Climate Systems

National Environmental Science Program

Understanding data inputs for a climate risk assessment

September 2024

Key messages

- You will make more rapid progress exploring climate risk if you adopt a formal risk assessment method in the process and before you start collecting climate data.
- The risk assessment process will guide you to the types of climate data you need to assess, short list the hazards relevant for your system and identify the values and objectives.
- The risk assessment process can give you confidence to make informed and defendable decisions, even if some information is uncertain.

Many organisations want to understand their risk from climate change. This might be for a few reasons such as making a financial disclosure, an initial exploration to help understand if this is something the organisation should be worried about, or a part of a formal risk management or adaptation framework process.

Whatever the reason, at some stage you will be looking for climate information. Many people start by collecting all the climate data they can find, often becoming overwhelmed and paralysed by choice. In this guide, we overview some key concepts and considerations for climate risk assessments to help you think about where and how you might need to apply climate data.

Note, this guide focuses on assessments of **physical climate risk** conducted for assets, services or systems. It does not consider the process of assessing **transition risks.**

Physical risk refers to negative impacts of natural hazards caused by human-induced climate change. These can result from acute shocks like natural disasters or from chronic changes including longer-term gradual shifts in climate patterns, such as changing rainfall patterns or sea level rise.

Transition risks arise from policy, regulatory and societal changes to address climate change, such as changes in values, markets and demand for products and services.

What is a climate risk assessment?

A climate risk assessment can assist organisations to identify their climate change-related risks or to test the relevance of their existing risk management strategies under climate change and identify the need to take further action. Climate risk assessments are completed as a structured process following a series of steps. They help analyse the consequences and likelihood of risk through consideration of three interacting components: hazard, exposure and vulnerability (Figure 1).

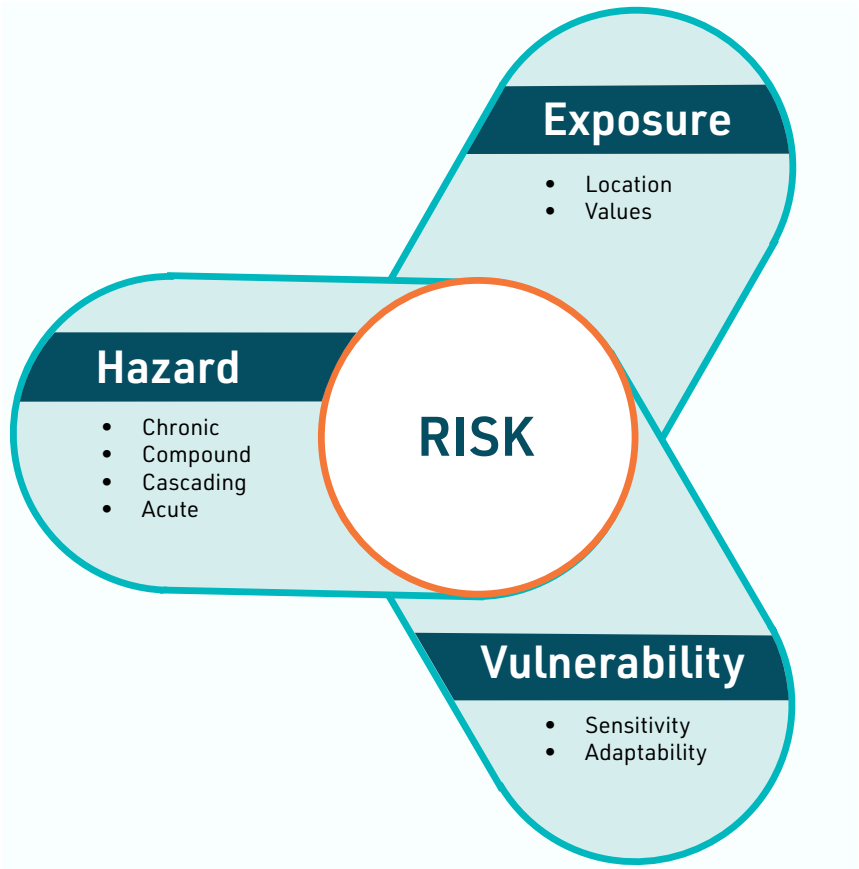

Figure 1. Climate risk is a factor of a hazard, exposure and vulnerability to that hazard.

A **hazard** is a natural or human-induced event with the potential to cause harm. Usually this 'harm' is damage to property, infrastructure, health, livelihoods, service provision and/or environmental resources. Climate hazards can be acute, such as extreme weather events (for example, cyclones or bushfires), or chronic, such as sea level rise, rising temperatures, or shifting climatic zones. It's important to remember that these climate hazards can overlap in time and/or space to occur as compound or coincident events – for example, severe wind, flash flooding and storm tide inundation can occur together with a tropical cyclone.

Exposure refers to the presence of people, assets or other values in places that could be affected by a hazard. Essentially, are you somewhere a hazard may occur.

Vulnerability is the susceptibility or predisposition to be adversely affected. Vulnerability can be thought of as the interaction of sensitivity or susceptibility to harm, and capacity or lack of capacity to cope and adapt often referred to as 'adaptive capacity'.

A rating of **risk** associated with a hazard or event is often determined by combining information on the likelihood of a hazard occurring (including exposure) and the consequence if it does. The risk rating can then be determined using a familiar risk matrix like the one in Figure 2a below. A modified risk matrix can also incorporate vulnerability for a more granular rating of risk (Figure 2b).

Importantly, you can include different levels of the same hazard in your risk matrix. For example, one level of a hazard (e.g. days over 35 degrees) may be likely and with moderate consequences, leading to a high-risk rating. A higher level of the same hazard (e.g. days over 40 degrees) may be less likely, but would have catastrophic consequences, leading to a medium risk rating.

A

	Consequence				
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

B

Vulnerability
Sensitivity - adaptive capacity

Likelihood
How often might you be exposed to hazards? Return period?

Likelihood (X)		**Rare (1)**					**Unlikely (2)**					**Possible (3)**				
Vulnerability (Y)		V.Low (1)	Low (2)	Mod (3)	High (4)	Extr (5)	V.Low (1)	Low (2)	Mod (3)	High (4)	Extr (5)	V.Low (1)	Low (2)	Mod (3)	High (4)	Extr (5)
Consequence (Z)	Insignificant (1)	VL1	VL2	VL3	L4	L5	VL2	VL3	L4	L5	L6	VL3	L4	L5	L6	M7
	Minor (2)	VL2	VL3	L4	L5	L6	VL3	L4	L5	L6	M7	L4	L5	L6	M7	M8
	Moderate (3)	VL3	L4	L5	L6	M7	L4	L5	L6	M7	M8	L5	L6	M7	M8	H9
	Major (4)	L4	L5	L6	M7	M8	L5	L6	M7	M8	H9	L6	M7	M8	H9	H10
	Catastrophic (5)	L5	L6	M7	M8	H9	L6	M7	M8	H9	H10	M7	M8	H9	H10	H11

Key VL = Very Low, L = Low, M = Medium, H = High, E = Extreme,

Scale: 1 (lowest) to 13 (highest)

Consequences
How it may impact a business or system

Figure 2. (a) A typical risk rating matrix can be used to determine overall risk ratings based on the likelihood and consequence of a hazard or event (adapted from Climate Compass). (b) Inclusion of vulnerability along with likelihood and exposure can provide a more granular risk rating (adapted from https://www.health.qld.gov.au/system-governance/strategic-direction/plans/climate-change/climate-change-strategy-and-planning).

There are common steps in most climate risk assessment methods addressing assets or services. The steps described in Figure 3 are typical of a more detailed risk assessment such as a second pass risk assessment (see below), with the initial first pass scan not typically including step 4. At the end of this process, you will have a list of priority climate risks relevant to your interests.

Figure 3. A high-level description of the key steps of a generic climate risk assessment process and main activities in each step (adapted from CoastAdapt and others).

Climate risk assessments can be completed at different levels of detail depending on your objective and available resources. A common way to describe these stages is as a first, second or third pass risk assessment (Figure 4). These are often performed in sequence, getting more focused and detailed at each step. A first pass climate risk scan can be a first step for considering if you need to undertake further planning.

Alternatively, different levels may reflect the scope of the assessment; for example, Climate Compass uses 'scan', 'strategy' and 'project' cycles to reflect a high-level scan to prioritise other cycles, a strategic level assessment and then a more targeted project-level assessment.

A climate risk assessment is often completed as part of an adaptation planning process (Figure 5) or is later incorporated into an adaptation planning process if risks are identified that need to be addressed. In an adaptation planning process, once risks are identified and prioritised, management or adaptation actions to reduce the risk are identified and sequenced, implemented and then a program of monitoring and evaluation set up (Figure 4).

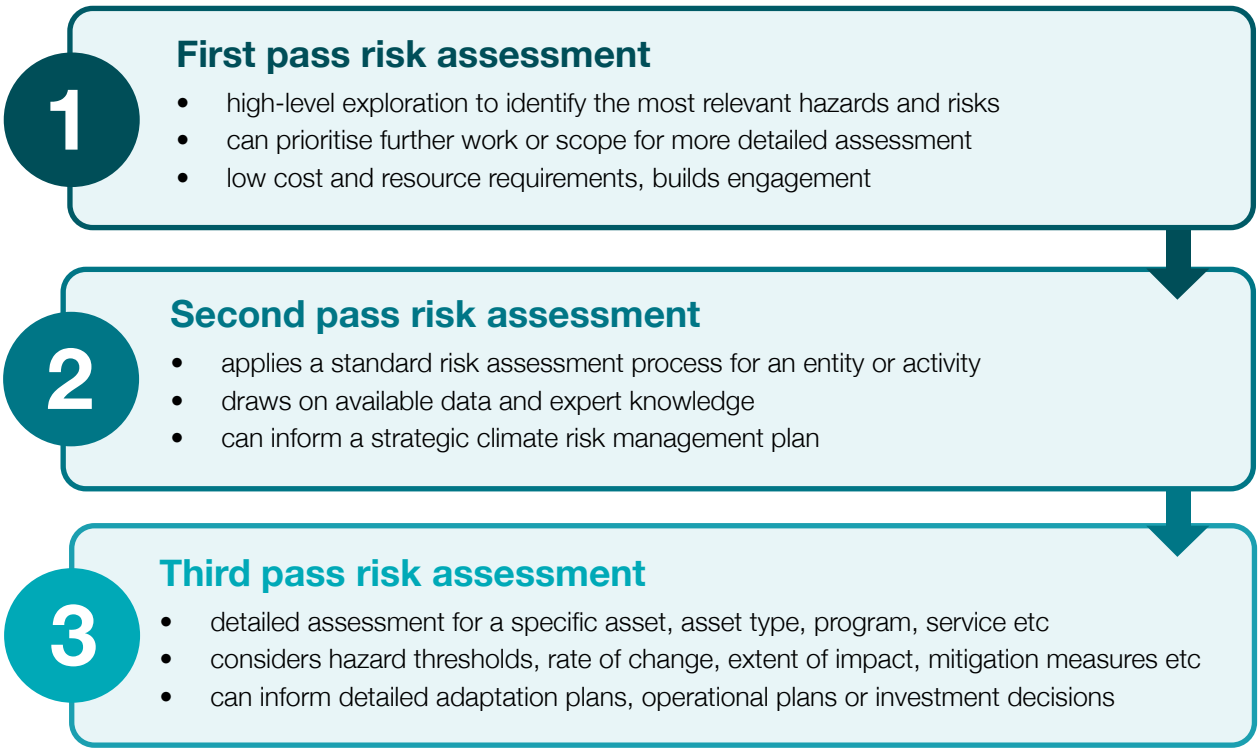

Figure 4. Common levels or stages of climate risk assessments.

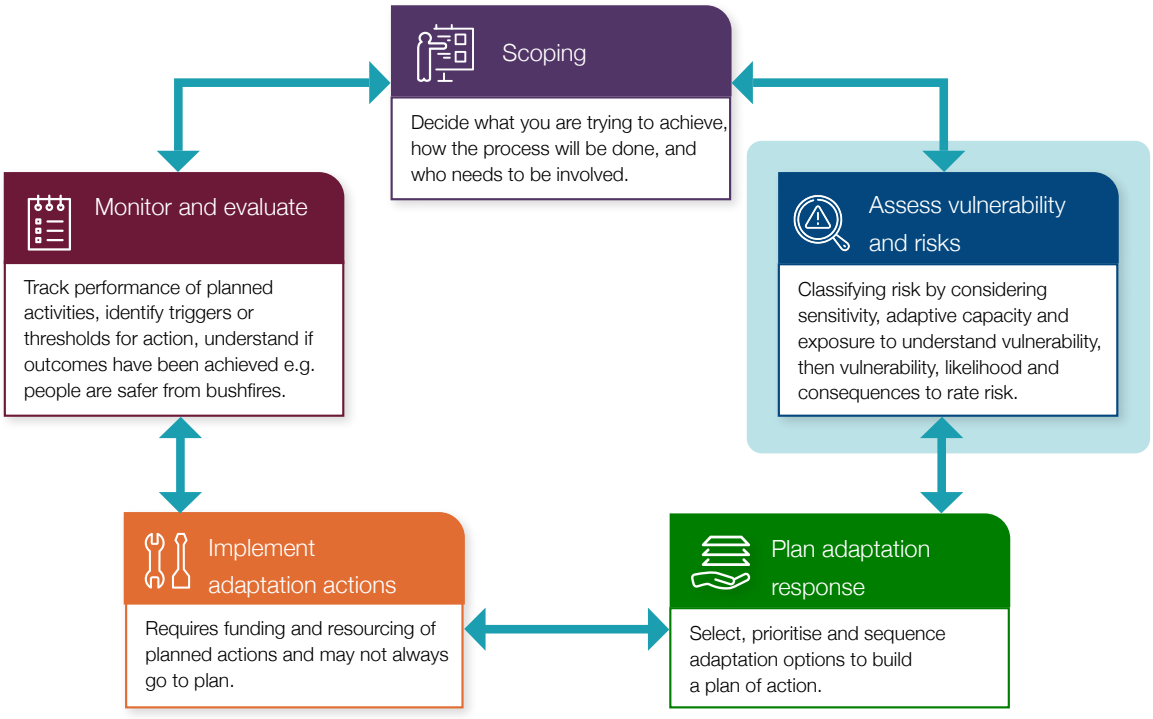

Figure 5. Assessing your climate risk and vulnerability is a critical step in an adaptation planning framework process. You might also undertake your climate risk assessment as a first step of considering whether you need to undertake further planning.

What data will I need?

A climate risk assessment is more than just projections of future climate and climate-related hazards. It also considers the socio-economic settings that determine vulnerability, risk and response (Figure 6).

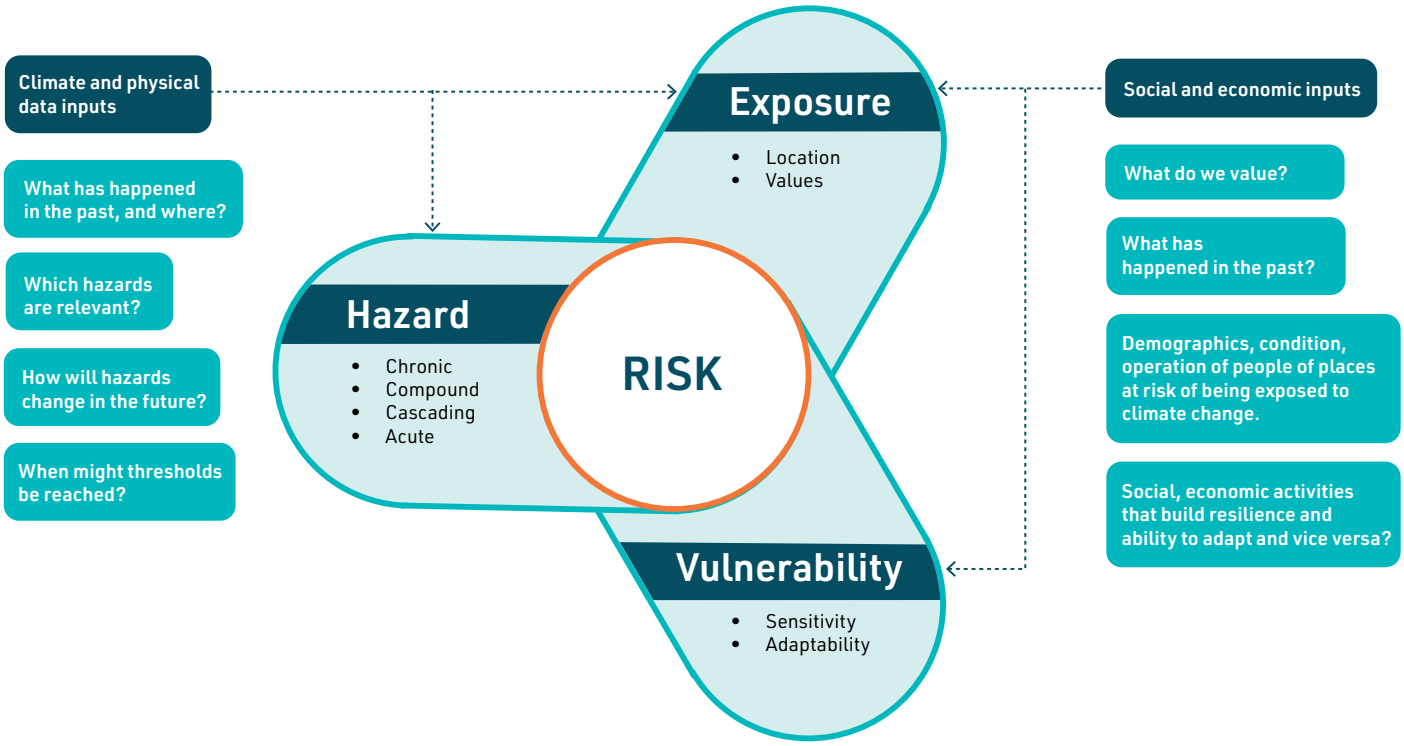

Figure 6. Both social and economic and climate data are needed in your climate risk analysis.

It is tempting to begin a climate risk assessment by gathering lots of climate information as a starting point. Beginning with the projections of future climate and climate-related hazards – often referred to as a 'top down' approach – can become overwhelming as you decide if you have enough information. As future climate projections are subject to variability both naturally and through ongoing global efforts to reduce emissions, they are often presented as a range of plausible scenarios.

Trying to understand how changes to the climate may impact your organisation or area of concern means presenting a range of scenarios that are all possible. This leads to having to consider large quantities of information and data.

While climate projections can give you an indication of how physical climate hazards may change in the future, more detailed analysis is often required, for example flood modelling or species distribution modelling. Understanding the potential impact an increased risk of climate hazards poses, also requires non-climate data including: information about buildings and physical assets, requirements for the reliable provision of services, financial data, social data, understanding of biological or ecological processes, impacts of historical events, critical hazard thresholds, and links and dependencies such as supply chain vulnerabilities (Figure 7).

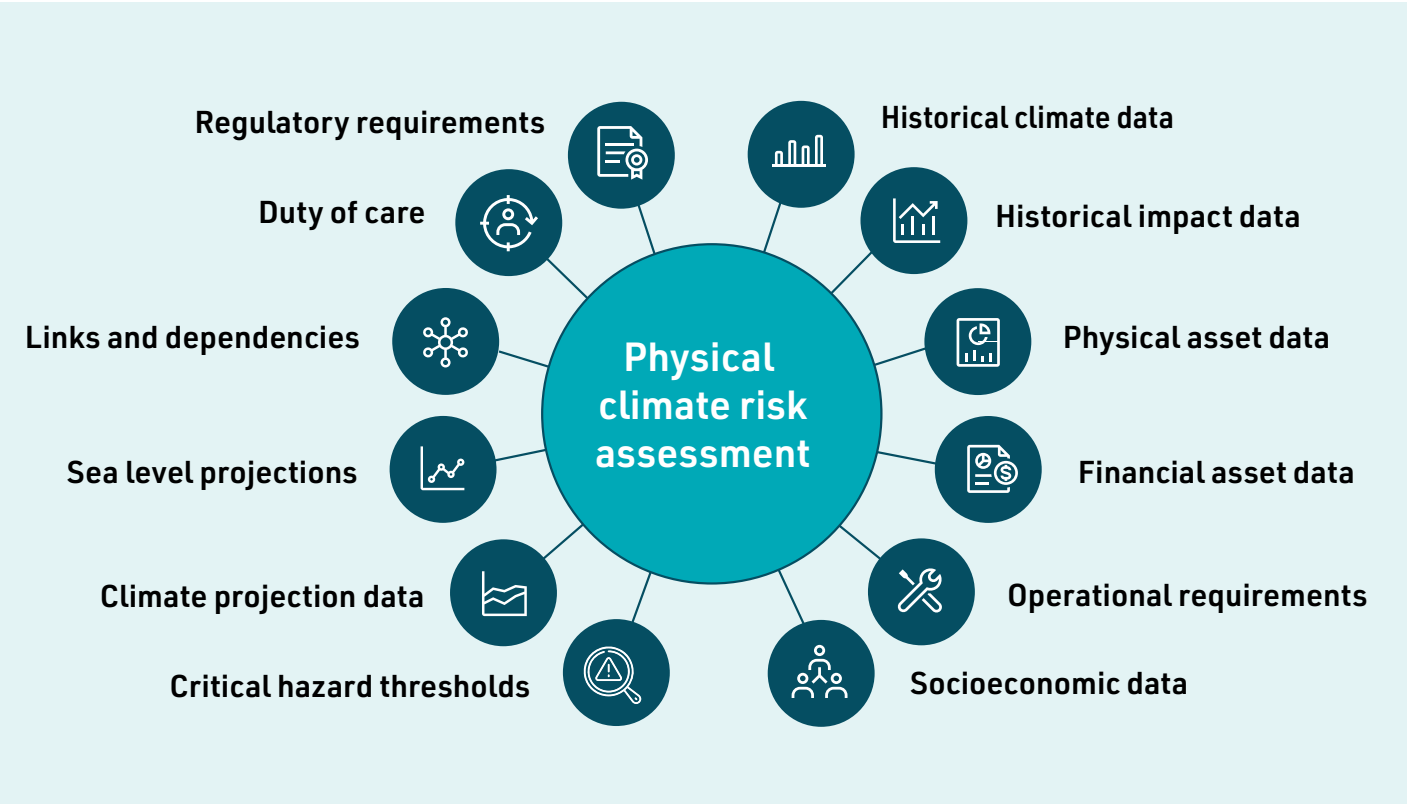

Figure 7. A non-exhaustive list of the types of data and information that may be required to perform a climate risk assessment.

Often, it is the availability and suitability of these other datasets that can create challenges for a climate risk assessment rather than the availability or uncertainty in climate projection data. You might need to consider the critical climate sensitivities or thresholds for your business, asset or service. For example, at what temperature will a critical piece of equipment be likely to stop working? This is also an important consideration in identifying the climate data you need for your risk assessment and will help to narrow down your search for climate data. See the hub's separate guide on *Finding and selecting the right climate change information for your needs* for some of the main sources of climate data and how you can pick one that meets your needs.

Climate information often provides a range of alternative future climate conditions against which you can assess risk. It is likely that there will be multiple plausible futures. A common principle in assessing climate risk is to look at the **greatest plausible change** in a relevant hazard, not just what's most likely or what is known with high confidence.

This enables the consideration of events that may have a low likelihood but very high impact, should they occur.

Another common practice is to consider at least two alternative climate futures that provide plausible upper and lower bounds for a risk assessment, such as different future emissions pathways or scenarios. A risk assessment tool or framework will usually provide guidance on selecting the most appropriate scenarios to use.

Considering the **greatest plausible change** means using the upper end or the upper and lower limits of a climate variable or hazard based on climate projection information. This may not be the absolute extreme values, but rather a level of change corresponding to the 95th or 99th percentile of possibilities. How you interpret 'plausible' will depend on your attitude to risk.

Where to begin

Before looking for climate projections, building an understanding of the inherent vulnerability of infrastructure or a population, rather than only focusing on the potential impacts of hazards, can help to identify the most relevant climate hazards. This can help to identify what kind of climate data you need and simplify your search for climate data.

For example, looking at past hazards and the impact they had can provide clues on what information to look for. Imagine a past heatwave led to machinery failures at a hospital. The risk assessment could therefore focus on changes in heatwave conditions frequency and changes in peak temperatures.

The type and scale of information you bring into your risk assessment will depend on what level of assessment you are undertaking. For a first pass scan, you might work in-house using readily available high level summary information and in-house expertise and experience. The more detailed your assessment, the more likely you are to work with external stakeholders and undertake more sophisticated analysis to understand vulnerability and assess risk. For hazards that present high or extreme risks, you may need to conduct a more detailed third pass risk assessment. These types of assessments usually require much more detailed or specialised climate data to support more complex analyses. We suggest seeking expert advice before moving to more complex risk assessments (Table 1).

Table 1. Examples of the level of information, expertise and resources for each level of risk assessment.

Risk assessment level	Socio-economic information	Climate and hazard information	Expertise	Resources
First pass scan	In-house experience and knowledge.	Readily available high-level summaries of basic climate projections information.	In-house – people with different expertise and experience.	Low Desktop study and in-house workshop/s.
Second pass assessment	Internal records, external participants, some high-level data, some external engagement.	More detailed climate projections, sets of climate projections for individual hazards e.g. heatwave, peak temperature, duration and frequency.	In-house plus expert or consultant opinion to help rate risks.	Moderate Conduct workshop/s with stakeholders using available data and information.
Third pass assessment	Data sets or technical expertise Detailed site-specific studies of exposure and possible impacts.	Data sets or technical expertise to feed into models and analysis.	Expert or consultant analysis. Detailed estimation of risk or when risk might cross tolerable threshold	High Detailed analysis and studies completed by topics experts.

Judgement and expert opinion will be required to supplement hard data when assessing vulnerability, likelihood and consequence. It is common practice to conduct a risk assessment in a group setting that brings together people with expertise in different parts of your organisation or system. This ensures multiple perspectives of potential vulnerabilities, and that existing management or risk reduction practices and possible consequences are considered.

Importantly, a climate risk assessment process provides a way to navigate uncertainty, identify required data and information (both climate and non-climate), consider a range of scenarios, and to make appropriate decisions with often incomplete or imperfect information.

Past climate may not always be a good indicator of future risks

Traditional risk assessments rely heavily on past patterns and experience. This is useful to understand the sensitivity of your business or system. But be aware that past climate may not be a reliable indicator of future climate patterns. The likelihood of climate hazards occurring, and the consequences of those conditions, will change over time because of ongoing and accelerating changes in the climate and the implementation of new management responses. For example, we may expect some extreme events to occur in rapid succession or at levels that exceed past records, and it can be difficult to understand how that may impact your area of concern. Some future consequences and impacts can be difficult to envisage in the current environment. There may be an increased likelihood of simultaneous or multiple overlapping hazards or events. This may require 'war gaming' new 'what if' scenarios for future climate conditions.

What can I expect at the end of a climate risk assessment?

At the end of your risk assessment, depending on the level you undertook, you will have a better understanding of whether you need to undertake a deeper or more comprehensive assessment, you may have a list of rated risks, some understanding of the likelihood of being exposed to a hazard and considered the consequences of that happening. You may also have begun thinking about possible responses or adaptation actions. If the risk assessment is part of an adaptation framework process (Figure 5), you can use this list to start to plan and prioritise your response, develop an approach to implementing those responses and begin to evaluate your process and monitor for change and outcomes.

As the risk assessment process considers the role of sensitivity, adaptive capacity, exposure and likelihood, you should now have a greater understanding of how management responses might reduce risk by reducing exposure and vulnerability (either by reducing sensitivity or increasing adaptive capacity).

Finding the right climate risk assessment framework for your needs

There are a multitude of risk assessments tools, methodologies, frameworks, and adaptation planning tools that incorporate some level of climate risk assessment. Many focus on the needs of specific sectors. Most methodologies follow much the same process and align with the International Standard for Risk Management (ISO 31000). However, they can vary in use of terminology or recommended information sources depending on their target audience or sector.

Some Australian examples of risk assessment and adaptation planning tools designed for specific sectors or applications include:

- Climate Compass (CSIRO) – a risk management tool for government agencies that enables the consideration of climate risk within current risk management processes
- National Climate Risk Assessment Methodology – developed by the Australian Government to support the first National Climate Risk Assessment
- CoastAdapt (National Climate Change Adaptation Research Facility) – a resource to support coastal adaptation that includes information for risk assessments and adaptation decision support
- Climate Risk Ready NSW Guide (NSW Government) – public sector climate risk management
- Climate risk management tools for households and small businesses (Queensland Government).

You may prefer to apply a methodology tailored for your sector, or you might be required to use a particular methodology as directed by policy or compliance requirements. For example, the Australian Government's Climate Risk and Opportunity Management Program (CROMP) is designed for government entities to assess, manage and disclose climate risks and opportunities within their organisation (replacing *Climate Compass* as the recommended approach for Australian Government entities). Reviewing a few different frameworks may help understand the rationale of the methodology or in finding additional tips that suit your situation. New climate risk methodologies and frameworks continue to be developed, reflecting the evolution of approaches to climate risk management for different sectors and activities, and a desire to have approaches tailored to specific situations. There is no right or wrong way to approach assessing climate risk and developing an adaptation plan.

Following one of these climate risk assessment methodologies will however, provide confidence in the decision-making process and provide a way to make progress without being distracted by uncertainty or becoming overwhelmed by the volume of data available. It's highly recommended to adopt a risk assessment methodology or approach early in your exploration of climate risk to maximise chances of timely and effective progress.

For more information:

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Guides in this series include:

- Everything you need to know about the latest in climate modelling
- Finding and selecting the right climate change information for your needs
- Understanding data inputs for a climate risk assessment
- Navigating climate information

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CoastAdapt - https://coastadapt.com.au/how-to-pages/how-to-conduct-a-climate-change-risk-assessment

Climate Compass - https://www.agriculture.gov.au/sites/default/files/documents/climate-compass-climate-risk-management-framework-commonwealth-agencies.pdf

IPCC (2012) Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA. https://www.ipcc.ch/site/assets/uploads/2018/03/SREX_Full_Report-1.pdf

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