

DECISION SUPPORT FOR ADAPTATION



DECISION SUPPORT FOR COASTAL ADAPTATION: THE WORKBOOK



Prepared for the Hunter & Central Coast Regional
Environmental Management Strategy



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Introduction

Workbook purpose and contents

This workbook has been developed through the Australian Government's Coastal Adaptation Decision Pathways project to assist local council members of the Hunter and Central Coast Regional Environmental Management Strategy (HCCREMS) with decision-making on adaptation actions in response to coastal impacts associated with actual or projected sea level rise, storm tides, coastal flooding and coastal recession.

It is a companion document to *Decision Support for Coastal Adaptation: The Handbook*, which provides detailed discussion and reference information on the coastal adaptation decision-making process.

This workbook goes through the major stages involved in coastal adaptation decision-making, detailed in the Handbook, providing at each stage:

- a checklist of the major steps to be completed and key points to be addressed in the course of completing those steps; and
- worksheets to assist decision makers record key relevant information consistent with the checklists.

Adaptation decision stages

A sound decision-making process provides the foundation for effective coastal adaptation. Figure 1 identifies the key stages in the process, covering:

Structuring of the problem

- Stage 1 Define the issue or problem;
- Stage 2 Clarify roles & responsibilities;

- Stage 3 Establish decision-making objective;
- Stage 4 Assess hazards and risks;

Analysis of adaptation options

- Stage 5 Identify options;
- Stage 6 Establish threshold and triggers;
- Stage 7 Assess options;
- Stage 8 Deal with risk and uncertainty in the assessment;

Managing adaptation response

- Stage 9 Select and implement preferred options;
- Stage 10 Monitor changes and evaluate outcomes.

Each stage involves a number of steps, with each step providing a range of choices. The steps and choices are summarised in Figure 1.

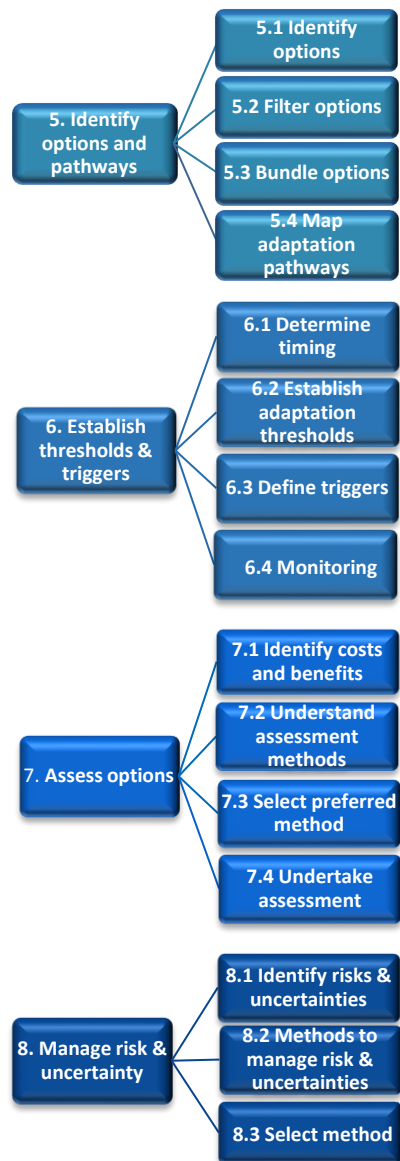
Note stages have been numbered from one to ten, to assist with use of the Handbook and Workbook. This sequential numbering is not intended to imply that adaptation decision-making should be or will be a linear process. On the contrary, decision-making will almost certainly be an iterative process and will involve jumping backwards and forwards between different stages and even skipping some stages altogether, depending on the nature and scale of the issue and decision process.

Figure 1: Stages and steps in the decision-making process

Structuring



Analysis



Managing

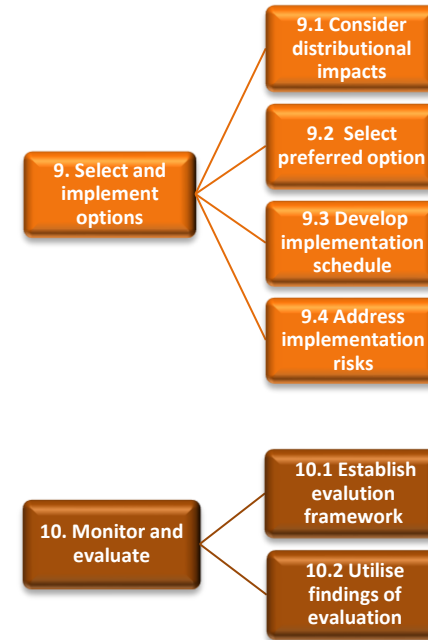


Table 1: Steps and decisions at different stages in the decision process

Decision stage		Step 1 decisions	Step 2 decisions	Step 3 decisions	Step 4 decisions
Structuring	1. Define the issue or problem	Understand nature of the issue <ul style="list-style-type: none"> - scale (macro, micro) - issue category (land use, statutory planning, infrastructure) - issue type (established land use, new land use) - time horizon 	Identify regulatory and policy framework <ul style="list-style-type: none"> - relevant instruments (Acts, regulations, plans, policies) - binding requirements and guidance 	Identify information & resource requirements <ul style="list-style-type: none"> - risk priority setting - costs and feasibility of options - resource requirements - statutory framework 	Map communications and engagement plan <ul style="list-style-type: none"> - collaboration (who and how); - communication and engagement (who, how and when)
	2. Clarify roles & responsibilities	Establish primary responsibility <ul style="list-style-type: none"> - council - Commonwealth or State government, authority, utility - shared 	If council responsibility <ul style="list-style-type: none"> - constraints - internal roles & responsibilities - resourcing - consultation 	If shared responsibility <ul style="list-style-type: none"> - identify responsibilities & map - constraints - resourcing - collaborative decision-making 	If other agency <ul style="list-style-type: none"> - council liaison - watching brief - implications for council plans
	3. Establish objective	Identify objectives <ul style="list-style-type: none"> - local - regional and State level - Commonwealth level 	Align and prioritise objectives <ul style="list-style-type: none"> - economic development - environmental protection - social, cultural and community 	Establish primary objective and constraints <ul style="list-style-type: none"> - primary objective - conditions 	
	4. Assess hazards and risks	Determine assessment process and scale <ul style="list-style-type: none"> - site specific - multiple locations/ regional 	Consider types of hazards & impacts <ul style="list-style-type: none"> - sea level rise - storm tides - coastal recession - coastal flooding - range & scale of impacts and risks 	Set parameters <ul style="list-style-type: none"> - site specific or regional? - timescale 	Review process <ul style="list-style-type: none"> - technical specifications - sensitivity analysis - expert review
Analysis	5. Identify options & pathways	Identify options <ul style="list-style-type: none"> - identify possible adaptation strategies 	Filter options <ul style="list-style-type: none"> - criteria - timeframe (short term, medium term, long term) 	Bundle options <ul style="list-style-type: none"> - complementary options - mutually exclusive bundles - timeframe 	Map adaptation pathways <ul style="list-style-type: none"> - timeframe - flexibility

Decision stage		Step 1 decisions	Step 2 decisions	Step 3 decisions	Step 4 decisions
	6. Establish thresholds & triggers	Determine timing <ul style="list-style-type: none"> - short term - medium term - long term 	Establish adaptation thresholds <ul style="list-style-type: none"> - physical - economic - level of service - social - transformational 	Define triggers <ul style="list-style-type: none"> - threshold projections - timing of response - safety buffer - monitoring interval 	Monitoring of thresholds & triggers <ul style="list-style-type: none"> - monitoring process including intervals - monitoring of the trigger variable
	7. Assess options	Identify costs & benefits <ul style="list-style-type: none"> - direct market - indirect market - direct non-market - indirect non-market 	Understand assessment methods <ul style="list-style-type: none"> - cost-benefit analysis - cost effectiveness assessment - multi-criteria analysis - rules based & qualitative 	Select method <ul style="list-style-type: none"> - assess benefits and put a monetary value on them? - resources and time 	Undertake assessment <ul style="list-style-type: none"> - assessment approach - business as usual - feasibility of options - assumptions - assessment review
	8. Manage risk & uncertainty	Understand risks & uncertainties <ul style="list-style-type: none"> - uncertainty or risk? 	Consider methods for managing risk <ul style="list-style-type: none"> - scenario analysis - sensitivity analysis - threshold analysis - Monte Carlo simulation - real options 	Select preferred method <ul style="list-style-type: none"> - uncertainty or risk? - probabilities? - external expertise required? 	
Managing	9. Select and implement options	Select preferred option <ul style="list-style-type: none"> - Basis for the decision (decision rule) 	Consider distributional impacts and cost recovery <ul style="list-style-type: none"> - who benefits? - cost sharing - funding of options 	Develop implementation schedule <ul style="list-style-type: none"> - when? - how? 	Address implementation risks <ul style="list-style-type: none"> - what are the risks? - how can they be mitigated?
	10. Monitor & evaluate	Establish evaluation framework <ul style="list-style-type: none"> - evaluation aim - timeframe - benchmarks - evaluation methodology 	Utilise findings of evaluation <ul style="list-style-type: none"> - adjust adaptation approach? 		

How to use the Workbook

Following is a list of pointers to assist with using the Workbook.

- The Workbook should be used together with the Handbook. The Workbook provides stage by stage, step by step and point by point guidance on the decision-making process. The Handbook sets out the process in more detail and provides background and reference information to assist with understanding of relevant issues.
- At any given stage in the process, users of the Workbook should first read the introduction to that stage. The introduction explains the purpose or rationale for the particular stage, outlines the steps that would normally be undertaken to complete the stage, and intended outputs of the stage.
- Users should then work through the relevant checklist for that stage. The checklist provides:
 - step by step (numbered) and point by point (↙ points) instructions on completing the stage;
 - references to key support material in the Handbook (blue); and
 - ‘hints’ on the implications of responses at particular steps - for example, for other aspects of the decision-making process (red).
- One or more worksheets accompany each checklist. The worksheets have been designed to closely match the steps and points listed in the checklist and provide a means for users to record relevant information.
- Some columns in worksheets include ‘drop down’ lists to assist with responses. These columns are colored.
- Users may prefer to use their own templates to record information or to reconfigure the worksheets provided.
- The time spent on each stage and the level of detail provided in recorded information should be commensurate with the nature and scale of the issue in question. Thus decisions involving a relatively small, discreet piece of public infrastructure for example, might require only a small team (e.g. 2-3 people) working through the process in a matter of hours, skipping some steps or even entire stages and recording the relevant information in a few brief notes. Large scale decisions on the other hand (e.g. contributing to the development of coastal strategic plan), might require a larger team (consisting of internal and external members) to work systematically through the process over an extended period.
- The Workbook is structured in the same order as the stages and steps set out in Figure 1 and Table 1. It is not necessary though, to follow the Workbook in this order. Although the stages and steps are intended to follow an ostensibly logical pathway, councils may find that it makes sense for them to complete stages in a different order or steps within stages in a different order.
- Similarly, individual stages have been designed to be completed as stand alone exercises. Although decision-making is likely to benefit from a complete application of the process, many councils will find that it is not useful or necessary to complete all stages in the process or all steps within a stage.

Stage 1. Define the issue

Overview

At an early stage in the decision-making process it is important that councils and other decision makers define the issue or problem that they are seeking to address. This means:

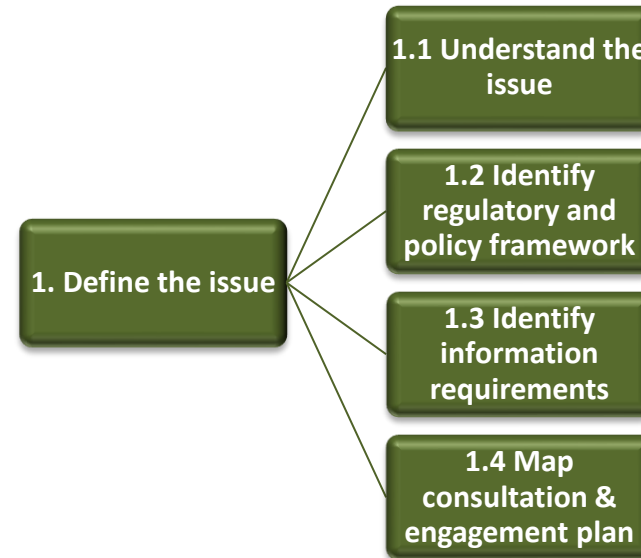
- understand the issue by considering:
 - the general nature and level of hazards faced and the locality or region affected
 - the category and type of issue
 - its scale
 - who is affected
 - the time horizon over which decisions may need to be made;
- identify and understand the regulatory and policy framework under which decisions may need to be made;
- identify information requirements and gaps and resource requirements and availability; and
- consider who will need to be consulted and engaged over the course of the decision-making process and map out a consultation and engagement plan.

Issue definition is important for informing:

- the level of priority that should be assigned to the issue;
- the overall decision-making approach (i.e. whether a very comprehensive, detailed assessment is required or whether a more contained assessment will suffice); and

- other stages of the decision-making process.

Figure 2: Steps in defining the issue



Useful information for this stage

- Refer to Stage 1 of the Handbook for additional information
- Any material that will help to inform issue definition could be useful including LEPs and DCPs, coastal, estuary and flood risk management plans and asset management plans
- Hazard and risk assessments (if completed)
- The Citizen Science Toolbox (<https://app.secure.griffith.edu/03/toolbox>) reviews a range of tools that could be used to map and/or implement an engagement plan

Stage 1 checklist

Step 1. Understand the issue (refer to Handbook Stage 1.1, including Table 4 and Box 8, for supporting information)

- Where is the affected region or locality and what is the general nature and level of hazards and risks faced? Is this a priority area for adaptation response?

Hint: If responses to either of these questions are unclear then it could be worth completing an initial, high level risk assessment (see Stage 4).

- What is the category and type of decision to be addressed? What is its scale?

Hint: The category and type of issue relates to whether it is a strategic planning, infrastructure or development approval issues, for example, or perhaps a multi-dimensional issue. Scale relates both to geographic scale, as well as numbers of people affected and value of assets affected.

- Who is likely to be affected?

- What is the time horizon over which decisions will need to be made?

Hint: Responses to the questions in Step 1 will help to inform the overall approach to the decision-making process, level of detail, stakeholder engagement etc.

Step 2. Identify and understand the regulatory and policy framework

- What are the instruments (Acts, regulations, plans, policies, guidelines etc.) under which the issue or problem falls?
- Do these set binding requirements or provide specific guidance in relation to decision-making or determining responsibilities or consultation processes?

Step 3. Identify information requirements and gaps and resource requirements (refer to Handbook Stage 1.3 for supporting information)

- Has a quantitative hazard and risk assessment already been completed for the affected locality / region?

- Does it address all key hazards and risks?

- If no, what information is missing?

Hint: If responses to any of these questions is 'no' then some or all of the steps in Stage 4 should be completed.

- What additional information (not linked to hazards and risks) could be required to complete the decision-making process?

Hint: A key requirement includes data on the feasibility and cost of options - this data will generally be compiled as part of the options assessment (Stage 7).

- Is this information readily available? If not, how can it be obtained?

- What resources (financial, staffing, other) are required for the decision-making process? Are these resources available?

Hint: Types and detail of information sought, and level of resources applied to the process should be commensurate with the nature and scale of the issue and available resources.

Step 4. Map out engagement and consultation plan *(refer to Handbook Part A, Table 3 and Stage 1.4 for supporting information)*

- When, at what stages and how should elected councillors be engaged and consulted through the course of the decision-making process?
- Are there any mandatory requirements or processes required for engaging stakeholders and the community?
- When and how should other stakeholders and the broader community be engaged through the course of the decision-making process?

Hint: Resources and effort put into development of the consultation and engagement plan should be commensurate with the nature and scale of the issue.

Stage 1 worksheets

Step 1: Understand the issue

Decision	Response <i>(provide as little or as much information as required)</i>
<i>Where is the affected region or locality and what is the general nature and level of hazards and risks faced? Is it a priority area?</i>	
<i>Who are the main stakeholders affected?</i>	
<i>What is the category and type of issue?</i>	
<i>What is its scale?</i>	
<i>What is the time horizon over which decision will need to be made on the issue?</i>	
<i>Considering responses to the above, provide observations on general approach to the process</i>	

Step 2: Identify and understand the regulatory and policy framework

Decision	Acts & regulations	<i>Policies, strategies & plans</i>	<i>Guidelines</i>	<i>Other</i>
<p><i>What are the key instruments (Acts, regulations, plans, policies, guidelines etc.) under which the issue or problem falls?</i></p>				
<p><i>What are their key binding requirements or guidance relevant to the decision-making process?</i></p>				

Step 3: Identify information requirements, resourcing requirements & gaps

Decision	Response <i>(provide as little or as much information as required)</i>	Comment <i>(explanation / key reasons for the response)</i>
Hazards and risks		
<i>Has a quantitative hazard and risk assessment already been completed for the affected locality / region? If yes, detail.</i>		
<i>Does it address all key hazards and risks? If no, what information is missing?</i>		
Other information		
<i>What additional information could be required to complete the decision-making process? Detail.</i>		
<i>Is this information readily available? If not, how can it be obtained?</i>		
Resources		
<i>What resources are required for the decision-making process?</i>		
<i>Are these resources available?</i>		

Step 4: Map stakeholder engagement plan

Decision	Stages	Detail who and how <i>(provide as little or as much information as required)</i>	Comment <i>(explanation / key reasons for the response)</i>
<i>When and how should councilors be engaged and consulted through the course of the decision-making process?</i>			
<i>Which stakeholder organisations need to be engaged and consulted through the course of the decision-making process?</i>			
<i>When and how should those organisations be engaged and consulted through the course of the decision-making process?</i>			
<i>When and how should the broader community be engaged and consulted through the course of the decision-making process?</i>			

Stage 2. Clarify roles & responsibilities

Overview

Early in the decision-making process it is important that councils and other decisions makers clarify roles and responsibilities for addressing the identified issue or problem. They should decide on whether primary responsibility for the issue belongs to council, to other agencies, or whether responsibilities can and should be shared.

The process of clarifying roles and responsibilities is important for a number of reasons.

- It will give greater surety to the assessment process.
- It will help to resolve issues around resourcing (of the process) and cost sharing (of preferred options).
- If responsibilities are shared (as they frequently are), clarifying roles and responsibilities will open the way for collaborative decision-making, thereby adding credibility to the process and outcomes.

On the other hand, lack of clarity on roles and responsibilities can and already does present a significant barrier to effective decision-making on coastal adaptation.

Figure 3: Steps in establishing roles and responsibilities



Useful information for this stage

- Refer to Stage 2 of the Handbook for additional material to help complete this stage. Figure 13 in the Handbook provides an overview of the legislative and policy framework in NSW
- *Council Risk of Liability in the Face of Climate Change – Resolving Uncertainties* discusses Federal and State government and Council responsibilities and legal risks. <http://www.climatechange.gov.au/publications/local-govt/resolving-uncertainties.aspx>

Stage 2 checklist

Step 1. Ensure roles and responsibilities are clearly understood (refer to Handbook Stage 2.1, including Figure 13 and Table 7, for supporting information)

- Does responsibility for addressing the issue reside primarily with council?
- Is responsibility shared?
- Is it another agency's responsibility?

Hint: Response to these questions will determine whether council should proceed to Step 2, Step 3 or Step 4.

Step 2. Where primary responsibility resides with council (refer to Handbook Stage 2.2 for supporting information, including Box 10)

- Have constraints and conditions on councils' roles and responsibilities been identified? How will the constraints affect the decision-making process?
Hint: In some cases constraints will influence establishment of the objective (Stage 3). In some cases they will influence feasibility of options (Stage 5) or how they will be assessed (Stage 7).
- Are constraints so great that council feels reluctant to make a decision? If so, how does council propose to respond?
Hint: If the answer to these questions is 'yes' then council may decide to delay the decision until legislative or institutional reforms have been made.
- Have decision-making roles and responsibilities been allocated internally?
- Have resourcing responsibilities been allocated internally?
- Has a consultation, communication and engagement plan been mapped out?

Hint: Refer to Step 1.4.

Step 3. Where responsibilities are shared (refer to Handbook Stage 2.3 and Handbook Part A, Table 3 for supporting information)

- Have roles and responsibilities been agreed and allocated between council and agencies?
Hint: Mapping the issue at hand will entail breaking it down into its components/sub-issues and clearly assigning responsibilities at all stages in the process.
- Has a collaborative decision-making process been mapped?
Hint: Council and other decision makers need to decide who will be involved in the actual decision-making process (not just consulted), how and when.
- Have constraints and conditions on shared roles and responsibilities been identified? How will the constraints affect the decision-making process?
- In the absence of adequate guidance by the State government or other agencies, is council leadership on the issue warranted?

Hint: Any decision by council on assuming a leadership role will be largely discretionary. Its decision on this will be influenced by the level of importance it attaches to

the issue and consideration of local community expectations (i.e. does the local community expect the council to resolve the issue?).

Step 4. Where responsibilities reside primarily with other agencies *(refer to Handbook Stage 2.4 for supporting information)*

- Does council need to maintain a watching brief on the issue?
- Is there any other role for council?

Stage 2 worksheets

Step 1: Allocate roles and responsibilities

Step 2: Where council has primary responsibility

Step	Decision	Response <i>(provide as little or as much information as required)</i>	
1. Ensure roles and responsibilities are understood and allocated	Council responsibility? Shared responsibility? Other agency's responsibility?		
2. Where Council has primary responsibility	Identify constraints and conditions on council roles. How will these affect the decision-making process?		
	Are constraints so great that council feels reluctant to make a decision? If so, how does council propose to respond?		
	Allocate roles and responsibilities internally for decision-making – department/ personnel	Role (i.e. who)	Responsibility/ resourcing
	Allocate roles and responsibilities internally for resourcing - department		

Step: Where responsibilities are shared

Step 4: Where responsibilities reside with another agency

Step	Decision	Role (organisation)	Responsibility
3. Where responsibilities are shared	Allocate and agree on roles and responsibilities between council and relevant agencies		
	Decision	Response <i>(provide as little or as much information as required)</i>	
	Map and agree on collaborative decision-making process		
	Identify constraints and conditions imposed on roles		
	Are policy or institutional changes needed before a decision can be made?		
	Is council leadership warranted?		
4. Where responsibilities reside primarily with another agency	Does council need to maintain a watching brief on the issue? If so, how?		
	Is there any other role for council?		

Stage 3. Establish objective

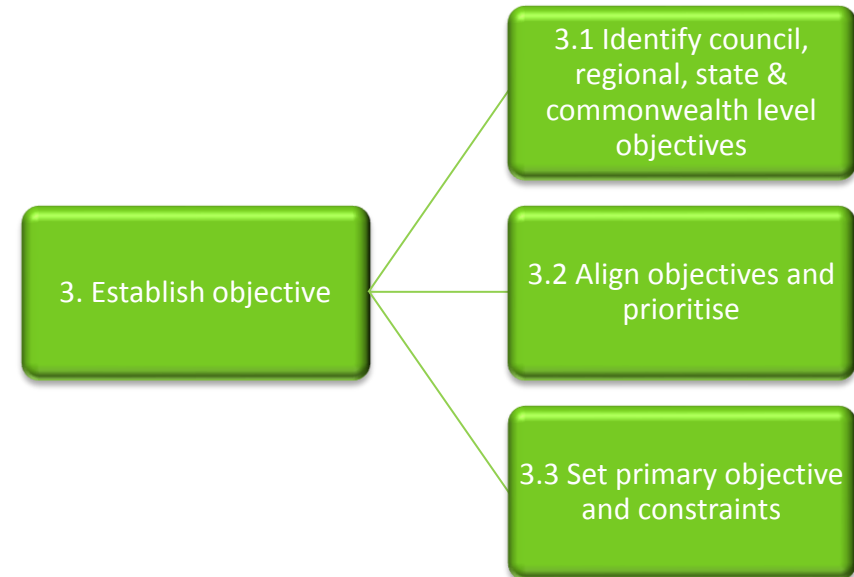
Overview

Before councils can identify and assess adaptation options it is important that they have a clear objective or objectives against which options will be assessed. A clearly defined objective will be critical to identifying the 'decision rule', which in turn will provide the basis for selecting the preferred option or bundle of options (Stage 9). The objective is also important for assisting with the process of identifying, filtering and assessing options (Stages 5 and 7) and selecting thresholds (Stage 6).

To clarify objectives, councils should seek to:

- identify council, regional, State and Commonwealth level objectives, as established in relevant legislation, strategies, the planning framework and related documents;
- align and, if necessary prioritise competing objectives; and
- set a primary objective and constraints or conditions that should apply to the primary objective.

Figure 4: Steps in establishing objective



Useful information for this stage

- Refer to Stage 3 of the Handbook
- Council community strategic plans
- Relevant legislation
- Local Environment Plans and Development Control Plans
- NSW Coastal Policy
- Relevant State Environmental Planning Policies including SEPP 71
- Regional Strategies

Stage 3 checklist

Step 1. Identify objectives relevant to the issue *(refer to Handbook Stage 3.1, including Table 8, for supporting information)*

Hint: Decision makers may choose to skip Steps 1 and 2, setting a primary objective and constraints without going through the convoluted process of identifying, aligning and prioritising all relevant objectives. A systematic application of Steps 1 and 2 however, will reduce the potential for missing key factors influencing the primary objective.

- Have **key** council objectives been identified? Have **key** regional level objectives been identified?
- Have **key** Commonwealth and State level objectives been identified? Have **key** objectives of other stakeholders been identified?

Step 2. Align objectives and prioritise *(refer to Handbook Stage 3.2 for supporting information)*

- Do some of the council, regional and State level objectives align?

Hint: Aligned objectives are ones that are broadly similar and are compatible with each other.

- If so, can a revised and condensed list of objectives be produced?
- Are some of the objectives (within the condensed list) contested, inconsistent or incompatible?
- If so, which of these objectives should have highest priority?

Hint: Criteria such as community expectations, legislative requirements and objectives of other decision makers and stakeholders will influence this decision.

Hint: It is up to decision makers to determine how best to identify the highest priority objective. One possible approach is 'pairwise comparison'. This approach, undertaken as a group process, will involve starting with the list of the condensed list of objectives. Then working from the bottom of the list, the two last objectives are compared, with the preferred objective of the two advanced for comparison against the next objective in the list and so on up the list. After each comparison, the overall ranking of objectives is adjusted. This process is re-iterated until a final, highest priority objective has been agreed.

Step 3. Set a primary objective and constraints *(refer to Handbook Stage 3.3, especially Boxes 16 and 18, for supporting information)*

- Considering the prioritised list of objectives, what is the primary objective?

Hint: The primary objective should reflect the highest priority objective. It should not be internally inconsistent and ideally will be measurable in some way.

- Should the primary objective be subject to constraints or conditions?

Hint: The constraints or conditions are likely to reflect other (secondary) objectives, legislation, policies etc.

Hint: There is no limit on the number of constraints or conditions that can be attached to the objective. The greater the number of constraints however, the more complex will be the decision rule and decision (see Stage 9).

- If so, what are those conditions?

Stage 3 worksheets

Step 1: Identify current objectives

Step 2: Align and prioritise objectives

Step	Decision	Response <i>(provide as little or as much information as required)</i>	Comments <i>(explanation / key reasons for the response)</i>
1. Identify current relevant objectives	Council/ internal		
	Regional		
	State level		
	Commonwealth level		
	Community/ other stakeholders		

2. Align and prioritise objectives	Which objectives are similar or compatible?		
	Which objectives are potentially inconsistent or incompatible		
	Revised list of objectives based on above steps		
	Prioritise objectives from revised list		

Step 3: Set primary objective and conditions

Step	Decision	Response <i>(provide as little or as much information as required)</i>	Comments <i>(explanation / key reasons for the response)</i>
3. Set primary objective and conditions	Select primary objective		
	Identify constraints or conditions to achieving the primary objective (considering legislative requirements and other incompatible objectives)		
	Are steps required to specifically address the constraints or conditions that have been identified? If so what are these steps?		

Stage 4. Assess hazards & risks

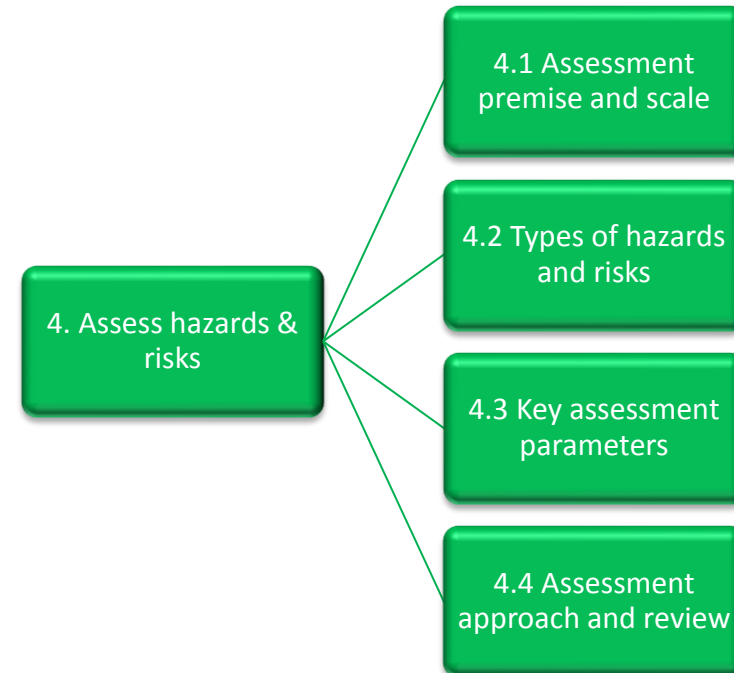
Overview

All decisions on coastal adaptation need to be underpinned by a sound understanding of potential climate changes and the local and regional scale consequences of those changes. A hazard and risk assessment (often referred to as a vulnerability assessment) will seek to do this, considering the likelihood (or probability) of changes, the land, waterways, ecosystems, settlements, infrastructure and communities exposed to the changes and also the underlying environmental and social conditions that can provide an understanding of the sensitivity of systems to the changes and, by extension, the consequences of the changes.

When undertaking a hazard and risk assessment, important considerations that councils and other decision makers will need to address are:

- assessment planning and design including:
 - the underlying premise for and scale of the assessment;
 - the types of hazards and risks to be assessed and how they will be assessed; and
 - parameters to be used in the assessment.
- review processes, including sensitivity analysis and expert review.

Figure 5: Steps in assessing hazards & risks



Useful information for this stage

- Refer to Stage 4 of the Handbook.
- Guidelines for Preparing Coastal Zone Management Plans
<http://www.environment.nsw.gov.au/resources/coasts/101019GdlnsCZMPs.pdf>
- The Floodplain Risk Management Guide
<http://www.environment.nsw.gov.au/resources/floodplains/FRMGuidelinePracticalConsiderationClimateChange.pdf>

Stage 4 checklist

Step 1. Determine assessment premise and scale *(refer to Handbook Stage 4.1 for supporting information)*

- What is the purpose of the assessment?
Hint: refer back to the primary objective
- What areas should be covered by the assessment? Will the assessment be site specific or more regionally focussed?
Hint: A regional scale assessment may be preferred if possible.
- Particularly if the latter, which other (non-council) decision makers should be involved in framing and undertaking the assessment?
Hint: Mapping of collaborative decision-making processes (Stage 2, Step 2) will inform this decision.

Step 2. Identify hazards and risks to be covered in the assessment and approach *(refer to Handbook Stage 4.2 for supporting information)*

- Which hazards should be addressed in the assessment?
- Which impacts and risks should be addressed in the assessment?
Hint: Impacts and risks are the consequences of the physical hazards.
Hint: The nature of the issue (Stage 1, Step 1) and primary objective (Stage 3, Step 3) will influence both the hazards and risks to be assessed.

Step 3. Determine assessment parameters *(refer to Handbook Stage 4.3 for supporting information)*

- What parameters are required for the assessment?
- Are the values for all of these parameters known? What are the data/ information gaps?
Hint: Outputs of Stage 1, Step 3 will inform this decision.

Step 4. Undertake and review the assessment *(refer to Handbook Stage 4.4, including Table 8, for supporting information)*

Pre-assessment

- Is external expertise needed to undertake or assist with the assessment? What is the nature of expertise required?
- Has the assessment methodology been detailed? Is it consistent with State requirements?
Hint: It may be best to detail the assessment methodology in a separate document.
Hint: Refer in particular to 'Guidelines for Preparing Coastal Zone Management Plans' and 'Floodplain Risk Management Guide'.

Post assessment

- Has sensitivity analysis of key parameters been undertaken? Is expert review of parameters and assumptions required?

Stage 4 worksheets

Step 1: Determine assessment premise and scale

Step 2: Identify hazards and risks

Step 3: Determine assessment parameters

Step	Decision	Response	Comments <i>(explanation / key reasons for the response)</i>
1. Determine assessment premise and scale	What is the purpose of the assessment?		
	Is the assessment site specific or regional? Detail.		
	Which other decision makers should be involved?		
2. Identify hazards and risks to be covered in the assessment	Hazards to be addressed in the assessment.		
	Impacts/ risks to be addressed in assessment.		
3. Determine assessment parameters	Parameters required for the assessment.		
	Are values for these parameters known? What are the data gaps?		

Step 4: Undertake assessment and review

Step	Decision	Response	Comments <i>(explanation / key reasons for the response)</i>
4. Undertake and review the assessment	<i>Pre assessment</i>		
	External expertise needed?		
	Has the assessment methodology been detailed? Is proposed approach consistent with State/ regional requirements?		
	<i>Post assessment</i>		
	Has sensitivity analysis been undertaken? Detail.		
Is external review required? Outline who will undertake the review and how.			

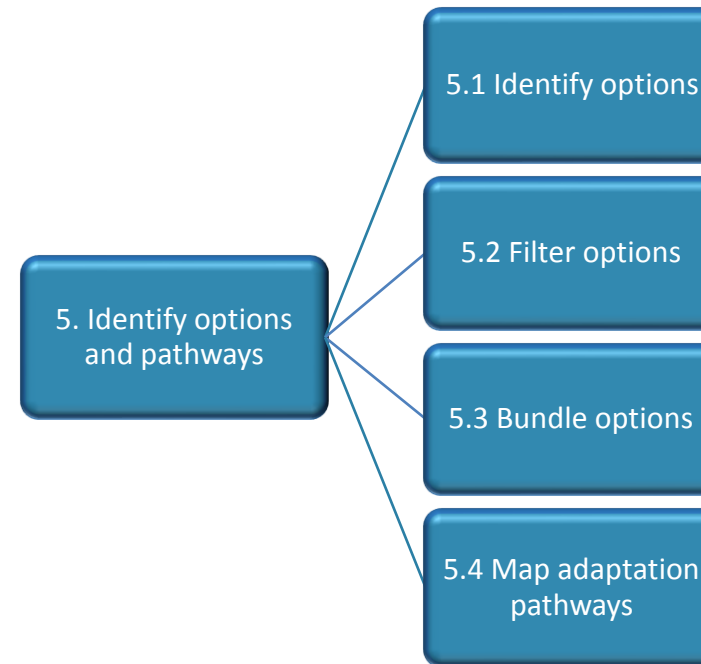
Stage 5. Identify options & pathways

Overview

Councils and other decision makers may already be quite aware of the range of options available to them to assist with adapting to coastal impacts identified through a hazard assessment (Stage 4). This awareness may derive from a sound understanding of the issue at hand (Stage 1) or from previous experience. Notwithstanding this awareness, it is important that councils engage in a process of systematically identifying adaptation options prior to undertaking a full assessment of the options.

This section goes through the process of identifying coastal adaptation options, considering the types of options available and principles underpinning option selection (Step 5.1). Another important step in the options identification process is an initial consideration or ‘filtering’ of options so as to ‘weed out’ options that do not pass the common sense test (Step 5.2). Options are not necessarily mutually exclusive but nor will they necessarily have the same implementation timeframes. Rather, an effective adaptation strategy will almost certainly involve implementing a range of options, quite possibly over different timeframes. Thus bundling (grouping) of options (Step 5.3) and the process of mapping adaptation pathways, so that alternative approaches to implementing options over time can be understood (Step 5.4), are crucial steps in preparation for a detailed assessment (Stage 7).

Figure 6: Steps in identifying adaptation options



Useful information for this stage

- Refer to Stage 5 of the Handbook for additional material to help complete this stage. Table 10 in the Handbook provides an overview of adaptation options.
- A number of software tools are available for producing decision trees; a useful way of mapping adaptation pathways.

Stage 5 checklist

Step 1. Identify adaptation options *(refer to Handbook, Stage 5.1 for discussion and Table 10 for more information)*

- What are the possible adaptation options given the nature of issue and primary objective? Has a full range of options been considered?
Hint: Categories include information & education, planning & regulatory (adaptive design, avoidance or relocation) and technical & structural works.
- Has the 'business as usual' option been included and detailed?
- Is each option sufficiently detailed to allow a meaningful review:
 - What is the focus and location of the option (i.e. what specific aspect of the issue is it seeking to address)?
 - Does the option have different subsets?

Step 2. Filter adaptation options *(refer to Handbook, Stage 5.2 for discussion and Box 22 for more information on criteria)*

- What are the most appropriate filtering criteria given the objectives defined in Stage 3? What are critical criteria, what are merely desirable?
Hint: The use of 5 or 6 criteria is recommended.

Hint: Critical criteria are key aspects or conditions that options need to fulfill in order to be able to efficiently and effectively address the issue. Desirable criteria are additional beneficial aspects that may enhance the effect and/or increase the value of the option.
- Have suitable timeframes been defined?
Hint: Assessment against the criteria should be against a number of time periods (i.e. short term (ST), medium term (MT), long term (LT) where: ST will generally fall within strategic planning horizons (e.g. to 2020); MT might be consistent with relatively short lived assets (e.g. 2020-2050); and long term (LT) might be consistent with relatively long lived assets (e.g. 2050-2100). This is because an option that is judged to fail against a criterion in the short term (e.g. because it is not 'proportional to the problem') may meet that criterion in the medium or long term.
- Given assessment against the criteria, do any of the options have flaws or constraints that are so great to prevent them from being advanced for further assessment?
Hint: If an option fails against any of the critical criteria for a given time period, then it should be ruled out for that time period. If an option fails against one or a number of desirable criteria for a given time period it is at the discretion of the decision maker(s) to rule out or advance the option.
- Do interdependencies exist between options? Can benefits be gained from bundling any of these options? If yes, with which other option(s) should the option be bundled?
Hint: If an option is likely to be more effective by being implemented with one or more other options then it should be bundled (grouped) with those options.
- Has a short list of options that warrant further assessment been established for each time period?

Hint: It may be helpful to list the options under their major categories (e.g. protect, accommodate, retreat (for established areas), or 'avoid', 'adapt', 'accept' (for new developments)).

Step 3. Shortlist bundled adaptation options (refer to Handbook Stage 5.3 for discussion)

- Has a shortlist of bundled options been established for each time period?

Hint: Different bundles can contain different combinations of the same options but no two bundles will contain exactly the same options.

Hint: The end result of the bundling process will be two or more bundles that are mutually exclusive – i.e. the aim will be to implement one or other of the bundles but not both or all of them. The business as usual (BaU) option(s) will always constitute one of the bundles.

- Have no-regrets options been included in all bundles?

Hint: By definition, no-regrets options are options that 'should be implemented as a matter of course'. Thus all bundles should include options identified as no-regrets.

Step 4. Map adaptation pathways (refer to Handbook Stage 5.4 for discussion, Box 25 for an example)

- Are any of the bundles inflexible? Does the implementation of any of the bundles preclude options or bundles from being implemented in the future?

Hint: Bundles that have the potential to 'lock' Council in to a particular adaptation pathway or that have a long life span (e.g. several decades or longer) could be regarded as being inflexible.

Hint: If the answer to this question is 'no' (i.e. all bundles are flexible) then pathway mapping of the bundles is not necessary. In this situation, decision makers will only need to assess bundles for the short term (see Stage 7).

- Should inflexible bundles be subject to more detailed analysis?

Hint: If the answer is 'yes' (i.e. the bundles warrant detailed analysis despite being inflexible), mapping of adaptation pathways is desirable to ensure all bundles / adaptation pathways are assessed over the same timeframe in the detailed assessment of options (Stage 7).

- Have all potential adaptation pathways been mapped?

Hint. A template for mapping out adaptation pathways has not been provided because this task will vary greatly depending on the various adaptation bundles. However, Box 25 in the Handbook provides an example of how adaptation bundles and pathways could be mapped. Part C of the Handbook, 'Useful materials and links' section provides examples of computer software that can be used to map adaptation pathways.

Stage 5 worksheets

Steps 1 and 2: Option identification and filtering

Option identification		Decision criteria for filtering							Bundling	Comment <i>(explanation / key reasons for responses)</i>
Option #	Description Include a brief description of option. What is the focus of option? Which location does it address? etc.	Time-frame	Critical criteria			Desirable criteria			Are there interdependencies with other options?	
			Effectiveness	Proportionality	Compliance	No regrets	Acceptability	Flexibility	Would bundling increase effectiveness of the option?	
1	Business as Usual	ST	Select	Select	Select	Select	Select	Select	Bundle?	
		MT	Select	Select	Select	Select	Select	Select	Bundle?	
		LT	Select	Select	Select	Select	Select	Select	Bundle?	
2		ST	Select	Select	Select	Select	Select	Select	Bundle?	
		MT	Select	Select	Select	Select	Select	Select	Bundle?	
		LT	Select	Select	Select	Select	Select	Select	Bundle?	
3		ST	Select	Select	Select	Select	Select	Select	Bundle?	
		MT	Select	Select	Select	Select	Select	Select	Bundle?	
		LT	Select	Select	Select	Select	Select	Select	Bundle?	

Key for drop down fields: ✓ = 'yes'; ✗ = 'no'; ? = unsure

Steps 3 and 4: Shortlist of bundled and sequenced options

Bundling of options				Sequencing of bundles	
Timeframe	Bundle ID	Option numbers (from Steps 1 & 2) included in bundle	Description of option(s)	Is this bundle inflexible? Will it limit future options? <i>If no, sequencing is not required</i>	If yes, does this bundle warrant more detailed assessment? <i>If no, sequencing is not required</i>
Short term	A	1	Business as usual	Inflexible?	Detailed assessment?
	B			Inflexible?	Detailed assessment?
	C			Inflexible?	Detailed assessment?
				Inflexible?	Detailed assessment?
				Inflexible?	Detailed assessment?
				Inflexible?	Detailed assessment?
				Inflexible?	Detailed assessment?
Medium term					
Long term					

Key for drop down fields: ✓ = 'yes'; ✖ = 'no'; ? = unsure

Stage 6. Establish thresholds & triggers

Overview

Climate change poses significant uncertainties, with a range of plausible future scenarios for sea level rise and other climate variables. Climate change projections on the local and regional level are being continually revised as new information and data become available. This calls for a flexible and adjustable approach to climate change adaptation to avoid premature redundancy of valuable infrastructure and putting communities and assets at risk.

Thresholds and triggers carefully selected to fit given circumstances and options, can serve as ‘red flags’ and prompt management response and/or implementation of a predefined option or set of options at an appropriate time. Thresholds and triggers support adaptation strategies that maintain the acceptable level of risks and only implement adaptation actions, if actual changes in risk are expected to occur.

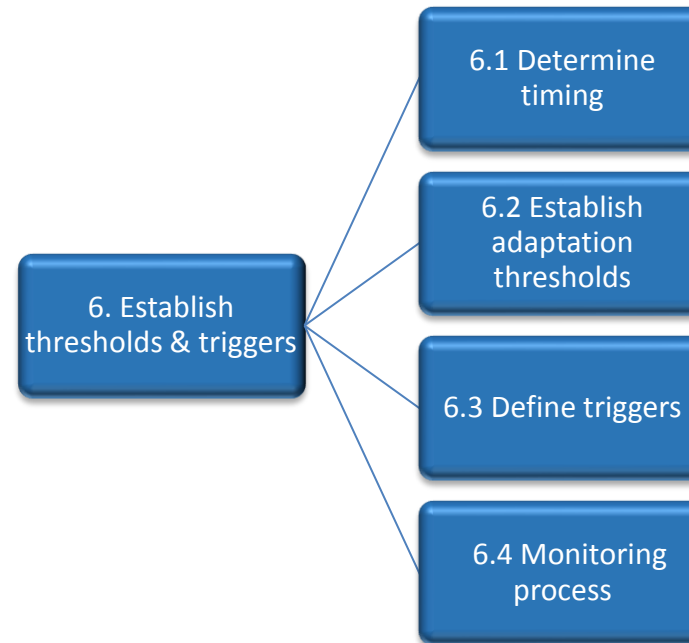
This section provides a guided process for identifying suitable triggers and thresholds.

Decision makers should note the specific legal or liability issues that may affect the utilisation of triggers and thresholds, particularly in regard to:

1. the location of the triggers and thresholds in the regulatory and policy framework; and
2. the flexibility of triggers and thresholds.

Decision makers are advised seek legal advice where appropriate when considering the application of thresholds and triggers.

Figure 7: Important steps in establishing thresholds and triggers



Useful information for this stage

- Refer to Stage 6 of the Handbook for additional material to help complete this stage.
- Results of the hazard and risk assessment (Stage 4) will be important inputs for the process of establishing thresholds.

Stage 6 checklist

Step 1. Determine timing (refer to Handbook Stage 6.1 for more information)

- What is the estimated response time of the shortlisted option or bundle (i.e. how much time is required to make a decision and /or identify, assess and implement the adaptation action(s))?

Hint: The timeframe to fully implement the option or bundle of options (response time) should include all necessary steps, including planning & design, funding, and implementation.

- Considering the estimated response time do options/ bundles need to be implemented immediately or can they be delayed?

Hint: Options with a short timeframe may need to be implemented immediately, whereas delays may be possible for medium- to long-term options.

Hint: If options need to be implemented immediately then the process of establishing thresholds and triggers becomes superfluous for those (short term) options. However, it may still be important to go through the following steps to determine suitable thresholds and triggers for medium and long term options.

Step 2. If the action can be delayed, establish and select adaptation threshold(s) (refer to Handbook Stage 6.2 and Table 11 for more information)

- Have potential thresholds been identified for each option or bundle?

*Hint: Thresholds could be linked to (physical) drivers/ hazards or they could be linked to the social, economic or environmental risks stemming from those hazards.
Hint: Look for thresholds that are suitable for more than one option.*

- From the potential thresholds that have been identified, what are the most appropriate one(s)?

Hint: Suitability of a threshold is conditional on it meeting a range of criteria including: the threshold can be linked to the objective; it is quantifiable; it can be readily measured or observed; it follows a trend; and data underpinning threshold measurement can be readily obtained and cannot be manipulated or distorted.

Step 3. Define the trigger (refer to Handbook Stage 6.3 for more information)

- Have projections for the threshold variable been developed or obtained?

Hint: The Hazard and risk assessment will be an important source of information for establishing projections for the threshold variable. Historical trend data may also be needed when developing projections relevant to economic and social thresholds.

- Has the response time required to identify, assess and/or implement the option been established?

Hint: An initial estimate of the response time will have been established in Step 1.

- Has a reasonable safety buffer been established?

- Has the trigger point relevant to the selected threshold been calculated?

Hint: The trigger point will be calculated backwards from the threshold taking into account the response time, safety buffer and monitoring interval.

Hint: When considering upgrades or replacement of existing infrastructure, decision makers will need to take into account the remaining asset life of the existing asset before setting the trigger (see Handbook, Box 31).

Step 4. Monitoring of thresholds and triggers (refer to Handbook Stage 6.4 for more information)

a. Establish monitoring process for trigger variable

- Taking into account the projections obtained for the threshold variable, at what rate is change occurring / projected to occur?
Hint: Slow = no or little marked change over an extended period [i.e. 2-5 years]; moderate = some change over an extended period [i.e. 2-5 years]; rapid = marked change in a relatively short period [<2 years].
- Is regular reporting on the trigger variable already available? Is the reporting interval appropriate considering the rate of change?
Hint: If answers to these questions are 'yes', then the monitoring interval aligns with the existing reporting interval.
- If regular reporting is not available (or the reporting interval is too long and therefore not appropriate), what data is required for the monitoring? Is the cost of collecting this data proportionate to the scale of the issue?
- Given the rate of change, the data required and the associated costs, what is the proposed monitoring interval?
- Have other important aspects of the monitoring regime been established?
Hint: Important aspects include how the monitoring will be undertaken, who it will be undertaken by, data compilation and reporting and resourcing.

b. Monitoring of trigger variable

- Has the end of the monitoring interval been reached and monitoring of the trigger variable been undertaken?
- Has the trigger point been reached or is close to being reached and does the adaptation action need to be implemented?
- Given the additional information that has become available through monitoring, are adjustments necessary to:
 - projections of the variable into the future;
 - the length of the monitoring interval; and/or
 - the trigger point.

Hint: Initial monitoring does not take place until the end of first monitoring interval.

Stage 6 worksheets

Step 1: Determine timing

Shortlist of options/bundles				Timing	Delay possible?	Comment <i>(explanation / key reasons for responses)</i>
Timeframe	Option ID / Bundle ID	Description	Location / issue addressed	Estimated Response Time (incl. decision-making, planning, implementation)		
Short term					Select	
					Select	
					Select	
					Select	
Medium term					Select	
					Select	
					Select	
					Select	
Long term					Select	
					Select	
					Select	
					Select	

Key for drop down fields: ✓ = 'yes'; ✗ = 'no'; ? = unsure

Step 2: Identify and select threshold

Option/ bundle IDs (Location/Issue addressed)	Possible thresholds (based on causes and consequences)	Threshold description	Selection criteria				Comments (explanation / key reasons for responses)
			Quantifiable & measurable	Follows a trend	Available long-term	Not susceptible to influences	
			Select	Select	Select	Select	
			Select	Select	Select	Select	
			Select	Select	Select	Select	
			Select	Select	Select	Select	
			Select	Select	Select	Select	
			Select	Select	Select	Select	
			Select	Select	Select	Select	
			Select	Select	Select	Select	
			Select	Select	Select	Select	
			Select	Select	Select	Select	

Key for drop down fields: ✓ = 'yes'; ✗ = 'no'; ? = unsure

Step 3: Define a trigger point for each option/ bundle and threshold

Location / Issue	Option/ bundle ID	Threshold Variable	Projections		Response Time (as determined above)	Safety Buffer	Monitoring Interval	Trigger Point
			Available?	Source:				
			Select					
			Select					
			Select					
			Select					
			Select					
			Select					
			Select					

Key for drop down fields: ✓ = 'yes'; ✗ = 'no'; ? = unsure

Step 4a: Monitoring – monitoring process

Trigger variable	Rate of change	Regular reporting available?	If no, what are the data requirements?	Proposed monitoring interval?	Who Collects Monitoring Data
	Choose an item.	Select			
	Choose an item.	Select			
	Choose an item.	Select			
	Choose an item.	Select			
	Choose an item.	Select			
	Choose an item.	Select			

Key for 'select' drop down fields: ✓ = 'yes'; ✗ = 'no'; ? = unsure

Step 4b: Monitoring – monitoring of the trigger variable

Has the trigger point been reached?	Comments	Are adjustments necessary?					
		To projections	Comments <i>(explanation / key reasons for responses)</i>	To monitoring interval	Comments <i>(explanation / key reasons for responses)</i>	To trigger point	Comments <i>(explanation / key reasons for responses)</i>
Select		Select		Select		Select	
Select		Select		Select		Select	
Select		Select		Select		Select	
Select		Select		Select		Select	
Select		Select		Select		Select	
Select		Select		Select		Select	

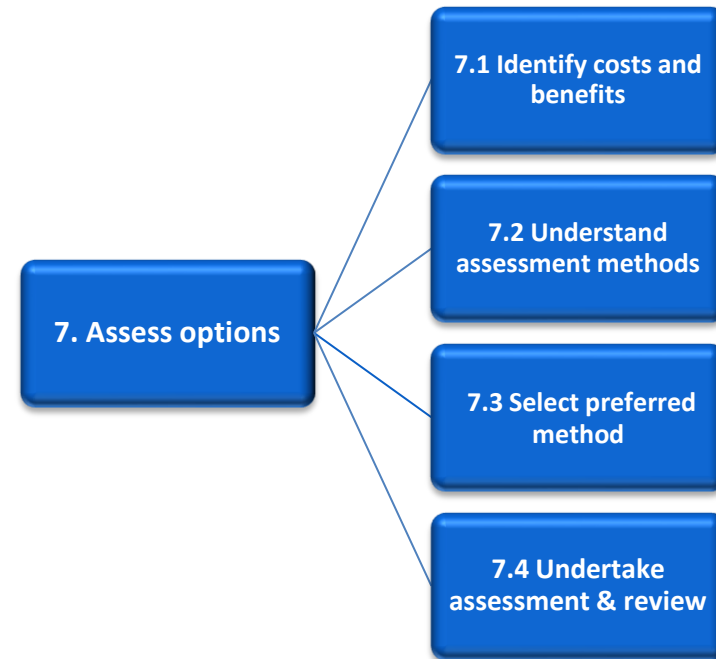
Stage 7. Assess options

Options assessment is at the core of the decision-making process, with many of the stages and steps discussed in the preceding sections being geared towards ensuring that assessment of options is soundly based.

This section provides a guided process for identifying the most suitable assessment method. A useful step to undertake prior to consideration of methods is preliminary identification of the costs and benefits that will need to be quantified (or otherwise considered) in the assessment (Step 7.1).

As discussed at the conclusion of Stage 5, the detailed assessment of options will often, in fact, be an assessment of ‘bundles’ (groups of options) or ‘pathways’ (bundles of options implemented over different timeframes) rather than individual options.

Figure 8: Steps in assessing options



Useful information for this stage

- Refer to Stage 7 of the Handbook for additional material to help with completion of this stage.
- The outputs of Stages 3, 4, 5 and 6 are also important for this stage: Stage 3 outputs will contribute to consideration of the assessment method; Stage 4 outputs will help to inform the costs and benefits of adaptation options; Stage 5 will provide the adaptation options or pathways for assessment; Stage 6 will provide information on the timing of those options.

Stage 7 checklist

Step 1. Identify major potential costs and benefits (refer to Handbook Stage 7.1 and Figure 43 for more information)

- Have major market and non-market **benefits** been identified for each bundle?
- Have major market and non-market **costs** been identified for each bundle?

Hint: It is preferable to identify benefits and costs for each bundle (including the business as usual bundle), as benefits and costs could vary quite considerably between bundles. The worksheet provided for this step will need to be duplicated.

*Hint: Some benefits could be listed as costs or vice versa. A benefit or cost should be listed as one or the other **but not both**, since listing them as both will lead to double counting in the options assessment. The easiest way of avoiding this is to only list benefits as benefits or costs as costs if this is the outcome that will result from implementing the options in the relevant bundle.*

Hint. Avoid including items that represent gains to one section of the community but equivalent losses to another. This is a 'transfer' rather than a benefit or cost.

- Has the section of the community who will gain (lose) from the benefit (cost) been noted?

Hint: This is not a necessary part of Step1, but it will improve understanding of the nature of the benefit and costs. Also, it will greatly assist with consideration of distributional issues and cost sharing (see Stage 9).

Step 2 and Step 3. Consider assessment methods and select preferred method (refer to Handbook Stages 7.2 and 7.3 for more information, especially Figure 47 and Table 13)

a. Do benefits (of options) need to be assessed?

- Will all options/ bundles/ pathways be likely to deliver substantially similar benefits?

Hint: If the answer to this question is 'yes' (bundles will deliver similar type and level of benefits) then cost effectiveness assessment (CEA) could be the most appropriate options assessment method. There is probably no need to answer the remaining questions in this step.

Hint: If the answer to this question is 'yes in part' (bundles will deliver similar types but different levels of benefits) then cost effectiveness assessment (CEA), levelised cost basis, could be the most appropriate options assessment method. There is also probably no need to answer the remaining questions in this step.

Hint: If the answer to this question is 'no' then proceed to the following questions.

b. Other factors influencing selection of method

- (i) Will the options assessment be enhanced by attaching monetary values to major non-market benefits?
- (ii) Are substantial budget, resources and time available to undertake the options assessment?
- What is the most suitable method considering these other factors?

Hint: If answers to both (i) and (ii) are 'no' then costs effectiveness assessment (either levelised cost basis or combined with multi criteria analysis) could be the most appropriate method.

If answer to i) is 'yes' and ii) is 'no' then a restricted cost benefit assessment (CBA), involving monetary assessment of major market benefits and qualitative assessment of other benefits may be an appropriate assessment method. Alternatively, a restricted cost benefit assessment (CBA), involving monetary assessment of major market benefits and combined with multi-criteria analysis for other, non-market benefits may also be appropriate.

If answer to i) and ii) is 'yes' then a full costs benefit analysis could be the most appropriate assessment method.

Step 4. Undertake assessment and review (refer to Handbook Stage 7.4 for more information)

a. Pre-assessment

- Has the proposed approach to the assessment been fully documented?
- Does the proposed approach to the assessment align with good practice (e.g. NSW Treasury Guidelines)?
- Has the business as usual case been established?
- Has the technical feasibility of options been assessed?

b. Post assessment

- Have uncertainties around key parameters and assumptions been documented and the effects of changes to these assumptions on outcomes been assessed (see Stage Stage 8)?
- Has the assessment been reviewed?

Hint. A template has not been produced for undertaking the assessment since this task will need to be documented in detail as part of the options assessment process.

Stage 7 worksheets

Step 1: For each bundle, identify potential benefits (avoided costs) and costs

Step	Category	Benefit/cost <i>(select from list or add own)</i>	Comment <i>(use this column to provide more detail)</i>	To who will gain (lose) from the benefit (cost)?	Comment <i>(explanation / key reasons for responses)</i>
Bundle #					
Identify significant potential benefits (or avoided costs)	Market benefits (i.e. avoided costs arising from implementation of options)	Choose an item		Choose an item	
		Choose an item		Choose an item	
		Choose an item		Choose an item	
		Choose an item		Choose an item	
		Choose an item		Choose an item	
	Non-market benefits (i.e. avoided costs arising from implementation of options)	Choose an item		Choose an item	
		Choose an item		Choose an item	
		Choose an item		Choose an item	
		Choose an item		Choose an item	
Identify significant potential costs	Market costs (i.e. actual costs arising from implementation of options)	Choose an item		Choose an item	
		Choose an item		Choose an item	
		Choose an item		Choose an item	
		Choose an item		Choose an item	
		Choose an item		Choose an item	
	Non-market costs (i.e. actual costs arising from implementation of options)	Choose an item		Choose an item	
		Choose an item		Choose an item	
		Choose an item		Choose an item	
		Choose an item		Choose an item	

Step 2: Consider assessment methods and Step 3: Select preferred method

a. Do benefits (of options) need to be assessed?

Step	Major benefits (market and non-market) from Step 1 (all bundles)	Will all bundles deliver the nominated benefit?	Comment (e.g. note bundles that will not deliver nominated benefit)
List and consider the major benefits associated with bundles		Choose an item.	
		Choose an item.	
		Choose an item.	
		Choose an item.	
		Choose an item.	
		Choose an item.	
		Choose an item.	
		Choose an item.	
Decision	Question	Response	Select assessment method
Select preferred method (a)	a. Considering above, are all bundles likely to deliver substantially similar benefits?	Choose an item.	Choose an item.

b. Other factors influencing selection of method

When completing this table, refer to Checklist hints and decision points / process for Steps 2 & 3

Step	Question	Response	Comment <i>(explanation / key reasons for responses)</i>
Other factors influencing selection of assessment method	Will the options assessment be enhanced by attaching monetary values to major non-market benefits? (e.g. will monetary valuation help to explain those benefits to the community?)	Select	
	Are substantial budget, resources and time available to undertake the options assessment?	Select	
Step	Question	Select an assessment method	Comment <i>(explanation / key reasons for response)</i>
Select preferred method (b)	b. What is the most suitable method considering these 'other factors'?	Choose an item.	

Key for 'select' drop down fields: ✓ = 'yes'; ✗ = 'no'

Stage 8. Manage risk & uncertainty

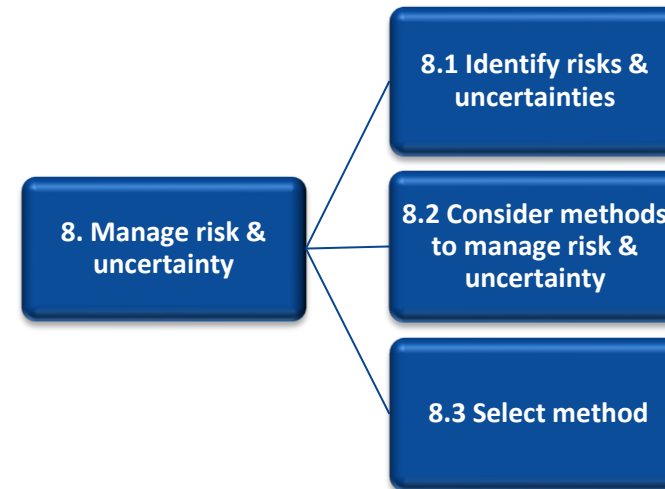
Overview

Decision-making, whether in business or government, almost always involves dealing with uncertainties, and making the best decision in light of those uncertainties. In this respect, decision-making on coastal adaptation options and pathways is not fundamentally different to other types of decisions. Nevertheless, the nature and range of uncertainties associated with coastal adaptation means that it warrants careful attention in the options assessment process (Stage 7).

Decision makers have a range of methods to choose from to handle these uncertainties. In order to determine the most appropriate method it is useful to go through a number of steps (Figure 9):

- first understanding the nature of the uncertainties;
- next considering the different methods available for managing the uncertainties; and
- finally, selecting the most suitable method given attributes of the different methods and the nature of uncertainties.

Figure 9: Steps in managing risk and uncertainty



Useful information for this stage

- Refer to Stage 8 of the Handbook for additional material to help with completion of this stage.
- The NSW Government Guidelines for Economic Appraisal (NSW Treasury 2007) provides further guidance on dealing with risk and uncertainty.
http://www.treasury.nsw.gov.au/_data/assets/pdf_file/0016/7414/tpp07-5.pdf

Stage 8 checklist

Step 1. Identify and understand the key potential uncertainties that could affect the decision *(refer to Handbook Stage 8.1 for more information)*

a. Identify uncertainties

- Which hazards are uncertain?

Hint: Examples include sea level rise, storm surge (return intervals, extent and duration), coastal recession rates.

- Which variables associated with exposure to the hazards are uncertain?

Hint: Examples include number of properties exposed, people exposed, infrastructure exposed.

- What impacts and risks associated with exposures are uncertain?

Hint: Examples include infrastructure damage costs, loss of assets, injuries or loss of life associated with exposure.

- What costs associated with adaptation are uncertain?

Hint: Examples include capital and operating costs of new infrastructure, future markets (e.g. property prices).

- Which of these uncertainties are likely to have a significant effect on results of the analysis?

Hint: If the variable is unlikely to have a significant effect on results then the fact that it is uncertain does not greatly matter to the analysis.

b. Understand the uncertainties

*Hint: Only include **key** uncertain variables at this step.*

- (i) Can plausible ranges of values (bounds) be placed on all or at least most of the **key** uncertain variables?

- (ii) Can plausible probabilities (or likelihoods) be estimated for different values (within ranges of uncertainty) for the key uncertain variables?

- (iii) Is there a link between two or more of the uncertain variables?

Hint: Examples include correlations between sea level rise and storm surge, or correlations between the rate of coastal recession, the number of properties exposed to damage and the level and cost of damage.

- (iv) Is it useful to understand the value or point (for a key uncertain variable) at which the best course of action changes?

Hint: See Box 36, Stage 7 of Handbook for an example of this.

- (v) Is there benefit in trying to value the flexibility associated with one or more of the bundles/ pathways?

Hint: Outcomes pathways mapping exercise (Stage 5, Step 4) will be important for informing the response to this question.

Step 2 and Step 3. Select an appropriate method for dealing with risk and uncertainty based on characteristics of the uncertainties (*refer to Handbook Stages 8.2 and 8.3 for more information*)

- Which method(s) is most appropriate given what is understood about the unknowns?

*Hint: If answer to (i) in previous step is 'no' then **scenario analysis** is likely to be the most suitable method with dealing with risk and uncertainty. If answer is 'yes' then consider answer to (ii).*

*Hint: If answer to (ii) is 'no' then **sensitivity analysis** is likely to be the preferred method. Now consider responses to (iii) and (iv). If answer to (ii) is 'yes' then consider answer to (v).*

*Hint: If answer to (iii) is 'yes' then **sensitivity analysis with correlations** could be an appropriate method to apply.*

*Hint: If answer to (iv) is 'yes' then it would be useful to incorporate **threshold analysis** in the sensitivity analysis.*

*Hint: If answer to (v) is 'yes' then **Real Options** may be the most appropriate method. If answer is 'no' then **Monte Carlo analysis** may be the most appropriate method.*

- Is the necessary expertise or level of resources available to implement the method?

*Hint: If answer is 'no' then **sensitivity analysis** could be the preferable method.*

Stage 8 worksheets

Step 1a: Identify uncertainties

Category	Key uncertain variable	Is this variable likely to have a significant effect on the result of the analysis?	Comment <i>(explanation / key reasons for responses)</i>
Physical hazards		Select	
		Select	
		Select	
		Select	
Exposure to hazard		Select	
		Select	
		Select	
		Select	
Impacts resulting from exposure to hazard		Select	
		Select	
		Select	
		Select	
Costs of adaptation		Select	
		Select	
		Select	
		Select	

Key for 'select' drop down fields: ✓ = 'yes'; ✗ = 'no'

Step 1b: Understand uncertainties (i), (ii), and (iii)

When completing this table refer to the Hints and decision points / path included in the Checklist for Step 1

Category	Key uncertain variable (bring forward from previous step)	(i) Can a plausible range of values (bounds) be estimated for the variable?	(ii) Can probabilities be put on values within this range?	(iii) Is there a link between the variable and another uncertain variable? If so, which?	Comment (explanation / key reasons for responses)
Physical hazards		Select	Select		
		Select	Select		
		Select	Select		
		Select	Select		
Exposure to hazard		Select	Select		
		Select	Select		
		Select	Select		
		Select	Select		
Impacts resulting from exposure to hazard		Select	Select		
		Select	Select		
		Select	Select		
		Select	Select		
Costs of adaptation		Select	Select		
		Select	Select		
		Select	Select		
		Select	Select		

Key for 'select' drop down fields: ✓ = 'yes'; ✗ = 'no'

Step 1b: Understand uncertainties (iv), (v)

Question	Response	List relevant variable(s)	Comment <i>(explanation / key reasons for response)</i>
iv) Is it useful to understand the value or point for a key uncertain variable at which the best course of action changes?	Select		
Question	Response	Explain	
v) Is there benefit in trying to value the flexibility associated with one or more of the bundles or pathways?	Select		

Step 2 and Step 3: Select method

When completing this table refer to the Hints and decision points / path included in the Checklist for Step 1

Question	Response	Comment <i>(explanation / key reasons for response)</i>
Which method(s) is most appropriate given what is understood about the uncertainties?	Choose an item.	
Is there sufficient expertise and resources available to undertake this method?	Select	

Key for 'select' drop down fields: ✓ = 'yes'; ✗ = 'no'

Stage 9. Select options & implement

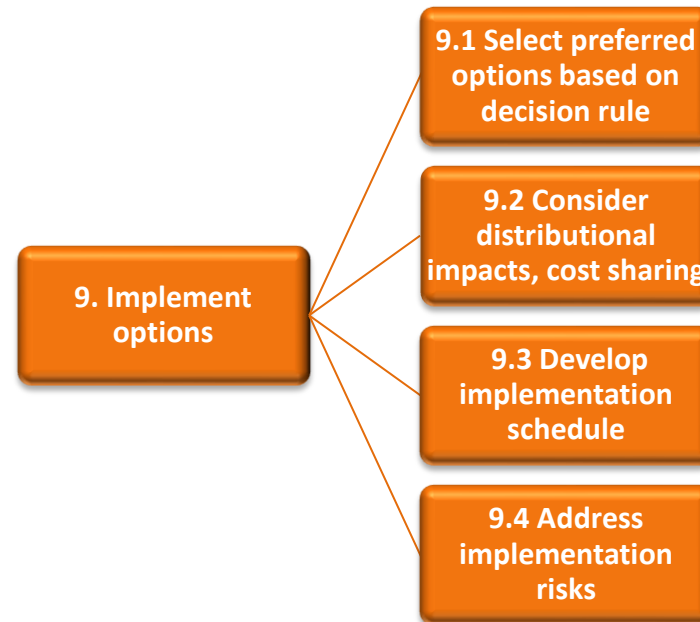
Overview

Once options have been identified and assessed, council and other decision makers need to select the preferred option, noting that for most multi-dimensional issues the preferred option will actually be a bundle of options or a pathway constituting multiple bundles to be implemented over time. A key factor influencing the selection of the preferred option or bundle is the ‘decision rule’, which in turn is influenced by the assessment method (Stage 7) as well as the objective and constraints (Stage 3). Another key issue that will need to be considered prior to options selection is ‘distributional issues’ covering:

1. Who benefits from the adaptation strategy?; and therefore
2. Who should pay?

Once the preferred option or bundle has been selected an implementation schedule should be developed and potential impediments to the implementation and operation of the option identified and mitigated.

Figure 10: Important steps in implementing options



Useful information for this stage

- Refer to Stage 9 of the Handbook for additional material to help with completion of this stage.
- The Handbook of Cost-Benefit Analysis (Department of Finance and Administration 2006) includes guidance on the application of decision rules and assessing distributional effects.
<http://www.finance.gov.au/publications/finance-circulars/2006/01.html>

Stage 9 checklist

Step 1. Select option based on decision rule *(refer to Handbook Stage 9.1 for more information)*

- Has the decision rule been defined and agreed upon, taking into account the primary objective (Stage 3)?
Hint: Examples of decision rules are 'select the least cost option' (Cost Effectiveness Assessment) or 'select the option with the greatest 'benefit cost ratio' (Cost Benefit Analysis).
- Has the preferred bundle or pathway been selected based on this decision rule, taking into account any constraints on the objective?

Step 2. Ensure distributional impacts and cost sharing and recovery have been considered *(refer to Handbook Stage 9.2 for more information)*

a. Consider distributional impacts

- Which segments of the community will gain or lose if the preferred bundle or pathway is implemented?
Hint: It may be useful to develop a distributional matrix drawing on outcomes of Stage 7, Step 1.

b. Cost sharing and recovery

- Noting this, who in principle should bear the costs of the preferred adaptation bundle or pathway?
- Given these considerations, what are the potential funding sources for the adaptation options?

Step 3. Develop implementation schedule *(refer to Handbook Stage 9.3 for more information)*

- Has a timeframe for the implementation of the adaptation action been developed?
- Have roles and responsibilities for the implementation been defined?
Hint: Refer to outputs of Stage 2.
- Is community and stakeholder engagement required? If so, who needs to be consulted and when?
Hint: Refer to outputs of Stage 1, Step 4.

Step 4. Address implementation risks *(refer to Handbook Stage 9.4 for more information)*

- Have implementation risks associated with the preferred option been identified?
- Have measures to mitigate these risks been identified?

Stage 9 worksheets

Step 1: Select the preferred option/ bundle or pathway

Step	Decision	Outline	Comments	
Select option based on decision rule, objective and constraints	Decision rule			
	Constraints			
	Preferred option/ bundle/ pathway based on decision rule and constraints	Short term		
		Medium term		
		Long term		

Step 2a: Consider distributional impacts

Step	Benefits/ costs associated with preferred bundle	Whole of local community	Wider Australian community	Residents/ businesses in affected area	Residents/ businesses in adjoining areas	Other	Comment (explanation for responses)
Which segments of the community will gain or lose if the preferred bundle or pathway is implemented?	Benefits						
		Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	
		Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	
		Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	
		Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	
		Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	
	Costs						
		Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	
		Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	
		Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	

Step 2b: Cost sharing and recovery

Step	Community segment	Comment (explanation for response / identification of community segment)
Noting results from 2a, who in principle should bear the costs of the preferred adaptation bundle?	Choose an item	
What are the potential funding sources for the bundle?	Choose an item	

Step 3: Develop implementation schedule

Step 4: Address implementation risks

Step	Outline		Comment <i>(explanation / key reasons for responses)</i>
Implementation timeframe	Milestone / Action	Timing	
Roles and Responsibilities	Role	Responsibility	
Community / stakeholder engagement	Stakeholders	General community	
Implementation risks & mitigation measures	Risks	Mitigation measures	

Stage 10. Monitor & evaluate

Overview

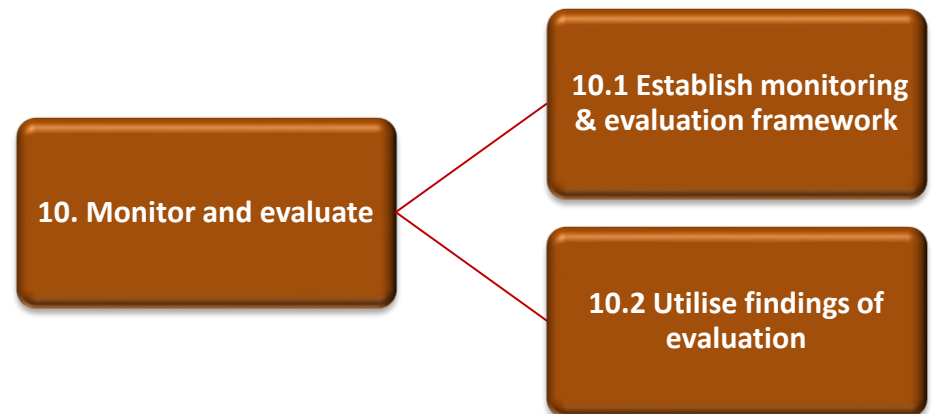
Climate change is a complex and long term issue, and the magnitude of change and impacts is uncertain. Adaptation to climate change is still relatively new for councils and communities. It is also, in many instances, a continuous and flexible process. It is therefore important to learn and improve over time how to best address climate change hazards, reduce vulnerability and enhance resilience.

Regular monitoring and evaluation of adaptation measures will provide necessary insights and answers to the following two questions:

- *Are we doing things right?* and
- *Are we doing the right things?*

This section provides guidance on establishing a monitoring and evaluation framework for adaptation actions.

Figure 11: Important steps in monitoring and evaluation



Useful information for this stage

- Refer to Stage 10 of the Handbook for additional material to help with completion of this stage.
- Developing and Using Program Logic in Natural Resource Management – User Guide provides step-by-step guidance for developing program logic in the context of natural resource management. <http://nrmonline.nrm.gov.au/catalog/mql:2164>

Stage 10 checklist

Step 1. Establish process for the evaluation and review of adaptation actions *(refer to Handbook Stage 10.1 for more information)*

- Has the aim of the evaluation been established? Does the evaluation aim to improve the adaptation action while it is underway or provide lessons for other adaptation initiatives?
- Taking into account the answers to the questions above, when should the evaluation be undertaken?
Hint: Possibilities include mid-way through the action, at the end of the action, sometime after the action has been completed - taking into account a possible time lag between implementation and effect.
- Have benchmarks been identified against which the adaptation action will be measured?
Hint: One reference point must be the primary objective set at Stage 3. Further reference points could be the baseline (e.g. how the system would have evolved without the adaptation action).
- Has an evaluation methodology been decided on?

Step 2. Utilising findings and lessons learnt from the evaluation *(refer to Handbook Stage 10.2 for more information)*

- Has the problem been solved or is further action required?
- Did other positive or negative effects occur that were not anticipated?
- Could the adaptation action be improved in any way? Is it still an appropriate action or is a different adaptation action required?
- Do we need to change the monitoring in any way (e.g. different threshold variables or trigger points) informing the next implementation timing or decision-making for the next adaptation pathway.

Stage 10 worksheet

Step 1: Establish evaluation process

Step	Decision	Outline	Comment <i>(explanation / key reasons for responses)</i>
Establish aim of evaluation	Choose an item.		
Establish timeframe for evaluation	Choose an item.		
Define audience of evaluation	Choose an item.		
Establish evaluation benchmarks or reference points	Project objectives		
	Good adaptation principles		
	Baseline (without project)		
	Other		
Decide on evaluation methodology	Cost benefit analysis (ex post)		
	Multi-criteria analysis		
	Stakeholder / end-user survey		
	Other		