system operates through humankind's ability to learn and improve lies at the centre of attention. Such framing recognises that adaptation is a continuous process of interaction between human social systems and their environment, which is characterised by social learning and development (Collins and Ison, 2009).

A process framing of adaptation inevitably emphasises the role of people and institutions, their evolving capacity of effectively dealing with climate change impacts (commonly referred to as 'adaptive capacity'), and the role of non-technological adaptation measures.

As Hinkel et al. (2010) seem to suggest, using scientific climate change information for adaptation may be best suited to awareness raising and to adaptation planning at national and international levels. Using case study narratives from Europe and Southern Africa, they illustrate that scientific data was less important for adaptation planning and decision-making at the local scale. More important for local decision-making was an awareness of climate change impacts brought about by the direct experience of climatic shocks or trends, for example with regard to the European heat wave in 2003; which changed local risk perceptions and resulted in the development of local heat wave strategies in several countries. While this finding may depend on idiosyncrasies of the local culture in the case studies, it does alert policy and decision-makers elsewhere to the opportunity provided by multiple avenues that, depending on local context, may all lead to effective engagement in adaptation initiatives.

¹⁰ The project 'Building common understanding of scenario based strategies to inform climate change adaptation' funded by VCCCAR is exploring this aspect of adaptation planning. See: www.vcccar.org.au/content/pages/scenarios-climate-adaptation

While the downscaling of climate change models can certainly prove useful for decision-making, they can be complemented by more reflexive bottom-up approaches to adaptation planning, which acknowledge that effective adaptation needs to be deeply embedded in local knowledge and that adaptation is a continuous process of social learning requiring the participation of actors and institutions at various levels of decision-making (Hinkel et al., 2010). Framing climate change adaptation as a learning process is useful in providing answers to the question of how adaptation is going to occur at local level and therefore should be considered a vital component of any operational adaptation framework (*ibid.*). In embracing a process of institutional and individual learning for climate change adaptation, local decision-makers are enabled to explore a broad range of adaptation options that will become more sophisticated as their adaptive capacity increases.

Identifying different types of adaptation measures

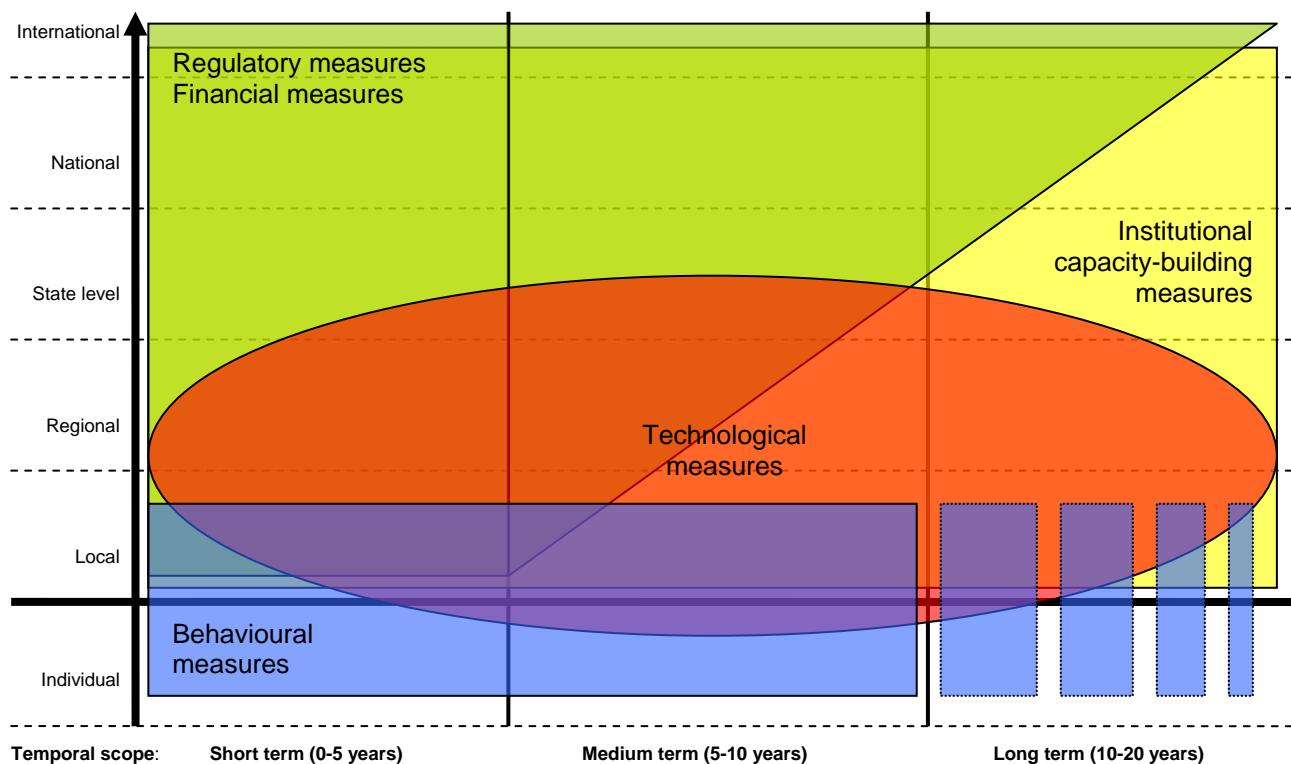
Decision-makers can come up with an infinite number of adaptation measures to achieve stated objectives, and the broad range of options available can often be overwhelming to practitioners. Different measures may have different temporal scopes (e.g. short-term versus long-term implementation), different spatial or administrative scope (e.g. local, regional or national), and they may be devised in reaction to an existing climate impact, during the occurrence of an impact, or in anticipation of an expected climate impact. Using these three dimensions of spatial scope, temporal scope and the timing of action in relation to an impact as descriptors, Figure 8 below provides a typology of possible climate change adaptation measures, which can help understand broad options available to policy developers and decision-makers. Five distinct categories of adaptation measures are proposed, namely behavioural measures, institutional capacity-building, technological measures, and financial and regulatory measures for adaptation (see the table below Figure 8 for local examples of adaptation). All of these measures can be implemented at different levels of government using a combination of policies, market-based and non-market based incentives.

The graph in illustrates that some of these measures can be useful adaptation actions at different spatial or administrative scales. Regulatory measures, for example, are most effective when they are coherent across all levels of government. Equally, financial incentives and other financial means of supporting adaptation can be instigated at all levels of government, including at international level, where negotiations on adaptation funding for developing countries has taken centre stage in recent UNFCCC discussions. Local governments, however, possess less agency in setting long-term regulatory environments, which is the domain of national and international agreements. Other types of adaptation measures, such as behavioural measures exclusively target individuals or organisations, thus focusing on the sphere outside the lowest level of government. While they are usually intended to lead to changes in the short and medium term, it can be expected that some measures will lead to sustained behavioural change. Technological adaptation predominantly resides on the local and regional scales, as these usually respond to particular, localised climate change impacts.

All types of adaptation measures can occur either reactively, concurrently or else in anticipation. However, planning to adapt to climate change by definition involves a focus on anticipatory adaptation. Also, any measures implemented with a medium to long-term view necessarily have to be anticipatory of future climate change impacts and broader socio-economic trends.

Figure 8 also highlights the central role that different levels of governance play in the process of adapting to climate change. The five types of measures form the pillars for integrated adaptation action across multiple levels of government, reaching into the community and the individual realms through participatory processes. In the long term, institutional transformation will be necessary in order to deal with the impacts of climate change, which can be achieved by providing institutions at all administrative scales with the opportunity and capability to learn and adapt, supported by adequate financial resources and better integrated multi-level policy and governance.

Figure 8: Typology of adaptation measures



| Type of adaptation measure | Local/regional examples |
|--|---|
| Behavioural | <ul style="list-style-type: none"> Awareness raising program on heat wave response Promoting a per capita water saving target to address increasing water scarcity Educating community members on making homes bushfire-proof Disseminating up-to-date information on extreme weather events via mass media |
| Institutional capacity-building | <ul style="list-style-type: none"> Local government staff training on climate change science Conducting scenario planning exercises Inviting community groups and local leaders to participate in adaptation planning processes Devising a local process for developing an adaptation plan Establishing a climate change working group in a local government Changing the organisational structure to increase the ability to respond to climate change |
| Technological | <ul style="list-style-type: none"> Building a sea wall as a response to sea level rise Retrofitting buildings to better protect from extreme heat Constructing a desalination plant to address water scarcity Improving the capacity of urban drainage systems |
| Financial | <ul style="list-style-type: none"> Bulk-buying schemes for domestic rain water tanks Transferring climate risks to insurance providers Provide funding for conducting local climate impact assessments |
| Regulatory | <ul style="list-style-type: none"> Committing to a 'native trees' policy for increasing the resilience of urban parks and gardens Mandating the development of heatwave response strategies Setting development controls in coastal hazard zones Amending planning schemes to take climate change impacts into account |

Source: Authors.

4.4 What is good adaptation?

What is good adaptation?

What can be deemed successful and efficient adaptation?
How can the success of adaptation be measured?
How can measures be adjusted to ensure robust adaptation outcomes?

Decision-making on local adaptation measures requires some form of qualitative or quantitative evaluation of the various adaptation options available. For each identified climate change impact, a range of options exist that could potentially be equally effective in combating negative climate change impacts, or alternatively, harnessing new opportunities. For example, to decrease the urban heat island effect in densely built up areas a combination of the following options may be found appropriate:

- Increasing shading of buildings and sealed surfaces, e.g. by planting trees
- Increasing evapotranspiration in the area, e.g. by converting sealed areas into green space and constructing water features etc.
- Ensuring better ventilation of the area, e.g. by creating corridors that enable cooler air flow into the area
- Rendering buildings in reflective colour to decrease heat absorption into thermal mass.

Each of these measures comes with an associated price tag, a specific minimum time line for implementation, and a series of secondary environmental and social effects that will inform public opinion and decision-making. Decision-makers, however, are expected and required to use evidence and best knowledge as the basis for decisions on adaptation measures.

Economic tools for assessing adaptation options

In the example of the heat island effect, adaptation metrics can be employed to assess cost-benefit ratios of the various options available *ex ante*, under current and projected climate change. In the context of mid-term to long-term adaptation and whenever non-technological adaptation is included in the equation, it is, however, far less straightforward to establish which adaptation options are most suitable, because many of the potential benefits may be unknown and lie in the future. While cost-benefit analysis can be a suitable tool for many technological adaptations (e.g. building or upgrading of infrastructure to protect from flooding), it has significant methodological limitations when it comes to measuring the expected costs and benefits of non-financial factors.

Ex post evaluation of adaptation measures is similarly difficult, in particular in terms of providing guidance for adaptation to future extreme events, which occur infrequently, at irregular intervals, but with potentially devastating impacts. Current extreme events may provide a significant trigger and incentive for adaptive action, which are likely to also reduce future vulnerabilities. It may be prove politically difficult, however, to justify and agree upon large-scale investment into costly adaptation measures for preventing future catastrophic impacts, in particular when an empirical evaluation of the suitability and effectiveness of measures already implemented cannot be ascertained within standard planning and political cycles because, for example, the infrequent occurrence of extreme events or the absence of an evidence base for the effectiveness of preventative measures.

This conundrum points to the limited suitability of cost-benefit analyses for guiding effective climate change adaptation at the local and regional levels. Cost-benefit analyses and similar economic tools need to be supplemented and informed by additional qualitative studies, for example exploratory research investigating past and present local practice of dealing with climate change. Such climate analogues can provide important contextual information on how socio-ecological systems are likely to respond to particular adaptation measures.

Furthermore, the limitations of applying a cost-benefit approach towards evaluating different adaptation options highlight the need for applying alternative metrics to the costing of climate change impacts that are able to accommodate non-financial costs and take into account contextual economic parameters¹¹. The shortcoming of economic assessment tools also reiterate that a focus on the process aspects of adaptation may provide a more flexible way forward in adaptation planning, rather than relying mainly on substantive adaptation outcomes that have been determined using conventional economically rational decision-making.

Avoiding maladaptation

Robust decision making for climate change adaptation also means ensuring that maximum precaution has been taken to avoid maladaptation, which refers to:

‘action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups’

(Barnett and O'Neill, 2010: 211)

In the absence of a large evidence base on what constitutes good adaptation, adaptation efforts should therefore at a minimum endeavour to avoid any ‘bad’ adaptations, including (*ibid.*):

- Measures that increase greenhouse gas emissions;
- Measures that disproportionately burden the most vulnerable social groups;
- Measures that come with high opportunity costs, i.e. high social, economic or environmental costs in comparison with alternatives;
- Measures that reduce the incentive for actors to adapt, e.g. by increasing the reliance of actors on others’ actions;
- Measures that create a path dependency, i.e. that adopt trajectories that are difficult to change in the future due to high costs involved in such change.

From a government perspective, such maladaptations do not only pose a risk of significant social, environmental and economic costs, they can also undermine the support and buy-in of key adaptation actors.

5 Examples of conceptual framing: adaptation approaches

In the previous section we have provided an overview of what we consider to be key issues in the context of adaptation framing. We have done this by focusing on a select series of questions that can help reveal hidden assumptions on the meaning of adaptation, on adaptation goals and expected outcomes, on pathways of how to achieve adaptation, and on what is considered to be good adaptation.

In adaptation policy and practice, the framing of climate change adaptation projects and planning processes is often implicit and manifests itself in unreflected decisions and choices, such as the way underlying theoretical concepts are used in arguing the business case for adaptation or in the choice of assessment approaches for climate change adaptation. In this section we examine a selected number of common approaches used in adaptation processes and unpack the conceptual framings inherent in these approaches. Reiterating the discussion of the previous chapters, we do this following the argument that greater clarity about various framings can help policy developers, decision-makers and practitioners develop adaptation processes which are best suited to a given context.

¹¹ A future Framing Adaptation project working paper will investigate the usefulness of cost-benefit analysis and alternative metrics for climate change adaptation in more detail.

5.1 Hazards approaches

In the emerging field of climate change adaptation, a focus on climate-related *hazards* provides a dominant backdrop for the ongoing scientific discussion about current and future climate change impacts and risks. Hazard research has also been one of the main disciplinary connectors between the climate change adaptation and disaster risk management communities. In the following we present an overview of key definitions underpinning hazards theory.

5.1.1 Evolution

Hazards research has always been closely associated with disaster risk management research. Four stages in the development of hazard theory can be discerned (Handmer, 2003, Füssel, 2007), all of which continue to co-exist and influence policy development in the present day:

- 1) Early conceptualisations of hazards (1950-60s onwards) were largely deterministic and based on economic rationalism thinking, where natural forces cause hazards to humans.
- 2) These gradually evolved into a technological approach in the 1960s, where the focus lay on engineering solutions to reduce the impact natural hazards have on communities.
- 3) In the 1970s, a human ecology approach emerged as an influential and sustained driver of hazards research, placing greater emphasis on human behaviour and perceptions of risk and hazards, and the role of human beings in creating or amplifying hazards.
- 4) Building on this notion of human agency, a political economy approach has gained momentum since the early 1990s, arguing that structural social inequalities, not nature or technology, creates hazards. As a result of this development, reducing vulnerability and sustainable development have become core objectives for disaster risk reduction.

This dynamic evolution of hazards research shows that the notion of contextual vulnerability (discussed in detail in section 6.3 below) has become a core concept in the hazards literature. Although all of the abovementioned strands of hazards theory continue to maintain relevance in local and regional planning, a greater focus on the root causes of vulnerability and disasters in hazards research has gradually moved into the realm of policy making, where it is increasingly acknowledged that strategies for dealing with hazards need to be embedded in a particular socio-economic context in order for them to be successful (Handmer, 2003). In Australia, the contextual nature of natural hazards has been particularly evident in relation to bushfires, and in the investigations and discussions about 'tree changers', bushfire prevention and evacuation procedures in the aftermath of the Black Saturday fires in Victoria in 2009 (Parliament of Victoria, 2010).

5.1.2 Definitions

The term 'hazard' has been used with different underpinning meanings across a number of fields. While the hazards research community has had a stronger focus on understanding sudden-onset hazard events, the climate change adaptation literature has tended to include gradual trends and emerging climate change impacts under the umbrella term of hazards (Romieu et al., 2010). In the climate change adaptation literature, 'climate change hazard' and 'climate change impact' have erroneously been used interchangeably. For actors involved with adaptation processes, it is crucial to understand the difference between natural hazards and the processes that lead to hazards having particular impacts. Natural hazards can be defined as 'threats to a system, comprised of perturbations and stress (and stressors), and the consequences they produce' (Turner et al., 2003). In this definition it is the consequences, or the impacts, that adaptation is trying to address.

5.1.3 Hazard frames in policy and practice

In adaptation policy and practice the 'natural disasters frame', where atmospheric and geological hazards cause natural disasters to humans, remains a strong underlying driver of planning and decision-making. This is reflected in the common view that more detailed modelling of climate change and its impacts is required in order to gain a better understanding of the frequency and intensity of future extreme weather events. Consequently, many decision-makers argue that short-term

adaptation response measures should focus on reducing the risk of harm resulting from extreme weather events. This approach is grounded in the need to protect assets and lives and hence is supported by considerable research efforts on behalf of the insurance industry.

Increasingly, however, the emergence of a trend similar to the gradual progression of hazards research and theory can be detected: while evidence-based decision-making on adaptation remains dominant across governmental and industry organisations, a move towards understanding adaptation as a process for development and vulnerability reduction is gaining momentum, in particular in international development. In industrialised countries such as Australia, some local and regional level governments have begun to adopt broader, contextual notions of climatic hazards, where climate impacts and risks are placed in context with other socio-economic and environmental trends, such as peak oil and demographic change (Sunshine Coast Regional Council, 2010, Gold Coast City Council, 2009).

It is noteworthy that in recent years there has been a convergence and mutual acknowledgement between the disaster risk management and climate change adaptation communities of practice. Climate change adaptation practice has benefited significantly in approach and methodologies from disaster risk reduction and management. Again, much of this trend can be ascribed to work carried out in developing countries, where bottom-up processes of disaster risk reduction have been merged with, and expanded by, considerations about climate change impacts and risk.

5.2 Risk management approaches

Notions of risk have been another important driver in climate change adaptation, significantly influenced by, and directly related to, hazards theory and the hazards approach described above. As we will discuss in this section, risk is a core concept in hazards theory. Some would argue that due to these deep connections between the concepts of hazard and risk, considerations of risk in the field of climate change adaptation are merely an extension of the hazards approach. We single out a separate 'risk management approach' here because we observe that in the Australian context, risk management has become a dominant, highly standardised organisational practice for dealing with uncertainties of all kinds, which is particularly well-established in the local government sector. Risk management is often the trigger for governments to embark on adaptation processes and hence warrants separate discussion.

5.2.1 Evolution

As indicated above, two different disciplines have been instrumental in promoting and developing risk management approaches.

Firstly, the concept of risk has been central to hazards research right from its beginnings in the 1960s. In the early 1990s a group of researchers offered a critical perspective on established notions of risk in hazards research, arguing that human action, and not 'nature's force', was mainly responsible for the fact that large numbers of people worldwide were *at risk* from natural disasters (Blaikie et al., 1994). This recognition of the role of human agency was widely influential in shifting the focus towards contextual factors, such as poverty, lack of access to basic services and poor governance.

Secondly, risk management approaches have strong operational roots in management theory and practice, where risk management is considered a key mechanism for private and public organisations to deal with various kinds of uncertainties, mainly to minimise any negative consequences. Risk management approaches are common, for example, in project management, engineering, financial management and actuarial practice, industrial process design, and in occupational health and safety. While the definitions, methods and goals of risk management vary greatly across sectors, common strategies employed as part of risk management processes include risk avoidance, risk acceptance, risk transfer and risk minimisation.

5.2.2 Definitions

Central to the notion of risk are notions of uncertainty and perception. In management theory, risk has been defined as ‘the effect of uncertainty on objectives’ (Standards Australia, 2009). In the hazards literature, risk has been defined as the product of hazards and vulnerability – a definition that can readily be applied to climatic risks (Blaikie et al., 1994, Wisner et al., 2004, Downing and Patwardhan, 2005):

$$\text{Risk} = \text{Hazard (climate)} \times \text{Vulnerability}$$

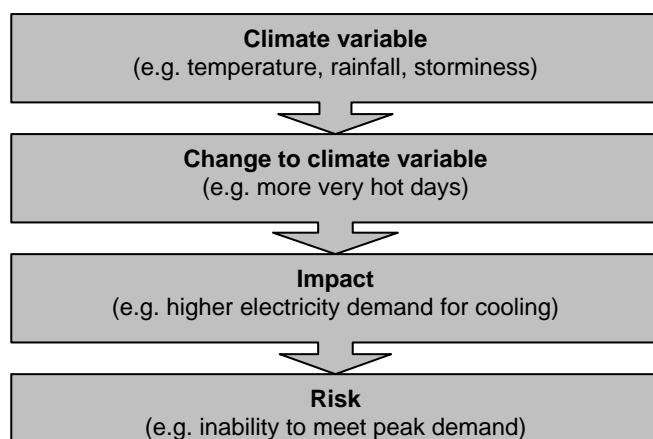
This definition underlines once again that vulnerability is considered a key condition for a particular climate hazard having an actual effect on social, ecological or coupled socio-ecological systems.

In organisational management, as well as in adaptation planning, risk has been operationalised as a function of magnitude (or consequence) and probability (or likelihood) of expected impacts (McCarthy et al., 2001, Standards Australia, 2009):

$$\text{Risk} = \text{Consequence} \times \text{Likelihood}$$

Likelihood is used to describe the probability of a climatic change taking place at some point in the future and its expected frequency, whereas consequences refers to the expected impacts of a climatic stressor on organisational goals and objectives. The links between climate change and risk are typically explained as a ‘chain of consequences’ (Australian Government, 2006), as outlined in Figure 9.

Figure 9: Links between climate change and risk



Source: Australian Government (2006: 16).

5.2.3 Risk management frames in policy and practice

Increasingly standardised risk management practices have emerged across the world for proactively addressing potential operational threats to the viability of an organisation (Standards Australia, 2004, Standards Australia, 2009). Australia has been leading this process of standardisation, which is reflected in the recently updated Australia/New Zealand standard for risk management becoming recognised as the global benchmark for risk management by the International Organisation for Standardization (Standards Australia, 2009).

In Australia and other Anglo-Saxon countries, risk management approaches have been widely applied to responding to climate change. In the Australian local government sector, for example, risk management has been the main driving force behind planning for climate change adaptation, and councils have started to integrate climatic risks into their organisational risk management frameworks. Since 2006, risk management approaches to climate change adaptation have been formally

encouraged in the Australian private and public sectors by the Australian Government, as outlined in an influential guide on '*climate change impacts and risk management*' (Australian Government, 2006).

Jones and Preston (2011: 10) argue that risk management can be considered 'the most appropriate overarching framework for assessing climate change adaptation', and that 'other methodological approaches often proposed as alternatives can sit comfortably within a broad risk assessment framework', including vulnerability and resilience approaches (discussed below).

5.3 Vulnerability approaches

The notion of vulnerability is increasingly used for conceptualising and analysing the effects of climate change, by focusing on who or what will be affected by climate change, in what way. Vulnerability has become an important concept underpinning all climate change adaptation efforts, albeit one with many different interpretations.

5.3.1 Evolution

Vulnerability is a widely used concept across the physical and the social sciences, in disciplines such as ecology, psychology, geography, public health, and poverty and development studies. The wide and differing use of the term is reflective of different disciplinary traditions and of the fact that vulnerability is a broadly applicable concept that can serve to address a range of research problems (Adger, 2006, Gallopín, 2006, Janssen et al., 2006). In addition to its wide application as a theoretical concept across various disciplines, vulnerability is also used in colloquial terms by the media and in political and public debate, also with greatly varying interpretations that tend to blur its meaning.

The evolution of vulnerability as a theoretical concept as it is applied to climate change adaptation can be tied to two fields research: hazards research (as discussed above), and international development and poverty research. In hazards research, broader notions of vulnerability have emerged since the early 1990s, which besides biophysical factors also include social and economic aspects of vulnerability to various types of disasters (Blaikie et al., 1994), and vulnerability is now considered an important concept for explaining the underlying causes of disasters (see above). Natural and technological disasters, however, have remained at the centre of attention in hazards research.

In fields such as human geography, development studies and poverty research, where significant bodies of research drawn on the notion of social vulnerability, the emphasis has been on eliciting knowledge on the vulnerability of social systems, mostly through the lens of a political economy approach that investigates which segments of a population or society are vulnerable to shocks and trends, and why (Adger and Kelly, 1999, Adger, 2006). A key assumption in this context is that social vulnerabilities are likely to be distributed unevenly across space and across socio-economic groups, and that demographic parameters such as age, gender and ethnicity have a significant role in determining the social distribution of vulnerability.

Since the emergence of climate change adaptation discourse in the 1990s, biophysical and social vulnerability have been central themes in the academic literature. However, the causal relationship between biophysical and social or socio-economic vulnerability has been contested. While some see biophysical vulnerability as a key factor determining socio-economic vulnerability (Klein and Nicholls, 1999), others have argued that 'social vulnerability may be viewed as one of the determinants of biophysical vulnerability' (Brooks, 2003).

To some extent, questions regarding such causalities have been circumvented by an increasing focus on investigating climate change impacts on coupled socio-ecological systems (Gallopín et al., 1989, Berkes and Folke, Turner et al., 2003, Walker et al., 2004, Wisner et al., 2004), where vulnerability is considered an instrumental concept in facilitating a more integrative perspective (O'Brien et al., 2004, O'Brien et al., 2007).

5.3.2 Definitions

Vulnerability, in its broadest interpretation that includes both biophysical and social aspects, has the ability to conceptually link the climate science and social science domains in climate change research and practice. However, many different notions of vulnerability are used by researchers and policy makers, representative of the fact that a wide range of possible policy responses to vulnerability co-exist (O'Brien et al., 2007). For this reason, defining vulnerability is an important but frequently neglected undertaking, and one that can influence the direction of any climate change adaptation process.

In the context of climate change adaptation, vulnerability can be broadly defined as the degree to which a coupled socio-ecological system or some part of it is likely to experience harm due to exposure to one or multiple hazards (Turner II, 2010), where the hazards may be climate change or a combination of climatic, other environmental and socio-economic factors. A more specific – and probably the most influential – definition of vulnerability is the one issued by the IPCC, where vulnerability is defined as:

‘The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity’ (McCarthy et al., 2001).

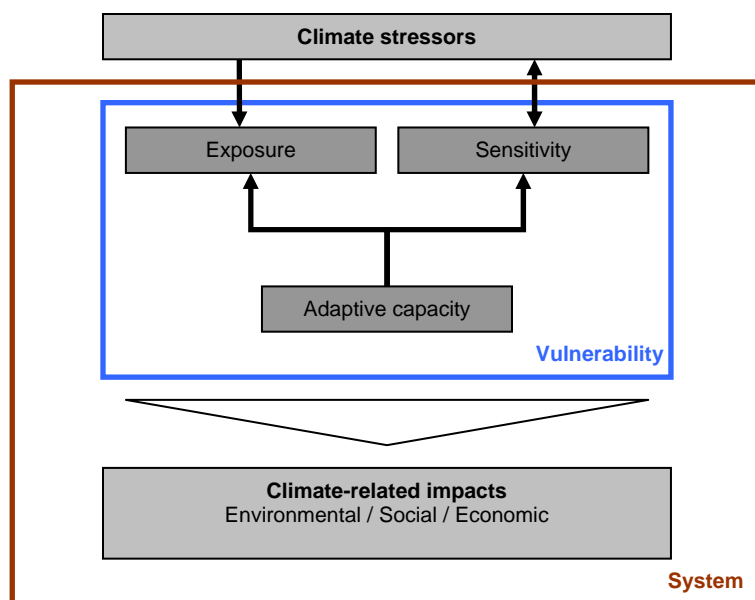
The following formula is frequently used to express this definition:

$$\text{Vulnerability} = \text{Exposure} \times \text{Sensitivity} / \text{Adaptive Capacity}$$

A large number of alternative definitions exist. Common to most definitions, however, is the notion that vulnerability is a product of exposure and/or sensitivity to external stressors such as climate change impacts, and adaptability or adaptive capacity (McCarthy et al., 2001, Adger, 2006, Smit and Wandel, 2006).

Exposure refers to a system being subject to the experience of climatic stressors, such as changing rainfall patterns, increasing average temperatures, and changes in the frequency of extreme weather events. *Sensitivity* is about a system’s responsiveness to climatic stressors, where it is assumed that the higher the sensitivity of a system, the higher will be an impact resulting from a stressor. *Adaptive capacity*, on the other hand, refers to a system’s ability to reduce its exposure and sensitivity as well as the capacity to respond to existing impacts, e.g. by changing how the system operates in a way that impacts resulting from climatic stressors are reduced. Adaptive capacity is an important concept for adaptation planning in a social context, which relates to issues of resource availability (e.g. time, financial and human resources), institutional barriers (e.g. political will), as well as the expertise, knowledge and experience of individuals. Figure 10 above illustrates the conceptual relationship of these different components of vulnerability.

Figure 10: Vulnerability and its components



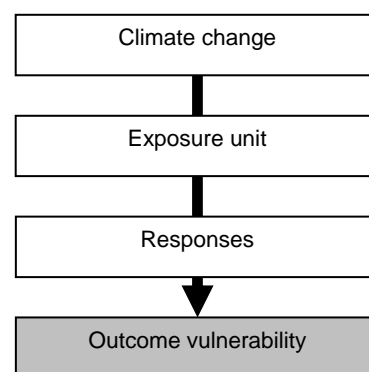
Source: Authors.

In an attempt to clarify how the concept of vulnerability can guide adaptive action, Kelly and Adger (2000) and O'Brien, Eriksen et al. (2004, 2007) distinguish conceptually between two types of vulnerability, which reflect the discussion of *adaptation as an outcome* versus *adaptation as a process* (section 4.3). On the one hand, vulnerability can be understood as a result of climate change, where it comprises the residual climate change impacts beyond what can be accommodated through adaptation. On the other hand, vulnerability can be used as a concept for understanding the socio-economic context (or 'starting point') in which climatic changes as well as other non-climatic stressors occur. This contextual vulnerability 'baseline' can then be used for developing a system's ability to deal with external pressures or changes.

Outcome vulnerability

The concept of outcome ('end-point') vulnerability relates to the expected residual climate change impacts to a predetermined unit of exposure (e.g. a habitat, an ecosystem, a municipality, a country, etc.) after all feasible adaptation responses have been taken into account (O'Brien et al., 2007)¹². Outcome vulnerability emphasises the 'problem' of anthropogenic climate change on well-defined, closed systems. Underlying the vulnerability-as-outcome perspective is the argument that 'the greater the [net] impacts [of climate change] the more need for mitigation' (Burton et al., 2002). An outcome vulnerability framing therefore underlines a research agenda that is inexorably linked to mitigation policy (ibid.).

Figure 11: Outcome vulnerability



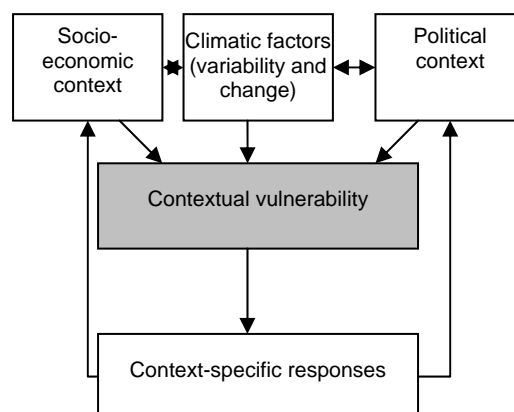
Source: O'Brien, Erikson et al. (2007): 75.

Contextual vulnerability

A contextual framing of vulnerability on the other hand considers vulnerability as embedded in a multi-dimensional context of climate-society interactions (O'Brien et al., 2007), where it can be a starting point for exploring options for adaptation specific to the local context. Using vulnerability as a starting point takes adaptation to be ongoing socio-ecological change that, while it may be triggered by particular climate change impacts, is part of a broader process of social development, political and institutional change, and environmental transformation (Figure 12).

Such a contextual understanding of vulnerability is largely consistent with a political economy approach (Füssel, 2007) to climate change. A contextual vulnerability approach is essentially about devising measures that reduce a system's and its components' (i.e. people, infrastructure, institutions) vulnerability to climate change as well as to ongoing socio-economic and political processes of change. A contextual vulnerability approach assumes that the systems under consideration are of a highly complex nature, consisting of a set of political, institutional, economic and social structures that are constantly changing, which interact with climate change and climatic variability. Vulnerability therefore is considered a place-based phenomenon that needs to be investigated in a particular geographic location, with the aim to understand the 'interaction of the hazards of place [...] with the social profile of communities' (Cutter, 1995). With regard to the interface of research, policy and practice, a contextual vulnerability framing predicates a research agenda that predominantly informs the development

Figure 12: Contextual vulnerability



Source: Adapted from O'Brien, Erikson et al.

¹² 'Residual climate change impacts' is not to be confused with 'unavoidable climate change impacts', which denotes impacts resulting from the degree of global warming that can no longer be mitigated through new commitments to greenhouse gas reductions due to the time lag inherent in the atmospheric system.

of local adaptation policy – rather than mitigation and compensation policies situated at national and international levels (Burton et al., 2002, Füssel, 2007).

5.3.3 Vulnerability frames in policy and practice

Summarising the discussion above, Table 7 provides a comparison of key characteristics of these two conceptual interpretations of vulnerability.

Table 7: Comparison of key characteristics of outcome and contextual vulnerability

| Characteristics | Outcome vulnerability | Contextual vulnerability |
|--------------------------------|---|---|
| Systems of interest | Biophysical, well-defined closed systems | Socio-ecological, open systems |
| Construction of climate change | Problem of human impacts on climate | Transformative process which has consequences for society and environment |
| Theoretical basis | Natural science | Social theory and post-positivism |
| Exogenous impacts | Single | Multiple |
| Methodology | Predominantly quantitative / reductionist | Predominantly qualitative / constructivist |
| Results focus | Technological | Social |
| Climate change policy focus | Informing mitigation policy, compensation and international assistance for adaptation | Informing adaptation policy and planning |

Source: Adapted from Pearson, Nelson et al. (2011)

In adaptation policy and practice, the outcome interpretation of vulnerability applies most readily to ‘top-down’ approaches, where predominantly reductionist methods are used to understand climate change impacts and their consequences on ecological and social systems. In an international policy context, the outcome vulnerability approach resonates strongly with ongoing discussions about the distribution of climate change mitigation responsibilities, developing compensation policies, and providing international financial assistance for mitigation (Burton et al., 2002, Füssel, 2007).

If the concept of vulnerability is to be operationalised for climate change adaptation at the local or regional scale, however, we argue that an outcome approach is of limited use, chiefly because it focuses on a better understanding of ‘problematic’ end-point outcomes. Such an interpretation isn’t conducive to instilling a sense of responsibility and opportunity for local level adaptation.

At a local institutional level, a contextual vulnerability framing calls for integration of adaptation within existing systems and processes of strategic planning and local development, often referred to as ‘mainstreaming’. Adaptation that works from the premise of reducing contextual vulnerability ultimately makes climate change considerations an intrinsic part of ‘good local governance’, driven by investing capacity and resources into those groups of society or parts of ecological systems most vulnerable to identified impacts of climate change.

In developing countries, a contextual framing of vulnerability inevitably means closely aligning climate change adaptation with poverty reduction and sustainable livelihood development agendas. Consequently, climate change is considered one of many challenges an organisation, group or individual face. Here, adaptation is centred on the reduction of overall vulnerabilities – to climate change impacts as well as to other effects of climate-society interactions’ within a complex, multidimensional system. This approach is increasingly labelled ‘climate-resilient development’ (Economics of Climate Adaptation Working Group, 2009, Fankhauser and Schmidt-Traub, 2010). Vulnerability then becomes a baseline for development measures that ‘buffer households and communities from the effects of climate change simply because they buffer them from nearly all sources of harm’ (McGray et al., 2007).

Similar conclusions can be drawn about applying a contextual vulnerability perspective to a developed country context. Gaining a robust understanding of the vulnerability of ‘system elements’ such as different segments of society, existing infrastructure and services in the context of various

external influences, including climate change, can provide a suitable starting point for discussing what type of adaptation measures are required, and which ones are likely to be most effective in a given context.

This brief discussion illustrates the important role that the concept of vulnerability plays for local climate change adaptation processes. Adaptation understood as a process of social and institutional learning is ultimately about reducing the vulnerability of a system and its components – whether they are people, living organisms, businesses, or infrastructure assets. Consideration of contextual vulnerabilities therefore needs to be central to any operational framework for adaptation.

5.4 The resilience approach

Resilience is a widely used and increasingly popular concept in adaptation policy, with wide application in particular in disaster risk management research and practice. In the context of adapting to climate change, the notion of *climate resilience* and *climate-resilient development* has gained traction over the past few years.

5.4.1 Evolution

The concept of resilience increasingly appears in climate change adaptation discourse, and it is often seen as directly related to the notion of vulnerability. In contrast to vulnerability, the term resilience has its origins in ecology and environmental sciences where it has been used widely to analyse processes of disturbance and change in ecosystems.

From these origins, the resilience perspective soon gained currency in other disciplines such as ecological economics, environmental psychology, human geography, and the broader social sciences. This also included hazards research, where resilience has become influential in the analysis of natural hazards on coupled socio-ecological systems.

In the context of climate change adaptation, the origins of the resilience perspective as one of the theoretical foundations of adaptive ecosystems management continue to influence climate change adaptation processes outside the ecosystems domain (Folke, 2006).

5.4.2 Definitions

The notion of ecosystem resilience emerged in the 1960s and 1970s, defined as:

‘the capacity of a system to absorb and utilize or even benefit from perturbations and changes that attain it, and so to persist without a qualitative change in the system’s structure’ (Holling, 1973).

Translating this fundamental definition into the realm of social science and the analysis of social systems, ‘social resilience’ has been described as:

‘the ability of groups or communities to cope with external stresses and disturbances as a result of social, political, and environmental change’ (Adger, 2000).

When relating the resilience concept to social processes of climate change adaptation, at least three different meanings can be discerned (Folke et al., 2002, Turner II, 2010):

1. Resilience understood as response to disturbance;
2. Resilience understood as a system’s capacity to self-organise;
3. Resilience as the capacity to learn and adapt.

Each of these interpretations bear direct relevance to central challenges of climate change adaptation, e.g. the questions of what perturbations we are adapting to, and how such adaptation is

going to occur. The third point above strongly resonates with understanding adaptation as a process for social learning. In this context, resilience has been defined as a system's 'capacity for renewal, re-organization and development' (Folke, 2006). In this context, resilience has also been described by some as a 'loose antonym for vulnerability' (Adger, 2000: 348) in that it increases adaptive capacity, although this view has been contested. Gallopín (2006), for example, argues that resilience is directly related to adaptive capacity as one of the constituent components of vulnerability and therefore is somewhat 'less than the flip side of vulnerability'.

5.4.3 Resilience frames in policy and practice

The applicability of resilience as a guiding concept for climate change adaptation remains problematic for a number of reasons.

Firstly, despite the fact that conceptualisations of resilience have evolved from the original definition by Holling (1973), the notion that resilience is about a system bouncing back to a previously functions after a shock remains a dominant principle underpinning the resilience perspective. In the context of climate change adaptation, however, the notion of bouncing back after a climate-related extreme event and to repair all functionality the system held prior to an event may be an insufficient, or even a mal-adaptive, response. In light of a constantly changing climate, returning to the conditions before an event falls short of instigating transformative action that takes responsibility for larger scale, systemic changes which may be necessary to avoid disastrous impacts of future climatic events.

Secondly, one of the unresolved fundamental challenges of the resilience approach and its transference into the domain of coupled socio-ecological systems is that its application to the social domains is largely underpinned by ecological dynamics of perturbation, equilibrium and non-equilibrium, which are difficult to apply to human systems, where complex regimes of knowledge creation, political power and reflexive decision-making underpin climate change adaptation processes (Adger, 2000).

Based on these reflections and methodological limitations, it seems appropriate to consider resilience as an important, though non-essential, concept to help better inform local and regional climate change adaptation processes. It can be an important reference point in communicating climate change adaptation issues, because it provides a positive contrast to the notion of vulnerability, and because it is closely tied to adaptive capacity. However, it continues to be a fuzzy concept that is difficult to put into operational practice and to date no specific method for assessing a system's resilience has emerged that could act to operationalise the resilience concept.

6 Examples of operational framing: climate change adaptation assessments

Reflecting the dominant role various assessment approaches play for adaptation in the local and state government spheres in Victoria, we continue our discussion on adaptation framing by illustrating, in this section, some of the points made above using the example of climate change assessment approaches.

This focus is deliberate and does not imply that climate change assessments are more important than other adaptation processes, such as exploring adaptation options or action planning. Rather, our focus on framing inherent in assessment methodologies is cognisant of the fact that for most local governments and state government departments in Australia, climate change assessments play a pivotal role during the early stages of formulating adaptation responses. Assessments serve as an excellent example of largely implicit conceptual framing, which often gets translated into operational activities without further reflection on the choice of approach and the implications of framing.

6.1 Climate change assessments: purpose and objectives

Climate change assessments are part of a vast array of predictive scientific assessment that have become established standards for decision-making and planning. The various kinds of climate change assessment differ in that they:

- Pursue different goals,
- Are underpinned by different theoretical foundations,
- Rely on different forms of input data,
- May elucidate different information on the effects of climate change,
- May ultimately lead to different adaptation responses.

Given the current dominance of climate change assessments in local and regional planning in Australia, clarity about the inherent framing, qualities and limitations of assessment approaches is important for making informed choices about which assessment method to employ for different adaptation processes.

The differences in framing climate change assessment methodologies are not necessarily made explicit by proponents of the various approaches, and labels are often applied confusingly and rather arbitrarily to assessment studies. While key climate change assessment approaches are widely discussed and constantly refined in climate change adaptation research, little consistency exists when it comes to their implementation. This inconsistency and lack of standardisation can only partly be ascribed to the huge variety of contexts and the need for flexibility in approach and methodology. To a larger extent, it is a reflection of the fact that adaptation policy and practice is still in its infancy and consistent operational framing of adaptation across government departments and across levels of government are yet to emerge.

Broadly speaking, all climate change assessments, irrespective of their approach, serve the purpose of gaining a better understanding of the current and expected future effects of climate change on a given region, population, community, sector, organisation, or parts thereof. A number of overarching goals of climate change assessments can be identified, all of which can be considered steps within a wider process of planning for and managing climate change impacts in a social context (Table 8).

Table 8: Goals of climate change assessments

| Goal | Information provided |
|--|--|
| Awareness raising, education, and creating shared ownership among stakeholders | <ul style="list-style-type: none"> • Understanding climate change projections and relating them to local context • Defining the system and its components that will need to adapt to climate change • Identifying main drivers of climate change adaptation within a system • Promoting a sense of responsibility for action, the intention to act and the ability act |
| Setting priorities for adaptation | <ul style="list-style-type: none"> • Identifying and prioritising vulnerable or at-risk areas, populations, communities, sectors, organisations or activities for further assessment and adaptation |
| Evaluating alternative decision options | <ul style="list-style-type: none"> • Understanding the expected social, economic and environmental costs and benefits of different adaptation actions • Enable robust decision-making based on understanding of the different types of costs and benefits |
| Implementing adaptation options | <ul style="list-style-type: none"> • Providing baseline information for implementing adaptation options to enable monitoring and evaluation |

Source: Modified from Preston and Stafford-Smith (2009).

This overview of goals may warrant a word of caution regarding broader limitations of climate change assessments. The rationale common to all assessment approaches is that increased knowledge will facilitate informed decision-making by enabling stakeholders to identify, develop and agree on

suitable measures – in the case of climate change assessments, measures for effective adaptation. Conducting a climate change assessment is considered critical for robust decision-making because it is assumed to provide for evidence-based planning and decision-making in the context of uncertainty. This expectation, however, that predictive scientific assessments are a necessary input into decision-making can be considered unreasonable (Herrick and Sarewitz, 2000), seeing that no predictive assessment, including the ones focusing on climate change adaptation, can eliminate scientific uncertainty. Climate change assessments, therefore, may assume a central place in a linear and sequential process of policy and decision-making, where an adequate science base is considered essential to policy action. The prevalence of predictive scientific assessment in planning and decision-making reflects the perception that ‘science is uniquely reliable among human institutions in identifying truths about the world’ (Herrick and Sarewitz, 2000: 310).

Climate change assessments can be instruments for elucidating and communicating possible futures in a changing climate, and help instigate a process of social learning on climate change adaptation. They can be a useful starting point for debate and reflection that can lead into a fruitful process of exploring different scenarios for the future and the role of climate change mitigation and adaptation within these. The usefulness of predictive assessments, however, is limited, because the complexity of coupled socio-ecological systems, including the repercussions of current and future political decisions, cannot be resolved sufficiently within any assessment process.

In the following sections we examine various climate change assessment methodologies, their evolution and underlying theoretical concepts, as well typical methods used for assessing climate change and its consequences at local and regional levels. For analytical purposes, these are presented here as distinct methodologies and methods. In government organisations, however, the distinctions between different methodologies are less clear cut, partially because different departments, divisions or organisational units prefer particular adaptation approaches over others, and because of a lack of open reflection on the framing of adaptation. It is also possible that various assessments have taken place within one organisation, serving different purposes and using different assessment methods. Choosing an approach to adaptation is often an iterative process, where initial, disparate ideas about goals and methods are changed iteratively, to reflect an organisation’s learning process and changing needs. This again suggests that effective adaptation needs to be a gradual and flexible process, during which different approaches and methods may feature prominently for a limited time or purpose.

6.2 Climate impact assessment

6.2.1 Objectives and methods

Climate impact assessment is mainly concerned with analysing the potential positive and negative effects of changes in climate parameters on terrestrial and marine systems; including ecosystems, social and economic systems. Climate impact assessments can focus on biophysical impacts, socio-economic impacts, or both. Impact assessment can also be conducted at various scales, from coarse national assessments to analyses of regional and local impacts of climate change.

The overarching goal of climate impact assessment approaches is to obtain a better understanding of the biophysical and/or socio-economic effects that can be expected in a particular geographic area under various climate change scenarios, hence assisting planning and decision-making.

The *IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations* (Carter et al., 1994) continues to be the most influential document setting the approach and broad methodology for climate impact assessments. According to the *IPCC Guidelines*, climate impact assessments have two broad objectives (Carter et al., 1994):

- To assess climate change impacts and suitable adaptations in a scientific manner, and

- To provide a mode of analysis that enables policymakers and decision-makers to choose among a set of alternative adaptation options.

In the *IPCC Guidelines*, climate impact assessment is defined as:

‘a sequential set of activities designed to identify, analyse and evaluate the impacts of climate variability and climate change on natural systems, human activities and human health and well-being, to estimate the uncertainties surrounding these impacts, and to examine the possible adaptive responses for reducing adverse effects or exploiting new opportunities’ (Carter et al., 1994).

The climate impacts approach relies to a significant extent on quantitative data on climate change phenomena, which typically are a combination of observational records and projections derived from Global Climate Models (GCMs). Depending on the approach taken and the scale of assessment, quantitative data may be complemented by qualitative studies of past and current climate variability and climate change, including qualitative studies of perceived climate change.

Climate impact assessments usually focus their analysis on a particular ‘exposure unit’, which can be defined as ‘the activity, group, region or resource exposed to significant climatic variations’ (Carter et al., 1994). An ‘impact’ can be defined as an effect the climate has on the exposure unit (*ibid.*).

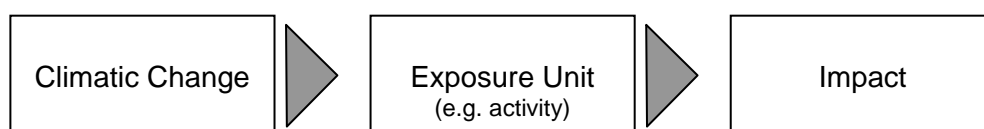
Defining the exposure unit is critical for ascertaining:

- A suitable assessment method and process,
- The type of data required for the assessment, and
- The expertise and technical skill required of assessors.

The definition of the exposure unit depends on the scale of the assessment, as defined by geographic and administrative boundaries. For example, the climate change impacts on the housing sector may be the subject of a nation-wide assessment commissioned by a national government body. At the other end of the scale, the exposure unit could be a particular residential area within a city, a demographic group in a given location, or threatened ecosystem.

The standard impact approach (Carter et al., 1994) assumes a simple cause and effect relationship between climate change hazards and their impact on an exposure unit, such as human or natural systems (Figure 13).

Figure 13: Schematic of the impact approach

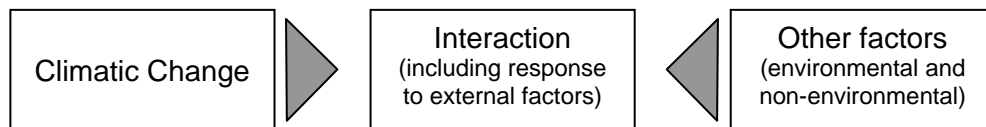


Source: Carter, Parry et al. (1994), after Kates (1985).

In this narrowly defined approach, the focus lies on analysing a specific climate change impact, assuming a controlled environment where any non-climatic effects (e.g. social or demographic processes) can be held constant. Using this deterministic approach can be justified, for example, for small-scale studies of the response of individual organisms to specific climate impacts, where direct biophysical impacts are analysed using a defined set of assumptions. However, the deeper the level of assessment the larger the set of assumptions that need to be taken into account, which increases the uncertainty of the assessment result. The fact that multiple climatic and non-climatic stressors co-exist in any given local context, combined with the high degree of uncertainty inherent in climate change, arguably limits the value of an impact approach for guiding adaptation planning at a local or regional scale.

For the study of systems of even limited degrees of complexity, an integrated approach that acknowledges the interaction between a range of climatic and non-climatic factors is much more suitable (Carter et al., 1994). Underlying such an interaction approach (Figure 14) is the assumption that the climate system, and consequently climate change impacts, interact in complex ways with socio-economic and other environmental factors.

Figure 14: Schematic of the interaction approach



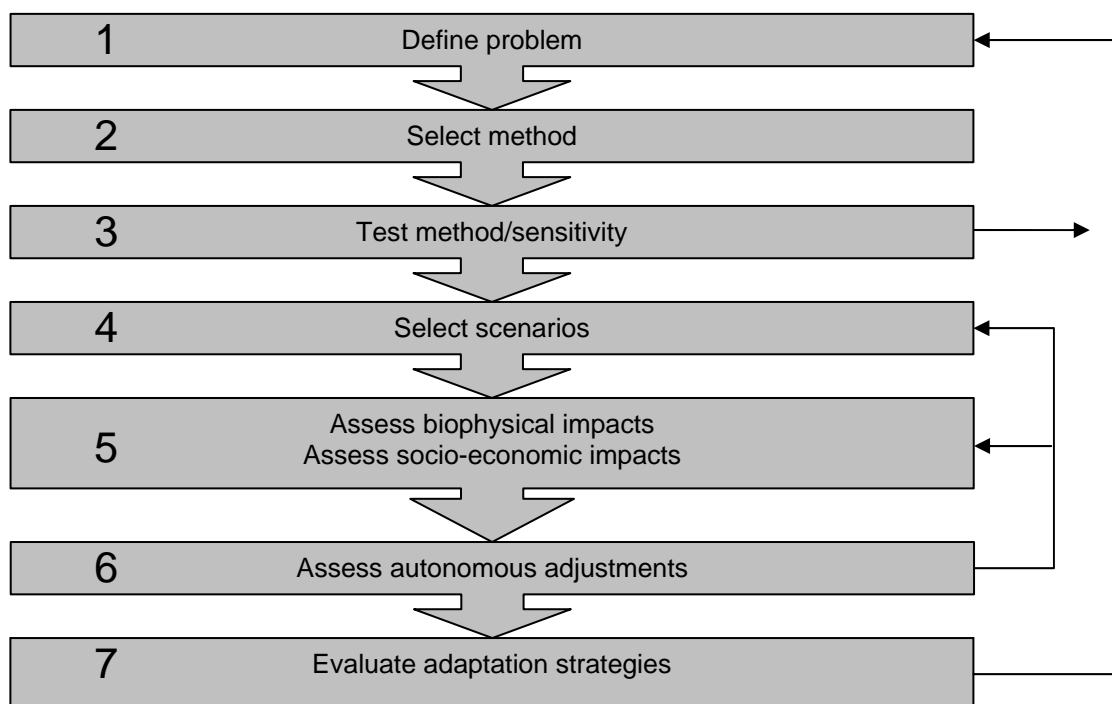
Source: Carter et al. (1994), after Parry and Carter (1988).

The exposure unit may be particularly sensitive to climatic change due to economic or social factors in the given location. For example, a particular city may be highly sensitive to a change in precipitation patterns due to reliance on rain as source for drinking water, whereas in an another region these changes may have less immediate economic and social effects due to drinking water being drawn from a variety of sources, such as ground water, rain water harvesting etc.

Integrated impact assessment approaches include analysing both biophysical and socio-economic climate change impacts and their interaction. An integrated approach to climate change assessment builds on the interaction approach outlined above and aims to analyse ‘the hierarchies of interactions that occur within sectors, [...] between sectors, and feedbacks, including adaptation, which serves to modify impacts and scenarios alike’ (Carter et al., 1994). Integrated assessments use quantitative and qualitative environmental, social and economic data as inputs into the assessment process. Scenarios of future climate change are used as a consistent reference point throughout the assessment process (Feenstra et al., 1998).

Critical to the effectiveness of the scientific method used in climate impact assessments is that the assumptions underlying the assessment process are maintained across scales and throughout the different stages of the assessment process, a criteria that is usually met by applying a single set of scenarios (e.g. IPCC climate change scenarios) to the assessment process.

Figure 15: IPCC’s ‘seven steps of climate impact assessment’



Source: Carter et al. (1994).

This approach is reflected in the 'seven steps' model for climate impact assessment, which remains widely used (Figure 15). The model consists of seven consecutive assessment phases. At the outset, the 'problem' of the assessment is defined, including objectives, exposure unit, time frame, study area, data needs and the wider socio-economic, environmental and policy context of the assessment. The second step, selecting the method, refers to choosing an analytical method such as using impact projections, empirical studies and expert judgement, followed by testing the selected method through feasibility studies, checking data availability, and testing the biophysical and/or socio-economic models used. Step four is concerned with selecting climate change scenarios, before leading into the actual assessment of biophysical and/or socio-economic impacts. The final stages of the model involve consideration of assessing autonomous adaptation and evaluating adaptation strategies derived from the assessment process.

Despite the predominantly sequential character of the model, redefinition of the problem based on evaluation outcomes as well as the repetition of some steps (indicated by arrows in Figure 15) is incorporated in the model.

6.2.2 Strengths and limitations

Arguably, one of the major benefits of the climate impacts assessment approach is that it uses quantitative input data where available, leading to quantifiable estimates of future climate change impacts. Quantitative information on the projected effects of climate change on particular exposure units or assets is often sought after by policy developers and decision makers in order to justify pursuing particular strategies in response to climate change. Using a climate impacts approach, which is modelled on widely used environmental impact assessment approaches, therefore can in some cases satisfy the accountability needs of standard decision-making processes.

This strength of the impact assessment approach, i.e. its ability to produce quantitative data, is also one of its main limitations. GCM data outputs, like all data derived from any modelling process, come with varying degrees of statistical confidence, and uncertainty of the projections is a major problem. Due to the relatively low resolution of current GCM outputs, regional climate downscaling processes are increasingly used to provide meaningful data on local and regional climate change scenarios for climate impact assessments. However, the process of downscaling is resource intensive and time consuming, and issues of uncertainty and limited statistical confidence remain unresolved (Wilby and Dessai, 2010).

Moreover, some question the relevance of such impact model information for adaptation decisions, in particular where decision-makers were not involved in the assessment process (Hinkel et al., 2010, Jones and Preston, 2011). Climate impact assessments are mostly top-down processes, driven by climate change scenarios, usually undertaken by scientific experts with limited knowledge of, and experience in, the local context. For adaptation measures to be effective and sustainable, however, local ownership of actions is essential. As Wilby and Dessai (2010) point out, only few examples exist where planned adaptation decisions have resulted from top-down approaches that focus on downscaling.

This observation relates back to the simplicity of climate change assessment suggested by the seven-step model. While this may be appealing to decision-makers as a straightforward process 'in which one can plug projected numbers into a model, prioritise, and select an adaptation, then act' (Jones and Preston, 2011: 10), the discussion in earlier sections of this document has show that adaptation, and the assessment of climate change impacts, is a tremendously complex task due to a vast array of climatic and non-climatic factors, multiple actors, socio-economic trends and unforeseeable future developments.

Typical areas of application for climate impact assessments are national economic studies, national and state level policy development, industry-wide standards for manufacturing and production, and, at the local level, land use planning and zoning, infrastructure development and investment; and 'climate proofing' of building codes.

6.3 Climate risk assessment

6.3.1 Objectives and methods

Risk assessment, as part of a risk management approach, provides a process for dealing with uncertainty. Although risk can be quantified using various formulas (see below), qualitative, perception-based approaches often inform risk assessments, in particular when socio-economic systems are the subject of risk assessments.

Standard risk assessment matrices are used to assess the likelihood and expected consequences of a climate change impact (discussed in section 5.2.2) under different scenarios, resulting in ratings of 'low', 'medium', 'high' or 'extreme' risk, which indicate the level of priority with which a risk should be treated (Table 9).

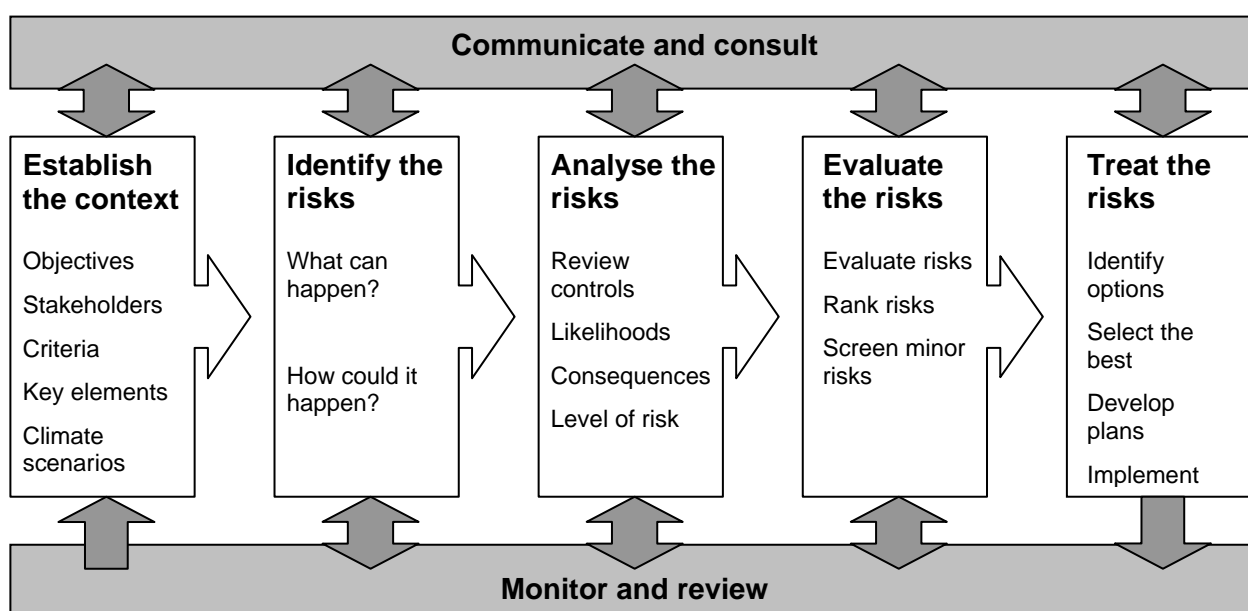
Table 9: Priority risk rating matrix

| Likelihood | Consequences | | | | |
|----------------|---------------|--------|----------|---------|--------------|
| | Insignificant | Minor | Moderate | Major | Catastrophic |
| Almost certain | Medium | Medium | High | Extreme | Extreme |
| Likely | Low | Medium | High | High | Extreme |
| Possible | Low | Medium | Medium | High | High |
| Unlikely | Low | Low | Medium | Medium | Medium |
| Rare | Low | Low | Low | Low | Medium |

Source: Australian Government (2006).

The Australian Government's (2006) *Climate Change Impacts and Risk Management* guide applies the Australia/New Zealand Standard for Risk Management (2004)¹³ to risks associated with climate change. A sequential process for climate risk assessment and management is suggested, consisting of five major steps (Figure 16) that rely on the active participation of stakeholders: establishing the context, identifying, analysing and evaluating climate change risks, and treating the risks by identifying adaptation options. The process, although sequential, relies on ongoing monitoring and evaluation, i.e. taking emerging information about climate change impacts into account when it becomes available; revisiting consequence ratings due to changing local circumstances; reconsidering adaptation options in the light of a changing policy context, etc.

Figure 16: Steps in the risk management process, according to the CCIRM guide



Source: Australian Government (2006): 19.

¹³ This standard has since been superseded by AS/NZS ISO 31000:2009 (Standards Australia 2009).

As part of establishing the context for climate risk management, the guide recommends carrying out a scoping exercise, which includes setting clear objectives, identifying key stakeholders, setting success criteria to be used for evaluating the outcomes of the risk management process, as well as identifying key elements at risk and choosing one or several climate scenarios that will inform the process. To ensure the validity of the process and its outcomes, it is critical that a diverse group of key stakeholders participates in the process. Part of the initial scoping process is also developing context-specific scales that define different levels of risk likelihood and consequence. These likelihood and consequence scales are to be developed based on strategic organisational objectives (referring back to the understanding that risk means a threat to an organisation achieving its objectives), and usually contain qualitative and quantitative elements.

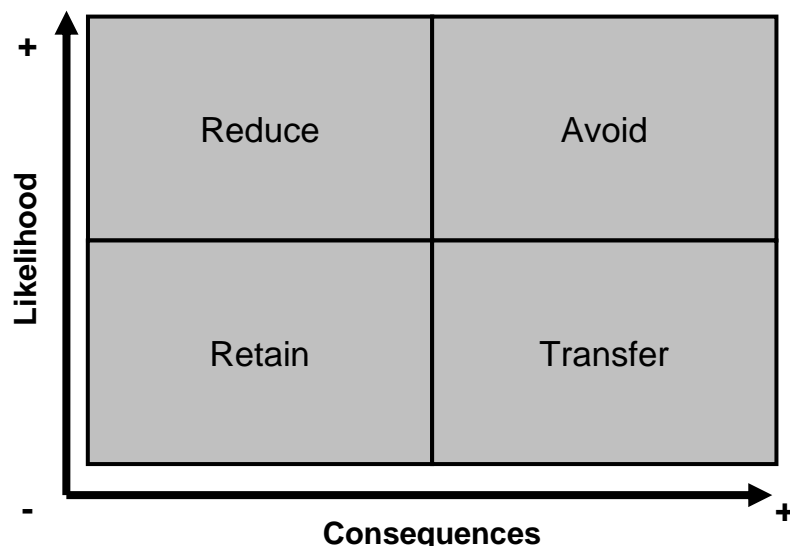
The second step in the process involves identifying climate change risks that various key elements (or exposure units, in the language of impact assessment) will be exposed to under different climate change scenarios, using participatory brainstorming and data gathering techniques. Qualitative cause-effect statements can help clarify why a particular issue is considered a risk. Risk analysis is conducted mainly qualitatively, by assigning each risk a level of priority based on the likelihood of the risk eventuating under different climate change scenarios and its expected consequences. The likelihood and consequence scales developed during the first step are applied here. Where possible, qualitative risk analysis and priority rating should be supported by quantitative studies that explain why a particular likelihood or consequence rating is appropriate.

During the third step, assigned priority risk ratings are evaluated by ensuring they are consistent with one another and match the stakeholders' interpretation of the local context in which they are operating. This assessment process, consisting of risk identification, analysis and evaluation, then forms the basis for exploring options for 'risk treatment', i.e. the development, selection and implementation of adaptation measures that reduce the levels of risk.

Risk treatment options can be clustered into four risk management strategies (following DeLoach, 2000, Economics of Climate Adaptation Working Group, 2009; see Figure 17):

1. *Avoiding* risks with high likelihood and major consequences, i.e. to decide not to become involved in, or action to withdraw from, a risk situation. An example is avoiding the immediate risks of sea-level rise by limiting coastal zone development, e.g. by changing local development approval policies.
2. *Reducing* high likelihood, minor consequence climate risks, i.e. actions taken to lessen the likelihood, the negative consequences, or both, associated with a risk. Examples are measures such as beach nourishment (extending beaches into the sea) to lessen storm surge impact; providing assistance to strengthening the roofs of residential buildings in cyclone-prone areas; or building homes on stilts in flood-prone areas.
3. *Transferring* risks with low likelihood but major consequences, i.e. sharing the burden of loss or benefit or gain for a risk with another party, such as different level of government or insurance. Regulatory frameworks can limit, prohibit or mandate the transfer of risk. An example is a business owner taking out an insurance policy for possible loss of revenue resulting from business interruptions due to flooding.
4. *Retaining* or *accepting* low probability, minor consequence climate risks, i.e. living with a climate risk that is well understood and considered negligible. An example may be that a city government in a temperate climate may decide to accept the risk of extreme heat waves due to their low frequency. In practice risk retention is often combined with risk reduction.

Figure 17: Decision-making matrix for identified risks



Source: Author, adapted from Deloach 2000.

6.3.2 Strengths and limitations

Climate risk management processes are suitable for organisations of various sizes, from community organisations to government departments. Due to their reliance on qualitative data and expert knowledge, engaging a suitable group of stakeholders from different backgrounds is essential to the success of the process, i.e. the effectiveness of the adaptation options developed in the final stage of the process.

One of the strengths of risk assessment approaches to climate change is that they can fit with existing organisational procedures and can readily be integrated into existing risk management systems and structures. A risk-based approach to climate change assessments enables stakeholders to establish likely cause-effect type linkages between projected climatic changes and the operational context in their department, their community or their organisation. By getting stakeholders to engage with projected changes in climatic parameters through understanding how these relate back to organisational objectives and services, ownership for adaptation processes can be created, which is critical for ensuring that adaptation measures derived from risk assessments are meaningful, feasible and effective.

In the context of governmental organisations, the implementation of risk assessment processes tends to be focused inwardly, sometimes to the neglect of external stakeholders, services and activities that are considered peripheral to an organisation. In the local government sector, for example, a risk management approach to climate change typically focuses on corporate risk, i.e. risks that threaten the key objectives of the organisation. However, such assessment processes, if conducted properly, will eventually lead to considering climate risks to the community (e.g. via organisational objectives that relate to service delivery, community satisfaction and well-being) and they thus can be a suitable entry point to a more holistic approach to adaptation, if they manage to instigate a process that moves beyond purely organisational considerations.

Another limitation of templated climate risk management processes, such as the one outlined by the Australian Government's guide, is that it relies to a significant extent on the views of individual stakeholders. In this context, it is important to acknowledge that an ideal-world scenario of equal representation and engagement of key stakeholders from different disciplinary backgrounds is rarely achieved in adaptation processes. It is more likely that some individuals will be more involved in the process than others, some will be able to dominate the discussions more than others, and that some stakeholders may choose not to participate or express their views. Therefore, careful and professional facilitation is required for any climate change assessment, including climate risk

assessment processes, and transparency about who is involved in what role needs to be achieved early in the process.

6.4 Vulnerability assessment

Vulnerability assessment has emerged as a common practice in climate change adaptation processes, and due to a lack of standardisation and the multi-faceted nature of the concept of vulnerability (see section 5.3.2) it is implemented in many different ways, using a range of definitions of vulnerability and various assessment methods (Preston and Stafford-Smith, 2009). The following sections are an attempt to provide an overview, acknowledging that it is difficult to do full justice to this diversity.

6.4.1 Objectives and methods

Conducting a vulnerability assessment is seen by many as a critical component of climate change adaptation processes at the local level (Mukheibir and Ziervogel, 2007, Romieu et al., 2010), as it can elicit knowledge about the expected distribution of impacts across a system.

Vulnerability assessments typically consist of assessing the characteristics of a vulnerable system, the type and number of stressors affecting that system, and the effects these have on the system (Füssel, 2004). The widely used IPCC definition of vulnerability (section 5.3.2) suggests that assessing vulnerability becomes meaningful and practicable only if it is conducted only in relation to a specified hazard, a range of hazards, or a specific system (Brooks, 2003). As opposed to climate impact assessment and risk assessment, vulnerability assessment is less rigidly defined, and processes labelled as vulnerability assessments reveal a great diversity in approach and methodologies used.

Over the past decade, vulnerability assessment methodologies have moved from an exclusive focus on the biophysical environment and questions of physical vulnerability towards the inclusion of, and a greater focus on, an assessment of the social vulnerability of segments of the local population (Romieu et al., 2010). Different types of vulnerability assessment continue to co-exist, however, reflecting the broad applicability of the vulnerability concept across different social and environmental phenomena. A biophysical vulnerability assessment may, for example, focus on evaluating the impact of increasing average night time temperatures on the evapotranspiration of trees in an urban park; a social vulnerability assessment of heat stress will identify groups within the population that are particularly under threat of suffering health and well-being impacts during a heat wave. A combined biophysical and social assessment may analyse, among other factors, the combined effects of changing evapotranspiration patterns of urban trees and the effect of heat fatigue due to warmer night-time temperatures. In many vulnerability assessment methodologies, four elements stand out as particularly relevant (Füssel, 2007):

- 1) A focus on a *vulnerable system*, which forms the scope for analysis and assessment. Depending on the disciplinary perspective and the scoping process, these typically comprise a coupled socio-ecological system, a social system or sub-systems (such as a social group), or a particular geographic region or area.
- 2) *Elements at risk* within the system under consideration. These are the 'valued attribute(s) of the vulnerable system that is/are threatened by [...] exposure to a hazard' (Füssel, 2007). Examples of typical elements at risk to climate change impacts are human lives, flora and fauna species, habitats, cultural and religious values, buildings and infrastructure.
- 3) The identification of a particular *hazard*, which denotes a potentially damaging influence on the system of analysis (Füssel, 2007). Hazards are sometimes differentiated into discrete hazards, or perturbations, and continuous hazards, or stress/stressors (Turner et al., 2003).
- 4) A *temporal reference*, which scopes out the time frame used for vulnerability assessment. Applying an explicit time frame is particularly relevant in the context of climate change adaptation, where impacts, to a large extent, lie in the future.

A technical paper informing the UNDP's Adaptation Policy Framework (Lim and Spanger-Siegfried, 2005) cited by Downing and Patwardhan (2005) serves as an example of how these elements are translated into a method for assessing social vulnerability, consisting of five discrete steps (Table 10). Similar to other types of assessment approaches discussed above, a definition phase is outlined, focusing predominantly on specifying a conceptual framework and a workable definition for vulnerability. The identification of vulnerable groups (step two) focuses on the scoping of system boundaries, including which groups are exposed to hazards.

This is followed by an assessment of sensitivity of the system and identified vulnerable groups, i.e. gaining an understanding of how climate hazards translate into climate impacts, risks and disasters. Importantly, the approach uses the identification of the drivers of current vulnerability to assess how future vulnerability is likely to be determined, and what role processes of autonomous adaptation can play in the reduction of vulnerability (step four). In a final step, assessment outcomes inform adaptation policy and decision-making.

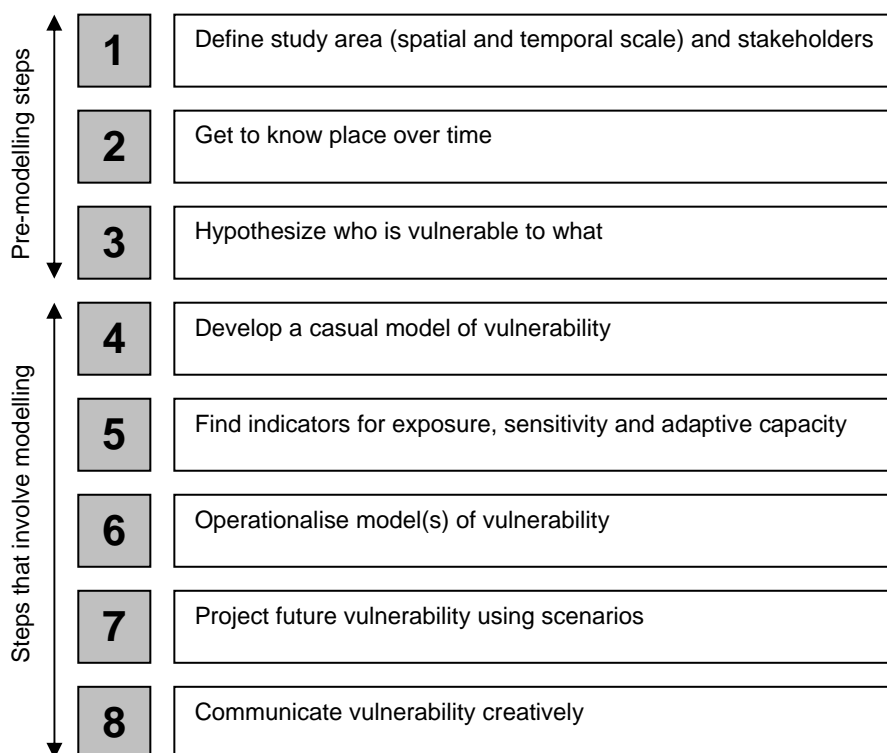
Table 10: Five-step approach to vulnerability assessment

| No. | Objective of activity | Description |
|-----|--|---|
| 1 | Structuring the vulnerability assessment: Definitions, frameworks and objectives | Clarifying the conceptual framework and analytical definitions of vulnerability being used for the assessment. |
| 2 | Identifying vulnerable groups: Exposure and assessment boundaries | Defining the system chosen for the assessment, including who is vulnerable, to what, in what way, and where. System characteristics to be defined include sectors, stakeholders and institutions, geographical regions and scales, and time periods. |
| 3 | Assessing sensitivity: Current vulnerability of the selected system and vulnerable group | Developing an understanding of the process by which climate outcomes (e.g. hydrological and meteorological variables) translate into risks and disasters. This includes identifying points of intervention and options for response to vulnerability. |
| 4 | Assessing future vulnerability | Developing a qualitative understanding of current drivers of vulnerability in order to better understand possible future vulnerability, including ways in which planned or autonomous adaptation may modify climate risks. |
| 5 | Linking vulnerability assessment outputs with adaptation policy | Relating vulnerability assessment outputs (2-4 above) to stakeholder decision-making, public awareness and further assessments. |

Source: Modified from Downing and Patwardhan (2005)

In an alternative, extended approach to vulnerability assessment (Schröter et al., 2005), greater emphasis is placed on qualitative aspects and the need for embedding vulnerability assessment as a bottom-up process in local knowledge and traditional 'wisdom'. Step two in the eight-step model outlined in Figure 18 below therefore emphasises the need for getting to know the study location (assuming an external researcher is conducting the assessment). Also, this approach explicitly mentions the use of exposure, sensitivity and adaptive capacity indicators, which constitute a model of vulnerability used for assessment (steps five and six).

Figure 18: Eight-step model for global change vulnerability assessment



Source: Modified from Schröter et al. (2005).

Using various approaches to vulnerability assessment, numerous studies have tried to develop composite local vulnerability indices, to assist communicating assessment outcomes, with mixed results. For example, overlaying vulnerability indicator data collected during an assessment with demographic information can produce maps of relative vulnerability and its variation across space.

6.4.2 Strengths and limitations

Vulnerability assessments can add a valuable, bottom-up perspective to climate change adaptation processes. Their strength is that they build the case for adaptation based on local data and information, thus helping ensure that adaptation options developed during planning processes can be designed in a way that they directly respond to local needs. If implemented in a participatory way, drawing on the knowledge and views of various local stakeholders, vulnerability assessments have the potential to pave the way for tangible local adaptation outcomes. Also, through the analysis carried out as part of vulnerability assessments, future climate impacts become directly linked to current contextual drivers of vulnerability (e.g. broader socio-economic processes affecting a particular place), hence enabling the identification of ‘starting points’ for adaptation by focusing on current vulnerability.

Vulnerability assessment is most useful for analysing how current climate variability and projected climate change impacts may affect different populations (or other system components), in different ways. Depending on the approach used the can add a quantitative or qualitative layer of local knowledge and information to decision-making processes, focused on the needs of vulnerable groups or system components.

Where vulnerability assessments mainly produce qualitative data on the expected consequences of climate change, their outputs often don’t meet current needs for an evidence-base to decision-making, for example in relation to costly infrastructure investments. This limitation, however, applies to other types of assessments as well, and purely quantitative assessment outputs, on the other hand, can suggest a degree of certainty that doesn’t reflect the complex and variable nature of climate change.

The heterogeneity of the various vulnerability assessment methods used also means that it is difficult to compare the results from different assessments, e.g. in order to understand the spatial variability of vulnerability. For example, maps of relative vulnerability, which are popular with planners and decision-makers in outcome-orientated organisations, suggest that vulnerability is quantifiable. While such maps can be a useful visualisation tool for communicating projected climate change impacts at local level, they contain a range of assumptions inherent in the methodology, including significant degrees of uncertainty, which need to be discussed with stakeholders and end-users. Preston et al. (2009) note that, where no clear guidance is given to stakeholders regarding the use of vulnerability maps, they may be interpreted by different audience in a range of different ways. Moreover, vulnerability assessments and any resulting maps are primarily about gaining a better understanding of local determinants of vulnerability. They are not, however, a shortcut to identifying context-specific adaptation measures and making value-based decisions.

7 Discussion: framing implications for policy-makers

Many of the points raised in this scoping paper highlight the value of making adaptation framing explicit across constituencies and stakeholder groups and discuss what is meant by climate change adaptation. Some themes that have emerged in the discussion are of direct relevance to effective adaptation policy and decision making at the regional and local levels. These issues are summarised in more detail below, with a view to raise questions for discussion and for further investigation during the Framing Adaptation project, rather than providing answers.

7.1 Adaptation as a learning process

Climate change adaptation can be considered a necessary outcome of dealing with climate change impacts, or it can be interpreted as a process of continuous social and institutional learning, adjustment and transformation. The perspective of 'adaptation as outcome' is relevant for informing adaptation discourse at all levels of government and in society, as it helps articulate what a future society adapted to climate change may look like. Understanding adaptation predominantly as an ongoing process of learning how to best deal with climatic and non-climatic change, however, is particularly relevant in the context of local and regional scale decision-making. This notion of adaptation as a learning process strongly resonates with the concept of 'contextual vulnerability', as discussed in section 5.3.2 above, where vulnerability as a result of climatic and non-climatic stressors is seen as a 'starting point' for climate change adaptation processes that are embedded in strategies of sustainable development and continuous improvement of living conditions and livelihoods.

Concepts such as vulnerability and risk can be considered important for framing context-specific local and regional adaptation planning processes. Gaining a robust understanding of local vulnerability and perceived risk using a combination of quantitative and qualitative data can provide a bottom-up perspective of climate change adaptation needs that is specific to a particular geographic area. Critically, a focus on local knowledge can help balance out the existing dominance of top-down approaches to climate change adaptation, where data of climate variability and climate change are the main criteria for justifying adaptation action. However, as has been exemplified in the discussion of the conceptual and operational framing of vulnerability, translating conceptual frames into local adaptation processes is often far from straightforward, mostly due to the multi-faceted and often unspecific use of conceptual frames in different communities of practice and in general public discourse. To make concepts such as vulnerability useful in local adaptation initiatives, for example by conducting a vulnerability assessment, it is essential to put effort into a process of engaging stakeholders in defining a context-specific use of the concept and agreeing on a set of objectives and methods by which conceptual terms can be operationalised.

Questions to consider:

- 1) What are the main challenges with operationalising conceptual frames in adaptation practice?*

- 2) *How can the notion of 'adaptation as a learning process' be embedded in government organisations?*
- 3) *What are the main capacity gaps in government organisations with regard to making informed choices about adaptation approaches and methodologies?*

7.2 Implicit and explicit adaptation framing

The discussion in section 3 illustrates that establishing a clear and shared understanding of the meaning of climate change adaptation in any given policy or decision-making context is vitally important. Questions of framing relate to clarity about the rationale for adaptation, the overarching aims of adaptation, the description of adaptation outcomes, the process to be followed, and the stakeholders to be involved, as well as the evaluation of adaptation measures and assessments of what constitutes 'good' adaptation.

In many cases, all or some of these dimensions of adaptation framing will be implicit in discussions, choices about planning approaches and processes, and the selection of assessment methodologies. While it may be time-consuming to explicitly discuss various existing framings for adaptation, going through such a process in a participatory manner is important for establishing a collaborative process for effective adaptation. Making various existing frames explicit and opening them up for discussion should not only be regarded as a way of defining adaptation planning processes; it is also likely to significantly influence the type of adaptation measures (and hence outcomes) that will emerge as a result of the process.

Questions to consider:

- 1) *What are the mechanisms by which implicit framing mainly occurs in adaptation policy and practice?*
- 2) *What are examples of explicit framing of adaptation approaches in policy, and what are the lessons one can learn from these examples?*
- 3) *What are the critical points in adaptation processes, where different framings can be made explicit and discussed?*

7.3 Choice of adaptation approach

In a situation of constrained time and financial resources, the choice of a particular adaptation approach or a combination of approaches, drawing on several conceptual frames, will be highly influential in establishing a particular dominant framing for an adaptation process. Policy developers and decision-makers should pause and query why a particular type of approach or method should be applied to any particular adaptation project and ascertain the relevance of the underlying concepts for the purposes of the activity.

In adaptation policy and practice, triggers for selecting a particular adaptation approach can be:

- **Policy requirement or recommendation:** New policy, legislation, or even broad guidance to clarify the scope of climate change adaptation, is likely to give implicit or explicit preference to particular approaches for adaptation planning. End users may be legally required or encouraged to use a particular approach for conducting their adaptation planning process. Such a tendency has been observed with the publication of the Australian Government Department of Climate Change's *Climate Change Impacts and Risk Management* (2006), which set out a risk management framework that has since been used, albeit with significant modifications, by many local governments as well as regional entities in Australia.
- **Set sectoral standards:** In sectors where climate change adaptation is not or not yet regulated, opinion leaders and early adopters, such as market-leading large corporations and key

government departments, may be at the forefront of providing the research and development input into the establishment of particular approaches for climate change adaptation in a particular sector, geographic area or level of government.

- **Alignment with organisational processes:** Where organisations have the choice, they are likely to use an approach for adaptation that fits in best with their organisational objectives. For example, a health department with a strong focus on well-being may be inclined to follow a vulnerability-based approach for adaptation, whereas a private sector company may find a risk management approach to adaptation better suited for dealing with the impacts of climate change. Organisations that already have corporate risk management systems in place may intuitively lean towards integrating climate change into the existing risk management system, whereas a social vulnerability perspective may not easily fit into such systems.
- **Prevailing individual / professional trajectories:** In many situations, climate change adaptation will be placed on the agenda and driven by influential individuals (such as community leaders, CEOs, managers, government department heads, leading consultancies etc.) that consider addressing climate change impacts part of their mandate, responsibility or core business. In the early stages of adaptation planning, such champions are well positioned for determining the approach used for an adaptation planning process. Their choice may be significantly influenced by their professional background, disciplinary traditions and focal areas of work. For example, a civil engineer may be more inclined to adopt a hazard or risk perspective, focusing on threats to existing infrastructure, whereas a social planner may come to the table with a view that social vulnerability and equity issues should be the lens through which adaptation planning is tackled.

These and other significant reasons that determine the course of action for adaptation planning need to be considered as critical to the outcomes of adaptation planning processes and, where possible, be made explicit and reflected upon at an early stage of adaptation planning by all key stakeholders involved in the process.

Questions to consider:

1. *What are the most common processes for deciding and settling on a particular adaptation approach or a set of approaches?*
2. *Other than the triggers listed above, which other factors contribute to choosing a particular approach / set of approaches over others?*
3. *What type of guidance would be most useful for assisting policy developers, decision-makers and practitioners in the choice of adaptation approaches?*

8 Outlook: how to respond to this document

Climate change is one of the main challenges faced by modern society. Government plays an important role in facilitating and influencing discussion on adaptation goals and in enabling effective adaptation. An effective response to climate change impacts is to a large extent reliant on understanding what the aims of adaptation are, where in the social and natural systems current and estimated future vulnerabilities are located, and through which processes these can be reduced. This scoping paper has laid out the key theoretical concepts that currently underpin climate change adaptation policy development and practice, and has shown how these concepts are reflected in existing climate change assessment methodologies.

This document was written with a view to initiate discussion and to inform the research objectives of the VCCCAR Framing Adaptation project. The document, while providing an overview of existing approaches and assessment methodologies, raises a number of critical questions that will be addressed in more detail in the course of the project, involving primary research in three case study locations and ongoing dialogue with local and state government stakeholders.

It is anticipated that the issues raised in this document will trigger commentary from adaptation policy developers, practitioners and researchers, which can be taken up by the project team and inform further research into the operational framing of climate change adaptation.

Comment on this paper is invited via email to:

Dr Hartmut Fuenfgeld
Research Fellow
Climate Change Adaptation Program (CCAP)
Global Cities Research Institute
RMIT University
Melbourne, Australia

Email: hartmut.fuenfgeld@rmit.edu.au

References

- AAHEIM, A., BERKHOUT, F., MCEVOY, D., MECHLER, R., NEUFELDT, H., PATT, A., WATKISS, P., WREFORD, A., KUNDZEWICZ, Z., LAVALLE, C. & EGENHOFER, C. 2008. Adaptation to Climate Change: Why is it needed and how can it be implemented? *CEPS Policy Brief*. Brussels: Centre for European Policy Studies.
- ADGER, W., DESSAI, S., GOULDEN, M., HULME, M., LORENZONI, I., NELSON, D., NAESS, L., WOLF, J. & WREFORD, A. 2009. Are there social limits to adaptation to climate change? *Climatic change*, 93, 335-354.
- ADGER, W. N. 2000. Social and ecological resilience: are they related? *Progress in Human Geography*, 24, 347-364.
- ADGER, W. N. 2006. Vulnerability. *Global Environmental Change*, 16, 268-281.
- ADGER, W. N. & KELLY, P. M. 1999. Social Vulnerability to Climate Change and the Architecture of Entitlements. *Mitigation and Adaptation Strategies for Global Change*, 4, 253-266.
- AUSTRALIAN GOVERNMENT 2006. Climate change impacts and risk management: A guide for business and government. In: AUSTRALIAN GREENHOUSE OFFICE (ed.). Canberra: Commonwealth of Australia.
- AUSTRALIAN GOVERNMENT 2007. Tackling Wicked Problems: A Public Policy Perspective. In: AUSTRALIAN PUBLIC SERVICE COMMISSION (ed.). Canberra: Commonwealth of Australia.
- BARNETT, J. & O'NEILL, S. 2010. Maladaptation. *Global Environmental Change*, 20, 211-213.
- BERKES, F. & FOLKE, C. (eds.) 1998. *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*, Cambridge: Cambridge University Press.
- BERNSTEIN, S., CASHORE, B., LEVIN, K. & AULD, G. 2007. Playing it Forward: Path Dependency, Progressive Incrementalism, and the "Super Wicked" Problem of Global Climate Change. *International Studies Association 48th Annual Convention*. Chicago, IL, USA.
- BLAIKIE, P., CANNON, T., DAVIS, I. & WISNER, B. 1994. *At risk: natural hazards, people's vulnerability, and disasters*, London, New York, Routledge.
- BOUWEN, R. 1998. Relational Construction of Meaning in Emerging Organization Contexts. *European Journal of Work and Organizational Psychology*, 7, 299 - 319.
- BOUWEN, R. & TAILLIEU, T. 2004. Multi-party collaboration as social learning for interdependence: developing relational knowing for sustainable natural resource management. *Journal of Community & Applied Social Psychology*, 14, 137-153.
- BROOKS, N. 2003. Vulnerability, risk and adaptation: A conceptual framework. *Tyndall Centre Working Paper*. Tyndall Centre for Climate Change Research.
- BURTON, I., HUQ, S., LIM, B., PILIFOSOVA, O. & SCHIPPER, E. L. 2002. From impacts assessment to adaptation priorities: the shaping of adaptation policy. *Climate Policy*, 2, 145-159.
- CARTER, T. R., PARRY, M. L., HARASAWA, H. & NISHIOKA, S. 1994. IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations. *Working Group II of the Intergovernmental Panel on Climate Change*. London / Tsukuba: University College London (UK) / Center for Global Environmental Research (Japan).
- CLARKE, M. & STEWART, J. D. 1997. *Handling the wicked issues: a challenge for government*, University of Birmingham, Institute of Local Government Studies.
- COLLINS, K. & ISON, R. 2009. Editorial: living with environmental change: adaptation as social learning. *Environmental Policy and Governance*, 19, 351-357.
- CSIRO 2007. Climate change in Australia - Technical report 2007. Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO).
- CSIRO & BUREAU OF METEOROLOGY 2009. Climate change in Australia - Science update 2009. *Science Update*. Melbourne: CSIRO / Bureau of Meteorology.
- CUTTER, S. L. 1995. *Living with Risk: The Geography of Technological Hazards*, John Wiley & Sons.
- DE BOER, J., WARDEKKER, J. A. & VAN DER SLUIJS, J. P. 2010. Frame-based guide to situated decision-making on climate change. *Global Environmental Change*, 20, 502-510.
- DELOACH, J. W. 2000. *Enterprise-wide risk management: strategies for linking risk and opportunity*, Financial Times Prentice Hall.

- DOWNING, T. E. & PATWARDHAN, A. 2005. Assessing vulnerability for climate adaptation. In: LIM, B. & SPANGER-SIEGFRIED, E. (eds.) *Adaptation policy frameworks for climate change: Developing strategies, policies and measures*. Cambridge: Cambridge University Press.
- ECONOMICS OF CLIMATE ADAPTATION WORKING GROUP 2009. *Shaping Climate Resilient Development: A Framework for Decision Making*. ClimateWorks Foundation, Global Environment Facility, European Commission, McKinsey & Company, The Rockefeller Foundation, Standard Chartered Bank, Swiss Re.
- FANKHAUSER, S. & SCHMIDT-TRAUB, G. 2010. *From adaptation to climate-resilient development: the costs of climate-proofing the Millennium Development Goals in Africa*. Leeds London: Centre for Climate Change Economics and Policy, Grantham Research Institute on Climate Change and the Environment.
- FEENSTRA, J. F., BURTON, I., SMITH, J. B. & TOL, R. S. J. 1998. *Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies*. Version 2.0 ed. Nairobi / Amsterdam: United Nations Environment Programme / Institute for Environmental Studies, Vrije Universiteit Amsterdam.
- FOLKE, C. 2006. Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, 16, 253-267.
- FOLKE, C., CARPENTER, S., ELMQVIST, T., GUNDERSON, L., HOLLING, C. S., WALKER, B., BENGTTSSON, J., BERKES, F., COLDING, J., DANELL, K., FALKENMARK, M., GORDON, L., KASPERSON, R., KAUTSKY, N., KINZIG, A., LEVIN, S., MÄLER, K.-G., MOBERG, F., OHLSSON, L., OLSSON, P., OSTROM, E., REID, W., ROCKSTRÖM, J., SAVENIJE, H. & SVEDIN, U. 2002. *Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations*.
- FÜNFELD, H., BOSOMWORTH, K., HANDMER, J., KEENAN, R., ISON, R., MCEVOY, D., PASCHEN, J.-A., WALLIS, P. & WHITTAKER, J. 2011. *Approaches to climate change adaptation in policy and practice*. Workshop summary report. Melbourne: Victorian Centre for Climate Change Adaptation.
- FÜSSEL, H.-M. 2004. Coevolution of the political and conceptual frameworks for climate change vulnerability assessments. In: BIERMANN, F., CAMPE, S. & JACOB, K. (eds.) *Proceedings of the 2002 Berlin Conference on the Human Dimensions of Global Environmental Change "Knowledge for the Sustainability Transition. The Challenge for Social Science"*. Amsterdam.
- FÜSSEL, H.-M. 2007. Vulnerability: A generally applicable conceptual framework for climate change research. *Global Environmental Change*, 17, 155-167.
- GALLOPÍN, G. C. 2006. Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change*, 16, 293-303.
- GALLOPÍN, G. C., GUTMAN, P. & MALETTA, H. 1989. Global impoverishment, sustainable development and the environment: a conceptual approach. *International Social Science Journal*, 121, 375-397.
- GOFFMAN, E. 1974. *Frame analysis : an essay on the organization of experience*, Cambridge, Mass., Harvard University Press.
- GOLD COAST CITY COUNCIL 2009. *Climate Change Strategy 2009-2014: setting direction, enabling action*. Gold Coast: Gold Coast City Council.
- GRAY, B. 2003. Framing of environmental disputes. In: LEWICKI, R., GRAY, B. & ELLIOTT, M. (eds.) *Making sense of intractable environmental conflicts: frames and cases*. Island Press.
- HANDMER, J. 2003. Adaptive capacity: What does it mean in the context of natural hazards? In: SMITH, J. B., KLEIN, R. J. T. & HUQ, S. (eds.) *Climate change, adaptive capacity and development*. London: Imperial College Press.
- HCCREMS 2009. *Climatic Change Impact for the Hunter, Lower North Coast and Central Coast Region of New South Wales*. Newcastle: Hunter & Central Coast Regional Environmental Management Strategy / University Of Newcastle.
- HERRICK, C. & SAREWITZ, D. 2000. Ex Post Evaluation: A More Effective Role for Scientific Assessments in Environmental Policy. *Science, Technology & Human Values*, 25, 309-331.
- HINKEL, J., BISARO, S., DOWNING, T. E., HOFMANN, M. E., LONSDALE, K., MCEVOY, D. & TABARA, J. D. 2010. Learning to adapt: Re-framing climate change adaptation. In: HULME, M. & NEUFELDT, H. (eds.) *Making climate change work for us: European perspectives on adaptation and mitigation strategies*. Cambridge: Cambridge University Press.

- HOLLING, C. S. 1973. Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, 4, 1-23.
- HORROCKS, L. 2007. Making Policy and Measuring Progress in Adaptation SKCC Workshop, May 2007.
- IPCC 2007. Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. Geneva: Intergovernmental Panel on Climate Change.
- JANSSEN, M. A., SCHOON, M. L., KE, W. & BÖRNER, K. 2006. Scholarly networks on resilience, vulnerability and adaptation within the human dimensions of global environmental change. *Global Environmental Change*, 16, 240-252.
- JONES, R. N. & PRESTON, B. L. 2011. Adaptation and risk management. *Wiley Interdisciplinary Reviews: Climate Change*, 2, 296-308.
- KASPERSON, J. X. & KASPERSON, R. E. 2005. *The Social Contours of Risk: Publics, risk communication and the social amplification of risk*, Earthscan.
- KASPERSON, R. E., RENN, O., SLOVIC, P., BROWN, H. S., EMEL, J., GOBLE, R., KASPERSON, J. X. & RATICK, S. 1988. The Social Amplification of Risk: A Conceptual Framework. *Risk Analysis*, 8, 177-187.
- KATES, R. W. 1985. The interaction of climate and society. In: KATES, R. W., AUSUBEL, J. H. & BERBERIAN, M. (eds.) *Climate impact assessment: Studies of the interaction of climate and society*. Chichester: Wiley.
- KELLY, P. M. & ADGER, W. N. 2000. Theory and Practice in Assessing Vulnerability to Climate Change and Facilitating Adaptation. *Climatic change*, 47, 325-352.
- KLEIN, R. J. T. & NICHOLLS, R. J. 1999. Assessment of coastal vulnerability to climate change. *Ambio*, 28, 182-197.
- LAVE, J. & WENGER, E. 1991. *Situated learning : legitimate peripheral participation*, Cambridge [England] ; New York, Cambridge University Press.
- LEWICKI, R., GRAY, B. & ELLIOTT, M. 2003. *Making sense of intractable environmental conflicts: frames and cases*, Island Press.
- LIM, B. & SPANGER-SIEGFRIED, E. (eds.) 2005. *Adaptation policy frameworks for climate change: Developing strategies, policies and measures*, Cambridge: Cambridge University Press.
- MCCARTHY, J. J., CANZIANI, O. F., LEARY, N. A., DOKKEN, D. J. & WHITE, K. S. (eds.) 2001. *Climate Change 2001: Impacts, Adaptation and Vulnerability*, Cambridge: Cambridge University Press.
- MCEVOY, D., MATCZAK, P., BANASZAK, I. & CHORYNSKI, A. 2010. Framing adaptation to climate-related extreme events. *Mitigation and Adaptation Strategies for Global Change*, 15, 779-795.
- MCGRAY, H., HAMMILL, A. & BRADLEY, R. 2007. Weathering the storm: Options for framing adaptation and development. *WRI Reports*. Washington DC: World Resources Institute.
- MUKHEIBIR, P. & ZIERVOGEL, G. 2007. Developing a Municipal Adaptation Plan (MAP) for climate change: the city of Cape Town. *Environment and Urbanization*, 19, 143-158.
- NELSON, R., KOKIC, P., CRIMP, S., MEINKE, H. & HOWDEN, S. M. 2010. The vulnerability of Australian rural communities to climate variability and change: Part I--Conceptualising and measuring vulnerability. *Environmental Science & Policy*, 13, 8-17.
- NISBET, M. C. 2009. Communicating climate change: why frames matter for public engagement. *Environment*.
- O'BRIEN, K., LEICHENKO, R., KELKAR, U., VENEMA, H., AANDAHL, G., TOMPKINS, H., JAVED, A., BHADWAL, S., BARG, S., NYGAARD, L. & WEST, J. 2004. Mapping vulnerability to multiple stressors: climate change and globalization in India. *Global Environmental Change Part A*, 14, 303-313.
- O'BRIEN, K. L., ERIKSEN, S., NYGAARD, L. & SCHJOLDEN, A. 2007. Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy*, 7, 73-88.
- O'BRIEN, K. L. & WOLF, J. 2010. A values-based approach to vulnerability and adaptation to climate change. *Wiley Interdisciplinary Reviews: Climate Change*, 1, 232-242.
- O'BRIEN, K., ERIKSEN, S., SCHJOLDEN, A. & NYGAARD, L. 2004. What's in a word? Conflicting interpretations of vulnerability in climate change research. Oslo: Oslo University.

- PAHL-WOSTL, C. 2002. Towards sustainability in the water sector – The importance of human actors and processes of social learning. *Aquatic Sciences - Research Across Boundaries*, 64, 394-411.
- PARLIAMENT OF VICTORIA 2010. 2009 Victorian Bushfires Royal Commission - Final report. Melbourne: Government Printer for the State of Victoria.
- PARRY, M. L., CANZIANI, O. F., PALUTIKOF, J. P., VAN DER LINDEN, P. J. & HANSON, C. E. (eds.) 2007. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge / New York: Cambridge University Press.
- PARRY, M. L. & CARTER, T. R. 1988. The assessment of effects of climatic variations on agriculture: Aims, methods and summary of results. In: PARRY, M. L., CARTER, T. R. & KONIJN, N. T. (eds.) *The impact of climatic variations on agriculture: Assessments in cool temperate and cold regions*. Dordrecht: Kluwer.
- PARRY, M. L. & CARTER, T. R. 1998. *Climate impact and adaptation assessment*, London, Earthscan.
- PEARSON, L. J., NELSON, R., CRIMP, S. & LANGRIDGE, J. 2011. Interpretive review of conceptual frameworks and research models that inform Australia's agricultural vulnerability to climate change. *Environmental Modelling & Software*, 26, 113-123.
- PIDGEON, N. F., KASPERSON, R. E. & SLOVIC, P. 2003. *The social amplification of risk*, Cambridge University Press.
- PRESTON, B., BROOKE, C., MEASHAM, T., SMITH, T. & GORDDARD, R. 2009. Igniting change in local government: lessons learned from a bushfire vulnerability assessment. *Mitigation and Adaptation Strategies for Global Change*, 14, 251-283.
- PRESTON, B. L. & STAFFORD-SMITH, M. 2009. Framing vulnerability and adaptive capacity assessment. *CSIRO Climate Adaptation Flagship Working Paper*. Aspendale: Commonwealth Scientific and Industrial Research Organisation.
- PUTNAM, L. L. & HOLMER, M. 1992. Framing, reframing and issue development. In: PUTNAM, L. L. & ROLOFF, M. E. (eds.) *Communication and negotiation*. London: Sage Publications.
- QUEENSLAND UNIVERSITY OF TECHNOLOGY 2010. Impacts and adaptation response of infrastructure and communities to heatwaves: the southern Australian experience of 2009. Report for the National Climate Change Adaptation Research Facility, Gold Coast, Australia. Gold Coast: National Climate Change Adaptation Research Facility (NCCCARF).
- RICKARDS, L. 2010. Governing the future under climate change: contested visions of climate change adaptation. *VCCCAR Scenarios for Climate Adaptation Working Paper*. Melbourne: Victorian Centre for Climate Change Adaptation Research.
- RITTEL, H. W. & WEBER, M. M. 1973. Dilemmas in a general theory of planning. *Policy Sciences*, 4, 155-169.
- ROBERTS, D. 2010. Prioritizing climate change adaptation and local level resilience in Durban, South Africa. *Environment and Urbanization*, 22, 397-413.
- ROMIEU, E., WELLE, T., SCHNEIDERBAUER, S., PELLING, M. & VINCHON, C. 2010. Vulnerability assessment within climate change and natural hazard contexts: revealing gaps and synergies through coastal applications. *Sustainability Science*, 5, 159-170.
- SCHRÖTER, D., POLSKY, C. & PATT, A. 2005. Assessing vulnerabilities to the effects of global change: an eight step approach. *Mitigation and Adaptation Strategies for Global Change*, 10, 573-595.
- SLOVIC, P. 2000. *The perception of risk*, Earthscan Publications.
- SMIT, B., BURTON, I., KLEIN, R. J. T. & STREET, R. 1999. The science of adaptation: A framework for assessment. *Mitigation and Adaptation Strategies for Global Change*, 4, 199-213.
- SMIT, B., BURTON, I., KLEIN, R. J. T. & WANDEL, J. 2000. An Anatomy of Adaptation to Climate Change and Variability. *Climatic change*, 45, 223-251.
- SMIT, B. & WANDEL, J. 2006. Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16, 282-292.
- STANDARDS AUSTRALIA 2004. Australian Standard AS/NZS 4360:2004 Risk Management. Standards Australia.
- STANDARDS AUSTRALIA 2009. Australian Standard AS/NZS ISO 31000:2009. *Risk management - principles and guidelines*. Standards Australia.
- SUNSHINE COAST REGIONAL COUNCIL 2010. Sunshine Coast Climate Change and Peak Oil Strategy 2010-2020. Noosa: Sunshine Coast Regional Council.

- TURNER, B. L., KASPERSON, R. E., MATSON, P. A., MCCARTHY, J. J., CORELL, R. W., CHRISTENSEN, L., ECKLEY, N., KASPERSON, J. X., LUERS, A., MARTELLO, M. L., POLSKY, C., PULSIPHER, A. & SCHILLER, A. 2003. A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences of the United States of America*, 100, 8074-8079.
- TURNER II, B. L. 2010. Vulnerability and resilience: Coalescing or paralleling approaches for sustainability science? *Global Environmental Change*, 20, 570-576.
- TVERSKY, A. & KAHNEMAN, D. 1981. The framing of decisions and the psychology of choice. *Science*, 211, 453-458.
- UNITED NATIONS 1992. United Nations Framework Convention on Climate Change. New York: United Nations.
- UNITED NATIONS 2010. Outcome of the work of the Ad Hoc Working Group on long-term Cooperative Action under the Convention. Bonn: United Nations Frameworks Convention on Climate Change.
- VOGEL, C., MOSER, S. C., KASPERSON, R. E. & DABELKO, G. D. 2007. Linking vulnerability, adaptation, and resilience science to practice: Pathways, players, and partnerships. *Global Environmental Change*, 17, 349-364.
- WALKER, B., HOLLING, C. S., CARPENTER, S. R. & KINZIG, A. 2004. Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society*, 9, 5.
- WEICK, K. 1995. *Sensemaking in organizations*, Sage Publications.
- WENGER, E. 1998. *Communities of practice : learning, meaning, and identity*, Cambridge, U.K. ; New York, N.Y., Cambridge University Press.
- WILBY, R. L. & DESSAI, S. 2010. Robust adaptation to climate change. *Weather*, 65, 180-185.
- WISNER, B., BLAIKIE, P., CANNON, T. & DAVIS, I. 2004. *At risk: natural hazards, people's vulnerability and disasters*, New York, Routledge.