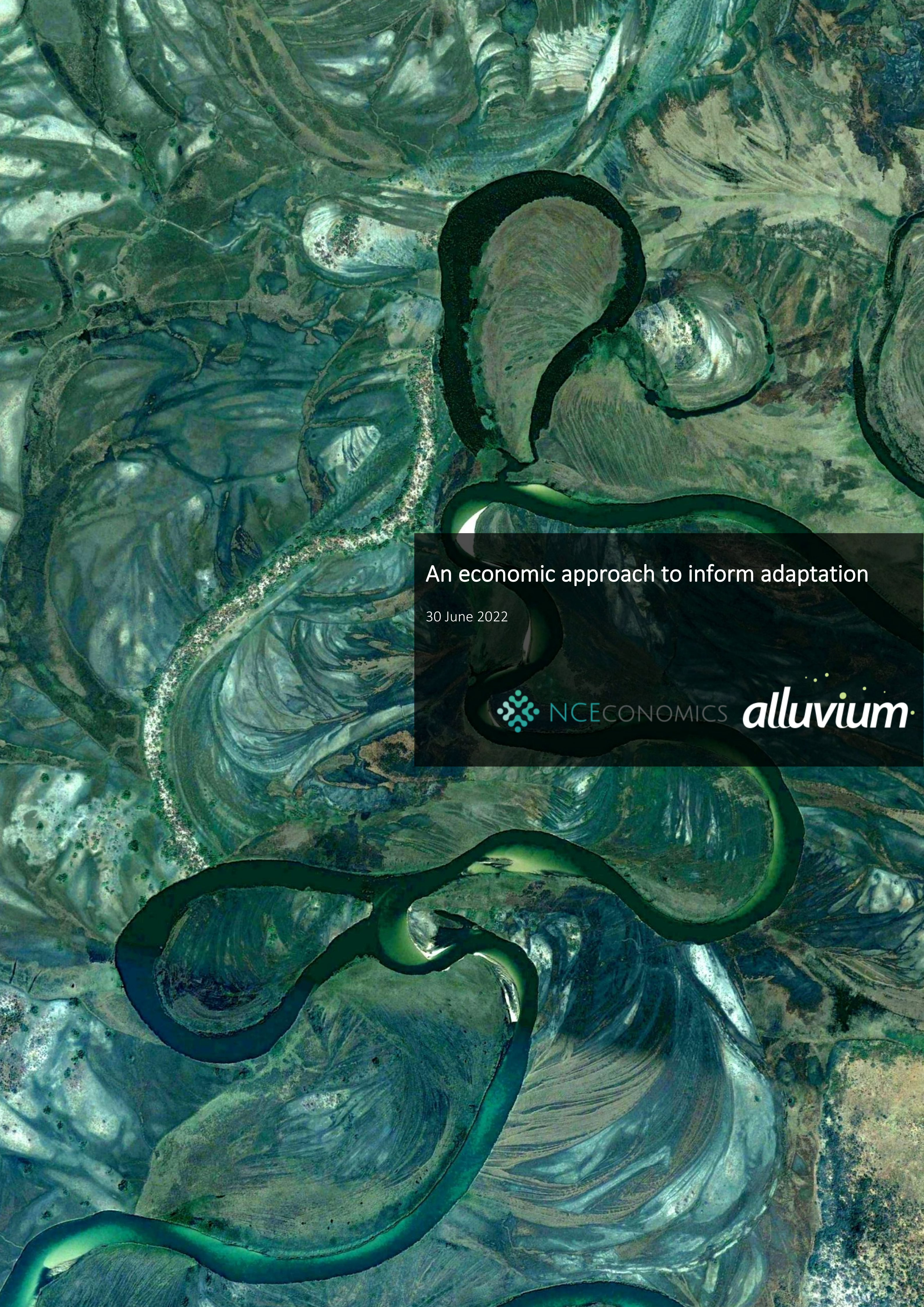

An economic approach to inform adaptation

30 June 2022

NCECONOMICS alluvium

Alluvium recognises and acknowledges the unique relationship and deep connection to Country shared by Aboriginal and Torres Strait Islander people, as First Peoples and Traditional Owners of Australia. We pay our respects to their Cultures, Country and Elders past and present.

Artwork by Vicki Golding. This piece was commissioned by Alluvium and has told our story of water across Country, from catchment to coast, with people from all cultures learning, understanding, sharing stories, walking to and talking at the meeting places as one nation.

This report has been prepared by Alluvium Consulting Australia Pty Ltd for DEPARTMENT OF ENERGY, ENVIRONMENT AND CLIMATE ACTION under the contract titled 'ECONOMICS FOR COASTAL HAZARD ADAPTATION IN VICTORIA – DEVELOPMENT OF BEST PRACTICE GUIDANCE, AND APPLICATION FOR THE CAPE TO CAPE RESILIENCE PROJECT.'

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Contents

Figures

Tables

Glossary of key economic terms

Acute climate risk — Severe climate-related events that occur over a short timeframe.

Annual exceedance probability (AEP) — Annual exceedance probability is the probability of occurrence of an event in a given year. It is analogous to an Annual Recurrence Interval (ARI) which is the average period between the recurrence of a given event. E.g. A 1% AEP is equivalent to a 1 in 100-year ARI.

Average annual damage (AAD) — A quantitative representation of the damage to or losses of coastal values, uses and infrastructure, in annualised terms, from climate hazards.

Base case — The situation that would exist without adaptation. It is sometimes described as business as usual, the “do nothing differently” scenario or counterfactual.

Benefit-cost ratio (BCR) — The ratio of the total benefits against the total costs of the project, with future values discounted to present value terms.

Benefit transfer — This method involves using values from relevant existing studies and adjusting them to fit the context of the site in question. Often used when incorporating values associated with environmental impacts.

Chronic climate risk — Slow-onset changes to climate over longer timeframes that also interact with biophysical processes, human health, productivity and the built environment.

Cost-benefit analysis (CBA) — 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 or adaptation options.

Damages and losses — Damages are the tangible and intangible impacts from coastal hazards, whereas losses are the monetised outcome of these impacts (QRA, 2021)

Discounted cashflow analysis (DCF) — A method to evaluate an investment by discounting the expected future cash flows.

Ecosystem services — The benefits people obtain from natural ecosystems.

Efficacy — The degree to which an adaptation option can achieve its desired result and reduce risk.

Inflation — Typically, increases in prices due to inflation or other sources of cost escalation should not be included in the values of future benefits and costs. However, if using costs or benefits from reference material that is relatively old, then it may be necessary to inflate these values so that all costs and benefits are assessed from the same reference year.

Mutually exclusive — Two or more events that cannot happen simultaneously.

Net Present Value (NPV) — Discounted value of benefits less the discounted value of costs for a project or adaptation option.

Sensitivity analysis — An assessment of the robustness of the estimates based on their sensitivity to changes in various inputs and assumptions.

Stakeholder — A person or organisation (including agencies) that can affect, be affected by, or perceive themselves to be affected by a decision or activity.

1 Introduction

1.1 Purpose and scope

This document provides guidance for using economic assessments to inform coastal hazard risk and adaptation planning in Victoria.

This guidance has been developed as a supporting module to Victoria's Resilient Coast - Adapting for 2100+ framework and guidelines (DEECA 2023, formerly DELWP).

1.2 Role of economics

Economic provides a range of techniques which can be used to compare alternative actions. When applied to coastal hazards, these techniques allow the costs and benefits of adaptation to be compared in a structured and consistent way which supports transparent decision-making.

Economic assessments:

- provides an articulation of the consequences of 'doing nothing further' in the face of climate change (i.e. the case for action)
- informs the sequencing and timing of actions to address coastal hazards
- includes processes by which less tangible impacts (e.g. environmental and social) can be valued and included in decision-making
- provides the basis for the development of business cases for investment in coastal hazard adaptation
- provide the basis for identifying beneficiaries from adaptation and potentially the basis for attracting investment in adaptation options.

1.3 This guideline

This guideline outlines an economic assessment approach that is based on five steps (see Figure 1) and can be used to evaluate impacts from slow onset (chronic) and sudden (acute) risks created by coastal hazards. It can also be used to compare the use of a range of adaptation options (e.g. engineering and nature-based).

The primary coastal hazards considered in the development of this guideline are storm tide inundation, coastal erosion and permanent inundation due to sea level rise. However, the approach can be used to assess other hazards.

This guideline is intended to assist land managers and decision-makers across the Victorian Marine and Coastal environment, including State and Local Government, with scoping project needs and progressing risk management and adaptation planning.

Application of each step may require inputs from specialists such as economists and coastal engineers. The guideline approach draws on the experience of applied economic assessments of coastal hazard and climate change risks nationally and internationally.

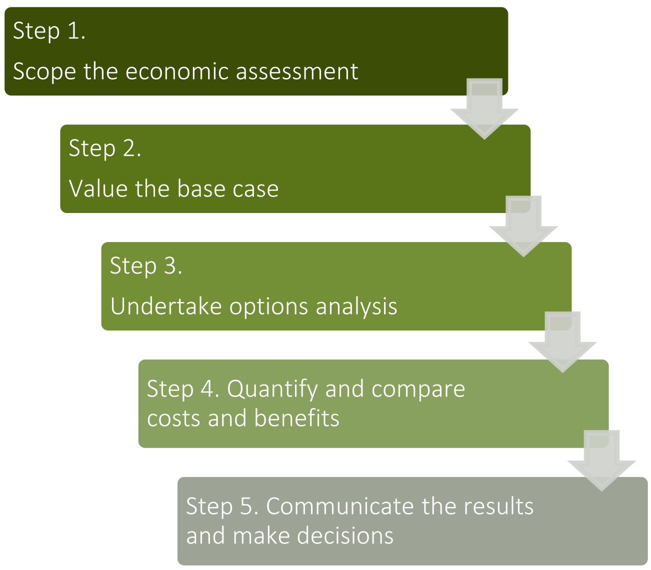

Figure 1. *Steps to perform an economic assessment of coastal hazard adaptation options.*

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2 Economic assessment guidelines

Victoria's Resilient Coast Stages			Economic guideline steps
STAGE 1	Scoping and preparation	Traditional Owner knowledge, rights and aspirations Collaborative process Engagement and communication	
STAGE 2	Values, vision and objectives		
STAGE 3	Coastal hazard exposure		
STAGE 4	Vulnerability and risk		Step 1. Scope the economic assessment Step 2. Value the base case
STAGE 5	Adaptation actions and pathways		Step 3. Undertake actions analysis Step 4. Quantify and compare costs and benefits Step 5. Communicate the results and make decisions
STAGE 6	Plan and implement		
STAGE 7	Ongoing monitoring and review		

Figure 2. *Victoria's Resilient Coast framework and links to the economic guideline steps.*

An economic assessment is typically undertaken in a series of steps (shown in Figure 2). Each step draws on the outputs of the previous step.

Each of the steps requires input information from all Stages of Victoria's Resilient Coast (VRC) framework and it's collaborative process (e.g. exposure of coastal values, uses, and infrastructure provides a direct input to the base case).

The Department of Treasury and Finance (2013) and the Department of Jobs, Precincts and Regions (2020) both provide generic guidance on performing economic assessments that is broadly similar to the steps outlined above; however, they do not provide detailed guidance on a number of aspects that are unique to assessment of coastal hazards (e.g. the treatment of risk, assessing the value of ecosystem services).

2.1 Step 1: Scope the economic assessment

The first step is to scope the economic assessment. This aims to ensure that the economic assessment is fit for purpose and, when complete, delivers the necessary outputs to inform decision makers.

The scope of an economic assessment of coastal hazards needs to include consideration of the following elements:

- The purpose of the economic assessment and the outputs required to achieve the desired outcome (e.g. analysis to support informed decision-making and enhanced resilience)
- The coastal hazard types and associated probabilistic events (e.g. 1%,10% or 0.2% annual exceedance probability (AEP), as outlined in VRC Stage 3) to be considered as part of the economic assessment
- The spatial boundaries of the economic assessment
- The planning horizons to be used when undertaking the assessment (e.g. 10 to 100 years as outlined in VRC Stage 3). Use of multiple planning horizons will enable adaptive management by identifying when different adaptation options become viable
- The need for specialist technical expertise (e.g. coastal engineers, economists, etc.)
- The required and available data.

The factors listed above will assist with defining the costs and benefits to be included in the economic assessment and their boundaries. Importantly, the economic assessment is underpinned by biophysical data of the coastal hazards being assessed. As such many of these considerations will be linked to existing or ongoing work associated with the biophysical modelling of coastal hazards, including exposure and risk assessment.

Scaling the assessment

In scoping the economics assessment, it is important to ensure that the effort and cost to undertake the assessment is proportionate to the scale of the problem or potential investment. In general, the cost of the economic assessment is linked to the time and effort required for quantifying the costs and benefits of adaptation options.

Detailed (costly) economic assessment	Suitable for large scale problem or potential investment. For example, a more complex regional scale location, involving multiple local government areas, multiple values and uses spanning multiple infrastructure types, economic sectors or industries. Assessments might include: • quantifying a broader scope of costs and benefits • providing more precise estimates of their value (QRA, 2021).
Less detailed (less costly) assessment	Suitable for smaller scale problems or potential investment. For example, as localised situation involving a single site with smaller number values and uses. Assessments might include: • simple, small-scale analysis • narrowing down a large list of alternatives before preceding to a more detailed assessment.

Data availability can also be a significant driver of assessment costs. Many assessments rely on the availability of infrastructure data, in appropriate formats. Localised and relevant valuations and other bespoke valuation assessments – such as on important values and uses (e.g. environmental values, can add to costs.

Case studies can be used to examine specific issues of concern associated with coastal hazards. This approach is helpful when it is not feasible to quantify all the relevant costs and benefits associated for inclusion into the CBA. Case studies can be described quantitatively or qualitatively and provide further information to support decision making.

Partnering with Traditional Owners

Victoria's Resilient Coast framework and guidelines include direction on a partnership approach with Traditional Owners. Intrinsic Traditional Owner cultural values are to be considered in all stages of VRC adaptation planning.

In the context of scoping economic assessments, project leads should work with local Traditional Owner groups to inform the best approach to inclusion / costing of cultural value elements.

Different groups may have different perspectives. Many may not want to do valuations, others may wish to consider it in certain contexts.

Cultural Heritage Management Plans often include valuations, and there are a range of bespoke approaches applied nationally in different contexts.

If the agreed scope of economic assessments does not include valuation for Traditional Owner cultural values, this should be stated clearly, and the alternative ways that cultural values will inform adaptation planning should be outlined.

Useful Resources

The economic assessment information portal – provides links to a range of information on performing economic assessments.

Guidance on undertaking economic assessment – provides guidance on performing, commissioning, and evaluating economic assessments.

Economic assessment framework of flood risk management projects — outlines an approach and provides tools for the economic assessment of flood risk management.

2.2 Step 2: Develop and value the base case (valuation of risk)

The second step is to define the base case. The base case refers to the outcome that would occur if adaptation to coastal hazards is not implemented. That is, business as usual.

Figure 3, Figure 4, and Figure 5 provide illustrative representations of a potential base case.

Importance of a base case

Defining the base case is essential, as it:

- provides a point of reference to understand the benefit of intervention.
- assists to inform an appreciation of current and emerging economic implications from coastal hazards.
- provides an economic perspective on the need to proactively manage coastal hazard risk and adapt,
- useful for project scoping and business cases contributes to the evaluation of adaptation

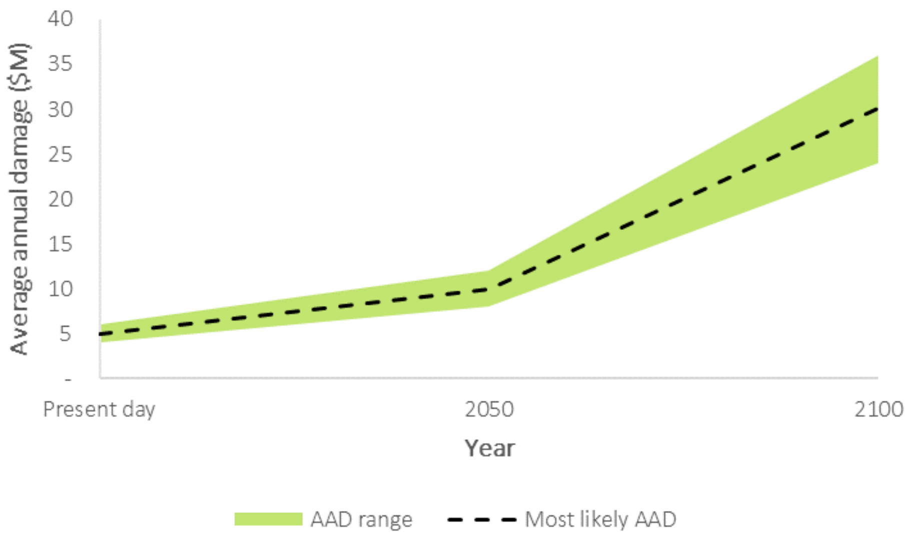

Figure 3. *Illustrative representation of the base case shown through time in terms of expected average annual damages.*

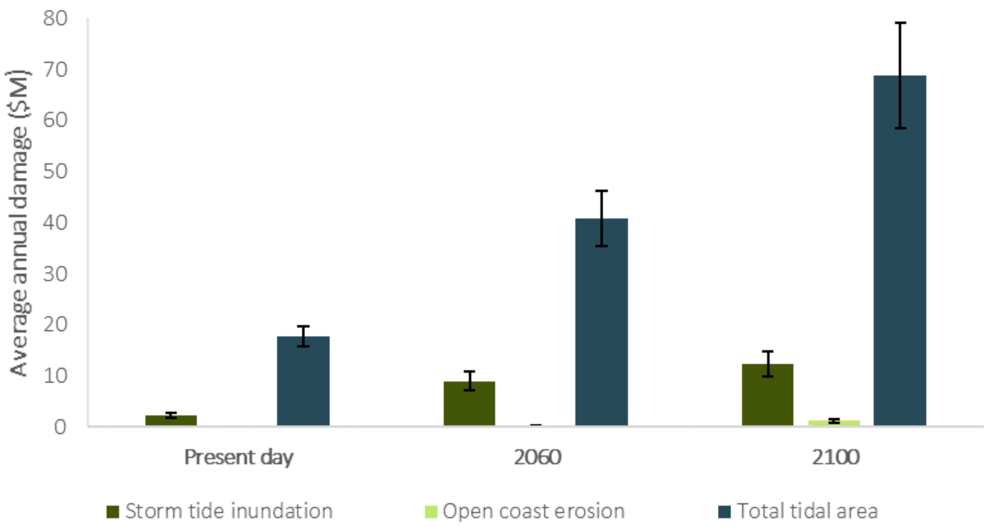

Figure 4. *Illustrative representation of the base case shown in terms of expected average annual damages at specific time intervals and broken down by hazard type.*

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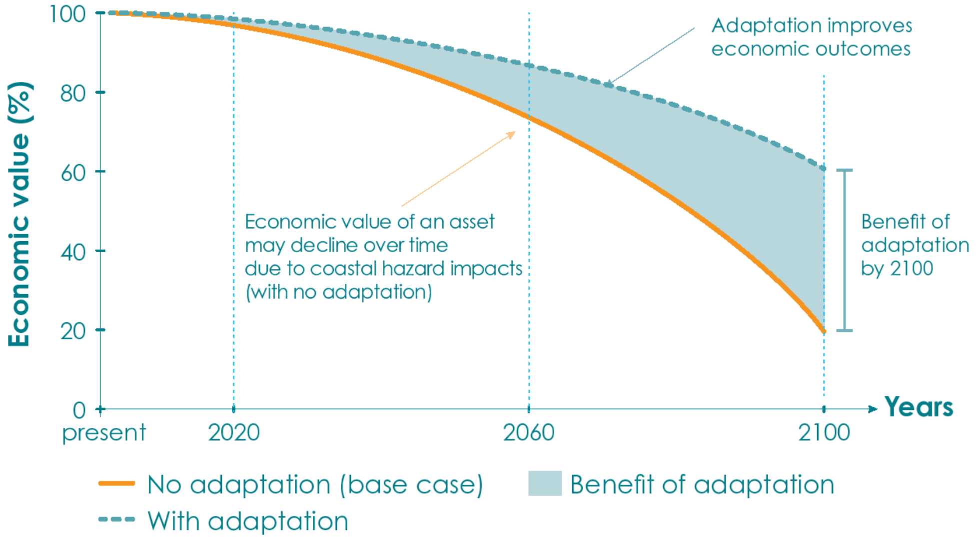

Figure 5. *Illustrative example of the benefits from coastal hazard adaptation relative to the base case.*

The base case is defined by estimating the expected average annual damages (AADs) for each hazard type. AAD is the average damage per year that would occur in the assessment area over a very long period.

The use of AAD accounts for the uncertainty associated with knowing the exact nature (e.g. size, severity) of the coastal hazard events that will occur in any one year.

The use of AAD is the best practice approach for understanding potential economic impacts of flood risk (QRA, 2021). It can also be applied to coastal hazards and the economic assessment of adaptation options. It is like the approach used by the insurance industry to work out the economic value of risk and can be understood using the standard risk equation below.

$$\begin{aligned}&\text{Economic value of risk}\\&= \text{Expected average annual damage}\\&= \sum_{i=1}^{n} (\text{Consequence}_i \times \text{Likelihood}_i)\end{aligned}$$

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.

As shown in the standard risk equation, AADs reflect the value of risk, which is the product of likelihood and consequence. The likelihood of a coastal hazard event is equivalent to the probability it will occur, while its consequences are associated with the damages or losses that it will cause

In this context, damages are the tangible and intangible impacts from coastal hazards, whereas losses are the monetised outcome of these impacts.

The likelihood of an event is informed by biophysical modelling which includes consideration of climate projections, while consequence is driven by asset exposure, community and stakeholder values and expectations.

A range of economic valuation techniques is required to estimate the monetary value of the consequences of an event. This may include:

Market valuation techniques — relies on market prices 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 techniques — used when market prices do not exist to estimate values such as recreational values, economic value for community assets and activities, and non-use values for natural asset.

The base case should include estimated monetary costs that are most material. Any costs that cannot be estimated in monetary terms should be described qualitatively.

A complete assessment of costs should consider direct impacts, indirect impacts, and intangible impacts (Table 1).

Further detail on environmental values, which are an important intangible impact is provided in the following section.

The base case must be defined for and align with the period of assessment (also known as the planning horizon, as described in VRC Stage 3).

Table 1. Coastal hazard impact categories and examples

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: o Damage to private property (e.g. houses) o Damage of public assets (e.g. roads, parks) o Increased maintenance costs (e.g. more frequent repairs)	For example: o Displaced tourism activity o Emergency costs o Alternative accommodation o Clean-up and rehabilitation o Business and service disruption o Disruption of public services and services to the community o Transport disruptions and indirect costs (travel time, delays, vehicle operating costs)	For example: o Mortality (Loss of Life) o Morbidity (Injury, stress and mental health, other health impacts) o Environmental values o Cultural and heritage values o Social and recreational values including recreational activity foregone

Environmental Values

The natural environment can provide a wide range of benefits to society through the provision of ecosystem services (e.g. supply of habitat, carbon sequestration, water filtration). Coastal hazards can potentially put the delivery of these services and their benefits at risk.

Ecosystem services are not typically bought or sold in markets. The four types of ecosystem services are shown in Figure 6.

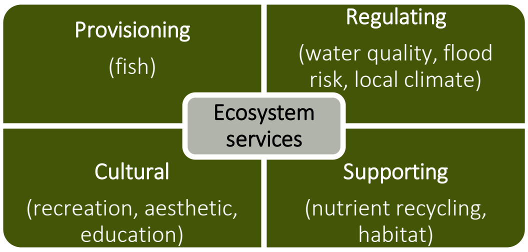

Figure 6. *Four types of ecosystem services.*

Without market prices, determining the monetary value of ecosystem services for inclusion in CBAs can be less straightforward than, determining costs associated with loss of built infrastructure or property. However, there are several economic techniques available, known as non-market valuation techniques, which make it possible. A benefit transfer approach is a cost-effective and commonly used technique and involves using values from relevant existing studies and adjusting them to fit the context of the asset or site.

The steps outlined in this guideline are designed to accommodate the intangible costs and benefits associated with ecosystem services. The accuracy of cost and benefit estimates included will be influenced by the time and resources available to undertake the valuation. It is expected that more effort will be required to accurately estimate intangible costs and benefits, like those of ecosystem services, than tangible benefits, which a more easily quantifiable. Sensitivity analysis of ecosystem services costs and benefits values is important due to high expected levels of uncertainty.

Useful Resources

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

NSW DPI Farm budgets and costs – provides farm budgets and gross margin estimates for a range of farming enterprises which can be used to determine the value of any agricultural losses.

INFFEWS Value Tool – Includes a range of potential benefit transfer values relevant to urban water and green infrastructure projects in Australia.

Environmental Valuation Reference Inventory – A global database of empirical studies on the economic value of environmental assets and human health effects. The database can be filtered to focus on studies related to water in Australia.

Ecosystem Services Valuation Database – A collection of over 6,700 value estimates across a range of ecosystems and locations.

Australian Bureau of Statistics – A wealth of socio-economic data (e.g. incomes, population, etc.) for a range of locations and geographical scales.

2.3 Step 3: Undertake options analysis

This step involves analysing the costs and benefits of adaptation options. This is completed for options that have been shortlisted (through MCA and strategic filters) for the economic assessment. Adaptation options are diverse and may include: land management, planning and design, nature-based, or engineering components.

The Adaptation Actions Compendium - VRC Module B (BMT 2022), provides further information regarding the range of adaptation options available.

The approach to analysing costs and benefits depends on the adaptation option being considered.

The economic cost of an adaptation option is its estimated lifecycle costs. Lifecycle costs are made up of:

- Capital costs – also referred to as establishment costs and are incurred when the option is implemented.
  Examples include costs of labour, materials and equipment for construction of adaptation infrastructure or implementation of nature-based solution.

- Operating and maintenance costs – also referred to as ongoing costs and are associated with keeping the option performing as intended.
  Examples include costs for maintenance, repair, and ongoing monitoring.

- Replacement/refurbishment costs – costs of replacing a component of infrastructure when it reaches the end of its design life.
  Examples include replacement of flood mitigation infrastructure like levees and water pumps or replanting failed mangrove areas

- Opportunity costs – the forgone value which occurs as a result of an adaptation option investment
  Examples include the loss in market-value for land used to mitigate flood risk.

The economic benefit of an adaptation option is based on its efficacy. The efficacy measures the reduction in risk that an adaptation action achieves relative to the base case. It 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. It is also important to consider how efficacy might change over time (e.g. declining efficacy from a degrading seawall or increasing efficacy from establishing vegetation).

Options that result in additional benefits

Many nature-based adaptation options result in additional benefits. For example, kelp forests provide important carbon sequestration benefits and mangrove forests provide important fish breeding habitats. Where material, such benefits should be included in the assessment.

The approach to valuing such benefits will depend on the benefits being valued and may draw on non-market valuation techniques.

Box 1 provides an example of how ecosystem service benefits can be incorporated in economic assessments.

All costs and benefits must also be inflation-adjusted to ensure they are compared on an equivalent basis. Inflation-adjusting refers to the use of the relevant price index to update prices from previous years to their present day equivalent. This accounts for the increase or decrease in prices due to inflation and helps to ensure that all costs are comparable.

It is important to note that assessment of cost and efficacy involves the combined input of coastal engineers and economists to agree the appropriate parameters for the assessment.

Table 2 provides examples of potential adaptation options to storm tide inundation with theoretical cost and efficacy information.

Table 2. Illustrative example of adaptation options to storm tide inundation

Option type	Capital cost ($/metre)	Annual operating costs (% of capital cost)	Design life (years)	Build time (years)			Efficacy (% reduction in hazard)
				10% AEP	1% AEP	0.2% AEP	
Road raising	3,500	0%	100	2	85%	75%	70%
Levee	2,600	2%	50	1	90%	80%	75%
Seawall	10,000	3%	50	1	80%	75%	65%
Mangrove enhancement	75	0%	30	10	10%	0%	0%

Box 1. Incorporating ecosystem services into an economic assessment

Background

The Blue Heart Sunshine Coast is an area of floodplain approximately 5,000 hectares in the Maroochy catchment. As a floodplain area, the Blue Heart is already prone to flooding. With climate change and rising sea levels, an expansion of the area that is permanently inundated is expected. Inland wetlands such as the Blue Heart provide a range of ecosystem services, including: climate regulation / carbon sequestration, disturbance regulation (e.g. flooding), habitat, and recreation and cultural.

Analysis

To understand the impact of an increase in the extent of the Blue Heart, a potential change in ecosystem services values is estimated. Specifically, the estimated gain in ecosystem services from expansion of wetlands relative to the losses to agriculture. Based on this analysis, it is likely that the value of the wetland ecosystem services created are likely to well exceed the value of any agriculture lost.

Current estimated extent of Blue Heart

Estimated future extent (2100) of Blue Heart

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Estimated value of wetland ecosystem services gained relative to agriculture foregone (2100) ($ / year – rounded to $ million)

Estimated total value	Low	Medium	High
Estimated total value of wetland ecosystem services gained	< $1,000,000	$12,000,000	$70,000,000
Estimated total value of agriculture foregone	< $1,000,000	$2,000,000	$3,000,000

Useful Resources

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

ABS (2021) Producer Price Index – provides price indexes for various producer industries, including mining, manufacturing, construction and services industries. Can be used for inflation-adjusting cost estimates where necessary.

ABS (2021) Consumer Price Index – provides price indexes for various categories of household expenditure. Can be used for inflation-adjusting valuation estimates where necessary.

2.4 Step 4: Quantify and compare costs

In a CBA, the total benefits are weighed against the total costs in monetary terms (Figure 7).

In this context, costs are the lifecycle costs of adaptation options. Benefits are the reduction in risk achieved as well as other additional benefits from adaptation. As part of a CBA, cost and benefits are recorded in a spreadsheet based on the year in which they are estimated to occur.

The sum of these future costs and benefits are then converted to present day values so that they can be compared on an equivalent basis[1]

Figure 8 provides a visual representation of this process, which uses a technique known as discounted cash flow analysis.

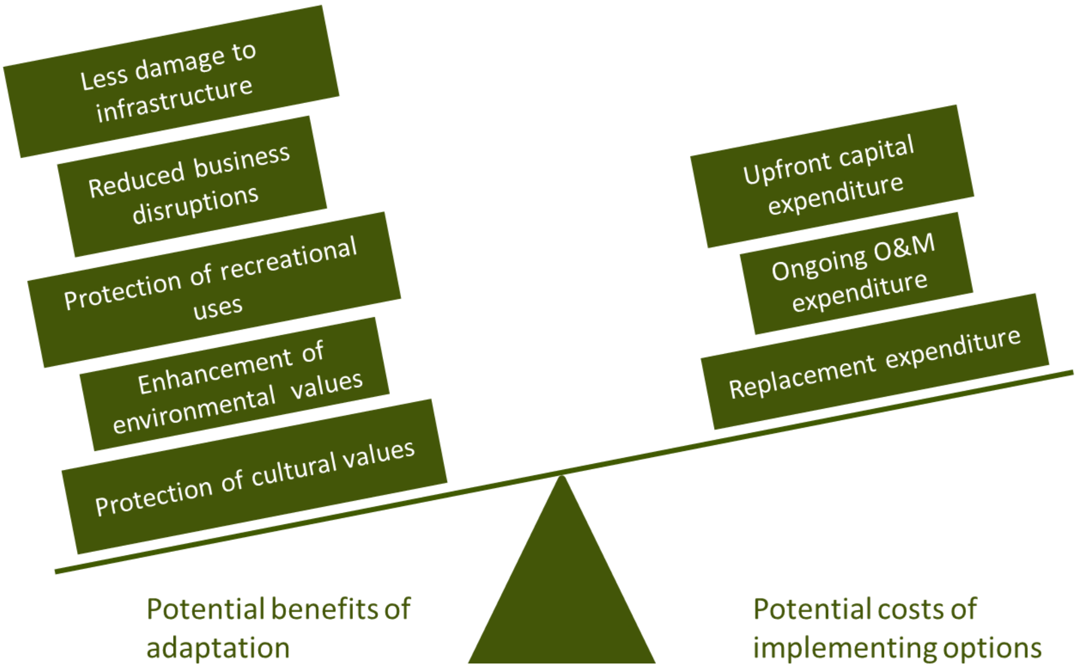

Figure 7. *An illustrative representation of a CBA which is used to transparently weigh benefits of adaptation against costs.*

Figure 8. *Illustrative representation of a discounted cash flow model for a CBA.*

[1] This process, known as discounting, enables a fair comparison of cost and benefits by taking account of the 'time value of money' or the fact that there is a preference to receive benefits early and delay costs.

The process of converting the sum of future costs and benefits to the present day enables the calculation of the net present value (NPV) and the benefit-cost ratio (BCR). These are the two primary decision criteria used to evaluate the economic viability of adaptation options. A NPV above zero and a BCR above 1 indicate an option has a net benefit to society, with a higher value indicating a higher benefit and a more preferred option.

The decision criteria are calculated using the following formulas:

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

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

Interpretation of these variables is discussed further in step 5.

> ***Useful Resource***
> Economic evaluation for business cases – Technical guidelines—recommendations for how a CBA may be conducted including a description of decision rules described above from the Department of Treasury and Finance.

Understanding uncertainty

Within CBA, it is common to have to make assumptions where data is missing or of a poor quality. To account for this uncertainty, it is important to perform sensitivity analysis to understand the extent to which such assumptions effect the overall results. Basic sensitivity analysis can be undertaken by simply changing the values of the data inputs to observe how it changes the outcomes of the assessment and importantly, to see if it changes the preferred option. If changes in an input have a significant influence on the preferred option, a higher degree of effort should be given to ensuring estimates are accurate.

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

Sensitivity analysis can also be performed using more sophisticated means like Monte Carlo simulations.[2] This approach will require input from specialists and the use of bespoke software. The resulting simulations can be used to estimate probabilistic ranges of outputs to illustrate the uncertainty of the results. It also measures which inputs to the modelling or assumptions explain most of the variance in the estimates. This is useful to identify and prioritise what issues and data should be the focus for additional work, based on their materiality on the findings of the CBA.

Figure 9 provides an example output from using a Monte Carlo simulation to test the sensitivity of a NPV. It illustrates the results of a CBA where, given the uncertainty in input assumptions, there is a 90% probability that the NPV will fall within the range of $2M and $7.5M. It also illustrates that there is a low probability that the NPV will be less than $0; i.e. the project is likely to be feasible, even with uncertainty in the input parameters.

[2] 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 assessment.

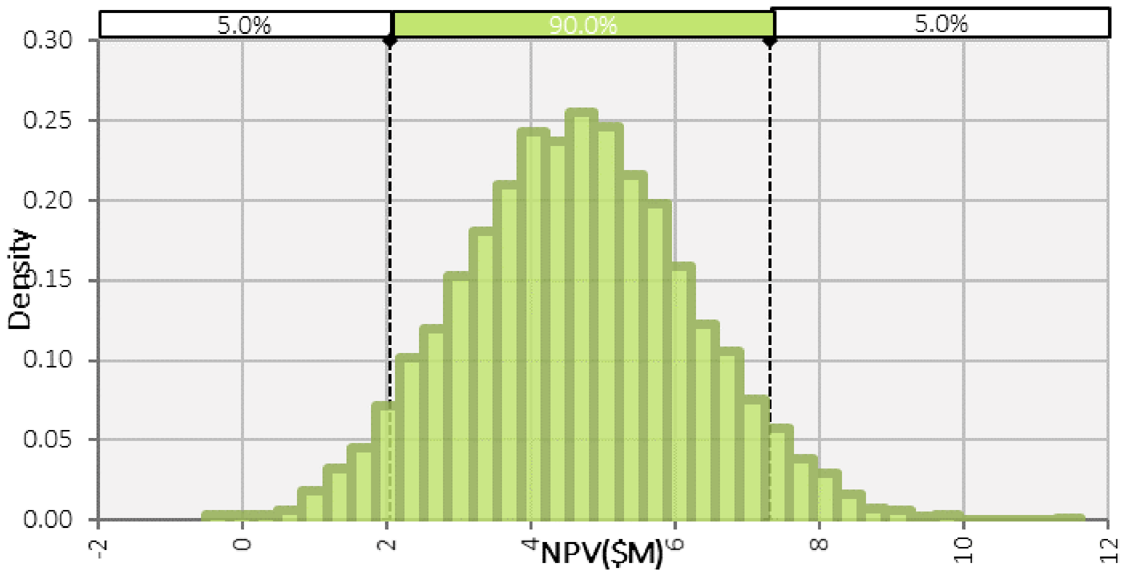

Figure 9. *Example of probabilistic distribution of net present value from Monte Carlo simulation.*

Threshold analysis
Threshold analysis is another supplementary form of sensitivity testing that allows the determination of the extent to which key variables would need to change from their base case levels to alter the outcome for an option or scenario.[3] In the case of a CBA, by selecting specific variables and constraining the NPV to equal 0 (the critical decision rule), the input cost or benefit required for the option or scenario to become economically unfeasible can be determined. Threshold analysis is particularly useful when a high level of uncertainty surrounds a key input.

Distributional analysis
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 assessment period to understand the equity implications of this distribution. 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 available.

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, 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).

[3] There are several common functions in Excel that allow for this testing, including the What-if and Goal-seek functions.

2.5 Step 5: Communicate the results and make decisions

This step involves interpreting and communicating the result of the CBA and using this to help identify the preferred option from an economic perspective.

The CBA results will include the values of the decision criteria and any accompanying sensitivity analysis, calculated as part of step 4.

When an adaptation option has a positive NPV, it indicates that the total discounted benefits of implementing the options are greater than the total discounted costs. Alternatively, when an adaptation option has a BCR greater than one, it indicates that the project has a positive net benefit to society. Example BCR outputs from an adaptation options assessment is shown in Table 3.

It is also important to consider that there are cases when using one decision rule over the other may result in different outcomes. For example, there may be cases where the option with the highest BCR may not have the highest NPV. In this case, one of the decision rules must be chosen to select the preferred option. 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. NPV is preferred if options are mutually exclusive except when multiple, non-exclusive projects can be funded with a limited budget.[4]

Table 3. Example BCR results for an assessment of adaptation options through time

Option	Present day	2060	2100
Seawall	0.05	0.08	0.07
Tidal barrage	0.03	0.09	0.09
Levee/bund	1.12	1.44	1.99
Rock revetment	0.02	0.04	0.05
Beach nourishment	0.59	1.07	1.26
Groyne	0.02	0.07	0.13
Dissipation structures (mangroves)	0.01	0.04	0.05
Dune revegetation	4.22	7.09	9.19

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.

[4] See Pannell (2020) for further discussion.

The results of the CBA will provide valuable information to support the decision-making process. As described earlier, it is often not possible to include all costs and benefits within a CBA. In such situations, these costs and benefits should be described qualitatively and be considered along with the CBA results, outputs from the sensitivity analysis and other available information as part of the overall decision-making process.

It is also important to consider the CBA results within the broader context of the broader adaptation needs and strategic planning process findings.

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

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