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Costs and benefits of climate change adaptation options for community assets: Final framework

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EXECUTIVE SUMMARY

Under the Local Government Act 2020 (the Act) and the Climate Change Act 2017, it is the responsibility of councils to manage climate related risks (DELWP 2020). Climate change adaptation is one way that councils can manage the risks of climate change and reduce its negative impacts. Climate change adaptation involves undertaking activities with the objective of making assets and communities more resilient to climate change.

Determining the most appropriate form of adaptation is a complex process due to the wide range of potential impacts and uncertainties associated with an impact's frequency, timing, duration, magnitude and extent. This makes it difficult for councils to determine the best form of adaptation or to demonstrate value for money when seeking funding from State or Federal Government. These factors limit Local Governments' ability to respond to climate change and meet legal obligations under the Act. The economic benefit of an adaptation option is primarily the reduction in risk it achieves relative to the base case or 'do nothing' scenario (Figure 1).

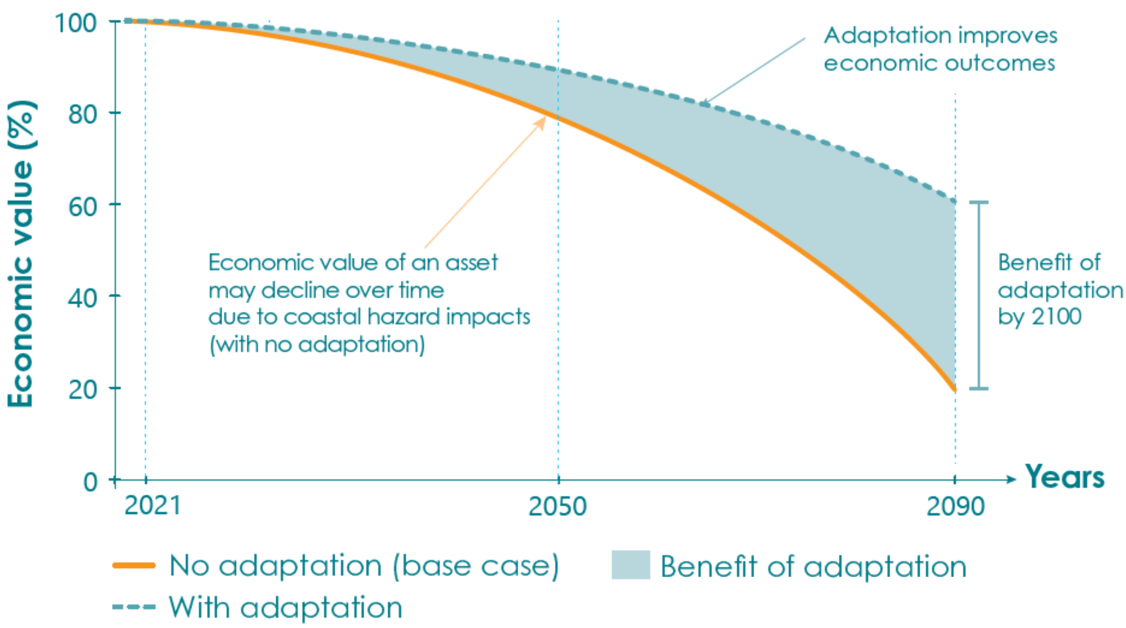

Figure 1. Illustrative example of how benefits from different adaptation options are estimated relative to the base case asset investment

The costs and benefits of climate change adaptation options for community assets framework (the Framework) provides councils in Greater Melbourne with an approach to determine the most appropriate climate change adaptation options through an assessment of costs and benefits. Such an assessment will allow councils to:

- Identify and prioritise adaptation options based on relative net benefits
- Establish a clear business case for the implementation of adaptation options to address risks to community assets

- Build an evidence base to assist in securing adaptation funding from State and Federal Government

The Framework is underpinned by two components: a risk and adaptation analysis that is more familiar to councils, and a cost-benefit analysis. To apply the Framework and understand the climate change adaptation options in this context we recommend councils take six steps that link the two components. The risk and adaptation analysis informs the cost-benefit analysis, with decision-making being dependent on the results of the latter. The 6 steps of the Framework are:

- Step 1: Understand climate context
- Step 2: Identify and scope hazards
- Step 3: Develop and value the base case
- Step 4: Undertake adaptation intervention analysis
- Step 5: Undertake cost-benefit analysis
- Step 6: Make decisions

The Framework is a key deliverable under the Regional Adaptation Strategy for Greater Melbourne region and has been developed as part of the Scoping Study: Costs and Benefits of Climate Change Adaptation Options for Community Assets project. This project was led by the Northern Alliance for Greenhouse Action, Western Alliance for Greenhouse Action, Eastern Alliance for Greenhouse Action, and South East Councils Climate Change Alliance and is being supported by Department of Environment, Land, Water, and Planning.

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Glossary

Acute climate risk	Severe climate-related events that generally occur over a short timeframe
Adaptation	Adjusting to climate risks to minimise the likelihood of climate hazards
Adaptive management	Process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change. Adaptive management involves adjusting approaches in response to observations of their effect and changes in the system brought on by resulting feedback effects and other variables
Average annual damage (AAD)	A quantitative representation of the damage to assets, in annualised terms, from climate hazards.
Benefit-cost ratio	The ratio of the total benefits against the total costs of the project, with future values discounted to present value terms
Chronic climate risk	Slow-onset changes to climate over longer timeframes that also interact with biophysical processes, human health, productivity and the built environment
Climate	Average climate conditions over a period of time, typically 30 years
Climate change	A change in the state of the climate that persists for an extended period, typically decades or longer. Climate change may be a result of natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions and human influence through atmospheric emissions or land use
Climate parameters (indices)	Measurable factors that influence the properties of the climate system e.g. atmospheric parameters such as air pressure, air temperature, precipitation and solar radiation, but also non-atmospheric parameters such as sea surface temperature or ice cover
Climate risk	Economic, environmental and social impacts on anthropogenic and natural systems resulting from changing climate conditions
Cost-benefit analysis	A method for assessing the merit of an investment by comparing the monetary value of the benefits against the costs incurred for the proposed project
Community	Members of a Greater Melbourne region
Counterfactual	The situation that would exist without adaptation. It is sometimes described as the "do nothing" scenario
Discounted cashflow analysis (DCF)	A method to evaluate an investment by discounting the expected future cash flows.
Mitigation	Efforts to minimise the potential impacts of climate change
Natural hazard	Natural processes or conditions which can cause a range of negative impacts on communities
Net Present Value	Discounter value of benefits less the discounted value of costs for an investment or project
Physical climate risk	Adverse climate conditions that cause negative economic, social or environmental impacts
Planning	Strategic or operational planning, not statutory or town planning
Resilience	Refers to the ability of systems to absorb and recover from adverse events induced by climate change.

Sensitivity analysis	An assessment of the robustness of the estimates based on their sensitivity to changes in various inputs and assumptions.
Threat	The potential for injury, damage or other negative consequences to values or assets arising from decisions or actions by council or others within and outside of the LGA
Transition	Identifying and managing the impacts and opportunities associated with progressing towards a low carbon future
Transitionary climate risk	Human action or inaction to address climate risks

1 INTRODUCTION

1.1 Context

Climate change is already occurring and has the potential to be highly detrimental to the value of assets and the wellbeing of communities across Greater Melbourne. Local Government assets are no exception and are exposed to a range of climate related risks from multiple climate hazards. Under the Local Government Act 2020 (the Act) and the Climate Change Act 2017, it is the responsibility of councils to manage climate related risks (DELWP 2020).

Climate change adaptation is one way that Local Government can manage the risks of climate change and reduce its negative impacts. Climate change adaptation involves undertaking activities with the objective of making assets and communities more resilient to climate change. Determining the most appropriate form of adaptation is a complex process due to the wide range of potential impacts and uncertainties associated with an impact's frequency, timing, duration, magnitude and extent. This makes it difficult for councils to determine the best form of adaptation or to demonstrate value for money when seeking funding from State or Federal Government. These factors limit Local Governments' ability to respond to climate change and meet legal obligations under the Act.

To assist councils, the Department of Environment, Land, Water and Planning (DELWP) has prepared six place-based Regional Adaptation Strategies (RAS). These five-year strategies are being developed to provide a long-term framework to support adaptation across Victoria.

The costs and benefits of climate change adaptation options for community assets framework (the Framework) is a key deliverable under the RAS for Greater Melbourne region and will assist Local Governments in meeting their responsibility to the community by providing an approach by which economically viable adaption options can be identified, selected and prioritised.

1.2 Purpose of the Framework

The Framework's purpose is to provide councils in Greater Melbourne with an approach which can be used to determine the costs and benefits of adaptation options. This includes both direct and indirect, and tangible and non-tangible costs and benefits.

An assessment of costs and benefits will allow councils to:

- Identify and prioritise adaptation options based on relative net benefits
- Establish a clear business case for the implementation of adaptation options to address risks to community assets
- Build an evidence base to assist in securing adaptation funding from State and Federal Government

Ultimately, the Framework will improve Local Governments' ability to make informed decisions in the face of current climate impacts and an uncertain climate future, which in turn, will improve the management of climate related risks which they have a legal responsibility to manage. Importantly, the Framework is designed to specifically complement and enhance existing climate change risk assessment frameworks. This ensures that the application of the Framework requires the minimum additional effort and data above existing climate change assessments and asset management already underway by councils. Council's ability to implement the framework will depend on the level of available resources.

Development of the Framework constitutes the first phase of larger project, the second phase of which is expected to see the Framework utilised in an initial assessment of a select number of adaptation options in greater Melbourne.

1.3 Using the Framework

The Framework was designed specifically for use when assessing the costs and benefits of climate change adaptation options for Local Government assets in the Greater Melbourne area. Specifically, adaptation options related to Local Government buildings, road, drainage and natural assets as well as built assets in natural areas (e.g. park benches).

The Framework primarily focusses on the use cost-benefit analysis (CBA) to assess the economic viability of adaptation options designed to improve the resilience of council assets to climate change. To facilitate the use of CBA, the Framework also includes reference to risk and adaptation analysis, which is an input to the CBA[1]. In addition, the Framework provides resources which can be drawn on to complete the CBA, where there are gaps or insufficient detail available.

The Framework draws on leading-practice CBA approaches, including guidance from the Victorian Department of Treasury and Finance. Thus, its content may have applicability to a wider range of adaptation projects across asset classes, regions and government and non-government projects. Applicability will depend on the specific details of the adaptations project and objectives of the analysis.

Is the Framework for you?

The intended users of this Framework are those individuals working in or for Local Government in Greater Melbourne on the construction and maintenance of community assets. This may include a range of internal council staff (e.g. finance, asset managers and sustainability officers) and external consultants engaged to assist councils. The outputs of the Framework will be of use to a range of stakeholders, including decision maker, as they provide an understanding of climate risks and the viability of adaption options.

The Framework aims to provide an approach which councils can use in-house. However, it is recognised that the capacity and resources available to deliver such work will differ between councils, with most requiring external assistance to undertake CBA and/or raise their capacity to undertake CBA in-house in future.

[1] While the risk and adaptation analysis is an important input to a CBA that is focussed on assessing adaptation options, it is not the focus of the Framework.

2 OVERVIEW OF THE FRAMEWORK

The Framework developed is underpinned by two components: a risk and adaptation analysis, and CBA (Figure 2, overleaf). The approach to applying the Framework and to understanding the climate change adaptation options in this context involves proceeding through the six steps that link the two components. As illustrated in Figure 2, the risk and adaptation analysis informs the CBA, with decision-making being dependent on the results of the latter.

This section provides an overview of the Framework and the information that needs to be considered when applying it. Further detail and technical information on the risk and adaptation and cost-benefit analyses are provided in the subsequent sections.

Step 1: Understand climate context

The first step of the Framework is to gain an understanding of the climate context relevant to the community assets and infrastructure owned and managed by councils. This can be done through consideration of projected emissions scenarios and related risks (chronic, acute and transitionary, as discussed in section 3).

Step 2: Identify and scope hazards

This step involves identifying the current and future climate hazards for each asset, the consequences of each hazard, and the likelihood of the hazard occurring. For the Greater Melbourne region, the hazards that are most relevant are: coastal and inland flooding, bushfires, drought, heatwaves and severe storms. These hazards can result in acute, chronic and transition risks or impacts.

Step 3: Develop and value the base case

The base case provides a 'do nothing' scenario against which adaptation initiatives are assessed. It represents the outcome for the assets and infrastructure if climate change adaptation is not implemented (i.e. the status quo, businesses as usual or counterfactual).

Determining the base case, typically requires calculating expected average annual damage (AAD)—a quantitative representation of the damage to assets in annualised terms from hazards identified in Step 2. This process draws upon on asset information including economic values and asset exposure to determine the consequences of hazard events. Depending on the range of consequences identified for each hazard, several economic approaches may be required to estimate the AAD value.

Step 4: Undertake adaptation intervention analysis

This next step involves identifying the adaptation interventions based on an investment logic approach, having consideration of the existing resilience of assets and possible improvements from adaptation. This involves scoping adaption interventions/options that are designed to reduce the impacts from a specific hazard, risk or consequence. There are two key outputs from this step: the costs of the interventions and the efficacy of the interventions, which informs the estimation of benefits.

Step 5: Undertake cost-benefit analysis

The costs and benefits estimated in Step 4 become inputs to the CBA. The results inform the prioritisation of adaptation interventions according to their feasibility (i.e. do benefits outweigh the costs?) and the overall net benefit of each intervention. The CBA includes sensitivity analysis to understand the drivers of uncertainty in the results and distributional analysis to understand the relative impact between stakeholders and to inform the identification of co-investment opportunities.

Step 6: Make decisions

Based on the range of results from the CBA, adaption interventions can be selected and prioritised. The results provide transparent metrics to support decision-making and communication to affected stakeholders.

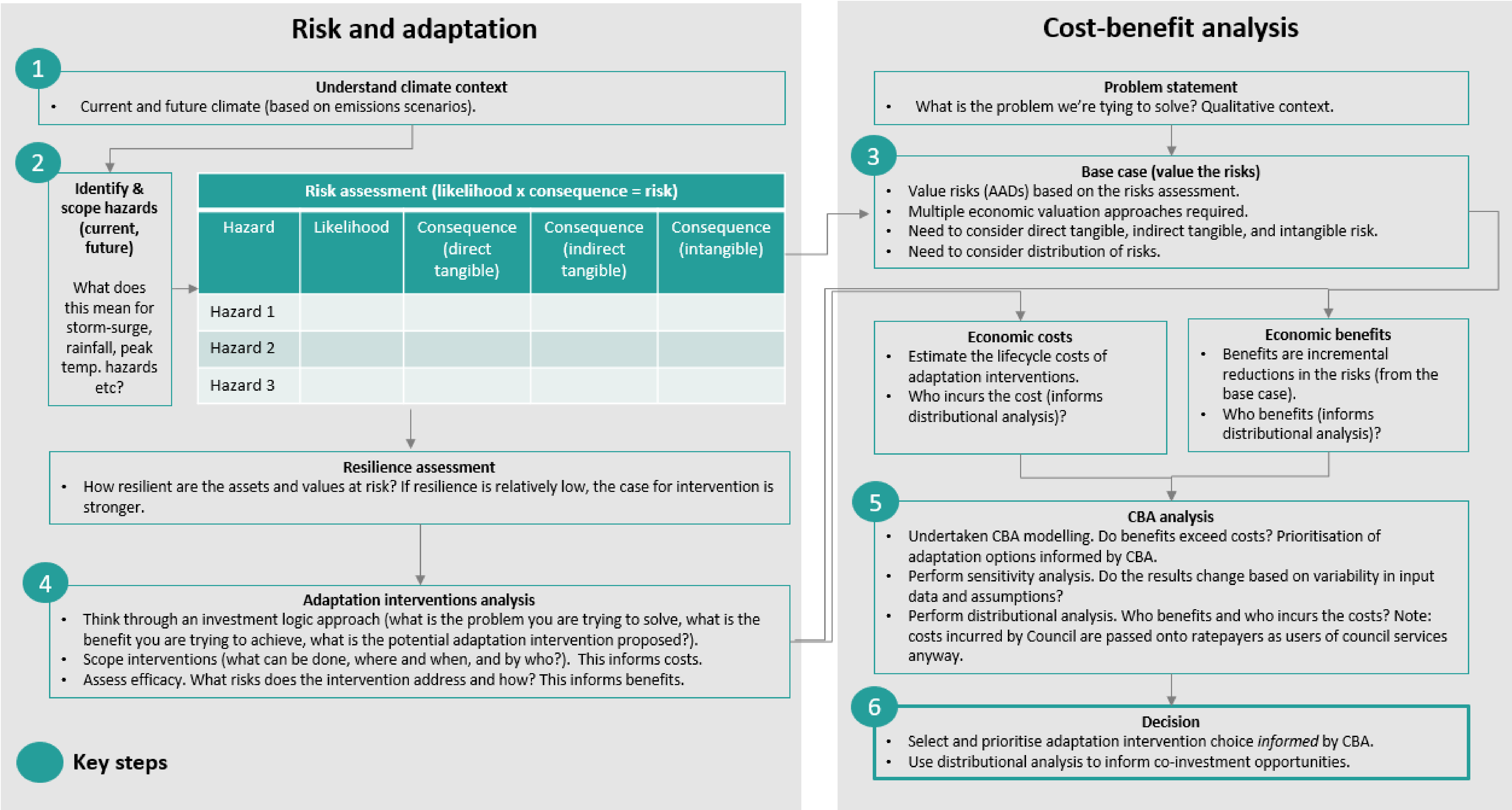

Figure 2. Overview of the Framework components

3 RISK AND ADAPTATION ANALYSIS

This section presents further detail on the risk and adaptation analysis component of the Framework outlined in section 2. The information provides high level guidance and highlights the key elements of the risk and adaptation analysis required, particularly the aspects that inform the CBA within the Framework.

3.1 Climate context

To implement the Framework, there is a need for councils to understand how climate is expected to change across their Local Government Area (LGA). This is required to understand future climate risks. How changes in climate affect climate related risks will be different for each council.

Climate projections are one tool which councils can use to assist them in understanding the future climate. They project climatic changes under a range of emissions scenarios[2] (Climate change in Australia, 2020-a).

Climate projections for Australia and Victoria can be accessed from the website Climate Change in Australia (2020-a) through a number of projection tools. Projections are typically presented as ranges with a confidence rating and are based on numerous climate models.

The future climate is best understood by exploring the range and likelihood of expected changes in climate variables as climate projections are inherently uncertain. This uncertainty is driven by unknown future levels of greenhouse gas emissions, how the climate will respond to these emissions, and natural climate variability (Climate Change in Australia, 2020-a; CMSI, 2020). As such, Clarke et al. (2019-a) suggest caution when relying on data from a single climate model.

Climate Change in Australia's (2020-b) projection tools enable users to explore changes in a range of climate variables associated with:

- Temperature
- Rainfall
- Wind
- Solar radiation
- Humidity
- Drought
- Sea level

In 2019, DEWLP released updated climate projections for Victoria (Clarke et al., 2019-a). These projections[3], which were developed by the CSIRO, can be accessed via the Climate Change in Australia website as well as DEWLPS's technical and regional reports (DEWLP, 2020). These projections provide climate variable information down to a scale of 5km. The regional report focuses on climate change projections for Greater Melbourne and is highly relevant to the users of this Framework (Clarke et al., 2019-b)

DEWLP's climate projections are intended to be used to support planning and policy decisions and continual improvement (Clarke et al., 2019-a). Using climate projections which are based on the most advanced and up to date modelling and science is expected to provide a more reliable view of the future climate.

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[2] Emissions scenarios are commonly referred to as Representative Concentration Pathways or RCPs. They represent a set of greenhouse gas, aerosol and land-use assumptions (Climate Change in Australia, 2020-b)

[3] As part of SECCCA's Asset Vulnerability Assessment, an interactive map of Victoria's Climate Projections has been created. This mapping has been completed at a 5km scale and for RCP 4.5 and 8.5 scenarios (D La Fontaine, personal communication, 25 October 2021)

The Climate Measurements Standards Initiative (2020) provides another useful resource for councils to understand the future climate and climate change risks. This initiative developed guidelines to provide a consistent approach to disclosing climate related risks[4]. This work has included the development of climate scenarios, developed from a range of climate models, as a further step to ensure a consistent approach

Currently, the climate projections available through the Climate Change in Australia website and its projection tools are expected to provide the best available, and most user-friendly data for councils to understand the climate context.

3.2 Climate hazards and impacts/consequences

The Framework provides an approach to assessing the costs and benefits of adaptation to climate change. In this type of assessment, costs typically relate to the financial expense of implementing an adaptation option, while benefits reflect the reduction in risk of negative impacts (i.e. the consequences of climate change) that occur due to climate hazards.

Climate or natural hazards are natural processes or conditions which can cause a range of negative impacts on communities. Negative impacts may include the following (further elaborated in Table 3):

- Health impacts (e.g. loss of life, injury, disease, chronic conditions)
- Damage to built assets and property
- Social and economic disruption
- Environmental degradation

The degree to which a climate hazard has a negative impact depends on many factors including the type of hazard and its frequency, timing, duration, magnitude, and extent. Under climate change, these factors may change, worsening impacts on communities and assets. The main climate hazards that Greater Melbourne is exposed to are likely to be coastal and inland flooding, bushfires, drought, heatwaves and severe storms. Other hazards may also exist, but these are not the focus of the Framework.

Victoria's Future Climate Tool is one resource which can be used by councils to begin to understand the risks associated with a number of climate hazards. The tool presents climate variables at a local scale for multiple emissions scenarios and time periods. This tool draws on information from Victorian Climate Projections 2019.

Victoria's Future Climate Tool spatially presents information on changes in temperature, extreme temperatures, rainfall extremes, drought (Standardized Precipitation Index) and a simple representation of coastal inundation. The Victoria's Future Climate Tool User Guide indicates that it does not provide data on flooding, bushfire risk, sea level rise and coastal erosion, storm and wind, or compound events (DELWLP and VMIA, n.d.). It provides a list of further resources which can be used to inform a risk assessment against these hazards.

Due to the limitations of Victoria's Future Climate Tool, councils may need to undertake their own research to gain a detailed and localised understanding of their climate hazards exposure (e.g., the

[4] While the focus of the Climate Measurement Standards Initiative is private companies, councils may also find the guidance useful.

extent of inland flooding). This may require input from specialists. Over time, this data gap may be filled with guidance from the State or Federal Government[5].

3.3 Climate risks

Climate risks are economic, environmental and social impacts on anthropogenic and natural systems resulting from changing climate conditions. These changing climate conditions drive risks by:

- Exacerbating the severity and frequency of natural hazards where they are already present in a given location
- Causing natural hazards to extend into new locations (a change of extent)
- Changing the climate risk profiles (e.g. causing long term changes to temperature, humidity and rainfall)
- Triggering tipping points due to the changing hazard and risk profiles

Climate risks generally fall into two types: physical and transitional risks. Physical risks pertain to adverse climate events that cause impacts to the human and natural systems, either through acute events—singular events that occur suddenly like natural or biological disasters—or chronic events—slow-onset climate change conditions such as increasing temperatures and sea levels. Transitional risks result from action or inaction to address climate risks Further descriptions of climate risk are provided in Table 1.

Table 1. Description and examples of climate risks

Climate risk type	Description	Examples
Physical risk	Adverse climate conditions that cause negative economic, social or environmental impacts	
Acute	Severe climate-related events that generally occur over a short timeframe	Extreme weather events (e.g. cyclones, hurricanes, heatwaves or floods)
Chronic	Slow-onset changes to climate over longer timeframes that also interact with biophysical processes, human health, productivity and the built environment	Sustained higher temperatures
Transitional risk	Human action or inaction to address climate risks	Policy inaction Lack of risk management Counter-productive policies
Policy	Adverse impacts from policy changes	Changed land use policies that limit capacity to adapt
Legal	Adverse impacts from not meeting legal obligations	Litigation for failing to protect property
Technology	Adverse impacts from changing technology	The need to shift to electric vehicles because combustion engines are no longer produced.

[5] Work to fill this data gap is currently underway as part of SECCCA's Asset Vulnerability Assessment (D La Fontaine, personal communication, 25 October 2021)

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Climate risk type	Description	Examples
Market	Adverse impacts from changes to markets in response to climate change	Changing prices due to shortages or supply chain disruption
Reputation	Adverse impacts from reputational damage	Loss of trust for an organisation

Source: DELWP (2021-a), pp. 4–5.

3.4 Risk assessment

Risk

The damage caused by climate hazards is likely to differ from year to year due to the size and severity of hazard events that occur or as climate conditions worsen. To account for this, and to understand the level of risk, councils need to consider both the consequences of hazard events and the likelihood/frequency of their occurrence.

This approach to performing a risk assessment is like the approach taken by insurance companies to understand risk and is illustrated by the standard risk equation.

$$\text{Risk} = \text{Expected average annual damage} = \sum_{i=1}^{n} (\text{Consequence}_i \times \text{Likelihood}_i)$$

Where: i is the hazard event, n is the number of hazard events, consequence is the damage or loss from a hazard event, and likelihood is the probability of a hazard event occurring.

It is suggested that councils wishing to undertake a risk assessment, first complete a qualitative assessment to determine those hazards that are most likely to result in material damages (i.e., high likelihood and high consequences). These hazards should be taken forward for detailed risk assessment. For example, for Local Government areas that have low levels of surrounding forest, bushfire is unlikely to result in material damages.

The detailed risk assessment involves the quantitative assessment of consequence and likelihood to develop an estimation of average annual damages (AADs). AAD is the average damage per year that would occur in the assessment area over a very long period of time. AADs provide the basis for comparing adaptation interventions/options on an equivalent basis. It is the change in AAD provided by each intervention (i.e., reduction in risk) that underpins the cost / benefit of that intervention.

Timing is a key consideration when performing a risk assessment against climate hazards. As climate change becomes more severe, so too will the climate risks faced by councils. Thus, consideration of long-term climate risks may improve the economic viability of adaptation options. The Framework uses the time horizons presented in the Victorian Climate Projections (2019) (i.e., 2030, 2050, 2070 and 2090) and extend to 2090.

Further information on the approach to determining likelihood and consequence is explained below.

Likelihood

The likelihood of a climate hazard event is equivalent to the probability of it occurring. All else being equal, an increase in likelihood will mean an increase in risk. The annual likelihood of hazard events can be forecast based on historic and current information on the frequency of events. These forecasts also need to take account of changes occurring due to climate change. The use of likelihood, rather than frequency, takes account of the uncertainty associated with predicting weather, including the possibility of rare events happening in quick successions. Table 2 provides an example of the difference between frequency and likelihood for flood events.

Table 2. Comparison of frequency and likelihood of flood events

Frequency	Annual likelihood
1 in 50-year flood	2.0%
1 in 100-year flood	1.0%
1 in 200-year flood	0.5%

Projected future values of climate variables can be used as an indication of changes in the likelihood of some climate risk, when compared to existing values. This type of high-level information may be enough to raise awareness and start conversations about the need to consider climate change in future decision making. For a quantitative risk assessment, climate data will need to be incorporated into applied models (e.g. biophysical models) to determine the 'downstream' impacts. For example, to determine how changing rainfall patterns affect the likelihood of flooding (Clarke et al., 2019-a).

Understanding how changes to the climate will impact the likelihood of different climate hazard events will require technical expertise. Thus, it is likely that much of this work will need to be undertaken by external specialists.

Consequence

The consequence is the impact from the climate hazard. Impacts can be direct tangible impacts (which include impacts that arise directly from the threat, (such as damage to infrastructure and the cost of repairs), indirect tangible impacts (which include the flow-on impacts that are not directly caused by the threat, but arise as a consequence of the event, such as disruption to public services), and intangible impacts (which include impacts such as morbidity that are more challenging to quantify, but are nonetheless important).

Some common categories of impacts are provided in Table 3.

Table 3. Climate change impact categories

Direct tangible impacts	Indirect tangible impacts	Intangible impacts
Costs incurred as a result of the hazard event. These costs have a market value such as the damage to public infrastructure.	Any tangible flow-on effects that are not directly caused by the hazard but arise as a result of the consequences of the damage and destruction.	Direct and indirect damages that cannot be easily priced.
For example: Damage to private property (e.g. houses) Damage of public assets (e.g. roads, parks) Increased operational costs (e.g. electricity costs for cooling) Increased maintenance costs (e.g. more frequent repairs)	For example: Displaced tourism activity Emergency costs Alternative accommodation Clean-up and rehabilitation Business and service disruption Disruption of public services and services to the community Transport disruptions and indirect costs (travel time, delays, vehicle operating costs)	For example: Mortality (Loss of Life) Morbidity (Injury, stress and mental health, other health impacts) Environmental values Cultural and heritage values Social and recreational values including recreational activity foregone

The consequence of a climate hazard event will depend on a number of factors including the timing, duration, magnitude and extent of each event. The extent is particularly relevant as it will determine what community assets are exposed, while magnitude and duration will influence the degree of damage that occurs. Depending on the type of impact, timing may also have an influence on the degree of damage. For example, flooding of roads during periods of high traffic will likely have a higher cost than flooding during periods of low traffic when traffic disruption would be lower.

The approach to quantifying the consequences of an event will depend on the type of damages being assessed and the level of detail required. To assess direct tangible impacts to built infrastructure, most councils will already hold the data required to estimate damages (i.e. replacement cost, maintenance costs, or historical damage costs). This information can be supplemented by other data on construction unit rates such as those available from Rawlinsons Construction Cost Guide (2021). To assess indirect tangible impacts, council data can be supplemented by publicly available information. Alternatively, as a high level first estimate, impacts can be valued based on applying a multiplier to the value of direct tangible benefits.

For intangible impacts, the consequences of climate hazards is harder to quantify due to the non-market nature of the impacts. As such, impacts may need to be described qualitatively by councils. With the assistance of specialist advice, benefit transfer methods or stated and revealed preferences studies can be used to quantify these impacts. This includes impacts to natural assets. DEWLP's (2021), Urban Environmental-Economic Account for Melbourne: Scoping reports provides a list of resources which could assist in using benefit transfer methods to assess impacts.

3.5 Resilience and adaptation

Climate change resilience refers to the ability of systems to absorb and recover from adverse events induced by climate change. All other things being equal, more resilient assets and communities should reduce the consequences from climate hazard events, leading to an overall reduction in climate risks. To build resilience, councils can undertake adaptation. Adaptation in this context refers to action taken to prepare for actual or expected changes in the climate, in order to minimise harm, act on opportunities, or cope with the consequences (Climate Change Act, 2017, as cited in DEWLP 2020).

The Local Government Act 2020 sets outs the roles and responsibilities of councils, which includes planning for climate change risks, while the Climate Change Act 2017 provides a framework for mitigation and adaptation action (DEWLP, 2020). Further information to inform councils understanding of adaptation actions can be found in:

- **Victoria's Climate Change Adaptation Plan 2017–2020.** As part of a commitment made under Victoria's Climate Change Adaptation Plan 2017–2020, DEWLP (2020) has prepared a document to assist councils (and others) to understand and deliver their adaptation responsibilities. It reiterates that Local Government have a responsibility to manage the foreseeable risk from climate hazards and that to do so effectively they need a robust and transparent decision-making process. The Framework provides one such method, which also helps to address the shared challenge associated with making decisions under uncertainty.

- **Victorian Planning Provisions Clause 13.01.** This clause identifies strategies to "minimise the impacts of natural hazards and adapt to the impacts of climate change" (DELWP, 2021-b). These strategies demonstrate that Local Government has a number of adaptation options available to minimise risk, in addition to the use of hard infrastructure for protection. For example, adjusting planning controls or directing population growth to low-risk locations. The benefit of such options can be assessed using the Framework and quantified based on the reduction in risk they achieve.

- **Asset Management Accountability Framework.** Although not mentioned explicitly, this Framework (DTF, 2016) requires accountable officers (in this case, local government asset managers) to “ensure there are appropriate risk management strategies and processes to support asset management established, including processes to identify and maintain assets that are at risk of critical service failure.” (pg. 26). The extension of this requirement is that councils must include consideration of the resilience of its assets to climate change risk, where this may lead to critical service failure.

- **Adaptation Action Plans.** The Victorian Government is preparing a set of adaptation action plans for seven ‘systems’, which are essential or vulnerable to climate change. These areas are Primary Production, Built Environment, Education and Training, Health and Human Services, Transport, Natural Environment, and the Water Cycle. These action plans will be prepared every five years as a requirement of the Climate Change Act 2017 (Engage Victoria, n.d.)

4 COST-BENEFIT ANALYSIS FUNDAMENTALS

4.1 Overview of cost-benefit analysis

Cost-benefit analysis (CBA) is an economic appraisal technique to systematically evaluate and assess the net benefit of a proposal and transparently compare alternative actions/options. In a CBA, the total benefits are weighed against the total costs in monetary terms, thereby providing a consistent basis for assessment and comparison. CBAs are widely used in decision-making and business case development—particularly where multiple options are being considered.

There are a number of frameworks outlining the method for conducting a CBA. These frameworks are largely similar in overall approach, which align with Figure 3 (overleaf). Essentially, a CBA of an individual proposal or outcome requires:

- Identifying affected stakeholders
- Determining the costs and benefits associated with alternative options
- Having consideration for matters like the timing of costs and benefits—and discounting these for a consistent basis of comparison
- Selecting and applying appropriate decision criteria to assess options for prioritisation and implementation (Government of Victoria, 2011)

The benefits and costs are estimated across an appraisal period, which is a period in which the benefits and costs are expected to accrue. For the purposes of comparison between options or outcomes, a consistent appraisal period is used. The costs and benefits are discounted and aggregated for each option/outcome.

A CBA is based on two decision rules that reflect a net benefit to society:

- A net present value (NPV) greater than zero—NPV is the net benefit (total discounted benefit less costs) over the appraisal period
- A benefit-cost ratio (BCR) greater than one—BCR is the ratio of discounted benefits over costs

Both NPV and BCR can be used as a basis of comparison between options/outcomes in the development of business cases.

In addition, the sensitivity of these metrics and the distribution of net benefits across affected groups of stakeholders are considered in developing business cases for each option or outcome.

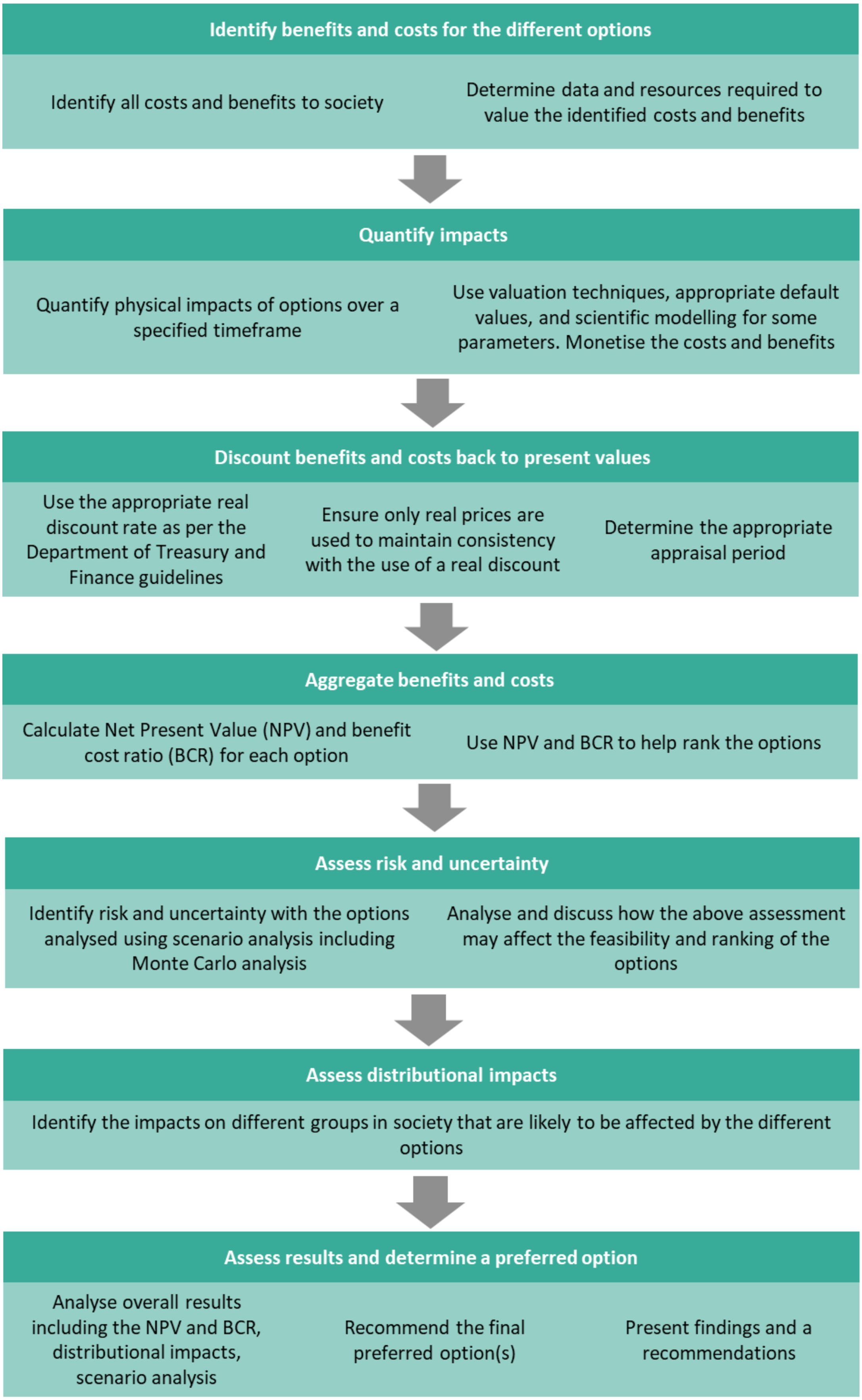

Figure 3. Overview of key steps in a CBA

5 CONDUCTING A CBA

This section describes the key steps for conducting a CBA of climate change adaptation options for community assets and infrastructure owned and managed by local governments in Greater Melbourne.

5.0 Step 0: Defining the problem

For a CBA to be valuable in decision-making, it is critical to describe the problem to be addressed. In this instance, the CBA would look to inform the decision-making around adaptation options for community assets and local government-owned infrastructure based on the risks from climate change. The CBA would be used to determine:

- What is the expected outcome for these assets if there is no adaptation to climate change risks (base case)
- What are the net benefits to society from various adaptation options designed to reduce these risks
- Should adaptation options be implemented—and if so, which option(s) should be prioritised—based on the highest net benefits

Illustrative problem definition:

The increasing risks from climate hazards poses potentially increased asset management and replacement costs. There are a range of climate adaptation options that could be implemented to reduce these risks and potentially provide additional benefits to the community. However, these options require investment (both capital and ongoing). Council must consider the choice (or prioritisation) of adaptation option(s) that provides the greatest net benefit to the community based on the available budget for investment.

5.1 Step 1: Establishing a base case

The next step involves defining and establishing the expected costs for the base case. In this context, the base case refers to the outcome for the assets and infrastructure if climate change adaptation is not implemented. The base case is equivalent to the value of risk determined as part of the risk assessment.

As shown in Figure 2, the risks are quantified in terms of average annual damage (AAD), which is average damage per year that would occur in the assessment area over a very long period of time.

Consideration will need to be given to the range of valuation methods required to determine costs. These may involve market and non-market valuation techniques:

- Market valuation—these techniques can be used to estimate the value of asset replacement costs, costs of damage (like emergency, clean-up, and rehabilitation costs), and loss of flow-on benefits (like tourism activity and productivity)
- Non-market valuation—these techniques can be used to estimate values such as recreational values, economic value for community assets and activities, and non-use values for natural assets

Although there is a preference to use primary data—as this will provide the most accurate and location-specific data—it is common for gaps to exist which prevent the use of primary data. This is particularly common for non-market values. In these cases, a benefit transfer approach can be used, which involves using values from relevant existing studies and adjusting them to fit the context of the asset or site.

The base case should include quantitative consideration of costs that are most material, as far as possible given resource constraints. Any costs that are not included because of such constraints should be described qualitatively.

The base case must be defined for and align with the period of assessment (also known as the evaluation period). A typical CBA might use a use an evaluation period of 30 years into the future. The Victorian Climate Projections (2019) present data across multiple time horizons. They include 2030, 2050, 2070 and 2090. For use of the Framework, aligning the assessment period with these time horizons is recommended.

The asset and cost profiles developed as part of the Framework are a key input into the establishment of quantitative baseline costs.

Inputs to this step	Comment
• The types and likelihood of climate change hazards in annual terms—for example, a flood event occurring once every five years would have an annual likelihood of 20%	This information can be sourced from climate science, data and information that has informed the development of the RAS for each region. See section 3.4 for further information about establishing likelihood. Specialist knowledge and skills may be required to establish the likelihood of some hazards.
• Type and count of impacted assets and infrastructure—these will need to be captured in a spatial database to determine the assets and infrastructure impacted by specific hazards	Review of the data provided by councils suggests that there are varying degrees of completeness and accuracy for existing assets and infrastructure. Most built assets are captured in spatial data, which combined with exposure mapping of each hazard will identify the exposed assets. Specialist knowledge and skills may be required to fill any data gaps.
• The consequences of each hazard for each asset—these should include direct (tangible and intangible) and indirect consequences of loss of these assets (as outlined in Table 3)	Estimates of consequences can be informed by the asset and cost profile spreadsheets developed as part of the Framework. This includes using the asset detail or replacement cost information to inform estimates of damage. This information can be supplemented by publicly available data on damage or the cost of (re)-construction.

Resources

DELWP's Environmental-Economic Accounting for Melbourne—provides information of asset extent, condition, services and benefits

Rawlinsons (2021) Construction Cost Guide—provides information for construction of adaptation infrastructure

Economic Assessment Framework of Flood Risk Management Projects —outlines an approach and provides tools for the economic assessment of flood risk management

5.2 Step 2: Identifying adaptation options

Once the base case has been established, adaptation options can be identified, scoped and assessed. It is important to note that options are not necessarily mutually exclusive and that there may be synergies or interdependencies between multiple options. This can be informed through the risk assessment and adaptation intervention analysis, as described in the example below.

While several approaches can used to identify adaptation options, a common approach involves identifying the desired outcome or benefit.[6] This can be informed by a risk and adaptation assessment (see Figure 1 and Section 3.4).

With the target defined, a range of adaptation options can be identified and scoped based on their ability to achieve the specific outcome. The extent to which the options address the target underpins the estimation of benefits. The location, scale, timing and delivery of the option underpins the estimation of costs.

When identifying and scoping the adaptation options, their performance should be considered relative the base case.

Illustrative example:

The risk assessment will identify the likelihoods and consequences of a flooding event on natural and built assets within a specific region, council area or catchment. The adaptation intervention analysis would then outline how each option may reduce the outcome of flood risk (through impacting the likelihood or consequence). This then allows the practitioner or decision-maker to identify one or several preferred adaptation options for consideration as part of the CBA, against the base case.

Inputs to this step	Comments
• Identify and scope adaptation options based on a target outcome or benefit, to identify location, scale, timing, and delivery	This should be informed by a risk and adaptation assessment

Resources

Risk assessment and adaptation intervention analysis as described in Section 3

EAGA's 'Exploratory Study: researching the costs of climate impacts on public and private buildings, energy supply systems and the urban forest.

EAGA's 'Resilient Emergency Relief Centres' project, assessing the risks and vulnerabilities of emergency relief sites (across eight councils) and prioritising and costing targeted upgrades

[6] Such an approach is consistent with Investment Logic, which underpins business case development.

5.3 Step 3: Estimating costs and benefits of adaptation options

Costs of adaptation options

The economic costs of climate change adaptation are the estimated lifecycle costs of the associated option, which includes initial capital costs, annual operating and maintenance costs and replacement costs. Each of these costs are described below:

- **Capital costs**. These costs, also sometimes referred to as establishment costs, are incurred when the option is implemented. Costs in this category are usually very large compared to other costs; however, they are only incurred in the first year, or sometimes in the first few years. *Examples include costs of labour, materials and equipment for construction of adaptation infrastructure.*

- **Operating and maintenance costs**. These costs tend to occur in each year that the adaption option is implemented. These are the ongoing costs associated with keeping the option performing as intended. *Examples include costs for maintenance, repair, and ongoing monitoring, such as the costs for managing street trees for urban heat.*

- **Replacement/refurbishment costs**. These costs are required when a component of an asset reaches the end of its design life. They are often calculated as a proportion of the capital costs. *Examples include replacement of flood mitigation infrastructure like levees and water pumps.*

- **Opportunity costs**. Some adaptation options may result in opportunity costs, which are forgone value from these investments (e.g. the loss in market-value for land used to mitigate flood risk). These could be based on an assessment of the current market value of land in nearby areas, or the potential productive value of that land.

Sources of data (often called unit values, e.g. $/hectare) can vary depending on the cost type being assessed. For example, capital costs for some items can be sourced from Rawlinsons (2021) Construction Cost Guide) and other industry standards. Alternatively, operating and maintenance costs are likely to require further information specific to the adaptation option being assessed, as well as the proposed designs.

Benefits from adaptation

The economic benefit of an adaptation option is primarily the reduction in risk it achieves relative to the base case (as shown in Figure 4). For a given year, this is estimated based on the difference between the cost of impacts under the base case and the cost of impacts when the adaptation option/action is implemented.

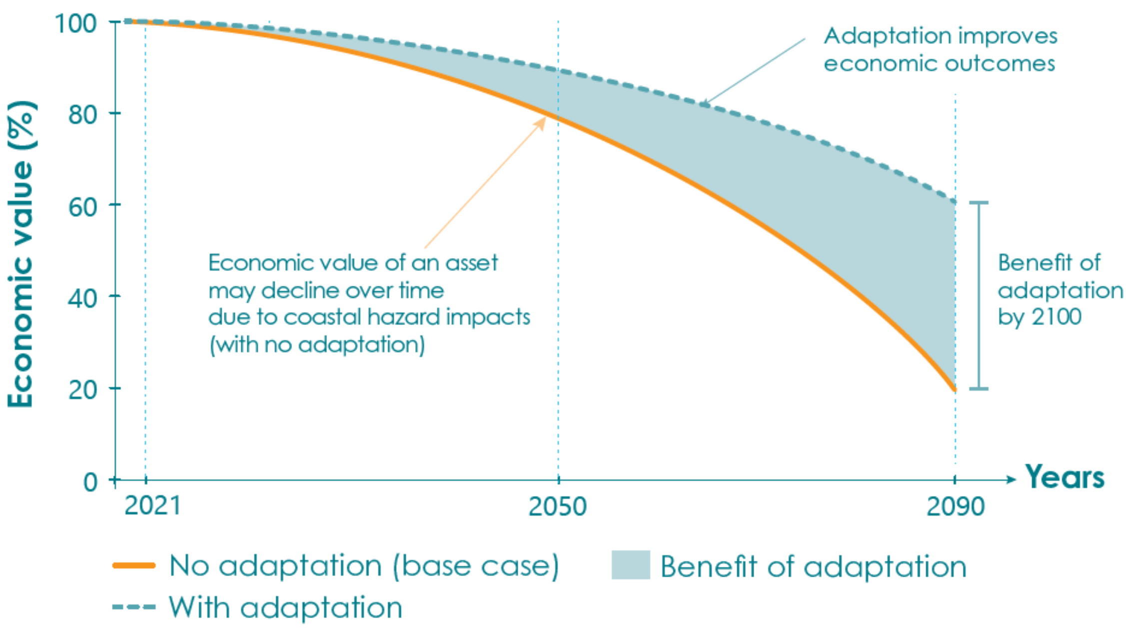

Figure 4. Illustrative example of how benefits from different adaptation options are estimated relative to the base case asset investment.

Additional benefits may also arise as a result of the adaptation option (e.g. improved amenity from WSUD). The approach to valuing such benefits will depend on the benefit under consideration.

There is a need to ensure that benefits are not double counted. For example, some assets provide benefits of reduced loads of multiple pollutants (e.g. nitrogen, phosphorus, suspended solids) in waterways. Capturing the benefits for each pollutant will result in significant double counting since the benefits of reduction of all pollutants are concurrent and cannot be isolated. A common approach is to only account for the benefits from the pollutant with the greatest load reduction as the overall value of this benefit.

Additional matters

It is critical that all benefits and costs are considered in a CBA, not just those that are readily quantified or in line with the adaptation objectives. This ensures the results of the analysis reflect the outcomes for all stakeholders in the community. It is recommended that the costs and benefits are explored qualitatively, if they cannot be quantified, such that a decision-maker can consider the value of these additional costs and benefits to the community. This is particularly relevant to potential costs and benefits that have a cultural value (e.g. if adaptation compromises or retains culturally-significant landmarks).

Consideration should be given to who bears the economic costs and benefits from adaptation options. This information is critical for the distributional analysis which can be used to decide between options as well as informing opportunities for co-investment in options. For example, private companies may benefit from the increased resilience of community assets and may therefore be willing to contribute to the cost of such measures.

Furthermore, forecasting future costs and benefits presents challenges. For example, if the replacement or refurbishment of assets is significantly different (due to design specifications). A CBA practitioner should consider approaches to address these forecasting challenges within the CBA such as through incorporating step-changes in cost estimation or expected changes to values based on scenario analysis—where there is sufficient information to do so. Further uncertainty in forecasting could also be addressed through additional sensitivity analyses (see Section 5.5).

While it is impossible to forecast for all future scenarios or accurately predict future outcomes, it is critical to consider and model some variation in results attributable to different outcomes to reduce potential error in the CBA and inform decision-making.

Inputs to this step	Comments
• Estimated cost of adaptation options	This should be informed by the cost profiles developed as part of the Framework.
• Estimated efficacy of adaptation options (e.g., expected incremental reduction in risk achieved relative to the base case)	Consideration should be given to the assumptions that underpin these incremental changes, including the efficacy of adaptation options. The efficacy of adaptation options relative to the base case should be transparent and where uncertainty exists, this should be incorporated within the sensitivity analysis (Step 5).

Resources

Rawlinsons (2021) Construction Cost Guide—provides construction cost information

5.4 Step 4: Conducting the CBA

The net benefit of each adaptation option is then estimated in the CBA using a discounted cashflow (DCF) analysis. As briefly described earlier, this involves determining the benefits and costs for each year in the appraisal period based on the steps above, discounting future values to present value terms using an established discount rate[7], aggregating the benefits and costs, and calculating the Net Present Value and the Benefit-Cost Ratio (BCR) using the following formulas:

$$Net\ Present\ Value\ (NPV) = Present\ value\ of\ benefits\ (PVB) - Present\ value\ of\ cost\ (PVC)$$

$$Benefit\ Cost\ Ratio\ (BCR) = \frac{Present\ value\ of\ benefits\ (PVB)}{Present\ value\ of\ costs\ (PVC)}$$

The CBA is typically conducted using spreadsheet applications like Microsoft Excel (and complementary plug-ins for sensitivity analysis as discussed below). Developing a CBA tool requires specialist knowledge and technical skills. While several free templates exist, CBAs tend to be highly context-dependent and thus, often require a bespoke approach to ensure the results are fit-for-purpose. Figure 5 illustrates a typical DCF model for a CBA, developed in Microsoft Excel.

[7] The Department of Treasury and Finance recommends a discount rate of 7% for values that are monetized.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1			Year	Comment	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	**Option 1: Base case**				2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
3		**Park Beach Reserve (North)**																		
4	-	Average on-going maintenance costs			15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000
5	-	Cost of pathway damage			239	239	239	239	239	239	239	239	239	239	239	239	239	239	239	239
6	-	Cost of road damage			206	206	206	206	206	206	206	206	206	206	206	206	206	206	206	206
7																				
8																				
9	**Option 2- Coastal design**				2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
10	**Costs**	**Park Beach Reserve (North)**																		
11	-	Capital costs			1,290,510															
12	-	Contigency			327,628															
13	-	Vegetation establishment (first 3months)			20,000															
14	-	OPEX				4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500
15		**Total costs (undisc.)**			**1,638,138**	**4,500**	**4,500**	**4,500**	**4,500**	**4,500**	**4,500**	**4,500**	**4,500**	**4,500**	**4,500**	**4,500**	**4,500**	**4,500**	**4,500**	**4,500**
16																				
17	**Benefits**				-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
18	+	Avoided annual remediation works	Council	130,294.93		10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500
19	+	Avoided pathway damage	Council	2,967.65		239	239	239	239	239	239	239	239	239	239	239	239	239	239	239
20	+	Avoided road damage	Council	2,559.17		206	206	206	206	206	206	206	206	206	206	206	206	206	206	206
21																				
22	+	Proxy value of markets to the community	Broad communit	116,334.46		9,375	9,375	9,375	9,375	9,375	9,375	9,375	9,375	9,375	9,375	9,375	9,375	9,375	9,375	9,375
23	+	Avoided loss site booking revenue	Council	19,237.12		1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550
24																				
25	+	Avoided loss of market stall revenues	Business	89,531.23		7,215	7,215	7,215	7,215	7,215	7,215	7,215	7,215	7,215	7,215	7,215	7,215	7,215	7,215	7,215
26																				
27	+	Estimated recreational value	Broad communit	1,735,078.34		139,824	139,824	139,824	139,824	139,824	139,824	139,824	139,824	139,824	139,824	139,824	139,824	139,824	139,824	139,824
28																				
29	+	**Total benefits (undisc.)**			-	**168,909**	**168,909**	**168,909**	**168,909**	**168,909**	**168,909**	**168,909**	**168,909**	**168,909**	**168,909**	**168,909**	**168,909**	**168,909**	**168,909**	**168,909**
30				**2,096,002.91**																
31		**Include contribution to tourism value add**	**No**																	
32																				
33			**Timeframe options**						**Sensitivity analysis**											
34		**Cost-benefit analysis results**	40 years	30 years				Low	Most likely	High										
35		**Present value of costs (PVC)**	1,698,131	1,693,979			**PVC**	3,798,215	3,798,215	3,798,215										
36		**Present value of benefits (PVB)**	2,251,850	2,096,003			**PVB**	4,107,294	4,107,294	4,107,294										
37		**Net present value (NPV)**	553,719	402,024			**NPV**	309,079	309,079	309,079										
38		**Benefit cost ratio (BCR)**	1.33	1.24			**BCR**	1.08	1.08	1.08										
39																				
40																				

Figure 5. Illustrative discounted cash flow model for a CBA

Inputs to this step	Comments
• Spreadsheet program to capture and analyse scoped and valued costs and benefits.	Spreadsheet programs (e.g. Microsoft Excel) can support the efficient delivery of this step, but requires skilled practitioners to ensure results are robust.
• Discount rate	7% is recommended by Office of Best Practice Regulation and Department of Treasury and Finance, but other discount rates can be incorporated within the sensitivity analysis.

Resources

Department of Treasury and Finance. 2013. Economic evaluation for Business Cases – Technical Guidelines—provides details and recommendations for how a CBA may be conducted including a description of decision rules described above.

5.5 Step 5: Sensitivity testing

The impact of risk and uncertainty associated with the CBA should be analysed to further inform decision-making. This can be done through sensitivity analysis of the results based on the variability of data inputs—in this case variation in benefit and cost values.

In basic sensitivity analysis, input values may be changed one at a time or in combination with other inputs to test scenarios. Depending on the number of inputs, it may be possible to perform sensitivity analysis across the full range of inputs. However, it is most important to test inputs that have significant influence on the outcome of the analysis and those that have high degree of uncertainty.

Preferably, the amount to vary each input is informed by available information on the possible range of values. If information on likely high and low values is not available, an alternative approach might be to vary inputs by a specified margin of safety (e.g., ±20%).

Basic sensitivity analysis can be undertaken by simply changing the values of the CBA inputs to observe how it changes the outcomes of the analysis and importantly, to see if it changes the preferred options. If changes in an input have a significant influence on the preferred option, a higher degree of effort should be made to ensure estimates are accurate

Sensitivity analysis can also be performed using more sophisticated methods like Monte Carlo simulations.[8] This approach will require input from specialists. The resulting simulations can be used to estimate probabilistic ranges of outputs to illustrate the uncertainty of the results. Figure 6 provides an illustrative output from a sensitivity analysis, which indicates that, given input parameters, the NPV result will fall between approximately $2 and $4, with 90% confidence.

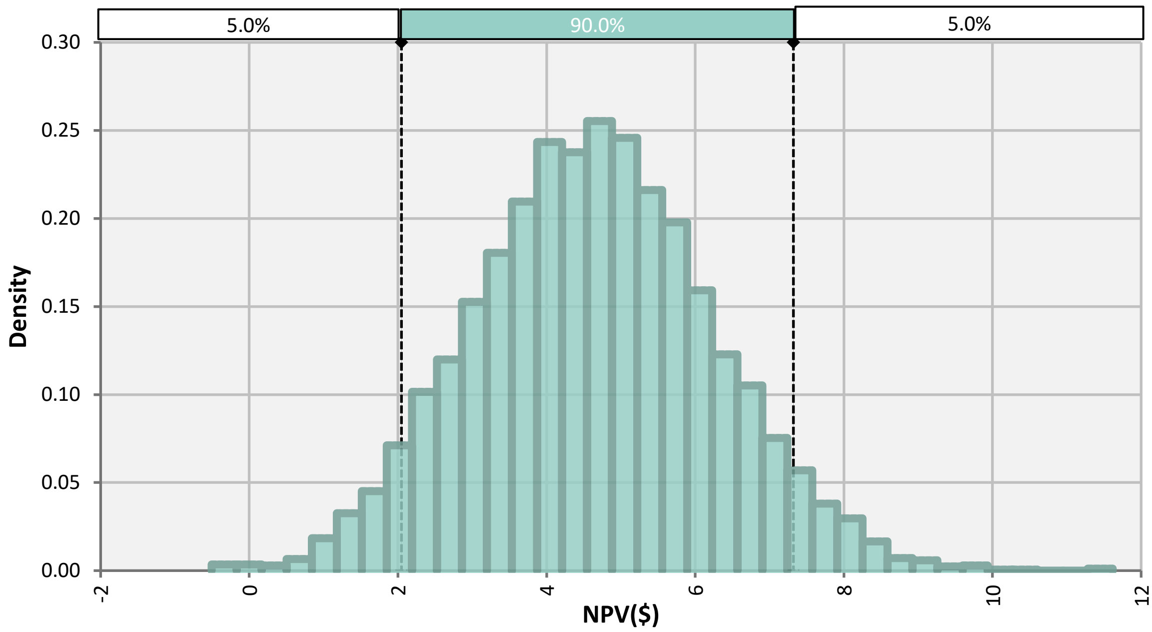

Figure 6. Example of probabilistic distribution of net present value from Monte Carlo simulation

[8] Monte Carlo simulations are statistical techniques used to model the probability of different outcomes in a process that cannot easily be predicted due to the variability in multiple input variables used in the analysis.

It also allows the determination of the key input parameters which are driving the uncertainty. These parameters can then be targeted for further refinement to reduce the uncertainty if necessary. This is consistent with leading practice economic analysis underpinning business cases.

Figure 7 provides an illustrative example of this analysis, which shows that Input 1 makes the greatest contribution to variance in the overall results, while Input 16 contributes the least. Decision makers wishing to reduce the variance in the overall results, could focus on improving the reliability of Input 1.

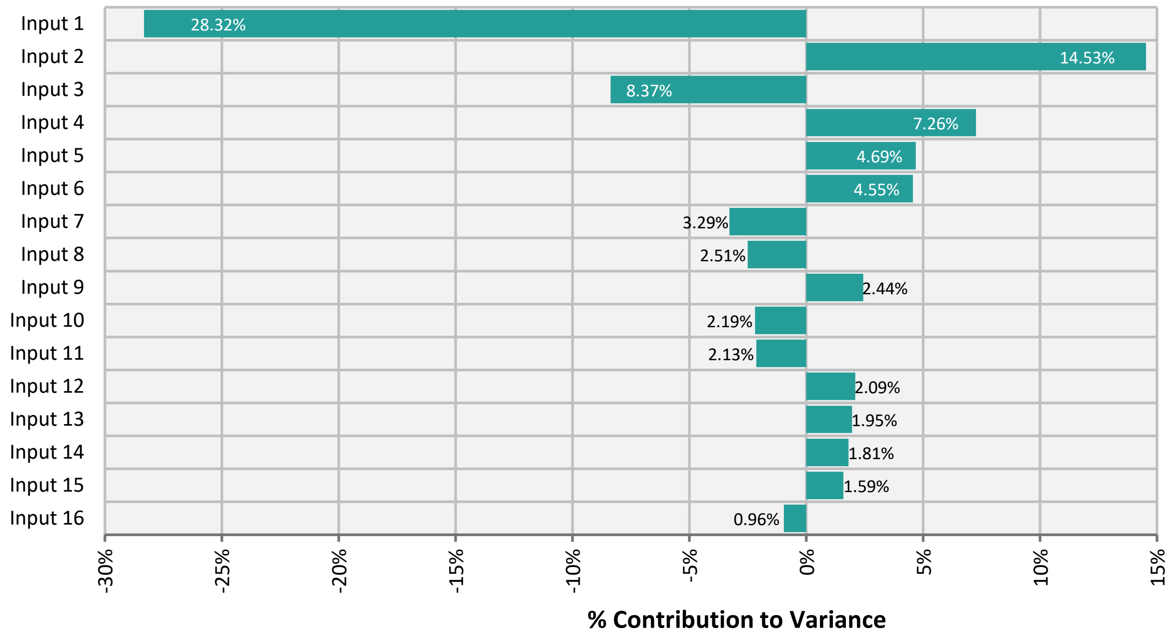

Figure 7. Example of impact of input variance to output sensitivity

Inputs to this step	Comments
• Range and distribution of costs and benefits	This can be obtained from the data sources (e.g. cost references, literature on benefits/avoided costs).
• Software to perform simulations for sensitivity analysis. (Basic sensitivity analysis can be performed without the need for specialist software)	There are several software plug-ins for Microsoft Excel that can perform this analysis to varying levels of complexity. This will also require an experienced practitioner to perform and interpret results from the analysis for use in decision-making.

Resources

Crystal Ball. Oracle. www.oracle.com/au/applications/crystalball/

@Risk. Palisade. www.palisade.com/risk/default.asp

XLSTAT. Addinsoft. www.xlstat.com

MCSim, Wabash College. www3.wabash.edu/econometrics/EconometricsBook/Basic%20Tools/ExcelAddIns/MCSim.htm

ModelRisk. Vose. www.vosesoftware.com/products/modelrisk/

RiskAMP. Structured Data LLC. www.riskamp.com

5.6 Step 6: Understanding distributional impacts

While the NPV and BCR provide insight into the net benefits to society on aggregate, it is important for decision-makers to identify and understand which groups are expected to accrue benefits and costs over the appraisal period to understand the equity implications of the options under consideration. For example, where a stakeholder group disproportionally bears the burden of the implementation of the option, it may be possible to compensate these stakeholders.

Understanding the distributional impacts can also provide insight into the incentives of different stakeholders and whether they are likely to support or not support adaptation options, and whether opportunities for attracting co-investment in the adaptation option may be attractive.

Distributional analysis can range in complexity based on the scale of the project and expected impacts. Where the scale of impact is expected to be significant, detailed scoping and appraisal of impacts to specific groups may be necessary (e.g. based on income, age, residents in specific regions, cultural/immigration background, Indigeneity, business sizes). Where impacts are less significant, qualitative analysis can still provide useful information and context in decision-making (Office of Best Practice Regulation, 2020).

Inputs to this step	Comments
• Information on stakeholder groups that stand to gain/lose (for distributional analysis) including the geographical scope of the analysis	This can be determined from desk-top analysis and informed opinion. The geographical scope of the analysis will generally be the specific LGA undertaking the assessment (the exception probably being disruptions to services such as transport that have spill-over impacts to other LGAs). Furthermore, where the impacts are likely to be significant and/or where they are not well-understood, consultation with stakeholder groups, including industry and community representatives, may be necessary.
• Allocation of costs and benefits across stakeholder groups	This can be undertaken in the same spreadsheet as the CBA by apportioning costs and benefits to the main stakeholder groups (e.g. council, developers, households) and aggregating to derive a net benefit position for each group. There may be uncertainty regarding the distribution and where possible, should be accounted for in the sensitivity analysis.

• Information on mechanisms to reallocate costs/benefits	This step requires an understanding of regulatory and commercial drivers and may require specialist input.

Resources

ABS Catalogues 8165.0, 8175.0, 6306.0 and ATO Taxation Statistics for business size.

ABS Catalogues 6202.0, 6302.0 and 4125.0 for labour market and gender effects.

ABS Catalogues 3235.0 and 3101.0 for geographic and demographic effects.

ABS Catalogues 4430.0 provides detailed information on people with disability, while ABS catalogue 3302.0.55.001 are Australian Life Tables (showing mortality rates based on different ages).

ABS catalogue 6227.0 provides information about education and work outcomes; it supplements the monthly Labour Force Survey (Cat 6202.0).

Department of Treasury and Finance. (2013). Economic Evaluation for Business Cases: Technical guidelines.

5.7 Step 7: Interpreting and communicating results

Identifying the option that provides the greatest net benefit is based on consideration of the NPV and BCR results. A positive NPV indicates that the total discounted benefits are greater than the total discounted costs while a BCR greater than one indicates that the project has a positive net benefit.

Table 4 illustrates how these different decision rules can be used in decision-making, with reference to the extent to which the options are mutually exclusive and the extent to which budgets are constrained. Generally, NPV is preferred if options are mutually exclusive except when multiple, non-exclusive projects can be funded with a limited budget.

Table 4. Decision rule selection matrix

		Exclusivity	
		Options mutually exclusive	**Options not mutually exclusive**
Budget	**Limited**	**NPV preferred** Choose the project with the largest NPV within the budget constraint.	**BCR preferred** Rank all projects by BCR and fund all projects in order of their BCRs (highest to lowest) until the budget constraint is reached.
	Unlimited*	**NPV preferred** Choose the project with the largest NPV.	**NPV or BCR** Fund all projects with NPV greater than 0 (or BCR greater than 1).

* Unlimited budget refers to the availability to fund multiple project options to achieve a desired outcome as opposed to a limited budget, which requires decision-making and choice of one or few projects to yield the greatest net value within the budgetary constraints.

The results from a CBA are largely based on monetary values. Therefore, they provide both valuable information in decision-making but also transparent means of communicating investment decisions and prioritisation of project options. However, it should be noted that not all benefits and costs may be estimated in monetary terms and included in a CBA. In these circumstances, the results of a CBA should form just one part of a decision-making process where costs and benefits that cannot be considered quantitatively are nonetheless considered.

Inputs to this step	Comments
• Results from Step 0–6	In communicating the results of the CBA it is important to include a comprehensive list of assumptions, description of the approaches used to establish the estimates of costs and benefits, and any limitations that are pertinent to decision-making. Any costs and benefits that have not been estimated quantitatively also need to be described.

Resources

Department of Treasury and Finance. (2014). Victorian Guide to Regulation Toolkit 2: Cost-benefit analysis—the Departments outlines recommended approaches to decision-making using CBAs including use of the decision rules.

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