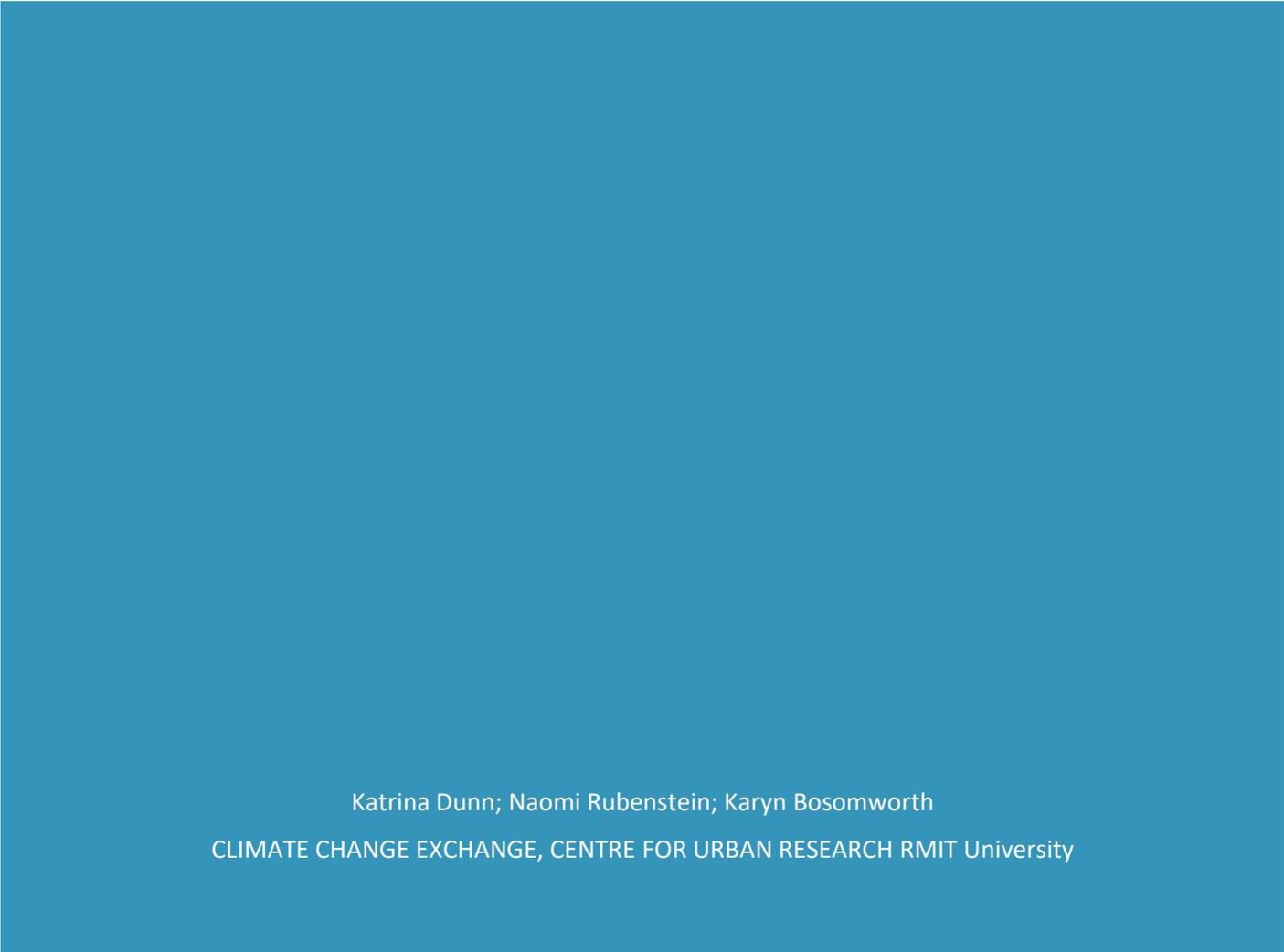




# CLIMATE CHANGE ADAPTATION PLANNING IN VICTORIA'S WATER SECTOR: scenario use and principles for embedding climate change into decision-making

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RMIT wish to acknowledge the Boon Wurrung and Woi Wurrung peoples of the Eastern Kulin Nation as the Traditional Custodians of the unceded lands on which we research, teach, and work, and pay respect to their Elders past, present, and emerging. We also wish to acknowledge and pay respect to all Aboriginal and Torres Strait Islander peoples, and their Ancestors; Traditional Custodians of all lands and waters on which we live, work, and learn, and thank them for continuing to care for Country. We acknowledge that sovereignty was never ceded. So we commit to learning how our work can practice responsibilities with Country, First Nations peoples, and cultures.

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# 1 INTRODUCTION

## 1.1 Report purpose

Victoria's Climate Change Act (2017) requires seven systems to develop Adaptation Action Plans (AAPs). The Water Cycle System was one of those systems and one of three to develop a *pilot* AAP that sets out several Actions. This report addresses two of those pilot's actions:

- Action 10: to ***Develop a framework to inform consistent and systematic embedment of climate change considerations into water business decisions;*** and
- Action 12: to ***Review the use of climate change scenarios in water sector planning.***

This report addresses Action 10 through presenting an initial stage of that framework – understanding the sector's needs and questions regarding adaptation planning. It also presents principles for this embedment, informed by research findings regarding issues the sector faces in embedding climate change into its decision-making.

It also addresses Action 12, and the associated need to define 'best practice' scenario planning for adaptation, by presenting principles for the use of scenarios in adaptive planning in the water sector. These principles are informed by research findings regarding current approaches and needs in using scenarios in water sector climate change planning and current best practice.

## 1.2 Report structure

This report has six sections:

1. This Introductory section, describing the report's purpose and context
2. A brief overview of climate change adaptation planning, key challenges and considerations in such planning, and how this relates to adaptation planning in the Water Sector.
3. A brief summary of the peer-reviewed literature regarding scenario-planning in climate change adaptation planning generally.
4. The research methods and findings regarding
  - a. scenario use in the Victorian Water Sector, and
  - b. current approaches to adaptation planning in the sector and needs expressed by participants.
5. A discussion of the results and findings, and the recommendations to come from this report.
6. Recommendations, including:
  - a. Principles for embedding climate change considerations in Water Sector decision-making
  - b. Principles for using scenarios in adaptation planning
  - c. Research gaps and future needs identified through this research.

### 1.3 Context: Victoria’s Pilot Water Sector Climate Change Adaptation Action Plan

Under the Climate Change Act (2017), Adaptation Action Plans (AAPs) must be developed every five years from 2021 for seven systems that are “essential or vulnerable to the inevitable impacts of climate change and are therefore a priority for the State Government”. The first legislated AAPs are required to be prepared by 2021. One of these systems is the Water System, or, as the Act describes it ‘*The Water Cycle System*’. For the purposes of the AAP process, the Act defines the Water Cycle System (also see Figure 1 below), referred to herein as the ‘water sector’ as:

- a. the collection, storage, treatment, delivery and supply of water, including recycled water; and*
- b. sewerage services, including the collection, treatment and disposal of wastewater through sewerage systems and wastewater treatment plants; and*
- c. drainage services, including the operation of drainage systems; and*
- d. flood management services, including the operation and maintenance of infrastructure to mitigate floods*

Therefore, the Pilot Water Sector Climate Change Adaptation Action Plan (WSAAP) focuses on these elements and the relevant uses and values set out in Water for Victoria. Figure 1 from the WSAAP below.

Definition in the Act	How this has been interpreted and considered in this WSAAP
<b>Water Supply</b>	
 <p>The collection, storage, treatment, delivery and supply of water, including recycled water.</p>	<ul style="list-style-type: none"> <li>• All sources of water including recycled water and alternative sources</li> <li>• Availability and allocation of water for consumptive (urban, agricultural and industrial), environmental, recreation and cultural uses</li> <li>• Water quality of all water sources used for consumptive purposes</li> </ul>
<b>Sewerage</b>	
 <p>Sewerage services, including the collection, treatment and disposal of wastewater through sewerage systems and wastewater treatment plants.</p>	<ul style="list-style-type: none"> <li>• Sewage transport, pumping and treatment</li> <li>• Sewage quality</li> <li>• Recycled water treatment and quality</li> <li>• Sewerage assets, their planning, operations and management</li> </ul>
<b>Drainage</b>	
 <p>Drainage services, including the operation of drainage systems.</p>	<ul style="list-style-type: none"> <li>• Nuisance inundation in urban and rural drainage schemes</li> </ul>
<b>Flood management</b>	
 <p>Flood management services, including the operation and maintenance of infrastructure to mitigate floods.</p>	<ul style="list-style-type: none"> <li>• Overland flooding and riverine flooding</li> <li>• Sea level rise, storm surge and coastal flooding</li> </ul>
<b>Common issues</b>	
 <p><i>Common issues are not defined in the Act, but have been addressed in development of the WSAAP to meet the Act's policy objectives and guiding principles.</i></p>	<ul style="list-style-type: none"> <li>• Adaptation to extreme events as well as long-term changes.</li> <li>• Decision-making under uncertainty.</li> <li>• Built assets, their design, management, operation, renewal and replacement.</li> <li>• Financial, risk, legal, insurance, reputational and regulatory compliance issues.</li> <li>• Water sector contribution to urban liveability.</li> <li>• Community engagement.</li> <li>• Internal culture, business engagement and capability around adaptation.</li> </ul>

Figure 1: Elements of the water sector addressed through the current WSAAP (DELWP 2018, p. 12). Well implemented scenario planning can improve risk assessment and decision making in all key service delivery focus areas outlined.

The pilot WSAAP's second objective is "to develop frameworks, policy, and tools to help address the challenges climate change presents the sector". Both Action 10 and 12 form part of DELWP's work towards achieving that objective.

### 1.3.1 Action 10 Develop a framework to inform consistent and systematic embedment of climate change considerations into water business decisions

The pilot WSAAP states that the outcome of this action will be "a framework that enables climate change to be incorporated into all relevant business decisions. The Framework should also inform future gaps and development of future WSAAPs" (pg 55). The pilot WSAAP describes this action as **DELWP will work with water service providers and develop a draft framework to inform consistent and systematic embedding of climate change considerations into all relevant water business decisions. The framework will be developed,**

*reviewed and tested by the water service providers, and improved over time. It could include elements such as assessing the sensitivity of a decision to climate change, assessing sensitive decisions against a range of future climate scenarios, and identifying preferred approaches and triggers for action in the future.*

This report presents an initial stage of that framework – understanding the sector’s needs and questions regarding adaptation planning. It brings those issues together with ‘good adaptation’ principles drawn from current literature that the sector can further develop, test, and refine.

### *1.3.2 Action 12: Review use of climate change scenarios in water sector planning*

The pilot WSAAP second objective identifies that there is an opportunity to *review how scenario planning is used across the water sector beyond water supply, to see if it is in line with best practice*. The WSAAP states that the outcome of this action will be “Greater understanding of use of scenarios in water sector planning”. This leads to Action 12 to **Review the use of climate change scenarios in water sector planning**, which states:

*DELWP will work with the water sector to review how climate change has been incorporated into selected long-term planning activities relating to water, sewerage, drainage and flood management. Differences in approaches will be identified and considered. Reviewing the existing activities for the extent to which they include climate change and variability will build awareness and, potentially, identify opportunities to better integrate climate planning into broader water sector activities.*

This report presents findings from research thought sought to understand how the sector currently uses different kinds of scenarios. It then brings these insights together with current and pertinent literature to define and present principles for ‘best practice’ scenario use in adaptation planning.

## 2 Overview of climate change adaptation and approaches to planning and practice

### **Key Messages from this chapter**

- The adaptation approach is the lens through which adaptation policy makers, planners and other decision-makers will understand and interpret a system and make judgements about its adaptation needs.
- Different approaches and assessment methods will reveal and conceal different aspects of a system. Ultimately, these visions and views underpin decisions about what is considered at risk or vulnerable, what is valued, what is deemed worthwhile protecting from harm, what can be traded off, and how to do it.
- Best practice adaptation planning should consider the many social, economic and environmental elements in a system, and their relationships. Broad and diverse engagement that is inclusive of multiple perspectives is key to gaining a contextually relevant understanding of adaptation risks and vulnerabilities and reducing the risk of maladaptation.

**Human-induced climate change is occurring now, and the impacts are increasing in Australia and across the world (IPCC 2014). We need to plan effectively to adapt effectively and effective adaptation planning can assist this process.**

Australia has already experienced warming of just over one degree since 1910, with most warming occurring since 1950 (Bureau of Meteorology and CSIRO, 2018). In Australia this has already caused increases in extreme heat, rainfall events, fire weather, cyclones, and rising sea levels (Bureau of Meteorology and CSIRO, 2018). Reduced overall rainfall and higher temperatures have created longer and more severe droughts (Bureau of Meteorology and CSIRO, 2018). Carbon dioxide and other greenhouse gases which have been released into the atmosphere, and are driving climate change, will remain for centuries. This means that even if all greenhouse emissions were to cease today, climate change will continue for centuries (IPCC, 2014). It is now a question of the scale of change, with higher emission scenarios resulting in greater impacts, risks and climate change adaptation challenges. For this reason, climate change adaptation, or a process of adjusting to the changes, is now unavoidable. According to the IPCC 'adaptation' is:

*"The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects." (2014: 1758).*

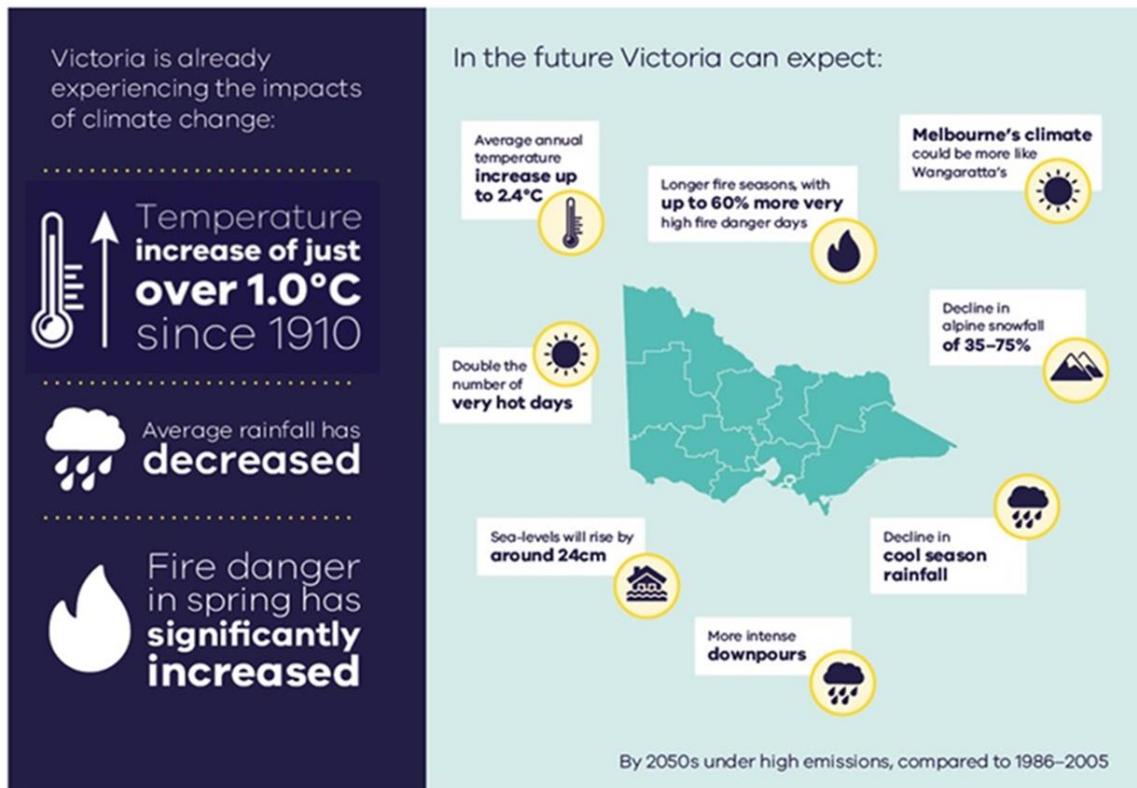


Figure 2: Summary of climate change in Victoria (DELWP 2019)

**Climate change adaptation is predominantly a context specific and place-based process, because the impacts of climate change can only be understood in relationship to a given context (Brunner, R.D.; Lynch, 2010; Adger et al., 2016). For adaptation planning to be effective, it must understand the whole system.**

Climate change impacts different sectors in different ways, and impacts upon people in the places they live, work and spend time. Climate change also has contextually specific consequences for ecosystems and natural environments. It is inadequate to think about or plan for climate change adaptation in isolation from the unique features of particular societies, sectors or environments (Adger et al. 2013; ISO 2019).

Therefore, climate change adaptation planning requires an understanding of not only the bio-physical climatic changes, but the whole system, including the social, economic and ecological components, their characteristics and dynamics (Maani, 2013). An adaptation planning process should start by defining the boundaries of the system that is being considered and its constituent parts including, for example, the natural and built environment and social groups (ISO, 2019). Because none of these elements are static, and many factors drive change in systems, climate change adaptation should be conceived of as an ongoing and evolving interplay between the various components in a system (Ison, 2010).

**Climate change adaptation planning involves making decisions in complex situations where goals and values are contested, and trade-offs are usually necessary. Because of this, diverse participation and equity are key principles of adaptation planning.**

Adaptation challenges are typically complex and involve many different stakeholders with different interests, levels of authority, responsibilities, vulnerabilities, capacities and power (Brunner and Lynch 2010). Interdependences between issues and stakeholders mean that no group can effectively manage complex issues alone (Brunner and Lynch 2010; Australian Government 2019) and attempts to do so may lead to maladaptive responses (Barnett and O’Neill, 2010); Adger et al 2013). Each adaptation planning process must consider how climate change is to be defined in that setting, who should be involved in the process, what are the goals and what would be considered successful adaptation (Smit et al 2000). Climate change adaptation planning requires fair and equitable forms of collaboration and multi-stakeholder processes to incorporate the diverse perspectives, knowledges, capabilities and needs into decision-making processes (Innes and Booher 2003; Bosomworth et al 2017; Schlosberg et al 2017).

**Best practice adaptation aims to avoid “maladaptation”. This means that an adaptation action does not create or perpetuate social vulnerabilities or environmental degradation, or shift the burden to other social groups or into the future (Barnett and O’Neill 2010; Eriksen et al 2011; Magnan 2014). Effective adaptation planning can help you identify and avoid potential maladaptations.**

Central to all adaptation decision-making are issues of social and ecological justice (Eriksen *et al.*, 2011); Mangan 2014). The benefits and costs of adapting, or not adapting, to climate change will be experienced variously by people, flora and fauna in places and sectors. How these costs and benefits are distributed, who pays and who benefits from adaptation measures are critical questions for any adaptation planning process (Eriksen et al 2011; Funfgeld and Mecvov 2011; Adger et al 2016). Any proposed or current actions should be evaluated on their potential to deliver socially just and environmentally sustainable outcomes (Eriksen et al 2011; Mangan 2014). Through these processes, adaptation needs to not only address acute and immediate risks, but it also to identify and target the root causes of currently unsustainability and inequity, for example underlying drivers of poverty and educational inequalities. This involves looking beyond simple cause-and-effect relationships, to identify and address systemic causes of unsustainability.

There are many ways to make changes in a system to facilitate adaptation. Incremental forms of adaptation often work from current practices and management approaches (IPCC 2014). They seek to maintain the system but may accrue over time into more substantial (transformative) changes (Pelling, 2010). These may also be understood to be resilience-based strategies. More transformative strategies seek to address the root causes or drivers of vulnerabilities, and make deeper- level system changes, or shift to new system-states (Pelling 2010; IPCC 2014). Explicitly transformative strategies are rare, because they generally involve challenges to the status quo, including questions of who has the power to define the issues and chose the actions. More typically, adaptation planning identifies a range of strategies encompassing both types of change.

**Adaptation planners must decide on adaptation approach or combination of approaches that will underpin their process. The choice of approach, whether explicit or implicit, can strongly influence which types of adaptation options and pathways are considered (de Boer et al 2010; Funfgeld and McEvoy 2011).**

The choice of adaptation approach is a critical part of adaptation planning. This choice may happen explicitly, or may be influenced by implicit and unreflected framing choices (de Boer, Wardekker and van der Sluijs, 2010). Frames are apparent in value-driven priorities and preferences for certain types of knowledge, and expressed through expert language and narratives (Funfgeld and McEvoy 2011). What comes to be the dominant framing of an adaptation process strongly influences decisions about who should be involved in the process, which parts of an organisation are responsible, which stakeholders are involved and types of assessment methods applied.

The triggers for adopting an adaptation approach based on one or a combination of frames may be driven by (Funfgeld and McEvoy 2011: 58):

- **A policy requirement or recommendation:** Implicit or explicit preferences for particular approaches are embedded in new policy, legislation, or even broad guidance.
- **Set sectoral standards:** Where adaptation planning is new or unregulated, approaches may be driven by opinion leaders or early adopters or through research and development that establishes approaches.
- **Alignment with organisational processes:** Organisations may adopt an approach that aligns with existing processes and objectives. For example, a risk management approach to adaptation may be adopted where a current risk management system is already in place.
- **Individual / professional influences:** Choice of approach can be strongly influenced by individual professional backgrounds, disciplinary traditions, values, knowledge, experience and focal areas of those driving adaptation in an organisation or setting.

Funfgeld and McEvoy (2011) stress the importance of reflecting on the underlying frames to make them more explicit and to develop a shared and contextually relevant framing for a particular adaptation process. They suggest that policy makers and practitioners “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 purpose of the activity.” (p: 58). In practice this can be established through collaboratively discussing a set of reflective questions at various points in the adaptation planning process, and by ensuring a diverse range of stakeholders are involved. The argument is that greater reflection about various framings, and developed shared framings, can help policy developers, decision-makers and practitioners develop adaptation processes which is explicit, mutually understood, accepted and best suited to a given context (Funfgeld and McEvoy, 2011).

**The predominant framing approaches used in climate change adaptation are hazard, risk, vulnerability and resilience. It is increasingly agreed to be best practice for hazards, risk and vulnerability to be considered together when informing climate change adaptation plans (IPCC 2019).**

There are linkages and overlaps in the way in which different approaches and their underlying concepts are interpreted and applied in practice [Table 1]. The different approaches are associated with different types of assessments; such as climate change impact, risk or vulnerability assessments. These are structured ways of looking at who or what may be affected by climate change, the drivers and consequences. Depending on which type of approach and assessments are undertaken, vastly different views and visions of the system being considered, and its adaptation priorities may emerge. Some views, interests, impacts, risks or vulnerabilities will be revealed while others are concealed or suppressed. This, in turn, strongly influences which adaptation options and pathways are considered, how costs and benefits of adaptation are distributed and what is deemed as worthwhile protecting from harm (Barnett and O'Neill 2010). It is now increasingly understood that climate change adaptation plans should be informed through an assessment that provides considers hazards, risk and vulnerability together. The IPCC conceptualises risk as being influenced by the hazard (e.g. bushfire weather), exposure to the hazard (e.g. settlements in the urban fringe) and vulnerability (e.g. physical vulnerability or susceptibility of structures to combustion, and social vulnerability or socioeconomic disadvantage) [Diagram X].

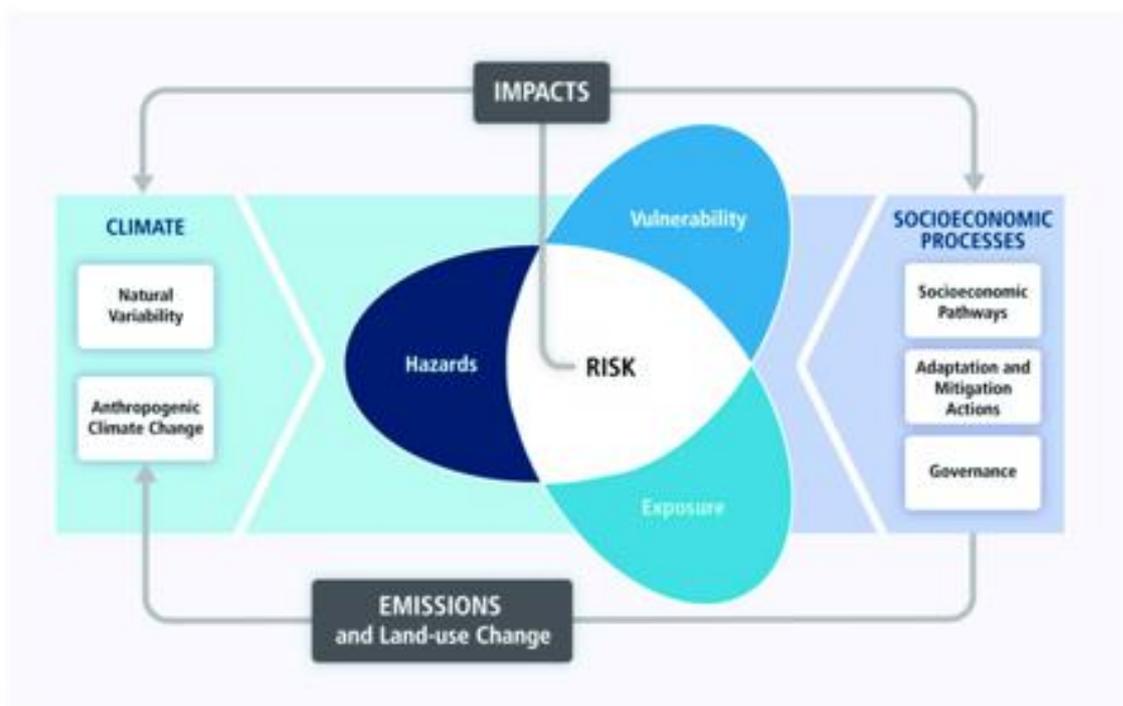


Table 1: Adaptation Approaches and Assessment Methods commonly used in practice (adapted from Funfgeld and McEvoy 2011)

<p><b>The Hazards approach:</b></p> <ul style="list-style-type: none"> <li>• A hazards frame is linked to natural resource management.</li> <li>• Although increasingly linked to broader notions of socio-economic and environmental trends, it is more narrowly linked to a linear and static notion of climate change impacts.</li> </ul> <p>A hazards approach is broadly associated with a <b>climate impact assessment:</b></p> <ul style="list-style-type: none"> <li>• This approach uses quantitative data where available, leading to quantifiable estimates.</li> <li>• Uncertainty is a major problem because climate models are not able to give accurate local and regional scenarios for many climate variables.</li> </ul>
<p><b>The Risk-management approach:</b></p> <ul style="list-style-type: none"> <li>• This is a dominant, organisational practice for dealing with many types of uncertainties in local government and the private sector.</li> <li>• Central to the notion of risk are uncertainty and perception.</li> <li>• Risks is defined as the combined product of hazards, exposure and vulnerability and there is a close connection between hazards and risk management approaches.</li> <li>• Risk management has become a dominant frame in the Australian context to deal with, and minimise many kinds of uncertainty.</li> </ul> <p>A risk management approach is broadly linked to a <b>climate change risk assessment:</b></p> <ul style="list-style-type: none"> <li>• Most risk assessment approaches, even those in adaptation planning, stem from disaster risk management. They aim to identify and prioritise risks and plan risk management strategies.</li> <li>• Some risk assessments consider likelihoods and consequences, while others consider risk as a function of vulnerabilities, exposure and hazards.</li> <li>• A strength they fits with existing organisational procedures and be readily integrated into existing risk management systems.</li> <li>• Can be effective in dealing with uncertainty</li> <li>• A limitation is that the approach can lead to a more inward focus, often to the neglect of the interests of other external stakeholders.</li> </ul>
<p><b>Vulnerability approach:</b></p> <ul style="list-style-type: none"> <li>• Focus is on who or what will be affected and in what way.</li> <li>• A wide range of policy responses to vulnerability are possible.</li> <li>• A contextual framing of vulnerability consider vulnerability in the broader context of interactions between climate and society.</li> </ul> <p>A vulnerability approach is broadly linked to a <b>vulnerability assessment:</b></p> <ul style="list-style-type: none"> <li>• There are many different vulnerability assessment methods.</li> <li>• They typically assess the characteristics of a vulnerable system, the type and number of stressors, and how these impact on the system.</li> <li>• They can add valuable, bottom-up perspectives for adaptation and be used to build a case for adaptation based on local data and information</li> <li>• 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.</li> <li>• A limitation is that transferability of assessment results can be difficult due to many different assessment methods</li> </ul>
<p><b>Resilience Approach:</b></p> <ul style="list-style-type: none"> <li>• There are many conceptualisations of resilience, but it stems from the idea of a system being able to bounce back to previous functions after a shock.</li> <li>• In the context of climate change repairing a system after a climate related event may be insufficient or maladaptive if the system was previously socially unjust and inequitable. Transformative systemic changes may be necessary to avoid future impacts.</li> <li>• Its strength may be as a concept for communicating climate change adaptation issues, but it is difficult to put into operational practice and has not been developed into any commonly used assessment methods.</li> </ul>

### 3 SCENARIO PLANNING: CHALLENGES, APPROACHES, AND KEY LESSONS

#### ***Key Messages from this chapter***

- Climate change, as well as many other drivers of change in systems, means that policy- and decision-makers must contend with inherent and deep uncertainty.
- The use of multiple future scenarios and robust strategies are methods that can be utilised to plan in the context of uncertainty
- There are many different types of scenario planning methods. Those that take a more participatory approach can encompass a wider range of uncertainties, values and needs.
- This chapter explores the challenges to best practice adaptation planning, the different scenario approaches can be used to suit different adaptation planning contexts, and more.

**Climate change adaptation planning must contend with deep uncertainties about how the future will unfold. Scenario planning allows for an exploration of what might happen in different sets of circumstances or system trajectories.**

Using scenarios can help people imagine, and plan for, very different futures states and pathways under different sets of assumptions. Scenarios can be broadly defined as ‘coherent descriptions of multiple alternative, hypothetical futures’ (Dessai, Lu and Risbey, 2005).

The IPCC (2014: 1270) defines scenarios as “A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e. g. the rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts but are useful to provide a view of the implications of developments and actions.”

*There are different scenario planning approaches and methods being used in adaptation planning, the most common of which are climate change scenarios.*

Climate change scenarios, broadly, model the changes in climate (e.g. precipitation, temperature, sea level rise) at various concentrations of atmospheric greenhouse gases over different timeframes. The most influential climate change scenarios on a global scale are those developed for the IPCC assessment process (IPCC 2014). The most recent iterations of these, used in the IPCC’s fifth assessment report (IPCC AR5) are the representative concentration pathways (RCPs). The IPCC presents four sets of RCPs that are based on ‘radiative forcing’ or measures of the combined effect of all greenhouse gases, aerosols and other radiative forcing’s that may be added to the global system in 2100 compared to pre-industrial levels. The RCP scenarios identify endpoints and plot potential pathways of how

concentration levels may get there. There are many possible ways that might take us towards those futures, but the RCPs are not associated with any socioeconomic or emissions scenario, or any probabilities.

*Climate change scenarios develop projections that can indicate the range of potential climatic changes.*

These projections can help to bound the ranges of uncertainty in terms of changes to the climate system. Climate change scenarios can be thought of as ‘top-down’ approach to scenario development, because they are generated using data derived from global trends (Dessai, Lu and Risbey, 2005; Biggs *et al.*, 2011; Rose and Star, 2013). It has been argued that “using scientific climate change information for adaptation may be best suited to awareness raising and to adaptation planning at international and national levels” (Hinkel *et al.*, 2010). While 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.

*‘Bottom up’ approaches, broadly, focus the development of context-specific, place-based vulnerability and adaptation needs.*

‘Bottom-up’ scenarios are often developed through a more participatory process that utilises context-specific knowledge to help identify implications and possible responses to climate change in specific settings (Wiseman *et al.* 2014). Bottom-up scenarios reflect an understanding that effective adaptation needs to be deeply embedded in local knowledge that that adaptation is a continuous process of social learning requiring the participation of actors and institutions at various levels of decision making. Distinctions between the two broad approaches (top-down and bottom-up) are outlined in Table 1.

**While different scenario approaches can be used to suit different adaptation planning contexts, those that take a more participatory approach can encompass a wider range of uncertainties, values and needs.**

In complex, interconnected systems, climate change impacts transmit and cascade in ways that are impossible to predict (Adger *et al.* 2009; Challinor *et al.* 2017; Lawrence *et al.* 2018). Further, climate change is just one driver of change; there are many other social, environmental, technical, political forces that can create even greater uncertainty when thinking about, and planning for, the future. ‘Bottom up’ scenario planning approaches enable groups to work together using different types of knowledge to test assumptions and develop alternative narratives about future trajectories of a system. Hence, these approaches to scenario planning are more than just a method to structure information; they are also a way to stimulate collaboration and social learning, creativity and greater confidence in dealing with uncertainty (Kahane, 2012).

Table 2: Comparison of ‘top-down’ and ‘bottom-up’ scenario approaches

	‘Top-down’ Scenario Approaches	‘Bottom-up’ Scenario Approaches
--	--------------------------------	---------------------------------

Driven by	Researchers, modelling community	Scenario users/ organisations, participants, stakeholders
Data type	Global trends, quantitative	Organisational, local and stakeholder knowledge, expert knowledge Quantitative and qualitative
Focus	Hazards, Impacts	Vulnerability, Adaptation
Assumptions to future states	Predictive, forecasts, projections,	Plausibility
Relationship to uncertainty	Probability, controllability	Unpredictability, inherent uncertainty, complex adaptive systems (CAS).
Supports planning that is	Predict-and-act or robust planning	Robust planning
Scale	Downscaled data from global and regional climate models	Tailored, context-specific planning process
Scenario types used	Predictive, 'Off the shelf'	Exploratory, normative

**Although uncertainty has always been a feature of water planning due to year-to-year variability; climate change presents new challenges in the way water managers plan for the future (Lempert and Groves 2010).**

Water managers can no longer assume that historical hydrological conditions of the past will be good guides for the future; including basic assumptions about future water yields, customer demands, health of water catchments and aquifers and regulatory environments (Lempert and Groves 2010). Further, the techniques commonly used for water modelling do not capture all the uncertainty and the ongoing dynamism inherent in climate, ecological, social and economic systems (Maier et al 2016). The deep uncertainty in how the future will unfold means that it is impossible to predict precisely how climate change will manifest in any context or timeframe (Hallegate et al 2012). This has led to the understanding that *multiple plausible future scenarios* need to be considered in planning (Haasnoot et al 2012; Hallegate et al 2012).

Planning that uses a 'most likely' climate change scenario, relies on a single 'worst case' or identifies 'optimal responses' has a high risk of developing the wrong options over the long

term or even making matters worse (Haasnoot et al 2012; Maier et al 2016). For example, we have no way of precisely defining what the ‘worst case’ might be; particularly given that some people or systems are already in ‘worst case’. One way of engaging with this challenge, is to test our thinking and plans against multiple plausible futures and use these to explore the robustness and flexibility of different climate change adaptation options across multiple possible futures (Haasnoot et al 2012).

Water management needs to identify adaptation options and pathways that could sustain under a range of possible futures and different possible pressures and a wide range of uncertainties. A robust strategy develops one or several options that will perform well across multiple plausible futures with a range of uncertainties (Haasnoot and Mittelkoop 2012). This includes natural uncertainties such as extreme weather events; social uncertainties e.g. changes in values and preferences; and technological uncertainties. A robust strategy is iterative and adaptive, integrating new information over time to allow decision-makers to switch from one strategy to another (Hallegate et al 2012).

“While quantitative modelling of climatic trends – and of other social, economic and environmental drivers – can be a useful input in scenario building, the real value and power of scenario planning lies in its emphasis on plausibility rather than probability; multiple rather than singular futures; and out-of-the-box surprises rather than linear trends” (Wiseman et al 2014: 118)

### 3.1 Scenario Typologies

**Within the broad approaches to scenarios described above, different scenario types can also be understood through more specific typologies of the ranges of scenarios used in practice.**

Borjeson et al (2006) have developed a typology of scenario use based on three different modes of thinking about the future. These are *predictive* (what will happen)? *Normative* (how can a specific target be reached)? And *exploratory* (what can happen)? (Borjeson et al 2006: 725). Each of these three types is further divided into two sub-types (figure 3), while further information on the types of questions which can be asked, and the scenario types that results, is found in table 2.

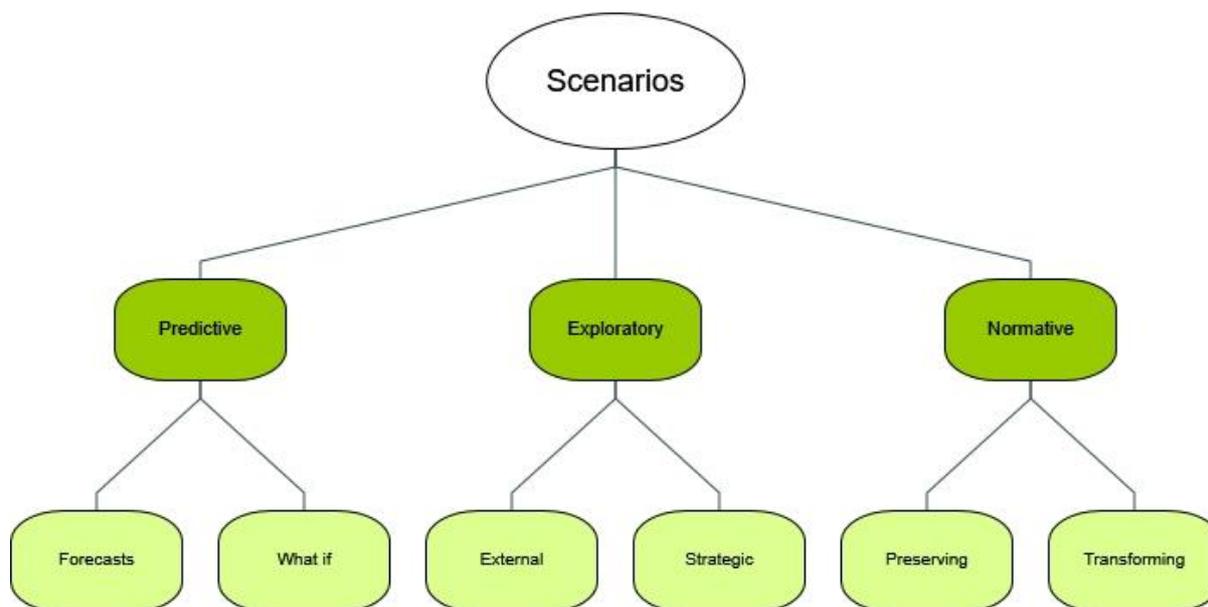


Figure 3: Scenario typology from Börjeson et al. 2006, with three categories and six types

Table 3: Principal future-oriented questions and corresponding scenario type, from Börjeson et al. (2006)

Question posed about the future	Scenario category	Sub-question	Scenario type
<i>What will happen?</i>	Predictive	What will happen, on the condition that the likely development unfolds?	Forecasts
		What will happen, on the condition of some specified events?	What-if
<i>What can happen?</i>	Explorative	What can happen to the development of external factors?	External
		What can happen if we act in a certain way?	Strategic
<i>How can a specific target be reached?</i>	Normative	How can the target be reached, by adjustments to current situation?	Preserving
		How can the target be reached, when the prevailing structure blocks necessary changes?	Transforming

**Predictive scenarios:** *These scenarios are essentially forecasts and are closely related to the concepts of probability or likelihood of a future taking place.*

The aim of predictive scenarios is to attempt to predict what is going to happen in the future, or to develop a ‘best guess’. As noted above, in climate change adaptation planning, where there is inherent uncertainty and long-term future planning is required, any prediction or any ‘best guess’ is most likely to be wrong. Therefore, the use of predictive scenarios or any one most likely scenario is not a reliable basis for long-term climate change adaptation decision-making. Other typologies exclude predictive scenarios altogether because they are regarded as projections and not scenarios (Wiseman et al 2014). So, while there is some debate as to

the extent to which predictive approaches are considered scenario planning, this term is widely used by practitioners and is therefore be considered in this analysis.

**Normative scenarios:** *Focus on how a certain desired future or objectives could be realised or 'what we want to happen'*

Normative scenarios may seek to maintain a current situation or achieve goals and objectives at some future point. These scenarios often use backcasting where scenario developers envision one or several desirable visions of images of the future. These may present a solution to a pressing problem and have a long-time perspective of 25–50 years (Borjeson et al 2006: 728-9).

**Explorative scenarios:** *These scenarios respond to the question 'what can happen' or 'what could happen'?*

The aim with explorative scenarios is to explore situations or developments that are regarded as plausible accounts of the future. These can be either external to (i.e. What can happen to the development of external factors?) or strategic scenarios (i.e. What can happen if we act in a certain way?) (Borjeson et al 2006). Explorative scenarios can help to explore complex situations where there are multiple stakeholders and deep uncertainties. This can be in situations when the structure to build scenarios around is unknown, e.g. in times of rapid and irregular changes or when mechanisms that will lead to some kind of threatening future scenario are not fully known. Borjeson et al (2006) divides these into external scenarios and strategic scenarios.

**External scenarios:** *This scenario type focuses on factors beyond control of the relevant actors*

They are typically used to inform strategy development of a planning entity. In explorative scenarios, the generating phase is very important. Generating techniques such as workshops have been frequently used in scenario planning. Policies are not part of the scenarios but the scenarios provide a framework for the development and assessment of policies and strategies. The external scenarios can then help to develop robust strategies, i.e. strategies that will survive several kinds of external development.

**Strategic scenarios:** *These scenarios incorporate policy measures at the hand of the intended scenario user to cope with the issue at stake*

The aim of strategic scenarios is to describe a range of possible consequences of strategic decisions. Strategic scenarios focus on the internal factors and take external aspects into account. They describe how the consequences of a decision can vary depending on which future development unfolds.

**Kahane's (2011) transformative scenario planning approach:** *This approach underscores the power of scenarios to shape the trajectory of a system through the development of new systemic understandings and cross-system relationships*

The power of a transformational approach to scenarios is through a developmental experience of key actors in the scenario process. The process engages key actors in the system in a process that acts as a milieu for the development of “new cross-system relationships and new system-transforming intentions” (p.34). Transformative scenario planning enables people to transform their problematic situation through building a strong alliance of actors who deeply understand the situation, one another, and what they need to do” (Kahane 2011: 21-22). Like Kahane (2011), Wilkinson and Eidinow (2008) emphasise the value of scenario development as an ongoing process that can lead to the co-production of knowledge and the importance of having key actors engaged in the process. The scenario process is not a one-off event but an ongoing process where each intervention builds onto the next round of scenario building need to change both mindsets and behaviours (Wilkinson and Eidinow 2008: 9).

#### **Participation in a process can also privilege certain perspectives over others**

For example, the professional settings in which scenario processes are carried out may have assumed and unquestioned ways of working, policy goals and norms of desirability and acceptance. Simply having a range of stakeholders in the room does not guarantee that all voices and perspectives will be equally weighted. The important point is to explicitly consider the aims, intentions, relative power and authority and underlying epistemological assumptions of participants in the process (Wilkinson and Eidinow 2008; Kahane 2011). A longer, more sustained and iterative scenario planning process may be more likely to lead to the emergence and co-evolution of different types of knowledge (Kahane 2011).

#### **While scenarios can be expert or participatory driven or wholly qualitative or quantitative, most scenarios involve a mix of methods, both subjective and objective inputs and outputs (Amer et al, 2013 in Rickards et al 2014; Star et al 2016)**

The benefits of combining both researcher and participatory are being tested at different levels (Star et al 2016). Scenarios present both the difficulties and possibilities in bridging different epistemological and research traditions (Rickards et al 2014).

## 4 CURRENT USE OF SCENARIOS IN THE VICTORIAN WATER SECTOR

### 4.1 Research methods

#### **Key messages from this section on the research methods undertaken in this study**

The study employed:

- An online survey, to understand how the water sector are using scenarios for climate change adaptation planning more broadly (n=28).
- A poll, to understand the extent to which scenarios are being used for climate change planning in the water sector (n=5). Subsequently excluded from analysis due to low uptake of the poll.
- Semi-structured interviews, to gain a richer and more in-depth understanding of this use (n=25).

Purposive sampling was used to target individuals working in Authorities within the water sector, as per the roles and responsibilities defined in Figure 2 from the pilot WSAAP.



Figure 4: Summary Water Sector Governance Framework (DELWP 2018, p. 28).

Table 3.1. Organisation and their responsibilities relating to climate change adaptation in the water sector (DELWP, 2018, pp. 30–32) also informed the RMIT teams mapping of the sector to inform recruitment, as outlined in fig.4 below. Organisations coloured green in fig.4 indicate representation in the interview process.

Respondents in both the survey and interviews had roles with relevance for / overseeing / pertaining to (determined through interview questions about the participants' role):

- water supply services
- wastewater services
- waterway management
- irrigation
- recreational area management
- floodplain management
- licencing
- asset management.

The project team also spoke to participants with oversight across their respective business through their role in strategic management, integrated planning, and / or climate change coordination and / or capacity building for their business.



Figure 5: Interview recruitment for 'Reviewing use of scenarios and understanding sector needs to inform principles for embedding climate change considerations in Water Sector decision-making'. For more information on the roles of different water corporations in Victoria, see <https://www.water.vic.gov.au/water-industry-and-customers/victorian-water-corporations>

The survey and interview responses were analysed and coded using the qualitative analysis software NVivo 12 (QSR International). The close-ended survey results were analysed in excel. The poll was excluded from analysis.

#### 4.1.1 Survey

The online survey was open for May and June 2020, and was distributed to water sector stakeholders (e.g. recipients of the Victorian Water and Climate Initiative (Vic WACI) newsletter) in several ways, as outlined in detail at [APPENDIX A](#).

Survey questions contained a mix of open-ended and close-ended responses and were largely focused on eliciting a qualitative response as to the participants' understanding and experience of scenario use with reference to adaptation planning.

A total of 43 responses were recorded for the survey, representing an 8.6% response rate (total distribution = 500). However, 15 responses were excluded from analysis as they were not completed (n=28 for survey respondents. 5.6% revised response rate).

#### 4.1.2 Poll

Because self-selection for the survey skewed towards those actively using scenarios for climate change adaptation planning, a further poll was proposed to understand this within the context of the water sector more broadly, and to help contextualise the response rate.<sup>1</sup> The poll asked for yes or no response to the question:

Does your organisation use any form of scenarios in its planning for climate change?

The poll was distributed to 125 water sector stakeholders via DELWP in the 5<sup>th</sup> Aug 2020, however, only five responses were recorded. Of those responses, two participants participated had already provided interviews for the project. As the poll did not elicit a meaningful response, it is excluded from analysis in the results and discussion.

The low response rate to the poll could be due to the distribution method, i.e. it was distributed in an update email, with information relating to the WSAAP more broadly, and including several different response requests. If a poll is conducted in the future, a standalone communication requesting a response to the poll could allow for better analysis of distribution success.

#### 4.1.3 Interviews

The project team conducted a total of 25 semi-structured interviews from June to August 2020 to elicit qualitative data relating to participants experience of the use of scenarios for

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<sup>1</sup> It should be noted though that as this was distributed through the Pilot Water Sector Adaptation Action Plan contacts by the Hydrology and Climate Science team within DELWP, self-selection was likely still skewed to individuals more likely to be considering scenarios and climate change within their work.

adaptation planning in the water sector, and what might facilitate uptake and use in adaptation planning (see Appendix C for the interview questions).

Interviewees were recruited through the survey (which provided an opportunity to opt into the interview process). Analysis of the distribution of those who opted in was completed by the project team to target further recruitment for interviews.<sup>2</sup> Further recruitment was completed through direct contact.

Interviews were conducted via Microsoft teams for a duration of thirty to sixty minutes, and recorded and transcribed (excluding one interview, for which notes were recorded).<sup>3</sup>

#### *4.1.4 Supplementary material*

To supplement the information provided in the interviews, several participants also shared relevant information to provide context to scenario planning and / or adaptive planning processes they were involved with or were familiar with.

The project team were also provided with responses to a separate survey conducted by DELWP in 2020. This separate survey was designed to inform the development of a guidance document on adaptation business cases. The question with relevance to this project:

Where appropriate does your organisation undertake a risk analysis of climate impacts, including economic, social and environmental impacts? Does this include climate scenario planning?

These results were analysed alongside the data collected for this project.

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<sup>2</sup> The survey sample was found to have good representation from individuals employed through Catchment Management Authorities and Metropolitan Melbourne water corporations but was limited in regional and rural representation.

<sup>3</sup> The audio recording was unavailable due to an Australasia wide Microsoft outage on the 15 June 20 in the morning and early afternoon, and the interview was conducted by phone and interview notes were taken.

## 4.2 Study results

### **Key messages from this section - key results from this initiative**

- Scenarios are being widely used in the Victorian water sector. They are viewed as an important part of adaptation planning.
- Participants most frequently use scenarios to deepen their understanding of risks, variables influencing the system, and possible directions of change. Scenario planning can help build capacity to undertake adaptation planning.
- Scenario planning is typically undertaken to address an identified risk or regulatory requirement.
- Predictive scenarios are the most utilised typology.
- Typically, climate change scenarios used in the sector relate to biophysical conditions (temperature, precipitation conditions) with socioeconomic inputs included through demand forecasting.
- Scenario planning is more established for water resource planning than for other areas of the water sector.
- The key strength of scenarios identified by participants is contribution to robust and / or flexible adaptation planning.
- Robust and / or flexible planning approaches are in the early stages in the Victorian water sector. While referenced on a strategic level, a lot of work is needed for these approaches to be embedded across all water business decisions.
- A risk management approach is the most common framing for adaptation planning amongst participants.
- See section 4.4 for a discussion of barriers and enablers for scenario use in adaptation planning identified through this research.

This section of the report describes how scenarios are being used across the water sector (the types and methods), and why they are being used. It then sets out findings in relation to how the sector (broadly) views the strengths and challenges of scenario development and use for adaptation. Read this section if you are interested in understanding the data in greater depth, including direct quotes informing coding, and the themes emerging from the data.

### **4.2.1 Use of scenarios in the Victorian Water Sector**

#### **Section key messages:**

- The overwhelming majority of the respondents indicated that their organisation is using some form of scenario planning in their adaptation work.
- Scenario development and use is most established for water supply planning.

All interviewees n=25 are, or have been, involved in scenario use or development to some extent. Of the 27 survey responses to this question, only one response (1, 3.7%) suggested that their organisation was not using any form of scenarios (Fig.5). This respondent did not

provide their organisation or role in their survey response. 9, 33.3% are using them moderately, 7, 25.9% are using them extensively, 7, 25.9% are using them to some extent, and 3, 11.1% are using them to a small extent.

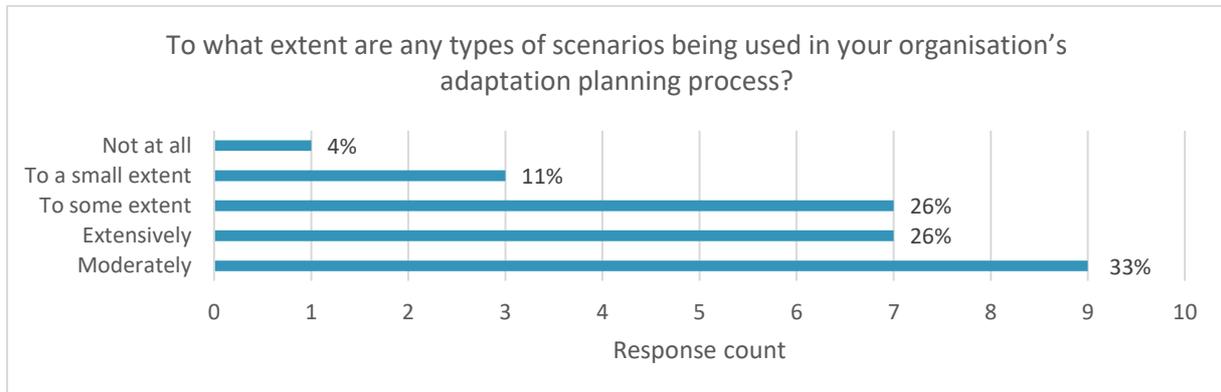


Figure 6: Extent of scenario use, survey response

However, the extent to which scenarios are used across the different business areas of the sector varies. Scenario planning was noted by participants to be most established within water supply planning where there is an existing policy mandate and guidelines for scenario development and use. It is less established for business areas such as sewerage and waterways.

*“the water supply planning is perhaps more sophisticated with regard to considering climate change and considering multiple possible futures ... Whereas there's other parts of the business that are maybe kind of just now starting to grapple with. What an adaptive approach looks like for them.”*

The descriptions of why this is relates to greater levels of uncertainty and complexity for other systems, a lack of established methods and guidance, less of an impetus from the Millennium Drought (see ‘catalysts’ below) and in some instances longer planning horizons.

#### 4.2.1.1 Types of scenarios used in adaptation planning

##### Section key message:

- Predictive scenarios (*what will happen?*) are the most frequently used scenarios in the water sector identified by participants.

Reflecting insights from the literature reviewed in Section 3.1, participants interpreted the term ‘scenarios’ in different ways. These conceptualisations broadly map the typology outlined by Börjeson *et al.* (2006): predictive, exploratory, and normative (see [Scenario Typologies](#)). The survey asked respondents to categorise scenario typologies utilised, through

a multiple-choice response.<sup>4</sup> Survey results<sup>5</sup> indicate that scenarios used in the water sector are typically predictive (15, 51.7%) applied through ‘top-down’ methods and reliant on quantitative data such as downscaled climate projections (see survey results at figure 7). Less used in the sector are exploratory (6, 20.1%) and vision scenarios (6, 20.1%) which typically combine qualitative forms of knowledge with quantitative knowledge, through a ‘bottom-up’ approach with multiple stakeholders, drawing on expert and organisational knowledge to explore climate projections and implications on a local / regional scale.

Figure 8 outlines trends for interviews. Categorisation in figure 8 is based on participants’ description of scenario development and use. Multiple typologies may be identified for the same interviewee. Predictive scenarios are referenced in 17 of 25 (68%) interviews, exploratory in 12, 48%, and normative in 2, 8%. It is displayed separately from survey results as it was not posed as a close-ended question. There was a tendency for participants to alternate using language indicating they framed scenarios functioning in predictive what if (what will happen?) and exploratory (what might happen?) ways. This indicates the role and function of scenarios is ambiguous even for practitioners.

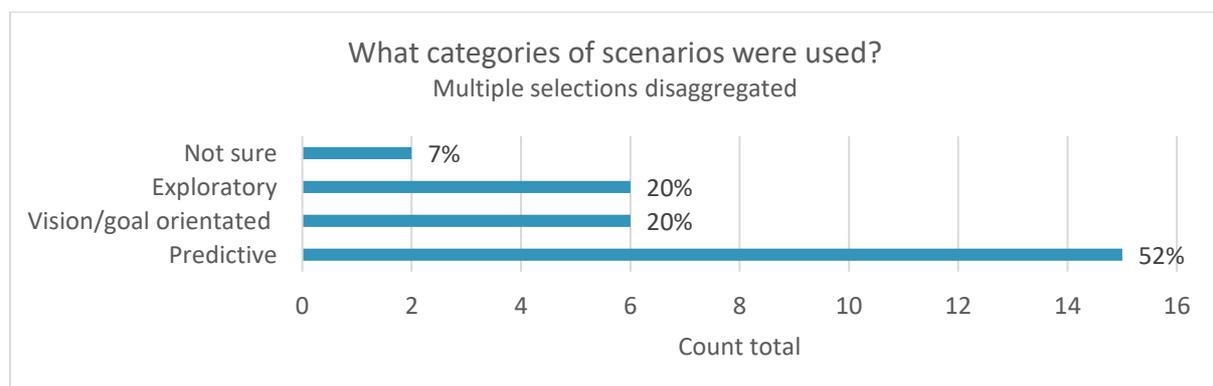


Figure 7: Categories of scenarios utilised across the organisation – multiple selections disaggregated.

<sup>4</sup> Utilising the typology *predictive – what will happen in the world (forecast or what if scenarios), exploratory – what might happen in the world (external) or to our organisation (strategic), vision/goal oriented – scenarios of an ideal world / organisation, other (please describe).*

<sup>5</sup> Disaggregated typology count=29, this is displayed in figure 8. This is total count for typology selections by participants as multiple selections were possible.

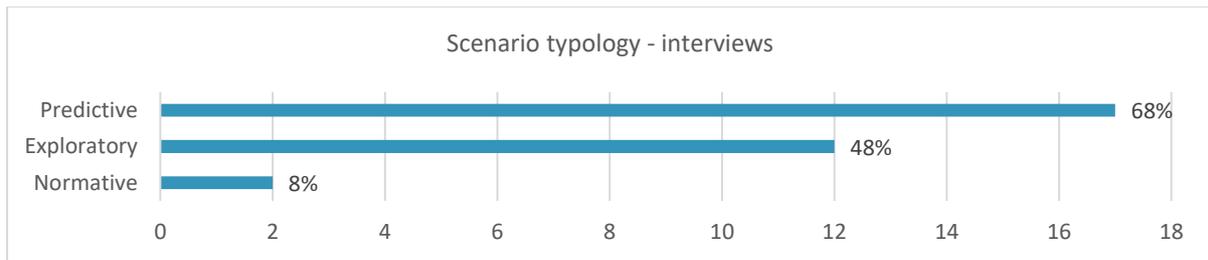


Figure 8: % of interviews in which different typologies were discussed in use across the organisation, of total n=25. As proportion of total count (comparable to survey results displayed in figure 7), disaggregated count is 31, normative (2, 6.45%), exploratory (12, 38.7%), predictive (17, 54.8%)

As noted in the literature, multiple methods and scenario types are increasingly being used to support adaptation planning (see for example Star *et al.*, 2016). This trend is reflected in the Victorian water sector. While survey respondents identified that predictive scenarios are frequently used as a standalone process (6, 33.3%), it is more common in the water sector to draw on a combination of scenario types (11, 61.1%) (see figure 9 for more detail).<sup>6</sup>

Subsequent interviews to identify how different scenarios are utilised identified that:

- Multiple types of scenarios are used discretely for projects or parts of the business –for example *forecasts* for water supply planning, *what-if* to conduct an asset risk assessment, etc.
- There is some experimentation (n=3) with using multiple methods to explore different aspects of a problem, such as engaging with risk and uncertainty through exploratory scenarios and engaging with external stakeholders about desirable futures.

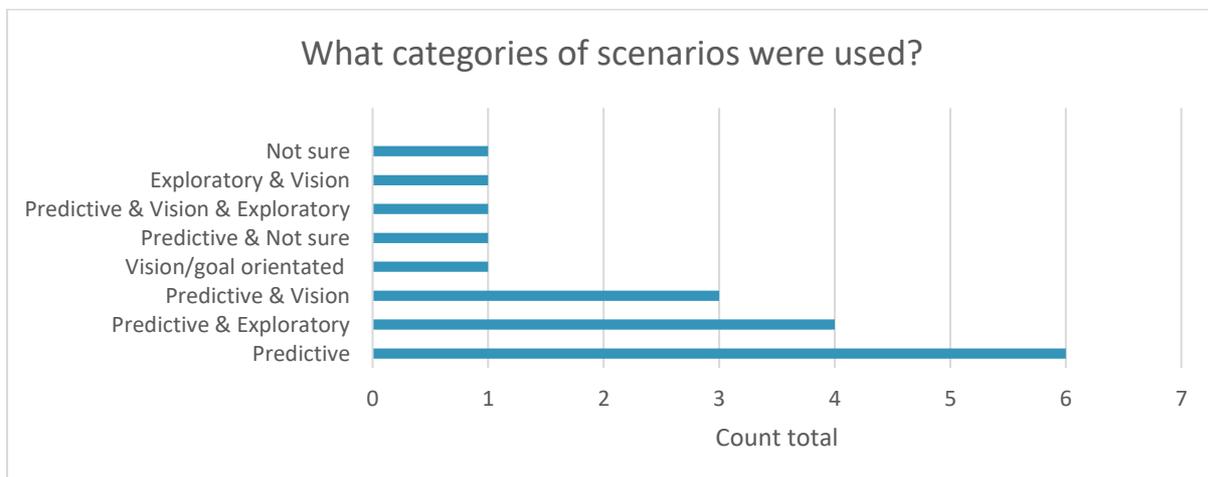


Figure 9: Categories of scenarios utilised across the organisation - multiple selections

Methodologies for scenario planning identified by participants in this research include:

- Stochastic modelling
- Socioeconomic modelling (particularly demand forecasting and population growth),

<sup>6</sup> Survey respondents to question, n=18.

- Monte Carlo analysis
- Hazard mapping
- Hydrological modelling
- Deductive methods whereby key uncertainties are mapped alongside key risks in a 'quadrant'
- PESTEL analysis, which analyses political, economic, social, technological, environmental, and legal factors.

Several participants argued a successful boundary or scope is the catchment / sub-catchment / infrastructure specific scale. Discussions suggested detailed scenario planning was more difficult when the geographic scope was too large, adding to the complexity of the system.

*"I think it was a successful because it had a scope and it had a kind of spatial location that could be grappled with, whereas some of the other parts of the business are so complex by nature and involve a lot of other stakeholders."*

Consultants are used extensively to both produce modelling outputs and facilitate exploratory / normative processes. It was noted that the role consultants should play in scenario development and use raises questions about the appropriateness of the extent of consultant use.

*"I think there's a real trap for DELWP and for all of us in relying on consultants to kind of record and share what to do because they will be tempted to go with what they know and we need to be reflecting and learning actively ourselves by participating and sharing what we learn with each other in order to get better at doing this."*

#### 4.2.1.1.1 Predictive scenarios

##### **Section key messages:**

- Interviews to gain farther insight into the data indicate *What-if* scenarios (*What will happen, on the condition of some specified events?*) are the most used form of predictive scenarios
- However, there is some evidence of *forecasts* (*What will happen, on the condition that the likely development unfolds?*) also being utilised in short- but also medium-term planning.

*What if* predictive scenarios (10, 40%) are used extensively in the water sector.<sup>7</sup> For example, incorporating RCP 4.5 and RCP 8.5 scenarios from the IPCC, often combining these emissions scenarios with population and demand forecasts. Several (n=3) interviewees noted utilising RCP 8.5 as a *forecast*, because they/their organisation suggested that it reflects extrapolations of observed conditions and / or judgments about the 'most likely' emissions scenario based on current emissions profiles.

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<sup>7</sup> Count from interview data only, n=25, as there was no further delineation of predictive scenario typologies in the survey

*“we decided to go a high emissions scenario because that's the trajectory that we're currently following”*

Use of predictive scenarios is evident in short-term planning (4, 20%)<sup>8</sup> (i.e. quarterly and annual planning) drawing on information such as the DELWP *Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria* (herein, DELWP Guidelines) (2016), BOM outlooks, commodity outlooks, and other relevant information. This is conducted in line with regulatory requirements such as water outlooks (including desalinated water orders), and water allocation. Multiple participants (5, 25%) also noted using predictive scenarios for medium term planning such as pricing submissions to the Essential Services Commission, and in long-term planning (7, 35%) to inform (for example) long-term strategy development and infrastructure decisions.

To construct predictive scenarios, participants noted drawing on a variety of quantitative inputs, depending on the area of the business. For water resource planning, the DELWP Guidelines are utilised. The DELWP Guidelines are likely to be interpreted through in-house expertise within water corporations. Other services and asset management (for example, waterways, sewerage) constructing predictive scenarios were likely to draw external information such as projections from the CSIRO and / or the VCP19 datasets (because of the relatively recent release of the VCP19, some participants expressed an intent to incorporate the VCP19 in future work). The predictive scenario outputs typically draw on projections and other information such as broad demographic trends (such as through *Victoria in Future*, and data as provided by local governments). Consultants are widely used to produce these types of scenario outputs.

#### 4.2.1.1.2 Exploratory scenarios

##### **Section key messages:**

- Interviews to gain farther insight into the data indicate *strategic* scenarios (*What can happen if we act in a certain way?*) are the most used form of exploratory scenarios.
- The inclusion of qualitative data about norms and goals are valuable inputs for context-specific scenarios.

There is evidence of both *external* (n=1) and *strategic* (n=18) exploratory scenarios being utilised in the Victorian water sector. For example, *external* scenarios may relate to sea level rise and risks to low-lying coastal assets. *Strategic* scenarios are used to examine what different interventions to sea-level rise might be. Informal or qualitative forms of knowledge, such as local and organisational knowledge about behaviours, expert elicitation and norms and values, are utilised in exploratory scenarios within the Victorian water sector, with the same range of quantitative data drawn on as for predictive (VCP19, DELWP Guidelines, CSIRO

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<sup>8</sup> Count where planning horizon was specified by participant, n=20

& BoM, as well as population forecasts, etc.). Norms and values are important in *strategic* scenario planning, as they will shape adaptation responses.

*“we as a group developed our own set of scenarios... that we then used to frame to think about options. So that they were ... quite unique to that spatial location and ... the type of development ... that might happen around it. They were ... things like what if... we decide to take an approach that really values community over biodiversity, then that could be a kind of key pillar within one of the scenarios. Or what about the inverse? What if we really decided to prioritise biodiversity over social outcomes? ... and ... drawing in other ... political... considerations about .... Selling land to developers alongside the ... treatment plant or increasing nearby resident residential development. “*

Exploratory scenarios are typically produced in the sector through a structured scenario planning process facilitated through external consultants. Exploratory scenarios were noted as being utilised in medium-term and long-term planning.

#### 4.2.1.1.3 Normative scenarios

##### **Section key message:**

- The inclusion of qualitative data about norms and goals are necessary inputs to answer the question *How can a specific target be reached?*
- Normative scenarios can be important to develop a vision or goal but changing practice and securing commitment for implementation can be difficult.

Normative scenarios are being utilised in the Victorian water sector (n=2, 8% in interview data, n=6, 20% in survey data). The two participants who identified normative scenarios through the interview process were referencing the same process (see Appendix E, Our Water Future for Upper Merri Creek Communities). Normative scenarios were identified as a powerful tool for engaging with stakeholders and building a shared understanding of the need for change, but difficult to engage with for the purposes of adaptation planning. The backcasting aspect of normative scenarios (working back from a vision or goal to understand structural changes that are likely to be necessary to achieve that goal or vision), was identified as difficult in terms of gaining commitment for change.

As with exploratory scenarios, normative scenarios incorporate qualitative as well as quantitative knowledge – i.e. organisational knowledge, expert elicitation, and a shared discussion of norms and values, with the same range of quantitative data drawn on as for predictive (VCP19, DELWP Guidelines, CSIRO & BoM as well as population forecasts, etc.). Normative scenarios also included external stakeholder participation (e.g. local government). As with exploratory scenarios, normative scenarios identified through this research are produced through a structured scenario planning process facilitated through external consultants. Normative scenarios are being utilised through the water sector for longer-term planning.

Table 4: Information inputs discussed by participants. All interviewees discussed utilising quantitative inputs. Qualitative inputs are less commonly utilised. Total n=25

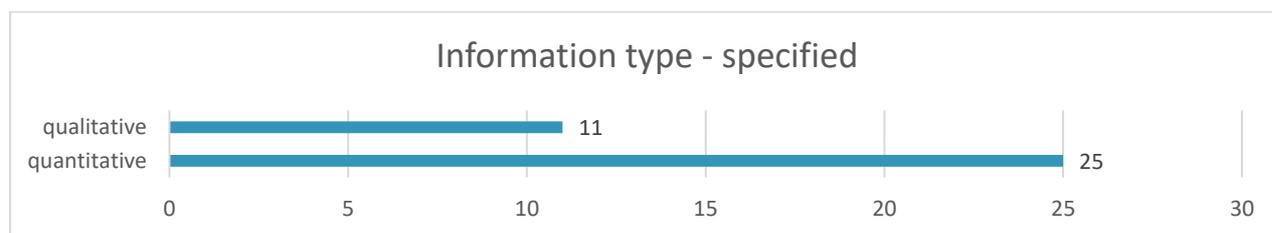
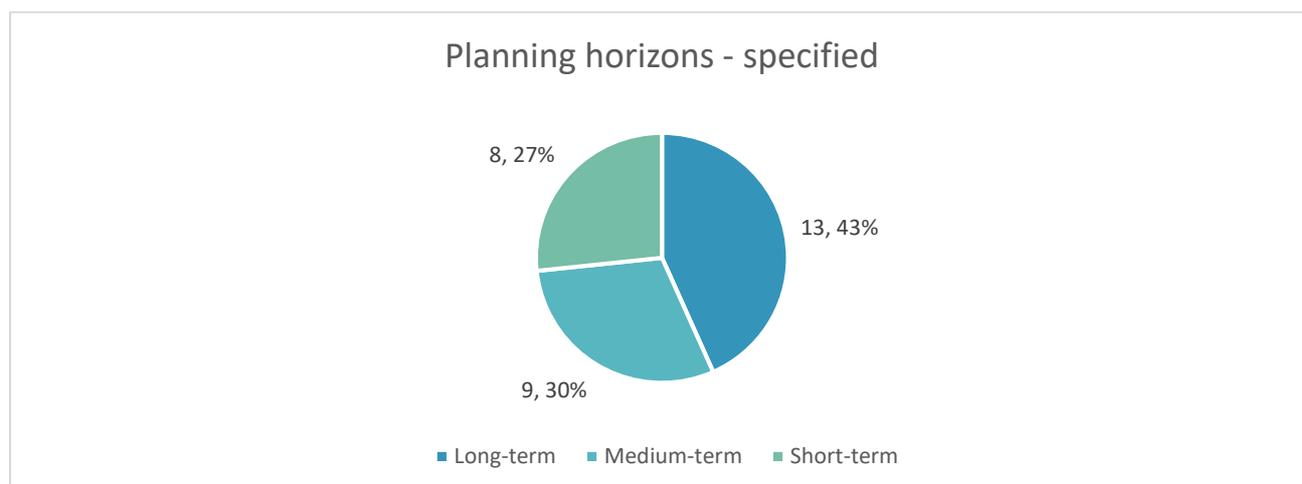


Table 5: Planning horizons specified by participants. Total n=29. Predictive scenarios are used for all planning horizons. Exploratory and normative scenarios are used for medium- and long-term planning.



#### 4.2.2 Why are scenarios used

##### Section key message:

- Scenarios are typically used to ‘improve understanding,’ and their use is often prompted through a regulatory / strategic planning driver or addressing an identified risk.

Wiseman *et al.* (2011) note that typically, scenarios are used to:

- improve understanding of climate change and its implications (for example, risks, goals, opportunities, and the interaction between drivers), think imaginatively about the future, and explore less likely futures such as crises and nonlinearity.
- improve planning for adaptation, through considering how different adaptation options might hypothetically perform under a range of scenarios.
- improve the implementation of adaptation through contributing to ongoing and evolving strategic planning.

Scenarios are most typically used in the Victorian water sector to improve understanding (n=25).

*“It was really interesting for me to discover... How much ... is occurring not because there is scientific uncertainty about the nature of the challenge, but because we have historical ways of operating”*

*“the way I think about scenarios now is a way to explore the challenge and deepen knowledge about the issues and the options and usually the work that we do is about finding the answer.”*

This objective is followed by a focus on improving planning processes (n=4). To a lesser extent, and reflective of the level of adaptation planning more broadly, scenarios are being used to improve implementation strategies, particularly as this related to communication with both internal and external stakeholders (n=2). However, this was noted as a difficult aspect to realise in practice: while scenario development is useful for building a shared understanding of the problem and the need for collaboration, securing commitment for implementation, particularly where benefits are shared across the catchment / sub-catchment was noted as a sticking point. This challenge, i.e. of translating scenarios through to adaptation action, was discussed as a challenging aspect of their use.

Catalysts for undertaking scenario planning include:

- *Accountability to customers* (n=2). This was expressed as a need to be accountable as an organisation responsible for the delivery of an essential service, and often coupled with reference to ensuring there is a sound investment of public funds.
- *Identified risks and / or impacts* (n=13). For example, the Millennium Drought or the 2019/2020 bushfire season were both cited as impacts catalysing awareness for adaptation and scenario planning.
- *Regulatory* (n=13), This related to requirements to utilise scenario planning or forecasting. For example, in water resource planning, the Victorian Environmental Water Holder, floodplain modelling within CMAs, etc. The Taskforce on Financial Related Climate Disclosures was referenced by participants as a further impetus to undertake scenario planning.
  - Strategic planning (of the above, n=5) – other participants noted strategic planning requirements within the regulatory environment provided the impetus for scenario planning – for example, Regional Catchment Strategies, Urban Water Strategies.
- Windows of opportunity (n=2) to support early action, for example asset renewal.

#### 4.2.3 Strengths of scenario planning

##### Section key messages:

- Scenarios are largely seen as a valuable input for adaptation planning.
- The key strength identified of scenarios is facilitating robust and flexible planning.
- Exploratory and normative scenario planning also helped facilitate capacity building, and better outcomes through diverse participation.
- Interview data suggests there is a need to build an understanding of what scenarios can and cannot do to ensure scenario use and development is appropriate for the planning being undertaken.

Scenarios were identified through interviews as a desirable (and essential) aspect of adaptation planning. 19, 79% of survey respondents<sup>9</sup> felt that it was worth their organisation utilising scenarios to inform climate change planning and 5, 21 % selecting 'maybe', with no respondents selecting 'no' (Fig 9). However, these results should be considered in light of the self-selection bias for the survey and interview recruitment, i.e. that participants are practitioners engaged in climate change adaptation and have some familiarity with scenario planning.

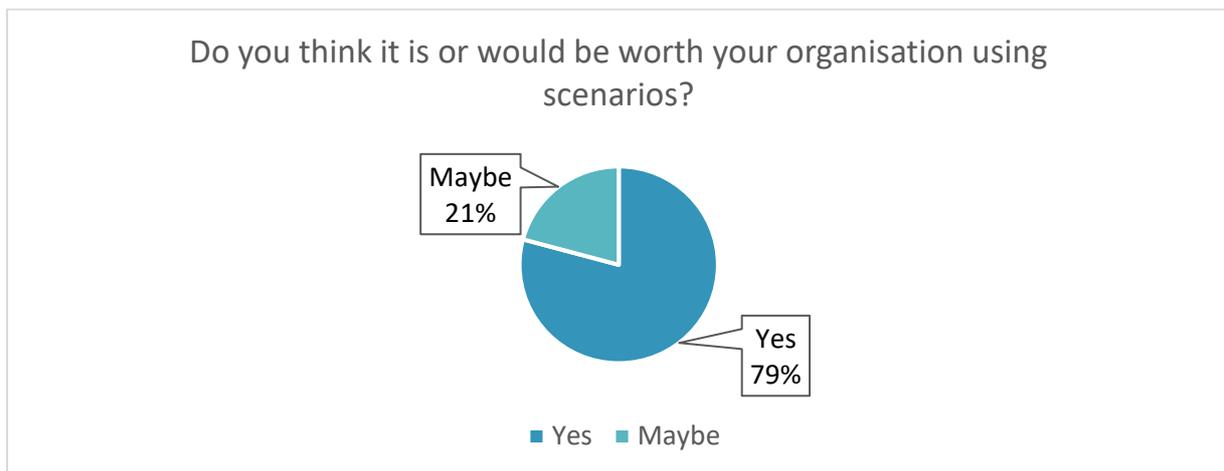


Figure 10: Opinion on scenario worth (survey results)

While scenarios were identified by the research participants as a worthwhile and important component of adaptation planning, participants noted it is unclear to what level or extent scenarios should be used across the business.

It was considered that scenarios should be matched in terms of scope and scale with the problem being addressed.

*"...developing a clear understanding of where... using scenarios or an adaptive planning approach might be useful, or where it might be ...Too complex with limited resourcing ...[which] could create some.... unwanted ... tension and frustration within a process. I guess I would hate to see. It being applied in a way that maybe isn't suitable or people having expectations beyond what's possible within an approach, and then it ...being perceived as maybe not ... useful or not... a good thing to pursue."*

Two participants also expressed that there should be a shared understanding prior to undertaking scenario planning about what the process can and cannot do i.e. that it is likely to open up a consideration of possible futures to encourage robust decision-making, and will not reduce uncertainty to clarify what an adaptation response should be.

Participants noted that a key strength of scenario planning is through facilitating adaptation planning that is more robust (n=9) and / or flexible (n=8).

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<sup>9</sup> 24 survey responses to this question.

Exploratory and normative scenarios were identified by participants as facilitating learning about vulnerabilities, drivers, and adaptation options. Scenario planning was identified by participants as building capacity for other areas of their adaptation work (n=4).

*“it's been really good to open people's eyes up like we've had a different level of discussion than perhaps we would have before . . . particularly when we start going through all the futures and uncertainties and we're starting to rank them in terms of, you know, uncertainty level and impact level, people will be saying, oh, well what if that happened? What would we do? We have to do it like this. Or what if that happened with? Yeah, that would have to do it like that and it's just sort of a different level of conversation perhaps than might have happened in planning meetings previously”*

Several participants also identified a diverse range of stakeholder input as helpful for developing appropriate context-specific responses (n=3).

*“[with a wider range of participation]...what a better outcome you get because you get that all that range of different thinking. And so it's about diversity in the room, making sure that's you've got really strong diversity because everyone has a different solution to a range of problems”*

#### 4.2.4 Approach to adaptation planning

The dominant framing of adaptation in the Victorian water sector is a risk management approach (utilising the framing categorisation as set out in section 3). There is also evidence of other approaches adopted by individuals and/or organisations (for example, participants from the same organisation did not necessarily frame adaptation in the same way).

Table 6: How interview participants predominately framed adaptation

<b>Framing</b>	<b>Count (n)</b>
Hazards approach	1
Resilience approach	8
Vulnerability approach	3
Risk management approach	13

Several participants mentioned flexible adaptation methods such as pathways planning (n=4), though it was noted that this was in the early stages and on a strategic level, and that organisations are still working through translating such approaches into decision-making processes and operational practices.

*“it's [adaptive planning] ... referenced reasonably strongly at a strategy level, but then when it comes to applying it... outside of maybe pilot type one off activities, it's... not quite there.”*

#### 4.2.5 Barriers and enablers to scenario use in adaptation planning

**Key messages from this section – scenario planning barriers and enablers**

- Some challenges identified for utilising scenarios in climate change adaptation planning for adaptation include: resource constraints, difficulties translating scenarios into adaptation options, poor cultural ‘fit,’ poor understanding of the need for change / relevance of climate change, short-termism, lack of certainty, sticky learning, and vague roles and responsibilities.
- Some needs identified by participants to facilitate the uptake of scenario use in adaptation planning include: facilitation of social learning, communication tools / techniques, collaboration, inclusion of diverse viewpoints, systems to support flexible planning (such as monitoring and evaluation), and a clearly defined scope.

This section contains an analysis of the overall themes raised by participants. See Appendix E for a full list of activities, processes, or tools participants identified as desired to help their organisation / themselves engage in both scenario planning, as well as adaptation planning more generally.

Barriers as expressed by participants to scenario and / or adaptation planning:

- A lack of human / technical resources to undertake scenario / adaptation planning, particularly given the resource-intensive nature of the work (n=6).

*“Scenario planning is great in theory. Is actually great in practice. But to have meaningful results that you can turn into adaptation decisions is a really big job.”*

*“in some cases taking an adaptive approach was much more difficult and resource intensive than expected, particularly at a strategy level / scale”*

- Translating into and realising adaptive planning (flexible/robust) (n=5).

*“In my mind, that's the bit we're really missing and really inexperienced at, and the real challenge moving forward 'cause it can be easy to use this to just defer infrastructure or put off decisions ... to actually monitor things well. Actually set up good triggers actually be ready to change your decisions and preferred pathways if you need to... that's a whole 'nother level, and I feel like that's the area that whole industry need support with.”*

*“Deciding to take an innovative (or new) approach like adaptive planning is one step, but then making a significant investment to pursue it and basing decisions on findings is another step”*

- Cultural ‘fit’ was identified as a barrier to engaging with uncertainty and complexity (n=4).

*“we are engineering businesses, and so the mindset's ...understand the parameters, control them and come up with a solution. So ... when you can't come to them with a tangible problem. It can be hard to engage them in... a long and ongoing dialogue... that is a challenge for everyone, but I just think the way our kind of businesses operate, it ... really doesn't encourage the kind of thought of ... uncertainty and how to manage it and still taking action.”*

*“Our risk system is not set up to deal with uncertainties, so as soon as you acknowledge that something is a risk, there is a desire to have the answer, and that's not necessarily appropriate for adaptation. We actually do have a while to work out our answers in a lot of cases, we don't want to be missing opportunities now, and we don't want to be locking ourselves into negative pathways... our risk system leads to people wanting to figure out what we're doing right now, so culturally it's a little bit tricky to talk about climate risks without having the answers.”*

Cultural fit also influences the evidence utilised.

*“we're an organization made up significantly of engineers, give them facts, give them numbers”*

- A lack of understanding about climate change (including scepticism), a poor understanding that is currently happening or how it impacts on different service / operational areas was also identified as a barrier (n=4).

*“A lot of my work is kind of trying to convince other people that that we need that. You know, we need to take more action that we need to consider this that we need to do more investigations into what it's going to mean”*

- Choosing the ‘right’ scenarios, and assignation of probability (n=3).

*“knowing which scenario will ...unfold”*

*“choosing the right ones”*

*“quantifying uncertainties is challenging, as the science to-date has been indicating that all scenarios are possible. An approach is needed to provide guidance on which are more likely and the probability”*

- Being able to communicate the value or relevance to decision-makers who have not been directly involved in the process was raised as a barrier for exploratory / normative scenario planning (n=2) – difficulty transferring learning is termed ‘sticky’ learning.

*“being part of that [exploratory scenario planning] process. The evolution of the scenarios made perfect sense because you got to see what was the thinking. What were the considerations and how did you end up at that point. And so you accept it and you own it. People that were given the scenarios to use that didn't have the benefit of being along the journey to develop them ...Don't understand where this came from and they don't buy into it.”*

- Short-term planning horizons which tend to favour short-term priorities (for example, this might not consider the long-term costs of not adapting (n=3).

*“Taking adaptive approaches [sic] is a cultural challenge and can be a poor fit with 5 year price planning process”*

*“Sometimes there are powerful financial drivers relevant to the short/immediate term that cause risk analysis to be deferred,”*

- A lack of clear roles and responsibilities was identified in a barrier in one instance (land-use planning) (n=1) but was conversely identified as an enabler where roles and responsibilities are clear (as with expectations for scenario use in water resource planning) – see catalysts, regulatory.

Enablers as expressed by participants to scenario and / or adaptation planning:

- Social learning – scaling learning approaches (capacity building, training, community of practice, sharing of case studies and approaches) (n=8)
- Communicating complex concepts such as climate change (n=2) and /or flexible and robust planning (n=6) in a way that is catered to specific audiences (for example, an infographic for engaging farmers would be different from synthesised findings to share with executive teams).
- Competing incentives, i.e. across organisations was identified as a barrier to adaptation including understanding interdependencies, but several participants (n=4) highlighted collaboration as an enabler of adaptation.
- Systems to support flexible planning, such as monitoring and evaluation (n=1) and Identifying thresholds (n=2).
- Defining a scope, to be able to engage with complexity, for example a geographic location (n=2)

For greater detail on these enablers, all suggested enablers for scenario use in adaptation planning are outlined in greater detail at Appendix E.

Several participants noted greater certainty about certain aspects of climate science would be useful for their work (n=1 unless specified), including: methodological clarity (n=2);<sup>10</sup> a greater understanding of rainfall and runoff across different catchments; better modelling for extremes (n=2); and work on revegetation.

However, it was noted that current knowledge does not necessarily translate into practice (n=3).

*“each of the flood studies that we’ve done have a climate... change component to them now. But then it just sits on the shelf”*

There should therefore be a careful consideration of the linear assumptions about how information provision is utilised in adaptation planning, to understand barriers more carefully. This is demonstrated in the quote below:

*“this is a bit of a debate at the moment ... obviously you can do it to various levels, you can sort of do it back of the envelope and workshop style and just sketch out stuff and then as you go deeper into it you need more and more modelling and more and more*

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<sup>10</sup> When this was discussed with the participants, they were discussing the DELWP Guidelines, and have already provided this feedback to DELWP via that consultation process.

*data . . . But we've also been discussing. We're not sure we need that level of detail for all of our system ... [and] we don't necessarily need super detailed tools for a lot of the changes we gotta make. It's more about us actually incorporating it into our systems."*

## 5 DISCUSSION

### **Key messages from this section**

This section will be of interest to stakeholders interested in understanding how the recommendations and principles relate to the findings from this research project.

- Scenarios are being used in the Victorian water sector to help build shared understandings of risks, challenges, and opportunities.
- However, to realise the strengths identified by participants of scenarios for climate change adaptation planning (robustness and flexibility), there needs to be a closer examination of the types of scenarios developed, how they are utilised, and how compatible they are with different frames and approaches to adaptation.

### 5.1 Scenarios for adaptation planning

Participants identified the key benefit of scenarios as facilitating robust planning, i.e. adaptation which will function well (though not necessarily optimally) under a range of plausible futures (Wilby and Dessai, 2010, p. 182), as well as flexible planning methods which emphasise learning, improvement and adjustment as part of the planning methodology.

The role of scenarios in adaptation planning should be considered against the key principles for successful adaptation planning, as outlined in the *Victoria's Climate Change Adaptation Plan 2017-2020* (DELWP 2016, p.17) and as based on the *Climate Change Act 2017* (Vic) part 4, div.3, to consider:

- How scenarios as currently used in the Victorian Water sector work towards meeting these principles.
- Any recommendations for scenario development and use.
- Considerations for the embedment of adaptation across decision-making in the water sector.

The following section will discuss these principles in turn, alongside relevant challenges or enablers identified by participants in applying scenarios or undertaking adaptation planning and provide key recommendations.

Table 6: Key principles for decision-making

<b>Informed decision-making</b>	Adaptation responses should be based on the best available evidence in the context of uncertainty; and be flexible and iterative, allowing for adjustments as circumstance change and new information is made available.
<b>Integrated decision-making</b>	Decision-makers should give priority to responses that are most likely to provide the greatest net social, economic and environmental benefit for Victoria; and consider the cost of climate change, including externalities and long-term costs.

<b>Risk Management</b>	Adaptation responses should: ensure that risks are addressed by those who are best-placed to manage them; avoid unintended consequences; not undermine our ability to adapt to climate change over the long-term; and consider the trade-offs, and understand and recognise the costs of and limits to adaptation.
<b>Complementarity</b>	Adaptation responses should: build on the experiences of regions sectors, communities and industry; complement existing and planned adaptation work; and contribute to and be compatible with efforts to reduce emissions.
<b>Equity</b>	Adaptation responses should: be equitable and fair; consider both the present and the short, medium and long-term future; and adhere to principles of intra and intergenerational equity.
<b>Community Engagement</b>	Adaptation responses should: actively involve the community in setting policy directions and priorities; and value and response the knowledge and perspectives of Traditional Owner groups and Aboriginal Victorians.

### 5.1.1 Informed decision-making

Adaptation responses should be based on the best available evidence in the context of uncertainty; and be flexible and iterative, allowing for adjustments as circumstance change and new information is made available.

There is a tendency in the Victorian water sector to favour predictive scenarios which aim to identify a ‘likely’ future to plan for. While all scenario types – predictive, exploratory, and normative – are engaged with change, predictive scenarios are focused on trying to understand the likely direction of change. Predictive scenarios can therefore work towards building an understanding of risks (for example, reduced rainfall and implications for the catchment) but may plan too narrowly around a ‘likely’ future. An overreliance on identified directions of change may close-off opportunities and fail to plan in a flexible way. Exploratory and normative scenarios engage more fully with multiple futures and are therefore more compatible with flexible and iterative approaches to decision-making.

#### 5.1.1.1 Cultural fit: evidence, prediction, and planning approaches

To consider the ‘best available evidence,’ it is necessary to understand how evidence is framed. Utilising the framework of Cash *et al.* (2003) following the VCCCAR *Scenarios for Climate Adaptation Project* (Rickards, 2013), it is useful to consider how well scenarios ‘fit’ as an information output (or evidence) for public decision-making. Cash *et al.* (2003) argue responses are shaped by the extent to which information is understood by practitioners to be credible, legitimate, and salient.

Table 7: Credibility-Legitimacy-Salience Framework, Cash *et al.* (2003)

<b>Credibility</b>	“the scientific adequacy of the technical evidence and arguments”
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<i>Legitimate</i>	“the perception that the production of information and technology has been respectful of stakeholders’ divergent values and beliefs, unbiased in its conduct and fair in its treatment of opposing views and interests”
<i>Salient</i>	“the relevance of the assessment to the needs of decision makers” (p.8086)

Discussions with interviewees reveal that credibility and legitimacy considerations are key drivers of the general trend to utilise quantitative inputs in the Victorian water sector. Information derived through external sources, or through methods that have gone through checks and balances (such as peer-review) can result in the preference for these types of inputs. Where drivers can be translated into more ‘familiar’ knowledge types (i.e. quantified) there is evidence of greater utilisation of human behaviour and values in scenario development. For example, in short- to medium-term planning, demand forecasting is used extensively. Through quantifying and modelling inputs through established methods, there is a greater acceptance of socio-economic inputs as credible and legitimate.

Exploratory and normative scenarios are identified by participants as incorporating a wider range of drivers, derived through qualitative inputs such as organisational knowledge or expert elicitation. Practitioner knowledge can be highly pertinent for understanding what works, what drives change, and how policy translates into practice (Head, 2008). It can also help to reveal agency on an institutional or organisational level, through highlighting the influence of decisions, behaviours, and processes on possible outcomes.

The credibility-legitimacy-salience framework helps reveal that there can be a disconnect between scenarios which are considered credible and legitimate, and those which are salient. While an over-emphasis on context-specific factors can omit broader uncertainties and drivers (Carlsen, Dreborg and Wikman-Svahn, 2013), multiple methods are increasingly utilised for scenario development to meet diverse needs for planning (Star *et al.*, 2016). Utilising a frame of ‘evidence-informed policy,’ as opposed to ‘evidence-based policy’ can also be helpful in contexts where action is necessary, but irreducible uncertainties persist in the system (Head, 2010a).

**Key recommendation (adaptation planning):**

**Climate change adaptation should be evidence informed**

Evidence for scenario development and adaptation decision-making should ideally consider multiple bases, including: technical analysis, practitioner experience, and political know-how (Head, 2008).

This also exposes a potential tension as to the purpose of scenarios. If scenarios are treated as predictions of future states on which to act, then the evidence on which to base public decisions is conventionally required to be “highly defensible” (i.e. evidence-‘based’) (Rickards *et al.*, 2014, p.642), and therefore weighted towards credibility and legitimacy. However, where the role of scenarios is to explore potential drivers and directions of change, reveal norms and assumptions, and consider value-conflict and trade-offs, then salience emerges as

a pertinent consideration. Therefore, practitioners should carefully consider the objective of the scenarios and the questions they are trying to answer, the value of different types of information inputs, and the trade-offs made to credibility, legitimacy and salience through the inclusion or exclusion of certain information types in scenario development.

Given the widespread use of models to produce scenarios within the sector, it is important to recognise that while modelled outputs have established and often shared approaches and understandings, they are also subject to assumptions and trade-offs in terms of accuracy and complexity (Saltelli *et al.* 2020). Clearly documenting assumptions such as the applicability of certain models and different inputs allows for replicability and ensures approaches can be updated to reflect new information, preferences, and values.

It should also be broadly understood how any change in an assumption impacts the scenario, or the plausible future, being considered as a scenario may be more sensitive to a change in one assumption compared to another. Consider population growth, for example; if population growth is 4% per annum, when the assumption is 5% per annum, would this significantly alter the outcomes, or implications, of the scenario being considered? This can help decision makers understand the sensitivity of scenarios to different core assumptions and ultimately make better decisions. For complex scenarios, a sensitivity analysis is one way to understand the range of uncertainty a model may produce in terms of outputs and is therefore important for ensuring transparency around these types of technical evidence.

The choice of certain models may preference particular outcomes and therefore align with normative choices, and evidence provided as inputs may also represent different framing and values. While some terms “promise uncontested precision [such as]... ‘cost–benefit’, ‘expected utility’, ‘decision theory’, ‘life-cycle assessment’, ‘ecosystem services’, and ‘evidence-based policy’... all presuppose a set of values about what matters — sustainability for some, productivity or profitability for others”(Saltelli *et al.* 2020, p.483). While outputs may be quantitative, it is important to recognise and make explicit the role of qualitative judgments and political choices. Transparency around these decisions allows for models to remain reflective of stakeholders’ values over time, in terms of “both inputs and desired ends” (Saltelli *et al.* 2020, p.484).

### **Key recommendations (scenarios):**

#### **Establish what scenarios can and cannot do**

Scenarios are descriptions of plausible futures and should not be understood as predictions. Scenarios won’t provide an ‘answer’ but can help to understand the problem to facilitate robust and flexible planning, avoid maladaptation, and to support informed decision making.

### Clearly document and understand assumptions

It is important to ensure that assumptions are transparent and well-understood throughout the process of scenario development and use, and clearly understood by decision-makers. This includes assumptions made with reference to methodology and inputs, and transparency around sources of uncertainty.

It is also important to understand how sensitive scenarios, or plausible futures, are to these assumptions – as to understand how ‘important’ an assumption is to the future being considered. Participatory processes can help elicit assumptions and values making them more explicit. Underlying assumptions can then be challenged and negotiated by stakeholders over time.

A traditional technological approach to water sector management was identified by some participants as persisting to some extent in the Victorian water sector. Van der Brugge and Rotmans (2007) characterise shifts in aspects of water management in the Netherlands (see table 3) from a technological style of management, to an ecological orientation. These shifts reflect broader trends in water management styles, including in Australia (Head, 2010b, p. 173). Interviews from this research suggest while the ‘past’ and ‘future’ management styles as outlined in table 3 are useful to conceptualise, a mix of these styles more accurately reflects contemporary water management styles in the Victorian water sector.

Table 8: Aspects of dominant water management styles (Van der Brugge & Rotmans, 2007)

Aspects of water management	1970s	2000
<i>Problem perception</i>	Singular	Interrelated
<i>Management perspective</i>	Problem solving	Anticipation
<i>Scale</i>	Local water problem	Water system structure
<i>Management style</i>	Technological solutions	Spatial solutions
<i>Strategy</i>	Pumping, drainage, dykes	Retention, natural storage
<i>Approach</i>	Planning	Process
<i>Competences</i>	Disciplinary	Interdisciplinary
<i>Staff</i>	Engineers	Engineers, biologists, public managers, spatial planners
<i>Institutional organization</i>	Hierarchical, top down	Networks, participation

These management styles are useful to consider how compatible they are with different methods of scenario development and adaptation planning. In particular, the hierarchical and top-down method aligns most closely with predictive scenarios, and therefore goes some way to explaining the preference for predictive scenarios as identified through this research. An approach of ‘problem-solving’ also favours to an extent an understanding of the problem, and

an underlying assumption in the traditional technological approach, i.e. that the problem can be defined, understood, and a solution can be implemented. Participants noted that this style then, is challenged by flexible and robust planning. Framing then relates to both adaptation approaches and water management styles, and practitioners should reflect on the approaches they adopt.

**Key recommendation (adaptation planning):**

**Adaptation planners should decide on adaptation approach or combination of approaches that will underpin their process**

The choice of approach, whether explicit or implicit, can strongly influence which types of adaptation options and pathways are considered. This is not fixed and should be negotiated over time.

**5.1.2 Integrated decision-making**

Decision-makers should give priority to responses that are most likely to provide the greatest net social, economic and environmental benefit for Victoria; and consider the cost of climate change, including externalities and long-term costs.

Integrated water management was identified as a strength of the Victorian water sector, but several participants noted collaboration could be improved. This was highlighted with reference to:

- Understanding interdependencies, as there are incentives not to share information on risks; and
- Securing commitment for implementation, particularly where incentives are not distributed evenly amongst stakeholders.

**5.1.2.1 Adaptive governance: connectedness and collaboration**

The benefits of exploratory and normative scenario development and planning identified by participants align with process-oriented accounts of scenarios: they allow for deliberation and negotiation between stakeholders to develop shared understandings of ‘the problem’ and foster collaboration (Berkhout, Hertin and Jordan, 2002). Participatory approaches to scenario planning can therefore help develop a collaborative and integrated approach to adaptation planning. However, participants highlighted that flexible and iterative approaches to adaptation planning require ongoing commitment and governance.

**Key recommendation (adaptation planning):**

**Adaptation planning should incorporate fair and equitable forms of collaboration**

Interdependences between issues and stakeholders mean that no group can effectively manage complex issues alone. Collaborative governance and multi-stakeholder processes are key components of integrated decision-making.

**Key recommendation (scenarios):**

### Scenario development should adopt a participatory approach

A participatory approach to scenario planning can encompass a wider range of uncertainties, values, and needs, and should be adopted wherever practicable.

#### 5.1.3 Risk management

Adaptation responses should: ensure that risks are addressed by those who are best-placed to manage them; avoid unintended consequences; not undermine our ability to adapt to climate change over the long-term; and consider the trade-offs, and understand and recognise the costs of and limits to adaptation.

Several participants noted that conventional risk management approaches can necessitate an organisational response. This may not always be compatible with the long timeframes associated with climate change adaptation, and could undermine the ability to adapt to the long-term, when compared to more flexible and iterative approaches. This goes back to the ‘cultural fit’ of predict-then-act approaches to planning, as discussed at [Cultural fit: evidence, prediction, and planning approaches](#). Adaptation under this approach is framed as an ‘outcome’ as opposed to an ongoing ‘process’ (Fünfgeld and McEvoy, 2011). This is problematic in a variable system subject to ongoing and potentially rapid change, as it can result in a lack of anticipatory planning for plausible risks (van Drunen, van’t Klooster and Berkhout, 2011).

#### Key recommendation (scenarios):

##### Scenarios should consider multiple futures and multiple drivers

Consideration of a broad range of drivers increases the robustness of adaptation planning. Planning for multiple futures through anticipatory planning considers a broader range of plausible risks.

#### 5.1.3.1 *Short-termism and resource constraints, lack of understanding, static outputs*

A focus on short-term planning horizons was also identified by several participants as a barrier to effective adaptation planning. Participants noted that this could see an under-investment in contemporary decision-making, which could result in a poor consideration of long-term costs and benefits. A focus on immediate drivers and needs can lead to a narrow focus – for example, on organisational needs and operational decision-making. This can be at the expense of examining systemic drivers of vulnerability, and considering transformational change (Butler *et al.*, 2016). Adaptation that does not address systemic drivers of vulnerability will therefore not address a key pillar of climate risk.

#### Key recommendation (scenarios):

### Scenarios should consider a range of planning horizons

Long-term planning horizons allows for an interrogation of systemic drivers of vulnerability and can more fully consider inter- and intra-generational equity, as well as long-term costs and benefits.

Several participants argued that a lack of understanding about climate change, or a poor understanding of its spatial or temporal relevance could be a barrier to embedding climate change considerations, which may exacerbate climate risk. Participants highlighted a need in the sector for communicating the relevance of climate change for contemporary decision-making. However, diverse needs and proposals were expressed (see Appendix D), and further research is needed into whether communication tools, synthesis of research, or capacity building (or a combination) across the sector would be most appropriate for meeting the sector's needs.

#### Key recommendation (gaps and research needs):

##### Further research into:

the relationship between information provision, how it is communicated, and how this relates to adaptation practice across the sector.

Several participants observed that extensive and detailed modelling was expensive to produce, and as such could only be completed infrequently. This is a limitation of static outputs – i.e. they cannot remain reflexive and responsive to change, a necessary component of flexible adaptation planning (Wise *et al.*, 2014; Star *et al.*, 2016). The extent to which detailed outputs assist with adaptation planning is unclear. Methodologies for scenario planning, and their appropriateness for different approaches and needs therefore warrant careful consideration prior to undertaking scenario development.

#### Key recommendation (scenarios):

##### Establish the objective, scope, and scale of scenarios

Identifying scope and scale can determine the likely drivers, stakeholders, and interests relevant to the scenario planning. A shared understanding of who or what the scenarios are trying to influence is important for shaping the methodology and inputs to the scenarios. Understanding the end-user of the scenarios may also help in shaping and communicating the outputs, and this is also an opportunity to consider how the scenarios fit together with strategic and operational decision-making.

#### 5.1.3.2 Roles and responsibilities

Understanding who is 'best-placed' to manage risks is difficult in complex systems. It was noted that a lack of clarity around expectations of roles and responsibilities can be a barrier

to adaptation action - particularly for land-use planning. This is in line with previous Australian research (Head, 2010b; Pillora, 2010; Productivity Commission, 2012). Within adaptation, roles and responsibilities are necessarily shared, though this can also be an issue where roles and responsibilities are vague or not accepted (see for e.g. Wamsler and Brink, 2014).

A clear policy mandate was identified by a range of participants as instrumental for their organisations uptake of scenario planning and / or adaptation planning in this research. However, as one participant noted, clear mandates can also be limiting through artificially limiting the scope of focus to short-term and organisational priorities (as opposed to long-term equitable responses), and this focus can limit flexible and collaborative responses.

Aspects of governance that embrace negotiated and collaborative methods are increasingly utilised in the management of socio-ecological systems, particularly to elicit place-based and contextually relevant responses (see for e.g. Tompkins and Eakin, 2012; Wamsler, 2016). However, as the water sector is responsible for the provision of an essential service, there needs to be close attention paid to the opportunities and potential tensions between flexibility and accountability in the governance of the sector (Mees and Driessen, 2019).

**Key recommendation (gaps and research needs):**

**Further research into:**

how best to facilitate the negotiation of roles and responsibilities, in ways that are both flexible and accountable, across the Victorian water sector.

**5.1.4 Complementarity**

Adaptation responses should: build on the experiences of regions sectors, communities and industry; complement existing and planned adaptation work; and contribute to and be compatible with efforts to reduce emissions. In order to build on the ‘experiences of regions, sectors, communities, and industry,’ adaptation planning should deliberately plan for reflection and learning.

**Key recommendation (adaptation planning):**

**Adaptation should emphasise reflection and learning**

Adaptation is an ongoing process, and we are constantly learning about what works, particularly in different contexts. Adaptation should therefore be deliberately reflexive, to allow for individual and social learning.

Scenarios are largely being used in adaptation planning to develop an understanding of the drivers of change, and, in the instance of exploratory and normative scenarios, assumptions and values. Participants identified carrying over an engagement with complexity, uncertainty, and ambiguity through to other areas of their work, reflecting a building of capacity which is beneficial for adaptation work more broadly. Such impacts can be hard to evaluate and can

be undervalued in institutional contexts when compared to more tangible outputs (Haasnoot and Middelkoop, 2012), however learning has been identified as an important aspect of scenario ‘success’ (Hulme and Dessai, 2008). Scenarios can therefore be understood as one method to facilitate learning within the sector, and this is supported by the experience of participants.

#### 5.1.4.1 *Social learning*

Social learning emerged as the key enabler to facilitate the embedment of flexible and robust adaptation planning, as identified by participants in this research.

Social learning can be defined as:

*“emerging through practices that facilitate knowledge sharing, joint learning, and co-creation of experiences between stakeholders around a shared purpose in ways that:*

- 1. Take learning and change beyond the individual to communities, networks, or systems; and*
- 2. Enable new shared ways of knowing to emerge that lead to changes in practice.”*

(Ensor and Harvey, 2015, p. 510)

Participants expressed that capacity building through an emphasis on social learning at an organisational level as well as a practitioner level is important for facilitating context-specific adaptation responses (also see Fazey *et al.*, 2007). This is in line with broader trends in natural resource management, where social learning is increasingly understood as a vital component of organisational adaptive capacity (Thi Hong Phuong, Biesbroek and Wals, 2017).

However, there were divergent views amongst participants as to how this should be done, or how this might differ from existing networks such as the Water Services Association of Australia (WSAA). Preferences as to who might constitute a network (e.g. a wider range of stakeholders, or similar organisations) and the advantages and disadvantages of each i.e. diversity of views as opposed to openness of discussion was raised by participants, though with different preferences expressed between participants. It is worth understanding the priorities of the sector in greater depth, to ensure appropriate methods to promote social learning are adopted (Rodela, 2011), and to consider facilitation at an institutional level (see for e.g. Pelling *et al.*, 2008).

In this research, participants argued social learning could help to identify shared risks (alongside opportunities for collaboration) and provide opportunities for embedment and change across the sector. Methods such as dedicated communities of practice, case studies, and a sharing of what works in terms of communicating, planning, and implementing adaptation were suggested by participants as ways to facilitate the uptake of scenario development and its use in adaptation planning. This is in line with findings that social learning can help facilitate the coproduction of knowledge, develop new ways of understanding and managing, and build capacity to re-orient practice (Pahl-Wostl, 2007; Goldstein and Butler, 2010).

As noted by Ensor and Harvey (2015), social learning can be informal, but can also be facilitated through deliberate interventions. Deliberate interventions warrant close attention to the frames and shared understandings across the sector, in order to understand “the level at which social learning change is anticipated, and the expected pathway (and associated mechanisms) for promoting that change” (Ensor and Harvey, 2015, p. 517). This is also an important consideration for evaluating the effectiveness of interventions. Developing a deeper understanding of social learning needs, and how these are distinct from existing processes and networks will be important for their success in the Victorian water sector.

**Key recommendation (gaps and research needs):**

**Further research into:**

how best to facilitate social learning outcomes within the Victorian water sector, and the expected pathway of change.

Consultants are used extensively in the Victorian water sector for scenario development and adaptation planning. It is difficult to draw any conclusions about the role and influence of consultants on adaptation planning in the Victorian water sector through this research, given the different approaches to the management of consultants described in participant responses. Nevertheless, one participant highlighted that an outsourcing of expertise can limit internal capacity building, and another argued that an outsourcing of expertise leaves space for external consultants to play an outsized role in the Victorian water sector. One participant also highlighted a misalignment of incentives for consultants to share learnings and produce a commissioned output. In an evolving space such as adaptation, where learning is central to the process itself, this has the potential to be problematic. The appropriate role for consultants is an ongoing debate in public policy settings (see for example Howlett and Migone, 2013) and further research specific to the sector is recommended.

**Key recommendation (gaps and research needs):**

**Further research into:**

the role of consultants in adaptation planning, and how and when this meets the needs of the sector.

### 5.1.5 Equity

Adaptation responses should: be equitable and fair; consider both the present and the short, medium and long-term future; and adhere to principles of intra and intergenerational equity.

Water management (and adaptation) is not only technical but also political. Water management involves “complex debates over appropriate trade-offs between ecological, residential, agricultural and industrial uses of water” (Head, 2010b, p. 178) including Aboriginal water rights (Marshall, 2017). This highlights the need for greater incorporation of

qualitative “evidence concerning the values, attitudes and perceptions of stakeholders and decision-makers” within adaptation decision-making across the water sector (Head, 2010a, p. 82). These values and trade-offs are important in shaping appropriate and contextually relevant adaptation responses.

Exploratory and normative scenario planning can help to reveal and negotiate these trade-offs, as can participatory approaches to scenario development and use. The principle of equity further underpins previous recommendations, and the need to consider:

- The types of knowledge and evidence included in adaptation planning (and whether certain types of knowledge and evidence are privileged), and whether systemic drivers of vulnerability are considered / addressed.
- The adaptation approach taken, and what outcomes might be given implicit preference.
- The ways in which collaboration is fair and equitable, for both scenario development and adaptation planning.
- The timeframes for planning, and how well these timeframes account for inter-and intra-generational equity.

#### 5.1.6 *Community engagement*

Adaptation responses should: actively involve the community in setting policy directions and priorities; and value and response the knowledge and perspectives of Traditional Owner groups and Aboriginal Victorians.

Several participants highlighted the value of bringing together diverse perspectives for developing context-specific and place-based adaptation plans or options. However, this is still preliminary for a lot of organisations, who are at the stage of engaging with internal stakeholders. It is therefore recommended that wherever it is feasible to do so, diverse and inclusive engagement in scenario development and adaptation is pursued, through participatory methods and approaches. This supports the recommendation outlined at [Adaptive governance: connectedness and collaboration](#).

## 6 KEY RECOMMENDATIONS

Throughout Chapter 5 a number of key recommendations were outlined under three key categories: adaptation, scenarios, and gaps and research needs. The recommendations outlined are based on the findings from this research, incorporating findings from academic literature on scenario planning and climate change adaptation. These recommendations have been consolidated into one spot in chapter 6.

### 6.1 Principles: for embedding climate change considerations in Water Sector decision-making

Processes which facilitate social learning are needed to support the embedment of these principles across the Victorian water sector.

**1. Climate change adaptation should be evidence informed.**

Evidence for scenario development and adaptation decision-making should ideally consider multiple bases, including: technical analysis, practitioner experience, and political know-how (Head, 2008).

**2. Clearly document and understand assumptions.**

It is important to ensure that assumptions are transparent and well-understood throughout the process of scenario development and use, and clearly understood by decision-makers. This includes assumptions made with reference to methodology and inputs, and transparency around sources of uncertainty.

It is also important to understand how sensitive scenarios, or plausible futures, are to these assumptions – as to understand how ‘important’ an assumption is to the future being considered. Participatory processes can help elicit assumptions and values making them more explicit. Underlying assumptions can then be challenged and negotiated by stakeholders over time.

**3. Adaptation planners should decide on adaptation approach or combination of approaches that will underpin their process.**

The choice of approach, whether explicit or implicit, can strongly influence which types of adaptation options and pathways are considered. This is not fixed and should be negotiated over time.

**4. Adaptation planning should incorporate fair and equitable forms of collaboration.**

Interdependences between issues and stakeholders mean that no group can effectively manage complex issues alone. Collaborative governance and multi-stakeholder processes are key components of integrated decision-making.

**5. Adaptation should emphasise reflection and learning.**

Adaptation is an ongoing process, and we are constantly learning about what works, particularly in different contexts. Adaptation should therefore be deliberately reflexive, to allow for individual and social learning.

## 6.2 Principles: for developing appropriate scenarios for use in adaptation decision-making

### **6. Establish what scenarios can and cannot do.**

Scenarios are descriptions of plausible futures and should not be understood as predictions. Scenarios won't provide an 'answer' but can help to understand the problem to facilitate robust and flexible planning.

### **7. Scenario development should adopt a participatory approach.**

A participatory approach to scenario planning can encompass a wider range of uncertainties, values and needs, and should be adopted wherever practicable.

### **8. Scenarios should consider multiple futures and multiple drivers.**

Consideration of a broad range of drivers increases the robustness of adaptation planning. Planning for multiple futures through anticipatory planning considers a broader range of plausible risks.

### **9. Scenarios should consider a range of planning horizons.**

Long-term planning horizons allows for an interrogation of systemic drivers of vulnerability and can more fully consider inter- and intra-generational equity, as well as long-term costs and benefits.

### **10. Establish the objective, scope, and scale of scenarios.**

Identifying scope and scale can determine the likely drivers, stakeholders, and interests relevant to the scenario planning. A shared understanding of who or what the scenarios are trying to influence is important for shaping the methodology and inputs to the scenarios. Understanding the end-user of the scenarios may also help in shaping and communicating the outputs. This is also an opportunity to consider how the scenarios fit together with strategic and operational decision-making.

## 6.3 Gaps and research needs

Scenario planning is a widespread practice, but empirical research on scenario planning is relatively scarce, and it is an emerging discipline. There are important gaps to fill through qualitative research in terms of understanding user and participant experiences, as well as identifying future research questions (Chermack, 2018). This research has identified the following tensions, gaps, and future research in understanding the practice and applicability of scenario planning for climate change adaptation in the Victorian water sector:

**11. Further research into:**

the relationship between information provision, how it is communicated, and how this relates to adaptation practice across the sector.

**12. Further research into:**

how best to facilitate the negotiation of roles and responsibilities, in ways that are both flexible and accountable, across the Victorian water sector.

**13. Further research into:**

how best to facilitate social learning outcomes within the Victorian water sector, and the expected pathway of change.

**14. Further research into:**

the role of consultants in adaptation planning, and how and when this meets the needs of the sector.

## 7 REFERENCES

- Australian Government (2019) *Climate and Disaster Risk: What they are, why they matter and how to consider them in decision making; 2 Guidance on Governance*. Department of Home Affairs.
- Adger, W. N. *et al.* (2013) 'Cultural dimensions of climate change impacts and adaptation', *Nature Climate Change*. Nature Publishing Group, 3(2), pp. 112–117. doi: 10.1038/nclimate1666.
- Adger, W.N. *et al.* (2016) 'Place, well-being and fairness shape priorities for adaptation to climate change.' *Global Environmental Change*. 38 A1-A3.
- Adger, W Neil, Eakin, Hallie, and Winkels, Alexandra (2009) 'Nested and Teleconnected Vulnerabilities to Environmental Change.' *Frontiers in Ecology and the Environment* 7(3), pp. 150-57.
- Barnett, J. and O'Neill, S. (2010) 'Maladaptation', *Global Environmental Change*, 20(2), pp. 211–213. doi: 10.1016/j.gloenvcha.2009.11.004.
- Berkhout, F., Hertin, J. and Jordan, A. (2002) 'Socio-economic futures in climate change impact assessment: Using scenarios as "learning machines"', *Global Environmental Change*, 12(2), pp. 83–95. doi: 10.1016/S0959-3780(02)00006-7.
- Biggs, C. *et al.* (2011) *Scenario planning for climate adaptation*, Policy brief, Victorian Centre for Climate Change Adaptation Research. Available at: [www.vcccar.org.au](http://www.vcccar.org.au).
- de Boer, J., Wardekker, J. A. and van der Sluijs, J. P. (2010) 'Frame-based guide to situated decision-making on climate change', *Global Environmental Change*. doi: 10.1016/j.gloenvcha.2010.03.003.
- Börjeson, L. *et al.* (2006) 'Scenario types and techniques: Towards a user's guide', *Futures*, 38(7), pp. 723–739. doi: 10.1016/j.futures.2005.12.002.
- Van der Brugge, R. and Rotmans, J. (2007) 'Towards transition management of European water resources', *Water Resources Management*, 21(1), pp. 249–267. doi: 10.1007/s11269-006-9052-0.
- Brunner, R.D.; Lynch, A. H. (2010) *Adaptive Governance and Climate Change*. American Meteorological Society.
- Bureau of Meteorology and CSIRO (2018) *The State of the Climate Report*. Australian Government.
- Butler, J. R. A. *et al.* (2016) 'Scenario planning to leap-frog the Sustainable Development Goals: An adaptation pathways approach', *Climate Risk Management*. Elsevier B.V., 12(December), pp. 83–99. doi: 10.1016/j.crm.2015.11.003.
- Carlsen, H., Dreborg, K. H. and Wikman-Svahn, P. (2013) 'Tailor-made scenario planning for local adaptation to climate change', *Mitigation and Adaptation Strategies for Global Change*, 18(8), pp. 1239–1255. doi: 10.1007/s11027-012-9419-x.
- Cash, D. W. *et al.* (2003) 'Knowledge systems for sustainable development', *Proceedings of the National Academy of Sciences of the United States of America*, 100(14), pp. 8086–8091. doi: 10.1073/pnas.1231332100.
- Challinor, A.J. *et al.* (2018) 'Transmission of climate risks across sectors and borders.' *Philosophical Transactions of the Royal Society A*, 376 (2121).
- Chermack, T. J. (2018) 'An analysis and categorization of scenario planning scholarship from 1995-2016', *Journal of Futures Studies*, 22(4), pp. 45–60. doi: 10.6531/JFS.201806.22(4).0004.
- DELWP (2016) *Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria*. Victorian Government.
- DELWP (2018) *Pilot Water Sector Climate Change Adaptation Action Plan*. Victorian Government.

- Dessai, S., Lu, X. and Risbey, J. S. (2005) 'On the role of climate scenarios for adaptation planning', *Global Environmental Change*, 15(2), pp. 87–97. doi: 10.1016/j.gloenvcha.2004.12.004.
- van Drunen, M. A., van't Klooster, S. A. and Berkhout, F. (2011) 'Bounding the future: The use of scenarios in assessing climate change impacts', *Futures*. Elsevier Ltd, 43(4), pp. 488–496. doi: 10.1016/j.futures.2011.01.001.
- Ensor, J. and Harvey, B. (2015) 'Social learning and climate change adaptation: Evidence for international development practice', *Wiley Interdisciplinary Reviews: Climate Change*, 6(5), pp. 509–522. doi: 10.1002/wcc.348.
- Eriksen, S. *et al.* (2011) 'When not every response to climate change is a good one: Identifying principles for sustainable adaptation', *Climate and Development*, 3(1), pp. 7–20. doi: 10.3763/cdev.2010.0060.
- Fazey, I. *et al.* (2007) 'Adaptive capacity and learning to learn as leverage for social-ecological resilience', *Frontiers in Ecology and the Environment*, 5(7), pp. 375–380. doi: 10.1890/1540-9295(2007)5[375:ACALTL]2.0.CO;2.
- Fünfgeld, H. and McEvoy, D. (2011) *Framing Climate Change Adaptation in Policy and Practice*. Working Paper 1. RMIT University.
- Goldstein, B. E. and Butler, W. H. (2010) 'The U.S. Fire Learning Network: Providing a narrative framework for restoring ecosystems, professions, and institutions', *Society and Natural Resources*, 23(10), pp. 935–951. doi: 10.1080/08941920903012494.
- Hallegatte, S., A. Shah, R. J. Casey Brown, R. Lempert, and S. Gill. (2012) *Investment Decision Making under Deep Uncertainty: Application to Climate Change*. Policy Research Working Paper. 6193: 41
- Haasnoot, M. and Middelkoop, H. (2012) 'A history of futures: A review of scenario use in water policy studies in the Netherlands', *Environmental Science and Policy*. 19(20), pp. 108–120. doi: 10.1016/j.envsci.2012.03.002.
- Head, B. W. (2008) 'Three lenses of evidence-based policy', *Australian Journal of Public Administration*, 67(1), pp. 1–11. doi: 10.1111/j.1467-8500.2007.00564.x.
- Head, B. W. (2010a) 'Reconsidering evidence-based policy: Key issues and challenges', *Policy and Society*, 29(2), pp. 77–94. doi: 10.1016/j.polsoc.2010.03.001.
- Head, B. W. (2010b) 'Water policy-Evidence, learning and the governance of uncertainty', *Policy and Society*. Policy and Society Associates Ltd Partnership, 29(2), pp. 171–180. doi: 10.1016/j.polsoc.2010.03.007.
- Hinkel, J. *et al.* (2010) 'Learning to adapt: Re-framing climate change adaptation', in Hulme, M. and Jeufeldt, H. (eds) *Making climate change work for us: European perspectives on adaptation and mitigation strategies*. Cambridge: Cambridge University Press.
- Howlett, M. and Migone, A. (2013) 'Policy advice through the market: The role of external consultants in contemporary policy advisory systems', *Policy and Society*. Policy and Society Associates Ltd Partnership, 32(3), pp. 241–254. doi: 10.1016/j.polsoc.2013.07.005.
- Hulme, M. and Dessai, S. (2008) 'Predicting, deciding, learning: can one evaluate the "success" of national climate scenarios?', *Environmental Research Letters*, 3(4), p. 045013. doi: 10.1088/1748-9326/3/4/045013.
- IPCC (2014) *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Edited by R. K. Pachauri and L. A. Meyer. Geneva: IPCC.
- ISO (2019) 'Adaptation to climate change: principles, requirements, and guidelines'. International

Standard Organisation.

Ison, R. (2010) *Systems Practice: how to act in a climate change world*. London: Springer-Verlag.

Kahane, A. M. (2012) *Transformative Scenario Planning*. London: Springer-Verlag.

Lafferty, W. M. and Hovden, E. (2003) 'Environmental policy integration: Towards an analytical framework', *Environmental Politics*, 12(3), pp. 1–22. doi: 10.1080/09644010412331308254.

Lawrence, J., Blackett, P., Cradock-Henry, N. and Nistor, B.J. (2018) *Climate Change: The Cascade Effect. Cascading impacts and implications for Aotearoa New Zealand*. Wellington: Deep South Challenge.

Maani, K. (2013) *Decision-making for climate change adaptation: a systems thinking approach*. Available at: <https://apo.org.au/node/34598> (Accessed: 9 August 2019).

Marshall, V. (2017) *Overturing Aqua nullius: Securing Aboriginal water rights*. Aboriginal Studies Press. Available at: <https://www.golder.com/insights/block-caving-a-viable-alternative/>.

Mees, H. and Driessen, P. (2019) 'A framework for assessing the accountability of local governance arrangements for adaptation to climate change', *Journal of Environmental Planning and Management*. Taylor & Francis, 62(4), pp. 671–691. doi: 10.1080/09640568.2018.1428184.

Pahl-Wostl, C. (2007) 'Transitions towards adaptive management of water facing climate and global change', *Water Resources Management*, 21(1), pp. 49–62. doi: 10.1007/s11269-006-9040-4.

Pelling, M. *et al.* (2008) 'Shadow spaces for social learning: A relational understanding of adaptive capacity to climate change within organisations', *Environment and Planning A*, 40(4), pp. 867–884. doi: 10.1068/a39148.

Pelling, M. (2010) 'Adaptation to climate change: From resilience to transformation', *Adaptation to Climate Change: From Resilience to Transformation*, pp. 1–203. doi: 10.4324/9780203889046.

Pillora, S. (2010) *Australian Local Government and Climate Change*. Working Paper 1. Australian Centre of Excellence for Local Government.

Productivity Commission (2012) *Barriers to effective climate change adaptation*. Report No. 59, Final Inquiry Report. Canberra. Available at: <https://apo.org.au/node/33158> (Accessed: 9 August 2019).

Rickards, L. (2013) 'Climate change adaptation and scenario planning: framing issues and tools', *Proceedings of the Royal Society of Victoria*, 125(1), p. 34. doi: 10.1071/rs13015.

Rodela, R. (2011) 'Social Learning and Natural Resource Management : The Emergence of', *Ecology and Society*, 16(4), p. 30. doi: 10.5751/ES-04554-160430.

Rose, M. and Star, J. (2013) *Using Scenarios to Explore Climate Change: A Handbook for Practitioners*. National Park Service, Department of the Interior.

Schlosberg D., Collins, L.B. and Niemeyer, S. (2017) 'Adaptation policy and community discourse: risk, vulnerability, and just transformation,' *Environmental Politics*, 26(3), pp. 413-43.

Smit, B., Burton, I., Klein R. J. T. & Wandel, J. 2000. 'An Anatomy of Adaptation to Climate Change and Variability.' *Climatic Change*, 45, pp. 223-251.

Star, J. *et al.* (2016) 'Supporting adaptation decisions through scenario planning: Enabling the effective use of multiple methods', *Climate Risk Management*, 13, pp. 88–94. doi: 10.1016/j.crm.2016.08.001.

Thi Hong Phuong, L., Biesbroek, G. R. and Wals, A. E. J. (2017) 'The interplay between social learning and adaptive capacity in climate change adaptation: A systematic review', *NJAS - Wageningen*

*Journal of Life Sciences*. doi: 10.1016/j.njas.2017.05.001.

Tompkins, E. L. and Eakin, H. (2012) 'Managing private and public adaptation to climate change', *Global Environmental Change*. Elsevier Ltd, 22(1), pp. 3–11. doi: 10.1016/j.gloenvcha.2011.09.010.

Wamsler, C. (2016) 'From Risk Governance to City–Citizen Collaboration: Capitalizing on individual adaptation to climate change', *Environmental Policy and Governance*, 26(3), pp. 184–204. doi: 10.1002/eet.1707.

Wamsler, C. and Brink, E. (2014) 'Interfacing citizens' and institutions' practice and responsibilities for climate change adaptation', *Urban Climate*, 7, pp. 64–91. doi: 10.1016/j.uclim.2013.10.009.

Wilby, R. L. and Dessai, S. (2010) 'Robust adaptation to climate change', *Weather*, 65(7), p. 180–180. doi: 10.1002/wea.504.

Wise, R. M. *et al.* (2014) 'Reconceptualising adaptation to climate change as part of pathways of change and response', *Global Environmental Change*. Elsevier Ltd, 28, pp. 325–336. doi: 10.1016/j.gloenvcha.2013.12.002.

Wiseman, J. *et al.* (2011) *Scenarios for climate adaptation*. Victorian Centre for Climate Change Adaptation Research.

#### Legislation

*Climate Change Act 2017* (Vic)

## 8 APPENDICES

### 8.1 APPENDIX A: Summary of survey distribution

Table 1: Survey distribution summary

Distribution method	Total
Direct email to water sector contacts	24
Local government stakeholders via BaseCamp (an online project management software used to communicate with sustainability officers for other adaptation work)	26
via the Pilot Water Sector Adaptation Action Plan (WSAAP) Newsletter (individuals in roles directly relevant)	125
via the Victorian Water and Climate Initiative (VicWaCI) newsletter (broader spread of individuals, based on subscription to the VicWaCI newsletter)	300
IWM Forums and working groups	15

### 8.2 APPENDIX B: Introduction blurb to recruit survey participants

DELWP is looking to better understand how the water sector uses scenarios in planning for climate change and identify what support the sector may need from government and research in undertaking future planning.

Your insights and reflections will be invaluable.

Please take the time to complete the survey: Water sector use of scenarios in adaptation planning

It is voluntary and anonymous and should only take you about 15 minutes to complete. Further information can be found on the front page of the survey.

### 8.3 APPENDIX C: Interview questions

#### Scenario use in the Water sector Interview questions

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##### Intro blurb

1. To begin, I'd like to know a little about your story, how did you come to be working in this sector?
  2. Tell me something about the focus of your role?
    - a. What sort of organisations, groups, people, do you work with in your work?
- 

This research is seeking to understand how the water sector is undertaking climate change adaptation planning, and in particular, how the use of scenarios features in that work

3. How would you describe your organisation's approach to adaptation planning?
  - a. Why is that?
4. How are you currently involved in adaptation planning?
  - a. Can you please tell me a little about it?
    - i. How is it going? Why is that?
  - b. How was that work instigated?
    - i. Why did it start there/with that?

#### **Scenario use**

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5. We are finding that people have quite different interpretations of what is meant by scenarios, so could you please describe what scenarios mean to you?
6. To what extent are any types of scenarios being used in your organisation's adaptation planning process?

#### ***If not being used***

7. Why do you think they're not being used?
  - a. Do you think it would be worth your organisation using scenarios? Why/why not?
  - b. What might help scenarios being used in such planning?

#### ***If yes***

8. What was the objective for using scenarios?
9. What type of scenarios were used (e.g. climate change, narrative-based, socio-economic)?
  - a. Why were these types of scenarios used? (for each type)
10. Can you please broadly outline the process in which scenarios were used?
  - a. who was involved?  
(e.g. parts of the organisation, external consultants, stakeholders)

- b. what types of knowledge and expertise were drawn upon?  
(e.g. quantitative, qualitative, local knowledge, scientific analysis)
- c. who or what are the scenarios intended to inform or influence?
- d. how many scenarios were used?

11. How would you describe your experience in using scenarios?

- a. What have been key strengths their use?
  - i. Why is that?
- b. What has been more challenging?
  - i. Why is that?
- c. What would you do differently in the future?
  - i. Why is that?
- d. What do you think might help their use?
  - i. Why is that?

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12. If you think about a scale of 0-10, where 0 is not at all confident and 10 is very confident, how confident do you {or would you} feel in using scenarios in adaptation planning?

- a. Why is that?
- b. What might help build your confidence?

13. Have you seen any uses of scenarios that you thought were successful?

- a. Could you describe that?
- b. Why do you think it/they were successful?

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14. So, in general, what would most help your organisation undertake adaptation planning?

- a. Why is that?

15. What sorts of activities, processes, or tools might help you personally engage in adaptation planning?

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16. Finally, anything else you'd like to add, ask, or mention that we haven't already discussed?

- a. Is there anyone else you would recommend speaking to in terms of adaptation planning/ scenario use?
- b. Are there any resources you have drawn on for the development of your scenarios?
- c. Are there any resources you could share documenting your approach to scenario planning?

17. Future contact... where to from here

## 8.4 APPENDIX D: Activities, processes, or tools to support scenario planning and / or adaptation planning

Participants were asked whether there were any activities, tools, or processes that would help their organisation / themselves engage in both scenario planning, as well as adaptation planning more generally. Table 8 provides a summary of responses.

Table 2: Summary of responses - activities, processes, or tools to support scenario planning and / or adaptation planning

Suggestion	Rationale	Coded
Social learning	Numerous participants identified a community of practice, understanding what other are doing across the sector, case studies of application by other organisations, and sharing learnings from what has worked (and what hasn't) as integral to capacity building at an individual and organisational level.	Collaboration and social learning, networked governance
Place-based approach, with IWM facilitated through a formal process at the sub-catchment scale	Allows for a defined scope while bringing together a wide range of perspectives, to help foster collaboration.	Collaboration and social learning, broad range of drivers
Alignment inter- and intra-organisationally	There are mutual interdependencies, and organisations need to understand shared vulnerabilities and interactions between systems for them to function well. In a broad sense, there needs to be alignment of adaptation framings so that strategies and organisations aren't working at cross-purposes.	Collaboration and social learning, networked governance, community of practice
Consideration of shared vulnerabilities	There is a poor understanding of this, and organisations have incentives not to share their vulnerabilities and risks. There needs to be a shift to a more collaborative mode to build a better understanding of interdependencies.	Collaboration and social learning, networked governance
Training and upskilling	Help build knowledge and capacity around what scenarios can and cannot do, as well as adaptation planning. Having expert policy advice systems that were collaborative (such as a 'coach') were identified as valuable. This also allows for organisationally specific responses	Collaboration and social learning, expertise, policy advice systems

Cultural change (and attendant planning styles)	There needs to be space to consider uncertainties and unknowns, without necessitating a response. This is a consideration of institutional culture, but also attendant processes such as risk management	Institutional fit, risk
Consider the quality of facilitation for resilience and adaptation planning	Consultants play a large role in the process, but there is a lot of variance in the quality of facilitation. No specific recommendations were identified by the participant, but it was noted that facilitation could substantially impact outcomes.	Policy advice systems
Clarity of expectations, roles and responsibilities	While there is clear guidance for water resource planning, expectations across other areas of the sector, particularly land-use planning, are less clear	Roles and responsibilities, accountability
Social resilience	Identified as an important factor in adaptation, and important though not always considered in the same way as physical infrastructure.	Social resilience
Translation into flexible planning	The gap is not necessarily data, and having the best available modelling, but how this is incorporated into adaptation planning. This includes the identification of triggers, monitoring and evaluation, and associated decision-support processes and frameworks (developed internally). Also, systems to support flexible planning, such as monitoring and evaluation, and different ways to realise this (for example, using citizen science).	Flexible planning
Investment in research and development of adaptation options	There are a lot of projections with general trends (a hotter, drier climate). We need to focus on adaptation options.	Adaptation options
Clear and readily communicable information on adaptation pathways	Quick and readily digestible information such as infographics can facilitate communication with a wide range of stakeholders who are not familiar with adaptation pathway concepts.	Flexible planning, adaptation pathways, communication
Projections presented spatially	Allows for a local understanding of likely impacts. Also, there is the potential to tailor this presentation for specific industries, to make them more directly relevant for end-users.	End-user

Likely impacts on water availability	Several participants noted greater certainty about rainfall and runoff implications for their catchment area would be helpful	Certainty, science
Greater certainty about future water allocations	Greater certainty for forward planning	Certainty
Funding	Funding to consider long-term planning, including exploring options proactively	Resources
An identified role within an organisation to provide advice	This role could be to provide project level advice about how to utilise scenarios and adaptive planning and help build capacity across the organisation.	Resources, social learning, flexible planning
Research collaboration	Sustained collaboration with research institutions and different areas of Government.	Social learning, collaboration
Methodological clarity	This was discussed in reference to the DELWP Guidelines. This feedback has been provided to DELWP via that consultation process.	Certainty
Plain English guide for complex concepts	Being able to communicate justifications for actions to stakeholders can be difficult – for example, the rationale for reduced water entitlements. Being able to clearly communicate this would be helpful. It was also noted this could be helpful for communicating complexity to boards.	Communication
Regional / rural support	Much of the adaptation research is focused / derived from metropolitan areas. More support for what works in regional areas.	Resources, adaptation options
Improved modelling	Historical inflows are a poor gauge for future conditions.	Science, certainty, modelling

## 8.5 APPENDIX E: Scenario planning identified through this research

This table is a summary of scenario development, planning, or use, either that participants were (or are) directly involved in, identified as successful, or identified through word of mouth.

This table summarises responses relevant for *publicly available* information (internal scenarios were also discussed in this research but are not detailed in the table below).

**Strategic plans are only included where they were referenced by participants as influential**, as there was general agreement that adaptive responses are referenced strongly on a strategic level in adaptation planning. This table also does not contain standard approaches (for example to water resource planning or flood studies within Catchment Management Authorities), as DELWP and the sector are familiar with these scenarios.

Organisation (lead)	Project / Plan	Project details if available – inputs, method, etc.	Weblink if applicable
Yarra Valley Water	Our Water Future for the Upper Merri Creek Communities	Collaborative approach including a number of stakeholders, exploring three scenarios, including BAU, and normative scenarios of sustainable and regenerative development.	<a href="https://uppermerricreek.com.au/">https://uppermerricreek.com.au/</a> Details on scenarios developed available here: <a href="https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.mw-yoursay.files/5215/7301/2434/Project_overview_final.pdf">https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.mw-yoursay.files/5215/7301/2434/Project_overview_final.pdf</a>
Melbourne Water	Melbourne Water System Strategy	Three key strategic scenarios used: 1. low change scenario: lower growth in water demands and low climate change 2. incremental change scenario: medium growth in water demands and medium climate change	<a href="https://www.melbournewater.com.au/sites/default/files/2017-09/Melbourne-Water-System-Strategy_0.pdf">https://www.melbournewater.com.au/sites/default/files/2017-09/Melbourne-Water-System-Strategy_0.pdf</a>

		3. rapid change scenario: higher growth in water demands and high climate change. Climate projections & demand forecasts.	
Victorian Government	Central Region Sustainable Water Strategy	Not detailed by participant.	<a href="https://www.water.vic.gov.au/planning-and-entitlements/long-term-assessments-and-strategies/sws/central-region-sustainable-water-strategy">https://www.water.vic.gov.au/planning-and-entitlements/long-term-assessments-and-strategies/sws/central-region-sustainable-water-strategy</a>
NECMA	Embedding climate change in agriculture	Using projections to engage with the community about relevant key risks, with an eventual aim to inform adaptation responses	<a href="https://spatialvision.com.au/case-study-embedding-climate-adaptation-in-agriculture/">https://spatialvision.com.au/case-study-embedding-climate-adaptation-in-agriculture/</a>
Yarra Valley Water	Servicing the Northern Growth Corridor	A flexible approach to infrastructure provision.	<a href="https://www.yvw.com.au/about-us/news-room/yarra-valley-water-completes-work-australias-largest-sewage-storage-facility">https://www.yvw.com.au/about-us/news-room/yarra-valley-water-completes-work-australias-largest-sewage-storage-facility</a>
GBCMA	Bogies and Beyond	Climate change scenarios and workshops engaging the community in flexible and iterative planning.	<a href="#">Flyer is here</a>
WGCMA	Designing for the future	Water control gates factoring in projections.	<a href="#">Flyer is here</a>
CCMA	Western District Lakes adaptation pathways	Exploring adaptation pathways to plan strategically for natural resource management.	<a href="https://ccma.vic.gov.au/2017/09/18/western-district-lakes-adaptation-pathways/">https://ccma.vic.gov.au/2017/09/18/western-district-lakes-adaptation-pathways/</a>
Greening Australia	Climate Future Plots	A guide and workshops for developing climate-resilient habitat.	<a href="https://www.greeningaustralia.org.au/climate-future-plots/">https://www.greeningaustralia.org.au/climate-future-plots/</a>