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Selecting climate scenarios

Key criteria and principles

Department of Climate Change,
Energy, the Environment and Water

NSW GOVERNMENT

Acknowledgement of Country

Department of Climate Change, Energy, the Environment and Water acknowledges the Traditional Custodians of the lands where we work and live.

We pay our respects to Elders past, present and emerging.

This resource may contain images or names of deceased persons in photographs or historical content

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Artist and designer Nikita Ridgeway from Aboriginal design agency Boss Lady Creative Designs created the People and Community symbol.

Cover photo: Metz Solar Farm, New England. Mike Terry/DCCEEW

Published by:
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ISBN 978-1-76186-206-9
EH 2026/0172 June 2026

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Contents

List of tables

Introductory note

This document supports New South Wales Government agencies and stakeholders in the appropriate, consistent and transparent selection of climate scenarios.

Climate scenarios describe different plausible future conditions based on varying assumptions about greenhouse gas emissions, socio-economic development and policy choices. This guidance uses shared socio-economic pathways (SSPs) as the primary scenario framework for selecting and interpreting future climate conditions.

SSPs are a scenario framework developed by the international research community (Moss et al. 2010; O'Neill et al. 2013; Riahi et al. 2017) and adopted by the Intergovernmental Panel on Climate Change (IPCC) to explore how different socio-economic development pathways may influence future greenhouse gas emissions, climate change and adaptation challenges.

Glossary of terms

Term	Definition
Adaptation[1]	Adjustments in human or natural systems in response to actual or expected climate change to reduce harm or take advantage of opportunities.
Asymmetry of consequences[2, 3]	The idea that underestimating climate risks can lead to greater harm than overestimating them, particularly for high-impact risks.
Baseline (historical period)[1]	A past reference period used to compare and assess future climate changes.
Climate model[2, 4]	A mathematical representation of the climate system used to simulate past, present and future climate conditions.
Climate projections[2]	Simulated responses of the climate system to emissions and climate scenarios, produced using climate models to show how climate variables may change.
Climate scenario[2]	A plausible description of how the future may develop based on assumptions about socio-economic development, emissions, technology and policy choices.
Decision context[3]	The specific situation, purpose and conditions under which a decision is made, including risks and objectives.
Emissions[2]	The release of greenhouse gases into the atmosphere from human or natural sources.
Ensemble (model ensemble)[2]	A collection of multiple climate model simulations used to capture a range of possible future outcomes.
Ensemble mean[2]	The mean result across multiple climate models, used to summarise projections.
Extreme events[2]	Climate or weather events such as heatwaves or floods that occur infrequently but have high impacts.
Greenhouse gases[2, 4]	Gases in the atmosphere that trap heat and contribute to warming (for example, carbon dioxide and methane).
Higher-emissions pathway[2]	A scenario associated with relatively high greenhouse gas emissions and higher levels of warming over time. For this guidance, higher-emissions pathway refers to SSP3-7.0 or SSP5-8.
Irreversibility[1]	A state where changes cannot be undone, or only over very long timescales.
Lock-in risk[1]	The risk that decisions create long-term exposure or limit future adaptation options, making it difficult to change later.

Term	Definition
Maladaptation[1]	Actions that may lead to increased risk of adverse climate-related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future.
Model uncertainty[2]	Uncertainty arising from differences in how climate models represent the climate system.
Natural variability[2]	Natural fluctuations in climate that occur without human influence (for example, cycles of the El Niño-Southern Oscillation).
Path dependency[1]	The way earlier decisions shape or limit future options and outcomes.
Physical climate risk[1, 5]	Risks arising from the direct physical impacts of climate change, such as heat, flooding or sea-level rise.
Radiative forcing[2]	A measure of the change in energy balance in the Earth's atmosphere caused by greenhouse gases or other factors.
Risk appetite[3]	The amount and type of risk an organisation is willing to accept in pursuit of its objectives.
Scenario uncertainty[2]	Uncertainty about the future caused by unknown human choices, such as emissions and policy decisions.
Sensitivity testing[3]	Testing how outcomes change under different assumptions or scenarios to assess robustness.
Shared socio-economic pathways (SSPs)[2]	Standardised global socio-economic pathways used to explore how different development futures may influence greenhouse gas emissions, climate change and adaptation challenges.
SSP1-2.6[2]	A low-emissions SSP scenario consistent with strong mitigation and sustainability.
SSP2-4.5[2]	A medium-emissions, 'middle-of-the-road' SSP scenario based on current trends.
SSP3-7.0[2]	A high-emissions SSP scenario with regional rivalry and limited climate action.
SSP5-8.5[2]	A very high-emissions SSP scenario with fossil-fuel intensive development.
Stress testing[3, 5]	Evaluating how systems perform under extreme or adverse conditions.
Structured decision-making[3]	A systematic and transparent process for making decisions that considers objectives, risks and uncertainty.
Time horizon[2]	The time period over which impacts and decisions are considered.
Transition risk[5]	Risks related to the transition to a low-emissions economy, including policy, market and technology changes.
Uncertainty[2]	A state of incomplete knowledge about future outcomes, including uncertainty arising from climate scenarios, climate models and natural variability.

Sources: 1. IPCC 2022; 2. IPCC 2021; 3. ISO 2018; 4. NASA 2023; 5. TCFD 2027.

1. About this document

This document serves as guidance for government agencies and practitioners who use climate scenarios to inform decisions where future climate conditions may materially affect outcomes. Future climate conditions are expected to differ from those represented in the historical record. As a result, this guidance emphasises the use of forward-looking climate scenarios and projections to inform decisions. Historical climate information may still be used as a benchmark to provide context for projected change, but it should not be relied on to represent future conditions.

The guidance focuses on selecting climate scenarios in a principled and transparent way that is appropriate to the specific decision. It draws from a technical review of key criteria and principles for selecting climate scenarios (Section 8), as well as consultation with NSW Government agencies. The review highlighted that no single scenario is suitable for all applications and that multiple scenarios are often required, particularly for long-lived assets, critical infrastructure, coastal hazards, and decisions that may create long-term exposure, constrain future adaptation options, or involve potentially irreversible impacts.

The key criteria and associated principles are translated into explicit guidance by:

- linking key criteria to suggested minimum scenario requirements
- identifying typical decision contexts and the scenarios to consider in each
- distinguishing (the limited) situations where the use of a single scenario may be acceptable from those situations where it is not appropriate
- showing how decision type, time horizon, risk appetite and uncertainty shape scenario choice.

This document responds to growing demand for practical guidance on climate scenario selection, particularly following the release of projections from the NSW and Australian Regional Climate Modelling project (NARCliM; AdaptNSW 2026a) and the NSW coastal erosion and inundation assessment (DCCEEW).

Who is this document for:

- State and local government agencies, statutory authorities and industry when considering climate change in risk assessment, strategic planning, adaptation and disaster assessments, and service delivery.

2. How to use this document

The recommended way to use this document is to:

- Start with Section 3 to understand shared socio-economic pathways (SSPs), which are the climate scenarios widely applied across NSW Government.
- Use Section 4 to structure your decision-making process.
- Apply the criteria in Section 5 to identify the minimum climate scenario requirements for your decision. This section sets out key **principles**, **suggested minimum requirements** for each criterion, and **examples** for illustrative purposes. Refer to Section 7 for specific examples of how the criteria are applied in practice.
- Consult the technical review (Section 8) where justification is required.
- Note: Section 6 provides a look-up table of criteria and suggested minimum requirements for selecting scenarios.

Suggested minimum requirements

Suggested minimum requirements refer to the baseline scenarios and selection criteria relevant to a given decision context. Within this document, they define both the minimum set of scenarios required for each decision criterion and, in the examples (Section 7), the minimum baseline scenarios for specific applications. In all cases, the suggested minimum requirements represent a suggested starting point rather than a complete or limiting set of scenarios.

3. Climate scenarios

Climate change is often communicated using global warming levels, such as 1.5°C or 2°C above pre-industrial levels, which provide a useful way to describe temperature-related outcomes. However, for decision-making, this guidance document uses climate scenarios based on SSPs, which are widely applied across NSW Government.

The SSPs provide a comprehensive framework for exploring potential future climate conditions (IPCC 2021), by outlining different socio-economic futures, such as varying levels of population growth, economic development and policy choices. Each SSP includes an approximate level of radiative forcing reached by the year 2100, expressed in units of watts per square metre (W/m^2). For example, SSP2-4.5 represents a 'middle-of-the-road' future in which current development trends continue, and emissions stabilise at intermediate levels, leading to approximately 4.5 W/m^2 of radiative forcing by 2100.

Using a range of climate scenarios supports more robust and transparent decision-making by accounting for uncertainty in future socio-economic development and emissions pathways. The IPCC emphasises that no single scenario represents a most-likely future and that climate outcomes diverge over time depending on societal choices. Considering multiple scenarios enables decision-makers to test the robustness of decisions, identify vulnerabilities and thresholds, and avoid over-reliance on a single set of assumptions.

Understanding shared socio-economic pathways (SSPs)

In the shorthand SSPx-y, the SSPx refers to the shared socio-economic pathway (the socio-economic storyline), and y refers to the approximate radiative forcing level reached by 2100 (in W/m^2).

Radiative forcing is a measure of the Earth's energy imbalance, that is, the net change in energy entering and leaving the climate system. Higher radiative forcing means more energy is retained, which drives greater warming and generally larger changes in climate hazards over time. The differences between 2.6, 4.5, 7.0 and 8.5 W/m^2 therefore matter because they represent substantially different levels of long-term warming and risk, particularly after mid-century (2041–2060, centred on 2050).

In New South Wales the SSPs have been described as follows, and this terminology is used in this document accordingly:

- **SSP1-2.6**: a low-emissions scenario consistent with strong mitigation and sustainability
- **SSP2-4.5**: a medium-emissions, 'middle-of-the-road' scenario based on current trends

- **SSP3-7.0**: a high-emissions scenario with regional rivalry and limited climate action
- **SSP5-8.5**: a very high-emissions scenario with fossil-fuel intensive development.

Note that SSP1-1.9 and SSP4 are not currently used in NSW climate projection datasets or guidance frameworks.

4. Structured decision-making

Scenario selection should be deliberately aligned with the purpose of the decision and the risks being assessed. Users should select scenarios according to a structured decision-making process.

The following process is based on the key criteria detailed in Section 5:

1. Setting the context – clearly defining the decision context and purpose.
2. Time horizons – identifying the relevant time horizon and asset or policy lifetime.
3. Risk appetite – assessing the severity of consequences and risk appetite associated with the decision.
4. Model uncertainty – considering the nature and level of climate uncertainty relevant to the risks being assessed.

Note: The steps 1 to 4 are presented in a logical sequence to support decision-making. However, users may adapt the order as appropriate to their specific context, decision type, or stage of analysis.

Scenario selection should reflect the level of risk by considering several fundamental factors, particularly when deciding whether to include higher-emissions pathways. A precautionary approach is warranted where decisions are difficult or costly to reverse, especially for long-lived assets, land-use planning and strategic policy. In these situations, choices shape exposure for decades and a broader range of futures is needed to reduce maladaptation risk. Early decisions can also create path dependency and 'lock-in', constraining future options and increasing the cost or complexity of adaptation. In these cases, testing against higher-emissions pathways helps ensure decisions remain robust under more extreme conditions.

It is also important to recognise the asymmetry of consequences. For hazards such as extreme heat, flooding and coastal inundation, underestimating risk can lead to severe and sometimes irreversible impacts, often outweighing the costs of overestimating risk. This supports the inclusion of higher-emissions pathways, even where future emissions pathways remain uncertain.

Together, these considerations support a structured decision-making process in which a narrower range of scenarios may be suitable for short-term, low-consequence or reversible decisions; while long-term, high-consequence or inflexible decisions require inclusion of higher-emissions scenarios to ensure outcomes remain robust across a wide range of plausible futures.

Adaptation pathways can further support decision-making by enabling a staged approach under uncertainty. While climate scenarios define plausible future conditions, adaptation pathways help decision-makers plan how and when to respond as risks emerge or intensify. This includes identifying decision points, triggers or thresholds (such as changes in hazard frequency or severity) that signal when additional actions may be required. Used together, these approaches link scenario analysis to timely, practical responses and support more flexible and resilient outcomes.

5. Selecting the scenarios

This section sets out the key criteria for selecting climate scenarios and explains how each criterion influences the suggested minimum requirements.

5.1 Setting the context

Setting the context for selecting the climate scenario(s) helps explain why different SSPs may be needed. Scenario selection depends on the application, such as mitigating emissions, managing physical climate risks, or preparing for economic and policy changes. The context should take into account where impacts may occur, how exposed or vulnerable places and assets are, and whether impacts are gradual, acute, compounding or cascading. Table 1 summarises the main decision contexts, how climate scenarios are applied in each context, and the suggested minimum baseline scenarios.

While the NSW Government is committed to achieving a net zero emissions future, emissions reduction remains a shared global challenge. Historical emissions have already contributed to a warming baseline, meaning some degree of climate change is unavoidable. New South Wales is therefore expected to experience ongoing increases in the frequency and severity of climate impacts, including flooding, bushfires, rising temperatures and sea-level rise. In this context, decisions affected by physical climate risks are expected to consider higher-emissions pathways to address these future challenges.

Within this guidance, SSP3-7.0 is generally applied as the primary high-emissions scenario for physical climate risk assessment. SSP5-8.5 may be used for sensitivity testing or where understanding upper-bound physical impacts is important, particularly for long-lived assets or decisions involving potentially irreversible consequences.

Principle

Scenario choice is context-specific and reflects the purpose of the decision, type of risk, and policy or legislative requirements. No single SSP is universally appropriate.

Table 1 Setting the context: suggested minimum scenario requirements

Decision context	Application	Suggested minimum requirement
Mitigation/net zero alignment	Policy development, emissions pathways	Use SSP1-2.6 as the primary scenario and use additional SSPs for sensitivity testing
Physical climate risk	Adaptation, infrastructure, land-use, emergency management	Include at least 2 SSPs, with SSP2-4.5 as the suggested minimum scenario, and the other scenario associated with a higher-emissions pathway (SSP3-7.0 or SSP5-8.5)

Decision context	Application	Suggested minimum requirement
Transition risk	Financial disclosure, policy stress-testing	Use SSP1-2.6 or SSP2-4.5 as the primary scenario and use additional SSPs for sensitivity testing
Hybrid risk	Combined physical climate and transition risk	Use at least 2 SSPs, including one associated with a higher-emissions pathway (SSP3-7.0 or SSP5-8.5)

Examples

- For decisions involving long-lived assets, higher-emissions SSPs are to be included because the assets are difficult and costly to modify once built. Decisions made today can shape exposure to climate risk for decades or longer. If future climate outcomes are more severe than assumed during planning, designing only for moderate scenarios could result in infrastructure or services that are unsafe, unfit for purpose, or require costly retrofitting in the future. Including higher-emissions pathways helps ensure that long-lived assets remain robust under a wider range of plausible future conditions.
- For decisions aligned with mitigation policy objectives, SSP1-2.6 is typically used.
- Where consequences include irreversible damage or potential loss of life, reliance on a single scenario or on SSP1-2.6 alone is not acceptable. The impacts of underestimating climate risk are often far greater and more difficult to recover from than the costs of planning for more severe but plausible future conditions. Testing against higher-emissions pathways helps reduce the risk of unacceptable outcomes.

5.2 Time horizons

Time horizons are used to group future climate projections into periods over which climate change signals, uncertainties and risks differ. Time horizons strongly influence the appropriateness and usefulness of different climate scenarios, the scale and nature of risks, and the feasibility of adaptation or mitigation strategies. Appropriate time horizons depend on decision contexts, sector, and asset or system of interest; and may range from immediate operational needs to long-term strategic and intergenerational planning.

In many cases, it is necessary to consider multiple time horizons to support robust decision-making. This ensures that decisions made today do not lead to maladaptation over time, while enabling longer-term planning to identify appropriate adaptive pathways, including staged or flexible responses. Considering multiple horizons allows decision-makers to align immediate actions with long-term resilience, particularly where decisions may have lasting or irreversible consequences.

Table 2 provides time horizons used by the IPCC: 2021–2040, 2041–2060 and 2081–2100. The 2021–2040 time horizon is dominated by natural variability, while the latter time horizons increasingly reflect differences between emissions pathways.

Principle

Differences between SSPs are small during the 2021–2024 time horizon and diverge substantially after mid-century (2041–2060). The number of scenarios selected scales with time horizon and/or asset life cycle.

Table 2 Time horizons: suggested minimum scenario requirements

Time horizon/asset life	Suggested minimum requirement
2021–2040	One SSP for screening-level/initial analysis, or where assets and/or decisions are short-lived and easily reversible. Note: Scenario uncertainty is small relative to internal (natural) variability and model uncertainty between 2021 and 2040, so SSP choice has limited effect on projected outcomes. For physical risk screening, use a central pathway (e.g. SSP2-4.5) unless the decision is explicitly about mitigation/net zero alignment (use SSP1-2.6). Where the decision context warrants a more robust understanding of uncertainty, using multiple SSPs can help to better sample internal variability and model uncertainty.
2041–2060	Use at least 2 SSPs spanning lower- to higher-emissions pathways.
2060–2080	This period reflects increasing divergence between emissions pathways and may be considered alongside long-term projections where relevant to the decision context.
2081–2100	Use 2 or more SSPs, including one associated with a higher-emissions pathway. This reflects increasing divergence between emissions pathways over time and ensures that decisions remain robust under more severe but plausible future conditions, particularly where adaptation options become constrained.
Post-2100 relevant (relevant to sea-level rise)	Include SSPs associated with high- or very high-emissions pathways and explicitly test for long-term lock-in risk. This is necessary because sea-level rise is irreversible on human timescales. Decisions that do not account for these long-term consequences may lock-in exposure to impacts that cannot be feasibly managed or reversed later.

Examples

- For 2021–2040 operational planning, use SSP2-4.5.
- For strategic infrastructure planning involving assets with long life cycles, use SSP2-4.5 and SSP3-7.0.
- For coastal assets or decisions involving potentially longer-term exposure, use SSP3-7.0 and/or SSP5-8.5 to stress test decision robustness under more severe futures.

5.3 Risk appetite

Risk appetite describes the amount and type of risk an organisation is willing to accept in pursuit of its objectives (NSW Treasury 2025; Audit Office 2024; DPIE 2021). Risk appetite defines the amount and type of risk an organisation is willing to accept to achieve its objectives, while risk tolerance translates this into operational limits, identifying thresholds beyond which risks must be actively managed or escalated. Both are critical in risk assessment and are often used interchangeably, but risk appetite ultimately informs scenario selection, as it sets the strategic boundaries for decision-making under uncertainty.

Risk appetite sets these strategic boundaries by clarifying how much uncertainty and potential impact are considered acceptable, while guiding whether decisions should be precautionary, moderate or more optimistic.

Principle

Where assessed risks for decisions could involve severe or irreversible consequences, or where a high level of protection is needed, SSPs associated with higher-emissions pathways are typically included to test the full range of plausible impacts, even where future emissions pathways remain uncertain.

This reflects a precautionary approach where the consequences of failure are high. In such cases, scenario selection is driven more by the severity of potential outcomes and decision robustness than by assumptions about future emissions trajectories.

If your organisation does not have a defined risk appetite, focus scenario selection based on decision consequences. For example:

- Would failure affect public safety, legal compliance or essential services?
- Would impacts be hard or impossible to reverse later?
- Does this decision lock-in exposure or constrain future adaptation options for decades or longer?

If the answer to any of these questions is yes, the decision should include SSPs associated with higher-emissions pathways.

If the answer to any of these questions is no, SSPs associated with lower-emissions pathways may be proportionate.

Formal risk appetite statements, where they exist, can be used to confirm or document the decision, but they are not a prerequisite for applying the guidance presented in Table 3.

Table 3 Risk appetite: suggested minimum scenario requirements

Risk appetite	Planning/decision emphasis	Suggested minimum requirement
Low	Stress test decisions against severe outcomes and/or levels of protection; prioritise precautionary planning; assess robustness under adverse futures	Use SSPs associated with higher-emissions pathways (e.g. SSP3-7.0, SSP5-8.5)
Moderate	Balance planning between moderate futures and preparedness for extreme outcomes	Use SSP2-4.5 and a higher-emissions pathway for stress testing
High	Focus on optimistic outcomes while still using other pathways to reveal vulnerabilities; support innovation and opportunity-seeking	Use SSPs associated with medium-emissions pathways (SSP2-4.5) where consequences are reversible and physical climate impacts are not the primary driver of the decision

Examples

- For critical infrastructure, higher-emissions futures are typically planned for, not treated solely as extreme stress-test scenarios. This ensures that essential services remain functional under a range of plausible future conditions, including those where climate change is more severe than expected.
- For decisions that are easier to change or reverse, medium-emissions futures may be sufficient.

5.4 Model uncertainty

The first 3 criteria focus on climate scenarios, which reflect uncertainty about future human choices, such as how much greenhouse gases are emitted, how technology develops, and how societies and economies change. A separate but equally important source of uncertainty comes from the climate models themselves, as different models simulate the Earth's climate system in slightly different ways.

Climate scenarios capture uncertainty about the future, while uncertainty from climate models reflects differences in how they represent and simulate the climate system.

Even when driven by the same emissions scenario, different climate models produce a spread of plausible future outcomes (or projections). The uncertainty is explored using a group of models together, known as a model ensemble. The spread of projections from the ensemble helps identify where projections are more uncertain, and where outcomes are relatively consistent across models. Accounting for model uncertainty therefore supports more risk-informed and resilient scenario selection, particularly for adaptation decisions where tolerance for uncertainty and extreme outcomes is limited.

However, presenting decision-makers with multiple, and sometimes conflicting, model outputs introduces another challenge. Without guidance, uncertainty can become ambiguity. A common and useful approach is to summarise projections using summary statistics, such as the ensemble mean or median, to provide an overall picture of projected change. These summaries are most helpful when they are used alongside information about the full range of projections (such as the minimum, maximum or 90th, 10th percentiles of the ensemble), as extreme outcomes can be important for understanding risk. Summary statistics are most informative when uncertainty is relatively small, whereas climate projections (particularly for extreme hazards) often benefit from also considering the spread of the ensemble and the upper and lower extremes of the ensemble distribution, often referred to as the 'tails'.

Table 4 summarises the main decision contexts, rationale and the suggested minimum baseline scenarios.

Principles

- Use the full range of model results to understand risk, with summary statistics like the ensemble mean providing context rather than the basis for decisions.
- Use the ensemble of models to identify where they agree on climate changes and where there is uncertainty between them.
- Align risk appetite with deviation from the ensemble mean. For low-risk appetite (high-consequence decisions), prioritise physically plausible worst-case outcomes.
- Use the model spread to 'book-end' the risk. Where models diverge, use the full spread to bound risk rather than simplifying it away.
- Distinguish the 'what' from the 'how'. Clearly understand and communicate the differences between climate scenario (SSP) uncertainty and model uncertainty.

Table 4 Model uncertainty: suggested minimum scenario requirements

Decision context	Rationale	Suggested minimum requirement
Screening-level/ initial analysis	Provides a quick overview of the total uncertainty space	Use the full ensemble range or a defined range (e.g. 10th to 90th percentiles)

Decision context	Rationale	Suggested minimum requirement
Risk assessment	Allows for deeper stress testing of specific potential vulnerabilities without processing every model	Select representative models[1], that sample different regions of the climate response space (e.g. 'hot/dry', 'warm/wet', 'central')
Critical assets	Ensures the asset is resilient to the most severe plausible physical responses	Focus on models projecting higher physical impacts (the tails of the model ensemble distribution)

1. An approach for detailed risk assessment is the physical climate storyline method, or climate space sampling. Rather than summarising the model ensemble statistically, this approach selects a small number of representative models, each telling a physically coherent story about how the climate system might respond. Each storyline can then be interrogated for its specific implications for the decision at hand, such as what a hot/dry future means for water storage, bushfire risk and urban heat simultaneously, without collapsing that rich information into a single average/mean.

Examples

- For water security planning, use models/statistics that specifically sample the driest models of the ensemble to assess supply risks under high-stress conditions and correspondingly plan appropriate water infrastructure.
- For urban heat mitigation, prioritise models/statistics that capture the upper bounds of extreme heat intensity, duration and frequency, to understand thermal resilience requirements and plan appropriately, such as ensuring effective cooling infrastructure.
- For flood risk and stormwater management, prioritise models/statistics that capture the upper bounds of extreme rainfall intensity, duration and frequency, to ensure that infrastructure and evacuation planning are robust against the most severe plausible precipitation increases.
- For bushfire risk and emergency services planning, select models/statistics that sample the hottest and driest ends of the ensemble, specifically those projecting the highest increases in fire weather indices (such as Forest Fire Danger Index), to account for the most extreme plausible future fire seasons rather than relying on a dampened ensemble mean.

6. Summary of criteria and suggested minimum requirements

Table 5 provides a summary of suggested minimum requirements, noting that additional scenarios or sensitivity testing may be required where exposure, uncertainty or consequences are high.

The examples in Section 7 of this document show how these suggested minimum requirements can be applied in practice across NSW decision contexts.

Table 5 Summary of suggested minimum requirements

Key criterion	Purpose	Suggested minimum requirement
Decision context	Purpose of the decision and type of climate risk (mitigation, physical, transition or hybrid)	**Mitigation**: use SSP1-2.6 as the primary scenario. **Physical or hybrid risk**: use at least 2 SSPs, including one higher-emissions pathway (SSP3-7.0 or SSP5-8.5). **Transition risk**: use SSP1-2.6 or SSP2-4.5 as the primary scenario, with sensitivity testing.
Time horizon/ asset lifetime	How long the decision influences exposure, performance or future adaptation options	**2021–2040**: use one SSP for screening-level analysis or short-lived decisions and assets. **2041–2060**: use at least 2 SSPs spanning lower to higher emissions. **2081–2100**: use 2 or more SSPs, including one associated with a higher-emissions pathway. **Post-2100**: include SSPs associated with high- or very high-emissions pathways and test for long-term lock-in risk where relevant to the decision context (e.g. sea-level rise).
Risk appetite/ consequence	Severity and reversibility of impacts if assumptions are wrong	Where consequences are severe or irreversible, or where a high level of protection is required, SSPs associated with higher-emissions pathways are typically included. The use of a single scenario is typically not acceptable where failure could result in irreversible damage, harm or loss of life.
Model uncertainty	Uncertainty arising from differences between climate models	Use multi-model ensembles by default. Do not rely on the ensemble mean alone. For high-consequence decisions, prioritise physically plausible worst-case outcomes and use model spread to bound (book-end) the range of plausible risk.

7. Examples of guidance applications

This section includes examples on selecting minimum climate scenario requirements for:

- state significant development and state significant infrastructure
- physical risks and adaptation planning
- NSW water infrastructure business cases
- local government
- coastal hazard adaptation in national parks
- agricultural impact assessment.

The examples are informed by NSW decision-making contexts. They are illustrative in nature and are not based on actual projects and/or decisions.

7.1 Selecting minimum climate scenario requirements for state significant development and state significant infrastructure

State significant development and state significant infrastructure represent the most complex, high-impact planning decisions in New South Wales. These projects are typically subject to detailed environmental assessment and approval under the NSW planning system; and are characterised by their scale, strategic importance and long-term consequences for land use, infrastructure performance and community outcomes (DPHI 2026).

State significant development and state significant infrastructure decisions differ from other planning decisions in 3 key ways:

1. they often involve capital-intensive, long-lived assets, including transport, energy, water and social infrastructure
2. approval decisions made at the assessment stage can lock-in land-use patterns, exposure to hazards, and infrastructure performance for decades or longer (50–100 years or more)
3. these projects must account for multiple climate hazards, including flooding, heat, bushfire and coastal risks, which may affect critical infrastructure and vulnerable communities.

Once delivered, the developments are often difficult or impossible to reverse, particularly where they involve major infrastructure corridors, energy systems or large-scale urban development.

At the same time, these projects are subject to a comprehensive environmental assessment process, including preparation of an environmental impact statement, public exhibition and whole-of-government review before determination by the Minister or Independent Planning Commission. This process is explicitly designed to assess future environmental conditions and risks, not just current baselines.

Under this context, SSP3-7.0 would represent an appropriate minimum scenario (see Table 6), as it:

- captures plausible high-impact future conditions
- reflects divergence in climate outcomes beyond mid-century
- helps to ensure that major investments in New South Wales are not based on optimistic assumptions, but remain safe, functional and fit-for-purpose over their full lifetime.

Table 6 **Rationale for selecting SSP3-7.0 as minimum requirement for state significant development and infrastructure**

Key criterion	Rationale
Decision context	State significant development (SSD) and state significant infrastructure (SSI) are projects of statewide significance, assessed to consider economic, environmental and social outcomes at scale. They frequently involve critical infrastructure and large populations, and must consider multiple interacting climate hazards such as flooding, heat, bushfire and coastal risks. Given this scale and exposure, scenario selection must test decisions against plausible high-impact futures, not just central or optimistic pathways.
Time horizon	The land-use and infrastructure performance of SSD and SSI projects often span 50 to 100 years or longer, extending well beyond mid-century. As climate outcomes diverge increasingly over time depending on emissions pathways, using only moderate- or low-emissions scenarios would underrepresent long-term risk. SSP3-7.0 provides a credible high-emissions pathway that captures this divergence and ensures long-term exposure is properly assessed.
Risk appetite	SSD and SSI decisions undergo rigorous assessment, public scrutiny and high-level determination, reflecting their potential to affect public safety, essential services and economic outcomes at scale. Many decisions involve irreversible consequences (e.g. land-use lock-in, infrastructure siting). Under these conditions, the acceptable risk appetite for failure is often low, requiring a precautionary approach. SSP3-7.0 is therefore an appropriate minimum requirement to test whether decisions remain acceptable under more severe but plausible future conditions.
Model uncertainty	The SSD/SSI assessment framework requires a detailed, evidence-based evaluation of environmental impacts through the environmental impact statement process. This includes consideration of uncertainty and variability in future conditions.

Key criterion	Rationale
	Reliance on a single scenario or the ensemble mean alone is not sufficient. Using SSP3-7.0 in conjunction with model ensembles enables decision-makers to capture the range and upper bounds of plausible impacts, ensuring infrastructure and development are not designed to perform only under central estimates.

7.1.1 When exposure is greatest: look beyond the minimum

In some locations and for some land uses, the suggested minimum requirements may not fully capture long-term risk. Coastal areas affected by committed sea-level rise, critical infrastructure or highly sensitive land uses may face impacts that extend well beyond a century.

Under these circumstances, additional sensitivity testing should be undertaken using a very high-emissions pathway (SSP5-8.5) at a minimum and consider 'low-confidence' projections of sea-level rise which factor in the potential effect of low-likelihood, high-impact ice sheet processes that cannot be ruled out. This allows decision-makers to better understand the upper bounds of future exposure and avoid locking in outcomes that may become unacceptable over time.

7.2 Selecting minimum climate scenario requirements for physical risks and adaptation planning

The *Climate Change (Net Zero Future) Act 2023* establishes an adaptation objective for New South Wales to be more resilient to a changing climate and aims to give effect to Australia's international commitments under the 2015 *Paris Agreement* (UNFCCC 2015). Central to those commitments is the global goal on adaptation to enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change, and ensure an adequate adaptation response in the context of holding global warming well below 2°C, while pursuing efforts to limit warming to 1.5°C.

A clear, consistent and realistic baseline for assessing climate risk and planning adaptation responses can support decision-making across government, helping to translate this global goal into effective action at the state level.

SSP2-4.5 reflects a 'middle-of-the-road' global future in which current policies and socio-economic trends continue, and global emissions peak but decline slowly. While the NSW Government remains committed to emissions reductions consistent with a 1.5°C pathway, the world is not currently on track to meet that goal. Adaptation planning based solely on a 1.5°C future would therefore underestimate risk and leave communities, infrastructure and services exposed.

Using SSP2-4.5 as a minimum baseline for physical risks and adaptation acknowledges this reality and supports prudent risk management. It provides a defensible planning foundation that reflects a plausible level of warming which New South Wales may experience over coming decades, particularly around mid-century, while still allowing agencies to test higher-warming scenarios where the consequences of failure are severe or irreversible (Table 7).

Applying SSP2-4.5 as a common baseline also supports greater consistency across sectors and scales, reduces fragmentation in risk assessments, and shifts planning away from reliance on historical climate conditions that no longer reflect current or future risks.

In practice, SSP2-4.5 should set the floor, not the ceiling. State and local governments could use SSP2-4.5 as a minimum when assessing risk and designing responses and consider higher-warming scenarios where assets are long-lived, risks are high, or failure would have significant social, economic or environmental consequences.

Table 7 Rationale for selecting SSP2-4.5 as minimum requirement for physical risks and adaptation planning

Key criterion	Rationale
Decision context	Adaptation planning is typically concerned with managing physical climate risks to communities, infrastructure, services and ecosystems across New South Wales. These decisions are undertaken at a whole-of-government or system scale, influence multiple sectors, and shape preparedness and resilience outcomes over extended periods. To ensure consistency and adequacy of response, a defined future climate state is required as a common baseline across agencies, rather than reliance on historical climate conditions that are no longer representative.
Time horizon	Adaptation planning remains relevant across current to mid-century timeframes, when climate change signals increasingly diverge from historical baselines and materially affect hazard frequency and severity. SSP2-4.5 provides a plausible representation of climate conditions which New South Wales may experience over coming decades, particularly around mid-century, while avoiding reliance on late-century divergence alone. Because adaptation decisions can also influence exposure beyond mid-century, SSP2-4.5 is expected to complement higher-warming futures where decision lifetimes extend further or where long-term lock-in risk exists.
Risk appetite	Government adaptation planning typically reflects a moderate risk appetite – it should be precautionary enough to avoid systematic underestimation of risk, while remaining proportionate and defensible. Planning solely against a 1.5°C future would assume successful global mitigation outcomes that may not eventuate, exposing New South Wales to avoidable risk. SSP2-4.5 represents an appropriate minimum planning baseline, supporting prudent risk management while maintaining flexibility to stress test against higher-impact scenarios where consequences of failure are severe, irreversible or affect vulnerable communities.
Model uncertainty	Model uncertainty becomes a significant source of variability in projected climate outcomes, particularly for extremes. It is a relatively larger source of variability between 2021 to mid-century, and under a medium-range emissions pathway, compared to longer-term time horizons and higher-emissions pathways. Using SSP2-4.5 in conjunction with a multi-model ensemble allows adaptation planning to capture the plausible range of

Key criterion	Rationale
	physical responses without collapsing uncertainty into a single mean. This supports identification of robust adaptation responses and avoids designing systems that are resilient only to central or optimistic outcomes. Where model spread is large or impacts are highly sensitive, planning should explicitly consider ensemble extremes to bound the range of plausible risk.

7.3 Selecting minimum climate scenario requirements for NSW water infrastructure business cases

Water infrastructure decisions in New South Wales typically relate to assets with long operational lifetimes and high capital investment, and they are strongly influenced by climate variables such as rainfall, temperature and evaporation. Choices made during the business-case stage effectively determine system capacity, operating arrangements and exposure to climate risk over decades, with limited flexibility for modification after implementation. Consequently, the selection of climate scenarios needs to enable robust, forward-looking evaluation of system performance under future conditions, rather than relying solely on historical climate records.

To meet this need, NSW water infrastructure business cases adopt a dual-scenario approach, using SSP2-4.5 and SSP3-7.0 as the default climate scenarios for analysis (DCCEEW 2026a). SSP2-4.5 represents a 'middle-of-the-road' global trajectory broadly aligned with current policies and trends and provides a realistic baseline for assessing how assets may perform over their operational life. SSP3-7.0 represents a higher-emissions, higher-risk future and is used to stress test infrastructure against more adverse conditions, including increased drying, higher temperatures and more extreme events.

The selection of these scenarios reflects both NSW Treasury requirements and emerging best practice in climate-informed infrastructure planning (NSW Treasury 2025). Treasury guidance requires Tier 1 and Tier 2 business cases to assess resilience under multiple climate scenarios and to incorporate climate change into the base case, rather than treating it as a sensitivity. Using SSP2-4.5 and SSP3-7.0 together ensures compliance with these requirements while providing decision-makers with a clear understanding of how infrastructure performance, costs and risks may change across a plausible range of future climates.

Scenario analysis is undertaken over the mid- to long-term planning horizon (2051–2080), which aligns with the typical lifespan of major water assets and captures the period when climate change impacts become most material. Differences between emissions pathways are modest between 2021 and 2040 but diverge significantly by mid-century, particularly for variables critical to water security such as inflows, evaporation and the frequency of extreme droughts and floods. Stress testing infrastructure performance over this period ensures that investments are assessed against the climate conditions they may experience during their operational lifetime.

This dual-scenario approach supports low-regret and resilient investment decisions. SSP2-4.5 provides a credible baseline for optimising design and economic performance, while SSP3-7.0 helps identify vulnerabilities, thresholds and potential failure modes under more severe futures. By explicitly testing both scenarios, water infrastructure planning in New South Wales moves beyond reliance on a single planning assumption and instead embeds climate uncertainty into decision-making in a transparent, defensible and proportionate way.

Table 8 outlines the criterion and rationale for minimum climate scenario requirements for NSW water infrastructure business cases.

Table 8 Rationale for dual-scenario approach, using SSP2-4.5 and SSP3-7.0, for NSW water infrastructure business cases

Key criterion	Rationale
Decision context	Water infrastructure business cases in New South Wales concern large, long-lived public assets where climate change may materially affect performance, cost and risk. Assets such as dams, pipelines and treatment plants are capital-intensive, difficult to modify post-construction, and are directly exposed to climate variables. Climate risk assessment is mandatory under NSW Treasury requirements, and historical climate conditions alone are no longer considered appropriate.
Time horizon	Climate scenario analysis is undertaken over a 2051–2080 planning horizon (centred on 2065). This aligns with the typical operational life of major water assets and captures the period when climate impacts are expected to become more significant for system performance and reliability. Emissions pathways diverge most strongly at this planning horizon, making this timeframe critical for testing infrastructure assumptions.
Risk appetite	Water infrastructure decisions carry high consequences of failure or underperformance, including impacts on water security, public safety, environmental outcomes and regional economies. NSW Treasury guidance requires Tier 1 and Tier 2 business cases to assess multiple climate scenarios. The combined use of SSP2-4.5 and SSP3-7.0 reflects the need to assess both plausible future conditions and more adverse outcomes.
Model uncertainty	Climate projections show substantial model uncertainty, particularly for mean rainfall changes and extremes that strongly influence water systems. Extreme conditions are addressed by stress testing system performance using long paleo-stochastic datasets (see Section 7.3.1), which capture rare and severe hydroclimatic events beyond the historical record, including critical multi-year drought periods.

7.3.1 Use of paleo-stochastic approaches

Paleo-stochastic approaches provide a complementary way of addressing climate uncertainty by focusing on the full range of plausible natural climate variability rather than probabilistic sampling across climate model ensembles (DCCEEW 2026b). These methods combine instrumental records, paleo-climate proxies and stochastic modelling to generate long synthetic climate sequences (often thousands of years). This enables the representation of extended droughts, prolonged wet periods and compound extremes that are not captured in the short observational record.

Uncertainty is therefore characterised through system exposure to a wide envelope of variability, rather than likelihood estimates. This supports direct stress testing of system performance, where outcomes are interpreted in terms of robustness, thresholds and failure modes under extreme and persistent conditions, rather than probabilistic interpretations based on the ensemble spread.

To incorporate climate change, paleo-stochastic datasets are typically scaled using climate projections, allowing the extended baseline sequence to be adjusted to reflect future conditions. This is commonly done using change-factor methods, where projected shifts in rainfall, temperature or evapotranspiration (for example, from NARCliM) are applied to the stochastic time series (such as via monthly scaling ratios).

This combined approach enables decisions to be tested against both deep uncertainty in natural variability and the directional influence of climate change, providing a robust foundation for long-term risk-based planning where rare, high-impact events are critical drivers of system performance.

7.4 Selecting minimum climate scenario requirements in local government

Councils make decisions today that should remain safe, affordable and defensible in a future that will be hotter, more variable and more disruptive than the past. While future climate conditions cannot be predicted with certainty, councils can manage this uncertainty by deliberately testing decisions against a range of plausible futures, rather than relying on a single assumption about what the future might look like.

In this context, climate scenario selection is a core governance and enterprise risk-management responsibility. Councillors and executives are responsible for setting and endorsing the council's risk appetite, including the level of risk the council is willing to accept if future climate conditions are worse than assumed during planning. They should ensure that major decisions, strategies and long-lived investments are tested against climate scenarios that are aligned with this risk appetite, proportionate to the consequences of failure, and appropriate to the longevity and reversibility of the decision. Climate scenario selection is therefore primarily treated as a governance decision, not solely a technical exercise.

Scenario selection follows a clear executive logic. Decisions that affect public safety, legal compliance, essential services, long-lived assets or irreversible land-use outcomes are areas where councils typically have a low tolerance for failure. For these decisions, testing only a lower-emissions pathway (for example SSP1-2.6) is not sufficient where physical climate impacts are material; higher-emissions pathways are needed to stress test safety and service delivery. Councils deliberately assess whether decisions continue to perform acceptably under more severe future climate conditions, even where those futures are uncomfortable or challenging. Where consequences are less severe or decisions are more easily changed, testing against lower-emissions pathways may be proportionate.

This logic is applied consistently across different types of council decisions, including assets and infrastructure, land-use and growth planning, long-term financial planning and governance. A clear distinction is made between physical climate risks (such as heat, flooding and extreme rainfall) and transition risks (such as policy change, emissions lock-in and community expectations). Physical risks are managed by stress testing whether decisions remain safe and functional under tougher conditions, while transition risks are addressed by avoiding lock-in and maintaining flexibility over time.

Table 9 and Table 10 provide examples of scenario choice for suggested minimum climate scenario requirements in local government, based on low-risk and moderate-risk appetites, respectively.

Table 9 Suggested minimum climate scenario requirements in local government based on low-risk appetite

Key criterion	Rationale
Decision context	Decisions affecting public safety, legal compliance, essential services, long-lived assets or irreversible land-use outcomes are areas where councils often have a low appetite for failure. These decisions require deliberate testing against more severe future conditions, rather than reliance on lower-emissions pathways alone, because failure would result in unacceptable harm or long-term consequences.
Time horizon	Decisions with long-lasting or irreversible consequences (e.g. major assets or growth precincts) are to be assessed over long-term horizons, reflecting how long-term impacts persist and how difficult they are to reverse. Testing over extended horizons supports evaluation of whether decisions remain safe and functional as conditions worsen over time.
Risk appetite	Where a council's appetite for failure is low, the executive logic requires testing decisions against more severe future climate conditions, even if those conditions are challenging or precautionary. Assumptions about future emissions trajectories are not the primary driver; the severity of consequences determines scenario choice. This approach is primarily treated as a governance decision.
Model uncertainty	Uncertainty is managed by testing decisions against the spread of the model ensemble. The focus is on whether decisions are still appropriate when conditions are worse. This avoids optimistic bias and ensures residual risk is visible, documented, and assessed against council's risk tolerance.

Table 10 **Suggested minimum climate scenario requirements in local government based on moderate-risk appetite**

Key criterion	Rationale
Decision context	Decisions where consequences are material but not catastrophic, and where outcomes can be adjusted over time, are treated as having a moderate appetite for risk. These include decisions focused on cost, efficiency, or operational optimisation rather than immediate safety or compliance impacts.
Time horizon	For decisions with shorter lifetimes or greater flexibility, scenario testing may focus on a lower-emissions pathway future, with consideration of a more severe future where appropriate. The time horizon reflects how easily decisions can be revisited, staged or corrected if conditions change.
Risk appetite	Where a council's appetite for failure is moderate, the approach is to test decisions against lower-emissions pathways and also consider higher-emissions pathways where this improves understanding of vulnerabilities. This balances proportionality with preparedness, ensuring risk testing is commensurate with potential impacts.
Model uncertainty	Uncertainty is managed by testing decisions against the spread of the model ensemble, rather than relying solely on central estimates. The focus is on whether decisions are still appropriate when conditions are worse. This avoids optimistic bias and ensures residual risk is visible, documented, and assessed against council's risk tolerance.

7.5 Selecting minimum climate scenario requirements for coastal hazard adaptation in national parks

National parks and reserves managed by the NSW National Parks and Wildlife Service (NPWS) form a large and diverse protected area network of more than 890 parks and reserves covering over 7.6 million hectares, including extensive coastal landscapes. This network protects biodiversity, natural systems and cultural heritage, including Aboriginal cultural sites, historic places and habitat for threatened species. It also supports important social and economic values through recreation, tourism and wellbeing benefits.

A significant proportion of the New South Wales coastline sits within the NPWS estate, including beaches, cliffs, estuaries and coastal ecosystems with high biodiversity values, strong recreational use and cultural significance. Managing these places requires protecting a wide range of assets and values, including:

- built infrastructure which supports safe public access and visitation, for example, roads, buildings, walking tracks, lookouts, picnic areas and campgrounds
- natural systems, including diverse habitats for native plants and animals
- Aboriginal cultural heritage, including sites, landscapes and artefacts of cultural and spiritual significance

- tourism and recreation assets which attract visitors and support regional economies.

Coastal national parks, in particular, attract high visitation and include beaches, coastal walks, beach access tracks, camping areas and scenic lookouts, reflecting their importance for both recreation and conservation.

These coastal environments are increasingly exposed to climate-driven hazards, particularly coastal inundation and erosion associated with sea-level rise and more extreme events. Managing these risks requires consideration of how hazards could evolve under different future climates, because impacts may affect not only infrastructure, but also irreplaceable environmental and cultural values.

NPWS uses coastal hazard datasets to assess how projected sea-level rise and associated hazards may affect different assets over time under specified climate scenarios. Scenario selection is embedded within a broader prioritisation assessment that considers the level of impact, timing, scale and acceptability of risk across different asset types.

A key feature of this approach is that scenario choice is not uniform. Instead, scenarios are matched to the importance of the asset or value, the consequences of failure or loss, and the feasibility of adaptation (including whether responses can be staged or reversed). This enables decision-makers to align scenario selection with risk appetite and park management objectives, rather than applying a single scenario across all assets and values.

Table 11 outlines the criterion and rationale for minimum climate scenario requirements for coastal hazard adaptation in national parks.

Table 11 Suggested minimum climate scenario requirements for coastal hazard adaptation in national parks

Key criterion	Rationale
Decision context	Coastal hazard planning in national parks involves managing physical climate risks across multiple asset classes, including infrastructure, biodiversity and cultural heritage. These assets vary widely in their value, replaceability and social significance. Scenario selection is therefore embedded within a prioritisation framework that assesses impacts (e.g. inundation and erosion) across all values and determines appropriate adaptation responses. Assets that are critical, irreplaceable or culturally significant require more precautionary scenario selection than those that can be relocated or substituted.
Time horizon	Time horizons are selected based on both when impacts occur and how long adaptation actions take to implement. Time horizons ~2040–2050 are prioritised for decision-making where impacts are already emerging and require action, and/or where adaptation measures (e.g. biodiversity translocation or cultural protection) require long lead times.

Key criterion	Rationale
	Longer-term projections (e.g. late century) are considered to plan for climate trajectories and increasing divergence between emissions pathways but are not always used as the primary decision horizon where they limit actionable planning or reduce stakeholder engagement. This reflects the principle that scenario selection aligns with decision usefulness, not just physical climate endpoints.
Risk appetite	Risk appetite varies by asset type and drives scenario choice. **Low-risk appetite** (e.g. cultural heritage, critical biodiversity): where loss is irreversible or unacceptable (e.g. a rock carving or culturally significant site), a precautionary approach is used. Higher-emissions pathways (e.g. SSP3-7.0) test more severe but plausible future impacts, including conditions associated with higher-end coastal inundation and erosion exposure, to avoid unacceptable loss. **Moderate- to high-risk appetite** (e.g. campgrounds): where impacts are acceptable or reversible, scenario choice is less sensitive to the emissions pathway and more focused on impact thresholds and adaptation triggers (e.g. inundation frequency before relocation). Decisions may be triggered by defined physical impacts such as permanent inundation rather than scenario choice alone. This approach keeps scenario selection proportionate to consequences and consistent with risk-based decision-making.
Model uncertainty	Coastal hazard assessments use scenario outputs alongside hazard datasets and consider the range of possible impacts across model projections. For high-consequence assets, decision-makers focus on upper-bound impacts (e.g. severe inundation and erosion outcomes) to ensure robustness under plausible worst-case conditions. Where multiple scenarios produce similar outcomes in the 2021–2040 time horizon, scenario selection may be simplified to support interpretation, provided that sensitivity testing has confirmed that omitted scenarios do not materially change conclusions.

7.6 Selecting minimum climate scenario requirements for agricultural impact assessment

Agricultural systems are sensitive to both climate variables (such as temperature, rainfall, radiation and extremes) and atmospheric carbon dioxide (CO_2). Climate change impact assessments must therefore consider the combined influence of these factors. CO_2 directly affects photosynthesis, water-use efficiency and biomass production, meaning crop responses cannot be assessed using climate variables alone.

At a policy and decision-making level, reliance on a single emissions pathway is not appropriate. Different scenarios produce substantially different CO_2 trajectories and associated crop responses, which can introduce systematic bias and reduce the reliability of projections. A consistent, defensible framework is therefore required to capture both climate variability and CO_2-driven processes.

To support this, assessments should include at least 2 emissions pathways representing a moderate and a very high-emissions future. For example:

- SSP2-4.5 provides a stabilisation pathway consistent with moderated emissions and slower CO_2 increases
- SSP5-8.5 represents a very high-emissions trajectory with continued CO_2 growth, stronger fertilisation effects, and greater exposure to climate extremes such as heat and drought.

Considering both scenarios enables clearer interpretation of the interaction between climate stress and CO_2-driven productivity responses.

However, scenario selection alone is not sufficient for agricultural applications. Agricultural systems respond non-linearly to the interaction, sequencing and extremes of multiple climate variables. Crop growth depends on factors such as the timing of rainfall, heat stress during critical growth stages, radiation during grain filling and soil moisture dynamics. These processes are represented differently across global climate models, meaning that 2 models under the same scenario can produce materially different outcomes.

Using multiple global climate models is therefore essential to capture the range of plausible climate trajectories, particularly for extremes and compound events. This approach helps constrain uncertainty, reduces the influence of model-specific bias, and improves the robustness of projected impacts on yield and system performance.

In addition, agricultural assessments should adopt multi-decadal time horizons to appropriately represent climate variability. Crop yields are strongly influenced by interannual variability, including droughts, wet periods and extreme temperatures. Using 30-year periods (for example, 2031–2060 and 2071–2100, relative to a 1991–2020 baseline) reduces short-term variability while preserving long-term trends in climate and CO_2. This supports more stable estimates of crop response and enables assessment of system change over time.

Table 12 outlines the criterion and rationale for minimum climate scenario requirements for agricultural impact assessment.

Table 12 Suggested minimum climate scenario requirements for agricultural impact assessment

Key criterion	Rationale
Decision context	Agricultural impact assessments account for both climate drivers (e.g. temperature, rainfall, radiation) and atmospheric CO_2, which together determine crop growth. Unlike many sectors, productivity is directly influenced by CO_2 fertilisation (particularly for C3 crops) through enhanced photosynthesis and water-use efficiency.

Key criterion	Rationale
	Assessments should use at least 2 emissions pathways (e.g. SSP2-4.5 and SSP5-8.5) to capture divergence in CO_2 trajectories and should incorporate multiple global climate models (GCMs). This reflects the dependence of agricultural systems on interacting climate variables and extremes, which are represented differently across models. Using a multi-model ensemble captures structural climate uncertainty and supports more robust and defensible farm management, adaptation planning and policy decisions.
Time horizon	Crop yields exhibit strong interannual variability driven by climate extremes such as droughts and heatwaves. Using multi-decadal periods (e.g. 2031–2060 and 2071–2100, relative to a 1991–2020 baseline) smooths short-term variability while preserving long-term trends in climate and CO_2. Applying these time horizons across multiple GCM simulations enables robust estimation of variability and uncertainty, as models capture different sequences and intensities of climate extremes. This approach captures contrasting conditions (e.g. dry and wet periods) and supports assessment of how crop responses evolve under increasing warming and changing CO_2 levels. Using multi-decadal periods also aligns with agricultural planning cycles and supports both near-term adaptation and long-term system transformation.
Risk appetite	Agricultural planning balances potential CO_2-driven productivity gains against increasing climate risks. Moderate scenarios (e.g. SSP2-4.5) reflect pathways where CO_2 concentrations stabilise or decline under effective mitigation, limiting fertilisation benefits but reducing extreme climate impacts. Higher-emission scenarios (e.g. SSP5-8.5) provide stronger CO_2 fertilisation but also greater exposure to heat and water stress. Incorporating multiple GCMs within each scenario enables a probabilistic or risk-based assessment across a range of plausible futures. This supports evaluation of best-case, median and worst-case outcomes, helping stakeholders avoid over-reliance on a single model or an optimistic assumption.
Model uncertainty	Crop models (e.g. APSIM – the Agricultural Production Systems sIMulator) vary in their representation of CO_2 fertilisation, water stress and climate interactions, leading to uncertainty in projected yields. This uncertainty is compounded by differences among GCMs, which produce varying climate signals even under the same emission scenario. Using ensembles of both GCMs and emission scenarios allows separation and quantification of uncertainty arising from climate models, emission pathways and crop model structure. Using a multiple-model, multi-scenario ensemble approach provides a more comprehensive range of outcomes, supports more robust interpretation of results, and reduces the risk of overconfidence in projections, particularly when informing adaptation strategies or policy decisions.

8. Technical review of scientific literature and reports

Table 13 summaries the key findings from a review of scientific literature and reports on selecting and using climate change scenarios for decision-making. The review informed the resulting criteria and principles for scenario selection presented in this guidance. Representative sources are listed in Section 8.1.

Table 13 Summary of review findings

Criteria	Key finding	What the literature demonstrates	Representative sources
Setting the context	SSP-based framework integrates physical and socio-economic dimensions	The SSP–RCP (shared socio-economic pathway – representative concentration pathway) matrix links climate forcing (RCPs) with socio-economic pathways (SSPs), enabling assessment of both physical climate risks and adaptive capacity/transition dynamics.	van Vuuren et al. 2014; O'Neill et al. 2017; O'Neill et al. 2020
Setting the context	Framework is widely adopted across sectors	Meta-analyses show extensive uptake of SSP/RCPs across water, agriculture, energy, health and finance, indicating robustness and versatility of the framework. Middle-of-the-road scenario as a commonly used baseline.	Riahi et al. 2017; O'Neill et al. 2020
Setting the context	Scenario numbers should balance insight and usability	2–4 scenarios are often sufficient for decision-making; more scenarios increase analytical burden with diminishing returns.	NOAA Fisheries 2025; NPS 2025a
Setting the context	SSP/RCP framework has known limitations	Integrated assessment model assumptions, limited representation of adaptation, feasibility	O'Neill et al. 2020; EDHEC Climate Institute 2026

Criteria	Key finding	What the literature demonstrates	Representative sources
		concerns and usability challenges are well documented.	
Setting the context	Global warming levels as an alternative framing Global warming levels–based framing supports threshold-based risk assessment independent of emissions pathways	Climate risks and impacts scale more consistently with global temperature thresholds than with specific emissions pathways. Global warming levels enable pathway-independent assessment of hazards, tipping points and adaptation triggers.	IPCC 2021
Setting the context	Geographic factors determine the extent of impact (including vulnerability and resilience) and the types of hazards that must be assessed	Setting the context for climate scenario analysis requires careful consideration of geographic location e.g. low-lying coastal and estuarine regions may necessitate the use of higher-emissions pathways due to the heightened risk of sea-level rise, which compounds the impacts of coastal erosion, coastal overwash and estuarine inundation.	Adger et al. 2018; Cth DCCEEW 2025a
Setting the context	Use of multiple scenarios is common	Most jurisdictions recommend applying at least 2 scenarios to capture a plausible range of futures, particularly for medium- to long-term decisions.	Cth DCCEEW 2025a, b; DEW 2022; DPC 2024; DWER 2022
Setting the context	Scenario guidance is principles-based rather than prescriptive	Across Australia, most guidance documents emphasise principles and process over mandating specific emissions scenarios or timeframes, requiring agencies to apply judgement based on context.	Cth DCCEEW 2026a; Queensland Government 2026; DEW 2026; RECFIT 2026; Victoria State Government 2026; Government of WA 2026

Criteria	Key finding	What the literature demonstrates	Representative sources
Setting the context	Global warming levels as an alternative framing	UK agencies frame risk around +2°C and +4°C thresholds for clearer communication.	Met Office 2026
Setting the context	Adaptation and mitigation use scenarios differently	Adaptation prioritises robustness across futures; mitigation focuses on emissions pathways.	EUMACC 2026
Setting the context	Classification of climate impacts as chronic or acute, and may also be compounding or cascading in nature	Climate impacts can be classified as chronic or acute, and may also be compounding or cascading. In practice, organisations often need to consider multiple impact types together, using different scenarios, including higher-emissions pathways, to capture the full range of risks and support robust planning.	TCFD 2017; IPCC 2021; IPCC 2022a
Setting the context	Global warming levels are increasingly used	Some national frameworks define future climate conditions using global warming levels rather than SSPs or RCPs, particularly in cross-sectoral risk assessments.	Cth DCCEEW 2023b
Setting the context	Emissions scenario guidance is largely non-prescriptive	Most agencies avoid mandating a single ‘correct’ scenario, instead emphasising flexibility, project context and judgement.	DPIE 2019; Ministry for the Environment 2021
Setting the context	Scenario choice should be driven by risk, not probability	Scenarios are not assigned probabilities; emphasis is on acceptable risk and consequences.	Bush and Lemmen 2019; Environment and Climate Change Canada 2026
Setting the context	Storyline approaches support understanding and communication	Narrative or storyline approaches are used to make complex climate futures more accessible to decision-makers and non-technical audiences.	Cth DCCEEW 2023b; IPCC 2021

Criteria	Key finding	What the literature demonstrates	Representative sources
Setting the context	Physical and transition risks may require different approaches	Guidance distinguishes between physical and transition risks, recognising they may require different scenarios, timeframes and data sources.	Cth DCCEEW 2026b
Setting the context	Scenario guidance is still evolving and inconsistent	Approaches to scenario guidance vary across jurisdictions, reflecting differences in policy settings, data availability and maturity of guidance frameworks.	Cth DCCEEW 2026; Queensland Government 2026; SA DEW 2026; RECFIT 2026; Victoria State Government 2026; Government of WA 2026
Setting the context – geographic location	Global SSPs require regional/local contextualisation	Direct application of global scenarios is often insufficient; participatory downscaling and contextual embedding improve relevance and legitimacy. Need for downscaling global scenarios to regional/local contexts.	Absar and Preston 2015; Kebede et al. 2018; Pedde et al. 2025
Setting the context – physical risks	Higher-emissions scenarios are commonly used for physical risk	Several jurisdictions prioritise higher-end emissions scenarios for assessing physical climate risks, particularly for infrastructure and government assets.	DEW 2022; DWER 2022; DEC 2024
Setting the context – classification of climate impacts	Compound events and interacting hazards amplify impacts beyond single-hazard assessments	Concurrent and sequential hazards (e.g. heat–drought, post-fire flooding) substantially increase risk and challenge single-scenario or single-hazard planning, requiring integrated scenario and pathway-based approaches.	IPCC 2022a; Zscheischler et al. 2020
Setting the context –	Low-emissions scenarios remain important in New South Wales	NSW's Net Zero 2050 commitment means guidance must include a low-emissions scenario	*Climate Change (Net Zero Future) Act 2023*, no 48

Criteria	Key finding	What the literature demonstrates	Representative sources
legislative and policy requirements		(SSP1-2.6), alongside additional scenarios to capture uncertainty and risk.	
Setting the context – legislative and policy requirements	Jurisdictions rely on endorsed regional climate datasets	Guidance typically directs agencies to use jurisdiction-specific, endorsed climate projection datasets, with NARCliM2.0 mandated for NSW Government use.	NSW Treasury 2026
Setting the context and risk appetite	Adaptation strategies should be flexible and iterative	No-regret, co-benefit, flexible and reversible actions are emphasised; Resist-Accept-Direct frameworks and adaptive pathways support this.	Haasnoot et al. 2013; Hallegatte et al. 2020; NPS 2025b
Risk appetite	Participatory approaches improve decision relevance	Stakeholder-led narratives and co-production help integrate local values and knowledge, though they increase resource requirements.	Kebede et al. 2018; Birkmann et al. 2022; Pedde et al. 2025
Risk appetite	Water resource risks are amplified by coupled socio-economic change	Integrating land use, development pathways and climate improves assessment of water security and system vulnerability.	Alizadeh et al. 2022; Tang et al. 2023
Risk appetite	High-end emissions scenarios for high-risk or long-lived assets	RCP8.5 or SSP5-8.5 is recommended as a precautionary stress-testing scenario for critical infrastructure.	Ministry for the Environment 2021; Bush and Lemmen 2019; Environment and Climate Change Canada 2026
Risk appetite	Moderate emissions scenarios suit lower-risk or shorter-term projects	RCP4.5 or SSP2-4.5 is commonly used where risks or asset lives are lower.	Bush and Lemmen 2019; Environment and Climate Change Canada 2026
Risk appetite	High-end scenarios for stress-testing resilience	Worst-case scenarios help identify limits and cascading risks.	EUMACC 2026; Met Office 2026

Criteria	Key finding	What the literature demonstrates	Representative sources
Risk appetite	Scenarios associated with lower likelihood, but higher potential consequences may be appropriate where impacts could be severe, irreversible on planning timescales, or affect long-lived assets, communities, or ecosystems	Scenario selection is risk-based (consequence-sensitive), rather than solely likelihood-based.	Wood et al. 2023; Arnell et al. 2025
Risk appetite	Risk appetite ultimately informs scenario selection, as it sets the strategic boundaries for decision-making under uncertainty	Risk appetite defines the amount and type of risk an organisation is willing to accept to achieve its objectives, while risk tolerance translates this into operational limits, identifying thresholds beyond which risks must be actively managed or escalated.	Brown 2025
Risk appetite	Scenario selection should stress test whether decisions remain acceptable if future conditions are worse than expected (climate extremes, compound events), and not determined by alignment with a central (averages) estimate	Low-risk appetite decisions are often informed by a range of plausible climate scenarios, with greater weight given to higher-impact outcomes i.e. following a precautionary principle. A low-risk appetite generally reflects a preference to minimise the likelihood of severe or irreversible impacts, avoid maladaptation or lock-in, and prioritise safety margins and robustness.	Gambhir et al. 2022; IPCC 2022b
Risk appetite	For climate hazards, an organisation's risk appetite is closely linked to both the frequency and severity of impacts	Lower-frequency but higher-consequence events may, in some contexts, be considered acceptable due to their rarity or the disproportionate cost of mitigation. In contrast, climate scenarios resulting in higher-frequency events with moderate to severe impacts often exceed an organisation's risk appetite because	IPCC 2021; UNDRR 2022

Criteria	Key finding	What the literature demonstrates	Representative sources
		their recurring and cumulative damage, economic burden, and heightened threat to life and wellbeing make them unacceptable.	
Risk appetite	Risk appetite sets these strategic boundaries by clarifying how much uncertainty and potential impact are considered acceptable	Probabilistic risk assessment frameworks can guide an organisation's risk appetite as they support evaluation of trade-offs by combining information on hazard likelihood, severity, asset vulnerability, exposure and value.	IPCC 2021; Flinders et al. 2025
Risk appetite	SSP5-8.5, which is commonly used to explore upper-bound coastal risk	Integrating SSP5-8.5 into planning for sea-level rise and coastal hazards is essential, as these processes are effectively irreversible on planning timescales. While the magnitude and timing of sea-level rise impacts depend on global mitigation pathways and the pace of transition to net zero, delayed adaptation can significantly constrain future response options and increase long-term exposure.	Nauels et al. 2025
Risk appetite	Understanding risk appetite requires consideration of community expectations and institutional capacity	Social factors such as cultural values, economic capacity, trust in institutions and past experiences play a significant role in shaping risk appetite.	Granderson 2014; Areia et al. 2023; Dhar et al. 2023; Reveco et al. 2025
Risk appetite	Risk appetite is not static and should be revisited as climate conditions, exposure, vulnerability and societal expectations evolve	Risk management frameworks help articulate an organisation's risk appetite by using tools such as risk matrices, which combine assessments of likelihood and consequence. Risks rated as almost certain (e.g. rising temperature) with major consequences (e.g. increased heat-related illnesses and deaths	Cth DCCEEW 2023b

Criteria	Key finding	What the literature demonstrates	Representative sources
		from heat exhaustion, heatstroke and cardiovascular strain) typically trigger immediate planning responses, whereas risks assessed as low likelihood and low consequence may be considered acceptable.	
Risk appetite	Scenario choice should be reviewed regularly	Guidance stresses iterative review as science and policy evolve.	Ministry for the Environment 2021
Using projections – model ensembles	Interpreting ensembles and upper-end risk Upper-percentile and tail risks are decision-relevant for infrastructure and hazard planning	Multi-model ensembles are not probabilistic forecasts. Median outcomes under-represent decision-critical extremes, and upper-percentile or high-end scenarios are necessary for planning of long-lived, risk-averse assets and for assessing low-likelihood, high-impact outcomes.	IPCC 2021; Kopp et al. 2014
Time horizon(s)	Short-term vs long-term divergence matters	Near-term (to ~2030) differences between SSPs are modest, while post-2050 divergence is substantial, requiring multiple scenarios for long-lived assets.	Riahi et al. 2017; O'Neill et al. 2020
Time horizons	Near-term climate change is largely scenario-independent; pathway divergence emerges later	In the near term, climate outcomes may be dominated by historical forcing and internal variability. Differences between SSPs may emerge primarily over longer horizons, supporting near-term planning that is robust across scenarios and longer-term testing against divergent pathways.	IPCC 2021
Time horizons	Limited divergence between scenarios to around 2050	For decisions up to approximately 2050, differences between scenarios are relatively	DEW 2022

Criteria	Key finding	What the literature demonstrates	Representative sources
		small, meaning some guidance allows use of a single scenario for near-term assessments.	
Time horizons	Scenario choice becomes more important beyond mid-century	For longer-term decisions, differences between scenarios widen substantially, reinforcing the need for careful scenario selection and use of multiple scenarios.	Cth DCCEEW 2026b
Time horizons	Limited scenario divergence to ~2050	Up to mid-century, projected changes are similar across scenarios; using any future scenario is key.	EUMACC 2026
Time horizons	Multiple scenarios beyond mid-century	Post-2050 divergence supports use of at least 2 contrasting scenarios.	Ministry for the Environment 2021; EUMACC 2026
Time horizons	Choice of time horizon often aligns with asset life cycle	Use of 3 broad assessment periods are essential for understanding chronic risks, cumulative impacts and intergenerational impacts: • short-term (0–10 years), focused on near-term variability and operational risks • medium-term (10–30 years), aligned with infrastructure and investment cycles • long-term (30–100+ years).	DPIE 2021
Time horizons	Regular review and updating of scenarios is important as new information emerges, projections are refined and conditions change	In operational planning contexts, scenario analysis is typically applied over shorter to medium horizons (approximately 5–30 years), combining quantitative climate information with qualitative foresight to support flexible and adaptive decision-making.	IPCC 2019; Butler et al. 2020; Grace et al. 2024

Criteria	Key finding	What the literature demonstrates	Representative sources
Time horizons	Consider longer planning horizons, particularly where exposure and vulnerability increase over time (e.g. next 50–100 years)	Disaster risk management has traditionally focused on relatively shorter horizons tied to emergency preparedness, response and recovery. Climate change introduces longer-term systemic risks, like sea-level rise and shifting hazard baselines.	Jenkins and Jenkins 2015; UNDRR 2015
Time horizons	Disclosures rely on scenario analysis to test the resilience of strategies under different climate futures, especially those aligned with a 2°C or lower pathway	Climate-related financial disclosures, such as those aligned with the Task Force on Climate-related Financial Disclosures framework, emphasise the use of multiple timeframes. While not prescriptive, common practice distinguishes between short-term (0–3 years), medium-term (3–10 years) and long-term (10–30+ years) horizons.	TCFD 2017
Time horizons	Multiple timeframes should be considered, and these timeframes should be linked to both the decision being made and the lifetime of the affected assets or systems	Short-lived or operational decisions may be informed using time horizons prior to 2040, whereas decisions involving assets with lifetimes of several decades (such as transport, water, energy and coastal protection infrastructure) require mid- to long-term horizons. Decisions associated with irreversible exposure or lock-in, particularly in coastal and estuarine environments, may warrant consideration of long-term and post-2100 conditions.	Lee et al. 2021; PTGCC 2022; IPCC 2023
Time horizons	Choice of time horizon influences the number of climate scenarios required	For time decisions prior to 2040, differences between emissions pathways are often small relative to internal climate variability. As a	World Bank 2021; Cth DCCEEW 2023a; Narsey et al. 2025

Criteria	Key finding	What the literature demonstrates	Representative sources
		result, it is generally inappropriate to characterise one emissions scenario as being more realistic than another for near-term planning horizons. For longer-term horizons, and for decisions involving long asset lifetimes, high exposure or potentially irreversible impacts, it may be necessary to consider 2 or more scenarios, spanning lower- to higher-emissions pathways, to adequately stress test performance, resilience and potential failure modes under a range of plausible futures.	
Time horizons	Scenario selection should align with decision or asset lifetime	Time horizons for climate risk assessments are expected to reflect the lifetime of the decision, asset or policy, rather than fixed definitions of short, medium or long term.	CSIRO 2018; Cth DCCEEW 2026b
Time horizons	Time horizons should align with asset life	Guidance encourages tailoring timeframes to decision context rather than fixed definitions.	HM Treasury 2025; Ministry for the Environment 2021
Uncertainty	Decision-making under deep uncertainty (DMDU) is essential	Predict-then-act optimisation is inadequate; robustness-focused approaches better handle deep uncertainty in climate futures.	Groves and Lempert, 2007; Lempert et al. 2013; Marchau et al. 2019
Uncertainty	Multiple DMDU methods are now mainstream	Scenario planning, robust decision-making, adaptive pathways and decision scaling are complementary and increasingly integrated.	Haasnoot et al. 2013; Kalra et al. 2014; Marchau et al. 2019

Criteria	Key finding	What the literature demonstrates	Representative sources
Uncertainty	IPCC assessments increasingly embed DMDU concepts	Recent IPCC assessments shift away from single-future optimisation toward robustness, pathways and uncertainty-aware planning.	Lempert et al. 2024
Uncertainty – communication of uncertainty	IPCC-calibrated likelihood language is systematically misinterpreted by non-specialists, who regress probability phrases toward 50% Pairing verbal terms with explicit numeric ranges substantially reduces misinterpretation	Across many languages and countries, audiences consistently misread phrases such as 'very unlikely'. Showing verbal and numerical ranges together improves interpretive consistency. Guidance and reporting should state numeric ranges alongside calibrated terms.	Mastrandrea et al. 2010, 2011; Budescu et al. 2014; Janzwood 2020
Uncertainty – sea-level rise	Sea-level rise uncertainty and low-likelihood, high-impact outcomes Ice-sheet dynamics introduce deep uncertainty requiring explicit high-end scenarios	Standard 'likely range' projections may under-represent physically plausible high-end sea-level rise. Structured expert judgement and low-confidence storylines are required to inform risk-averse coastal planning and long-term adaptation pathways.	IPCC 2021
Uncertainty – low-likelihood, high-impact (LLHI) outcomes	Prudent risk management requires explicit treatment of low-likelihood, high-impact outcomes because probability/average-weighted estimates under-weight high-consequence tails	IPCC Sixth Assessment Report of Working Group 1 formally endorses low-likelihood, high-impact storylines where consequences are very large, even if the outcome is not the most likely. Risk-based scenario selection should therefore include physically plausible high-end cases, not only central estimates.	IPCC 2021 (Ch 4 Box 4.1); Wood et al. 2023; Arnell et al. 2025
Uncertainty – decision scaling/	Bottom-up approaches invert the cascade: first identifying the conditions that cause a system to fail, then using	Decision scaling and scenario-neutral methods stress test systems across a wide envelope of	Prudhomme et al. 2010; Brown et al. 2012; Brown

Criteria	Key finding	What the literature demonstrates	Representative sources
vulnerability-led methods	projections to weight those failure states. This has the potential to yield more decision-relevant information than scenario-by-scenario impact studies	conditions and overlay multiple climate information sources. They complement DMDU and pair naturally with the scenario-planning approach used elsewhere in this guidance.	and Wilby 2012; Culley et al. 2016

8.1 Representative sources

This section includes the list of 'Representative sources' referred to in Table 13.

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