Climate Governance Initiative Australia

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Climate Change – Science Snapshot 2025

An overview for Australian directors

Introduction

Australian organisations are navigating increasing complexity in climate governance, driven by evolving risks, regulatory shifts, and investor expectations. This March 2025 snapshot equips directors with the latest insights from climate science, including global progress on emissions reductions and the potential impacts of different global warming thresholds. Designed to support boardroom discussions on scenario analysis and transition planning, this resource covers:

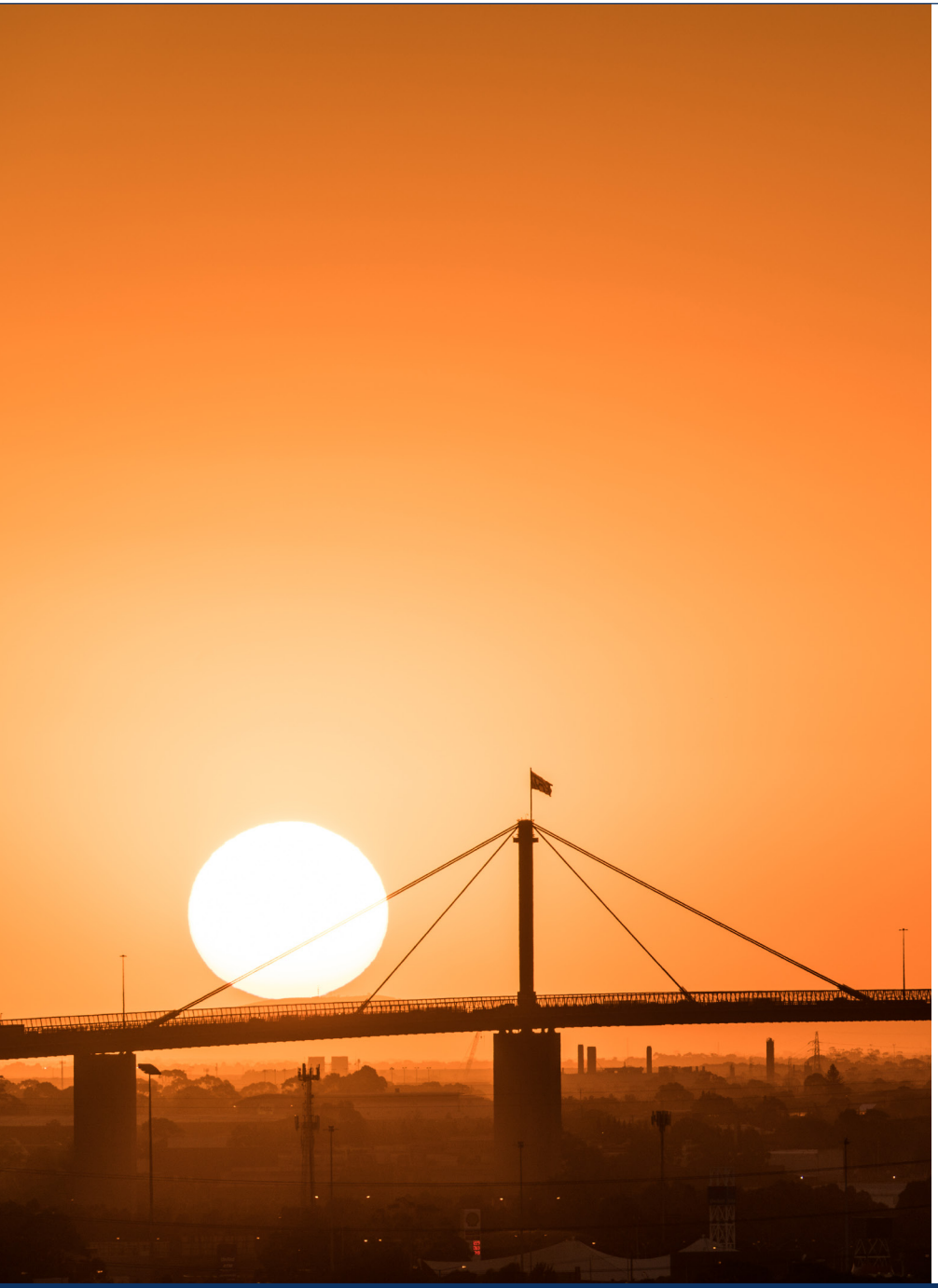
1. Key climate change concepts
2. Future global outlook
3. Overview of Australia's changing climate
4. Outlook for Australia
5. Key questions to guide boardroom discussions

KEY INSIGHTS

Australia's average temperature has risen more than the average temperature of the globe. Australia has warmed by more than 1.5°C since the mid-19th century, whereas the globe has warmed by about 1.2°C.

Climate risks are significant for Australian organisations, communities, and ecosystems. A large component of these risks is from increases in the frequency and intensity of extreme climate events.

Global emissions of carbon dioxide are not yet declining, and global warming is expected to exceed 1.5°C around the end of the decade. Passing 1.5°C of global warming will bring significant additional climate hazards, including more extreme events.



How is the global temperature tracking?

- 2024 was the warmest year on record globally.[1] The temperature of the Earth's surface, averaged across the whole globe, was greater than for any year in the observational record.
- A better indicator of climate change than the temperature of a single year is the temperature of the globe averaged over decades. It is used to track past climate change, in projections of future climate change and in international agreements seeking to limit climate change.
- Since the mid-19th century, the global average temperature has risen by about 1.2°C due to greenhouse gas emissions from human activities. This increase is enough to have caused significant changes to the climate, such as more frequent heatwaves, altered rainfall patterns, more intense storms, increased frequency and severity of fire weather and rising sea levels.
- In 2015, 196 countries*, including Australia, adopted the Paris Agreement. The treaty aims to limit the increase in global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C.
- With current policies, the world is on a path to around 3°C of warming by the end of the century.[2] Without an immediate significant reduction in global emissions, the 1.5°C threshold is likely to be breached around the end of this decade. If global emissions continue at their current rate, the 2°C global warming limit may be breached around the middle of the century.

* The United States is currently not a party to the treaty, having withdrawn in January 2025.

1. World Meteorological Organization (2025) **WMO confirms 2024 as warmest year on record at about 1.55°C above pre-industrial level**
2. United Nations Environment Program (2024) **Emissions Gap Report 2024 (UNEP)**

1. Key climate change concepts

Since the mid-19th century, the global average temperature has increased by about 1.2°C due to emissions of greenhouse gases from human activities. 2024 was the warmest year on record globally. Average global sea levels have risen by around 22cm since 1900, there have been changes to seasonal patterns such as the monsoon, and some types of extreme weather events have become more intense and frequent.

Around 90 per cent of the world's carbon dioxide (CO_2) emissions – the largest contributing greenhouse gas – come from burning fossil fuels, mainly for electricity, heat and transport. Other human activities, such as some agricultural and manufacturing processes, emit additional CO_2 into the atmosphere. CO_2 concentrations in the Earth's atmosphere are now at their highest since records began and are likely the highest for at least two million years.

As a signatory to the Paris Agreement, Australia is committed to contributing to efforts to hold 'the increase in the global average temperature to well below 2°C above pre-industrial levels' and pursue efforts 'to limit the temperature increase to 1.5°C above pre-industrial levels'.

Key terms explained

Net zero emissions: A situation where the amount of a greenhouse gas that is being released into the atmosphere is balanced, on an ongoing basis, by removal of the greenhouse gas from the atmosphere. Meeting the goals of the Paris Agreement requires net zero CO_2 emissions (together with reductions in emissions of non-CO_2 greenhouse gases). The most realistic ways of achieving net zero CO_2 emissions involve reducing emissions to as close to zero as possible and offsetting the remaining emissions by removing an equal amount of CO_2 from the atmosphere and storing it for centuries. The removal and storage of atmospheric CO_2 requires the deployment of new Carbon Dioxide Removal technologies and potentially the enhancement of natural sinks of carbon.

Carbon Dioxide Removal (CDR): Human-facilitated activities that remove CO_2 from the atmosphere. For CDR to be effective at lowering levels of CO_2 in the atmosphere, it must also involve locking the removed CO_2 away from the atmosphere for centuries using geological reservoirs, the ocean or manufactured products as long-term storage. CDR is different to carbon capture and storage (CCS) technologies that seek to prevent emissions from entering the atmosphere in the first place.

Overshoot scenario: A scenario where the increase in global average temperature temporarily exceeds a global warming limit but is later reduced to a temperature below the limit. The required cooling of the planet can be achieved by sustained removal of CO_2 from the atmosphere using CDR. However, the deployment of CDR on a scale large enough to correct an overshoot will be challenging as this involves rapidly developing and deploying new technologies across nations.

2. Future global outlook

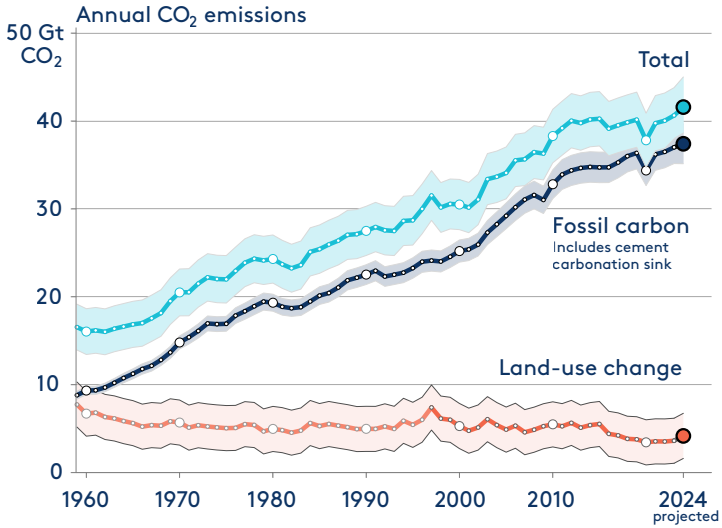
Global emissions are not yet declining, risking further climate destabilisation

The climate can begin to stabilise only once global greenhouse gas emissions reach net zero. Once net zero is reached, the global average temperature will begin to stabilise within decades. However, significant changes in other aspects of the climate will continue for centuries.[3] These include climate changes over parts of Australia and global and regional increases in sea level. A net zero state can only be reached once the global energy system and economy are almost entirely decarbonised and Carbon Dioxide Removal (CDR) technologies that remove and store atmospheric carbon for many centuries are developed and deployed.[4]

These measures need to be adopted urgently if the world is to have a chance of limiting global warming to 1.5°C. To achieve this goal, annual global CO_2 emission must be cut by 43 per cent by 2030 relative to 2019 levels[5] and net zero CO_2 emissions reached by 2050, or sooner. Achieving the global 2°C limit requires a slower emissions reduction rate but still necessitates that emissions are on a trajectory to reach net zero in the early 2070s.[6]

Global CO_2 emissions are not yet declining (see **Figure 1**). The most recent assessment shows annual fossil fuel emissions of CO_2 continuing to rise, reaching a record high in 2024.[7] However, the world's annual emissions due to changes in land use have decreased, causing total (fossil fuel plus land use change) emissions to level off over the past decade after a century of growth.

FIGURE 1: Global CO_2 emissions from fossil fuel use and changes in land use



Sourced from the **Global Carbon Project 2024** (used with permission under the **CC-BY 4.0** license)

3. King, AD, et al. (2024) **Exploring climate stabilisation at different global warming levels in ACCESS-ESM-1.5**, Earth Systems Dynamics
4. Lenton, A, Brent, K, (2024) **Plans to stabilise Earth's climate rely on emerging carbon removal technology – we need to get moving**, The Conversation
5. New Insights in Climate Science (2023) **Overshooting 1.5°C is fast becoming inevitable**
6. Intergovernmental Panel on Climate Change (2022) **Sixth Assessment Report: Climate Change 2022 – Mitigation of Climate Change**
7. Global Carbon Project (2024) **Global Carbon Budget 2024**

If the world continues to emit CO_2 at the current rate, the 1.5°C global warming limit will be breached around the end of this decade. Preventing this will be challenging as the CO_2 emissions expected over the remaining lifetime of existing fossil fuel infrastructure are enough to cause the world to warm to above 1.5.[8] Unless deployment of CDR is both rapid and large-scale, limiting warming to 1.5°C will require retiring some existing infrastructure before the end of its design lifetime. Building new fossil fuel infrastructure would further increase the need for CDR and early retirement of existing facilities.

Another challenge faced by efforts to limit global warming relates to natural carbon sinks. Historically, land and ocean ecosystems have absorbed about half of human CO_2 emissions. However, as CO_2 levels in the atmosphere rise and the climate changes, these ecosystems may become less effective at absorbing CO_2. This would amplify the warming effect of emissions, requiring deeper and faster emissions cuts to stabilise the climate.

It is increasingly likely that stabilising global warming at 1.5°C, and perhaps 2°C, will be achieved only via an overshoot scenario, where warming exceeds 1.5°C or 2°C temporarily. While it may be theoretically possible to reduce the global average temperature back below these limits, it would be difficult. The physical risks of overshoot scenarios are greater than for stabilising warming below a limit. Temporary warming to above a limit may cause severe impacts, such as damage to marine ecosystems that could reduce biodiversity and food security,[9] that will not be reversed as temperatures later fall.

Overshooting also carries a greater risk of triggering global climate 'tipping points', which could lead to large-scale, relatively sudden, irreversible changes in the climate system.

Climate tipping points

Failure to achieve rapid and deep cuts in global greenhouse gas emissions may have severe consequences as every increment of global warming increases the risk that the global climate will pass a 'tipping point'.[10] Global climate tipping points are relatively sudden, self-sustaining and effectively irreversible changes to the global climate triggered by global warming. Examples include:[11]

- Accelerated loss of the Greenland and Antarctic ice sheets, leading to greater and more rapid sea level rise.
- Dieback of the Amazon rainforest, leading to accelerated global warming.
- The circulation of the Atlantic Ocean weakening, leading to major changes to the climate of many different regions of the world.

Further global warming increases the risk of triggering tipping points. Triggering one tipping point could set off others, causing a cascade of irreversible changes to the global climate.

More research is needed to better pinpoint the global warming levels that could trigger specific tipping points and understand their potential impacts on Australia. However, current scientific knowledge makes it clear that tipping points could have significant consequences and should be factored into climate risk analyses. Tipping points may directly affect Australia's climate and indirectly affect the country through disruption to global trade, migration and conflict.

8. New Insights in Climate Science (2023) **A rapid and managed fossil fuel phase-out is required to stay within the Paris Agreement target range**
9. Santana-Falcon, Y, et al. (2024) **Irreversible loss in marine ecosystem habitability after a temperature overshoot**, Communications Earth & Environment
10. CSIRO (2024): **Understanding the risks to Australia from global climate tipping points**
11. Armstrong McKay, DI, et al. (2022): **Exceeding 1.5°C global warming could trigger multiple climate tipping points**, Science

3. Overview of Australia's changing climate

Climate-related hazards are increasing in Australia

The most recent Intergovernmental Panel on Climate Change (IPCC) Assessment Report shows the socioeconomic costs of climate variability and climate change have been increasing in Australia. This is due to a combination of chronic hazards and acute hazards (**Figure 2**).

The risk of climate-related impacts arises from a combination of climate-related hazards and the vulnerability and exposure of human and natural systems. As the frequency and intensity of climate-related hazards increase, physical climate risks may also increase for the environment, community and businesses.

Physical risks to a business may include damage and/or financial loss to organisational assets, supply chains, operations, and markets due to exposure and vulnerability to climate-related hazards. For example, a business with a factory in a low-lying coastal area may be exposed to more frequent coastal inundation due to sea-level rise. If the factory contains critical machinery that is easily damaged by floodwater and is expensive, hard to insure, and time-consuming to replace, the business is also vulnerable and, therefore, at risk.

FIGURE 2: Key examples of chronic and acute hazards

Chronic hazards	Acute hazards
Increasing mean temperatures	Heatwaves
Rising sea levels	Storm tides
Increasing ocean acidification	Marine heatwaves
Increasing sea surface temperatures	Floods
Decreasing mean rainfall	Storms and tropical cyclones
	Bushfires

A SUMMARY OF KEY CLIMATE CHANGES IN AUSTRALIA

CHANGES IN AVERAGE CONDITIONS

On average, Australia has warmed by around 1.5°C since 1910.* This may seem like a small increase in temperature, but it represents a significant and impactful change to our climate – most years are now warmer than almost any year during the 20th century. The interior of the country has warmed more than areas closer to the coast.

The warming of Australia's climate is expected to continue over the coming decades. 2019 was Australia's hottest year on record. By the 2050s, this could be an average year.

Climate change is reducing the amount of rain that falls across southern Australia. Rainfall in the cool season (April to October) has declined by around 16 per cent since 1970 in the south-west of Australia. Cool season rainfall has declined by around 9 per cent since 1994 in the south-east of Australia. These trends are expected to continue.

Globally, oceans have risen by 22cm since 1900. Sea level rise has been accelerating, and half of this rise has occurred since 1970. Rates of sea level rise since 1993 have varied around Australia, with the largest increases to the north and south-east of the Australian continent. Sea level rise will continue throughout the 21st century and beyond.

CHANGES IN EXTREME CLIMATE EVENTS

The frequency of extreme heat events has increased. Extreme heat kills more people than any other natural hazard. The future will bring even more heatwaves and fewer cool days and nights.

There has been a decrease in the number of tropical cyclones observed since at least 1982. This trend is expected to continue. However, when tropical cyclones do occur, they are more likely to be intense.

Heavy rainfall has become 10 per cent more intense in recent decades in some regions, with associated flash flooding risks. This trend is expected to continue.

Since the 1950s, fire seasons have generally become more intense and are starting earlier and lasting longer. These trends are expected to continue.

The oceans around Australia have warmed, leading to an increase in the frequency of marine heatwaves since the 1970s. Marine heatwaves will become even more frequent, longer and more intense in the future.

Created from information in **State of the Climate 2024 (Bureau of Meteorology and CSIRO report)**

* This refers to warming of the Australian land surface since 1910. It is different from the 1.5°C of global warming since the mid-19th century referred to by the Paris Agreement, which has not yet been reached. The Australian land surface has already warmed by more than 1.5°C since the mid-19th century. The global average temperature has not warmed as much (by ~1.2°C), mainly because it includes temperatures over the oceans, which warm more slowly than temperatures over land.

4. Outlook for Australia

Further global warming will bring further climate risk

Future climate changes will have far-reaching effects on Australia's environment, economy and people. Significant impacts are already being experienced with the current level of global warming (1.2°C). Due to time lags in the climate system, some future changes are 'locked in' and unavoidable. For example, projections show sea level rise continuing until well beyond the end of this century.

The impacts of future climate change will depend on the level of global warming the world reaches. If global warming reaches 3°C, Australia could face extremely severe consequences (see **Table 1** for examples of impacts under this scenario). If the Paris Agreement goals of limiting global temperature increase to 1.5°C or well below 2°C relative to pre-industrial levels are met, the impacts of climate change will be more limited, but still significant, requiring substantial investment in mitigation and adaptation.

Global emission reductions, and hence global warming, will be influenced by government policies and climate action by the public, private and not-for-profit sectors. Some climate change risks may also be mitigated if federal, state and territory governments, businesses, and communities are able to adapt and respond to the changing climate. Australia's ability to adapt could also be affected by how well other countries adapt, especially those that Australia depends on for trade and resources.

Compound events and cascading impacts

A major climate change risk for Australia comes from 'compound events' and 'cascading impacts'. A compound event is when multiple extreme weather events occur at the same time and place, in sequence, or simultaneously in different locations. The impact of a compound event is often greater than if its component events had occurred independently of each other. Cascading impacts occur when the initial impact of a weather or climate event on a socioeconomic system, such as a city or a company, has knock-on effects that cause other impacts. The total impact is much greater than if there had been no knock-on effects.

A notable example is Tasmania's experience in 2015-2016. A warm, dry October–April season combined with a large number of lightning strikes in January and February, resulted in bushfires that burned more than 120,000 hectares, costing the state more than $50 million. In late January, heavy rainfall caused flooding in other parts of the state, forcing emergency services to simultaneously manage both fires and floods. The extended dry period also further reduced low water levels in Tasmania's hydro-electric dams, reducing power generation capacity. In addition, a marine heatwave along Tasmania's east coast affected fisheries. Together, these events impacted key industries, such as agriculture, forestry, fishing, and energy sectors, and reduced Tasmania's Gross State Product to 1.3 per cent, well below the anticipated growth of 2.5 per cent.

Climate change is expected to make extreme events more frequent and intense, increasing the risk of compound hazards and cascading impacts. Climate risk analysis must consider interconnected risks from interconnected hazards, not just individual risks from weather events in isolation.

Created from information in **Extremes, Abrupt Changes and Managing Risks (Chapter 6 in IPCC Special Report on the Ocean and Cryosphere in a Changing Climate)**

Physical climate risks are projected to increase for a wide range of systems, sectors and communities. **Table 1** outlines nine key climate change risks identified by the IPCC, and potential implications for Australian industries. The Australian government is conducting a National Climate Risk Assessment (NCRA) to identify priority risks for Australia.

TABLE 1: Key climate change risks and examples of impacted Australian industries

Impact	Examples of Australian industries impacted	Risk for 1.5°C of global warming	Risk for 2°C of global warming	Risk for 3°C of global warming
Loss and degradation of coral reefs and associated biodiversity and ecosystem service values due to ocean warming and marine heatwaves	Marine fisheries and aquaculture, Tourism	Very high	Very high	Very high
Loss of alpine biodiversity due to less snow	Tourism	High (moderate to high with moderate adaptation)	High to very high	Very high
Transition or collapse of alpine ash, snowgum woodland, pencil pine and northern jarrah forests in southern Australia due to hotter and drier conditions with more fires	Tourism, Forestry, Emergency Management	Moderate to high (moderate with moderate adaptation)	High (moderate to high with moderate adaptation)	Very high (high to very high with moderate adaptation)
Loss of kelp forests in southern Australia due to ocean warming, marine heatwaves and overgrazing by climate-driven range extensions of herbivore fish and urchins	Tourism	High to very high	Very high (high to very high with moderate adaptation)	Very high
Loss of natural and human systems in low-lying coastal areas due to sea level rise	Coastal infrastructure owners and operators	Moderate	Moderate to high (moderate with moderate adaptation)	High to very high (high with moderate adaptation)
Disruption and decline in agricultural production and increased stress in rural communities in southwestern, southern and eastern mainland Australia due to hotter and drier conditions	Agriculture, Supply chains	Moderate	Moderate to high (moderate with moderate adaptation)	Very high (high to very high with moderate adaptation)
Increase in heat-related mortality and morbidity for people and wildlife due to heatwaves	Health	Moderate to high (moderate with moderate adaptation)	High (moderate to high with moderate adaptation)	Very high
Compound events involving cascading, and aggregate impacts on cities, settlements, infrastructure, supply chains and services due to wildfires, floods, droughts, heatwaves, storms and sea level rise	Critical infrastructure, Supply chains, Transport	High to very high (high with moderate adaptation)	High to very high (high with moderate adaptation)	Very high (high to very high with moderate adaptation)
Inability of institutions and governance systems to manage climate risks	All industries	High to very high (moderate to high with moderate adaptation)	High to very high (high with moderate adaptation)	Very high (high to very high with moderate adaptation)

Created from information in **Australasia (Chapter 11 in Contribution of Working Group II to the Sixth Assessment Report of the IPCC)**

5. Key questions to guide boardroom discussions

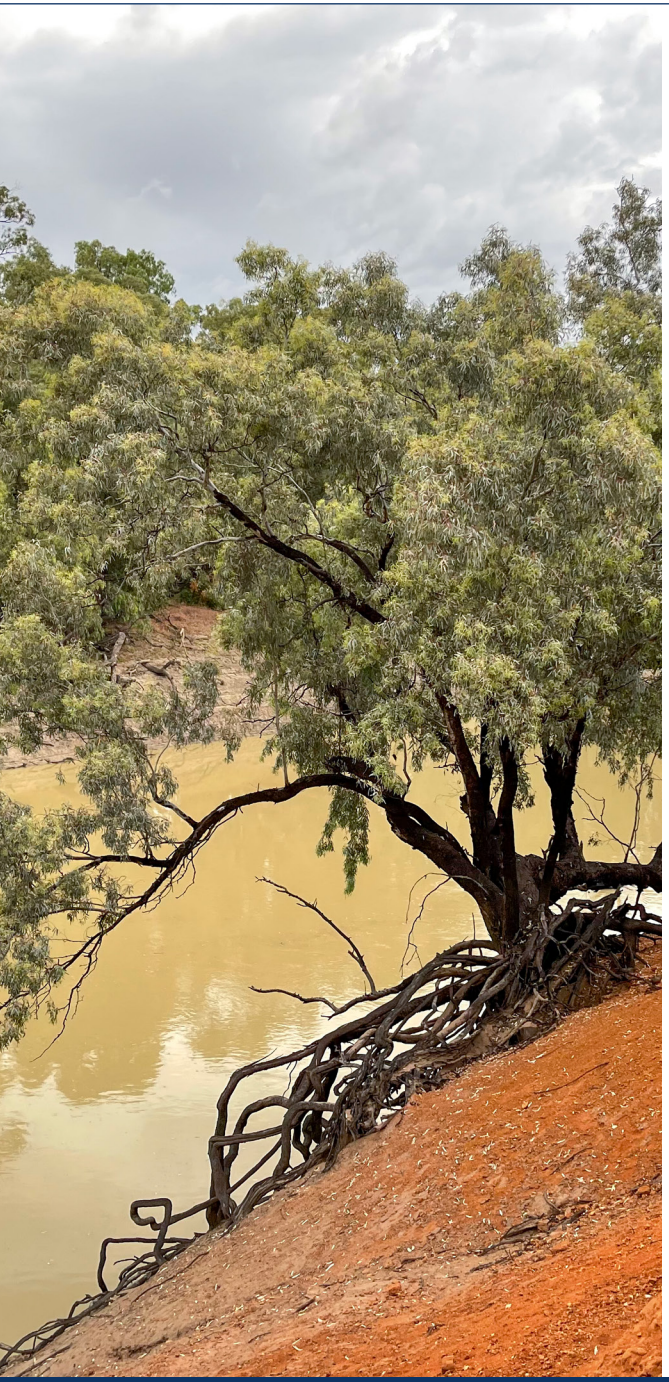
1. What is our process for integrating the latest climate knowledge into our strategy and risk management approaches? Is a 'storylines' approach appropriate?
2. What process do we need to follow to undertake robust scenario analysis for our organisation? Are our chosen scenarios aligned with the Paris Agreement goals, and do they also consider alternative global projections with increased greenhouse gas emission concentrations?
3. What scientific assumptions are underlying our transition plan?
4. How is the board/management team upskilling themselves on physical risks and their material implications for our organisation?
5. What expertise do we need internally and/or can access externally to support us to understand and manage climate change impacts and risks?

What is a storylines approach?

When managing climate risk, it would be useful to know the likelihoods of different future climate outcomes. Given the complexity of the climate system, precise probabilities are often unavailable. Instead, an approach should be taken that avoids false precision and maladaptation.

One such approach is 'storylines', which focuses on plausible scenarios with narratives, rather than probabilities. Storylines explore how events might unfold, drawing on our knowledge of the past, present and future. They highlight key drivers, their interactions, and the underlying 'causal network' behind climate change and its impacts, including exposure and vulnerability to risk. The storylines approach aims to consider the full range of possibilities and can be tailored to specific concerns and decisions.

Storylines still compare different scenarios of human development and future global warming, but they emphasise narrative-based insights rather than precise numbers or probabilities.



Further resources

Guides and reports

- **A director's guide to mandatory climate reporting | Version 2** – AICD, Deloitte, and MinterEllison (2024)
- **Principles for setting climate targets: A guide for Australian boards** – AICD, Insurance Council of Australia, and Herbert Smith Freehills (2024)
- **State of the Climate 2024** – CSIRO and Bureau of Meteorology (2024)
- **Global Carbon Budget 2024**

Intergovernmental Panel on Climate Change (IPCC) resources

- **Regional Fact Sheet – Australasia** – IPCC Working Group I (2021)
- **Climate Change 2022: Impacts, Adaptation and Vulnerability (Chapter 11 – Australasia)** – IPCC Working Group II (2022)
- **Fact Sheet – Carbon Dioxide Removal** – IPCC Working Group III (2022)

Articles and research

- **Plans to stabilise earth's climate rely on emerging carbon removal technology – we need to get moving** – The Conversation (2024)
- **Dangerous climate tipping points will affect Australia. The risks are real and cannot be ignored** – CSIRO (2024)
- **Storylines: A science-based method for assessing and measuring future physical climate-related financial risk** – Accounting and Finance (2024)

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ACKNOWLEDGEMENT OF COUNTRY

The Australian Institute of Company Directors and CSIRO acknowledge the Traditional Custodians of the Lands on which we are located and pay our respects to the Elders, past and present. We acknowledge the First Nations people across this Country and recognise their unique cultural and spiritual relationships to the Skies, Land, Waters, and Seas and their rich contribution to society.

ABOUT THE AICD

The AICD is committed to strengthening society through world-class governance. We aim to be the independent and trusted voice of governance, building the capability of a community of leaders for the benefit of society. Our membership includes directors and senior leaders from business, government and the not-for-profit sectors.

ABOUT CSIRO

As Australia's national science agency and innovation catalyst, CSIRO is solving the greatest challenges through innovative science and technology. Together with its research partners, CSIRO provides the best available climate science to enable business and government to make better decisions.

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