# A brief guide to comparing the costs and benefits of climate adaptation

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## Introduction

Economic valuation compares the costs and benefits that result from tradeoffs in terms of people's preferences. In the case of adaptation, we are interested in the costs and benefits that result from their preferences over the streams of goods and services that result from alternative courses of adaptation action.

Economic costs and benefits are based on people's individual preferences that are reflected in their willingness-to-pay, and then aggregated to obtain a value for society. It is important to keep in mind that the estimates of costs and benefits that are used to support decision-making result from the differences between the alternative courses of action. We are interested in the differences in value between the alternatives. This means we need to estimate how the provision of goods and services that people care about might differ between the alternatives.

The overall objective of valuation is to identify the course of action that has the highest net benefit. To do this requires considering how the costs and benefits differ between alternative courses of action. These values are determined by the preferences of the individuals who will be affected by the different courses of action and therefore the involvement of key stakeholders and the broader community is essential. A general process is described in Box 1.

This guide provides an outline of the set of steps needed to arrive at an estimate of costs and benefits. At each step, we identify key activities, factors that should be considered, and useful reference sources. We focus on the steps of the decision-making process where alternative adaptation courses of action are compared in terms of costs and benefits. This assumes that sensible choices have already been made at the stage of problem formulation— the stage where alternative courses of action are generated. It also assumes that the consequences of alternative courses of adaptation for the

biophysical provision of benefits have already been modelled and assessed adequately enough for a comparison of costs and benefits, as shown in Figure 1 below. This allows us to provide a short guide to the available procedures.

We show how costs and benefits ultimately depend on the preferences of the people who are affected by the outcomes of adaptation actions. Individual preferences are the basis of economic costs and benefits. This fact allows us to provide guidance about whether the assumptions needed for market prices, non-market valuations, or other deliberative approaches to assessing people's costs and benefits, are likely to provide the best estimates for particular kinds of cost and benefit.
This also allows us to provide guidelines on how to compare costs and benefits whilst taking into account the fact that many critical assumptions about conventional forms of cost-benefit analysis are not valid in important adaptation contexts.

The following guide first presents the implications of comparisons of costs and benefits for the stages of decision-making. These initial comparisons are pre-requisites for estimating and comparing the costs and benefits of alternative courses of action. The guide then presents guidelines for estimating and comparing the costs and benefits of alternative courses of climate adaptation.

### Box 1: A general process of economic valuation

1. Problem formulation
    1.1. Establish the context
2. Generate alternatives
    2.1. Identify appropriate policy actions based on the drivers of the system
3. Compare alternatives
    3.1. Construct alternative scenarios to compare
    3.2. Compare the provision of goods and services between alternative scenarios
    3.3. Estimate the trade-offs between alternative scenarios
    3.4. Collect information about people's preferences for the attributes of the market and non-market goods and services that differ between the alternative scenarios
        3.4.1. Market prices
        3.4.2. Non-market valuation (monetisable)
        3.4.3. Non-market valuation (non-monetisable)
4. Apply decision criteria
    4.1. Consider distributional impacts
    4.2. Sensitivity analysis
        4.2.1. Information-gap analysis
5. Implement
6. Evaluate

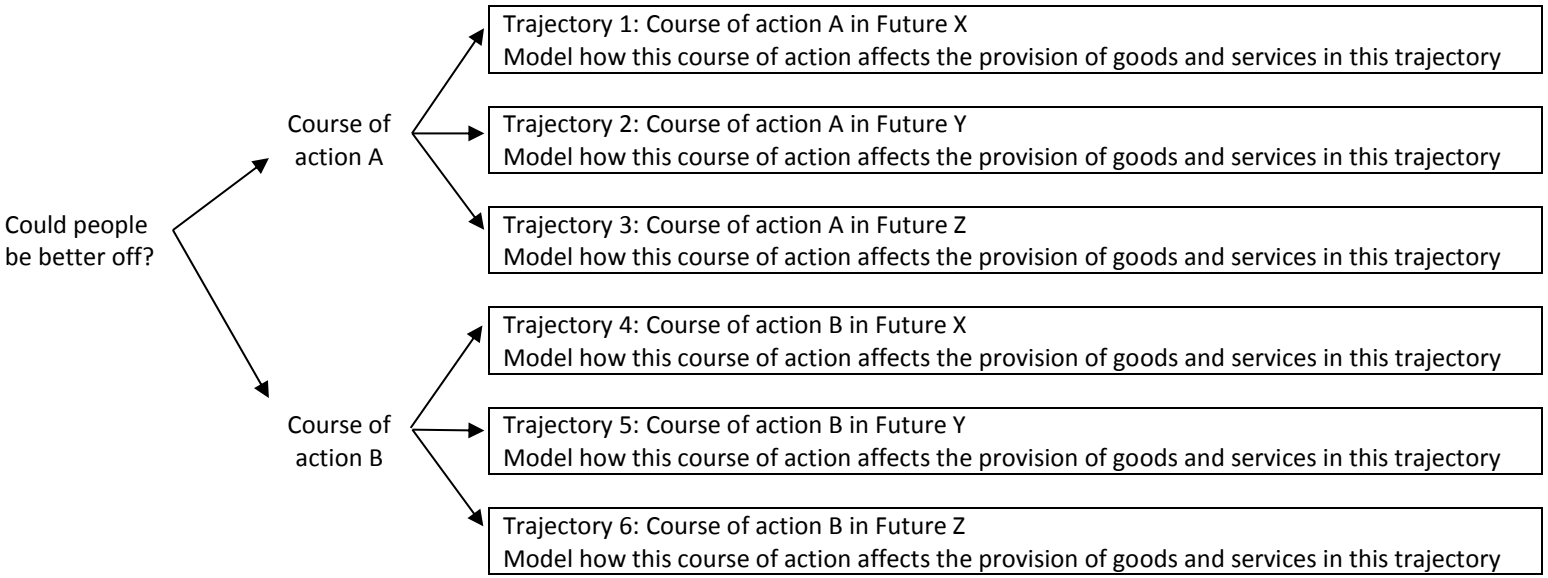


**Figure 1:** This diagram shows how two alternative courses of action (A and B) interact in alternative possible futures (X, Y, and Z) that represent the range of possibilities due to uncertainty about the future. Comparing costs and benefits involves modelling how the provision of goods and services differ between alternative trajectories so that people's preferences over the alternatives can be estimated. Source: Author

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| **1 Problem formulation**<br><br>Identify whether people could be made better off | What is the problem? That is, how could people be better off than they currently are? | Following an adaptive or iterative approach to decision-making, this step will need to draw upon lessons learned from previous stages of implementation and evaluation. |
| ***1.1 Establish the context***<br><br>Establish a common understanding of the purpose, objectives, stakeholders, and scope of the assessment. | What is the purpose of the analysis?<br>What are the objectives of the analysis?<br>Who are the relevant stakeholders?<br>What is the scope of the analysis?<br>What are the relevant constraints?<br><br>After this step is completed you should have a common understanding of your purpose, objectives, stakeholders, and scope of the assessment amongst your stakeholders.<br><br>After this stage you should understand the nature of the problem in terms of the difference between people's understanding of the actual situation and their ideas about situations where they are better off. | Involve stakeholders from government and the public sector, non-government organisations, the private sector, communities, and other individuals in this process. Be sure to include key stakeholders from communities and society in general in the decision-making process.<br><br>Find out what people care about. Ultimately, it is the values and preferences of the individuals who will be affected by alternative courses of action that determine costs and benefits. Other stakeholders can contribute expert knowledge to the decision-making process.<br><br>For valuation purposes, you can also identify relevant stakeholders based on the kinds of stakeholders who care about various types of goods and services. This means that you can identify representative stakeholders based on representative types of use of a resource. For example, a range of stakeholders can be identified by considering different types of uses for a wetland area, e.g. the types of people who want to harvest timber or fish, convert wetlands into fertile agricultural land, extract water, benefit from storm abatement, flood mitigation, or biodiversity conservation (e.g. Tuner 2000b). They also may represent the potentially conflicting preferences for the use of a resource that lead to the trade-offs you will be trying to measure using costs and benefits.<br><br>Specialised users might also provide expert knowledge needed for assessing the consequences of alternative courses of action. |

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| **2 Generate alternatives**<br><br>***2.1 Identify appropriate policy actions based on the drivers of the system***<br><br>Alternative policies or management actions that aim to provide higher net benefits than a business-as-usual alternative can be identified based on an understanding of the drivers of the system. | What are the alternative courses of climate adaptation?<br><br>After this step you should have identified alternative policy actions. These alternatives should be viewed as alternative courses of action instead of one-off actions.<br><br>These alternative pathways will include acting to influence institutional processes, social and economic processes, and biophysical processes.<br><br>Ongoing adaptation actions include ongoing decision-making processes. These processes are part of the policy alternatives that you will need to compare in terms of costs and benefits since people can have preferences over decision-making processes as well as their outcomes.<br><br>Taking an iterative approach to adaptation, and an adaptive management approach to decision-making, can help you manage the risks associated with incomplete information. | At this stage it is very important to avoid overlooking relevant alternatives. If you make this mistake, then the most appropriate alternative will not be included in your choice set. Don't just include alternatives where it is easiest to calculate costs and benefits or where it is easiest to estimate costs and benefits in dollar terms.<br><br>There are numerous tools available to help you identify relevant policy actions in terms of an understanding of the drivers of the system, e.g. the OECD's DPSIR framework.<br><br>Consider adaptation actions that help you manage the risks associated with your incomplete knowledge of both the problem and the consequences of alternative courses of action. This means taking an iterative approach and avoiding costly forms of irreversibility such as path dependency. Consider actions that will collect information that will be relevant to future decision-making. In order to help manage risk, consider portfolios of actions (e.g. Boyd 2010).<br><br>There are political and institutional factors that constrain the courses of action available for decision makers. Don't ignore any important constraints when identifying alternative courses of action. It is also likely you will need to consider actions that can help overcome some institutional constraints in order to enable future adaptation actions.<br><br>The challenge of adaptation is to manage uncertainty. This means that certain kinds of policy action need to be considered and it there are particular challenges in assessing costs and benefits when the outcomes of policy actions are uncertain. This should not prevent including these kinds of policy actions in the list of alternatives to compare. |

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| **3 Compare alternatives**<br><br>***3.1 Construct alternative scenarios to compare***<br><br>To evaluate alternative policies, two or more hypothetical scenarios are compared. This includes the business-as-usual scenario and one or more policy alternatives. Each scenario is identical, except for the consequences of the specific policy actions being tested. | How do the alternative courses of action interact with multiple possible futures to produce the range of possible outcomes?<br><br>Alternative courses of action will interact with changes to the states of the system as the future unfolds. Because the future is uncertain, each alternative course of action can lead to multiple possible scenarios. When viewed over time, these scenarios describe the possible trajectories of outcomes into the future.<br><br>You need to be able to describe and model these alternative trajectories as a precursor to estimating the resulting costs and benefits.<br><br>How do the adaptation actions affect the production of the different kinds of benefits over time? | To support economic valuation, you need to model the possible outcomes of your alternative courses of action in terms of their impacts on what people care about. This means that your modelling and comparisons needs to reveal how the attributes that people care about differ between the alternative scenarios.<br><br>Because the future is uncertain, you will need to model the consequences of each alternative course of action over the range of possible future trajectories of the system. These possible future trajectories need to take into account possible changes in environmental, social, and economic variables, and their interactions.<br><br>At this stage, keep in mind how you are going to measure people's preferences over the alternative scenarios and elicit the trade-offs they are willing to make between the attributes of alternative scenarios. For example, because many forms of uncertainty that affect adaptation decisions are difficult to quantify, various methods of scenario analysis can provide tools that help you construct the scenarios you will need to elicit people's preferences using that kind of approach.<br><br>The models of the alternative scenarios that could result from alternative courses of action that you will use to estimate costs and benefits are only approximations of the real situation. Models of complex social-ecological systems, with their many interactions, positive and negative feedback loops, and multiple sources of heterogeneity, only provide a rough approximation of reality. The limitations of modelling the consequences of alternative courses of actions in complex systems and over long periods of time means that your estimates of costs and benefits will be wrong. You will need to examine the consequences of this at later stages of decision-making by conducting sensitivity analyses on the assumptions you are making at this stage.<br><br>Ensure that you have considered how adaptation actions affect all the relevant kinds of market and non-market goods and services. One way to check this is to consider the geographic relationships between people and the production of the goods and services they consume. For example, Balmford et al. (2008, p. 17) delineated services (1) used at their point of production, e.g. sitting on a beach, (2) used in an area around the area of their production, e.g. pollination (3) directional benefits, e.g. storm protection, (4) used far from their point of production, e.g. water, and (5) used anywhere regardless of their point of production, e.g. climate change mitigation by carbon sequestration. |

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| ***3.2 Compare the provision of goods and services between alternative scenarios***<br><br>Compare alternative scenarios in terms of the impacts of the adaptation actions on the provision of the goods and services people care about, i.e. the attributes of the scenarios they might have preferences over. | How do the alternative courses of action compare with each other in terms of their effects on the things people care about?<br><br>This means you need to be able to describe and model the effect of alternative courses of action in sufficient detail to understand the differences between these scenarios in terms of all the different kinds of things people care about.<br><br>After this step you should be able to describe and model how the different scenarios affect the provision of the attributes that people care about, plus an understanding of the uncertainty that affects this provision.<br><br>In other words, you should now have some understanding of how the provision of goods and services differs between the alternative scenarios that result from your adaptation actions and their interaction with multiple possible futures. Plus, you should have some understanding of the sources of chance that affect the provision of goods and services in each scenario.<br><br>For example, public access to a beach for recreation might be more uncertain under some scenarios than others. This needs to be described or modelled in a way that allows people's preferences over a variable or uncertainty supply of goods and services to be assessed.<br><br>At the end of this step, for each scenario you need to know how all the possible scenarios differ in terms of all the attributes of the market and non-market goods and services provided in those scenarios and the variability and uncertainty that affects their provision. | People care about all kinds of things. The aim in comparing costs and benefits is to take into account the preferences of anyone affected by a course of action. People can have preferences over their consumption of goods and services and they can also have social preferences, i.e. preferences over the wellbeing of other people and other people's consumption of goods and services. In other words, people can have preferences over their own experience of these attributes and the experiences of other people, i.e. various forms of social preferences.<br><br>In other words, people can have preferences over whatever they like. It is also important to keep in mind that people's preferences are often uncertain and poorly formed or articulated. Preference uncertainty is one reason people might prefer to preserve flexibility into the future, when they might have a better idea of what they prefer. People might also have other reasons for preferring to preserve flexibility, such as a preference for variety. This means alternative scenarios need to be compared in terms of their consequences for flexibility, irreversibility, and path dependency into the future.<br><br>The following list provides one possible classification of all the different kinds of attributes of the goods and services that differ between the alternative scenarios and that people might care about, have preferences over, and therefore make tradeoffs between. Estimating the economic costs and benefits involves measuring tradeoffs over people's preferences over these attributes or bundles of attributes.<br><br>• Attributes of uncertainty. These are the variables that describe the levels of variability and uncertainty that affect the production of all the other attributes people might care about in the possible scenario, e.g. people's preferences over variability can be expressed as a risk preference – most people are thought to be slightly risk-averse and therefore have a preference for a more reliable supply of goods and services; people can also have a preference for preserving the flexibility to choose differently in the future, i.e. an option value.<br>• Attributes of goods and services. These are the variables that describe the attributes of traded goods and services and the attributes of non-traded goods and services, e.g. ecosystem services like clean air, clean water, biodiversity, recreational fishing, or pleasant views.<br>• Attributes of individuals, communities and society. These are social variables people care about, e.g. characteristics of local communities, social institutions, etc.<br>• Attributes of the economy. These are economic variables people care about, e.g. employment, types of job, types of economic opportunities etc.<br>• Attributes of the environment. These are the attributes of the environment people care about, e.g. clean air, water, availability of shade, presence of beaches, access to beaches, number and type of fish.<br>• Attributes of decision-making procedures. These are the attributes of decision-making procedures that people care about, e.g. whether procedures are seen to be fair, inclusive, legitimate, credible, efficient, effective etc.<br>• Attributes of the distribution of costs and benefits, i.e. distributional preferences. These are a form of social preference where people are concerned not just about what other people get but also about the distribution of who gets what. |

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| ***3.3 Estimate the trade-offs between alternative scenarios*** | What are the trade-offs, in terms of people's preferences that differ between alternative scenarios?<br><br>What information do you already have about people's preferences for the attributes of the market and non-market goods and services that differ between the alternative scenarios?<br><br>Answering this question involves establishing your prior expectations about the nature of people's preferences over the attributes that differ between the alternative scenarios, e.g. you might expect that for a coastal tourist town that people have a high preference for access to the beach.<br><br>Do the expected benefits of more information about costs and benefits exceed the costs of acquiring that information?<br><br>Answering this question will tell you whether more information, and of what form, would change your prior expectations. This includes asking whether increased accuracy in estimates of costs and benefits would change the outcome of the decision-making process. | Economic costs and benefits are based on people's individual preferences, as reflected in their willingness-to-pay, and then aggregated to obtain a value for society. It is important to keep in mind that the estimates of costs and benefits that are used to support decision-making are the marginal differences between the alternative scenarios that could result from alternative courses of action.<br><br>Based on the information you already have, you will be able to conduct an initial evaluation of the scenarios based on their relative desirability and work out which of the possible scenarios you think a priori make the most people better off, i.e. have the highest social net benefit.<br><br>The benefits of more information can then be assessed in terms of whether it would lead to a better decision, i.e. a greater likelihood of choosing a preferred course of adaptation action. |

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| ***3.4 Collect information about people's preferences for the attributes of the market and non-market goods and services that differ between the alternative scenarios*** | What are people's preferences for the attributes of the market and non-market goods and services that differ between the alternative scenarios?<br><br>How well are the assumptions for the various methods for estimating people's preferences met for the attributes of the market and non-market goods and services that differ between the alternative scenarios?<br><br>The strength of people's preferences for various attributes is measured by assessing the trade-offs they are willing to make between these attributes. For example, what someone is willing to pay for one more unit of a good or a service (or conversely, what someone is willing to accept for one less unit of a good or a service) reflects the strength of their preference for money relative to their preference for the good or service. The strength of people's preferences can also be assessed based on the trade-offs they are willing to make between other attributes.<br><br>At the end of this stage you should be able to put together a table for each of the outcomes for the alternative courses of action that identifies whether the outcome is a net cost or benefit and an appropriate valuation method, i.e. choosing between the various market and non-market valuation methods that are available. | Different methods for estimating people's preferences and trade-offs make a number of assumptions. There is a set of assumptions for all methods for estimating these values, including assumptions for market pricing, various methods of non-market valuation in dollar terms, and other methods for eliciting preferences and the strength of trade-offs.<br><br>It is necessary to decide how well the assumptions are supported in your context before relying upon any of these methods for estimating costs and benefits. You will need to keep track of any assumptions you make in the analysis and test the consequences of these assumptions when you conduct sensitivity analyses later in the decision-making process.<br><br>Market prices provide some information about people's willingness to pay for goods and services. When the assumptions needed for market prices to provide an accurate measure are not met, then non-market valuation methods can be used. Some of these methods can provide estimates of the strength of people's preferences as their willingness-to-pay in dollar terms. Other methods can provide estimates of the strength of people's preferences in terms of the trade-offs they are willing to make between their consumption of the attributes directly, i.e. instead of asking how much money someone would give up for an apple you try to find out how many oranges they would give up.<br><br>For an example of how to summarise information about costs and benefits, see Buncle et al. (2013). This document provides examples of how to summarise information about costs and benefits qualitatively when other valuation methods are not appropriate or the costs of getting more information about costs and benefits exceeds the likely benefits of that information.<br><br>If you have information from different types of stakeholder or alternative competing uses for the same resource, then this information can be summarised as a separate table of costs and benefits for each category.<br>Refer to Table 2 "Commonly used approaches to generate monetary values for non-traded goods and services" in *Valuation of adaptation options relative to the avoided Impacts*. |
| *3.4.1 Market prices* | What does the information available from market prices reveal about people's preferences over the attributes that differ between the alternative scenarios?<br><br>Are there 'external' costs and benefits because of market failure? What other methods could be used to assess the costs and benefits associated with these externalities? | Market prices provide an accurate measure of the value of scarce resources only if a number of assumptions are met, including i. free choice based on self-interest, ii. rational behavior, iii. perfect information, iv. perfect competition, v. mobility of resources, and vi. non-attenuated property rights (Hussen 1999).<br><br>Property rights are attenuated if they do not clearly and completely specify the characteristics of a resource, confer exclusive rights to owners, and cannot be transferred or enforced (Randall 1987). When property rights are attenuated there are external costs or benefits imposed on other people. |

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| *3.4.2 Non-market valuation (monetisable)* | What are the methods available for estimating people's willingness-to-pay for the attributes that differ between the alternative scenarios?<br><br>How well are the conditions met for these methods to provide useful information about costs and benefits?<br><br>Are the benefits of improved information from these methods likely to exceed the costs of that information? | Sometimes when market prices do not provide an accurate measure, non-market valuation can be used to estimate people's willingness-to-pay.<br><br>Although economic valuation only seeks to compare the differences between alternative scenarios, the classification provided by the 'total economic value' framework seeks to identify all the different types of economic value that could differ between alternative scenarios. These are use values (direct and indirect) and non-use values. Non-use values include (1) the value of preserving a resource for potential future uses (option value), (2) the value people place on preserving a resource for future generations (bequest value), and (3) the value people place on the existence of a resource (existence value).<br><br>Non-market valuation methods that seek to provide dollar values make some of the same assumptions as estimates based on market prices. For more analysis of the challenges associated with non-market valuation under conditions of climate change, see Russell (2001). Essentially, non-market valuation performs poorly when future changes are more extreme, unfamiliar, and uncertain. |
| *3.4.3 Non-market valuation (non-monetisable), e.g. deliberative approaches, various kinds of scenario analysis* | Are the benefits of improved information from these methods likely to exceed the costs of that information? | These kinds of approaches for estimating the strength of people's preferences over the attributes that differ between the alternative scenarios might not make some of the same assumptions about market prices, but they do make other assumptions. Any approach that relies upon a process of selecting representative stakeholders to ask about their preferences makes implicit assumptions about the representatives of this group relative to the larger population that would be affected by alternative courses of adaptation action.<br><br>Keep in mind that the preferences elicited from a group process may be quite different from preferences elicited from individuals. Social networks might be important (e.g. Borgatti et al. 2009). Be aware that some groups may already have a history of consultation or deliberation and may experience 'stakeholder fatigue' (e.g. Turner et al. 2016).<br>See also Kenter et al. 2015. |
| *3.4.4 Estimating the cost of implementing policy actions* | | In addition to the costs and benefits experienced by people in general as a result of alternative courses of adaptation actions, you will need to estimate the costs of the each of the alternative courses of adaptation actions themselves. This will involve estimates, based on market prices, provided by people whose goods and services would be necessary for the alternative courses of adaptation actions. This will also involve estimating costs to the decision-making agency. To estimate the costs to the agency, you can draw on standard project management guidelines (e.g. O'Connell 2011). This includes working out the opportunity cost of engaging in courses of adaptation actions compared with other priorities. |

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| ***3.5 Aggregating costs and benefits*** | What are the aggregate costs and benefits associated with the alternatives? | Aggregating is focused on combining estimates of monetary values. Keep in mind that you will only be able to aggregate costs and benefits into a single number or ratio for costs and benefits you have estimated in dollar terms. You will need to summarise the information about costs and benefits you have quantified, in terms of other preference methods and qualitative assessments with aggregated dollar values; you need to do this to ensure you do not discard important information about costs and benefits at this stage. If you assume that you can estimate net benefits based only on data you have that is expressed in dollar terms, when in fact important information about preferences was estimated in other forms, then your estimate of economic efficiency will be wrong.<br><br>For example, if you have identified a cost such as a negative impact on an important ecological function (e.g. an estuary vital for an important local fishery), then you will need to take this information forward to the next stage where you apply decision criteria. Even when quantitative assessments of costs and benefits are not available, some qualitative assessments of costs and benefits can be deciding factors for decision-making, e.g. adaptation actions that damage an important cultural site might be ruled out even by a qualitative assessment (e.g. Venn and Quiggin 2007).<br><br>See Buncle et al. (2013, p. 16) |
| ***4 Applying decision criteria*** | Combining quantitative and qualitative information about the costs and benefits of alternative courses of climate adaptation; what course of adaptation has the highest net benefit?<br><br>This will involve aggregating information in dollar terms into a net present value and combining that with information about costs and benefits expressed as individuals' weightings over the various attributes that differ between scenarios, and qualitative information about costs and benefits. | Since it is likely that you only have had some information about people's preferences expressed and aggregated in dollar values, you can consider multiple criteria approaches at this stage. See Fish et al. 2011.<br><br>Criteria can include the consideration of the effectiveness, efficiency, legitimacy and equity of the alternative courses of adaptation. Keep in mind that courses of adaptation action include the ongoing decision-making processes that take place within them so people's preferences over decision-making processes and potential changes to courses of adaptation action are relevant sources of costs and benefits.<br><br>This will involve considering the consequences of uncertainty in the estimates of people's preferences, people's preferences to preserve flexibility in future choices, some institutional and political parameters, as well as the constraints within which you try to identify the courses of action with the highest expected social net benefits.<br><br>For guidance on calculating Net Present Values and the use of discount rates, see the *Information Manual 4: Costs and benefits* (p. 17). |
| ***4.1 Consider distributional impacts*** | | E.g. see Buncle et al. (2013, p. 20) |

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| **4.2 Sensitivity analysis** | How sensitive is the result of your decision-making process to the assumptions you have made along the way?<br><br>This includes assumptions about the nature of the problem, the range of available courses of adaptation actions and the consequences of these actions, assumptions about people's preferences over these consequences, and assumptions about the methods used to estimate the consequences of people's preferences for the aggregate costs and benefits.<br>At the end of this stage, you should have a better understanding of how the outcome of your decision-making process would differ with alternative sets of assumptions. | See the *Information Manual 4: Costs and benefits* (p. 22).<br><br>In particular, there are challenges are around quantifying the effect of uncertainty on costs and benefits (see Practitioners Handbook, Randall et al. 2012), quantifying the value of information that can reduce uncertainty, quantifying the value of flexibility and reversibility, and quantifying costs and benefits over long periods of time.<br><br>There is also uncertainty because in the adaptation context, people's preferences will not be clearly revealed by market prices and in this context people will often have difficulty articulating their preferences. |
| *4.2.1 Information-gap analysis* | What information would be likely to change the outcome of your decision? | See the *Information Manual 4: Costs and benefits* (p. 7). |
| **5 Implement** | Keep in mind the role of implementation in collecting relevant information for future decision-making. | As adaptation actions unfold over time, and you engage in further iterations of adaptation decision-making, you will implement actions of monitoring and evaluation that will help you also to collect relevant information and experience for future adaptation decision-making. |
| **6 Evaluate** | The evaluation of adaptation actions will help inform future iterations of adaptation decision-making. This includes helping you learn how to better formulate the nature of adaptation problems in the future. | |

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