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Australian Greenhouse Office

Climate Change Impacts & Risk Management

A Guide for Business and Government

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Department of the Environment and Heritage
Australian Greenhouse Office

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Climate Change Impacts & Risk Management

A Guide for Business and Government

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Minister's Foreword

Climate change is a significant global challenge that requires a strategic approach from both government and private enterprise to ensure our nation's future. Our climate has changed and this will continue as a result of the greenhouse gases already in the atmosphere. In Australia average temperatures have risen by around 0.7°C over the last century, and there has been an average sea-level rise of between 120mm and 160mm. Future climate change could well bring higher temperatures and less rainfall to southern Australia, and more frequent extreme weather events such as storms, heatwaves and drought.

These changes are likely to affect a wide range of human activities and natural ecosystems. Early thinking about how to adapt can put governments, businesses and communities in the very best position to minimise risks from the impacts of climate change.

Australia is fortunate to have an internationally recognised risk management standard that is already widely used by government, business entities, and other organisations. This guidance demonstrates how the standard can be used to systematically manage the risks associated with climate change impacts. A risk management approach enables an organisation to manage adaptation to climate change as one of several risks it may face in the future. This approach ensures that adaptation is 'mainstreamed' as part of normal business operations and integrated with other existing business strategies.

The Government's $14.2 million National Climate Change Adaptation Programme ensures the nation takes early steps to successfully adapt to the unavoidable impacts of climate change. Working in conjunction with this, the Australian Government has a comprehensive climate change strategy, supported by funding of almost $2 billion, to responsibly reduce Australia's greenhouse gas emissions and build an effective global response to climate change.

This publication is complemented by Climate Change Scenarios for Initial Risk Assessment, prepared by the CSIRO for 10 Australian regions, to assist in the risk management process.

I am delighted to recommend this publication to you as a valuable resource to help business, government and the community manage the risks associated with climate change impacts and give strong direction to how we face the challenges of climate change in the years ahead.

Senator the Hon. Ian Campbell
Australian Minister for the Environment and Heritage

CONTENTS

PART A

What This Guide Is About

1. Introduction

A 1.1

1.1 Purpose of this Guide

The global climate is changing, and will continue to change, in ways that affect the planning and day to day operations of businesses, government agencies and other organisations[1]. The manifestations of climate change include higher temperatures, altered rainfall patterns, and more frequent or intense extreme events such as heatwaves, drought, and storms.

This document is a guide to integrating climate change impacts into risk management and other strategic planning activities in Australian public and private sector organisations. The purpose of this Guide is to assist Australian businesses and organisations to adapt to climate change[2].

The Guide is directed to:

- **elected representatives and directors** who wish to ensure their organisations are aware of their risks from climate change impacts and that suitable management responses are put in place;
- **general management** of organisations who need to understand the nature of the risks associated with climate change impacts and to know that these are identified and incorporated into processes for management and strategic planning; and
- **specialist risk managers or external risk experts** who must apply risk management frameworks to ensure their organisations or those they are advising have identified and considered the risks of climate change impacts.

The Guide is consistent with the Australian and New Zealand Standard for Risk Management, AS/NZS 4360:2004, which is widely used in the public and private sectors to guide strategic, operational and other forms of risk management. The Guide describes how the routine application of the Standard can be extended to include the risks generated by climate change impacts.

1 We use the term 'organisation' in this Guide to include public sector agencies, semi-Government businesses, private companies and communities. The general approach to climate change risk management is the same for all kinds of organisations, although there may be differences in detail.

2 It is not concerned with policy and other actions aimed at mitigating the extent or speed of climate change.

1.2 Scope of the Guide

The Guide provides a framework for managing the increased risk to organisations due to climate change impacts. The prime focus of the Guide is on the initial assessment and prioritisation of these risks.

The Guide aims to help businesses and organisations:

- enumerate risks related to climate change impacts;
- prioritise risks that require further attention; and
- establish a process for ensuring that these higher priority risks are managed effectively.

In most instances this initial assessment level of risk appraisal can be undertaken by people with a sound professional knowledge of the relevant organisation, together with a general understanding of the likely directions and magnitudes of climate change.

Climate change scenarios for risk assessment accompany this Guide. These scenarios have been developed by CSIRO for the Australian region using current best understanding of climate change and are designed specifically for use in the process of the initial strategic assessment of risks arising from climate change. The Australian Greenhouse Office will update and extend these scenarios from time to time[3].

The planning horizon suggested for this Guide is, in the first instance, a period of approximately 25 years hence. This coincides with the strategic planning horizon of many organisations and also with the investment period for many long-lived assets. Users of the Guide may however, choose to adopt an even longer-term focus - for example, climate scenarios can be constructed for 50 and even 100 years into the future using information that is easy to access.

The Guide is not intended to address:

- risks associated with 'normal' variable states of climate; nor
- measures and actions aimed at mitigating climate change itself, such as reducing greenhouse emissions or introducing emission trading schemes.

This Guide was developed through a series of case studies with four partner organisations, including a large private company, a public utility, a government agency and a local government. The recommendations in this Guide are based largely on the experience gained through these case studies.

3 Thus, most organisations seeking to apply this Guide to undertake an initial assessment of risks do not need to develop their own climate change scenarios or to draw on external expert support on climate change science.

A
1.3

1.3 Structure of the guide

The Guide is separated into three parts.

Part A describes what the Guide is about. In addition to the items covered in the Introduction, it discusses why there is a need to assess climate change risk (Chapter 2) and the fundamentals of risk assessment and management (Chapter 3).

Part B outlines how to conduct an initial strategic assessment centred on a workshop process. Chapter 4 describes the tasks and necessary steps that must be taken in preparation before the workshop. Chapter 5 describes the workshop process itself and how to effectively identify, analyse and evaluate the risks to the organisation arising from changes in climate. Chapter 6 describes the actions and responses required post-workshop in order to treat the identified risks. It notes that the 'treatment' of risks may involve more detailed analyses of some specific risks.

Part C deals with other considerations. Chapter 7 briefly outlines some of the considerations that arise if a more detailed analysis of some specific risks is required. Chapter 8 sets the risk assessment in the broader context of strategic planning and management, and therefore deals with the wider questions of the preparation, planning and integration of the risk assessment in an organisation's normal processes for planning and management.

A summary checklist of tasks and hints and a glossary of climate change and risk management terms are provided as appendices.

2. Why assess the risks of climate change?

2.1 Climate change and risk[4]

Each year there are climatic events that represent risks to people and organisations. These risks arise from 'normal' day-to-day, seasonal, and year-to-year variability in climate as well as regional climate differences.

Most organisations have practices and strategies in place to deal with this routine climate variability. For these organisations, climate variability will continue to raise challenges and risks that have to be managed.

However, when managing climate variability in the future, organisations cannot simply rely on the assumption that the prevailing climate will be more or less the same as it was over the past 50 or 100 years.

Climate change is likely to invalidate this assumption, with changes in both average conditions and the frequency and severity of extreme climate events. We can expect to live and operate in a climate that is warmer, with different patterns of rainfall, less available moisture retained in the soil and more severe storms – in short, a climate that progressively will become different from the current climate in many ways, albeit with many similar but more acute challenges and risks posed by climate variability.

Climate change is likely to have pervasive affects. These affects will be felt in some way by every person and every organisation, public or private, and at all levels, from strategic management to operational activities. The affects will impact across environmental issues, economic performance, social behaviour, infrastructure and other aspects of human existence. Changes are likely to develop gradually but could be abrupt.

Examples of the risks from climate change that may be faced by Australian organisations or communities are provided in Table 1 (over page).

While experience in dealing with natural climate variability may be valuable in formulating strategies for dealing with climate change, there are important differences. With climate change, the timescale is longer, the affects may be more far reaching and the changes will not go away or be reversed in the foreseeable future.

As climate changes, human behaviour will need to (and will) adapt to accommodate it – that is the natural tendency of people and organisations. Effective adaptation however, requires an awareness of the risks posed by climate change and, importantly, an understanding of the relative significance of those risks. This Guide will assist organisations gain that awareness and understanding.

4 As noted, users of the Guide do not need to have a detailed understanding of the science of climate change to undertake the risk assessment process described in this Guide. Nevertheless, users may wish to refer to more detailed information on the science and impacts of climate change. Information can be obtained from a number of sources including the Australian Greenhouse Office website, which lists numerous publications relating to climate change science, impacts and adaptation in Australia. See **http://www.greenhouse.gov.au/science/index.html**.

A 2.2

Table 1: Examples – risks arising from climate change

1.	For urban planners, more frequent heatwaves may increase the stress on emergency services and hospitals while more intense storms and rising sea levels may increase the vulnerability of coastal housing and infrastructure.
2.	For the electricity sector, an increase in the number of days over 35°C and over 40°C would further stimulate air-conditioning demand. Increased peak demands on generation and distribution systems will challenge system reliability. Since investment needs are strongly driven by peak demand rather than by average levels of consumption, the per unit cost of electricity can be expected to increase in response to the increased peak demand.
3.	For Australian agriculture, increases in temperature and net reductions in average rainfall across Southern and Eastern Australia could make drought sequences more common, while the impact of increased temperatures would make them more damaging to plant and livestock viability and production. To the extent that these increases in drought frequency or severity result from continental impacts, then drought management based on shipping livestock and fodder between areas of localised drought may not be possible.
4.	For local government, climate change may affect the economic base of the local region, for instance, by reducing the viability of pasture growth and therefore carrying capacity or perhaps causing the southward spread of pests and diseases previously limited to tropical areas. Climate change may also create new demands for services, for instance, due to more frequent heatwave conditions. Thus, some local governments may be faced with a reduced ability to raise income accompanied by increased demands for services, ranging from geriatric care to emergency services.

2.2 Major aspects of climate change

There is strong and increasing scientific consensus that the global climate is changing. In 2001, the Intergovernmental Panel on Climate Change (Houghton et al. 2001), acknowledged as the most authoritative analysis of information on climate change, concluded that:

- the present global climate is significantly warmer than at the beginning of the 20th Century, with global temperatures having increased by around 0.6°C;
- it is likely that 1990-1999 was the warmest decade in the last 1,000 years, at least in the Northern Hemisphere;
- most of the observed warming in the last 50 years is attributable to human activities – notably the release of greenhouse gases, such as carbon dioxide, methane and nitrous oxide, into the atmosphere; and
- due to the long atmospheric lifetime of major greenhouse gases and time lags in the ocean-atmosphere system, climate change will continue for decades or even centuries to come, even if large scale action to mitigate greenhouse gases was taken in the near future.

Scientific information compiled since 2001 confirms and strengthens the conclusions of the IPCC assessment and earlier assessments by the CSIRO. Global temperatures, for example, have increased by around 0.4°C since 1990 and 2005 was the hottest year on record for Australia.

2.2.1 Temperature and sea level

The IPCC (Houghton et al. 2001) projected additional global warming of 1.4 to 5.8°C by 2100 relative to 1990[5]. It also projected sea level rise of 9 to 88 cm by 2100, due mainly to thermal expansion of sea water but also from some melting of glaciers.

Temperature trends in Australia over the past century are consistent with global trends in showing a more or less steady warming, totalling 0.8°C over the last century. The warming trend is observed across the continent, with the exception of a small region in the northwest. All climate modelling undertaken for Australia projects future average temperature increases.

The range of projected temperature increase for Australia in the near term (to 2030) is about 0.5 to 2.0°C above the 1990 level (CSIRO 2001), For the longer term (to 2070), the CSIRO (2001) projected temperature increase of about 1 to 6°C above 1990.

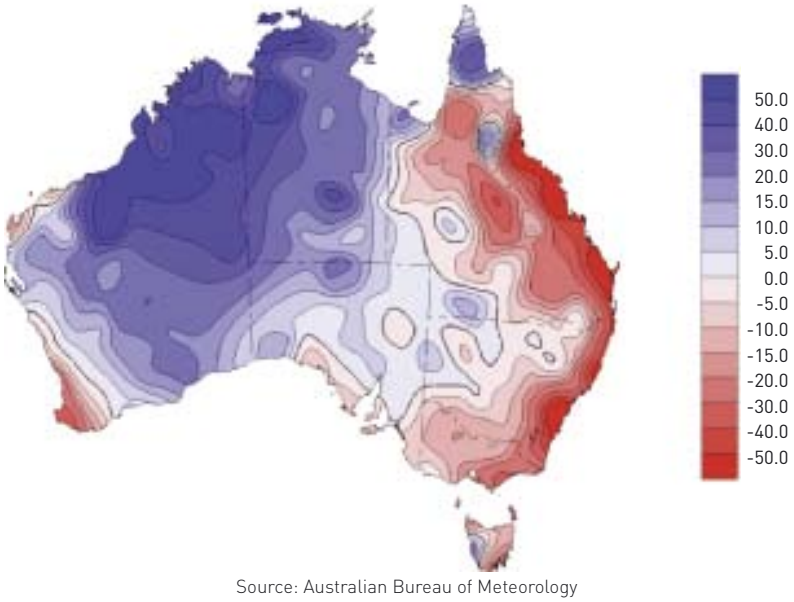
All regions in Australia are projected to experience similar increases in temperature, although inland areas are likely to experience slightly higher temperature increases than coastal areas. Greater warming is expected to occur in spring and summer than in winter.

2.2.2 Rainfall

Regional projections for rainfall are less certain than for temperature. Average rainfall is expected to decrease or remain about the same in most of southern and eastern Australia but may increase in northern-western Australia. However, when increased evaporation due to higher temperatures is taken into account, drier conditions are expected even in places where there is more rain.

In Australia, rainfall trends over the past half century indicate a drying of the east coast, southwest and southeast of the continent and increases in rainfall over northwest and central Australia (Figure 1), although drying is not as evident over a period of one hundred years. These drying trends are consistent with most climate model projections associated with a warmer Australia in the 21st Century.

Figure 1: Trend in rainfall based on 1950 to 2003 (mm/10 yrs)



Source: Australian Bureau of Meteorology

5 The range of projected warmings reflects both uncertainties in projections of future greenhouse gas missions and limitations in the ability of models to represent how the climate will respond to these changes. These sources of uncertainty contribute in approximately equal measure to the range.

A 2.2

The historical evidence also indicates that abrupt or stepped changes in rainfall and associated stream flows are possible. The south west region of Western Australia is the best known example of such a down-step (Figure 2).

Higher temperatures are likely to increase evaporation. The difference between potential evaporation and rainfall gives net moisture or water balance. Most parts of Australia have a net water balance deficit – potential evaporation is greater than rainfall. Projections by the CSIRO (2001) indicate that in all regions of Australia annual water balance is likely to decrease, regardless of whether rainfall increases or decreases. Average decreases in water balance range from 15 to 150 mm by 2030 and 40 to 500 mm by 2070, with the greatest decreases occurring in spring. This means reduced run-off and greater moisture stress for most parts of Australia.

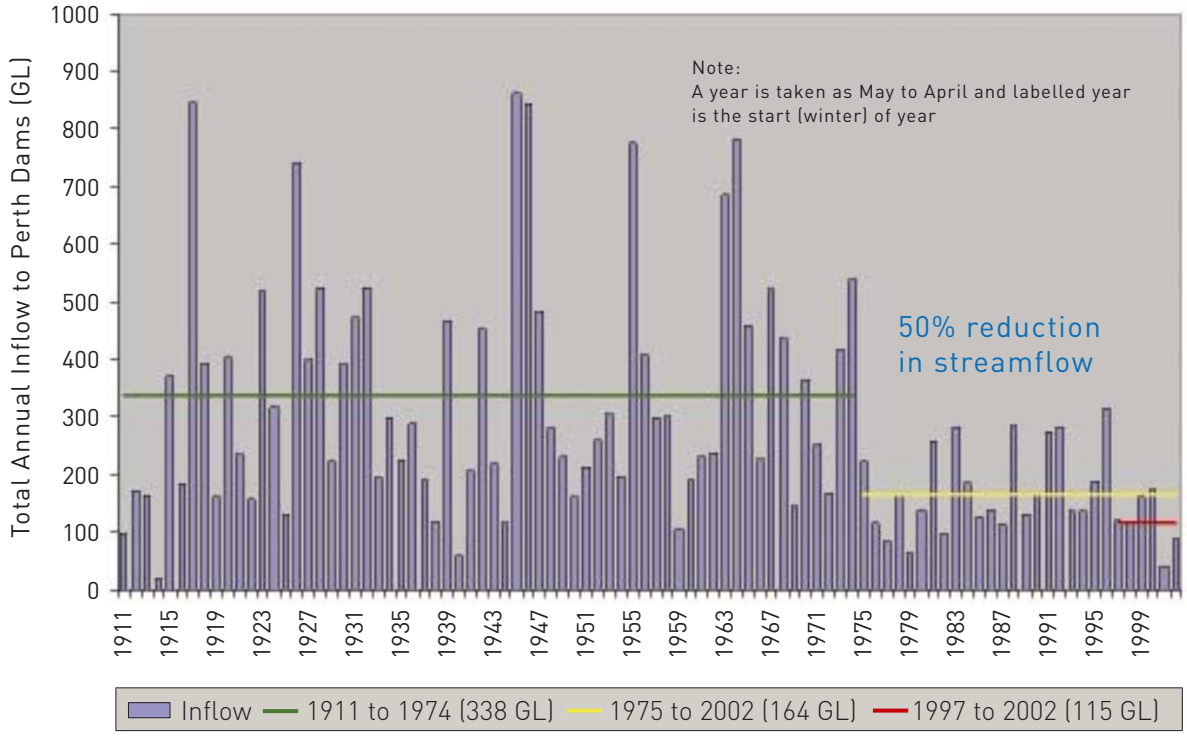
2.2.3 Extreme events

Climate change is likely to result in increases to the frequency or intensity of extreme weather events such as heat waves, tropical cyclones and storms.

The relationship between averages and extremes is often non-linear. For example, a shift in average temperature is likely to be associated with much more significant changes in very hot days. The disproportionate increase in the frequency of extreme events is not limited to the frequency of very hot days but could occur with many other climate extremes. Figure 3 illustrates the proportionally greater impact on building damages from a relatively smaller increase in peak wind gust speed.

In some instances the frequency of extreme events could increase even when there are small declines in averages – this is likely to be the case for rainfall (Risbey et al. 2006).

Figure 2: Abrupt changes to dam inflows, Perth

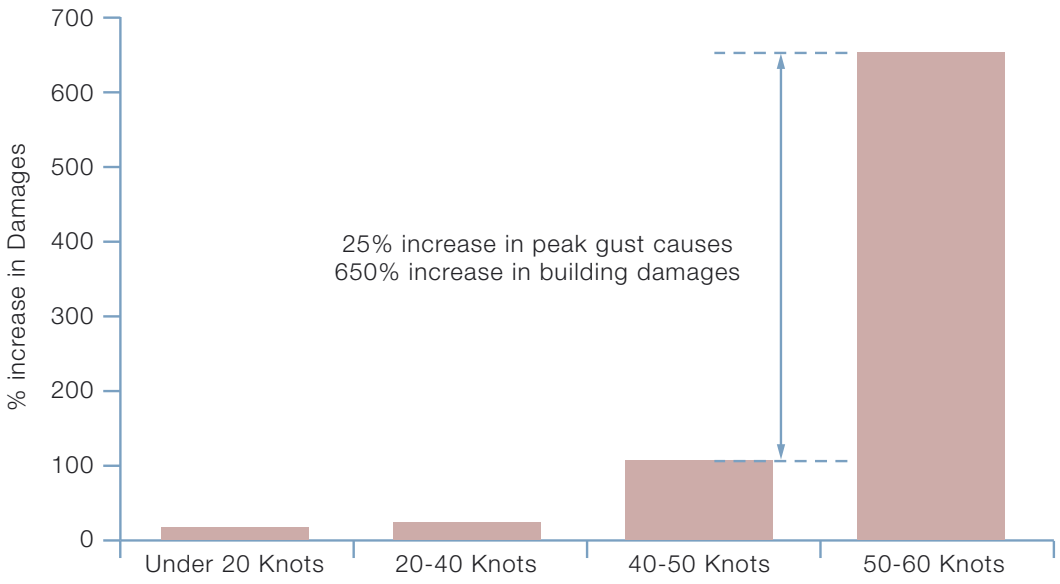


Source: Water Corporation, Western Australia

Examples of how climate change could affect climate extremes are:

- more frequent very hot days;
- more frequent and longer droughts;
- more frequent and larger floods;
- more frequent and more intense heavy rain;
- more intense tropical cyclones;
- more intense storms;
- higher peak wind speeds; and
- higher storm surges.

Figure 3: Non-linear damage functions from extreme events



Hazard	Cause of Change in Hazard	Resulting Change in Damage/Loss
Windstorm	Doubling of windspeed 2.2°C mean temperature increase	Four-fold increase in damages Increase of 5-10% in hurricane wind speeds
Floods	25% increase in 30 minute precipitation	Flooding return period reduced from 100 years to 17 years
Bushfire	1°C mean temperature increase Doubling of CO_2	28% increase in wildfires 143% increase in catastrophic wildfires

Source: *The Impact of Climate Change on Insurance against Catastrophes*, Tony Coleman, Insurance Australia Group, 2003. Presentation to the Institute of Actuaries of Australia.

A 2.3

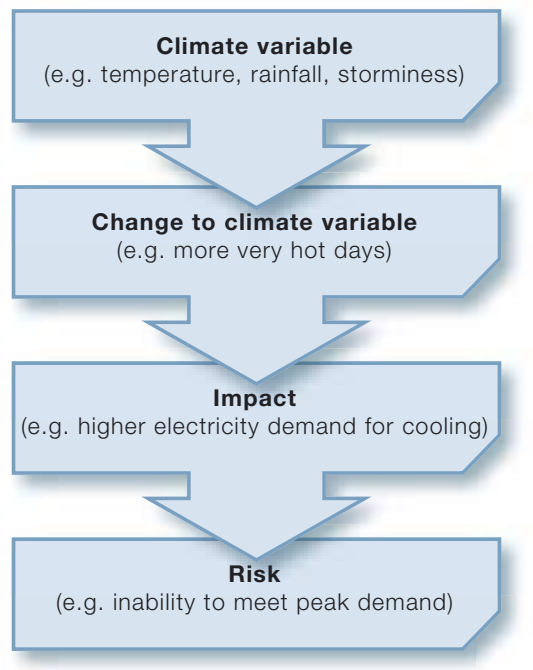
2.3 Understanding the links between climate change and risk

2.3.1 Overview

The risks of climate change to an organisation – for instance, to its reputation as a reliable provider of products or services or its ability to meet its statutory mandate – do not arise directly from changes to climate and climate related variables per se, but from a chain of consequences like those illustrated in Figure 4.

These consequences may affect directly the organisation's capacity to serve its customers or clients or affect other stakeholders of the organisation.

Figure 4: Links between climate change and risk



In order to assess the risks of climate change, users of this Guide should understand the causal links in this chain as they affect their organisation.

2.3.2 Impacts of climate change

Table 2 illustrates the link between changes to specific climate variables (likely to occur in many parts of Australia) and resulting bio-physical and social impacts. Some impacts are linked to changes to more than one climate variable or derive from other impacts. For example, droughts are linked not only to a decrease in rainfall but also to warmer temperatures, which, for example, exacerbated the severity of the 2002 Australian drought (Risbey *et al.*, 2003; Nicholls, 2004).

Table 2: Impacts associated with changes to climate variables

Change to climate variable	Examples of impacts
Higher mean temperatures	→ Increased evaporation and decreased water balance. → Increased severity of droughts (see below). → Reduced alpine winter snow cover. → Reduced range of alpine ecosystems and species. → Increased stress to coral reefs.
Higher maximum temperatures, more hot days and more heat waves	→ Increased incidence of death and serious illness, particularly in older age groups. → Increased heat stress in livestock and wildlife. → Increased risk of damage to some crops. → Increased forest fire danger (frequency and intensity). → Increased electric cooling demand and reduced energy supply reliability.
Higher minimum temperatures, fewer cold days and frost days	→ Decreased cold-related human morbidity and mortality. → Decreased risk of damage to some crops and increased risk to others. → Extended range and activity of some pest and disease vectors. → Reduced heating energy demand.
Decrease in precipitation	→ Decreased average runoff, streamflow. → Decreased water quality. → Decreased water resources. → Decrease in hydro-power potential. → Impacts on rivers and wetland ecosystems.
Increased severity of drought	→ Decreased crop yields and rangeland productivity. → Increased damage to foundations caused by ground shrinkage. → Increased forest fire danger.
Decreased relative humidity	→ Increased forest fire danger. → Increased comfort of living conditions at high temperatures.
More intense rain	→ Increased flood, landslide and mudslide damage. → Increased flood runoff. → Increased soil erosion. → Increased pressure on disaster relief systems.
Increased intensity of cyclones and storms	→ Increased risk to human lives and health. → Increased storm surge leading to coastal flooding, coastal erosion and damage to coastal infrastructure. → Increased damage to coastal ecosystems.
Increased mean sea level	→ Salt water intrusion into ground water and coastal wetlands. → Increased coastal flooding (particularly when combined with storm surge).

A 2.3

2.3.3 Risks to an organisation arising from climate change

Users of this Guide are ultimately seeking to identify those activities and assets that are at risk from a changing climate. In order to do so they must:

1. consider (based on their professional knowledge) which activities and assets of the organisation are sensitive to climate change; and
2. form a judgement as to whether climate change is a significant source of risk to the assets and activities relative to other sources of risk. This judgement will be reached with reference to the objectives and success criteria of the organisation (discussed in detail in Part B).

Risk is generally defined as a combination of the **likelihood** of an occurrence and the **consequence** of that occurrence.

In practice, neither likelihoods nor consequences are known with certainty. In the context of climate change risk assessment, uncertainty arises because, although we can be confident the climate is changing, we do not know precisely the magnitude of the changes or their associated impacts and in some regions it is not clear whether rainfall will increase or decrease. As well, uncertainty may arise because decision makers do not know the exact point (or threshold) at which a climate change impact has a particular level of consequence for their organisation.

For the majority of users of this Guide, these sources of uncertainty will not be so great as to prevent them understanding, at least qualitatively, the likelihood and consequences (and therefore risks) to their organisation that are associated with climate change.

Risk assessment may involve quantitative or qualitative techniques and information to describe the nature of risks. Qualitative techniques are particularly useful in circumstances, such as with climate change, where there is uncertainty about likelihoods or consequences. Notwithstanding sources of uncertainty, the initial assessment process discussed in Part B of this Guide will provide a comprehensive and rigorous means of identifying and prioritising risks of climate change. The process requires only standard climate scenarios, a general understanding of the impacts of climate change, comprehensive understanding of the business or organisation and sound professional judgement.

Some users of the Guide, having undertaken the initial risk assessment process, will decide that there are a small number of risks to their organisation that warrant further analysis in order to reduce uncertainties. General issues surrounding this more detailed analysis are discussed further in Chapter 7.

3. Climate change
risk management: framework and overview

A 3.1

3.1 The risk management framework

The recommended framework for risk management is provided by the Australian and New Zealand Standard AS/NZS 4360 Risk Management (Figure 5).

Figure 5: Steps in the risk management process

Following is a summary of each step in this process.

Establish the context by:

- defining the business or organisation to be assessed and the scope of the assessment;
- clarifying explicitly the objectives of the organisation;
- identifying the stakeholders and their objectives and concerns;
- establishing success criteria against which risks to the organisation's objectives can be evaluated;
- developing key elements of the organisation (such as its major areas of responsibility) as a means of structuring the process; and
- determining relevant climate change scenarios for the assessment.

Identify the risks by:

- describing and listing how climate changes impact on each of the key elements of the organisation.

Analyse the risks by:

- reviewing the controls, management regimes and responses already in place to deal with each specific risk;
- assessing the consequences of each risk against the organisation's objectives and success criteria, taking into account the extent and effectiveness of existing controls;
- forming a judgement about the likelihood of each identified risk leading to the consequences identified; and
- determining the level of risk to the organisation, for each of the climate change scenarios used in the analysis.

A 3.2

Evaluate the risks by:

- re-affirming the judgements and estimates;
- ranking the risks in terms of their severity;
- screening out minor risks that can be set aside and which would otherwise distract the attention of management; and
- identifying those risks for which more detailed analysis is recommended.

Treat the risks by:

- identifying relevant options to manage or adapt to the risks and their consequences; and
- selecting the best options, incorporating these into forward plans and implementing them.

3.2 Communication and consultation

Communication and consultation are key components of any risk management process and are required at each step. Success relies on achieving a high level of creative input and involving all parties with a role to play in identifying, assessing and managing climate change risks. In both the planning and execution of the risk management process it is important to ensure that all those who need to be involved are kept informed of developments in the understanding of risks and the measures taken to deal with them.

At the very beginning, it will be necessary to engage personnel in the process and help them understand the need for climate change risk management to become part of routine management activity. The communication and consultation process will contribute towards the long term development of risk management and help to establish a foundation for its continuing maintenance.

With both the effectiveness of the initial implementation and the long term quality of the process in mind, it is important to pay close attention to the team chosen to participate in the process. Reasons to include someone in the team may be that he/she:

- is a source of relevant information about the organisation's susceptibility to climate change, providing climate change expertise or an understanding of how the organisation's activities will be affected by climate change;
- is the organisational owner of important functions or assets;
- has the authority to act on or sanction action on treatment requirements; and
- is required to ensure that the process itself proceeds smoothly with personnel and other resources being made available as required to participate in the process and manage the administration of the exercise.

3.3 Monitoring and review

The outputs of all steps of the risk management process must be kept under review so that, as circumstances change and new information comes to hand, plans can be maintained and kept up to date.

Several aspects of the monitoring and review activity are important, including:

- keeping the analysis and evaluation up to date, including updating climate change scenarios or incorporating new information about climate change impacts;
- reviewing progress on actions flowing from the process, including implementing treatment actions to reduce risks or undertaking further and more detailed analyses; and

→ ensuring that the process itself is implemented in a timely and cost-effective fashion with documents produced, meetings held, plans reviewed and so on. The focus of this Guide is firmly on the framework and process for an initial strategic assessment.

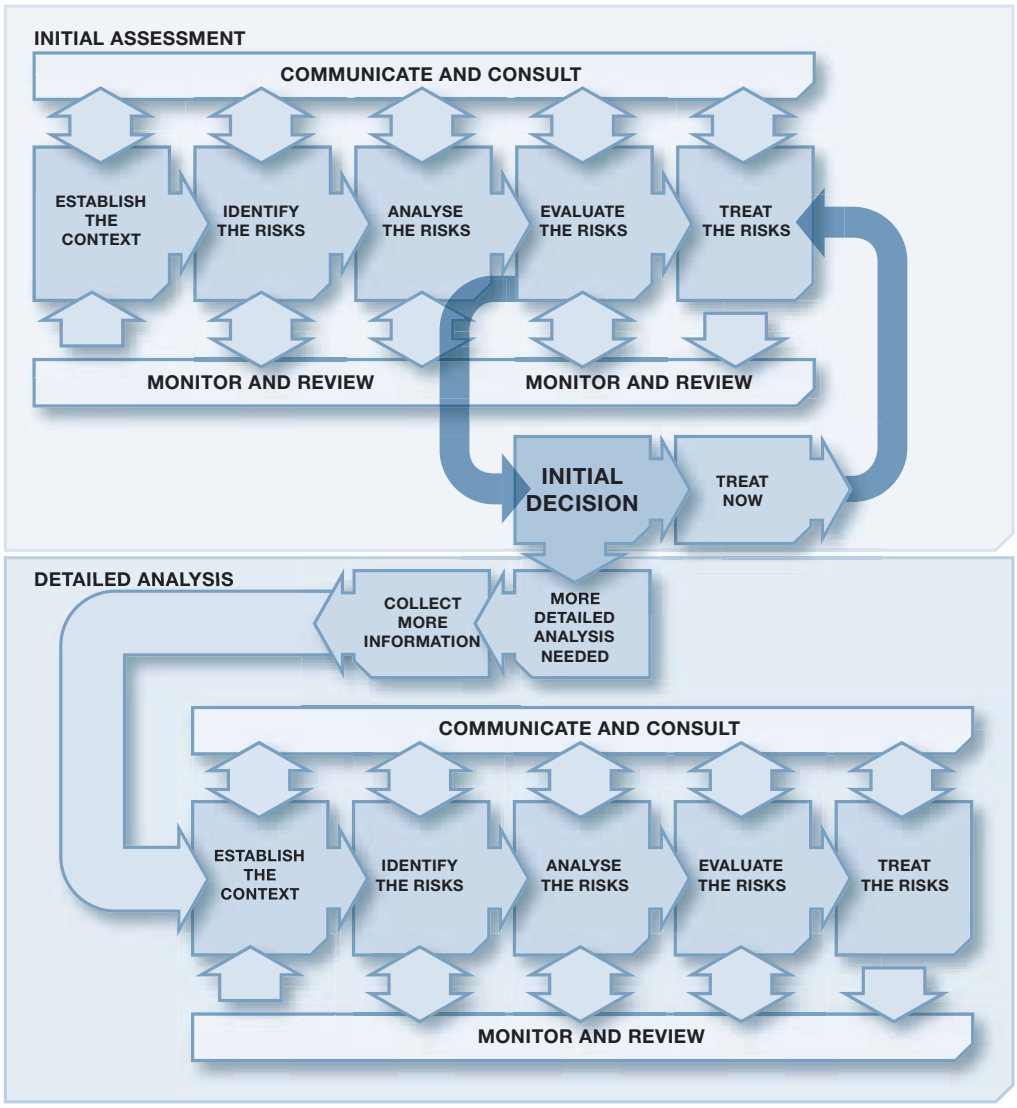
3.4 Initial assessment and detailed analysis

To allow effort to be directed towards the highest priority issues, a two-stage approach to risk assessment is recommended to users of this Guide.

1. An initial assessment identifies and sifts risks quickly, followed by treatment planning and implementation for those risks that clearly require it.
2. Detailed analysis is used where additional information is needed to determine whether treatment is required or what form of treatment to adopt.

Essentially, the same process as outlined in 3.1 above should be followed in both the initial assessment and detailed analysis stages of the process (Figure 6).

Figure 6: Initial assessment and detailed analysis



A 3.5

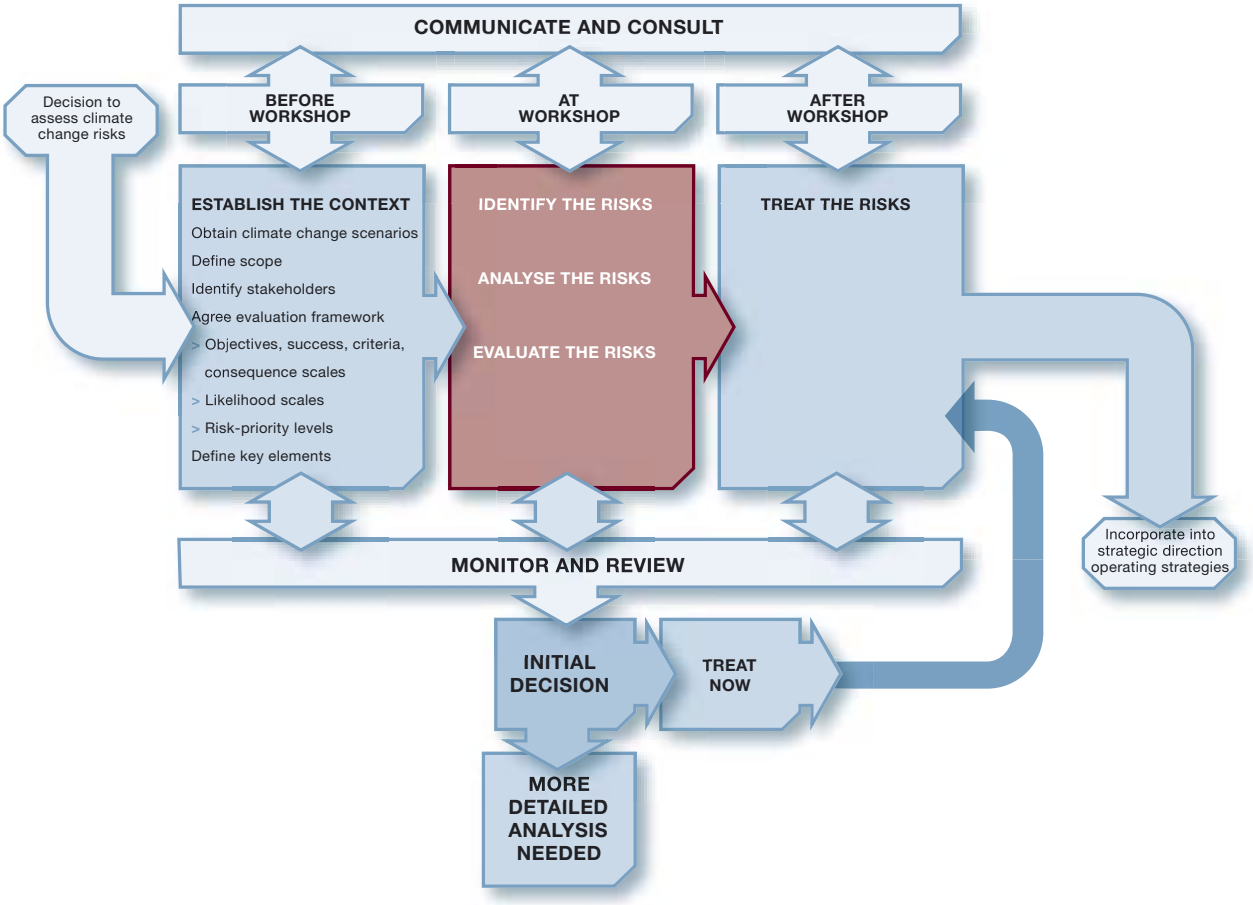
3.5 Overview of initial assessment

The stage at which most users of this Guide will be able to make the greatest gain with the least effort is in the initial assessment. This is where, with relatively simple summary climate change information and a straightforward risk management approach, significant insights may be generated leading to early and effective action.

An initial assessment is a cost effective, yet rigorous method of identifying and appraising risks – whether new or pre-existing. The use of an initial assessment stage is intended to:

- capitalise on any immediate insights arising from a simple analysis where, once a risk is documented, it is clear that it needs to be addressed through adaptation or other treatment measures;

Figure 7: The initial assessment is centred on a workshop process



- permit issues not requiring any further consideration to be set aside as early as possible; and
- allow for more detailed technical analysis of risks to determine if they require attention or to determine the most effective treatment.

Experience, both in preparing this Guide and in other risk assessment work, shows that with careful preparation, a workshop is generally the most efficient method for undertaking the initial assessment. Figure 7 (see opposite) recasts the standard risk management process diagram, giving primacy to a workshop as the method for identifying, analysing and evaluating climate change risks in the initial assessment.

The initial assessment process effectively falls into three overall stages:

- Before holding a workshop, it is essential to **establish the context** of the initial assessment process including by: determining climate change scenarios that will be used in the assessment; defining the scope of the assessment; considering stakeholders; and establishing the evaluation framework.
- The risk workshop is a focused activity designed to **identify, analyse and evaluate risks** so that the highest priority issues can be addressed with an appropriate level of effort and urgency.
- After the workshop, the most severe risks can be tackled with **treatments** to reduce their likelihood or deal with the consequences of the risks if they do arise.

Part B sets out, step by step, these stages of the initial assessment process.

PART B

Conducting An Initial Assessment

-The Workshop Process

4. Before the workshop
—establish the context

B 4.1

4.1 Overview

The context for risk management sets up a framework for identifying and analysing risks. It places the assessment on a clear foundation so that everyone works from a common understanding of the scope of the exercise, how risks are to be rated and how the analysis is to be approached.

Establishing the context consists of five parts:

- **Climate change scenarios** – defining how the climate will be assumed to change in the future.
- **Scope** – defining the scope of the assessment including activities to be covered, geographic boundaries and the time horizon.
- **Stakeholders** – determining whose views need to be taken into account, who can contribute to the analysis and who needs to know its outcomes.
- **Evaluation framework** – defining how risks will be evaluated by clarifying the objectives and success criteria for the organisation and establishing scales for measuring consequences, likelihoods and risk priorities.
- **Key elements** – creating a framework that will assist in identifying risks by breaking down the organisation's concerns into a number of areas of focus and relating them to the climate scenarios.

The participants in a climate change risk management exercise must have a common view of all these matters for the exercise to operate efficiently, be repeatable from one review to the next and for the outputs to be communicated clearly to others.

4.2 Climate change scenarios

To manage the risks of climate change it is necessary to define how climate is projected (or assumed) to change in the future. This is achieved by using climate change scenarios.

Climate change scenarios provide a plausible summary of the changes to climate variables that could apply in your geographical region and timescale of interest[6]. Scenarios can provide a consistent and efficient basis for assessing climate-related risks across different organisations without affecting the integrity of the analysis.

A set of standard climate change scenarios is available in an accompanying volume to this Guide. These scenarios have been developed by CSIRO to reflect broad regional differences in climate and alternative paths of projected climate changes. Scenarios will be updated from time to time as new climate change information becomes available; the latest version of the scenarios can be obtained from the Australian Greenhouse Office website. However, users of the Guide should note that small changes in climate projections are unlikely to make a significant difference at the initial assessment stage of the risk assessment process.

Table 3 (see page 28) contains information that may be used to construct a climate change scenario such as those used in developing and testing this Guide.

6 Refer to the Glossary for a definition of 'climate change scenario'.

The scenarios generally provide information on the direction of change in climate variables using a time horizon of approximately 25 years. Where feasible, estimates of the magnitude of change to those variables are also provided. In practice, to make a climate change scenario meaningful to your organisation it is useful to accompany the bare 'factual' information of the scenario with a 'word picture' outlining the conditions that would prevail in each scenario.

While the majority of users of this Guide will find the standard scenarios entirely suitable for the identification and assessment of climate-related risks in the initial assessment stage of the process, there is nothing that precludes you from developing tailored scenarios or extending the standard scenarios to include additional climate variables[7].

A general rule is that only a limited number of scenarios should be used. One or two scenarios covering the major plausible climate changes will generally be sufficient. This rule was confirmed during the case studies that tested the application of the Guide. The rule applies regardless of whether standard scenarios or tailored scenarios are used.

7 If users of this Guide choose not to use the standard scenarios, it is important to note that the information on the climate features listed in a scenario should, as a minimum, include information on the direction of change and information on the timing and magnitude of change and correlations between changes in two or more parameters. All of the information provided in a scenario should be:

- plausible (i.e. it should be within the range of change indicated by best available scientific information);
- internally consistent (i.e. a change indicated in a scenario to one climate feature should not be contradicted by a change indicated to another climate feature, also based on the best available scientific information);
- unidirectional (i.e. information presented on the climate feature should indicate that it will either increase or decrease under the scenario, but not both).

B 4.2

Change in climate for Victoria by 2030, relative to 1990[a]

Victoria is likely to become **warmer**, with **more hot days** and fewer cold nights. For example, the number of days above 35°C could average 10-16 in Melbourne (now 9) and 36-50 in Mildura (now 33), while the number of days below 0°C in Mildura could average 1-4 in (now 6)[1].

Increased peak summer energy demand for cooling is likely, with reduced energy demand in winter for heating[2].

Warming and population growth may increase annual heat-related deaths in those aged over 65, e.g. from 289 deaths at present in Melbourne to 582-604 by 2020 and 980-1318 by 2050[3]. Higher temperatures may also contribute to the spread of vector-borne, water-borne and food-borne diseases.

Water resources are likely to be **further stressed** due to projected growth in demand and climate-driven changes in supply for irrigation, cities, industry and environmental flows. A **decline in annual rainfall** with higher evaporative demand would lead to a tendency for **less run-off into rivers**, i.e. a decline of 0-45% in 29 Victorian catchments[4]. For Melbourne, average streamflow is likely to drop 3-11% by 2020 and 7-35% by 2050[5].

Droughts are likely to become **more frequent** and more severe, with **greater fire risk**, e.g. by 2020, the number of days with very high or extreme fire danger could average 10-11 in Melbourne (now 9), 16-18 in Laverton (now 15) and 84-91 in Mildura (now 80)[6].

A 10-40% **reduction in snow cover** is likely by 2020[7], with impacts on ski resorts and alpine ecosystems.

Research experiments have shown grain yield increases under elevated atmospheric carbon dioxide concentrations. However, it is not known whether this will translate to field conditions in Australia due to water and nutrient limitations and elevated temperatures.

Low to moderate warming may also **help plant growth** especially **frost sensitive crops** such as wheat, but more hot days and a decline in rainfall or irrigation could reduce yields. Warmer winters can **reduce the yield of stone fruits** that require winter chilling and **livestock** would be adversely affected by greater **heat stress**[8].

In forestry, the CO_2 benefits may be offset by decreased rainfall, increased bushfires and changes in pests[9].

In cities, changes in average climate and sea-level could affect building design, standards and performance, energy and water demand, and coastal planning[10].

Increases in extreme weather events are likely to lead to **increased flash flooding**, strains on sewerage and drainage systems, greater insurance losses, possible black-outs, and **challenges for emergency services**.

1 Suppiah *et al.* 2006;
2 Howden and Crimp 2001;
3 McMichael *et al.* 2003;
4 Jones and Durack 2005;
5 Howe *et al.* 2005;
6 Hennessy *et al.* 2006;
7 Hennessy *et al.* 2003;.
8 Howden *et al.* 2003;.
9 Howden *et al.* 1999;
10 PIA 2004.
a These scenarios should not be used in detailed impact assessments (consult CSIRO for model specific scenarios);

Table 3: Change in climate for Victoria by 2030

Feature		Low Global Warming Scenario		High Global Warming Scenario	
		Estimate of Change	Uncertainty	Estimate of Change	Uncertainty
Annual average temperature		+0.5°C	±0.2°C	+1.1°C	±0.4°C
Average sea level rise		+3 cm		+17 cm	
Annual average rainfall		-1.5%	±5%	-3.5%	±11%
Seasonal average rainfall	Summer	0%	±6.5%	0%	±15%
	Autumn	-1.5%	±5%	-3.5%	±11%
	Winter	-1.5%	±5%	-3.5%	±11%
	Spring	-5%	±5%	-11%	±11%
Annual average potential evaporation		+2.2%	±1.1%	+5.0%	±2.5%
Annual average number of hot days (>35°C)		+1		+10 days (near coast) +20 days (inland)	
Annual average number cold nights (<0°C)		-1 day		-10 days (inland) -20 days (highlands)	
Annual average number of very high & extreme forest fire danger days[b]		+1 day		+11 days	
Extreme daily wind speed (95th percentile)		0.0	±1.6%	0.0%	±3.7%
Extreme daily rainfall intensity (1 in 20 year event)[c]		+5%		+70%	
Carbon dioxide concentration		+73ppm		+102ppm	

b % changes for forest fire danger are for 2020 (2030 changes unavailable);
c Results for 2050 (changes for 2030 not available).

Recommendations

Using climate change scenarios

1. Apply climate change scenarios as the basis for assessing risks in the initial assessment stage of the risk assessment process. Standard scenarios accompany this Guide, and will be updated periodically as new information about climate projections becomes available.
2. When applying climate change scenarios to the risk assessment ensure that workshop participants are provided with both quantitative and descriptive information on the scenarios.
3. Limit the number of scenarios used to one or two.
4. More specific and detailed climate change information than is provided in the standard climate change scenarios may need to be used for detailed analysis.

B 4.3

4.3 Scope

It is important to be clear what the initial assessment is to encompass and what it is to exclude. The scope description should cover:

- the operational activities to be included, which may be everything an organisation does or a specific subset of its activities;
- the geographical area covered by these activities;
- the organisational boundaries of the assessment; and
- the time horizon to be covered, which has a strong bearing on the definition of climate change scenarios.

Table 4 provides some examples.

An organisation with geographically or operationally diverse activities may choose to break them into sections for the assessment. Some care is required when doing this to ensure that sections and activities that only make sense across the entire organisation are not overlooked. Ways to deal with the scope of the analysis that are likely to meet most requirements include:

- one exercise that covers the entire scope of the organisation or all of that part of the organisation under consideration; or
- a number of separate exercises that cover distinct geographical or operational parts of the entire scope, possibly with a further high level exercise spanning the entire scope to deal with strategic and organisation wide issues, carefully defined to ensure that, taken together, they leave nothing out.

Table 4: Examples – scope definitions

Scope definition for a public utility
→ The process will consider all matters associated with maintaining current operations and meeting future requirements within existing service level agreements and regulations, including the management, forecasting and planning functions required to direct efforts to meet future requirements and the operation of regulatory price setting mechanisms for the next 25 years.
Scope definition for a Government agency with policy responsibility
→ The process will consider the activities of all organisations falling within the Department's responsibility, and the Department's capacity to deliver the outputs expected by Government over the next 25 years
Scope definition for the State operations of an Australian manufacturing business
→ The process will consider all current State operations as well as any developments that have been approved for the next 25 years, including dependencies on interstate raw material suppliers and the worldwide market for our products.

Recommendations

When defining the scope

5. Try to address the entire scope of the organisation's operations in one assessment exercise if you can.
6. If it is necessary to split the scope into parts, look carefully for potential gaps between the parts and consider whether you need a separate, high level assessment to deal with issues that are not confined to one area.
7. Make sure the geographical area, organisational boundaries, operational boundaries and timeframe are specified explicitly.

4.4 Stakeholders

Stakeholders are any individuals, groups or organisations whom it is useful to take into account to achieve a successful outcome for your organisation. These will usually include internal groups such as the executive management, staff and workforce, as well as obvious external groups such as local communities, suppliers, associates, clients or customers, competitors, and legal or regulatory authorities.

Many people may have or feel that they have a stake in your organisation. Some will be able to exercise direct influence while others may make their presence felt through indirect pressure in the public arena, perhaps via the media.

Stakeholders may include:

- customers or clients;
- individuals or groups living or operating in your region or neighbouring regions who may be affected by your activities;
- visitors and others who make use of natural and other resources that you rely upon or are required to maintain and protect;
- your organisation's personnel;
- suppliers and service providers;
- associates and partners;
- regulatory agencies and authorities; and
- political and special interest groups who may share a common interest in your activities for reasons of policy or in pursuit of independent agendas.

Stakeholder analysis is typically concerned with identifying the main stakeholder groups and what they wish to happen.

Table 5: Example – stakeholder summary for a local government authority

Stakeholder	Summary of objectives and concerns
Residents within the authority's region	Maintenance of employment opportunities, protection of the environment, local authority service levels and containment of rates and other charges.
Businesses based in or operating in the region	Quality of infrastructure, availability of staff and customers, local authority service levels and containment of rates and other charges.
Visitors to the region	Availability of services, quality of infrastructure, accessibility, protection of the environment.
Local authority workforce	Maintenance of employment and earning levels, conditions of employment.
State and Federal Government agencies	Compliance with policies that overlap jurisdictions.

Table 6: Example – stakeholder summary for a transport company

Stakeholder	Summary of objectives and concerns
Customers	Prices, service levels, safety, comfort and reliability
Shareholders	Earnings, long term viability of the business
Workforce	Rates of pay, conditions, security of employment
Suppliers	Prices, levels of activity, stability of demand
Regulators	Compliance with standards and other regulations

Recommendations

When defining the stakeholders

8. Start with broad groups of stakeholders rather than small groups or individuals.
9. Break groups down if they contain two or more distinctly separate sets of motivations and concerns.
10. Group together stakeholders with essentially the same motivations and concerns.
11. Think widely about anyone who is not directly involved but could have an affect on the success of your organisation.
12. List the stakeholders with a short summary of their motivations and concerns.

4.5 Evaluation framework

There are three components of the framework used to evaluate risks in the initial assessment:

- scales to describe the level of consequence of a risk if it should happen;
- a scale to describe the likelihood of suffering that level of consequence; and
- a means of assigning a priority rating, given this consequence and likelihood.

If your organisation has an existing risk management framework, use this or stay as close to it as possible, so that the output of the climate analysis is comparable with other risk assessments you carry out.

4.5.1 Objectives, success criteria and consequence scales

An organisation's objectives are linked into the risk management process via criteria for measuring success. Success criteria are essentially a summary of the organisation's long term objectives. By combining success criteria with a consequence scale it is possible to describe the level of consequence to an organisation of a risk associated with climate change, should it happen.

Table 7 (over page) provides examples of success criteria for different types of organisations. Experience shows that an organisation's long term success can usually be summarised in a small number of criteria, usually four to six. They will generally cover:

- financial or economic matters;
- outputs, service or product delivery;
- regulatory or ethical compliance; and
- image, reputation and public relations.

Most organisations will be able to construct a set of success criteria around these four themes. To check if your set of success criteria is adequate, consider two questions:

1. If we are successful against all of these criteria, is there any way we could still fail to achieve overall success for our organisation? If so, something may be missing from the set.
2. Do any of these criteria only matter because they affect one of the others? For example, the level of income generated is usually only a component of budget compliance or profit generation rather than being a key issue in its own right; if so, it may be possible to combine some criteria.

B 4.5

Table 7: Examples – success criteria

Success criteria for a local authority:
→ Maintain public safety
→ Protect and enhance the local economy
→ Protect existing community structures and the lifestyle enjoyed by the people of the region
→ Sustain and enhance the physical and natural environment
→ Ensure sound public administration and governance
Success criteria for a public utility:
→ Maintain service quality
→ Ensure reliable service delivery
→ Manage interaction with other providers to achieve cost-effective operation
→ Ensure that community and regulatory standards of administration are met
→ Maintain and strengthen community confidence in the organisation
Success criteria for a business:
→ Build shareholder value
→ Achieve planned growth
→ Protect the supply chain
→ Maintain required human resources
→ Ensure regulatory and legislative compliance

Once the success criteria have been established, it is necessary to describe how badly a risk would affect any one of the criteria. This is usually achieved by defining a five point scale that describes levels of consequences for each criterion ranging from:

→ catastrophic, the level that would constitute a complete failure;

to

→ insignificant, a level that would attract no attention or resources.

Scales like those in Table 8, Table 9 and Table 10 are proven mechanisms for describing the consequences of risks. Note that they contain no firm numbers but use simple descriptions that are understood by the participants in the process. There may be occasions where numbers are appropriate, such as in describing levels of financial loss, but even here descriptions of how the organisation would react may be adequate: for example, Catastrophic may equate to closure of operations or replacement of the senior management team, Major to having to carry a financial burden over into future years, Moderate to having to curtail planned expenditure in the short to medium term and so on.

Table 8: Example – consequence scales for a local authority

Rating	SUCCESS CRITERIA				
	Public safety	Local economy & growth	Community & lifestyle	Environment & sustainability	Public administration
Catastrophic	Large numbers of serious injuries or loss of lives	Regional decline leading to widespread business failure, loss of employment and hardship	The region would be seen as very unattractive, moribund and unable to support its community	Major widespread loss of environmental amenity and progressive irrecoverable environmental damage	Public administration would fall into decay and cease to be effective
Major	Isolated instances of serious injuries or loss of lives	Regional stagnation such that businesses are unable to thrive and employment does not keep pace with population growth	Severe and widespread decline in services and quality of life within the community	Severe loss of environmental amenity and a danger of continuing environmental damage	Public administration would struggle to remain effective and would be seen to be in danger of failing completely
Moderate	Small numbers of injuries	Significant general reduction in economic performance relative to current forecasts	General appreciable decline in services	Isolated but significant instances of environmental damage that might be reversed with intensive efforts	Public administration would be under severe pressure on several fronts
Minor	Serious near misses or minor injuries	Individually significant but isolated areas of reduction in economic performance relative to current forecasts	Isolated but noticeable examples of decline in services	Minor instances of environmental damage that could be reversed	Isolated instances of public administration being under severe pressure
Insignificant	Appearance of a threat but no actual harm	Minor shortfall relative to current forecasts	There would be minor areas in which the region was unable to maintain its current services	No environmental damage	There would be minor instances of public administration being under more than usual stress but it could be managed

Table 9: Example - consequence scales for a public utility

Rating	SUCCESS CRITERIA				
	Service quality	Service delivery	Interaction with other providers	Administration	Community confidence
Catastrophic	Services would fall well below acceptable standards and this would be clear to all	Services would be incorrectly targeted, delivered late or not at all in a large number of cases	The organisation would be in conflict with other providers and this would directly affect services	Administration of the organisation would be seen to have failed and in need of external intervention	There would be widespread concern about our capacity to serve the community
Major	The general public would regard the organisation's services as unsatisfactory	There would be isolated instances of services being incorrectly targeted, delivered late or not delivered at all	The effort of managing relations with other providers would drain resources and badly degrade service delivery	Administration of the organisation would be seen to be deficient and in need of external review	There would be serious expressions of concern about our capacity to serve the community
Moderate	Services would be regarded as barely satisfactory by the general public and the organisation's personnel	There would be isolated but important instances of services being poorly targeted or delivered late	Unnecessary overheads arising from relations with other providers would be a drain on resources but the public would be unaware of this	Administrative failings might not be widely seen but they would cause concern if they came to light	There would be isolated expressions of concern about our capacity to serve the community
Minor	Services would be regarded as satisfactory by the general public but personnel would be aware of deficiencies	There would be isolated instances of service delivery failing to meet acceptable standards to a limited extent	Unnecessary overheads in dealing with other providers would absorb some effort but the public would be unaware of this and would not be affected	There would be some administrative shortcomings demanding attention but they would not be regarded as serious failures	There would be some concern about our capacity to serve the community but it would not be considered serious
Insignificant	Minor deficiencies in principle that would pass without comment	Minor technical shortcomings in service delivery would attract no attention	Minor unnecessary overheads arising from relations with other providers but no material effect	There would be minor areas of concern but they would not demand special attention	There would be minor concerns but they would attract no attention

Table 10: Example - consequence scales for a commercial business

Rating	SUCCESS CRITERIA				
	Shareholder value	Growth	Supply chain	Human resources	Compliance
Catastrophic	The business would have to be wound up	The business would contract markedly placing its long term viability in question	Loss of a key source of supply or distribution channel, threatening the business	Severe shortages of personnel or workplace disruption would make it difficult to sustain operations	Obvious and proven breaches of legal and regulatory requirements with the prospect of corporate or individual penalties
Major	Shareholder value would decline markedly and necessitate significant remedial action	The business would contract and require significant remedial action	Disruption of a key source of supply or distribution channel, having a serious effect on the business	Operations would be severely affected by shortages of personnel or poor industrial relations	Significant amounts of management and advisers' effort would be required to answer charges of compliance failures
Moderate	Shareholder value would stagnate	There would be no growth	Components of the supply chain would require more than normal levels of management attention to protect the business	Parts of the workforce and staff team would require more than normal levels of management attention to protect the business	Formal action would be required to answer perceived breaches or charges of compliance failure
Minor	Shareholder value would increase but fail to meet expectations	Growth would be achieved but it would fail to meet expectations	Isolated difficulties would arise in the supply chain but would be resolved	Isolated personnel shortages or poor workplace relations would be resolved	Minor perceived or actual breaches of compliance would be resolved
Insignificant	There would be a minor shortfall in meeting expectations for shareholder value but they would pass unnoticed	There would be a minor shortfall in growth but this would not attract much attention	Minor issues with the supply chain would pass without any special attention	Minor workforce issues would pass without any special attention	Concerns about compliance would be resolved without special action

Where two or more climate scenarios are employed, consequences must be interpreted as if each scenario has arisen. The consequences of one risk may differ depending on which scenario is being considered.

Recommendations

When developing consequence scales

13. If you have an existing risk management framework, stay as close to it as you can while satisfying the following recommendations.
14. Aim for four to six criteria.
15. Test the criteria before developing the scales to make sure they are a complete set and there are not too many of them.
16. Define the extremes of the consequences, Catastrophic and Insignificant, before specifying the Major, Moderate and Minor levels.

4.5.2 Likelihood scales

It is necessary to describe the likelihood of a risk arising if a particular climate change scenario comes about. This is a conditional likelihood, to be assessed as if the climate change scenario was going to happen. The likelihood of the scenario actually arising and how to take this into account in the analysis is discussed later.

Likelihood scales for risk analysis are less dependent on the details of the application than are consequence scales. A five point scale has proved effective for likelihood ratings just as it has for consequences. The extreme ends of the scale in this case are risks that are almost certain to happen and those that are almost, but not quite, certain not to happen.

There is one potential source of confusion to be addressed concerning how often the same risk might occur. Some risks are most realistically thought of as events that could happen once, such as the loss of an endangered plant or animal species at the centre of a tourism business or a permanent move of population from increasingly arid land to regional centres and major cities. Other risks make more sense when considered as recurring events such as structural damage to domestic buildings from severe storms or episodes of heat related deaths.

A scale that can be used to rate the likelihood of both single and recurrent events is shown in Table 11. This has been used widely, including in the case studies undertaken in preparing this Guide, and is likely to be relevant to most applications.

Where two or more climate scenarios are employed, the likelihood of the risk arising must be interpreted as if the climate change scenario has arisen. The likelihood of a specific risk arising may differ depending on which scenario is being considered.

Table 11: Likelihood (given that the climate scenario arises)

Rating	Recurrent risks	Single events
Almost certain	Could occur several times per year	More likely than not – Probability greater than 50%.
Likely	May arise about once per year	As likely as not – 50/50 chance.
Possible	May arise once in ten years	Less likely than not but still appreciable – Probability less than 50% but still quite high.
Unlikely	May arise once in ten years to 25 years	Unlikely but not negligible – Probability low but noticeably greater than zero.
Rare	Unlikely during the next 25 years	Negligible – Probability very small, close to zero.

The timescale used for the recurrent events should be comparable with the time horizon of the analysis. Subject to ensuring this alignment between timescales, the scale has proved very reliable as an effective workshop tool.

It is not very common but if the highest likelihood you face will be a lot less than one, say a maximum probability of 10% or even less, it may be more effective to:

- set the highest likelihood (level A) at a value you believe will equal or just slightly exceed the highest you might face; and
- use the levels between this and the bottom of the scale (levels B, C and D) to discriminate between risks in the narrower range applicable to your situation.

This will usually only be relevant to situations where all risks under consideration are 'rare' in common parlance, such as catastrophic structural failures, major transport disasters or widespread and severe health system failures.

Such events will usually form only part of an analysis alongside several more likely risks. However, there may be situations in which, due to the nature of the matter under consideration, all the risks that will arise would all fall into the bottom one or two levels of Table 11. If this were to happen, the likelihood scale would not be serving any useful purpose as all risks would have the same likelihood rating.

There are other considerations that arise when events all have very low probabilities. It would be advisable to seek expert advice on analysing risks in these circumstances.

Recommendations

When developing likelihood scales

17. If you have an existing risk management framework, stay as close to it as you can while satisfying the following recommendation.
18. Use the default scale shown here unless there is a pressing reason not to, such as there being an established scale in use already or the range of likelihoods you face being very low.

B 4.5

4.5.3 Risk priority levels

Use a matrix, similar to that in Table 12, to define the level of priority associated with each combination of consequence and likelihood.

Table 12: Priority (given that the scenario arises)

	Consequences				
Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Medium	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	High
Unlikely	Low	Low	Medium	Medium	Medium
Rare	Low	Low	Low	Low	Medium

The interpretation of the priority levels is usually as follows:

- **Extreme** risks demand urgent attention at the most senior level and cannot be simply accepted as a part of routine operations without executive sanction.
- **High** risks are the most severe that can be accepted as a part of routine operations without executive sanction but they will be the responsibility of the most senior operational management and reported upon at the executive level.
- **Medium** risks can be expected to form part of routine operations but they will be explicitly assigned to relevant managers for action, maintained under review and reported upon at senior management level.
- **Low** risks will be maintained under review but it is expected that existing controls will be sufficient and no further action will be required to treat them unless they become more severe.

When first setting up the framework, think about each cell in the priority matrix and consider whether the initial priority rating is appropriate given the meaning of the consequence and likelihood and the interpretation of the priority set out above. Depending on the attitude of the organisation towards risk, the boundaries between the priority regions in the matrix may be moved. There is an opportunity to adjust priorities at the end of the risk identification and analysis but the more initial priorities that are acceptable on the first pass the more efficient the overall process will be.

The most common pitfall in defining the priority matrix is to make the Extreme region too large and the Low region too small. Careful reflection on a few example risks is a good way to test this before putting the matrix to use.

Recommendations

When developing a priority matrix

19. If you have an existing risk management framework, stay as close to it as you can while satisfying the following recommendations.
20. If you need to start afresh, use the examples here as a foundation.
21. Create a few examples of risks to test the scales.
22. If in doubt, err on the side of making the Extreme and High regions of the matrix smaller rather than larger, as severe risks that are understated will usually be picked up in the review at the end whereas it is often more difficult to downgrade risks that are overstated and they can clog the process.

4.6 Key elements

To ensure that the process of risk identification is systematic and efficient, break the issues facing your organisation into discrete elements or areas. The key elements provide a framework for thinking about risks efficiently and making good use of the time and resources devoted to the subsequent activities of risk assessment, analysis and evaluation.

Key elements are a set of topics that can be considered one by one during the risk identification step of the process. Each topic is somewhat narrower than the whole scope being addressed, allowing those performing the identification to focus their thoughts and go into more depth than they would if they tried to deal with everything in one go. A well designed set of key elements will stimulate creative thought and ensure that all important issues are raised, with effort being balanced between the different topics.

The set of key elements must be complete, in that it covers all significant issues. However, as the number of key elements tends to drive the duration of the risk identification activity, it must also be contained to an appropriate scale. Finally, it must balance the need for sufficiently specific language to stimulate the identification of risks against ensuring enough generality to avoid prejudging the identification process. For example, a key element presented under the label "Climate induced fatalities" is likely to be perceived as a risk statement in itself and so limit creative thought on the subject, whereas the label "Health impacts of climate change" might be expected to stimulate a broader discussion.

There are many ways to derive a set of key elements. They can be based on any concept that makes it possible to break down your organisation's activities into separate areas. For example:

- organisational functions or activities;
- geographical areas or different land uses within the region of interest;
- technologies or assets employed (eg. IT, electronic, electrical, mechanical, human systems); or
- service or product types.

A useful set of topics may include items of different types. The main requirement is to be comprehensive, cover everything, leave scope for creative input and achieve an appropriate level of detail.

Table 13: Examples – key elements

Key elements for a transport organisation:
→ Assets (vehicles, maintenance facilities)
→ Infrastructure
→ Demand (current and forecast usage, population demographics, land use and growth)
→ Users
→ Staff
→ Funding (development and maintenance)
Key elements for a water company:
→ Water sources
→ Infrastructure & resources
→ Customers
→ Environment & community
→ Business environment
Key elements for a manufacturing business:
→ Supply chain
→ Manufacturing operations and assets
→ Markets
→ Labour and other human resources
→ Energy and resources
Key elements for a public sector service provider
→ Service delivery
→ Related services and service providers
→ Personnel
→ General public
→ Systems & equipment
→ Administration & support

4.7 Briefing note

The output of the context stage is a briefing document summarising the context and the process to be used in the workshop for the initial assessment. A typical contents list for the briefing note is provided in Table 14.

Prior to a workshop the briefing note should be distributed to workshop participants, allowing sufficient lead time for it to be read carefully. If there are objections or errors to be addressed, it is more efficient to resolve them before the workshop than in an open meeting.

This and other organisational matters relevant to planning the workshop are discussed further in section 8.1.

Table 14: Briefing note contents

Section	Contents
Introduction	Purpose of the exercise Time, date and location of the workshop(s) Identity of the facilitator and, if different, the administrator of the exercise List of workshop participants Outline of the process with reference to AS/NZS 4360 and this guide
Context	Climate scenarios to be considered Scope, stakeholders, evaluation framework and key elements
Workshop	Procedural description of workshop Agenda with intended timetable

5. At the workshop
—identify, analyse & evaluate the risks

5.1 Introduction

The set of tasks referred to here collectively as a risk assessment, consists of three central steps in the risk management process:

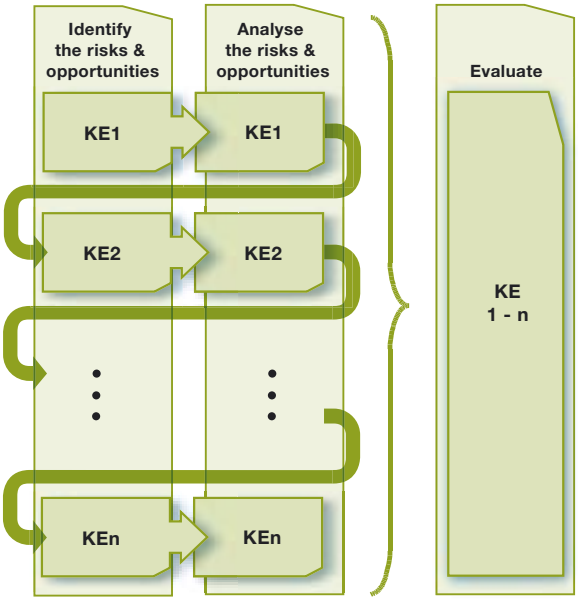
- identify the risks;
- analyse the risks; and
- evaluate the risks.

These steps are best undertaken as a single exercise in a workshop setting. The three steps must generate a list of risks associated with climate change that is as comprehensive as possible, not overlooking any major area of exposure, and do so as efficiently as possible. At the conclusion of these steps you will have a list of risks and existing controls that tend to mitigate them, with consequence and likelihood ratings in each scenario you have decided to consider and an agreed overall priority rating for each risk to your organisation.

The workshop will generally be most effective if it is led by an experienced facilitator, possibly an independent risk assessment specialist. Smooth running of the workshop may also benefit from having an additional person, either independent of the organisation or drawn from junior or administrative personnel, to assist with recording workshop outputs. Considerable attention will need to be given to ensuring that consensus outputs from the identification, analysis and evaluation steps are fully and systematically recorded during the course of the workshop. Workshops participants should be fully aware of what is being recorded. In practice, this probably means recording the information on a whiteboard, a computer spreadsheet projected on to a screen or a similar mechanism that provides visibility of proceedings to the participants.

At the workshop, the identification and analysis steps will require different modes of thought: creative open thinking to identify risks, and closed methodical thinking to analyse them. By interspersing them as indicated in Figure 8, the pace of the workshop can be maintained without the participants becoming stale and the focus that the key element structure brings to the exercise can be maintained.

Figure 8: Risk assessment steps for Key elements



KE=key element

In practice, the key elements are considered in conjunction with the climate change scenarios being examined, as shown in Figure 9.

Figure 9: Key elements and climate scenarios for risk identification

	Climate Scenario	
Key element	Scenario 1	Scenario 2
Element 1	KE 1.1	KE 1.2
Element 2	KE 2.1	KE 2.2
...	...	...

B
5.2

5.2 Risk workshop process overview

In a workshop setting, the recommended risk identification, analysis and evaluation process is to take each key element and each climate change scenario in turn and:

1. Brainstorm risks associated with the element until the main issues are felt to have been exposed.
2. Taking each risk in turn:
   - → identify any existing controls (features of the environment, natural and man made structures and mechanisms, procedures and other factors) that are already in place and tend to mitigate the risk;
   - → describe the consequences the risk would have if it was to arise, given the controls, and in each of the scenarios under consideration;
   - → describe the likelihood of suffering that level of consequence, again given the controls, in each of the scenarios under consideration;
   - → assign an initial priority in each scenario based on the likelihood and consequence of the risk; and
   - → where two or more scenarios are being considered, consider adjusting the priority in recognition that some scenarios are less likely to occur than others.
3. Return to step (1) for the next key element.

Apart from the need to consider two or more climate change scenarios, this process is a routine risk workshop exercise. Expert facilitation can be very valuable in producing a sound outcome and making cost-effective use of the effort invested in the workshop. Comprehensive advice on the operation of the process can be found in the Standards Australia Handbook HB 436, a companion to the Standard AS/NZS 4360.

5.3 Identify risks

A risk is the chance of something happening that will have an impact on the organisation's objectives. A brainstorming approach to risk identification encourages all participants to raise issues and provide opportunities for the contributions of one person to spark ideas for others.

The usual rules of brainstorming, that is allowing practically any input and suspending judgement during the brainstorming activity, should be applied. All issues raised in the workshop should be included, even if they prove later to be trivial or duplicates of other risks. The analysis step will screen out the trivial issues and duplicates can be drawn together in later rationalisation of the risk register if necessary.

There are a few recommendations for a successful risk identification exercise:

- → ensure that every risk statement includes a verb, saying "Road access may be cut" rather than just "Road access";
- → aim for a cause effect statement (X, the cause, may happen leading to Y, the effect) or equivalent;
- → apply a common sense test to check whether the statement will be understood by anyone who was not present in the workshop and clarifying it if not.

It can be difficult to disentangle risks from separate sources when long timescales and complex issues are concerned. The inclusion of a few non-climate change risks in the process will do no harm apart from absorbing a little time. If a risk is partly related to climate change, it should be included Any risks that are nothing to do with climate change that do slip into the process can easily be excised later and referred to other risk management activities in the organisation.

Recommendations

When running the risk identification activity

23. Adopt the conventional rules of brainstorming that allow almost any input and suspend judgement.

24. Do not allow the workshop to be diverted into debating whether a risk is a climate change risk or not. If in doubt let it remain in the process and consider the matter later, after the workshop.

5.4 Analyse risks

The analysis stage assigns each risk a priority assuming that each of the climate change scenarios being considered arises. It takes account of any existing factors that will operate to control the risk, which may be features of the environment, existing practices by which people can adapt as the climate changes or other trends that will happen at the same time and modify the effects of the risk (Table 15).

Table 15: Examples of risk controls

Only measures that are already in place or committed and require no further action to be implemented can be claimed as controls. Measures that might be taken to treat risks in the future cannot be assumed to be in place.
Controls on degradation of infrastructure: → Routine monitoring and repair systems → Inherent robustness in the design and construction → The existence of alternatives that can be used if the main infrastructure system fails
Controls on flooding due to storms and high tides: → The existing elevation of homes and other buildings above sea level → The design and construction of assets that may be affected by flooding → Existing barrages, levees and other flood control mechanisms
Controls on outbreaks of plant, animal or human diseases: → Early warning monitoring systems → Prophylactic treatments already in place → Naturally occurring mechanisms that compete with or counter the disease and will develop at the same time as the conditions that promote the disease
Controls on movements of population → Economic barriers to relocation → Existing distribution of health, transport and other infrastructure → Established government programs that provide incentives to remain in place → Growth of business opportunities associated with climate change that offer fresh employment in existing centres of population

B 5.5

Priorities are assigned in two stages:

- first, each risk is assigned a qualitative consequence and likelihood rating in each climate scenario being considered; and
- second, a priority is then assigned in each scenario, based on the combination of the consequence and likelihood ratings.

Consequences, likelihoods and risk priorities are assessed using the scales developed in the context step and described in Section 4.5.

If more than one climate change scenario has been used in risk identification then the priority rating of risks may need to be adjusted in recognition of the fact that some scenarios are less likely to occur than others. This can be addressed in two relatively simple ways according to the wishes of the participants.

The simplest approach is to examine the most severe risks and consider whether the relative likelihood of the alternative scenarios mean that some risks should be given more or less priority than has been assigned using Table 12 based on the initial assessment of consequences and likelihood. A risk that only rates a high priority in an unlikely scenario might be downgraded compared to one that rates a high priority in all scenarios or in the most likely scenario. This approach relies on direct examination and judgement, which is the basis of the entire process.

A slightly more mechanistic alternative is to reduce the priority rating of risks in the least likely scenarios systematically, while leaving those in the most likely scenario as they are. This is illustrated in Table 16.

Another alternative is not to adjust the priority ratings. This course may be prudent when there is little information about the likelihood of different scenarios. Better information about the likelihood of the alternative scenarios is expected to become available in the next 1-2 years.

Table 16: Adjusting priority ratings

More likely scenario		Less likely scenarios	
Initial	Adjusted	Initial	Adjusted
Extreme	Extreme	Extreme	High
High	High	High	Medium
Medium	Medium	Medium	Low
Low	Low	Low	Low

Using this approach, each risk is assigned an overall priority equal to the highest priority it received in any of the climate scenarios being considered. This ensures that any risks that may be significant, in at least one of the possible sets of future climatic conditions, are given appropriate attention in later stages of the analysis.

No matter which approach to adjusting priorities is adopted, the final priority rating assigned to a risk must be a realistic reflection of the workshop team's opinion of how important the risk is. This is considered explicitly in the next step of the workshop, after all key elements have been addressed with risk identification and risk analysis.

5.5 Evaluate risks

The objective of the evaluation step is to ensure the priority ratings are consistent with one another and match the participants' general view of the context within which they are operating.

When all key elements have been considered, assemble all the risks into a single set in priority order and review them as a whole. Manually adjust any risks found to have been over- or under-rated to show the agreed priority the participants feel is appropriate.

The outcome will be a list of risks with all the information recorded in the identification and analysis as well as the agreed priority allocated in the evaluation review.

5.6 Review the initial assessment

The initial assessment review is an extension of the risk evaluation stage. The aim of the review is to place risks into the following categories:

- risks that should be treated immediately without further analysis and for which the appropriate treatment is clear;
- risks that can be set aside without further action for the time being; and
- risks that will require more detailed analysis before determining whether to treat them or not or to select the most appropriate form of treatment.

In determining how to categorise risks it is useful to consider the following general principles:

- **Extreme** priority risks demand urgent attention at the most senior level and can not be simply accepted as a part of routine operations without executive sanction.
- **High** priority risks are the most severe that can be accepted as a part of routine operations without executive sanction but they will be the responsibility of the most senior operational management.
- **Medium** priority risks can be expected to form part of routine operations but they will be explicitly assigned to relevant managers for action and maintained under review.
- **Low** priority risks will be maintained under review but it is expected that existing controls will be sufficient.

In general, extreme and high priority risks will need to be treated immediately or subjected to more detailed analysis.

Low priority risks, on the other hand, will generally be set aside with no further action required to treat them apart from routine reviews to ensure that there has been no change that would make them more severe.

Starting with the most severe risks and working down to lower priority ratings as time and resources permit, you need to determine whether:

- the action required to address a risk is obvious, requires no further justification and can be implemented immediately;
- further analysis is required to determine the detailed nature of the risk or identify the most appropriate action to take; or
- it must simply be borne, either because it is insignificant or because there is no cost-effective treatment and this is clear without further analysis.

6. After the workshop
—treat the risks

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6.1

6.1 Risk treatment

6.1.1 Overview

Risk treatment consists of determining the most cost-effective actions to be undertaken in response to the identified risks and implementation of those actions. This will usually result in the modification of existing strategies and plans, the development of new plans, allocation of resources and responsibilities for the plans and their implementation. The formulation and implementation of actions is a matter for the routine operating practices of the organisation.

It is often the case that one treatment action will have an effect on several risks and one risk will be affected by more than one treatment. Some consideration of natural groupings among the risks and strategic combinations of treatments will be beneficial in completing this stage of the process.

6.1.2 Climate change risk treatment

Literature dealing with response by human or natural systems to the impacts of climate change generally refers to the concept of 'adaptation', adjustments in response to climate change that lead to a reduction in risks or a realisation of benefits (see for example: McCarthy et al. 2001; Willows & Connell 2003). Risk treatments developed and implemented by an organisation in response to climate change can be regarded as one type of adaptation.

Because of the long time scales, climate change risk treatments will usually involve strategic planning and the allocation of new resources. They are thus often distinguished from short term, reactive adjustments.

Climate change risk treatments can include technological and infrastructure measures, planning, research and education or a combination of actions. Table 17 provides an overview of different types of possible measures that can be adopted as risk treatments.

Table 17: Examples - Climate change risk treatments

Treatment type	Description and examples
Spread risk	**Insurance and diversification strategies:** → Use of financial products that off-lay the risk → Geographical diversification
Structural and technological	**Prevent effects through engineering solutions and changed practices:** → Increase reservoir capacity → Implement energy demand management measures → Scale up coastal protection measures → Change design of storm-water systems → Build more resilient housing → Install more efficient irrigation systems → Create wildlife corridors
Regulatory and institutional	**Prevent or mitigate effects through revised regulations and planning:** → Adopt integrated planning approaches → Amend local planning schemes to give greater weight to flood risk → Revise guidance notes for urban planners → Amend building design standards → Increase resources for coastal planning → Factor climate change into criteria for designation of species or ecosystems requiring increased protection → Improved contingency and disaster planning → Lengthen strategic planning horizons (from say 5-10 years to 20-30 years)
Avoidance	**Avoid or exploit changes in risk:** → Grow new crops → Migration of people way from high risk areas → Change location of new housing developments → Improve forecasting systems to give advance warning of extreme climate events
Research	**Research to improve understanding of relationship between climate change and risk:** → Improve knowledge of relationship between past and present variations in climate and performance of economic, social and environmental systems → Improve modelling of regionally-based climate change impacts → Improve knowledge of the probability of frequency and magnitude of changes to extreme climate events and other climate variables under climate change → Improve understanding of the relationship between changes to frequency and magnitude of extreme events and critical thresholds for individual risks
Education, behavioural	**Educate and inform stakeholders about the risks of climate change:** → Increase public awareness about the potential impacts of climate change and about climate change adaptation measures → Educate and inform management and personnel about climate change risks and adaptation measures

Source: adapted and revised from Burton 1996

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6.1

6.1.3 Principles for treating risks from climate change

There is a growing body of literature on climate change adaptation processes (see for example Willows & Connell 2005). A synopsis of generic principles of 'good climate risk treatment' drawn from that literature, which users of this Guide may find relevant and useful when developing risk treatments for their organisation is set out below:

1. **Achieve balance between climate and non-climate risks.**
   Implementing a climate change risk treatment is itself not risk free. An organisation may under-estimate the risks associated with climate change relative to other non-climate risks to the organisation, leading to insufficient actions taken to treat the climate change risks (referred to as 'under-adaptation'). Alternatively, the risks of climate change may have been over-estimated relative to other risks, resulting in too much attention and resources being devoted to treating the climate change risks (referred to as 'over-adaptation').

   One means of avoiding under- or over-adaptation is for organisations to take a balanced approach to managing climate and non-climate risks. This is best achieved by integrating climate change risk management with the broader risk management processes of the organisation (see Chapter 8). Ideally, all forms of risk management operating within an organisation will be integrated with one another and with all general management processes.

2. **Manage priority climate change risks.**
   The initial assessment detailed earlier provides organisations with a process for identifying and prioritising their climate change risks. As discussed in section 5.6, the risk treatment process of organisations should focus on their high priority risks (i.e. extreme and high risks). This is simply a statement of the general rule that it is necessary to set priorities for the allocation of management attention and resources.

3. **Use adaptive management.**
   Adaptive management is an important strategy for dealing with climate change uncertainties. It is the process of putting in place small, flexible, incremental changes based on regular monitoring and revision of plans using information available at the time, rather than relying on one-off, large-scale treatments. Adaptive management leaves scope for decisions about treatments to be reviewed in the future as improved information becomes available about the nature of climate change risks. An advantage of this approach is that it reduces the potential for over-adaptation (discussed above), while providing scope for an organisation to strengthen its risk treatment should it become apparent in the future that the organisation is under-adapting to one or more climate change risks.

4. **Look for win-win or no-regrets treatment options.**
   Organisations should look for and give priority to implementing 'win-win' or 'no-regrets' treatment options.

   Win–win treatments refer to measures that address the targeted climate change risk while also having other environmental, social or economic benefits.

   No-regrets treatments are measures that should be undertaken anyway, regardless of whether climate change is an issue.

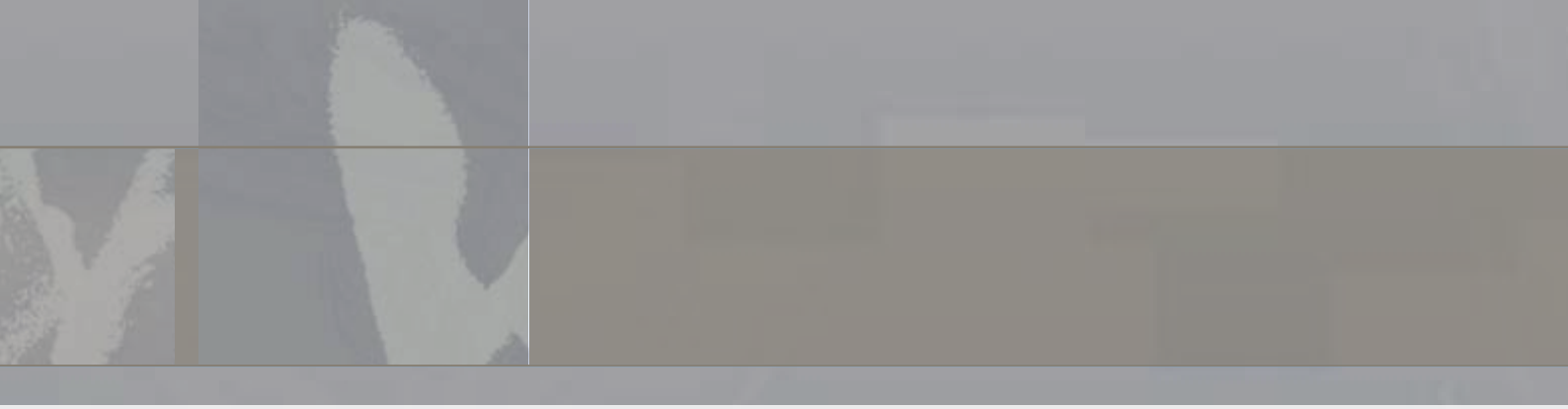
   Examples of no-regrets and win-win treatments are provided in Table 18.

5. **Avoid adaptation constraining decisions.**
   Organisations should avoid taking decisions that will make it more difficult for them or others to manage climate change risks in the future. These decisions are sometimes referred to as 'adaptation constraining decisions'. An example of an adaptation constraining decision is a local council permitting a residential development in a flood-prone area.

6. **Review your treatment strategy.**
   An organisation should regularly review its climate change risk treatment strategy as part of the monitoring and review step discussed in section 3.3.

Table 18: Examples of win-win and no-regrets treatments

Win-win treatments:
→ changed cropping in response to climate change leads to reduced soil erosion
→ climate change risk treatment by an electricity distribution company increases reliability of customer supply
→ strategic response to climate change by a local government helps to build community networks
No-regrets treatments:
→ treatment measures that are cost neutral—maybe involving an initial capital investment but reducing overall costs in the longer term
→ improved management practices by an organisation (e.g. strategic planning)



PART C

Other Considerations

7. If detailed analysis is needed

C 7.1

7.1 Purpose and major aspects of detailed analysis

Some climate change risks are complex matters, with impacts affecting several components of an organisation and interactions with other trends and changes during the same time frame. In many cases the initial assessment process will prove sufficient for an organisation to identify and prioritise the risks that it faces from climate change and to develop and implement treatments.

Some risks may need more detailed analysis before the need for treatment or the nature of appropriate treatment measures can be determined. Detailed analysis may be needed to:

- address uncertainty in the likelihood, projected level or rate of change to climate variables – i.e. understand the climate change itself;
- analyse the sensitivity of particular risks to changes in climate variables – i.e. understand the way your operations will be affected by climate change; or
- assess treatment options.

This chapter provides a brief overview of each of these aspects of detailed analysis. The process of implementing the detailed analysis will, in most cases, be particular to your organisation and to the different risks faced by your organisation. For this reason, it is not feasible or appropriate to offer specific guidance on the detailed analysis.

Throughout the remainder of this chapter, while dealing with detailed analytical issues, it is important to bear in mind the purpose of the exercise. It is to provide a sound basis for deciding whether to act on an identified risk or not and, if action is to be taken, to select the most appropriate form of treatment.

7.2 Addressing uncertainty associated with climate change

Uncertainties exist about the magnitude, rate and direction of changes to specific climate variables, especially at the regional and local levels. Some organisations may decide that, in order to assess a risk, more detailed analysis is required on one or more climate variables to reduce the uncertainty in projections.

7.2.1 Reducing uncertainty about the likelihood of changes

The IPCC (2001) has provided estimates of confidence in projected changes to extreme events and other climate variables (Table 19).

Table 19: Estimates of confidence in projected changes in extreme events and other climate variables

Climate variable	Confidence in projected changes[1]
Higher maximum temperatures and more hot days over nearly all land areas	Very likely
Higher minimum temperatures, fewer cold days and frost days over nearly all land areas	Very likely
Reduced diurnal[2] temperature range over most land areas	Very likely
Increase of heat index[3] over land areas	Very likely, over most areas
More intense precipitation events	Very likely, over most areas
Increase summer continental drying and associated risk of drying	Likely, over most mid-latitude continental interiors
Increase in tropical cyclone peak wind intensities	Likely, over some areas
Increase in tropical cyclone mean and peak precipitation intensities	Likely, over some areas

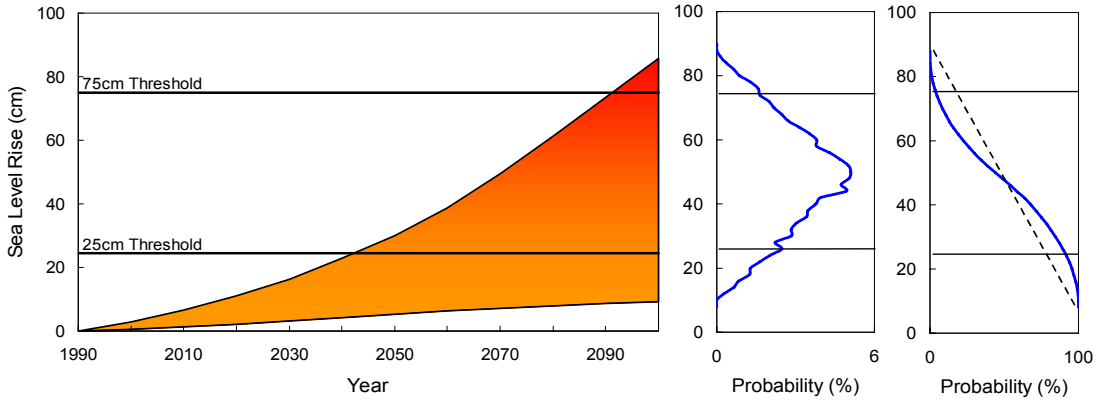
1. The IPCC uses the following definitions of confidence:: very likely - 90-99% confidence; likely - 66-90% confidence .
2. Diurnal temperature range is the range experienced within a 24-hour period.
3. Heat index is a combination of temperature and humidity that measures effect on human comfort.

Source: IPCC 2001

These estimates are fairly coarse, particularly for local application, and organisations may decide that they require more specific understanding of the changes. One way to gain this understanding is to produce probability distributions of changes to specific climate variables such as temperature, rainfall or sea level using statistical methods such as Monte Carlo analysis.

The CSIRO, for example, has undertaken an analysis of the probability of exceeding sea level thresholds (Figure 10). It has also produced probability distributions (single variable) and probability density plots (multiple variables) for temperature and rainfall changes in specific regions. Probability distributions such as these do not remove uncertainty but they do provide an assessment of the realistically likely ranges of outcomes and the likelihood of particular outcomes within each range.

Figure 10: Probability of Exceeding Sea Level Thresholds



Source: Hennessey et al. 2004

Probability distributions such as that outlined in Figure 10, rely heavily on assumptions about global and regional climate changes. Therefore organisations seeking to improve their understanding of the probability of changes to specific climate variables are likely to require assistance from climate change specialists.

7.2.2 Reducing uncertainty about regional and local changes

The climate change scenarios accompanying this Guide provide an indication of the sort of changes in climate that business and communities may have to prepare for in a number of regions in Australia. The CSIRO and other researchers in Australia have also undertaken studies which address projections of climate changes at the state and regional levels. A number of state climate change reports provide regional and even site-specific information on projected changes to the frequency of:

- very hot and very cold days and spells;
- droughts;
- extreme rainfall;
- extreme winds; and
- storm surges.

Many of these studies are available publicly.

Some organisations may decide that the level of detail provided in existing reports is insufficient for their needs. For example, they may want to know the implications of projected rainfall changes for streamflow in a specific catchment, or the impacts of sea level rise and storm surge on a specific stretch of coast. If this is the case for your organisation, it is likely that you will need to engage specialist support.

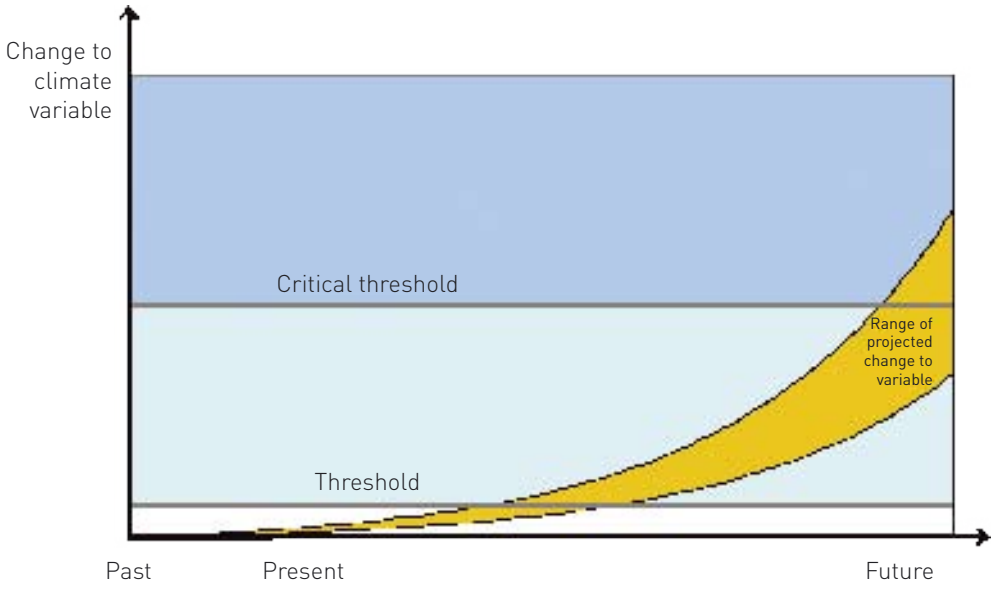
7.3 Understanding sensitivity to climate change

'Sensitivity' refers to the degree to which an area or activity of interest will be affected, either adversely or beneficially, by a particular change in climate or a climate-related variable. For the activities or assets of some organisations, relatively minor changes in the climate may pass unnoticed up to a certain point, and even significant changes may be manageable without the need for treatment. For example, there may be some civil engineering and building constructions that would be unaffected by a 5°C temperature rise. Other structures however, perhaps due to being built on moisture sensitive soil, might be affected badly if the mean temperature were to rise even 1-2°C.

The concept of sensitivity was raised briefly in section 2.3.3, noting that for most organisations when undertaking an initial assessment, it is only necessary to have a qualitative understanding of the sensitivity to climate change in order to assess and prioritise risks. For instance, in a region where a large proportion of the housing stock is ageing, in poor repair and perhaps built to less stringent standards than those in force today, it may be clear that the community is already struggling to cope when severe storms strike; in this case, they might evaluate the effect of any increase in the frequency or severity of such storms quite easily by comparison with their existing situation. Where the existing climate conditions are at or close to an obvious threshold and change can only make it worse, it might not be necessary to engage in very much more analysis to identify the fact that action is required.

Many sensitivities may be less obvious, and organisations will need to assess each risk on its merits. Some may decide that more detailed analysis is required to increase their understanding of the sensitivity of a particular risk or risks to potential changes in climate. In particular, they may wish to understand the point at which changes to a climate variable begins to matter (threshold) as well as the point at which a change to a climate variable will have a catastrophic effect on the organisation's activities or assets if the risk remains untreated (critical threshold). This is illustrated schematically in Figure 11.

Figure 11: Schematic diagram of relationship between change to a climate variable and risk thresholds for an organisation



Once a change to a climate variable (e.g. temperature or rainfall) passes an initial threshold, problems could arise that require treatment, but it may be unclear where the threshold lies. This may require an analysis in itself, drawing on expertise in the operations relevant to the organisation rather than climate science. Even when the threshold at which change starts to matter is clearly defined, it may still be a challenge to determine whether and how far into the future that point is likely to be reached. This is another matter for climate science.

Expertise in the organisation's operations and in climate science will generally both be required for a detailed analysis of climate sensitivity. Such studies may be a significant undertaking and it is important to use the initial assessment to set priorities to ensure that they are not devoted to risks that are insignificant or for which it is clear, without further study, that action is required.

7.4 Assessing treatment options

Once a risk is well understood and it is clear that some treatment will be required, detailed analysis of treatment options may be required. There will usually be several options, each entailing different costs and benefits and each offering a different level of risk mitigation.

7.4.1 Adaptive capacity

The range of treatment options that are available to an organisation will often depend on its capacity to respond to climate change. Much of the literature dealing with climate change response makes reference to the 'vulnerability' of organisations or systems, defined as 'the extent to which a system or organisation can cope with climate change' (see for example McCarthy et al. 2001). It is a function of risk and 'adaptive capacity', defined as 'the ability of a system or an organisation to adjust or respond to climate change or moderate the potential risks of climate change to its assets or activities'.

Adaptive capacity can be an inherent property of the organisation or it could have been developed as a result of previous policy, planning or design decisions. There are a range of factors which can influence adaptive capacity:

→ **Information increases adaptive capacity**

Is good information available to the organisation on climate change and variability and is the information available to the right people within the organisation and to relevant stakeholders? Are effective monitoring or other programs in place to detect changes that are occurring?

→ **Flexibility and resources increase adaptive capacity**

How flexible is the asset or activity at risk – i.e. can changes be made relatively easily and quickly or are long lead times required? Are appropriate resources for treating a risk – human, financial or other – in place already?

→ **Other risks reduce adaptive capacity**

Will other (non-climate) risks to the organisation influence its ability to respond to the climate-related risk(s)?

Adaptive capacity factors such as these could determine the range of treatment options that are available to an organisation or the treatments that are required to deal with a climate-related risk, and ultimately the cost of implementing treatments. Organisations or systems with strong adaptive capacity can generally be expected to have lower costs and a wider range of treatment options to select from than organisations with weak adaptive capacity.

7.4.2 Costs and benefits of treatment options

Where an organisation has a number of options for treating the risks of climate change, detailed analysis may be required to assess the costs and benefits of the alternatives. A range of tools or techniques are available for assessing the costs and benefits of risk treatment options including those associated with climate change. Some of these involve a full quantitative analysis of the costs and benefits of options; others are semi-quantitative or qualitative. The choice of technique employed will depend on judgements about:

- the significance of the risk to be treated;
- the range of options that are available for treating the risk;
- the range of criteria – economic, social and environmental – that need to be considered when assessing each option;
- data and information requirements in relation to each of these criteria; and
- the capacity of the decision makers to assimilate the available information and form a judgement without formal modelling.

Table 20 (over page) provides a brief overview of some of the major techniques available for assessing risk treatment options. Further discussion of these techniques is beyond the scope of this Guide. There are numerous guides however, which discuss in depth general application of the techniques. In addition, reports discussing the application of assessment techniques specifically to the impacts of climate change are available through the Australian Greenhouse Office website: www.greenhouse.gov.au (for example Metroeconomica 2003; MJA 2004).

Regardless of the technique used to assess climate change risk treatment options, care is needed to ensure that the technique is correctly designed and implemented. If it is not, it may yield incorrect or misleading conclusions. With this in mind, organisations may consider seeking external advice when undertaking detailed assessment of treatment options.

Table 20: Tools and techniques for assessing risk treatment options

Tool/technique	Type	Description and purpose	Comments
Cost-Benefit Analysis	Quantitative, economic	Determine whether the total benefits to society of a treatment option out-weighs the costs of the option or which option (from a group of options) will produce the greatest net benefit.	→ Focus is on costs and benefits to society. → Relies on pricing major benefit and cost streams. → Pricing of non-market costs and benefits can be resource intensive.
Cost-Effectiveness Analysis	Quantitative, economic	Determine the least-cost way of achieving a predetermined physical or environmental goal.	→ Only costs of treatment options need to be monetised. → Each option should achieve the same or similar level of benefit.
Financial Analysis	Quantitative, financial	Determine whether the total benefits to an individual entity of a treatment option out-weighs the costs of the option or which option (from a group of options) will produce the greatest net benefits.	→ Focus is on costs and benefits to the individual entity.
General equilibrium analysis	Quantitative, economic	Determine the flow-on effects throughout the economy of a treatment option or options.	→ Usually undertaken using computable general equilibrium models. → Data and resource intensive.
Multi-Criteria Decision Analysis	Qualitative/ semi-quantitative	Determine overall preferences among alternative treatment options, where the options accomplish several objectives. Options assessed against a range of weighted criteria using qualitative or semi-quantitative scoring and then ranked based on scores and weights.	→ Often relies on expert judgement. → Methods are not yet universally agreed → Can be combined with economic or financial techniques.

8. Preparation, planning and integration

8.1 Preparation and planning

Planning is critical to the success of any risk management exercise. It must:

- → engage the people required to sanction, execute and act upon the outcomes of the analysis;
- → obtain relevant information;
- → specify the timing of activities; and
- → obtain the resources required for the administration, facilitation and data recording components of each task.

The following list sets out the major steps for initiating a climate change risk management process.

1. Review any existing risk management processes or earlier examination of climate change, if any, within your organisation.
2. Determine how climate change risk management will be integrated with other processes (unless it is decided to treat it as a stand alone exercise, which is not recommended).
3. Identify the sponsor and the audience for the output of the process, generally the directors and senior executive management of the organisation.
4. Determine how any actions flowing from this process will be inserted into routine operational activity with appropriate resources and controls.
5. Build around the entire exercise a simple communication plan setting out what will be said by whom and to whom about climate change risk management and the actions flowing from it.
6. Identify the participants in the process, including any external advisers and collaborators you may wish to use.
7. Prepare a simple project plan for the process, with dates for the completion of each step.

Key tasks in the project plan for the initial assessment are:

1. Check that you have the latest climate change scenarios relevant to your organisation, as explained in section 4.2.1.
2. Establish the context of the initial assessment.
3. Identify who will plan and manage the work and, if it is a different person, who will facilitate the workshop(s) and analyse the results.
4. Identify the participants in the workshop(s).
5. Determine whether all participants can be included in a single workshop or if more than one workshop will be required.
6. Estimate how long it will take to prepare and document the context definition.
7. Pick a workshop date or dates allowing sufficient time to prepare a briefing note for all participants and issue it a clear week, or more, before the first workshop.
8. Document the plan for:
   - → establishing the context;
   - → preparing a briefing note;
   - → holding the workshop(s); and
   - → conducting the initial assessment review.

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8.1

Recommendations

When planning the initial risk assessment:

25. Work on an initial estimate of one to three months elapsed time to complete the stage and adjust it as necessary to suit your circumstances, but try to avoid extended delays.
26. Take account of the timing of significant information inputs that might become available around the time of the analysis and try to plan workshops to take advantage of them.
27. Try to ensure the initial assessment output is available in time to be used in budgeting and target setting, towards the end of a planning year rather than just after the start of a year.
28. Plan workshops for a half or a full day, erring on the high side if in doubt, with a target of seven to fifteen people in each.
29. Engage workshop participants who have understanding and ownership of the issues and responsibility for taking action to treat risks.
30. Consider whether you need a specialist facilitator, in-house or external, to help with the rest of the process.

8.2 Integration with existing risk management practices

Many organisations have risk management practices in place. These may range from fully integrated enterprise wide risk management systems to piecemeal applications of safety and hazard assessments or individual project risk assessments.

This Guide is intended for any organisation, no matter how much or how little their risk management activity has been formalised to date. Two extremes, in terms of the current state of risk management, are discussed in the following sub-sections. From these, most organisations will be able to select guidance to suit their circumstances.

8.2.1 Building on a fully integrated risk management system

An organisation that has a fully integrated risk management system will have skilled resources that can be applied to climate change risk management and many personnel will be familiar with the general working of the process. The organisation is likely to have an agreed strategic context definition, processes for defining the context of separate parts of their operation, and mechanisms for evaluating risks. The organisation may also have in-house resources for facilitating the risk management process or access to such expertise elsewhere.

In all these respects, such an organisation should find it relatively easy to initiate climate change risk management as a relatively straightforward extension of existing practices.

Recommendations

If you have existing risk management processes:

31. Use the established process as the foundation for climate change risk management.
32. If it is necessary to adjust or extend existing processes to meet the needs of climate change risk management, integrate the two processes into a single framework.
33. Make climate change risk management an integral part of risk management in the organisation, not a separate risk management activity operating on a different basis from that used for other risk management tasks.

8.2.2 Starting 'from scratch'

Organisations that have no existing risk management systems will find all the basic information required to establish a climate change risk management process in this Guide. If it is put together well, this could be the first step towards establishing a sound general risk management system. Related resources that will be useful in such circumstances are the Standard AS/NZS 4360:2004 and the associated handbook HB 436, both of which are available from Standards Australia.

Whether the intention is to generalise risk management across the organisation or merely to implement climate change risk management, those who have never engaged in formal risk management activity, or who are unfamiliar with implementing the Standard, may find it useful to seek external risk management support. Risk management practitioners with adequate experience and expertise should have no difficulty taking the process laid out here and implementing climate change risk management.

Recommendations

If you have no formal risk management processes at the moment:

34. Consider whether this will be an isolated risk management exercise or part of a wider risk management development.
35. If there is an intention to develop a general risk management process as well as implement climate change risk management, seek additional advice as this Guide does not extend to the establishment of a full organisational risk management process.
36. Even if there is no intention to go beyond climate change risk management, consider using specialist risk management guidance, even though it may not be required by everyone to implement the process laid out here.

8.3 Integration with other activities

8.3.1 The annual planning cycle

Climate change is taking place on a similar timescale and in some cases with similar consequences to other long terms trends and changes. These include:

- population growth;
- ageing of the population;
- changes in land use;
- general aspiration towards higher living standards; and
- pressure to reduce greenhouse gas emissions and adopt sustainable development practices.

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A consideration of climate change risk can raise issues that are driven by both climate change and other factors as well, such as pressure on water supplies or growing susceptibility to pests and diseases. It makes a lot of sense to combine climate change risk assessment with the organisation's strategic planning process, as this can help to resolve the causes and consequences of risks and allow similar issues with long-term impacts to be considered together.

Given the timescale of climate change and related developments, it is likely that major reviews will take place about once a year. If the analysis takes place as part of the formulation of the next year's plans and budget setting, those plans and budgets can take account of climate change risk and be used to underpin the actions chosen to address the risks.

Planning and budgeting are usually conducted to a well defined timetable, but investigations that might feed into a risk analysis may be less predictable. Where possible, arrange for relevant information to be available before risks are identified or reviewed.

Recommendations

The annual planning cycle

37. Consider integrating climate change risk assessment with strategic planning.
38. Use all strategic planning and related information to identify changes that will take place at the same time as climate change.
39. Plan to have the conclusions of the risk management process available in time to be included in the annual objective setting and budget allocation exercises.
40. Use the communication and consultation activity in the risk management process to gather relevant information from other planning and investigation activities and disseminate climate change risk management information to these other activities.
41. As far as possible, try to make the outcome of other investigations and reports available before the risk analysis takes place.

8.3.2 Climate science and risk management expertise

Few organisations have in-house expertise in climate science. Somewhat more have in-house risk management process expertise. A simple initial implementation of the process set out in this Guide can be carried out with no more information than is included here, but some organisations will prefer to seek external support.

Whether you intend to take advice on climate change or risk management or on neither, it is important to check that you have the most recent climate science information. Climate science is a dynamic field and new insights are being gained every year. This Guide has been prepared using information available at the end of 2005. The risk management process described here should remain valid for many years but the climate change information used within it is expected to change. As noted previously, scenarios for use in initial climate change risk assessments will be updated as new information becomes available and included on the Australian Greenhouse Office web site.

Exhaustive interpretation of climate science information and quantitative analyses will usually only be required for the detailed analysis stage of the process. Support in these areas will generally have to come from external organisations. It is important that a member of the risk assessment facilitation team has a basic familiarity with current climate science to the level of, say, the 'summary for policy makers' in the IPCC Synthesis Report (IPCC 2001). If you do not believe this level of knowledge exists within your organisation or can be acquired readily, then additional third-party support should be sought.

Recommendations

Obtaining information and support

42. Check AGO website for the most up-to-date climate science information and scenarios.
43. Ensure that a member of the facilitation team involved in the initial assessment stage has a basic familiarity with current climate science to the level of, say, the 'summary for policy makers' in the IPCC Synthesis Report (IPCC 2001).
44. Consider using a specialist, whether in-house or externally sourced, to interpret climate science where it is necessary to go beyond the simplified scenarios accompanying this Guide.
45. Take account of the strategic nature of climate change risk management and the desirability of integrating the process with other management systems when selecting advisers for risk management support.

→ Checklist
of recommendations and hints

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Using climate change scenarios

1. Apply climate change scenarios as the basis for assessing risks in the initial assessment stage of the risk assessment process. Standard scenarios accompany this Guide, and will be updated periodically as new information about climate projections becomes available.
2. When applying climate change scenarios to the risk assessment ensure that workshop participants are provided with both quantitative and descriptive information on the scenarios.
3. Limit the number of scenarios used to one or two.
4. More specific and detailed climate change information than is provided in the standard climate change scenarios may need to be used for detailed assessments.

When defining the scope

5. Try to address the entire scope of the organisation's operations in one assessment exercise if you can.
6. If it is necessary to split the scope into parts, look carefully for potential gaps between the parts and consider whether you need a separate, high level assessment to deal with issues that are not confined to one area.
7. Make sure the geographical area, organisational boundaries, operational boundaries and timeframe are specified explicitly.

When identifying the stakeholders

8. Start with broad groups of stakeholders rather than small groups or individuals.
9. Break groups down if they contain two or more distinctly separate sets of motivations and concerns.
10. Group together stakeholders with essentially the same motivations and concerns.
11. Think widely about anyone who is not directly involved but could have an effect on the success of your organisation.
12. List the stakeholders with a short summary of their motivations and concerns.

When developing consequence scales

13. If you have an existing risk management framework, stay as close to it as you can while satisfying the following recommendations.
14. Aim for four to six criteria.
15. Test the criteria before developing the scales to make sure they are a complete set and there are not too many of them.
16. Define the extremes of the consequences, Catastrophic and Insignificant, before specifying the Major, Moderate and Minor levels.

When developing likelihood scales

17. If you have an existing risk management framework, stay as close to it as you can while satisfying the following recommendation.
18. Use the default scale shown here unless there is a pressing reason not to, such as there being an established scale in use already or the range of likelihoods you face being very low.

When developing a priority matrix

19. If you have an existing risk management framework, stay as close to it as you can while satisfying the following recommendations.
20. If you need to start afresh, use the examples here as a foundation.
21. Create a few examples of risks to test the scales.
22. If in doubt, err on the side of making the Extreme and High regions of the matrix smaller rather than larger, as severe risks that are understated will usually be picked up in the review at the end whereas it is often more difficult to downgrade risks that are overstated and they can clog the process.

When running the risk identification activity

23. Adopt the conventional rules of brainstorming that allow almost any input and suspend judgement.
24. Do not allow the workshop to be diverted into debating whether a risk is a climate change risk or not. If in doubt let it remain in the process and consider the matter later, after the workshop.

When planning the initial risk assessment

25. Work on an initial estimate of one to three months elapsed time to complete the stage and adjust it as necessary to suit your circumstances, but try to avoid extended delays.
26. Take account of the timing of significant information inputs that might become available around the time of the analysis and try to plan workshops to take advantage of them.
27. Try to ensure the initial assessment output is available in time to be used in budgeting and target setting, towards the end of a planning year rather than just after the start of a year.
28. Plan workshops for a half or a full day, erring on the high side if in doubt with a target of seven to fifteen people in each.
29. Engage workshop participants who have understanding and ownership of the issues and responsibility for taking action to treat risks.
30. Consider whether you need a specialist facilitator, in-house or external, to help with the rest of the process.

If you have existing risk management processes

31. Use the established process as the foundation for climate change risk management
32. If it is necessary to adjust or extend existing processes to meet the needs of climate change risk management, integrate the two processes into a single framework
33. Make climate change risk management an integral part of risk management in the organisation, not a separate risk management activity operating on a different basis from that used for other risk management tasks

If you have no formal risk management processes at the moment

34. Consider whether this will be an isolated risk management exercise or part of a wider risk management development.
35. If there is an intention to develop a general risk management process as well as implement climate change risk management, seek additional advice as this Guide does not extend to the establishment of a full organisational risk management process.
36. Even if there is no intention to go beyond climate change risk management, consider using specialist risk management guidance, even though it may not be required by everyone to implement the process laid out here.

The annual planning cycle

37. Consider integrating climate change risk assessment with strategic planning.
38. Use all strategic planning and related information to identify changes that will take place at the same time as climate change.
39. Plan to have the conclusions of the risk management process available in time to be included in the annual objective setting and budget allocation exercises.

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40. Use the communication and consultation activity in the risk management process to gather relevant information from other planning and investigation activities and disseminate climate change risk management information to these other activities.
41. As far as possible, try to make the outcome of other investigations and reports available before the risk analysis takes place.

Obtaining information and support

42. Check AGO website for the most up-to-date climate science information and scenarios.
43. Ensure that a member of the facilitation team involved in the initial assessment stage has a basic familiarity with current climate science to the level of, say, the 'summary for policy makers' in the IPCC Synthesis Report (IPCC 2001).
44. Consider using a specialist, whether in-house or externally sourced, to interpret climate science where it is necessary to go beyond the simplified scenarios accompanying this Guide.
45. Take account of the strategic nature of climate change risk management and the desirability of integrating the process with other management systems when selecting advisers for risk management support

→ References

CSIRO, 2001. *Climate change projections for Australia.* Technical report, CSIRO Australia. 8pp. Available from: **http://www.cmar.csiro.au/e-print/open/projections2001.pdf**

Hennessey, K., McInnes, K. Abbs, D., Jones, R., Bathols, J., Suppiah, R., Ricketts, J., Rafter, T., Collins, D. and Jones, D., 2004. *Climate Change in New South Wales. Part 2: Projected changes in climate extremes*, Counsultancy report for the New South Wales Greenhouse Office, CSIRO. 79pp.

Houghton, J. T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J., Dai, X., Maskell, K. and Johnson, C.A., (eds.) 2001. *Climate Change 2001: The Scientific Basis.* Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK. 572pp. Available from: **http://www.grida.no/climate/ipcc_tar/**

IPCC, 2001. *Climate change 2001: Synthesis Report. A Contribution of Working Groups I, II and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge. 34pp.

McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J. and White, K.S. 2001. *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK. 1032pp. Available from: **http://www.grida.no/climate/ipcc_tar/**

Metroeconomica Limited, 2003, *Costing the impacts of Climate Change in the UK: Implementation Guidelines*, Final Report, prepared for the UK Climate Impacts Programme, (UKCIP), UKCIP. Available from: **http://www.ukcip.org.uk/resources/publications/pub_dets.asp?ID=54**

Marsden Jacob Associates (MJA), 2004, *Economic Issues Relevant to Costing the Impacts of Climate Change*, A report prepared by Marsden Jacob Associates for the Australian Greenhouse Office, AGO, Canberra. 48pp. Available from: **http://www.greenhouse.gov.au/impacts/publications/costing.html**

Nicholls, N., 2004. The changing nature of Australian droughts. *Clim. Change*, 63:323-336.

Risbey, J., Karoly, D., Reynolds, A. and Braganza, K., 2003. Global warming signature in Australia's worst drought. *Bull. Aust. Met. Ocn. Soc.*, 16:6-11.

Risbey, J., Hamza, K., and J. Marsden 2006: Use of climate scenarios to aid in decision analysis for interannual water supply planning. *Water Resources Management.* In press.

Standards Australia, 2004. *AS/NZS4360:2004 Risk Management*.

Standards Australia, 2004. *Handbook HB436 Risk Management*.

Willows, R. and Connell, R. (eds.), 2003. *Climate adaptation: Risk, uncertainty and decision-making*, UKCIP Technical Report, UKCIP, Oxford. 153pp.

Water Corporation (Western Australia), 2005. *Integrated Water Supply Scheme Source Development Plan 2005-2050: An Overview*, Water Corporation, Perth. 40pp.

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→ Glossary

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Climate change

Adaptation

Actions in response to actual or projected climate change and impacts that lead to a reduction in risks or a realisation of benefits. A distinction can be made between a planned or anticipatory approach to adaptation (i.e. risk treatments) and an approach that relies on unplanned or reactive adjustments.

Adaptive capacity

The capacity of an organisation or system to moderate the risks of climate change, or to realise benefits, through changes in its characteristics or behaviour. Adaptive capacity can be an inherent property or it could have been developed as a result of previous policy, planning or design decisions of the organisation.

Climate

The composite of surface weather conditions such as temperature, rainfall, atmospheric pressure, humidity, sunshine and winds, averaged over a period of time ranging from months to thousands of years. The classical period for averaging, as defined by the World Meteorological Organisation, is 30 years.

Climate change

Any change in climate over time, whether due to natural variability or as a result of human activity.

Climate change mitigation

Response measures that reduce the emission of greenhouse gases into the atmosphere or enhance their sinks, aimed at reducing their atmospheric concentrations and therefore the probability of reaching a given level of climate change.

Climate scenario

A coherent, plausible but often simplified description of a possible future state of the climate. A climate scenario should not be viewed as a prediction of the future climate. Rather, it provides a means of understanding the potential impacts of climate change, and identifying the potential risks and opportunities to an organisation created by an uncertain future climate. A 'climate change scenario' can be defined as the difference between a climate scenario and the current climate.

Climate projection

A projection of the response of the climate system to scenarios of greenhouse gas emissions or atmospheric concentrations of greenhouse gases. Climate projections are often based upon simulations of the climate system by computer based mathematical models. Climate projections depend on assumptions about emission rates and concentrations and response of the climate system to changes in these variables and can therefore be distinguished from climate predictions.

Climate variability

Variations or deviations from the mean state of the climate. The climate system has natural, internal variability but variability could be affected by external factors driving climate change such as changes in the atmospheric concentration of greenhouse gases.

Enhanced greenhouse effect

Increases in the atmospheric concentration of greenhouse gases such as carbon dioxide, methane and nitrous oxide due to human activities, leading to an increase in the amount of thermal radiation near the Earth's surface. Most scientists agree that the enhanced greenhouse effect is leading to an increase in global average surface temperature (see global warming) and other changes in the atmospheric environment (see climate change). See also greenhouse effect.

Extreme event

Weather conditions that are rare for a particular place and/or time such as an intense storm or heat wave.

Global warming

An increase in the global average surface temperature due to natural or human caused factors.

Greenhouse effect

The process where gases in the lower atmosphere such as carbon dioxide and water vapour trap radiation released by the Earth's surface after it has been warmed by solar energy. These gases then radiate heat back towards the ground, adding to the heat the ground receives from the Sun. The surface of the Earth would be about 33°C colder on average than it is without the natural greenhouse effect. See enhanced greenhouse effect.

Sensitivity

The degree to which a system is affected, either adversely or beneficially, by climate related variables including means, extremes and variability.

Vulnerability

The extent to which a system or organisation can cope with the negative impacts of climate change, variability and extremes. It is a function of risk and adaptive capacity.

Risk management

Following the Standard AS/NZS 4360, the definitions below apply to this guide.

Consequence

Outcome or impact of an event

1. There can be more than one consequence from one event.
2. Consequences can range from positive to negative.
3. Consequences can be expressed qualitatively or quantitatively.
4. Consequences are considered in relation to the achievement of objectives.

Control

An existing process, policy, device, practice or other action that acts to minimise negative risk or enhance positive opportunities.
The word control may also be applied to a process designed to provide reasonable assurance regarding the achievement of objectives.

Event

Occurrence of a particular set of circumstances.

1. The event can be certain or uncertain.
2. The event can be a single occurrence or a series of occurrences.

Frequency

A measure of the number of occurrences per unit of time.

Hazard

A source of potential harm

Likelihood

Used as a general description of probability or frequency

Can be expressed qualitatively or quantitatively.

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Monitor

To check, supervise, observe critically or measure the progress of an activity, action or system on a regular basis in order to identify change from the performance level required or expected

Organisation

Group of people and facilities with an arrangement of responsibilities, authorities and relationships - eg. company, corporation, firm, enterprise, institution, charity, sole trader, association, or parts or combination thereof.

1. The arrangement is generally orderly.
2. An organisation can be public or private.

Probability

A measure of the chance of occurrence expressed as a number between zero and one.

1. 'Frequency' or 'likelihood' rather than 'probability' may be used in describing risk.

Risk

The chance of something happening that will have an impact on objectives.

1. A risk is often specified in terms of an event or circumstance and the consequences that may flow from it.
2. Risk is measured in terms of a combination of the consequences of an event and their likelihoods.
3. Risk may have a positive or negative impact.

Risk analysis

Systematic process to understand the nature of and to deduce the level of risk.

1. Provides the basis for risk evaluation and decisions about risk treatment.

Risk assessment

The overall process of risk identification, risk analysis and risk evaluation.

Risk evaluation

Process of comparing the level of risk against risk criteria.

1. Risk evaluation assists in decisions about risk treatment.

Risk identification

The process of determining what, where, when, why and how something could happen.

Risk management

The culture, processes and structures that are directed towards realising potential opportunities whilst managing adverse effects.

Risk management process

The systematic application of management policies, procedures and practices to the tasks of communicating, establishing the context, identifying, analysing, evaluating, treating, monitoring and reviewing risk.

Risk treatment

Process of selection and implementation of measures to modify risk.

1. The term 'risk treatment' is sometimes used for the measures themselves, in addition to the process of generating the measures to deal with a risk.
2. Risk treatment measures can include avoiding, modifying, sharing or retaining risk.

Stakeholders

Those people and organizations who may affect, be affected by, or perceive themselves to be affected by a decision, activity or risk.

1. The term 'stakeholder' may also include 'interested parties' as defined in AS/NZS ISO 14050 and AS/NZS ISO 14004.