Department of Transport and Main Roads

Queensland Good jobs Better services Great lifestyle

Engineering Policy 170

Climate Change and Natural Hazards Risk Assessment

June 2024

Queensland Government

Contents

Glossary

Terms, abbreviations and acronyms	Meaning
BoM	Bureau of Meteorology
CCNHRA	Climate Change and Natural Hazard Risk Assessment
Climate Change Adaptation	The planning, design and construction (including retrofitting) of infrastructure and services in order to avoid failure or impact from the weather.
Climate Change Mitigation	The actions taken to avoid or reduce release of greenhouse gas emissions including reduction of carbon footprint of construction materials.
Climate hazard	The potential occurrence of a [*climate-related*] natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources.
Climate variable	A variable that contributes to the characterization of Earth's climate e.g., sea level, temperature, wind, precipitation.
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Design Rating	An Infrastructure Sustainability rating type assessed at the end of detailed design (as applicable to the Contract). Assessed based on the inclusion of design elements and construction requirements for sustainability in the project documentation.
Infrastructure Sustainability (IS)	Infrastructure that is designed, constructed and operated to optimise environmental, social and economic outcomes over the long term.
Infrastructure Sustainability Accredited Professional (ISAP)	A person who has completed the ISC Infrastructure Sustainability for Professionals training and successfully passed the examination.
ISC	Infrastructure Sustainability Council
Natural hazard	The potential occurrence of a natural event that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources. Natural hazards include extreme events arising from heatwaves, bushfires, droughts, cyclones, severe storms, flooding, etc.
Physical risk	The physical consequence and outcomes on infrastructure and communities resulting from climate hazards, including direct damage to assets and networks, impacts to livelihoods and wellbeing, or liability due to failure to foresee and mitigate losses from any physical risks.
RCP (Representative Concentration Pathways)	The predicted concentrations of CO_2 in the atmosphere over the 21st century depending on different levels of global action to reduce greenhouse gas emissions.
Resilience	The planning, design, management or construction of infrastructure and/or services to plan for failures to ensure services are not interrupted or are able to be quickly re-established following failure (planning for failure).

Terms, abbreviations and acronyms	Meaning
Shocks	Large-scale high-impact events and catastrophes such as human-made and natural disasters. Examples of shocks include cyber-attack; digital network failure; terrorist attack; war and conflict, collapse of financial systems; natural disasters such as earthquakes and floods; widespread pandemics; and diseases.
SSP (Shared Socioeconomic Pathway)	The SSPs represent pathways of various hypothetical global socio-economic and political futures that result in various outcomes in the physical state of the climate.
Stresses	Often defined as the underlying 'slow burn' issues that have the potential to exacerbate a shock. Examples of stresses in the context of infrastructure may include social cohesion; housing affordability; access to transport; increased energy costs; and ageing population.
Transition risk	Uncertainties driven by policy, legal, technological or market changes that influence supply and demand, customer expectations and reputation, as global and local systems transition to a low carbon economy.
Treatment options	Treatment measures associated with climate and natural hazard risks can include: • Structural measures, such as physical changes to the infrastructure to achieve or facilitate adaptation. • 'Non-structural' measures, such as changes to maintenance contracts or the implementation of an emergency management plan. Treatment can be undertaken immediately, or at timescales when the risk occurs.

1 Introduction

1.1 Purpose

The purpose of this document is to provide contextual information on the importance of climate change and natural hazards as a critical issue for the Department of Transport and Main Roads and how the department intends to respond. Context includes policy direction and mandates, as well as historical and projected climate information. Further resources to implement this policy are provided in *Climate Change and Natural Hazards Risk Assessment Guideline* (CCNHRAG) with supporting templates found on the department's Technical Publications Climate change page.

This policy has been developed to guide teams and provide a consistent approach to climate change and natural hazards risk assessment and treatment options across the Queensland Transport and Roads Investment Program (QTRIP). The intent being to drive efficiency of process, building of capacity internally and generation of consistency of treatments. While it may not always be suitable to have consistent treatments, there are also benefits where it is practical. Consistency of treatment options will engender greater uptake of methodology as well as efficiencies during operational phase maintenance.

1.2 Background

This document provides policy direction, context and background information for considering and responding to climate change and natural hazards risks on infrastructure projects.

The policy provides guidance on evidence requirements outlined within the Infrastructure Sustainability Council (ISC) *Infrastructure Sustainability (IS) Technical Manual version 2.1* Design and As Built, credit Res-1: *Climate and Natural Hazards Risks*.

The document is structured to provide:

- policy context at the international, national, state and the Department of Transport and Main Roads levels, and
- sustainability assessment context; climate change exposure, natural hazards and projections specific to projects and programs.

2 Policy context

2.1 International policy

A global climate agreement was reached by 196 countries in Paris at the UN Climate Change Conference (COP21) on 12 December 2015. The Paris Agreement is a legally binding international treaty and provides a framework for all countries to take action on climate change post 2020.

2.2 National policy

The Australian Government recognises that '*Climate change poses significant risks to our economies, communities and the natural environment*' and through Infrastructure Australia's *Assessment Framework*, mandates the consideration of climate change risks for projects seeking federal funding.

Australia is committed to reducing its GHG emissions as per the Paris Agreement. Our current nationally determined contribution stands at 43% below 2005 levels by 2030.

Australia's *Powering Australia Plan* is the country's plan to reduce emissions, create jobs and reduce pressure on energy bills by boosting renewable energy. It has commitments on Australian leadership, transport, electricity and backing industry, agriculture and carbon farming.

The Australian Government's *National Climate Resilience and Adaptation Strategy 2021 - 2025* was released on 29 October 2021 and provides a set of principles to guide effective adaptation and build the resilience of communities, the economy and the environment. The guiding principles include priorities for shared responsibility, climate change risks factored into decision making, a risk management approach based on the best available scientific data, assisting the vulnerable, collaboration with stakeholders, and the need to revisit decisions and outcomes over time.

2.2.1 Climate Change Act 2022

The *Climate Change Act* 2022 came into effect on 14 September 2022. The law outlines Australia's greenhouse gas emissions reductions targets of a 43% reduction from 2005 levels by 2030 and net zero by 2050.

2.2.2 Engineers Australia and Infrastructure Australia

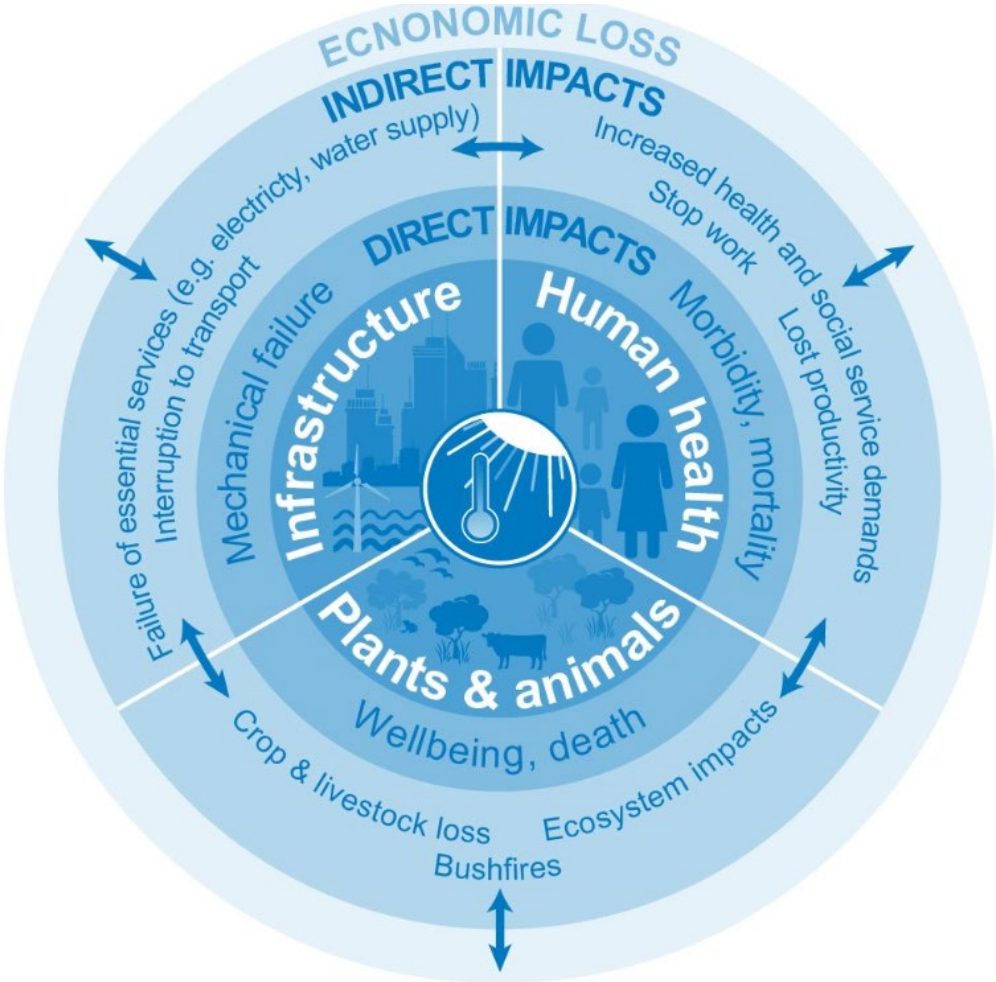
Engineers Australia have also formalised their stipulations for Professional Engineers to consider sustainability and climate change through the Code of Ethics and by publishing guidance *Implementing Sustainability: Principles and Practice*.

Climate change presents a risk to the organisation, its programs and the transport network in a number of ways. Infrastructure Australia groups the effects of climate change into three categories:

- **Direct** effects on an asset that alter its ability to deliver the intended services or its costs; these may be acute (for example, increasing disaster impacts from natural hazards such as flooding) or chronic (for example, trends towards higher average temperatures promoting faster corrosion).
- **Indirect** effects of climate that alter benefits flows even if the infrastructure itself is working as intended (for example, changing temperatures and rainfall altering demand for agriculture-related commercial transport).
- **Transitional** risks where changes in technology, policy or sentiment occur in response to climate change, altering the relevance of the services delivered by the infrastructure whether or not climate change itself eventuates (for example, changing fuel markets which reduce the demand for coal transport to export ports, driverless truck technology or improved telework which reduce the demand for transport.

Figure 2.2.2 depicts these direct, indirect and transitional effects on society.

Figure 2.2.2 – Climate change impacts on society (Queensland Government, 2017)



2.3 Queensland policy

In 2021, the Queensland Government released the *Queensland Climate Action Plan 2020 – 2030*. As part of this plan, the Queensland Government has committed to lifting Queensland's ambition on climate action by setting an emissions reduction target of 75% by 2035. The Queensland Government's *Queensland Climate Adaptation Strategy 2017 – 2030* serves as a core component of Queensland's climate change response to help guide a transition to a zero net emissions economy.

The strategy aims to deliver this guidance through four clearly defined pathways; people and knowledge, state government, local governments and regions, and sectors and systems.

In particular, the Strategy has set out a number of commitments for Transport and Main Roads including to 'manage risks to property, assets, infrastructure and services'. In making Queensland more resilient to a changing climate, the Queensland Government have committed to implementing a number of key actions including:

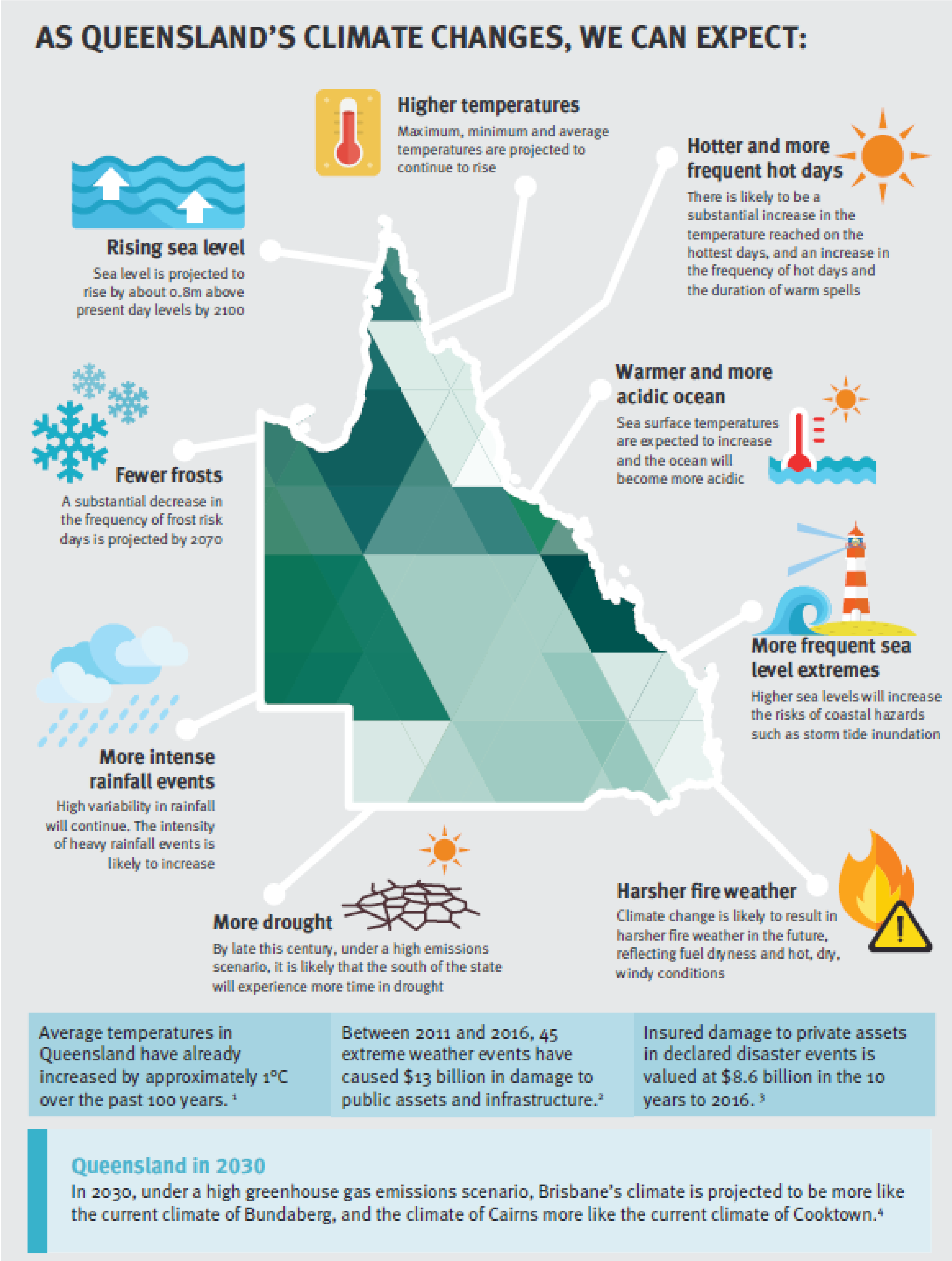
- Action 1.3 – Educate using the best climate science
- Action 2.2 – Manage risks to property, assets, infrastructure and services
- Action 2.4 – Incorporate sustainability objectives into infrastructure projects.

The *Climate Change and Natural Hazards Risk Assessment Guideline* supports these key actions by:

- using several climate scenarios informed by the latest science as provided by the Intergovernmental Panel on Climate Change (IPCC), Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Bureau of Meteorology (BOM)
- providing a risk assessment to manage both direct and indirect risks to the QTRIP program including assets, infrastructure and surrounding properties, and
- describing measures to meet ISC climate change and natural hazards risk assessment credits, while satisfying sustainability objectives.

The *Queensland Climate Adaptation Strategy 2017 – 2030* is supported by climate data and projections documented on both the Bureau of Meteorology and the Queensland Climate Futures Dashboard. A summary of the key projected impacts is provided in Figure 2.3.

Figure 2.3 – The climate change hazards projected to impact Queensland (Queensland Government, 2017)



¹ Climate change data and projections are based on Climate Change in Australia data from CSIRO and the Bureau of Meteorology. More detailed information on these and other climate variables is available at *www.qld.gov.au/environment/climate/climate-change*.
² Queensland Reconstruction Authority
³ Suncorp
⁴ Climate Change in Australia (Bureau of Meteorology and CSIRO).

The *Queensland Strategy for Disaster Resilience 2022-2027* aims to provide an overarching framework to guide and coordinate the delivery of strategic commitments and actions to improve the resilience of Queensland communities. The Strategy acknowledges flooding as the highest priority hazard for Queensland, and other high priority natural hazards as tropical cyclones, bushfires, severe thunderstorms, heatwaves, earthquakes and tsunamis. Future hazard risks noted in this document include an increase in risk of earthquakes of higher magnitudes in Queensland and an exposure to tsunamis generated from submarine landslides, earthquakes and volcanic eruptions.

2.4 Transport and Main Roads Climate Change and Natural Hazards Risk Assessment Guideline

The department's *Climate Change and Natural Hazards Risk Assessment Guideline* complements this policy and aims to provide a methodology for the consideration and assessment of impacts associated with climate change and natural hazards across its network and infrastructure projects.

The Guideline identifies a number of opportunities to integrate climate change and natural hazards into assessment to achieve maximum benefits including:

- through specifications and standard drawings
- risk profiles
- risk registers, and
- investment.

This Guideline builds off recommendations and findings from Infrastructure Australia around the effects of climate change, including the recognition of Infrastructure Australia's three categories: direct effects, indirect effects and transitional risks.

2.5 Integration of climate change and natural hazards into Transport and Main Road risk assessments

The CCNHRA should not be a stand-alone process. To identify maximum opportunities and achieve maximum benefits, climate change and natural hazards risk assessments should be integrated through:

1. Transport and Main Roads' investment policies and programs
2. Transport and Main Roads' specifications and standard drawings
3. Districts risk context profiles
4. Branch risk registers
5. Program risk registers
6. Project risk context profiles in accordance with EP153 *Risk Context Profiles*
7. Projects seeking funding through Infrastructure Australia can integrate this methodology as part of the Infrastructure Australia's methodology for considering climate change and natural hazards risks (Section D4.6 of the *Assessment Framework*), and
8. Infrastructure projects over $100M applying a climate change and natural hazards risk assessment.

On infrastructure projects, the CCNHRA should form part of the overall project risk and opportunity workshops and registers.

3 Sustainability Assessment context

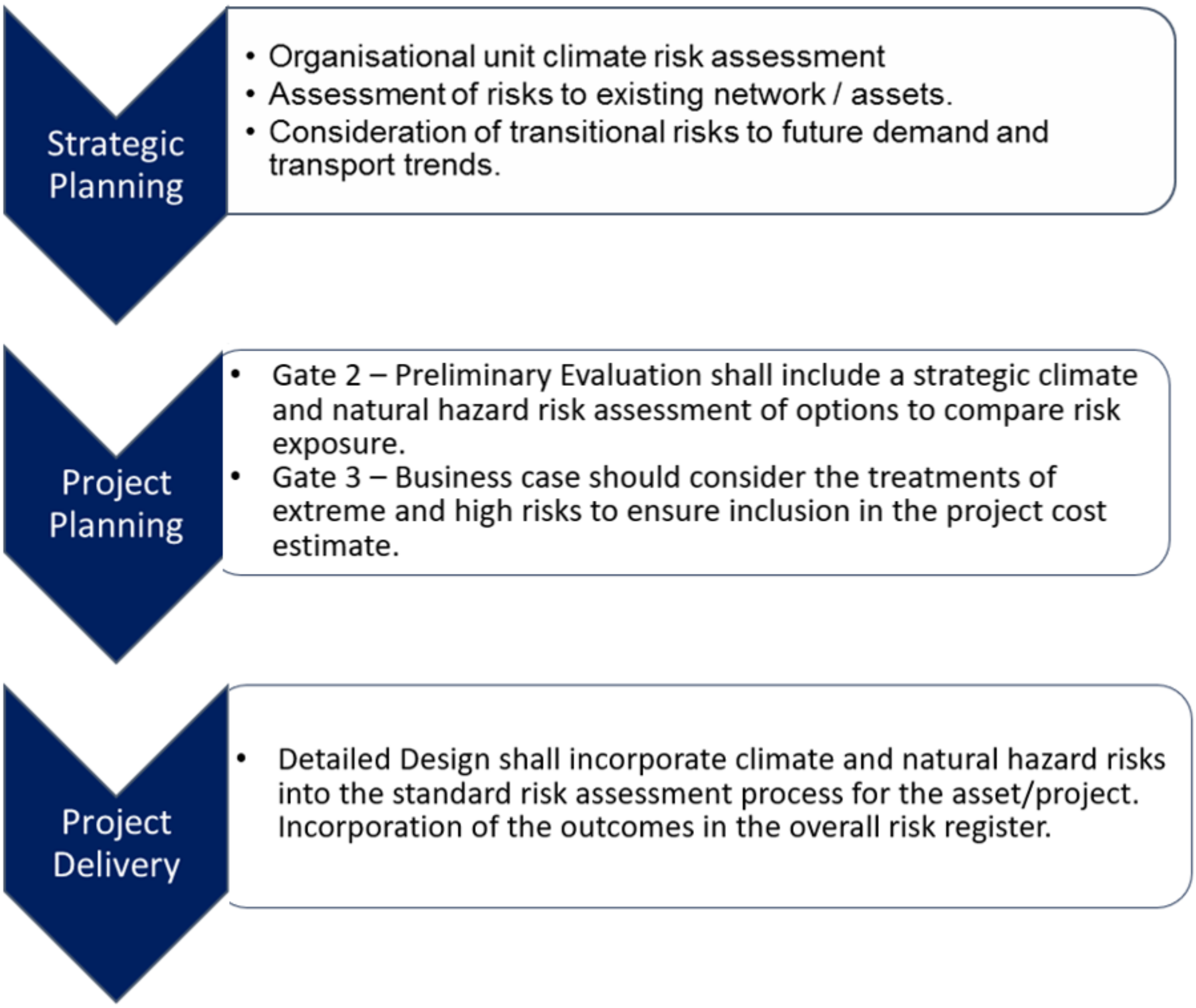
For major projects applying the ISC Infrastructure Sustainability Rating Scheme, this policy, *Climate Change and Natural Hazards Risk Assessment Guideline* and corresponding templates serve to provide a baseline for projects seeking to address climate and natural hazard risk. This is in alignment with the requirements outlined in the *IS Technical Manual v2.1* for Res-1.

Res-1 aims to reward the identification, assessment and treatment of risks to the asset associated with climate change and natural hazards.

4 Timing of climate change and natural hazard risk assessments

Climate change and natural hazard risk assessments should be incorporated into the risk assessments at various stages of planning and delivery. The level of detail in the risk assessment should be commensurate with the level of detail required at that phase of the project. Figure 4 highlights key climate and natural hazard risk considerations to be undertaken at different project stages. That is, detailed design risk assessments are generally very detailed while the assessments at a strategic level are considering broader-scale consequences of impacts.

Figure 4 – Project phase CCNHRA considerations



5 Methodology

Refer to *Climate Change and Natural Hazards Risk Assessment Guideline* for an overview of the steps to complete a CCNHRA.

6 Natural hazards

Natural hazards such as tsunamis, landslides and earthquakes have occurred in Australian history and studies have been undertaken to understand the threat of these hazards to the country. Whilst tsunamis are rare, dozens of tsunamis have been observed historically in Australia and have generated marine hazards and locally significant inundation. There are large uncertainties in how often tsunamis might occur in Queensland due to short historical records and the rarity of damaging tsunamis in the region, but hazard studies completed by QFES suggest the potential for larger events with greater impacts to occur. The most likely threat for the Australian community from a tsunami is a marine and immediate foreshore threat, where potentially dangerous rips, waves and strong ocean currents occur in the marine environment.

Landslides involve the movement of large amounts of earth, rock, sand or mud and can be sudden and fast moving, moving millions of tonnes of debris. Each year, landslides occur in Australia and cause millions of dollars damage to infrastructure, roads and railways. They can be caused by a major event such as an earthquake but in Queensland, landslides are generally caused when heavy rain saturates soil on a hillside past the point where vegetation can support the soil's weight against the force of gravity. Impacts can be extensive, including loss of life, destruction of infrastructure, damage to land and loss of natural resources.

Whilst earthquakes pose a lower threat to Queensland communities than many other regions, they have occurred in the past and there is a predicted increase in risk of earthquakes of higher magnitudes in Queensland. The largest recorded Queensland earthquake, a magnitude 6.05, occurred off the coast of Gladstone in 1918, with an estimated felt area exceeding 3 million square kilometres extending from Northern New South Wales (NSW) to Mackay, and as far inland as Roma. A magnitude 5.3 earthquake in Newcastle NSW in December 1989 had a felt radius of 800km, 13 lives were lost, and thousands of homes and buildings were damaged. The highest risk area in Queensland is the south-east, from Gladstone in the north to Logan and Scenic Rim in the south, and from the coast across to the Burnett and Western Downs regions. This zone has a 17% probability of experiencing a Newcastle-style of event and a 3% chance of a Gladstone-like earthquake, once every 100 years. This considers a range of factors including probability of occurrence, as well as the density of population, infrastructure, and economic activity.

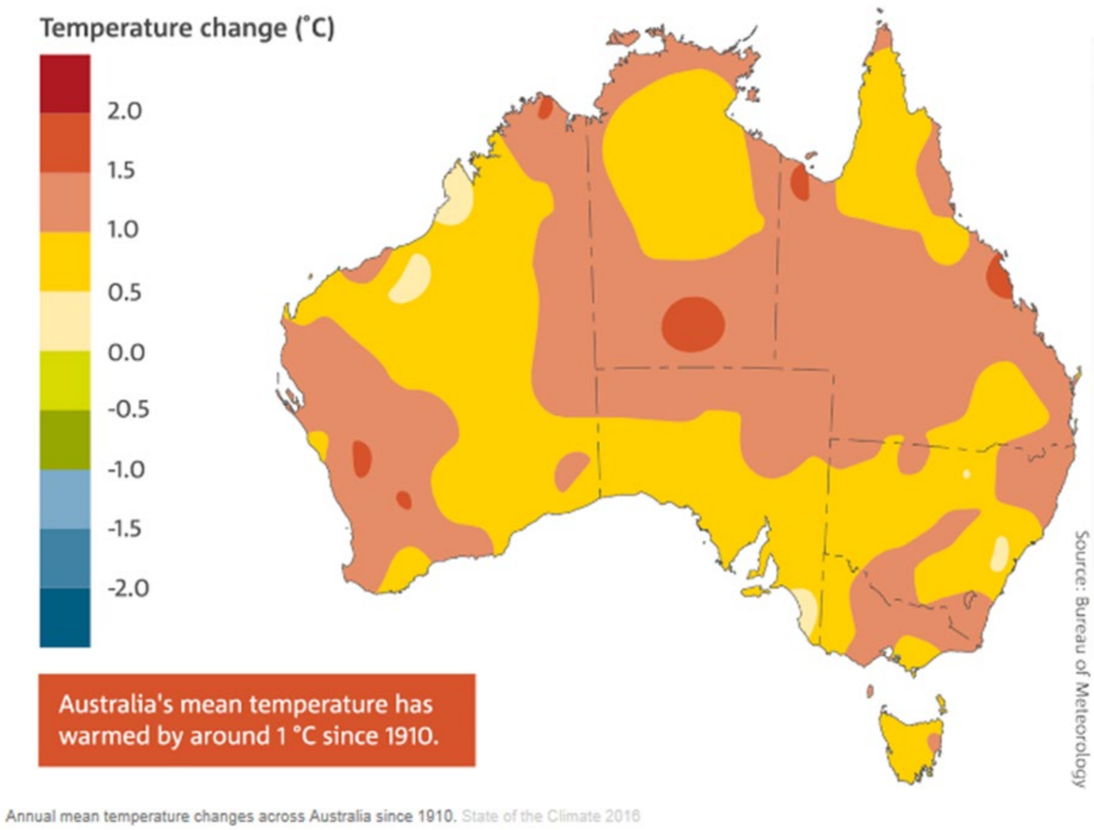
7 Climate change

7.1 Climate change context

Climate change is a global challenge posing significant threats to the natural environment, infrastructure, communities, and the economy. In recent years, Australia has experienced an increase in the duration, intensity and frequency of extreme weather events such as fires, floods and drought, which are likely to increase further in the future. It is essential that adaptation measures and resilience strategies be implemented both within infrastructure developments and within communities, in order to increase resiliency, preparedness and recovery against extreme climate events.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) has reported that Australia’s climate has warmed by 1 degree Celsius since national records began in 1910, and that the years 2013 to 2015 are among the top five warmest years on record, with 2019 being Australia's hottest and driest year on record. According to the World Meteorological Organization (WMO), 2023 was the earth’s hottest year in recorded history and the eighth hottest in Australia’s history. Figure 7.1 below displays the annual mean temperature changes across Australia since 1910, demonstrating that an increase in annual mean temperature is experienced across the country.

Figure 7.1 – Annual mean temperature changes across Australia since 1910 (Bureau of Meteorology and CSIRO, 2016)



In addition to an increase in mean annual temperature, oceans around Australia are warming and acidifying (decreasing in pH) and sea levels are rising. It is also predicted that longer droughts will be experienced in the south and increased flooding in the north, and a long-term increase in extreme fire weather and length of the fire season will progressively be experienced. The national annual accumulated Forest Fire Danger Index – an indication of the severity of fire weather – was the highest on record in 2019. The effects of climate change will not only be felt within Australia, but across the globe. These extreme weather events pose significant threat to the environment, society and the economy, and building self-resilience throughout Australian communities is critical.

7.2 Climate hazards

In accordance with the *Climate Change and Natural Hazards Risk Assessment Guideline*, the minimum climate and natural hazards that should be considered are listed below in Table 7.2.

Table 7.2 – The minimum climate and natural hazards that should be considered as part of the department's risk assessment

Primary variables (stresses)	Secondary variables (shocks)
Air temperature	Precipitation
Humidity	Wind and hail
Sea surface temperature	Bushfire
Precipitation	Coastal inundation
Sea level rise	Cyclones/storms
Wind and hail	Flooding
Coastal inundation	Heatwave
Drought	Landslides
Frost	Tsunami

7.3 Climate modelling

The climate of Queensland, as with global climate trends, is naturally variable. Climate change, however, will lead to shifts beyond this natural variability.

Risk assessment based on climate change requires an understanding of the current climate using historical data for comparison with future climate scenarios.

Future climate scenarios are generated and prepared using data from Global Climate Models (GCM). GCMs are tools used for understanding how the climate will respond to changes in greenhouse gas (GHG) emission levels.

7.3.1 Climate scenarios

The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental organisation of the United Nations whose primary objective is to conduct research and assessments in relation to climate change science in order to inform adaptation and mitigation measures. The IPCC has defined four greenhouse gas concentration trajectories (outlined in Figure 7.3.1 below) known as Representation Concentration Pathways (RCPs) for use in climate modelling and research.

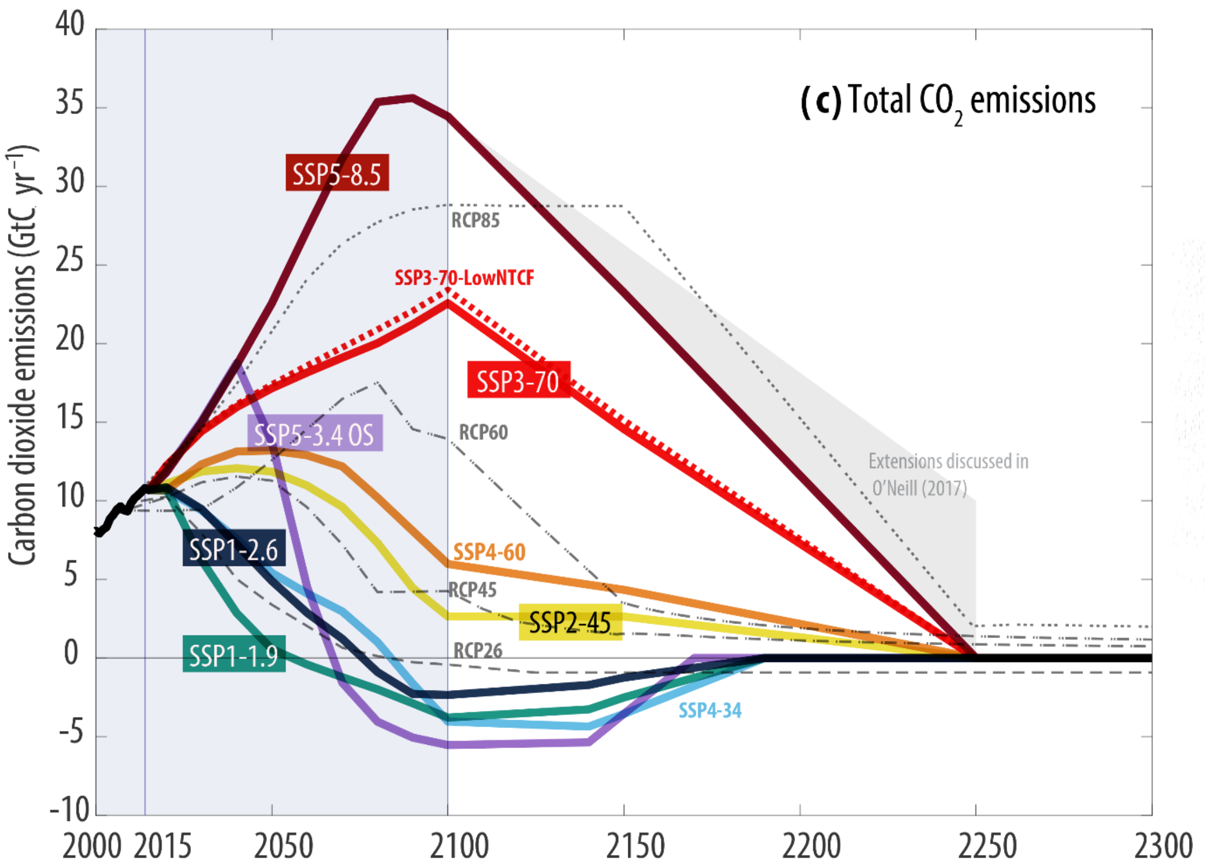
Projections are presented for an emission scenario or possible pathways, referred to as 'Representative Concentration Pathway' (RCP), each of which reflects a different concentration of global greenhouse gas emissions. RCPs have been modelled for low emissions (RCP 2.5), medium emissions (RCP 4.5) and high emissions (RCP 8.5). The RCP 8.5 pathway, which arises from little effort to reduce emissions and represents a failure to prevent warming by 2100, is similar to the highest Special Report on Emissions Scenarios (SRES) scenario and is used recommended for use under this policy. The RCP 8.5 pathway is also closest to the current emissions trajectory.

IPCC's Assessment Reports present new ranges of climate scenarios, the Shared Socio-economic Pathways (SSPs). Transport and Main Roads recommends use of the latest scenarios where available. These scenarios are considered to explore the climate response to a broader range of greenhouse gas (GHG), land-use and air pollutant futures. The modelling is based on a 2015 baseline, and includes:

- Scenarios with high and very high GHG emissions (SSP3-7.0 and SSP5-8.5) where CO_2 emissions roughly double from current levels by 2100 and 2050, respectively. A very high GHG emissions scenario of SSP5-8.5 is closest to an RCP 8.5 scenario.
- Scenarios with intermediate GHG emissions (SSP2-4.5) where CO emissions remaining around current levels until the middle of the century. An intermediate GHG emissions scenario of SSP2-4.5 is closest to an RCP 4.5 scenario.
- Scenarios with very low and low GHG emissions and CO_2 emissions declining to net zero around or after 2050, followed by varying levels of net negative CO_2 emissions (SSP1-1.9 and SSP1-2.6). A low GHG emissions scenario of SSP1-2.6 is closest to an RCP2.6 scenario.

NOTE: the SSP scenarios cover a broader range of GHG and air pollutant futures than the RCPs. They are similar but not identical, with differences in concentration trajectories for different GHGs.

Figure 7.3.1 – Total CO_2 emissions under various SSP and RCP scenarios (Meinshausen et al, 2020)



Timescales

Roadway infrastructure has a varied expected design life depending on the component or system (e.g., pavement versus electrical). It may be appropriate to re-consider minimum design lives on a project by project component basis where delayed climate change risk may be able to be better accounted for through delayed treatment.

For major projects, the time periods selected for assessment will depend on the design life of the nominated assets. For example:

- assets with <10 year design life would use 2030 to identify short term impacts, and 2050 for long term impacts
- assets with up to 40 year design life would use 2050 to identify short term impacts, and 2070 for long term impacts, and
- assets with 50+ year design life would use 2050 to identify short term impacts, and 2090 for long term impacts. This includes assets with 100-year design life, where the longest projections available should be used.

Climate projections for the selected time scales represent averages over a 20-year period:

- projections for 2030 represent the average for the 20-year period between 2020 and 2039
- projections for 2050 represent the average for the 20-year period between 2040 and 2059
- projections for 2070 represent the average for the 20-year period between 2060 and 2079, and
- projections for 2090 represent the average for the 20-year period between 2080 and 2099.

Ultimately, the selection of relevant timescales for the assessment should consider the design life of assets, with one timescale adopted that is at or beyond the final expected operating year of the asset. At present, 2090 represents the furthest time horizon for understanding projections and future changes to the climate. It is worth noting that the level of confidence in global models decreases with further time horizons however adaptation actions taken to reduce risk in 2070 are likely to have benefit to the 2090 scenario, including treatments identified currently that protect the longer design life elements (e.g., drainage and bridge piles). It is recommended that when new projections and other information become available (and have greater confidence), climate risks to the project should be reviewed and reassessed using this new information.

8 Potential likelihood

The likelihood of particular climate hazards impacting on an asset are largely dependent on:

- location of the asset, and
- local climate projections.

9 Summary of Transport and Main Roads Infrastructure climate change and natural hazards risks

A summary of Climate Change Risks identified for Transport and Main Roads assets can be found on the Technical Publications Climate change page. The project / asset specific likelihood and consequence of each risk must be considered on a project by project or asset by asset basis (refer to *Climate Change and Natural Hazards Risk Assessment Guideline* for more guidance on risk assessment methodology). The risk table includes examples for some shock and stress variables, and additional variables may need to be included if identified.

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