Waikato Regional Council Technical Report 2025/26

Climate Change Adaptation Guideline for the Waikato Region

A technical guide and reference document for navigating climate change adaptation in the Waikato region

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Version History

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Please contact the WRC Regional Resilience team for any further information or clarification on information within this guidance.

Abstract

Waikato Regional Council (WRC) is committed to making significant and long-lasting contributions to its communities, the natural environment and the region's economy by responding to climate change in an effective and meaningful way. This Climate Change Adaptation Guideline (guideline) provides the latest policy guidance, scientific information and frameworks on climate change adaptation relevant to the region to encourage a coordinated approach. It includes information on climate change risks to Māori and how to work with our iwi partners.

This guideline is for anyone preparing for the impacts of climate change. For WRC and territorial authorities in the Waikato region, it provides scientific and regulatory information and guidance for developing climate risk assessments, policies and plans. Community groups, iwi/hapū, and industry can use it to understand the information available to help prepare their community/sector.

This guideline is fairly technical due to the nature of the subject. It is a long document that is not intended to be read cover to cover. Instead, users may choose to read the Introduction and Key concepts (sections 1 and 2) and then pick and choose the specific sections relevant to their work to read. Further work is required to simplify the information contained in the guideline and to focus on key users such as iwi, modellers, developers, planners and community groups.

This guideline forms part of a suite of Waikato-specific climate strategies and information and should be used in conjunction with these documents. It does not cover mitigation of greenhouse gas emissions or provide localised or site-specific information.

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1 Introduction

Definition of Adaptation

WRC defines adaptation in the Waikato Climate Change Response Position Statement 2023
Adaptation means anticipating and proactively responding to climate change impacts that are already happening or are expected to happen, reducing exposure to physical climate risks and avoiding any future activities that increase the exposure to physical climate risks.

Waikato Regional Council (WRC) is committed to making significant and long-lasting contributions to its communities, the natural environment and the region's economy by adapting to climate change in a consistent, effective and meaningful way.

Climate change is a complex issue with rapidly evolving scientific information, guidance, regulatory requirements and legislation. WRC has developed the Climate Change Adaptation Guideline (guideline) to provide a home to the latest scientific and technical information and policy guidance relevant to climate change adaptation in the Waikato region. The guideline includes information on climate change risks to Māori and how to work with our iwi partners to address these risks.

WRC recognises that many in the region, including territorial authorities, iwi/hapū, community groups and other sectors, are individually preparing and planning for the impacts of climate change. This guideline is a one stop shop of information for WRC staff, territorial authorities, iwi and external stakeholders as the technical basis for planning for the effects of climate change and implementing climate change adaptation initiatives. This will also encourage a consistent approach to climate change adaptation across the region.

The guideline will be reviewed at least annually so it remains useful and relevant in the face of continual progression in the climate change space.

WRC's Strategic Direction (2023-2025) emphasises that a focus on responding to climate change is woven through all six of its strategic priorities. WRC recognises that its responses to climate change present a mix of economic and social opportunities, alongside necessary changes and challenges. This is outlined in the WRC Climate Change Response Position Statement 2023 and the Climate Action Roadmap 2023 where WRC has taken a proactive approach to its response to climate change in the Waikato Region.

The guideline is part of a suite of information and initiatives under the WRC's Understanding and Adapting to Natural Hazard Risk Programme.

1.1 Purpose and scope of guideline

The purpose of this guideline is to have all relevant national and regional climate science, policy and adaptation decision-making frameworks for the Waikato region referenced in one place

The guideline provides best practice guidance and the latest climate change science relevant to the Waikato region to ensure a consistent regional approach to climate change adaptation.

For WRC and territorial authorities within the Waikato region, the guideline provides underlying technical and regulatory information for the development of statutory and non-statutory climate policy and plans and the assessment of climate hazard and risk.

The guideline includes the following:

- Information on WRC's coordinated regional approach to climate change adaptation, including working with our iwi and territorial authority partners.
- A summary of key statutory and non-statutory national and regional policies and guidance on climate change adaptation.
- A summary of the information available on climate change projections, hazards and risks in Waikato region, including risks to Māori, and guidance on how to apply this information.
- Climate change adaptation frameworks and guidance to support decision making in the Waikato region.
- Scenarios, projections and guidance to inform risk assessments, modelling and scenario analysis in the Waikato region.

Some examples of how this guideline can be used are:

- To assist local adaptation planning and community resilience projects.
- To support the implementation of statutory policies, objectives and methods (including rules) related to climate change adaptation contained within the Waikato Regional Policy Statement, Regional Plan, Regional Coastal Plan, Regional Pest Management Plan and Long Term Plan.
- To assist the consideration of natural hazard risk in regional spatial planning.
- To support land use planning decisions by territorial authorities, including informing the preparation or assessment of resource consent applications.
- To inform engagement with iwi on climate change adaptation or iwi-led adaptation projects.
- To support risk assessment for the impacts of climate change when developing/ reviewing infrastructure, roading and asset management plans.
- To support technical modelling of hazards such as flooding that will be exacerbated by climate change.

What this guideline is not:

- This guideline does not cover mitigation of greenhouse gas emissions. WRC's work to transition to a low emissions economy is outlined in WRC Strategic Directions 2023 – 2025. WRC Strategic Direction 2023 – 2025 and its Climate Action Roadmap 2023.
- This guideline is regional and does not contain localised or site-specific information. It is recommended to research the relevant territorial authority in the region, or utilise the Waikato Hazards Portal for spatial natural hazard information.
- This guideline has been developed using existing information and guidance and does not seek to vary from adopted national policy guidance.

1.1.1 How to use and further work

This guideline is fairly technical due to the nature of the subject. It is a long document that is not intended to be read cover to cover. Instead, users may choose to read the Introduction and Key concepts (sections 1 and 2) and then pick and choose the specific sections relevant to their work to read.

Further work is required to simplify the information contained in the guideline and to focus on key users such as iwi, modellers, developers, planners and community groups.

1.2 Structure of guideline

Section One – Purpose, scope and structure of the guideline.

Section Two – Introduces key concepts and principles for climate change adaptation.

Section Three – Outlines how WRC is coordinating a regional approach to climate change adaptation, including through policy and plans, work programmes, and collaborating with our iwi and territorial authority partners.

Section Four – Summarises the information available on future climate, hazards and risks in the Waikato region. Includes information on key WRC and national reports, tools and data, as well as information on climate change risks for Māori. This section also provides a shortlist of suitable sources of climate change information, outlines common applications of this information, and provides a matrix to describe the suitability of sources for different applications.

Section Five – Summarises best practice guidance on climate change adaptation and provides recommendations for which climate scenarios and timeframes to use for different purposes. Discusses how to apply a te ao Māori approach to climate change adaptation and provides examples of adaptation planning within territorial authorities in the Waikato region.

Section Six – Describes national legislation, and regional and local policy and plans that guide climate change adaptation in the Waikato region and set out specific requirements. This section also includes a reference list of existing WRC policy, frameworks and guidance relevant to climate change adaptation.

Section Seven – Provides technical information for modelling, particularly for flooding, sea level rise and coastal hazards. Emphasises using an increments approach over a scenarios approach for modelling (except for infrastructure design) and describes how to do this.

This report includes the following appendices:

- Appendix One: Climate projections for territorial authorities in the Waikato region
- Appendix Two: Additional information on climate change risks for Māori
- Appendix Three: Additional resources for a te ao Māori approach to climate change adaptation

2 Key concepts and principles for climate change adaptation

This section covers:

- *Key concepts for climate change adaptation:*
  - *Adaptation vs mitigation*
  - *Climate scenarios and projections*
  - *Dynamic Adaptive Pathways Planning (DAPP) approach to adaptation*
- *Principles for climate change adaptation*

Definitions for the key terms in this guideline are provided in the Glossary in section 9.

2.1 Adaptation vs mitigation

For this guideline, adaptation is described as anticipating and proactively responding to climate change impacts that are already happening or are expected to happen, reducing exposure to physical climate risks and avoiding any future activities that increase the exposure to physical climate risks. By adapting to the unavoidable impacts of climate change, we become more resilient.

Adaptation involves taking both practical and strategic actions to manage changing risks from climate change. For example, creating and implementing a community adaptation plan, improving the resilience of buildings or infrastructure to coastal flooding, investigating a change in land use for frequently flooded areas or which are subject to drought or planning for the Waikato's future growth in a way that considers the changing risks from climate change. Adaptation must consider both long-term gradual changes from climate change and new or more frequent extreme events.

Adaptation is distinct from mitigation, which relates to dealing with the drivers of climate change by reducing greenhouse gas emissions; for example, planting trees or improving usage of public transport. Climate Change mitigation is not covered in the guideline. However, WRC does have a broad range of initiatives and work programmes that focus on climate change mitigation in our region (and within WRC), such as the Climate Action Roadmap. Further, some climate change mitigation measures will also contribute to adaptation and vice versa (such as planting on marginal land).

2.2 Climate scenarios and projections

The climate is already changing and will continue to do so in the future. However, the timing and magnitude of this change is uncertain because of uncertainties in factors such as the reduction of greenhouse gas emissions and the earth's climate system. Because of the inherent uncertainty, climate change science does not try to predict the future. Instead, a range of scenarios and projections are used to represent how different future climates might unfold. These scenarios and projections are produced internationally by the Intergovernmental Panel on Climate Change (IPCC), and NIWA have downscaled this IPCC data to be used for New Zealand.

2.2.1 Climate scenarios

Climate scenarios hypothesise how the future may unfold, so we can begin to understand the impacts of climate change. Each scenario sets specific values for key parameters, such as greenhouse gas emissions, based on different combinations of economic, technological, political, and social decisions.

The most recent IPCC report, the sixth assessment report (AR6), uses shared socio-economic pathways (SSPs) to illustrate a range of possible global futures depending on our collective choices. It combines these with representative concentration pathways (RCPs) from the fifth assessment report (AR5) which correspond to levels of radiative forcing (and degrees of global warming) by 2100. Five SSP-RCP scenarios were produced for AR6 that span a range of plausible societal and climatic futures. Four of these were used by NIWA to produce downscaled climate projections for New Zealand (MfE, 2024d):

- The ‘Sustainability’ scenario, SSP1-2.6, assumes that the world shifts gradually toward a more sustainable path, emphasising more inclusive development that respects environmental boundaries. It assumes that warming stays below 2˚C, with net zero CO2 emissions reached by 2050.
- The ‘Middle of the road’ scenario, SSP2-4.5, assumes that the world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns. It assumes that warming reaches 2.7˚C by 2100.
- The ‘Regional rivalry’ scenario, SSP3-7.0, assumes the world becomes more focused on national and regional security issues, and there is no additional climate policy. It assumes CO2 emissions approximately double from current levels by 2100 and warming reaches 3.6˚C by 2100.
- The 'Fossil-fuelled development' scenario, SSP5-8.5, represents the high end of the range of future scenarios. It assumes that the world places increasing faith in competitive markets, innovation, and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development, with warming of more than 4˚C by 2100.

Each scenario combines a socio-economic narrative (SSP) with an associated level of greenhouse gas emissions. These scenarios form the starting point, or input data, for climate models. More information on which climate scenarios to use is provided in section 5.2 of this guideline.

2.2.2 Climate projections

A climate projection is a scientific simulation - it describes how the climate would respond under the conditions laid out in a particular scenario. Unlike scenarios, projections are not influenced by societal choices. Projections come from complex climate models that are grounded in robust scientific equations. These models help translate human actions into data on future climate outcomes. The projections they produce (for example, projected average temperature by the end of the century) are the outputs of these models.

NIWA has produced climate projections for Aotearoa New Zealand based on the IPCC’s climate scenarios. These climate projections include changes in temperature, rainfall and wind and are calculated for three future time periods (2021 to 2040, 2041 to 2060 and 2081 to 2099) relative to two historical baseline periods (1986 to 2005 or 1995 to 2014). More information on climate projections for the Waikato region is provided in section 4.2 of this guideline.

2.3 Dynamic Adaptive Pathways Planning (DAPP)

The timing and magnitude of future change is uncertain. So, when planning for the impacts of climate change, we must take a different approach to planning for hazards and risks that are known and remain constant. We must be able to plan for the impacts of climate change, while remaining flexible to change our approach if it is no longer fit for purpose. Dynamic Adaptive Pathways Planning (DAPP) is the nationally recognised best practice tool to achieve this and is described in the Ministry for the Environment’s (MfE) Coastal Hazards and Climate Change: Guidance for Local Government (2024 guidance) (section 5.1.1 of this guideline).

The DAPP approach develops a series of adaptation options over time (pathways). It is based on the idea of making decisions as conditions change, before severe damage occurs, and as existing policies and decisions prove no longer fit for purpose. Over time, some adaptation options may no longer be suitable (for

example, ongoing sea level rise exceeding the design of a seawall). The DAPP approach allows for changing to a new pathway (for example, managed retreat) before this point is reached (threshold). To achieve this, monitoring is required to recognise when predetermined signals (early warning signs) and triggers (decision points) are occurring.

The DAPP approach requires ongoing review of new climate change information to ensure the adaptation plan remains anticipatory and flexible. It also requires that adaptation actions taken now do not prevent alternate actions being taken in the future, by locking the response onto one pathway.

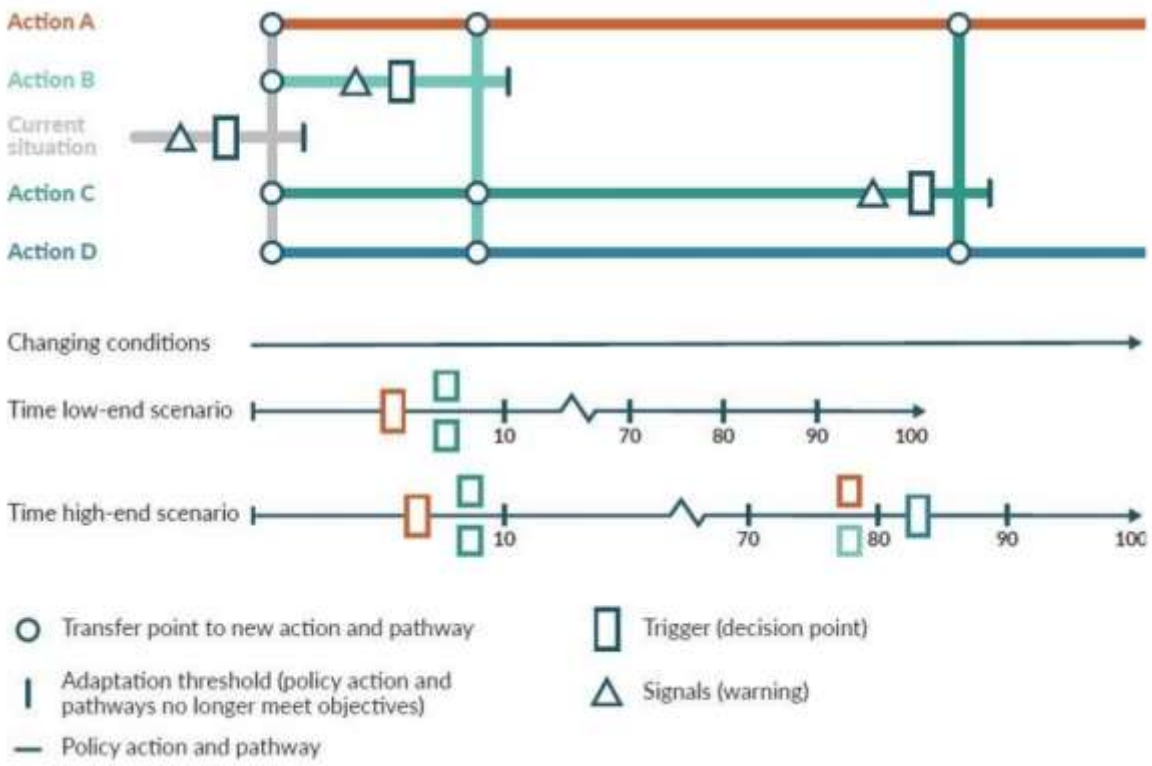


Figure 1 **A DAPP map showing pathways, signals, triggers and thresholds (MfE, 2024a – adapted from Haasnoot et al (2013); Hermans et al 2017)**

2.4 Principles for climate change adaptation

When commencing a climate change adaptation project, the following principles are a good place to start and should be followed. These principles were collated by Ministry for the Environment (MfE) (2024a) and are either set out in law or have evolved through good practice and case law.

Table 1 **Principles for managing coastal hazards under a changing climate (MfE, 2024a)**

Principle	Description
Sustainability and resilience	The Resource Management Act 1991 (RMA) concept of sustainable management and the Local Government Act 2002 (LGA) principle of sustainable development support the ability of communities to respond and adapt in a way that avoids or limits harm. Resilience is closely related to sustainability and is increasingly being enshrined in Aotearoa New Zealand legislation.
Meet the reasonably foreseeable needs of future	This RMA phrase requires consideration of the interests of future communities, and the direct and indirect impacts they may experience from

generations	decisions made today. This principle applies even where the need for a response to climate change has not yet been identified.
Avoid, remedy or mitigate adverse effects	Policy 25 of the New Zealand Coastal Policy Statement 2010 (NZCPS) refers to the risk of "social, environmental and economic harm" from coastal hazards and seeks to reduce, or at least avoid increasing, risks of harm and adverse effects.
Precautionary principle	This principle is applied at the planning response stage (steps 6 to 8 of the 2024 MfE Guidance decision cycle) (see section 5.1.1 of this guideline). It requires precaution for decisions where full information on effects is not available, particularly when effects are potentially significant or decisions are effectively irreversible. A precautionary approach is also included as Policy 3 of the NZCPS.
Stewardship/kaitiakitanga	This is reflected in both the LGA and RMA, stewardship, or kaitiakitanga, forms the basis of sound planning decisions in the interests of the community, to avoid or minimise loss of environmental values or quality over time. Hapū/iwi assert their right to own, control and manage their ancestral lands and territories, waters and other resources.
Community engagement	Engagement with communities, iwi and affected people is at the heart of local government decision-making. For this to be effective, communities must have enough information to understand the range of scenarios and the increasing risks posed by climate change over time.
Proportionality	Decisions affecting small areas and few people and requiring little sunk investment may reasonably consider climate change effects over a shorter timeframe. Decisions that result in large scale and/or permanent change, that affect important places of value and require considerable sunk investment must consider long-term impacts.
Financial responsibility and disclosure	Local government is expected to act within normal codes of financial responsibility on behalf of the community. Local authorities are required to disclose any known hazard information on Land Information Memoranda). Local government must also provide information on governance in relation to the risks and processes, metrics and targets used to assess and manage the risk, if requested by the Climate Change Commission or the Minister of Climate Change under s5ZW of Climate Change Response Act 2002.

3 A coordinated regional approach to climate change adaptation

This section covers:

- *WRC policy commitments to climate change adaptation*
- *How legislation guides WRC's climate response*
- *Working with our iwi partners*
- *Working with our territorial authority partners on climate change adaptation*

3.1 WRC commitments to climate change adaptation

WRC's commitment to planning for and adapting to climate change is formalised and expanded on in the key documents summarised below. WRC is also a signatory to the Local Government Leaders' Climate Change Declaration which acknowledges the important and urgent need to address climate change for the benefit of current and future generations.

Figure 2, from the 2023 Waikato Climate Action Road Map provides an overview of how legislation guides the climate response (adaptation and mitigation) in the Waikato region. Detailed information on legislation, policy and plans relating to climate change adaptation is provided in section 1 of this guideline.

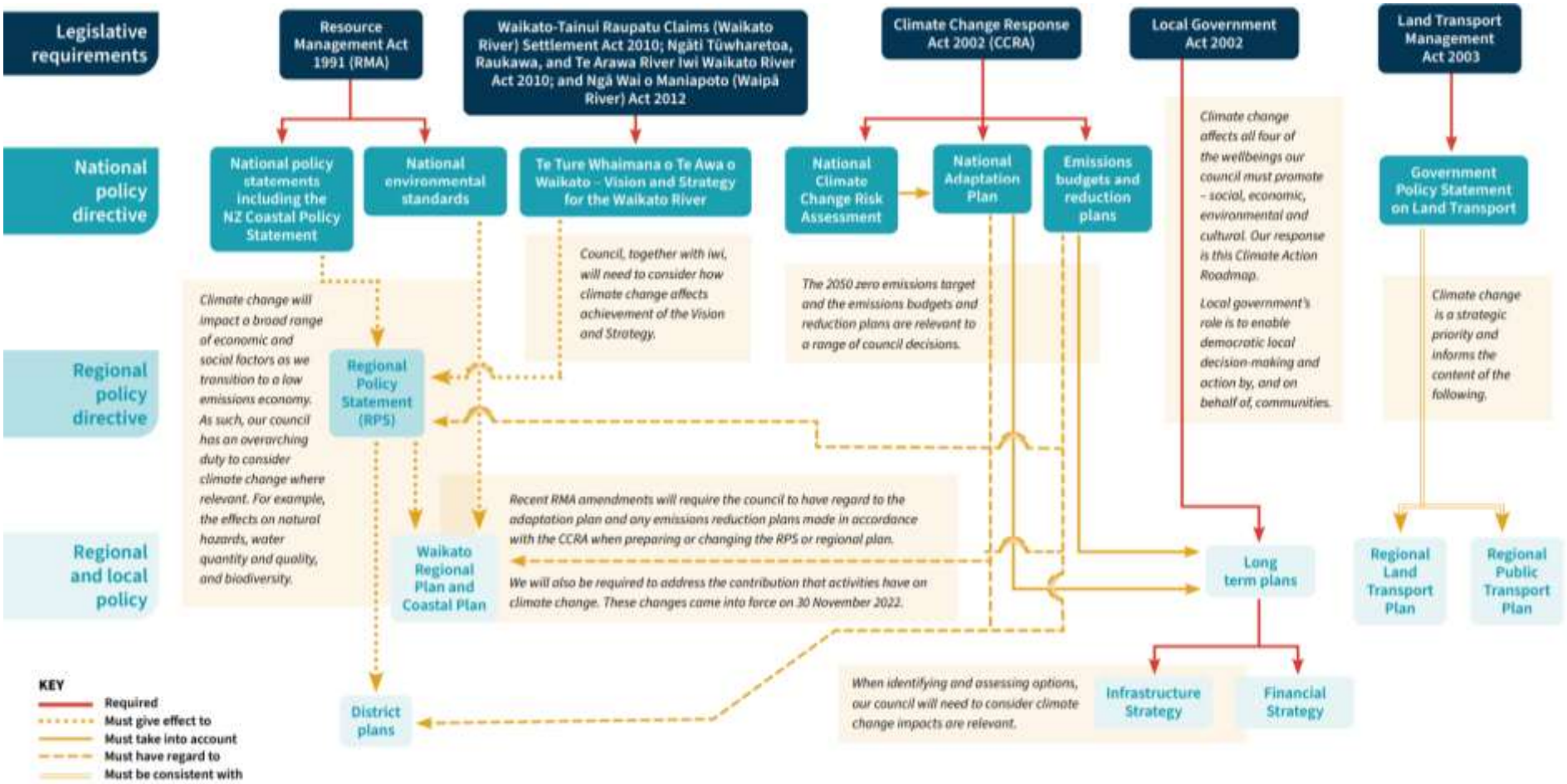


Figure 2 WRC Climate Action Road Map legislation overview (WRC, 2023a)

3.1.1 Takatū Waikato | Making a Stand for the Waikato: Strategic Direction 2023-2025

Matawhānui |Our vision
Waikato mārohirohi: Manaaki whenua, whakamana tangata.
The mighty Waikato: Caring for our place, empowering our people.

Purpose: Working together for a Waikato region that has a healthy environment, vibrant communities and strong economy.

WRC's Strategic Direction 2023-2025 emphasises that how we respond to climate change is woven through all six of its strategic priorities. Aligned with this, the Climate Action Roadmap identifies nine pathways to work with others to reduce emissions and adapt to climate change.

3.1.2 He Mahere Ārai Āhuarangi | Climate Action Roadmap 2023

The 2023 update of the Climate Action Roadmap is a call to our regional community to work together and signals how WRC will work with others to support the transition to a climate-resilient, low emissions society that is less vulnerable to disruption, more affordable and better for health and wellbeing.

The 2023 update incorporates international, national and council directions, including:

- The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) published in March 2023
- Changes in New Zealand legislation
- The National Adaptation Plan
- The Emissions Reduction Plan
- WRC's Strategic Direction 2023-2025

The roadmap identifies nine pathways which represent the biggest challenges and opportunities and depend on the sustained engagement of all sectors of society working collaboratively towards mutually agreed targets.

Figure 3 WRC Climate Action Roadmap pathways (WRC, 2023a)

The roadmap is a non-statutory document, which WRC has developed to provide regional leadership and direction for the Waikato's climate change response. Our response and commitments set out in each pathway guide conversations with staff, iwi partners and stakeholders, and guide investment decision-making for our Long Term Plan processes.

3.1.3 WRC's Climate Change Response Position Statement 2023

The purpose of the Climate Change Position Statement is to provide a summary of WRC's existing policies and positions to address climate change mitigation and adaptation in our decision making.

Distinct from regulatory policy and plans under the RMA, this document relates to internal council policies and is intended to assist council and council staff to evaluate the climate change implications of its operational decisions in a consistent way.

3.1.4 2024-2034 Mahere Whānui Long Term Plan

Every three years WRC develops a long term plan, which sets the budget and the areas of work we will focus on for the decade ahead. It's guided by our strategic direction – Takatū Waikato | Making a stand for the Waikato – and the feedback we receive through public consultation. Other influences that guide its development include the changing needs and expectations of communities as well as central government legislation. WRC's 2024-2034 Mahere Whānui Long Term Plan (LTP) identified resilience as a key theme during its consultation and it funds a range of activities and programmes supporting climate adaptation. These include:

- Building resilience within communities and reducing exposure and vulnerability to climate influenced natural hazards.
- Regional spatial planning to ensure our region strategically plans for its long-term future in changing climate.
- Understanding the impacts of increased rainfall intensity on our flood defence and drainage assets.
- Ensuring the climate influenced changes in the characteristics of natural resources are provided for when allocating natural resources.
- Activities that enhance the adaptive capacity of ecosystem services, while providing for ecosystem services that the residents and businesses of the region can rely on.

3.1.4.1 Understanding and Adapting to Natural Hazard Risk work programme

The 2024-2034 LTP also funded the Understanding and Adapting to Natural Hazard Risk Programme. It supports WRC's commitment to a strategic, coordinated approach to help Waikato communities understand and adapt to natural hazard risks, including those exacerbated by climate change.
The programme is intended to deliver the step change proposed by the council's Sustainable Development and Infrastructure strategic priority and invests in building a strong understanding of natural hazard risk, climate risks and catchment systems in our region to enable resilient decision-making across various sectors – such as infrastructure, planning, and emergency management.

3.2 Working with our iwi partners

Working with iwi is central to successful climate adaptation in the Waikato region. WRC staff and other stakeholders are encouraged to approach this work with openness, respect, and a commitment to genuine partnership. Drawing on iwi expertise, applying a te ao Māori lens, and supporting Māori-led adaptation delivers stronger and more durable outcomes. Ongoing collaboration, clear communication, and a willingness to listen and learn will maximise resilience for present and future generations across the region.

Waikato has six principal iwi — Waikato, Maniapoto, Raukawa, Hauraki, Te Arawa, Tūwharetoa—plus many hapū with distinct interests (Figure 4). These iwi are represented through iwi authorities, trust boards and rūnanga.

Figure 4 Principal iwi groups in the Waikato region (WRC, 2023a)

WRC works with iwi as Treaty partners across both formal and informal arrangements. Partnerships range from statutory co-governance to ongoing collaboration and joint projects. Joint decision making is central, and approaches adapt to match iwi aspirations and kawa (protocols). Strong engagement is built through everyday actions and respect for mana whenua leadership.

WRC is charting a pioneering course towards the principles of partnership and collaboration in decision-making with their Treaty partners. This innovative approach requires both the council and iwi to agree on their partnering destinations and shared points of convergence along the way.

Iwi are developing their own climate change strategies and plans. WRC supports these initiatives by sharing information, expertise, and resources, and enabling iwi-led solutions. Instruments such as the Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010 (section 6.1.1) and Te Ture Whaimana o Te Awa o Waikato (section 3.2.1) provide both a legislative and cultural base for collaboration, defining governance roles and shared outcomes.

WRC and iwi are working together to design, lead, and implement initiatives that strengthen resilience for Māori and the wider region. These partnerships can take many forms, from supporting local marae adaptation to shaping regional strategy. Approaches to working with iwi partners include:

- Partnering with iwi to identify and realise opportunities for adaptation initiatives
- Utilising existing collaboration mechanisms
- Continuing collaborative projects benefiting Māori communities

- Joint regional risk assessments and resilience programmes
- Supporting iwi to identify and address key sites vulnerable to climate change
- For river iwi, considering how climate change affects achievement of Te Ture Whaimana
- Support for marae adaptation and mitigation planning, including Oranga Marae Plans
- Providing expert advice and training to build capacity of tribal members
- Supporting development of investment models to enable iwi support for marae adaptation
- Ongoing collaboration on iwi strategies, such as the Raukawa Green Economy Pathway and Te Arawa's Te Ara ki Kōpū
- Iwi involvement in Dynamic Adaptive Pathways Planning (DAPP) for long-term responses to flooding and sea-level rise.

Recent examples include:

- supporting iwi-led environmental monitoring that blends mātauranga Māori and science. This support has enabled the use of cultural indicators in water quality monitoring and the delivery of technical training to iwi.
- Waikato-Tainui's Strategic Climate Alliance, developed jointly with WRC and partners, which formalises the process of co-governance and ensures that iwi priorities are embedded in regional adaptation. The Alliance provides a platform for ongoing collaboration, pooling knowledge, sharing resources, and driving coordinated action across agencies and sectors. This ensures transparent progress reporting and keeps the focus on delivering measurable, iwi-centred outcomes. The Alliance is transitioning from establishment to full operation, with regular reviews and active support for marae, hapū, and whānau across the region.

3.2.1 Te Ture Whaimana o Te Awa o Waikato | Vision and Strategy for the Waikato River

Tōku awa koiora me ōna pikonga he kura tangihia o te mātāmuri
"The river of life, each curve more beautiful than the last"
- King Tāwhiao, second Māori King

Te Ture Whaimana's vision is a future where a healthy Waikato River supports abundant life and prosperous communities, with shared responsibility for restoration and protection. Objectives relevant to climate adaptation include protection from climate change impacts, precautionary management, and integrating mātauranga Māori with science.

Waikato Tainui have indicated the importance of Te Ture Whaimana o Te Awa o Waikato as an instrument to help shape climate change action. Recognition of the potential for climate change to impact on achieving the Vision and Strategy for the Waikato River are acknowledged through the following objectives:

Table 2 Vision and Strategy: Objectives relevant to climate change adaptation and the management of natural hazards

Objective A	The health and wellbeing of the Waikato River is protected from the impacts of Climate Change
Objective B	Failing to protect the Waikato River and its wellbeing from the impacts of Climate Change is failing to protect the Waikato Tainui relationship with the river.

Objective E	Climate Change mitigation and adaptation is only achievable through an integrated, holistic and coordinated approach to the management of the natural, physical, cultural and historic resources of the Waikato River.
Objective G	The recognition and avoidance of adverse cumulative effects, and potential cumulative effects, of activities undertaken both on the Waikato River and within its catchments on the health and wellbeing of the Waikato River.
Objective H	The recognition that the Waikato River is degraded and should not be required to absorb further degradation as a result of human activities.
Objective I	The protection and enhancement of significant sites, fisheries, flora and fauna.
Objective M	The application to the above of both mātauranga Māori and latest available scientific methods.

A hui held in 2019 'Responding to Climate Change for the Waikato and Waipā rivers – implications for Te Ture Whaimana/Vision & Strategy was part of the conversation on how the Waikato River Authority can more purposefully pursue solutions for water and climate and further leverage the Vision and Strategy for the well-being of generations into the future. Some key findings from the hui included that Waikato-Tainui want to ensure the wellbeing of their people when tackling climate change and that Te Ture Whaimana, the strategy, is not silent on climate change.

"The architects who created it designed it in such a way that future issues, such as climate change, could be tackled. Waikato-Tainui sees climate change within the remit of Te Ture Whaimana. The term 'climate change' may not be within the strategy but the intent to take it on is. As such Waikato-Tainui has developed objectives for climate change in line with the strategy."

3.3 Working with our territorial authority partners

Adapting to climate change is critical to all functions of regional and local government. However, this section of the guideline focuses on two local government planning functions which play a key role in reducing climate change risk and climate change adaptation:

- Regional spatial planning which manages risk to future development and land use; and
- Community adaptation planning, which manages risk to existing development and land use.

3.3.1 Regional spatial planning

Regional spatial planning is an important tool to inform the management of climate risk to future growth, development and land use. It considers how to plan for a region's long-term future towards providing the very best outcomes for its communities.

Spatial plans already exist for some parts of the Waikato through the Future Proof partnership of iwi, local government and central government agencies, and a project was funded in the WRC 2024-2034 LTP to advance work on a spatial plan for the entire region.

The proposed Resource Management reforms anticipate a single combined plan per region, with spatial, natural environment and land use plan chapters. The spatial chapter is proposed to be a joint effort between regional council and territorial authorities, while the district chapters are proposed to be prepared and signed off by each individual council i.e. each council will prepare and sign off a chapter for their district. These district chapters are to be consistent with the regional spatial plan. The regional council is proposed to be solely responsible for the natural environment chapter of the combined plan.

3.3.2 Community adaptation planning

Both regional and local government have roles and responsibilities when it comes to climate change adaptation planning. WRC and territorial authorities in the region are working collaboratively with each other and with communities to assess climate change risks and create adaptation plans to respond to these risks.

Several territorial authorities have initiated their own community resilience and adaptation planning processes and have invited WRC staff and councillors to participate. Each process has been unique in its development, based on the needs of the community. Examples of community adaptation planning processes in the Waikato region are provided in section 5.4 of this guideline.

In 2023, the WRC Strategy and Policy Committee adopted a set of principles to guide WRC's ongoing participation in community adaptation planning and to respond to district council-initiated community adaptation planning. These principles will be reviewed and updated in the upcoming Regional Resilience Strategy and Plan. The principles are:

- WRC involvement in community adaptation planning will be governed by the outputs of the Regional Climate Risk Assessment
- WRC values its partnership with territorial authorities and will provide technical and governance support to community adaptation planning
- Input from WRC Staff and councillors into adaptation planning process will be agreed at the outset of projects, where the constituent councillors of the relevant community will be the first preference for governance appointment requests
- WRC will commit resources to any community adaptation process that is commensurate with the scale of risk posed to the community
- WRC acknowledge that preferred community adaptation options have associated costs and that WRC participation in the adaptation planning process does not indicate an agreement to fund interventions
- WRC will advocate for community adaptation plan processes that prioritise options for intervention, and where possible, include indicative costs to guide conversations
- WRC acknowledge that funding of options and interventions will:
    - need to be considered through additional funding processes
    - include consideration of whether targeted and/or general rates will apply, where a discussion on option beneficiaries will be well canvassed.

These principles have been relayed to each territorial authority to assist with our ongoing partnership approach.

4 What information is available on future climate, hazards and risks in the Waikato region?

This section covers:

- *Key WRC information, tools and data to support climate change adaptation*
- *Climate change projections and hazards for the Waikato region and territorial authorities*
- *Climate change risks in the Waikato region, including climate change risks for Māori*
- *Climate change projection and hazard resources and their suitability for different applications*

4.1 Key WRC information, tools and data to support climate change adaptation

4.1.1 Climate change hazards and risks in the Waikato region (technical and summary reports)

Waikato Regional Climate Change Hazards and Risks | Waikato Regional Council

The reports provide an overview of climate change hazards and risks in the Waikato region, identified through a high-level risk identification and screening process and incorporating insights from WRC subject matter experts, territorial authorities, iwi and others. The process compiled a comprehensive list of known and potential future direct and indirect climate change risks through desktop reviews, workshops, surveys and stakeholder engagement.

From this (alongside summaries of the identified climate risks), high level overviews and maps of climate hazards and risks for Hamilton city and districts making up the Waikato region have also been developed, along with an assessment of climate hazard exposure and impacts across the region.

The technical report compiles a significant body of information and valuable insights into the hazards and potential risks that are likely to affect the Waikato region, providing a central reference to support planning and responding to the impacts of climate change in the Waikato. The report can be used to:

- inform future work and research programmes
- help identify where focused risk management and/or further detailed risk assessment is required for specific:
    - locations (district/community scale)
    - sectors
    - organisations
- support communication with communities and stakeholders
- prioritise adaptation responses and investment.

4.1.2 Waikato Regional Hazards Portal and Coastal Inundation Tool

The Waikato Regional Hazards Portal and Coastal Inundation Tool present spatial data and information on natural hazards in the Waikato region. This information can assist with making informed decisions about

exposure to natural hazards, including those exacerbated by climate change such as coastal inundation and river flooding.

4.1.3 Waikato Data Portal

WRC has made its natural hazards data freely available on the Waikato Data Portal under a Creative Commons License 4.0. For detailed metadata information on Waikato Regional Council data, visit the Data Catalogue.

District councils also hold information relating to natural hazards and climate change, such as on stormwater, coastal erosion and minimum floor level requirements. Some councils have made some of this data freely available on the Waikato Data Portal.

4.2 Climate change projections and hazards for the Waikato region

Information on climate change projections and hazards for the Waikato region can be found in the Waikato Regional Climate Change Hazards and Risks report (Mills et al., 2025). This information is derived from NIWA's downscaled climate projections for New Zealand, NZSeaRise and Ministry for the Environment, as well as knowledge from council subject matter experts, iwi and external stakeholders.

4.2.1 Key climate hazards in the Waikato region

Climate change is expected to increase the frequency, severity and impact of many natural hazards in the region. Over the next century, the Waikato region can expect rising sea levels, more extreme weather, warmer summers and milder winters with seasonal rainfall shifts. It is projected that drought risk will increase in the north and east over spring and summer, and there may be seasonal changes in rainfall and wind in the west.

Natural hazards in the Waikato region that will be exacerbated by climate change include:

- Severe weather and flooding
- Landslides and erosion
- Coastal inundation and erosion
- Drought
- Temperature increase
- Increased fire weather
- Sea level rise and groundwater

More information on these climate change-exacerbated hazards is provided in section 6.2.1 of the Waikato Regional Climate Change Hazards and Risks technical report.

4.2.2 Expected changes across key climate indicators and hazards in the Waikato region

Section 6.2.2 of the Waikato Regional Climate Change Hazards and Risks technical report provides tables that summarise the range of expected changes across key climate indicators and hazards in the Waikato region. Information for the baseline period (1995-2014) is provided, along with the expected changes for

two time periods; mid-century (2040-2060) and end of century (2080-2100), and two SSP scenarios (SSP2-4.5 and SSP3-7.0) (with SSP5-8.5 being added in the future). The data provided is the average (mean) change expected across the whole region; it is possible for larger or smaller changes to occur in specific areas.

For a greater level of detail on the potential future climate of the Waikato region, see MfE's online Climate Projections Map. This map shows projected future changes to New Zealand's temperature, rainfall, and wind (and associated climate indicators) under different scenarios (SSP1-2.6, SSP2-4.5 and SSP3-7.0) at a 5 km resolution. The data provided is the mean of the values produced by each of the six climate models used by NIWA for the downscaling process. The dataset presented in this map and in the summary dashboard (below) is freely available to download (and has been downloaded by WRC). Note that although MfE's climate projections map and summary dashboard (referenced below) do not currently include SSP5-8.5, the dataset available to download does include this scenario.

4.3 Climate projections for territorial authorities in the Waikato region

MfE's Climate projections summary dashboard provides an overview of how key climate variables are projected to change for each territorial authority in New Zealand under different scenarios (SSP1-2.6, SSP2-4.5 and SSP3-7.0). The data provided is the mean of the values produced by each of the six climate models used by NIWA for the downscaling process.

Appendix 1 of this guideline provides a summary of the climate projections data in table form for each of our territorial authorities, including SSP5-8.5 which is not currently included in the MfE dashboard.

4.4 Climate change risks for the Waikato region

Section 7 of the Waikato Regional Climate Change Hazards and Risks report provides an overview of climate change risks for the region. The risks were identified through a regional high-level risk identification and screening project led and funded by WRC. The full list of risks is available in the Waikato Regional Climate Change Risk Identification Workbook.

The risks identified include approximately 230 direct risks and 55 indirect risks to a wide range of elements such as biosecurity, water quality, taonga species and flood defences. The risks have been grouped under five domains: human, natural environment, economy, built environment, and governance. However, it's important to recognise that climate-induced hazards and risks don't occur in isolation and often are interconnected. They can also compound, leading to secondary and cascading risks with both short and long-term consequences across different domains. Section 7 of the technical report also includes geographic examples where risks are currently known or expected to be present. The geographic examples are limited to specific locations that were identified during the project, such as in survey responses and workshops, and are not a conclusive and/or complete list of all "at risk" locations across the region

4.4.1 Climate change risks for Māori

Climate change creates risks that go beyond immediate physical impacts, affecting the social, cultural, spiritual, and economic wellbeing of Māori in distinct ways. Climate risks to Māori have been identified from

both the *Climate Action Roadmap (WRC, 2023a)* and the *Climate Change Hazards and Risks in the Waikato Region Report (Mills et al., 2025)* and are summarised below under themes.

Table 3 Summary of climate change risks to Māori in the Waikato region

Theme	Risks
Environmental & Ecosystem	• Ecosystem decline leads to loss of habitat for native species. • Loss of taonga species and biodiversity reduces customary food gathering. • Declining freshwater, land, and marine health affects mahinga kai and livelihoods. • Availability of kai species is reduced, impacting food security. • Changes to tohu (environmental indicators) disrupt planting, harvesting and seasonal knowledge. • Increased droughts and temperature extremes put extra pressure on waterways and ecosystems. • Iwi as kaitiaki face greater challenges maintaining balance with Papatūānuku.
Cultural Infrastructure	• Marae and urupā at risk from flooding, erosion, and land instability. • Limited land is available for relocating marae or urupā at risk. • Damage to marae infrastructure disrupts community gatherings and functions. • Disruption to cultural sites and loss of traditional resources for ceremonies. • Access to taonga and sites for customary use is restricted. • Climate change increases costs of protecting, maintaining, or relocating marae and urupā.
Social & Health	• Health inequities are made worse by climate-related impacts. • Kaumatua, pēpi and vulnerable groups at higher risk from heat and disease. • Poor access to safe drinking water and healthy kai is more common. • Low-income and remote Māori communities have limited adaptive capacity. • Infrastructure gaps (roads, power, water) worsen response and recovery. • Housing and transport insecurity increases vulnerability to climate events. • Climate-related stress can affect mental health and social cohesion.
Spiritual & Intergenerational	• Loss of mātauranga Māori and tikanga through species and habitat decline. • Intergenerational knowledge sharing is disrupted by changes to natural cycles. • Impacts on whanaungatanga and mana through loss of place and resources. • Disrupted connection to whenua, awa, and moana weakens spiritual wellbeing. • Climate change affects practices tied to specific times, places or species. • Language, stories and rituals linked to the environment may be lost.
Transition & Adaptation	• Fast-paced adaptation or policy change can leave Māori excluded. • Barriers to Māori-led decision-making limit effective solutions. • Risks from failing to uphold Treaty partnership and shared governance. • Costs and benefits of adaptation are unevenly distributed. • New adaptation strategies may disrupt social and cultural systems. • Historic land, governance and resource issues slow climate adaptation.

WRC recognises that these risks influence not only practical interests but also kawa (protocols), tikanga (cultural practices), and broader expressions of mana (authority, dignity, influence, and governance). Kaitiakitanga—the inherited responsibility to protect resources for future generations—is central. WRC's principles of partnership and collaboration, grounded in Treaty relationships, are intended to provide mechanisms to identify, assess, and address these risks in ways that reflect Māori priorities and leadership.

Additional information on climate change risks for Māori is provided in Appendix 2 of this guideline, specifically on:

- Impacts on the Māori economy
- Impacts on Māori communities
- The impact of climate change on Māori identity and wellbeing
- Climate hazards for Hapori Māori (Māori communities)

4.5 Which source of climate and natural hazard information to use

Many different sources of hazard and climate information are available. Usually these have been designed for specific purposes or to suit different audiences and they may present the information in different ways. The following section provides an overview of different sources of information and how they can be used.

4.5.1 A shortlist of suitable sources of climate change information

Table 4 provides a shortlist of sources of information relevant to climate change adaptation in the Waikato region, under the categories of climate change projections, climate change hazard information and climate change risk information. This list is not exhaustive but provides a useful starting point.

Table 4 Climate change projection and hazard information resources relevant to the Waikato region

Information/data source or tool (organisation, date)	Description	Section(s) referenced in this guideline and link to source
Climate change projections		
Climate projections map (MfE)	This map shows projected future changes to New Zealand's temperature, rainfall, and wind (and associated climate indicators) under different scenarios (SSP1-2.6, SSP2-4.5 and SSP3-7.0) at a 5 km resolution.	Section 4.2.2 Climate Projections Map
Climate projections summary dashboard (MfE)	The dashboard provides an overview of how key climate variables are projected to change for each territorial authority in New Zealand under different scenarios (SSP1-2.6, SSP2-4.5 and SSP3-7.0).	Sections 4.3, 5.2.3 and Appendix 1 Climate projections summary dashboard
NIWA Climate change projections dataset (NIWA, 2024)	This is the dataset behind the MfE climate projections map and summary dashboard, and includes SSP5.8.5 (which isn't currently provided in the projections map or dashboard). NIWA have completed an update of the national climate projections for New Zealand (previously released in 2018). The dataset is freely available to download and has been downloaded by WRC.	Sections 4.2, 4.3 and Appendix 1 Climate Projections Data
Waikato Regional Climate Impacts Report Applying CMIP6 Data (CLIMsystems for WRC, 2021)	This report investigates nine essential climate and two socioeconomic variables for the Waikato region, using historical and CMIP6 GCM SSP2-4.5 and SSP5-8.5 scenario data. Although this report is available, WRC recommends using the MfE/NIWA projections to encourage national consistency and as the differences between projections are minimal. However, the CLIMsystems work provides useful additional information for certain applications, particularly around drought, water resources and water availability. This includes: • The use of atmospheric climate projections to investigate future changes in runoff, PET, soil conditions and surface and ground water resources in the Waikato region. • Investigating the water availability and demand issues across the Waikato region using historical and climate change scenario data. • Analysis of statistical results of potential changes in precipitation and PET for the integrated water management zones and aquifers as identified by WRC.	Waikato Regional Climate Impacts Report Applying CMIP6 Data
High Intensity Rainfall Design System V4 (HIRDS) (NIWA)	HIRDS is an online tool which offers planners and engineers more certainty about the frequency of high-intensity rainfall events, enabling them to better design stormwater drainage, flood defence systems and other vital structures. It enables rainfall estimates to be provided to be provided at any location in New Zealand and allows for rainfall adjustment based on projected temperature increases.	Section 7.2 High Intensity Rainfall Design System
Sea level rise		

NZ SeaRise (NZ SeaRise)	The platform allows the user to explore projections of relative sea level rise by combining sea level rise projections with vertical land movement rates derived from satellite measurements at a 2 km spacing around New Zealand's coast.	Section 7.3.2 NZ SeaRise platform
Climate change hazard information		
Climate change hazards and risks in the Waikato region (technical and summary reports) (WRC, 2025)	The reports provide an overview of climate change hazards and risks in the Waikato region, identified through a high-level risk identification and screening process and incorporating insights from WRC subject matter experts, territorial authorities, iwi and others.	Sections 4.1, 4.2 and 4.4 Waikato Regional Climate Change Hazards and Risks
Waikato Regional Hazards Portal and Coastal Inundation Tool	The Regional Hazards Portal presents spatial data and information on natural hazards in the Waikato region and includes the Coastal Inundation Tool. The coastal inundation tool allows the user to see which areas may be subject to different levels of coastal inundation (and provides context information on storm surge and sea level rise).	Section 4.1.2 and 7.3 Waikato Regional Hazards Portal Coastal Inundation Tool
Waikato Data Portal (Waikato LASS)	The Waikato Data Portal holds all of WRC's spatial natural hazard data which is freely available under a creative Commons License, and some data from territorial authorities.	Section 4.1.3 Waikato Data Portal
Waikato Regional Water Resource Model (under development) (WRC)	WRC is developing a region-wide 2D hydrodynamic model using LiDAR terrain data and improved rainfall distribution inputs. This system is being developed in stages, with coarse-scale models being refined over time for high-priority areas.	Section 7.2.1
Coastal Hazards and Climate Change Guidance (MfE, 2024)	MfE's updated Coastal hazards and climate change guidance is a tool to help decision makers consider the potential effects of climate change, now and in the future, based on the latest scientific information. It also provides non-spatial information on sea level rise projections and coastal hazards.	Sections 5.1.1, 5.2, 7.2.4 and 7.3 Coastal hazards and climate change guidance
Flood hazard across Aotearoa New Zealand (Earth Sciences NZ)	The map provides a modelled representation of New Zealand's flood hazard due to a 1% annual exceedance probability (AEP) rainfall event in our current climate, and with the impact of 1, 2 and 3 degrees of additional warming on that rainfall. It also shows the estimated exposure of people and assets to flooding for New Zealand and by region. This tool was not designed for hazard and exposure analysis at higher resolutions (e.g., property level). Local scale flood models in the Waikato Regional Hazards Portal supersede this tool (refer to section 7.2.1.1 for more information).	National rainfall flood hazard map
National sea level rise flood spatial data (NIWA)	This national sea level rise flood dataset comprises nine extreme coastal flooding scenarios (between the 2- and 1000-year average recurrence interval) and 21 relative sea level rise scenarios ranging from 0 to 2 metres in 10 cm increments. Access is provided at no charge for non-commercial use.	National sea-level rise flood spatial data | DataHub
Climate change risk information		

Climate change hazards and risks in the Waikato region (technical and summary reports) (WRC, 2025)	The reports provide an overview of climate change hazards and risks in the Waikato region, identified through a high-level risk identification and screening process and incorporating insights from WRC subject matter experts, territorial authorities, iwi and others.	Sections 4.1, 4.2 and 4.4 Waikato Regional Climate Change Hazards and Risks
National Climate Change Risk Assessment for New Zealand (MfE, 2020)	The NCCRA is a national overview of how New Zealand may be affected by climate change-related hazards. It identified main risks and opportunities, highlights any information gaps and helps identify where the Government needs to focus its climate action.	Section 6.1.4 National climate change risk assessment for New Zealand

4.5.2 Common applications of climate change information

Climate change information is used in a variety of ways. How it will be used is an important factor in identifying the most appropriate source of the information. This section sets out a range of common applications of climate change information. The information in this section is primarily sourced from the Queensland Future Climate website.

General information - Many people start exploring climate change information out of curiosity or self-education. Others are seeking simple but trustworthy information that can be used in documents like school reports, communication materials, presentations, briefs and regional profiles. Simple summary tables and charts can often meet these needs.

Climate risk assessments - risk assessments vary in the level of detail required and are often performed in sequence, getting more focussed and detailed at each step.

- 1st pass risk assessment - an initial or high-level exploration to identify the most relevant climate hazards and risks, to prioritise further work or scope for the other cycles.
- 2nd pass risk assessment ('strategy cycle') - a formal climate risk assessment for a particular entity or activity to develop a strategic climate risk management or adaptation plan.
- 3rd pass risk assessment ('project cycle') - a detailed climate risk assessment that can be used for specific projects, including operational planning and major investment decisions.

Adaptation planning - This typically follows a multi-step process, including assess priority climate risks in relation to what is valued, identify options to reduce or manage those risks, plan, fund and implement management actions, and monitor and review to improve outcomes. Adaptation plans can vary greatly in their scope, level of complexity and requirements for climate data. MfE's Coastal hazards and climate change guidance (section 5.1.1 of this guideline) sets out best practice for climate change adaptation planning in New Zealand.

Strategic policy and planning - Large organisations, including all levels of government, NGOs and private sector organisations, will seek information on changes to climate hazards and risks over strategic timeframes to inform the development of or amendments to policies, regulations, governance structures, decision-making frameworks, operations and procedures that adequately consider the effects of climate change.

Reporting and compliance - Driven by emerging standards for reporting on environmental, social and governance (ESG) performance and financial disclosures of climate risk such as the Task Force on Climate-related Financial Disclosures (TCFD) , public and private organisations will need information to demonstrate the assessment and management of climate risks to support their climate related disclosures. In New Zealand, this is governed by the Aotearoa New Zealand Climate Standards (see section 6.1.3 Climate risk reporting).

Detailed hazard analysis - the quantification of climate hazards to enable estimates of exposure and vulnerability (which can also feed into risk assessments) can require more detailed information on extreme events under climate change, e.g. projected changes in the frequency, duration and intensity of events relating to extreme heat, rainfall, coastal flooding, wind and fire weather. Hazard-specific resources can often provide this kind of information in a variety of formats.

Research and modelling - Researchers and modellers are likely to seek high-resolution projections data at fine time scales and for specific climate models that are known to be appropriate for an application or to enable calculation of specialised indices. Examples include hydrological modelling, bioclimatic modelling and engineering applications.

4.5.3 Suitability matrix for climate change information

The suitability matrix in Table 5 can help match the climate change information sources against their ideal applications. Large dark green ovals indicate a close match between the source and intended use. Smaller lighter green ovals indicate that some features of the source may be suitable for that use, but that other options may provide a better match or be easier to use. Empty cells indicate that the source is not a good match for the application. Many of these information sources are designed to be flexible to meet a broad range of user needs, and many of the listed applications can also vary in their scope and data requirements. This is reflected in the matrix with some sources matching several uses.

Table 5 Matrix showing suitability of climate change information sources for different applications

Sources	Applications								
	General information	1st pass risk assessment	2nd pass risk assessment	3rd pass risk assessment	Adaptation planning	Strategic policy & planning	Reporting & compliance	Detailed hazard analysis	Research and modelling
MfE climate projections map and dashboard summary	●	●	●	●	●	●	●	●	●
NIWA climate projections dataset		○	●	●	●	○	○	●	●
Waikato Regional Climate Impacts Report Applying CMIP6 Data			○	○	●	○		●	●
NIWA High Intensity Rainfall Design System V4			●	●	○			●	●
NZ Sea Rise (sea level rise projections)	○	○	●	●	●	○	○	●	●
Climate change hazards and risks in the Waikato region	●	●	○		○	●	●		
Regional Hazards Portal & Coastal Inundation Tool	●	●	○		●	●	●	○	
Waikato Data Portal (data – varying applications)		○	●	●	●			●	●
MfE Coastal Hazards and Climate Change guidance		●	●	○	●	○		○	
Waikato Regional Water Resource Model (under development)	●	●	●	●	●	●	●	●	●
Earth Sciences NZ Flood hazard across Aotearoa New Zealand	●	●			●	●	●		
NIWA National sea level rise flood spatial data	●	●	○		○	●	●		
MfE National Climate Change Risk Assessment for New Zealand		○			○				

5 How to plan for the impacts of climate change in the Waikato region

This section covers:

- *Best practice guidance for climate change adaptation*
- *Which climate change scenarios and timeframes to use for climate change risk assessment and adaptation planning*
- *A te ao Māori approach to climate change adaptation*
- *Adaptation planning projects undertaken by territorial authorities in the Waikato region*

5.1 Best practice guidance for climate change adaptation

When planning for climate change adaptation, it is important that best practice is followed, to ensure that climate change adaptation occurs in an appropriate and consistent way across the Waikato region. A good place to start is the principles for climate change adaptation (collated by MfE) that are provided in section 2.4 of this guideline.

WRC endorses the following Ministry for the Environment (MfE) guidance documents as best practice for New Zealand. WRC also endorses the use of a dynamic adaptive pathways planning (DAPP) approach (section 2.3 of this guideline) for all climate change adaptation applications, not only for coastal hazards (as is discussed in detail the 2024 MfE Guidance referenced below).

MfE has produced several guidance manuals and summary publications on adapting to climate change. The most relevant and recent of these are summarised below and are regarded as the best current source of national information for local government. Recently produced guidance on risk tolerance is also summarised below.

5.1.1 Coastal hazards and climate change guidance (2024)

MfE's updated Coastal hazards and climate change guidance (2024 Guidance) is a tool to help decision makers consider the potential effects of climate change, now and in the future, based on the latest scientific information. The guidance includes a 10-step process to assess the risks and determine what actions to take and advocates for the dynamic adaptive pathways planning (DAPP) approach (section 2.3 of this guideline). It's intended for practitioners involved in land-use planning, resource management, building consenting, asset and flood risk management, and infrastructure planning.

The 2024 Guidance states:
"The cornerstone of this guidance is the use of SLR projections derived for climate change scenarios in hazard and risk assessments, district and regional plans and adaptation planning. Scenarios are not 'predictions' but rather a description (narrative) of how different futures might unfold, and they can be used to stress-test adaptation options, dynamic adaptive pathways, plans or strategies. They can help inform the development of objectives and policies and inform the effectiveness (or otherwise) of risk management strategies, including any lock-in dependencies relying on a single type of option.

Scenarios allow communities, iwi/hapū and stakeholders to explore questions like "What can happen?", "When might an adaptation threshold be reached?" and then "What can we do about it?" that help illustrate impacts and options under a variety of climate-related outcomes."

5.1.1.1 Key updates from the 2017 guidance

The 2024 Guidance revises the 2017 publication with the following key updates:

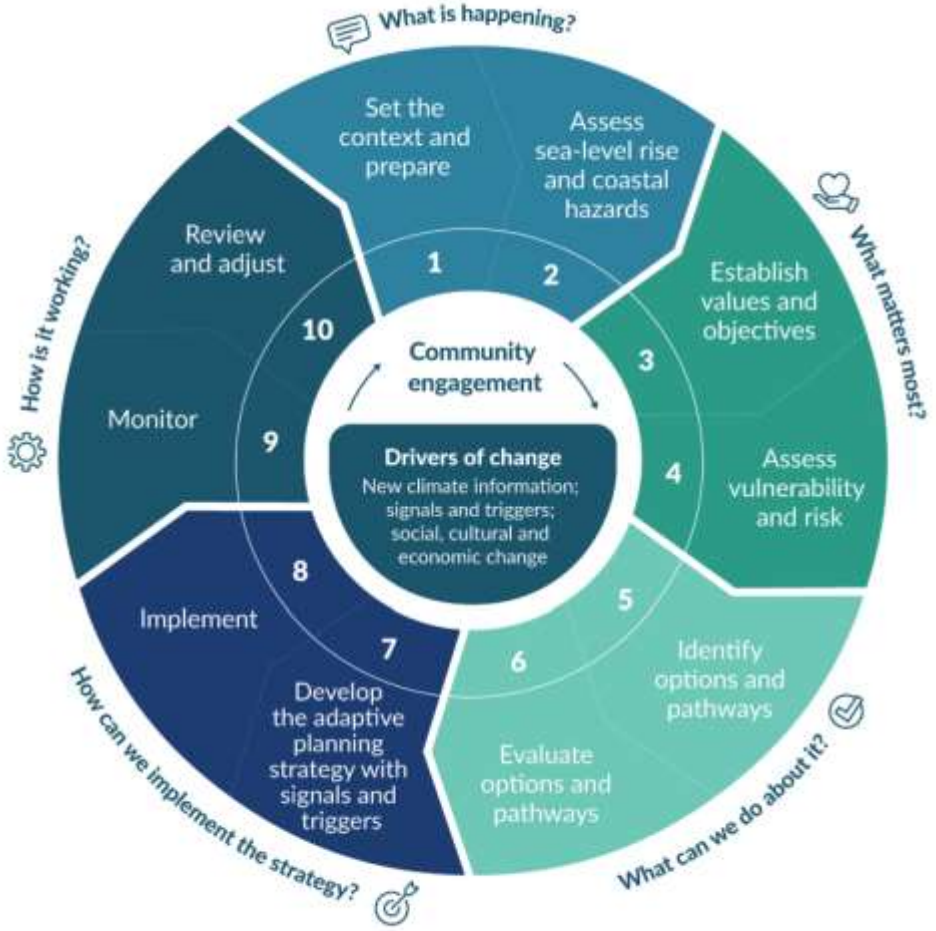
- Advances in sea-level rise science and updated global projections from the IPCC AR6
- New relative sea-level rise projections and vertical land movement estimates from the NZ SeaRise Programme
- Advances in knowledge relating to the types of coastal hazards (such as sea-level rise, storms, flooding, or rising groundwater) and how they interact with each other
- Updated guidance on carrying out risk assessments and adaptation pathways planning
- The national adaptation plan (NAP) directions on which climate scenarios to use for hazard and risk assessment within the resource management system.

5.1.1.2 10-step decision cycle for dynamic adaptive pathways planning (DAPP)

The 2024 Guidance contains an updated 10-step decision cycle for adaptation (Figure 5). The steps allow for both short- and long-term planning, adaptive pathways and decision-making for coastal areas that are, or will be, affected by coastal hazards and climate change. The 2024 Guidance provides a recommended framework to use but notes that local authorities should tailor this to their region or district.

The guidance is structured around five main questions in the 10-step decision cycle.

- What is happening?
- What matters most?
- What can we do about it?
- How can we implement the strategy?
- How is it working?



Source: Adapted from Max Oulton (University of Waikato) and UN-Habitat (2014)

Figure 5 Coastal Hazards and Climate Change 10-step decision cycle (Ministry for the Environment 2024)

5.1.2 A guide to local climate change risk assessments (2021)

MfE's "A guide to local climate change risk assessments sets out a climate change risk assessment framework for local use, which is broadly consistent with the National Climate Change Risk Assessment Framework.

The guide:

- outlines the context for risk assessments within adaptation planning
- sets out a step-by-step process to carry out local climate change risk assessments
- provides resources and sample templates for practical use.

It was developed with direction from a Local Government Working Group and Māori caucus and panel in early 2021. The aim is to review and update it as required, and as the context for risk assessments evolves.

The guide contains the most recent central government guidance on local climate change risk assessments in New Zealand, and as such, uses the most up to date thinking, processes and terminology.

5.1.3 Natural hazard and climate change risk tolerance conversations – Guidance to aid design (2025)

Let's talk about risk tolerance | ResOrgs

This resource has been developed to help councils and other agencies lead meaningful conversations with communities about natural hazard and climate change risk tolerance. It was developed by the Let's Talk About Risk team and funded by the Natural Hazards Commission Toka Tū Ake. It supports practitioners in designing and delivering engagement processes that reflect what matters most to people.

The guidance offers practical tools, methods, and design principles for eliciting public views on risk tolerance and includes tailored advice for both elected officials and communities. It includes in-depth case studies from across New Zealand, including Wharekawa Coast 2120 (section 5.4 of this guideline) in the Waikato region.

5.2 Which climate scenarios and timeframes to use

WRC endorses following the national guidance on which climate scenarios and timeframes to use when assessing climate change hazards and risks or undertaking an adaptation planning process. National direction and guidance is primarily provided by MfE in the National Adaptation Plan (2022), A guide to local climate change risk assessments (2021) and the Coastal hazards and climate change guidance (2024).

5.2.1 Legislative requirements

Councils are required to 'have regard to' the National Adaptation Plan (see section 6.1.4 of this guideline for more information) when making or changing regional policy statements or regional or district plans. The National Adaptation Plan (page 68) directs councils as follows (paraphrased):

When making or changing policy statements or plans under the RMA, including to give effect to the provisions of the NZCPS, councils should use the recommended climate change scenarios outlined below, as a minimum:

- *to screen for hazards and risks in coastal areas, use the Shared Socioeconomic Pathway scenario for the fossil-fuelled development scenario (SSP5-8.5) to 2130.*
- *for detailed hazard and risk assessments in coastal and non-coastal areas, use both the middle-of-the-road scenario (SSP2-4.5) and SSP5-8.5 to 2130, adding the relevant rate of vertical land movement locally.*
- *for all other climate hazards and risks, use the most recent downscaled climate projections for Aotearoa.*

In addition, councils should stress test plans, policies and strategies using a range of scenarios as recommended in the interim guidance (now MfE's 2024 Coastal hazards and climate change guidance) *and the National Climate Change Risk Assessment Framework, as relevant to the circumstance.*

Additionally, for coastal hazard risks in the coastal environment, the New Zealand Coastal Policy Statement 2010 (NZCPS) has a mandate to assess coastal hazard risks (including climate change) to "at least 100 years" (Department of Conservation, 2010).

5.2.2 National guidance

A guide to local climate change risk assessments (2021) recommends the following climate change scenarios and timeframes, which are precautionary and align with the National Climate Change Risk Assessment:

- climate change scenarios: RCP 4.5 and RCP 8.5 (these align with SSP2-4.5 and SSP5-8.5)
- timeframes: present day, around 2050, 2100 and 2150 (optional)
    - The present-day timeframe (past 10-20 years) is recommended as impacts already occurring from climate change are a starting point for considering the urgency of identified risks, and as a starting point when seeking feedback before considering future impacts.
    - Around 2050 (or 30 years) is recommended as this covers the next few cycles of council long-term plans and is the planning timeframe for council infrastructure strategies and asset management plans. It also aligns with the maximum granted resource consent timeframe of 35 years.
    - By 2100 (or 60-80 years) is typically where detailed climate projections are available to, thus enabling projections for a wide range of climate variables without needing to extrapolate. A limitation is that some decisions (e.g. land use planning) require at least 100-year timeframes.
    - 2150 is recommended for coastal hazard risks given the NZCPS mandate to assess coastal hazard risks (including climate change) to "at least 100 years". Further, New Zealand-specific sea level rise projections are available to 2150 (medium confidence) and 2300 (low confidence) on NZ SeaRise and national coastal flooding risk-exposure mapping is available for up to 3m of sea level rise.

MfE's 2024 Coastal hazards and climate change guidance provides guidance on scenarios and timeframes to use for coastal hazard risk assessments and adaptation planning processes, particularly when assessing sea level rise. More information on this is provided in section 7.3 of this guideline.

5.2.3 Waikato Regional Council recommendation

WRC recommends following national direction and guidance, while also recognising that the appropriate climate change scenarios and timeframes to use may vary depending on the purpose they are being used for and the information that is available. For example, shorter timeframes and/or less conservative scenarios/increments may be appropriate for non-habitable/short lived assets.

Figure 6 illustrates some of the different ways to consider climate change risk, varying by scale, level of detail and purpose. Another example of when a more granular risk assessment is required is when assessing coastal hazards and sea level rise for a proposed coastal subdivision.

Figure 6 Different ways to consider climate change risk

As such, WRC recommends the following:

For high-level, qualitative climate change risk assessments:

- Climate change scenarios: SSP2-4.5 and SSP5-8.5
- Timeframes: baseline (1995-2014), mid-century (2041-2060), end-of-century (2080-2099)

The above timeframes are those for which climate projection data is readily available on the MfE Climate projections summary dashboard and the Climate projections map. Projection data is not currently available on these tools for SSP5-8.5; however, it is available to download from the MfE website and is provided for territorial authorities in the Waikato region in appendix one of this guideline.

Some applications may require an additional timeframe out to at least 100 years (2130), for example if assessing coastal hazard risks. However, with the exception of sea level rise, projections data is not currently readily available for New Zealand.

For granular, quantitative climate change risk assessments:

- The above scenarios and timeframes (including to 100 years/2130), with the addition of additional scenarios to enable stress testing of resulting plans, policies and strategies. Alternatively, the use of increments of change (e.g. for temperature or sea level) which can be linked back to scenarios and timeframes (see section 7.3.2.2 of this guideline); **or**
- For detailed assessment of coastal hazard and river flooding risks, for example to inform community adaptation planning or a new housing development, section 7 of this guideline provides technical information for the scenarios, timeframes and methods to use for modelling. Here an increments approach is generally recommended over a scenarios approach (and this is discussed).

5.3 A te ao Māori approach to climate change adaptation

Climate adaptation in Waikato must address more than technical fixes. Changes such as flooding, drought, and biodiversity loss affect cultural, social, and spiritual wellbeing—especially for iwi Māori, whose identities are deeply tied to whenua and wai.

A te ao Māori lens brings mātauranga Māori and tikanga into climate policy and action, ensuring values like manaakitanga and kaitiakitanga guide decisions. Māori can face particular challenges due to land loss, unique governance, and strong relationships with natural resources, so adaptation must reflect Māori priorities at every stage.

Two examples of iwi-led strategic climate responses and adaptation planning using a te ao Māori approach are provided below. Additional resources are provided in Appendix Three.

5.3.1 Whakatupuranga Waikato-Tainui 2050

Whakatupuranga Waikato-Tainui 2050 is a fifty-year intergenerational development approach and the foundation for cultural, social, environmental, and economic advancement for Waikato-Tainui. Its five-year plans operationalise long-term aspirations, focusing on restoring and enhancing wai and whenua, responding to climate challenges, and strengthening the resilience of marae and hapū.

Key initiatives include:

- Comprehensive training for kaitiaki, enabling tribal members to lead restoration and protection work for their marae, hapū, and the environment.
- Supporting marae to develop, resource, and implement tailored adaptation and mitigation plans, often as part of Oranga Marae programmes.
- Direct investment in marae infrastructure to strengthen resilience against climate hazards—such as water storage, renewable energy, and emergency preparedness.
- Collaboration across the rohe to advance climate action, including co-designing policy, piloting low-emission technologies, and supporting localised carbon reduction initiatives.
- Fostering innovation through the integration of mātauranga Māori and technical expertise, with a strong focus on building community capability and self-sufficiency.

The Road to Whakatupuranga 2050 – The Five-year Plan FY20 to FY24 (Road to Whakatupuranga) has the aim of working towards the restoration and enhancement of our wai and whenua to the state in Kiingi Taawhiao's maimai aroha. It looks to operationalise the Waikato Tainui Environmental Plan – Tai Tumu, Tai Pari, Tai Ao so that their marae, tribal members, organisation and wider community have the tools necessary to care for their Taiao.

The Road to Whakatupuranga five-year plan includes *Understanding the potential impacts of environmental issues like climate change on our marae and having a plan to respond to and mitigate these impacts* and steps out the focus areas, initiatives, outcomes, key metric and milestones required to achieve this aim. Of relevance to climate change adaptation are those components in italics.

Table 6 Aspects of Whakatupuranga Waikato-Tainui 2050 relevant to climate change adaptation

Focus area	Ngaa Tohu priority initiatives	Priority outcomes over the 5 years	Key metrics after 5 years	Milestones		
Supporting our tribal members to restore,	Training and support for our tribal members so	A cohort of trained tribal members are leading taiao	A trained cohort of kaitiaki have the	Development of the training programme	Delivery of the training programme in	Training programme has been developed and rolled out

enhance and protect our wai and whenua	that they can lead Taiao initiatives	restoration work for the wai and whenua connected with their marae / hapuu	qualifications that will lead to employment or self-employment as kaitiaki *Identification of key sites that are vulnerable to climate change*	in association with relevant service providers	association with relevant service providers	Training programme has led to employment or self-employment of tribal members in kaitiaki restoration projects
				Development of mitigation plans with marae whaanau for those marae critically impacted by climate change (these plans are included as part of Oranga Marae plans)		Implementation of climate change mitigation plans
	Support our whaanau to respond to climate change impacts (and other environmental challenges) on their marae	*Marae whaanau have enough knowledge on climate change and other environmental issues to respond and protect their marae*	*Marae that are impacted by climate change and other environmental issues are implementing response plans*	*Development of an investment model to enable iwi to support marae to respond effectively to environmental challenges*		*Implementation of investment model*

Waikato Tainui have also identified opportunities to collaborate on climate change action. These include co-designing key policy and enhancing the capability of Waikato Tainui to contribute to the restoration that effect wai, moana and whenua; restoration projects; water storage and marae infrastructure and access to clean and safe drinking water.

5.3.2 Te Arawa Climate Change Strategy

Launched on 1 October 2021, Te Ara ki Kōpū: Te Arawa Climate Change Strategy represents a two-year collaborative research effort between Te Urunga o Kea (Te Arawa Climate Change Working Group), Te Arawa Lakes Trust, and Scion. The strategy was developed to empower whānau, hapū, and iwi to proactively shape their response to climate change—reflecting Te Arawa's distinctive whakapapa, mātauranga, and relationships with taiao. The strategy sets out six key focus areas: action planning, research and monitoring, awareness-building, social mobilisation, strategic alliances, and advocacy.

Action planning involves creating kaupapa-focused action plans and supporting whānau and marae to implement practical adaptation initiatives. The research and monitoring focus ensures robust information gathering, blending mātauranga and science to inform decision-making. Raising awareness among tamariki, rangatahi, whānau, and hapū about climate change—its impacts, risks, and adaptation pathways—is central, alongside social mobilisation to empower local leaders and support community-led action. Te Arawa's approach includes building and maintaining strong alliances at local, regional, and national levels, and advocating for iwi voices and priorities in all relevant forums. Implementation is supported through

dedicated training, resource sharing, and the regular review of progress. Te Ara ki Kōpū is a living document that is regularly updated to reflect feedback, learning, and the shifting climate landscape.

5.4 Adaptation planning within territorial authorities

The following is a summary of current adaptation planning projects led by territorial authorities in the Waikato region. These projects are following best practice as much as practicable and are useful examples to help inform future climate change adaptation projects.

Shoreline Management Pathways Projects - Thames Coromandel District Council

The Shoreline Management Pathways Project was completed in September 2022 and included finalising coastal hazard modelling and the development of community-led coastal adaptation pathways for sea-level rise. Thames Coromandel District Council are now looking to implement the outcomes of the project which are included in the 138 pathways. Each pathway is specific to a section of coastline and sets out how communities want to manage their risks from sea level rise.

From the Shoreline Management Pathways Project, the Thames Protection and Resilience Project aims to manage the risks to the Thames area from coastal hazards such as flooding and storms. Thames has been identified as a high-priority area due to $1 billion worth of assets at risk.

Wharekawa Coast 2120 – Hauraki District Council

The Wharekawa Coast 2120 Community Plan provides a pathway for how the community and the councils can work together to ensure a safe and resilient future for communities living on the Wharekawa Coast. The three partner Councils' (Hauraki District Council, Waikato Regional Council, and Waikato District Council) adopted the Community Plan in November 2023. The next steps are to implement the plan and undertake six-monthly and annual reporting and monitoring of the plan. Council's will review the plan every 3 to 5 years.

Hauraki Plains Adaptation Plan – Hauraki District Council

Commencing in 2024, Hauraki District Council and Waikato Regional Council are working to make a plan for the future, including adapting to the effects of climate change, for the Hauraki Plains. This will be through a dynamic adaptive planning process, in partnership with the community, which includes working closely with the Community Panel.

Waikato District Resilience Project – Waikato District Council

Waikato District Council (WDC) have developed the Climate Response and Resilience Strategy 2023-2027 to achieve the councils vision of, "Liveable, thriving and connected communities" in the face of climate change. The outcome of the strategy is, "we and our communities are building resilience and actively mitigating and adapting to climate change".

WDC has begun developing a district-wide resilience plan and will undertake adaptation planning with key communities at risk to multiple hazards. The plans will start with coastal adaptation planning for Port Waikato and Raglan, both highly vulnerable communities to multiple hazards, particularly coastal erosion, coastal inundation and land instability. The project will then move towards inland river communities and plan for the impact of increased river flooding and drought conditions along the Waikato River.

6 What legislation and climate plans are in place for the Waikato region and New Zealand?

This section covers:

- *Legislative requirements for climate change adaptation in New Zealand*
- *The direction and requirements for climate change adaptation in regulatory policy and plans prepared by WRC and Waikato territorial authorities*
- *A summary of WRC policy, frameworks and guidance relevant to climate change adaptation*

6.1 Legislative requirements for climate change adaptation

The New Zealand government has enacted several pieces of national legislation that address climate change. These laws provide a framework for developing and implementing climate change policies, aligning with global efforts to limit temperature increases and preparing for the effects of climate change. Legislation relating to climate change adaptation is a rapidly evolving space, with several pieces of work underway.

6.1.1 Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010

The Waikato River Settlement Act is the Waikato River Authority's enabling legislation that has given it the role as the custodian of the Vision and Strategy for the Waikato River. Te Ture Whaimana is the primary direction setting document for the Waikato River and activities which affect it. It sits ahead of all other subordinate legislation or planning documents under the RMA. Its foundation was set from the Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010, clause 19 the Vision & Strategy. Te Ture Whaimana requires that the health and wellbeing of the Waikato and Waipā Rivers is restored and protected for current and future generations. Climate change will pose additional challenges and opportunities that will need to be considered.

6.1.2 Climate Change Response Act 2002 and Climate Change Response (Zero Carbon) Amendment Act (2019)

The Climate Change Response Act 2002 and Climate Change Response (Zero Carbon) Amendment Act (2019) establish New Zealand's zero carbon framework and provide the tools to manage New Zealand's transition to a low-emissions (mitigation) and climate-resilient (adaptation) future.

The Climate Change Response Act 2002 provides a legal framework to enable New Zealand to meet its international obligations under the United Nations Framework Convention on Climate Change, the Kyoto Protocol and the Paris Agreement.

The Climate Change Response (Zero Carbon) Amendment Act 2019 amends the Climate Change Response Act 2002 and along with other amendments, including the establishment of the Climate Change Commission, sets a framework for effective adaptation across New Zealand, consisting of:

- Preparation of a National Climate Change Risk Assessment, every six years
- Preparation of a national adaptation plan, produced two years after each National Climate Change Risk Assessment

- Specifies requirements for monitoring the implementation of the national adaptation plan, and reporting on progress to ensure accountability.

6.1.3 National Climate Change Risk Assessment (NCCRA)

The first National Climate Change Risk Assessment (NCCRA) was released by MfE in 2020. The NCCRA is a national overview of how New Zealand may be affected by climate change-related hazards. It identified main risks and opportunities, highlights any information gaps and helps identify where the Government needs to focus its climate action.

The NCCRA identifies 43 priority risks across five value domains (natural environment, human, economy, built environment and governance) and highlights 10 risks considered to be the most significant (Table 7). The NCCRA enables the Government to prioritise actions through the National Adaptation Plan (discussed in section 6.1.4 below).

The Climate Change Commission will be responsible for delivering subsequent National Climate Change Risk Assessments to Government every six years. The second NCCRA is due by August 2026.

Table 7 The ten most significant risks Aotearoa will face from climate change in 2020–26, by domain (MfE, 2020a)

Natural	Risks to coastal ecosystems, including the intertidal zone, estuaries, dunes, coastal lakes and wetlands, due to ongoing sea-level rise and extreme weather events.	Risks to indigenous ecosystems and species from the enhanced spread, survival and establishment of invasive species due to climate change.
Human	Risks to social cohesion and community wellbeing from displacement of individuals, families and communities due to climate change impacts.*	Risks of exacerbating existing inequities and creating new and additional inequities due to differential distribution of climate change impacts.*
Economy	Risks to governments from economic costs associated with lost productivity, disaster relief expenditure and unfunded contingent liabilities due to extreme events and ongoing, gradual changes.	Risks to the financial system from instability due to extreme weather events and ongoing, gradual changes.
Built	Risks to potable water supplies (availability and quality) due to changes in rainfall, temperature, drought, extreme weather events and ongoing sea-level rise.*	Risks to buildings due to extreme weather events, drought, increased fire weather and ongoing sea-level rise.*
Governance	Risks of maladaptation across all domains due to the application of practices, processes and tools that do not account for uncertainty and change over long timeframes.	Risks that climate change impacts across all domains will be exacerbated because current institutional arrangements are not fit for climate change adaptation.

**The risk has disproportionate impacts on Māori.*

Supporting documents: The NCCRA was based on the Framework for the National Climate Change Risk Assessment for Aotearoa New Zealand developed in 2019 and was accompanied by a National climate change risk assessment for New Zealand - Method report in 2020.

A National climate change risk assessment for New Zealand - Technical report was developed in 2020 by MFE. This outlines the technical information that informed the risk assessment including profiles of all the

risks, opportunities and knowledge gaps identified. It provides the evidence base for the assessment findings, including further information on projected climate change in New Zealand.

6.1.4 National Adaptation Plan (2022-28)

The first National Adaptation Plan (2022–28) sets out the government's adaptation work programme for the next six years and contains strategies, policies and actions that will help New Zealanders adapt to the changing climate and its effects.

The National Adaptation Plan sets out what actions the Government will take over the next six years to help all New Zealanders adapt and thrive in a changing climate. It includes a programme of work to support councils to take action and adapt to climate change. It brings together existing actions and proposed future work to:

- enable better risk-informed decisions
- drive climate-resilient development in the right places
- lay the foundations for a range of adaptation options, including managed retreat
- embed climate resilience across government policy

Every two years, the Climate Change Commission provides a Progress report: National Adaptation Plan (August 2024) on the implementation, progress and effectiveness of the Government's National Adaptation Plan. As part of the Government's response to the progress report, some actions in the National Adaptation Plan were amended in January 2025.

6.1.4.1 'Having regard to' the National Adaptation Plan

WRC and territorial authorities must 'have regard to' the National Adaptation Plan when preparing or reviewing or amending regional policy statements, regional plans and district plans under the RMA. This requirement is to ensure consistency in planning nationwide, in line with New Zealand's long-term climate strategies and goals outlined in the NAP.

MFE have developed the National adaptation plan and emissions reduction plan: Resource Management Act 1991 guidance note that explains how local government must 'have regard to' the national adaptation plan and emissions reduction plan when they prepare policy statements and plans under the RMA. This guidance note applies to policy statements and plans prepared under the RMA.

6.1.5 National Adaptation Framework

The National Adaptation Framework (published in 2025) is the Government's long-term, strategic approach to help New Zealand prepare for and respond to the impacts of climate change.

The Framework is built around four pillars:

- Risk and response information sharing
- Roles and responsibilities
- Investment in risk reduction
- Cost-sharing pre- and post-event.

The Government has announced 16 initial actions which build on these pillars to form the foundations for the Framework. A key action in the Framework is amending the Climate Change Response Act 2002 to clarify requirements for local government by requiring adaptation plans in priority areas.

The National Adaptation Framework complements the National Adaptation Plan and refocuses effort on the actions which need to be accelerated. The Framework is consistent with the priorities in the first national adaptation plan. The 16 actions under the Framework will be incorporated into the next update of National Adaptation Plan actions.

The National Adaptation Framework considers the following pieces of work:

- The Independent Reference Group's report, A proposed approach for New Zealand's adaptation framework; and
- Parliament's Finance and Expenditure Committee's report, Inquiry into Climate Adaptation.

6.1.6 Climate risk reporting

6.1.6.1 Aotearoa New Zealand Climate Standards

The Aotearoa New Zealand Climate Standards, issued by the External Reporting Board (XRB), came into effect on 1 January 2023. These standards mandate around 200 organisations to disclose detailed information about the present and future effects of climate change on their operations. The mandatory reporting regime applies to large publicly listed companies, insurers, banks, non-bank deposit takers and investment managers. Auckland Council is a Climate Reporting Entity under the Financial Markets Conduct Act 2013 (FMCA). However, most other councils are not climate reporting entities and any climate-related disclosures are provided on a voluntary basis.

6.1.6.2 Reporting organisations under the Climate Change Response (Zero Carbon) Amendment Act 2019

Section 5ZW of the Climate Change Response (Zero Carbon) Amendment Act 2019 provides power to the Minister for Climate Change and the Climate Change Commission to request certain organisations (including the Public Service, local authorities, council-controlled organisations, crown entities, lifeline utilities, NZ Police and certain companies and organisations) to provide information on climate change adaptation. Reporting organisations must comply with these requests. The information requested may include:

1. a description of the organisation's governance in relation to the risks of, and opportunities arising from, climate change
2. a description of the actual and potential effects of the risks and opportunities on the organisation's business, strategy, and financial planning
3. a description of the processes that the organisation uses to identify, assess, and manage the risks
4. a description of the metrics and targets used to assess and manage the risks and opportunities, including, if relevant, time frames and progress
5. any matters specified in regulations.

Local authorities have previously been requested under section 5ZW to provide high-level information about how they are preparing for the impacts of climate change in order to track progress on adaptation preparedness of organisations providing essential public services.

6.1.7 Natural hazard information on LIMs

In 2025 two changes will impact natural hazard information disclosure in Land Information Memoranda (LIMs), and how regional councils provide natural hazard information to territorial authorities:

1. Changes to the Local Government Official Information and Meetings Act 1987 (the Act) came into force on 1 July 2025 and clarify what natural hazard information should be included in a LIM and provided by regional councils to territorial authorities.
2. The Local Government (Natural Hazard Information in Land Information Memoranda) Regulations 2025 (the Regulations), came into force from 17 October 2025. They outline how natural hazard information should be included in a LIM and provided by regional councils to territorial authorities.

These amendments are considered a critical action under the National Adaptation Plan to enable the public to make informed choices.

Refer to WRC's Position statement and supporting information on LIMs.

6.1.8 Resource Management reform

The resource management framework in New Zealand is currently undergoing a major reform process. The RMA reform objectives are:

- Unlocking development capacity for housing and business growth.
- Enabling delivery of high-quality infrastructure for the future, including doubling renewable energy.
- Enabling primary sector growth and development, including aquaculture, forestry, pastoral, horticulture, and mining.

The new resource management system must achieve these objectives while also:

- Safeguarding the environment and human health.
- **Adapting to the effects of climate change and reducing the risks from natural hazards.**
- Improving regulatory quality in the system.
- Upholding Treaty of Waitangi settlements and other related arrangements.

The reform of the RMA is being undertaken as a phased approach. Phase 2 includes a refocused package of national direction under the RMA. This includes proposals to prepare and amend 16 RMA national direction instruments in the infrastructure and development (package 1) and the primary sector (package 2) packages. These proposals include:

- new national direction for infrastructure, granny flats (minor residential units), papakāinga, and **natural hazards;** and
- amendments to the New Zealand Coastal Policy Statement.

6.1.8.1 Proposed National Policy Statement - Natural Hazards (NPS - NH)

As of July 2025, consultation on the indicative policy approach and provisions of the NPS - NH is underway. This Simpson Grierson article discusses the proposed NPS - NH.

The NPS - NH aims to support a consistent approach to natural hazard management when local authorities make planning and consenting decisions. The NPS-NH would introduce a framework emphasising proportionate risk management based on measurable data. The Government views this policy as a key step toward achieving its broader goal of ensuring that development is appropriately located and designed in accordance with the natural hazard risk profile of each area.

The potential impacts of climate change are proposed to be considered at least 100 years into the future to ensure the long-term impacts and risks are properly considered. However, no direction is provided in the consultation documents regarding the climate change projection scenario to be used.

6.1.8.2 Current Resource Management Act 1991

The existing resource management framework continues to inform the Waikato region's climate change response. The current RMA requires regional councils (and others), when exercising functions and powers under the RMA, to recognise and provide for matters of national importance (Section 6), including the management of significant risks from natural hazards and the preservation of the natural character of the coastal environment. Section 7 requires regional councils (and others) to have regard to the effects of climate change.

In addition, several national policy statements, which are developed under the RMA, contain objectives and policies relating to climate change adaptation including:

- The National Policy Statement on Urban Development (2020) has an objective (Objective 8) that New Zealand's urban environments 'are resilient to the current and future effects of climate change'. Policies 1 and 6 require certain planning decisions to take the likely current and future effects of climate change into account.
- Policy 4 of the National Policy Statement for Freshwater Management (2020) states that, 'freshwater is managed as part of New Zealand's integrated response to climate change'. Clauses 3.14 and 3.16 require regional councils to have regard to the foreseeable impacts of climate change when setting limits (3.14) and environmental flows and levels (3.16).
- National Policy Statement for Indigenous Biodiversity (2023) identifies the drivers of biodiversity loss include invasive pests, land-use change, natural resource overuse, pollution and climate change.
- New Zealand Coastal Policy Statement 2010 (NZCPS) guides councils in their day-to-day management of the coastal environment. Councils must avoid new development, redevelopment or changes in land use that will increase the risk of harm or adverse effects from coastal hazards. The NZCPS also supports increasing the resilience of development that must be in coastal areas.

RMA amendments from 2022 require WRC and territorial authorities to have regard to the national adaptation plan and the emissions reduction plan when preparing or amending regional policy statements, regional plans, and district plans (section 61 and 71).

6.1.9 WRC assumptions for legislative change

Transition to the new legislative and regulatory environment and the effect it will have on regional council's functions, existing legislative responsibilities and community adaptation processes are uncertain.

The WRC Long-Term Plan 2024 – 2034 (LTP) identifies the regional assumptions for legislative change and central government priorities under the 'Governance, partnering and engagement' section of the LTP (page 233).

- *It is assumed there will be change to legislation affecting our work programme, including how we operate, what we do and who pays for what.*

- *During the next ten years of the LTP 2024 – 2034, we assume the Resource Management Act will be replaced. Until such time, WRC note the provisions of the RMA are in force.*
- *Impacts of constant legislative changes will impact policy and plan development programmes.*
- *Shift in central government direction and priorities could potentially increase council's workload with respect to community engagement and decision-making processes.*
- *Te Ture Whaimana o Te Awa o Waikato, the Vision and Strategy for the Waikato and Waipa Rivers, is presently being reviewed (as at May 2025). Te Ture Whaimana is the primary direction setting document for the Waikato and Waipa catchment and should there be any inconsistency between national direction and Te Ture Wha Whaimana, Te Ture Whaimana prevails. Under the Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010, clause 19, the review of Te Ture Whaimana is to be initiated no later than 10 years from the previous review. Therefore, this is the first major review of Te Ture Whaimana since it was established more than 10 years ago as a key part of the River Settlement.*

WRC notes different functions and services may be required of the council to implement legislative changes or central government priorities. The timeframes and notice given to implement required changes may be shorter than expected.

6.1.9.1 Local Government (System Improvements) Amendment Bill

The expressed aim of the Local Government (System Improvements) Amendment Bill is to help alleviate pressure on council rates, by amending the purpose and role of local government so that councils focus on specific core services and "spending on the basics". WRC will work through the implications of the final form of the Bill once passed into legislation.

6.2 Regional policy requirements

Regional policy and plans must implement national legislation, including that relating to climate change adaptation.

6.2.1 Waikato Regional Policy Statement (Operative)

The purpose of the Waikato Regional Policy Statement: Te Tauākī Kaupapahere Te-Rohe O Waikato (RPS) is to achieve the purpose of the RMA by providing an overview of the resource management issues of the region, and policies and methods to achieve integrated management of the natural and physical resources. The RPS provides a sound basis for planning for and undertaking climate change adaptation actions.

The RPS acknowledges the need to manage natural hazards, such as coastal inundation and erosion, freshwater flooding, landslides and large-scale rock/soil mass movements, severe weather events, drought and fire. The RPS also acknowledges that climate change will increase the risk from these natural hazards and make their management even more important.

The relevant sections within the RPS include:

SRMR-I2 – Effects of climate change
The effects of climate change (including climate variability) may impact our ability to provide for our wellbeing, including health and safety.

While addressing this issue generally, specific focus should be directed to the following matters:

- *Increased potential for storm damage and weather-related natural hazards; and*
- *Long-term risks of sea level rise to settlements and infrastructure such as through increased coastal flooding and erosion; and*
- *Ability for urban environments to support a reduction in greenhouse gas emissions and to be resilient to the current and future effects of climate change.*

IM-O5 –Climate change

Land use is managed to:

1. *Avoid the potential adverse effects of climate change induced weather variability and sea level rise on:*
    a. *amenity;*
    b. *the built environment, including infrastructure;*
    c. *indigenous biodiversity;*
    d. *natural character;*
    e. *public health and safety; and*
    f. *public access.*
2. *Support reductions in greenhouse gas emissions within urban environments and ensure urban environments are resilient to the current and future effects of climate change.*

IM-M11 – Incorporating effects of climate change

Local authorities should, and regional and district plans shall, recognise and provide for the projected effects of climate change, having particular regard to:

1. *historic long-term local climate data;*
2. *projected increase in rainfall intensity, taking account of the most recent national guidance and assuming a **minimum** increase in temperature of 2.1°C by 2090 (relative to 1990 levels); and*
3. *projected increase in sea level, taking into account the most recent national guidance and assuming a **minimum** increase in sea level of 0.8m by 2090 (relative to 1990 levels).*

HAZ-M2 – Define primary hazard zones

Waikato Regional Council will identify primary hazard zones in consultation with key stakeholders including but not limited to territorial authorities, tangata whenua, infrastructure providers, and affected communities and these shall be recognised and provided for in regional and district plans.

Note: This method is key to the risk assessment and risk threshold setting processes.

HAZ-M3 – Assess natural hazard risk to communities

Waikato Regional Council will collaborate with territorial authorities, tangata whenua and other agencies to undertake assessments of coastal and other communities at risk or potentially at risk from natural hazards, and develop long-term strategies for these communities. The strategies will, as a minimum:

1. *include recommendations for any hazard zones that should be applied, including primary hazard zones;*
2. *identify risks to the community and existing infrastructure from natural hazards; and*
3. *identify options for reducing the risks to the community to an acceptable level and the relative benefits and costs of those options, including taking into account any effects on:*

a. *public access;*
b. *amenity values; or*
c. *natural character (including natural physical processes, indigenous biodiversity, landscape and water quality).*

There are several additional policies and implementation methods that directly reference or are related to climate change adaptation.

6.2.2 Waikato Regional Plan

The Waikato Regional Plan must give effect to the RPS. The plan contains objectives, policies and methods to manage the natural and physical resources of the Waikato region, excluding the coastal marine area (CMA) which is covered by the Regional Coastal Plan (see section 6.2.3), currently under review. Climate change, and specifically adaptation, is addressed through several of the policies and methods in the Waikato Regional Plan, and is directly referenced in:

- Section 3.3.3 Policy 1: Establish Allocable and Minimum Flows for Surface Water;
- Section 3.3.3 Policy 4: Establish Sustainable Yields from Groundwater; and
- Method 3.3.4.9 Review Allocable Flows/Sustainable Yields (to implement Policy 1).

Method 3.3.4.8: Assessment of hydrological flow statistics for water allocation, details the work that WRC Science and Environmental Monitoring do to update the flow statistics used in water allocation. Climate change may affect the flow of surface waterbodies and the sustainable yields in groundwater aquifers, and this needs to be considered.

Method 3.3.4.9 Review Allocable Flows/Sustainable Yields, part g), requires review of minimum and allocable flows of surface water or sustainable yields in aquifers when investigations indicate that climate change is affecting these.

The Decisions Version of Proposed Plan Change 1 (Waikato and Waipa Catchment Water Quality) Policy 8 also references climate change adaptation.

6.2.3 Waikato Regional Coastal Plan

The operative Regional Coastal Plan contains policies, rules and methods to manage the use and allocation of resources in the Waikato coastal marine area (CMA). The CMA is from the line of mean high-water spring (MHWS) out to 12 nautical miles (approximately 20 km).

Climate change adaptation is relevant to *Policy 8.1.2: Adopt a precautionary approach in the assessment of coastal hazard risk and in the assessment of potential risks for coastal permit applications* (Natural Hazards chapter). One of the reasons listed for adopting this approach is the uncertainty in predicting the effects of coastal hazards, e.g. sea level rise (because of climate change). Changes in sea level is also referenced in the assessment criteria for several of the implementation methods – rules, including those in section *16.4 Structures*.

The Proposed Waikato Regional Coastal Plan, notified in August 2023, intends to apply an adaptive management approach to coastal resources and manage the potential effects of climate change on existing and proposed use and development in the CMA. This is done by giving effect to the National Adaptation

Plan and ensuring resource consent applicants have adopted the most recent national guidance on climate change adaptation. Further, it provides for the recognition of adaptive management strategies, in relation to coastal hazards. Hearings on the proposed Regional Coastal Plan were held from February to April 2025. The Hearing Panel will make recommendations on the decisions requested by submitters for Council to consider later in 2025.

6.3 Territorial authority policy requirements

District Plans must give effect to the RPS and be consistent with Regional Plans. They often have provisions relating to climate change adaptation, for example, coastal set-back lines or minimum floor level rules that include or require allowances for the projected effects of climate change.

A link to the District Plan of each of the 11 districts/cities in the Waikato region is provided below, with a map of the boundaries available here.

Hamilton City Council
Hauraki District Council
Matamata-Piako District Council
Ōtorohanga District Council
Rotorua Lakes Council
South Waikato District Council
Taupo District Council
Thames Coromandel District Council
Waikato District Council
Waipa District Council
Waitomo District Council

6.4 WRC policy, frameworks and guidance relevant to climate adaptation

WRC has developed several frameworks, policy and guidance documents that can be used for risk assessments, planning and other decision making related to climate change adaptation. The following tables summarise each of the documents or provide a link to the summary in this guideline and provide a link to the document on WRC's website:

-
- Table 8 provides an overview of WRC policy and plansTable 9 provides an overview of WRC strategies
-
-
-
- Table 10 provides an overview of WRC frameworks, guidance and other information

Table 8 WRC policy and plans relevant to climate change adaptation

Title, year developed/ updated	Description	Link
Waikato Regional Policy Statement, 2016	See section 6.2.1 for detail	Waikato Regional Policy Statement: Te Tauākī Kaupapahere Te-Rohe O Waikato
Waikato Regional Plan, 2012	See section 6.2.2 for detail	Waikato Regional Plan
Waikato Regional Plan: Variation No. 6 (Water Allocation), 2012	Freshwater allocation issues are a core part of Waikato Regional Council's natural resource management responsibilities. When establishing allocable and minimum flows for surface water and sustainable yields from groundwater, the effects of climate change need to be considered. WRC will review allocable flows/sustainable yields if investigations show that climate change is affecting these.	Waikato Regional Plan: Variation No. 6 (Water Allocation)
Waikato Regional Coastal Plan, 2005 Proposed Waikato Regional Coastal Plan	See section 6.2.3 for detail	Waikato Regional Coastal Plan Proposed Waikato Regional Coastal Plan
2024-2034 Mahere Whānui Long Term Plan, 2024 Including section 6: Te Kaupapahere Tāpuatanga me te Whakapānga Infrastructure Strategy	See section 3.1.4 for detail Section 6 of the LTP is an Infrastructure Strategy to provide a high-level view of infrastructure managed by the council, and how WRC propose to manage that infrastructure over the next 50 years. It	2024-2034 Mahere Whānui Long Term Plan

Title, year developed/ updated	Description	Link
	identifies important infrastructure issues and challenges for our region and identifies transitional pathways to help address those issues. Over time, implementation of this strategy will help us achieve 'resilient communities that plan for intergenerational wellbeing, develop with nature in mind and are able to respond to and recover from adversity'. The strategy includes the options and preferred approach for climate change adaptation.	
Waikato Regional Land Transport Plan (RLTP) 2024-2054, 2024	The RLTP sets out how we intend to develop the region's land transport system over the next 30 years. It also identifies proposed regional transport activities for investment (local and central government) over the next six years. The RLTP points out that without active adaptive management, the long-term effects of climate change will make the Waikato region's transport network less resilient and subject to more frequent road closures due to extreme weather events.	Waikato Regional Land Transport Plan (RLTP) 2021 - 2051
Waikato Freshwater Policy Review 2020-2025	The Freshwater Policy Review is the council's response to Government's Essential Freshwater package. A key element of the package is an update to the National Policy Statement for Freshwater Management 2020 (NPS-FM), which provides direction on how we manage fresh water under the RMA. This is about stopping further degradation of New Zealand's fresh water and improving its quality and ecosystem health. Over the next two years, we'll be making changes to our Waikato Regional Policy Statement (RPS) and Waikato Regional Plan to bring them into line with this direction	Freshwater Policy Review National Policy Statement for freshwater management

Table 9 WRC strategies relevant to climate change adaptation

Title, year developed/ updated	Description	Link
Waikato Regional Council's Strategic Direction 2022-2025, 2022	See section 3.1.1 for detail	Waikato Regional Council's Strategic Direction 2022-2025
Climate Action Roadmap, 2023	See section 3.1.2 for detail	Climate Action Roadmap

Title, year developed/ updated	Description	Link
Growing together – Whakatupu Ngātahi Waikato Regional Aquaculture Strategy, 2024	Growing together – Whakatupu Ngātahi is our region-wide aquaculture strategy that serves as a blueprint for managing and enabling aquaculture in the region by taking a directive approach to enable aquaculture growth with an economic lens balanced by community, cultural and environmental wellbeing. This strategy includes a priority around minimising biosecurity risks and adapting to climate change and environmental impacts	Whakatupu ngātahi Growing together Waikato Regional Aquaculture Strategy
Waikato Regional Biosecurity Strategy 2022-2032, 2022	A non-statutory document setting out a blueprint for ensuring a collaborative, cohesive and comprehensive biosecurity system is operated and maintained within the Waikato region over the next 10 years. Climate change is altering our environment and creating challenges in the biosecurity system. This strategy includes the 2022-2032 Waikato Regional Pest Management Plan (RPMP) and all other biosecurity activities such as monitoring and surveillance, research, incursion responses and collaborative action.	Waikato Biosecurity Strategy 2022-2032
Waikato Freshwater Strategy, 2017	Identifies a programme of action to achieve the best use of fresh water through time, including actions relating to climate change adaptation.	Waikato Freshwater Strategy
Water Security Strategy for the Waikato Region	The Water Security Strategy for the Waikato Region builds on national and local water security initiatives to identify a roadmap for a coordinated regional response to changing water security. There is increasing concern among Waikato communities over climate-related reductions in water availability and the implications for freshwater ecosystems, urban and industrial water supply/demand dynamics, ongoing delivery of electricity generation, primary sector productivity and constraints on future growth.	He Rautaki Whakahaumaru Wai Water Security Strategy for the Waikato Region

Table 10 WRC frameworks, guidance and other information relevant to climate change adaptation

Title, year developed/ updated	Description	Link
WRC Climate Change Response Position Statement, 2023	See section 3.1.3 for detail	WRC Climate Change Response Position Statement
Waikato Regional Policy Statement – Implementation Practice note on Natural Hazards, 2019	This Implementation Practice Note is to help interpret and assist in the implementation of RPS Chapter 14 Natural Hazards, and related aspects of Chapter 4 Integrated Management and Chapter 6.2 Development in the Coastal Environment. ** Note that review of this Practice Note has been paused due to upcoming changes in National Direction.*	Waikato Regional Policy Statement – Implementation Practice note on Natural Hazards
Waikato Regional Climate Change Hazards and Risks, 2025	See section 4.1.1 for detail	Waikato Regional Climate Change Hazards and Risks
WRC Sustainable Infrastructure Decision-Making Framework (SIDF)	The SIDF is a best practice process for guiding long term infrastructure investment and management actions for the benefit of the region. It enables decisions to have a greater evidence base, be more objective and holistic, capture and account for more-clearly articulated community values and provide clarity on outcomes and greater certainty for investment. The SIDF provides a transparent and defensible investment decision making process that is evidence based and incorporates sustainability and all four well beings. It will be used to evaluate various response strategies and their impacts using drafted Strategic Investment Objectives and a multi-criteria analysis that includes economic, social and environmental assessments, and te ao Māori perspectives	Sustainable Infrastructure Decision-making Framework
Waikato Regional Council Submission on the Select Committee Inquiry into Climate Adaptation, 2023	See section 6.1.5 for detail	Waikato Regional Council Submission on the Select Committee Inquiry into Climate Adaptation

Title, year developed/ updated	Description	Link
WRC Climate Action Committee	The scope of the WRC Climate Action Committee is to receive scientific evidence and Mātauranga Māori to inform strategic leadership on how the Waikato Region could achieve climate change mitigation and adaptation. In relation to climate adaptation, this includes: • Overseeing the climate change risk assessment for the region. • Prepare for climate change (adaptation) to inform the development of a regional climate action plan for adoption by the council, and to monitor and report annually on achievement of the plan. • Advise on actions to deliver on responsibilities under the Climate Change National Adaptation Plan. • Promote consistent and effective leadership, advocacy, communication and engagement on climate change issues to enable individual and collaborative action. • Ensure climate change evidence and guidance informs council work programmes and that decisions include explicit consideration of climate change impacts.	WRC Climate Action Committee
Terms of Reference | Ngā Tikanga Whakahaere for Waikato Regional Council	All Councillors of WRC are governed by terms of reference which includes a section on Hautūtanga Āhuarangi |Climate Leadership which states climate leadership is a priority and therefore, all discretionary committees of WRC are tasked with the following responsibilities: • To set mitigation and adaptation objectives to decarbonise the activities overseen by the committee and ensure business resilience. • Ensure climate change evidence and guidance informs committee work programmes and that decisions include explicit consideration of climate change impacts.	

Title, year developed/ updated	Description	Link
	• Make use of available environmental, social, cultural and economic research, skills and capabilities to ensure climate risks, including transition risks, are considered and mitigated through the committee's work programme. • Monitor and report annually on achievement of the committee's objectives to mitigate emissions and adapt to the impact of the changing climate. • To promote consistent and effective leadership, advocacy, communication, and engagement on climate change issues.	
WRC Requirement to include Climate Considerations in Council Decisions, 2020	All Council decisions must consider the implications for climate change adaptation, mitigation and leadership. To assist with this, sections on these topics have been included in the standard reporting template.	Internal staff: Decision report template is available on Infocouncil External: Unavailable

7 Technical information for modelling

This section covers:

- *Vertical datums and the use of NZVD2016*
- *How to account for future climate change in hydrological and hydraulic modelling:*
  - *Existing flood modelling in the Waikato region*
  - *High intensity rainfall projections – using an increment-based approach*
  - *High intensity rainfall projections – specific guidance for infrastructure design*
  - *Boundary conditions*
- *How to account for sea level rise and coastal hazards in coastal adaptation planning:*
  - *Measured sea level rise*
  - *Projected sea level rise, including SSP scenarios, the increments approach and vertical land movement*
  - *Other coastal hazards*

7.1 Vertical datums and the use of NZVD2016

Vertical datums provide a reference surface for measuring elevations and water levels. In the past, different datums were used across New Zealand, often tied to local Mean Sea Level (MSL) or Land Levelling datums/ benchmarks or regional tide gauges. While locally relevant, these historic datums lack national consistency and can introduce confusion and errors, especially when integrating datasets across regions or assessing hazards like flooding and sea level rise.

To address this, Land Information New Zealand (LINZ) introduced the New Zealand Vertical Datum 2016 (NZVD2016) as the new national vertical datum. This datum is based on the New Zealand Quasigeoid, which is a model derived from the Earth's gravity field and is thus used to define the national zero height in a regionally consistent manner. More details can be found at Land Information New Zealand (New Zealand Vertical Datum 2016 (NZVD2016) | Geodetic Guidance) and they also provide useful tools to assist in converting between datums. Here NZVD2016 is also defined as the official vertical datum of New Zealand.

Recommendation:
All new ocean, coastal, and estuarine wave and hydrodynamic models as well as hydraulic and hydrological modelling projects should adopt NZVD2016 as the vertical reference for consistency, especially where the outputs will inform adaptation studies. For existing models on legacy datums, a transformation to NZVD2016 should be undertaken where feasible to support integration with regional and national datasets.

The WRC Spatial Information team has developed conversion grids and methods and can provide these as requested (via an online request for service).

7.2 Hydrological and hydraulic modelling

Hydrological modelling helps us to understand how rainfall translates to runoff within a catchment. It can be used to make flood flow estimates, which are able to be used in hydraulic modelling. Hydraulic modelling dynamically predicts how the above flow estimates or runoff will move through a representation of the catchment terrain or drainage pathways.

When undertaking hydrological and hydraulic modelling, the projected effects of climate change should be taken into account. Changes in rainfall (high intensity rainfall projections) associated with future climate

scenarios will influence the design flow estimates obtained from hydrological modelling. Future climate design flow estimates are then used as upstream boundary conditions in hydraulic modelling. Downstream boundary conditions can also be influenced by climate change, whether it be a shift in design flows and water levels at downstream locations or changes in sea level.

Hydrological and hydraulic modelling may be undertaken for a variety of applications, such as community adaptation planning, flood scheme design or stormwater design for a proposed development. Therefore, the approach to hydrological and hydraulic modelling may vary. WRC recommends the following high-level process:

1. **Does a community adaptation plan exist in the area of interest (see section 5.4 of this guideline)?**
   - *If so, any proposed new infrastructure or development should be consistent with this adaptation plan.*
     Detailed hazard modelling, risk assessment and dynamic adaptation pathways planning (section 2.3 of this guideline) may have already been undertaken and the results of this planning process may eventually feed into the relevant District Plan.

If not, what is the purpose of the model:

2. **Is the model multi-purpose or will it be used over an extended time period or subject to future review?**
   - *If so, follow the method provided in section 7.2.2 below*.

3. **Is the model for a specific, one-off application?** For example, infrastructure design for a proposed subdivision or minimum floor level for a new build or extension.
   - *If so, follow the guidance referenced in section 7.2.3 below.*

7.2.1 Existing and emerging models in the Waikato

WRC maintains a library of 1D and 2D flood models for large river systems, with models focused on the Hauraki, Lower Waikato, Coromandel, West Coast and Upper Waikato. WRC also maintains the region-wide Regional Scale Flood Hazard layer which provides a broad view but lacks sufficient resolution for property-level adaptation planning. The outputs of these models are available to view on the Waikato Regional Hazards Portal and can be downloaded from the Waikato Data Portal.

To improve accuracy and coverage, WRC is implementing a Waikato Regional Water Resource modelling Plan— comprising 2D hydrodynamic models across the region using LiDAR terrain data and improved rainfall distribution inputs. This system is being developed in stages, with coarse-scale models being refined over time for high-priority areas.

The three phases are summarised here:
Phase 1:

- Ground levels (LiDAR)
- Simple River information (no bathymetry)
- Landcover
- 1% AEP rainfall event.

- Not calibrated/validated

Phase 2:

- Addition of details: stopbanks, drains, culverts, floodgates, groundwater, river bathymetry
- Not calibrated/validated
- 10% and 1% AEP rainfall events

Phase 3:

- Addition of further details, e.g., pumpstations towards
- Model validation and calibration
- Model re-run for 10% and 1% AEP rainfall events
- Climate change

7.2.1.1 National scale flood hazard map (Earth Sciences New Zealand)

Earth Sciences New Zealand has published a national scale online map showing Flood hazard across Aotearoa New Zealand (national map) using a 1 % annual exceedance probability (AEP) rainfall scenario and including projected impacts of climate change at 1, 2 and 3 degree temperature increases. This national map has similarities with some elements of Phases 2 and 3 of the Waikato Regional Water Resource Modelling Plan.

However, the national map is regarded as Level 4 on the Natural Hazards Information Hierarchy. All 'Local Scale' models in the Waikato Regional Hazards Portal supersede the national flood hazard map. Phase 2 and 3 of the Waikato Regional Water Resource Modelling Plan will supersede the national map.

Please contact WRC for assistance or information on the applicability of the national map.

7.2.2 High intensity rainfall projections for adaptation planning

To ensure robustness and flexibility in the face of evolving climate science, WRC recommends that climate change modelling for hydrological and hydraulic design focuses on system response to temperature-based increments, rather than aligning models rigidly to any one scenario (e.g. SSP or RCP).

This "increment-based" approach enables practitioners to understand the sensitivity of a system to: increasing rainfall associated with warming, test a range of plausible future conditions (e.g. +1°C, +2°C, +3°C, +4°C, or at 0.5°C intervals) and decouple design modelling from fixed time horizons or climate change scenarios. The benefits of an increment-based approach include:

- greater flexibility to adjust to changes in international modelling frameworks (e.g. shifts from RCPs to SSPs, and potential future shifts to new paradigms);
- it supports adaptation planning where the aim is to understand how the impacts of flooding and/or performance of existing systems changes over time or under different levels of warming; and
- it's compatible with NIWA's High Intensity Rainfall Design System online tool (HIRDS v4), which allows rainfall adjustment based on temperature increases, even if currently tied to RCP-based timeframes.

7.2.2.1 How temperature increments can be mapped back to SSP or RCP scenarios

Although the increment-based method is the preferred approach, it is often necessary to link modelling results to policy, asset planning or regulatory guidance, which may still reference specific climate scenarios (SSPs/RCPs) and timeframes. We recommend running a range of temperature increments such as +1.0°C, +2°C, +3°C, +4°C. Depending on modelling resolution or criticality, 0.5°C (e.g. +1.5°C, +2.5°C) or even smaller increments may also be appropriate. This means that you do not only model a single increment (e.g. +2°C) but rather simulate several temperature increments. The range should capture both the expected warming over the design life of the asset and allow for sensitivity testing at higher warming levels. By running a small set of standardised increments, the results can later be interpreted and mapped to the most relevant climate scenario or design horizon at the time decisions are made. This approach avoids the need to re-run simulations if climate change scenario guidance changes in the future.

To link increments to time-based scenarios (if required), practitioners can:

- use tables like Table 11 below or equivalent SSP datasets to map increments to timeframes (e.g. "+2°C is approximately equal to SSP2-4.5 in 2100")
- choose an appropriate increment based on the design life of the asset (e.g. +2°C for infrastructure intended to operate to 2050)
- can design new infrastructure to +4°C or carry out sensitivity testing to determine if a lower temperature increase may be appropriate.
    - An adaptation plan is required outlining how and when infrastructure will be modified in the future if a lower temperature increase is chosen.

Table 11 Recommended temperature increases for climate impact modelling in the Waikato region

Increment above baseline* (°C)	Approximate year reached (SSP2-4.5)	Approximate year reached (SSP3-7.0)	Approximate year reached (SSP5-8.5)	Notes / application
+1.0	~2040	~2030s	~2030s	Short-term asset design (<20 yr life). Matches NIWA mid-century SSP2-4.5.
+1.5	~2060	~2040–2050	~2040	Mid-century planning horizon; aligns with NIWA SSP3-7.0 mid-century.
+2.0	~2100	~2060s	~2050	End-century SSP2-4.5; NIWA indicates +2 °C by 2080–2099.
+2.5	–	~2070s	~2060	Intermediate; not a direct NIWA point but interpolated. Use for sensitivity testing of long-life infrastructure.
+3.0	–	~2100	~2070	End-century SSP3-7.0; mid-to-late century SSP5-8.5.
+3.5	–	–	~2080	Approaching end-century high emissions.
+4.0	–	–	~2090–2100	NIWA downscaled end-century SSP5-8.5. Recommended temperature to use for new infrastructure as per the Regional Infrastructure Technical Specification (RITS).

** baseline is 1995-2014 with a midpoint of 2005*

Guidance notes on the use of Table 11:

For RITS only:

- *For planning and design, assume a worst-case warming of +4.0 °C as the default scenario. If project teams can justify a lower temperature increment (e.g. based on shorter asset design life, lower consequence of failure, or alignment with statutory/national guidance), they may adopt that increment — provided the rationale is documented.*

For RITS and this guideline:

- *Some applications require assessment to at least 100 years in the future; however the most recent downscaled climate projections for New Zealand only go to 2100 (with the exception of sea level rise).*
- *For planning and design, assume a worst-case warming of +4.0 °C as the default scenario. If a project can justify a lower temperature increment (e.g. based on shorter asset design life, lower consequence of failure, or alignment with statutory/national guidance), they may adopt that increment — provided the rationale is documented, including sensitivity testing.*
- *In all cases, conduct sensitivity testing across a range of increments (e.g. +1.5 °C to +3.0 °C) to assess the robustness of decisions under different futures. Where national guidance (e.g. MfE, RITS) or statutory requirements apply, use the temperature increment that best matches the required scenario while retaining increment-based results for flexibility in future reassessment.*

7.2.2.2 Climate sensitivity of rainfall intensities

To estimate future rainfall conditions for hydrological and hydraulic modelling under climate change, it is necessary to adjust current rainfall depths or intensities based on expected increases in atmospheric temperature. The relationship between temperature and rainfall intensity is not linear, and the degree of intensification depends on event duration, local climate conditions, and storm dynamics.

Table 12 provides percentage increases in rainfall per 1°C of predicted temperature increase, based on guidance from MfE (2018). These values are recommended for use in design where a temperature increment-based approach is applied (as outlined in Table 11). These percentages represent the “most likely” percentage increases and are intended to guide adjustments of rainfall inputs for future climate scenarios.

Where hydrological modelling uses synthetic or design storms (e.g. from HIRDS v4 or gauge-based DDF curves), these values can be applied as multiplicative factors to estimate future rainfall intensity or depth. This allows modellers to develop design rainfall inputs for a range of climate change increments (e.g. +1°C, +2°C, etc.) in a transparent and flexible way.

Note: The auto generated HIRDS v4 climate change rainfall data does not use the same % increase / 1°c per degree that is recommended by WRC for use in the Waikato region (to be consistent with updated national guidance). Thus, climate change rainfall should be calculated manually using the method below.

Table 12 should be used in conjunction with the recommended temperature increases from Table 11. For example, if modelling a future scenario based on a +4°C temperature rise, for a 100 year (1% AEP) storm with a duration of 24 hours, the modelled rainfall input should be increased by 34.4% (i.e. 4°C × 8.6%).

Table 12 Percentage increases in rainfall intensity per 1°C of predicted temperature increase, providing the "most likely" % increase (based on MfE, 2018)

Duration/ARI*	2 yr	5 yr	10 yr	20 yr	30 yr	40 yr	50 yr	60 yr	80 yr	100 yr
1 hour*	12.2	12.8	13.1	13.3	13.4	13.4	13.5	13.5	13.6	13.6
2 hours	11.7	12.3	12.6	12.8	12.9	12.9	13.0	13.0	13.1	13.1
6 hours	9.8	10.5	10.8	11.1	11.2	11.3	11.3	11.4	11.4	11.5
12 hours	8.5	9.2	9.5	9.7	9.8	9.9	9.9	10.0	10.0	10.1
24 hours	7.2	7.8	8.1	8.2	8.3	8.4	8.4	8.5	8.5	8.6
48 hours	6.1	6.7	7.0	7.2	7.3	7.3	7.4	7.4	7.5	7.5
72 hours	5.5	6.2	6.5	6.6	6.7	6.8	6.8	6.9	6.9	6.9
96 hours	5.1	5.7	6.0	6.2	6.3	6.3	6.4	6.4	6.4	6.5
120 hours	4.8	5.4	5.7	5.8	5.9	6.0	6.0	6.0	6.1	6.1

** The 1 hour value must be used for storm durations less than 1 hour*

**ARI is annual return interval; a 2 year ARI is equal to a 50% AEP (annual exceedance probability) event and a 100 year ARI is equal to a 1% AEP event.*

7.2.3 High intensity rainfall projections for infrastructure design in new developments

Higher intensity rainfall events resulting from climate change will put a strain on stormwater infrastructure, thus this needs to be accounted for when designing infrastructure for new developments.

Guidance on how to account for climate change when designing stormwater infrastructure will be provided in the updated (expected to be published soon) Regional Infrastructure Technological Specification (RITS) (section 4.2.4.4 Design rainfall). This section provides the requirements for the projected temperature increase to use (+4°C) with refence to the corresponding SSP scenario and future time period. It provides step by step instructions to determine climate change design rainfall and describes how to carry out sensitivity testing if project teams wish to show that a lower temperature increase is appropriate. WRC endorses the use of this method described in the RITS, and this guideline provides complementary information in Table 11 above.

WRC has also produced two documents to encourage regional consistency in stormwater design and management:

- WRC's 2020 Waikato Stormwater Management Guideline (TR 2020/07) provides comprehensive guidance on stormwater management. Section 7 on design criteria is particularly relevant to hydrological modelling and includes a section (7.1.6) on the effects of climate change - this section is high level; more detailed guidance is provided in this guideline and the RITS.
- WRC's 2020 Waikato stormwater runoff modelling guideline (TR2020/06) provides detailed information on stormwater runoff modelling, including worked examples . It includes section 4.3 Climate Change, which specifies that for stormwater design, pre-development rainfall data should not be adjusted for climate change while post-development rainfall data should be adjusted for climate change.

7.2.4 Boundary conditions

In assessing the effects of climate change in flood modelling, two key elements must be considered:

1. Changes in rainfall, which influence catchment hydrology and upstream inflows, and
2. Changes in downstream or coastal conditions, particularly sea level rise and storm-induced surges.

These elements should be explicitly accounted for in model boundary conditions, both upstream and downstream.

Upstream boundary conditions

Changes in rainfall intensity and depth due to climate change are accounted for in hydrological modelling using the temperature increments method described in section 7.2.2. This produces adjusted flow hydrographs for future climate scenarios. These flows, derived from modelled increases in rainfall under specific temperature rise increments (e.g. +1°C, +2°C), form the upstream boundary conditions in hydraulic models.

Hydrologists should use adjusted design storm rainfall (from HIRDS or gauge data), apply temperature-based multipliers (Table 12), and simulate resultant flood flows. Sensitivity testing with higher and lower temperature scenarios is encouraged to assess flood risk robustness.

Downstream boundary conditions

For riverine or estuarine systems, downstream boundary conditions often consist of either:

- Measured or estimated river levels from a larger, receiving water body, or
- A tide level (e.g. mean high water spring or storm tide elevation) if the river discharges into a tidal waterbody.

These boundaries can be influenced by climate change in several ways:

- Increased river levels due to downstream catchment flooding
- Higher base levels in estuaries or tidal rivers due to sea level rise
- Changes in tidal dynamics or storm surge frequencies.

Where applicable, sea level rise should be added to the selected tide level to reflect future boundary conditions (see section 7.3 for guidance). If downstream conditions are influenced by other rivers or flood control infrastructure, projected conditions must reflect any anticipated climate-related changes to flow regimes or operational rules.

Coastal boundary conditions

For coastal or tidally influenced systems, mean high water spring (MHWS) or storm tide levels are commonly used as downstream boundaries. In climate change scenarios, a sea level rise component must be added. This should reflect the most recent MfE guidance and be selected based on:

- The design life of the structure or asset
- Community expectations and adaptation timeframes
- Incremental sea level rise allowances or SSP-linked projections

Storm surge components (e.g. wave setup, wind setup) should also be included where these are material to flood levels. Where a joint probability analysis between rainfall and tide/surge has not been conducted, a reasonable tide level assumption (e.g. MHWS + 10% AEP storm tide) is often used in combination with design rainfall.

It is critical that upstream and downstream boundary conditions are aligned, particularly in climate change scenarios. For example, a +2°C rainfall scenario should be paired with a consistent sea level rise scenario based on the corresponding timeframe.

Due to the variability in system responses, sensitivity testing of flood levels under various climate scenarios is strongly recommended. For example:

- Steep, confined catchments may show little sensitivity to downstream sea level rise.
- Low-lying floodplains or tidally influenced rivers may be highly sensitive to even small changes in coastal boundary levels.

Sensitivity testing ensures model outputs inform risk-aware decision-making and help communicate the range of future conditions under which the asset may operate.

Worked example – incorporating sea level rise into coastal boundary condition:

A hydraulic model is being developed for a low-lying river system discharging into an estuary at the coast. The purpose is to assess flood risk for an existing residential development to 100 years in the future. The design rainfall corresponds to a +2°C warming scenario. The area is tidally influenced and affected by storm surge events.

Step-by-step approach:

1. Determine base tide level:
   Use MHWS as the base tide level.
   → *MHWS = 1.10 m NZVD*
2. Add a conservative allowance for storm surge and short-term coastal variability. Add a representative water level increase (e.g. +0.4 m) to account for storm surge, wave setup, barometric effects, and other short-term coastal dynamics during storm conditions.
   → *Storm surge = 0.40 m*
3. Determine sea level rise (SLR):
   Based on MfE's 2024 guidance, for a 100-year horizon (to ~2125), a conservative SLR increment under SSP2-4.5 (or equivalent +2°C scenario) is:
   → *SLR = 1.20 m*
4. Calculate total future sea level boundary *(1.10 + 0.40 + 1.20 m)*.
5. Use 2.70 m NZVD as the downstream water level in the hydraulic model for the future climate scenario.

Notes:

- Where available, a time-varying tide series with sea level rise added uniformly can be used.
- The SLR value should match the temperature increment used to adjust rainfall and runoff.
- Sensitivity testing with different SLR increments (e.g. 0.8 m, 1.4 m) is encouraged.
- With regards to the storm surge component: This could be equivalent to a specific AEP (Annual Exceedance Probability) such as a 10% AEP or 1% AEP event. Ideally, the co-occurrence (joint probability) between high river flows and storm tide should be assessed using joint probability analysis. However, this is complex and time-consuming, and in many practical applications, a representative or conservative single-value allowance (e.g. 0.4 m or another conservative value like a 10% AEP) is used as a pragmatic proxy. This value is typically sourced from regional coastal hazard assessments, MfE Coastal Hazards Guidance (2024) or local tide gauge records and storm tide modelling.

7.3 Sea level rise and coastal hazards

MfE has produced sea level rise (SLR) projections and guidance for coastal adaptation planning in New Zealand. Some of the key information from this guidance, as well as Waikato region-specific information, is provided in the following sections. More information is available in the guidance document here: Coastal hazards and climate change: Guidance for local government | Ministry for the Environment, 2024

WRC has developed the Coastal Inundation Tool to improve the accessibility of natural hazard information and assist with coastal adaptation planning. This tool can be used to assess which areas may be susceptible to coastal inundation, now and in the future with projected SLR.

7.3.1 Measured sea level rise

According to StatsNZ (2022), from 1900 up to 2018, the average rise in mean sea level in New Zealand waters has been 1.77 ±0.05 mm per year. Splitting this record into approximately two equal periods of 60 years shows a doubling in the rate of SLR around the New Zealand coastline since 1960, and this rate is continuing to accelerate (StatsNZ, 2022). *Sea level rose 0.21 metres on average across Aotearoa between 1901 and 2020 (StatsNZ, 2022) which explains why low-lying areas are already experiencing an increased incidence of coastal flooding (MfE, 2024a).*

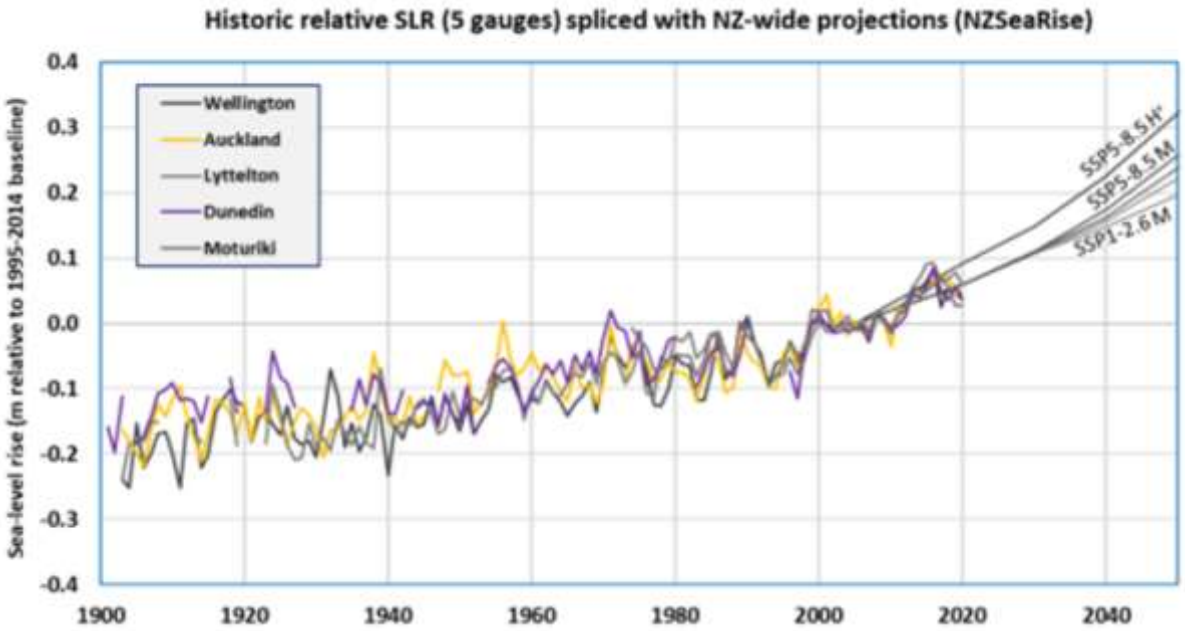


Figure 7 **Change in annual mean sea level for the four main ports and Moturiki between 1900 and 2020, spliced with a range of New Zealand averaged sea-level rise projections based on shared socio-economic pathway scenarios to 2050 (MfE, 2024a)**

WRC operates tide gauges at Tararu (Thames), Whitianga Wharf, Kawhia Wharf, Raglan Wharf and Manu Bay which enables tidal and storm surge statistics to be calculated. Analysis of these gauges indicate that sea levels have been rising around the region although the records are currently too short to provide any definitive patterns of regional variability (Stephens et al., 2015; Hunt, 2021).

A 2021 report into Optimisation of the Waikato Regional Council tide gauge network noted that monitoring long-term trends of sea-level rise will be difficult at Manu Bay and at any other location on the open west coast of the Waikato region due to the significant wave exposure. Monitoring long-term trends of sea level

rise on the west coast of the region is possible at the Raglan Wharf gauge despite its less optimal location in an estuary. The report recommended to install and maintain an open-coast tide gauge in a suitable location on the Coromandel east coast, which would be sufficient for characterising water levels including sea level rise along the open east coast - this has not yet been implemented. In general, tide gauges situated within estuaries and the Hauraki Gulf / Firth of Thames will have less relevance for the wider region due to location-specific modification of the tidal signal by the coastal morphology. However, the level of relevance to the wider region is site dependent and the gauges are locally relevant and important if situated in areas with specific hazard risk (Hunt, 2021).

7.3.2 Projected sea level rise

When considering future SLR, using projections across a range of scenarios avoids a pre-selected estimate of SLR (and associated impacts) being invalidated (as the rate and magnitude of future SLR is uncertain) (MfE, 2024a). Section 2.1 of MfE's 2024 guidance outlines how to assess sea level rise (SLR) when planning for the effects of climate change and includes information on the updated climate scenarios and sea level rise projections from IPCC AR6. It also outlines the difference between absolute and relative SLR (RSLR) which takes account of local vertical land movement (VLM) (section 7.3.2.3).

In 2021, the IPCC issued an updated set of global SLR projections, based on new scenarios called shared socio-economic pathways (SSPs) (Fox-Kemper et al, 2021 as cited by MfE, 2024a). The scenarios span a wide range of plausible societal and climatic futures, from a 1.5 degrees Celsius 'best-case' low-emissions scenario (SSP1-2.6) to over 4 degrees Celsius warming scenario (SSP5-8.5) by 2100 (Chen et al, 2021 as cited by MFE, 2024a). Even for the low-emissions scenario (SSP1-2.6), average SLR around Aotearoa could exceed 1 metre soon after 2200 (MfE, 2024a).

MfE (2024a) recommends using five representative SLR projections, derived from four SSPs and their associated local RSLR projections (by adding VLM), out to 2150 (Figure 8). These five projections cover a range of combinations of processes that contribute to SLR (e.g. glaciers, ocean heating, land water storage changes, ice sheets) across the four SSPs.

From the thousands of simulations carried out (representing different combinations of processes that contribute to SLR), each SSP scenario is represented by various percentiles of simulated SLR projection time series (MfE, 2024a). MfE (2024a) recommends using four estimates based on the median (M) value (50th percentile), which represents the middle of the likely range, for each SLR projection. An additional estimate based on the upper-bound of the likely range (the 83rd percentile) from the high-end emissions scenario SSP5-8.5 is also recommended (SSP5-8.5 H+) to represent a plausible upper range for SLR. SSP5-8.5 H+ reflects the deep uncertainties associated with changes to future sea level and should be used with the other median scenarios for completeness, particularly to stress-test dynamic adaptive pathways, policies and new greenfield and major infrastructure developments.

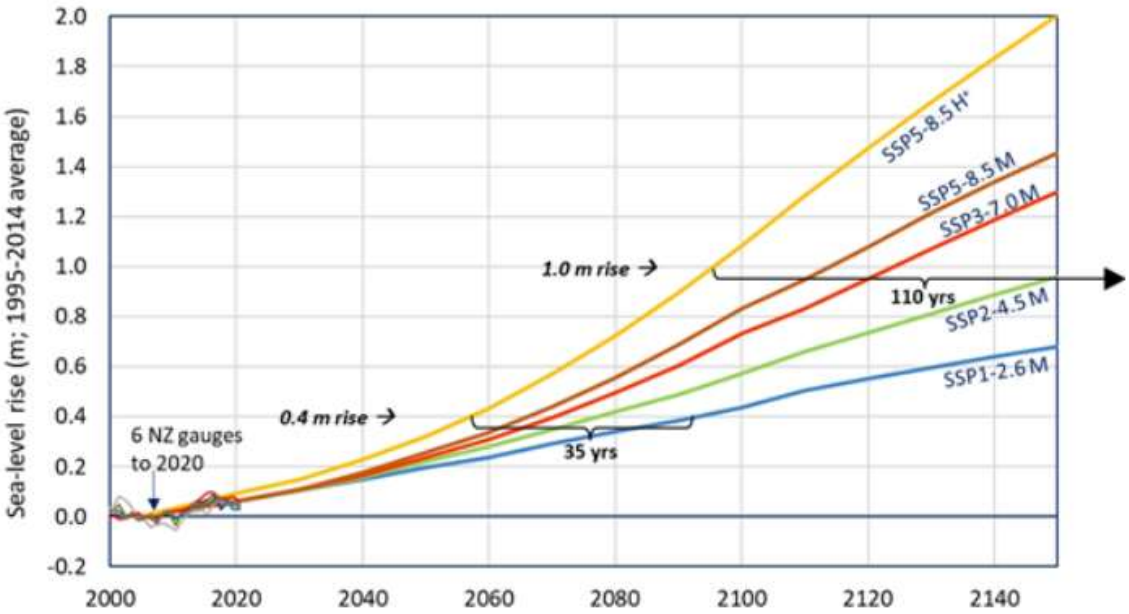


Figure 8 **Recommended SLR projections (excluding vertical land movement) based on SSPs (from a central location, broadly representative of SLR across Aotearoa New Zealand) (MfE, 2024a)**

The SSP scenarios and associated projections (in bold) align with the outdated 2017 MfE guidance (in italics) as follows (MfE, 2024a):

- **SSP1-2.6 M** ⇔ *NZ RCP2.6 M*
- **SSP2-4.5 M** ⇔ *NZ RCP4.5 M*
- **SSP3-7.0 M** ⇔ *n/a*
- **SSP5-8.5 M** ⇔ *NZ RCP8.5 M*
- **SSP5-8.5 H+** ⇔ *NZ RCP8.5 H+*

7.3.2.1 Using sea-level rise projections for coastal adaptation planning

The SLR projections in IPCC AR6 and in the NZ SeaRise platform have a new reference (zero) Baseline (MfE, 2024a). Projections are now referenced to the mean sea level from 1995–2014 (mid-point 2005).

It is best practice to use SLR projections for these main purposes (MfE, 2024a):

- as the primary input to hazard and risk assessments, along with projections for other climate drivers relevant to coastal areas (e.g. rainfall intensity, surface and water temperature, changes in storminess);
- for developing, evaluating and stress-testing district or regional plans and policies; and
- for informing and evaluating the viability, effectiveness and lock-in potential of adaptation options and pathways using the DAPP approach.

When using SLR projections, the two approaches for assessing coastal hazard and risk and informing a DAPP approach are (MfE, 2024a):

1) **Increments**: regular increments of SLR height (e.g. at 0.1 metre or 0.2 metre) with associated bracketed time windows when each height is reached, to cover the full range of the recommended projections out to 2150, or

2) **Projections:** the recommended SLR projections (or a subset covering the range) for the relevant planning timeframes from the NZ SeaRise platform that either:
    a) incorporate the satellite-derived VLM rate, or
    b) add a locally monitored VLM rate (if available) to the non-VLM projections.

Each of these approaches has advantages and disadvantages, depending on the purpose for which they are being used and can also be used in combination. **MfE and WRC generally recommend the increments approach over the projections approach (see below) for SLR.**

The NZ SeaRise platform provides all of the required SLR projection data (which can be downloaded) in an interactive map, where you can choose to add vertical land movement (VLM) (see below) or not for locations around New Zealand's coastline.

Section 2.1.4 of MfE's 2024 guidance recommends minimum SSPs and SLR projections (or increments approach) to be used for coastal hazard and risk assessments, which generally align with the National Adaptation Plan and Ministry for the Environment guidance on local climate risk assessment (MfE, 2021, 2022a) (Table 13).

Table 13 Recommended minimum shared SSPs for RSLR projections to use for screening and detailed phases of hazard and risk assessments (MfE, 2024a)

Assessment Phase	Recommended minimum SSP scenarios to use
Initial screening for coastal hazard or risk assessments	For a timeframe out to 2130 (≥100 years), at a minimum: For RSLR: use either the medium confidence SSP5-8.5 M or SSP5-8.5 H+ projections* that include the relevant VLM rate or preferably increments of RSLR heights, which would be needed later in detailed assessments (e.g. 0.1 metre or 0.2 metre covering the full range of RSLR up to SSP5-8.5 H+).
Detailed coastal hazard or risk assessments	For a timeframe out to 2130 (≥100 years), at a minimum: For RSLR: use both the medium confidence SSP2-4.5 M and SSP5-8.5 M RSLR projections that include the relevant VLM rate or preferably increments of RSLR heights (e.g. 0.1 metre or 0.2 metre covering the full range of RSLR up to SSP5-8.5 H+).

Notes:

- *H+ is the 83rd percentile (or p83 at the top of the shaded likely range in NZ SeaRise graphs).*
- *Relative sea-level rise projections are available from the NZ SeaRise platform.*
- *M = median or 50th percentile (or p50 at the middle of the shaded likely range in NZ SeaRise Platform graphs); RSLR = relative sea-level rise; SSP = shared socio-economic pathway; VLM = vertical land movement.*
- ***To achieve consistency with the Waikato Regional Policy Statement, a minimum of 0.8 m SLR (by 2090) should be assessed.***

However, section 2.1.3 of MfE's 2024 guidance also provides guidance on recommended SLR allowances to use for decision-making in the interim prior to the development of a detailed risk assessment and adaptive planning strategy (
Table 14). These interim precautionary SLR allowances are provided for four broad categories of development.

Table 14 Interim precautionary relative sea-level rise allowances recommended to use for coastal planning and policy before undertaking a dynamic adaptive pathways planning approach for a precinct, district or region (MfE, 2024a)

Planning category	Recommended interim precautionary RSLR allowances

A. Coastal subdivision, greenfield developments and major new infrastructure	Using a **timeframe** out to **2130** (≥100 years), apply the *medium confidence* **SSP5-8.5 H+** based RSLR projection* that includes the relevant VLM rate for the local and/or regional area. (Note: approximately 1.6 metre rise in MSL, before including VLM.)
B. Changes in land use and redevelopment (intensification and upzoning)	Using a **timeframe** out to **2130** (≥100 years), apply the *medium confidence* **SSP5-8.5 H+** based RSLR projection* that includes the relevant VLM rate for the local and/or regional area. (Note: approximately 1.6 metre rise in MSL, before including VLM.)
C. Land-use planning controls for existing coastal uses and assets (building additions)	Using a **timeframe** out to **2130** (≥100 years), apply the *medium confidence* **SSP5-8.5 M** based RSLR projection that includes the relevant VLM rate for the local and/or regional area. (Note: approximately 1.2 metre rise in MSL, before including VLM.)
D. Non-habitable, short-lived assets with a functional need to be at the coast, which are either low consequences or readily adaptable (including services)	Using a **timeframe** out to **2075** (≥50 years), apply the *medium confidence* **SSP5-8.5 M** based RSLR projection that includes the relevant VLM rate for the local and/or regional area. (Note: approximately 0.5 metre rise in MSL, before including VLM.)

Notes:

- *H+ is the 83rd percentile (or p83 at the top of the likely range on graphs in the NZ SeaRise platform).*
- *Relative sea-level rise (SLR) projections that include satellite-derived vertical land movement (VLM) are available from the NZ SeaRise platform. Alternatively, locally monitored VLM can be applied to the SLR projections.*
- *M = median or p50 (50th percentile); MSL = mean sea level; RSLR = relative sea-level rise; SSP = shared socioeconomic pathway used by the Intergovernmental Panel on Climate Change; VLM = vertical land movement.*
-
- *The approximate rise in MSL can be considered broadly representative across Aotearoa New Zealand, because the absolute SLR from north to south only varies by ± 0.025 metres by 2150 (relative to the central location)*

7.3.2.2 Increments for sea-level rise approach

SLR increments is a useful approach for hazard and risk assessment that informs decisions on adaptation thresholds for local planning purposes.

The increments approach involves using a series of regular SLR heights at either 0.1 metre or 0.2 metre increments. These increments can then be linked to the range of recommended SSP scenarios to estimate the time bracket (out to 2150) when any specific SLR height could be reached. Timeframes can be estimated with or without VLM, providing RSLR or SLR increments respectively, though there are some things to consider if using the NZ SeaRise platform or locally monitored VLM to do this.

Use of the increments approach for SLR hazard and risk mapping is particularly informative for engaging with communities and infrastructure providers to explore at what height of SLR, and where, coastal hazards (like flooding and erosion) become disruptive or intolerable. It is also useful for stress-testing the lifetime of adaptation options and pathways and means that hazard and risk modelling may not require updating if projections or VLM change (only the time brackets for when the increments are exceeded). The latter is key, given the resourcing required to produce hazard and risk modelling, and the frequency that projections are updated.

Table 15 shows the indicative timeframes (to the nearest five years) for reaching various absolute SLR heights, for a central location in Aotearoa, excluding vertical land movement. The left-hand column lists the earliest year when that SLR height could be reached (based on the SSP5-8.5 H+ projection) through to the latest year it could be exceeded (using a SSP1-2.6 M projection) at the right.

Table 15 Summary of approximate year when absolute sea-level rise (SLR) heights could be reached using the recommended projections for a central location in Aotearoa New Zealand (MfE, 2024a)

SLR (metres)	Year achieved for SSP5-8.5 H+ (83rd percentile)	Year achieved for SSP5-8.5 (median)	Year achieved for SSP3-7.0 (median)	Year achieved for SSP2-4.5 (median)	Year achieved for SSP1-2.6 (median)
0.2	2035	2040	2045	2045	2050
0.3	2050	2055	2060	2060	2070
0.4	2055	2065	2070	2080	2090
0.5	2065	2075	2080	2090	2110
0.6	2070	2080	2090	2100	2130
0.7	2080	2090	2100	2115	2150
0.8	2085	2100	2110	2130	2180
0.9	2090	2105	2115	2140	2200
1.0	2095	2115	2125	2155	>2200
1.2	2105	2130	2140	2185	>2200
1.4	2115	2145	2160	>2200	>2200
1.6	2130	2160	2175	>2200	>2200
1.8	2140	2180	2200	>2200	>2200
2.0	2150	2195	>2200	>2200	>2200

Notes: Approximate year (to the nearest five-year value) when each absolute sea-level rise (SLR) height could be reached from a central location from the NZ SeaRise platform, under the medium confidence SLR projections, relative to the 1995–2014 baseline (mid-point 2005). Excludes vertical land movement and the low confidence SLR projections. The table uses 0.1 metre SLR height increments up to 1 metre, thereafter 0.2 metre height increments.

Can be considered broadly representative across Aotearoa New Zealand, because the absolute SLR from north to south only varies by ± 0.025 metres by 2150 (relative to the central location).

7.3.2.3 Vertical land movement in the Waikato region

Two types of SLR are used for projections:

1. *absolute* (or eustatic) SLR, measured relative to the centre of the Earth, and related to the rise in ocean level; and
2. *relative* (or local) SLR (RSLR), which is the net rise in mean sea level (MSL) from both:
   i) the absolute rise in height of sea level; and
   ii) local vertical land movement (VLM).
   It is therefore the net rise in sea level relative to the local land surface or sea-bed elevation on which assets and people are placed.

Vertical land movement has a direct impact on local sea level along coastlines and describes how some areas of the coastline are going up (uplift) and some parts are sinking (subsiding). This can occur very suddenly during earthquakes, or more gradually due to things like tectonic plate movement or compaction of reclaimed land (e.g. parts of Thames) or peat land due to drainage (e.g. Hauraki Plains). Sections of New Zealand's coastal land that continue to subside will exacerbate the height and rate of SLR relative to the sinking land, even though the rise in absolute sea level is no different at the local level (Figure 9). Ongoing land subsidence will bring forward the timing of when a specific sea-level threshold is reached locally,

compared with stable or uplifting areas. Land that is uplifting locally or regionally will experience a slower rise in the height of sea level relative to the rising land (MFE, 2024).

Figure 9 The effect of downward VLM on local SLR (RSLR) (NZSeaRise, accessed 03/06/25)

The NZSeaRise platform allows you to explore projections of RSLR around New Zealand. The projections combine SLR projections (using the same method as for AR6) with VLM rates derived from interferometric synthetic aperture radar (InSAR) satellite measurements at a 2 km spacing around New Zealand's coast (large uplift or subsidence from major earthquakes is excluded). However, because of the uncertainty associated with the NZSeaRise VLM rates and that VLM can be highly variable within a 2 km radius (e.g. Thames coastal margin), MfE (2024a) recommends a multi-evidence approach for assessing RSLR. These should be used alongside a DAPP approach, which allows for adjusting pathways as new information emerges.

A multi-evidence approach for assessing RSLR may include:

- RSLR with satellite-derived VLM rates
- RSLR with locally monitored VLM rates (if available)
- SLR projections or increments without VLM
- local information and expert judgement
- experience and judgements of mana whenua and others with local knowledge.

VLM should be considered when assessing projected SLR (RSLR). For coastal developments this will need to be on a site-specific basis. Caution is advised when using current NZSeaRise projections due to the high spatial variation in VLM along parts of the Waikato coastline.

The 2021 Optimisation of the Waikato Regional Council tide gauge network report found that a gap in the WRC tide gauge network is the lack of monitoring of VLM (and incorporation of VLM into water level records). Currently WRC only measure VLM at the Tararu tide gauge on an annual or bi-annual basis. The report recommends that WRC should measure VLM at all gauges to help enable accurate measurements of sea level (and RSLR) to a known datum.

7.3.3 Other coastal hazards

Natural hazards for coastal areas in a changing climate can be related to either (MfE, 2024a):

- *a worsening of the impacts from coastal hazard events* (magnitude, changing frequency, persistence and compound or multiple contributors), or
- *a progressive change to the coastal environment* (e.g. high-tide flooding extending intertidal areas, groundwater rise and salinisation of land and freshwater) from ongoing SLR and other climate drivers.

Both need to be considered in coastal hazard assessments, rather than the conventional focus on coastal hazard events (MfE, 2024a). Section 2.2 out MfE's 2024 guidance discusses how to assess coastal hazards, including:

- Coastal inundation – incorporating changes in tides (phase and amplitude), storm surge, waves (including wave overtopping), storm intensity (winds) and ocean drivers (ocean currents), coastal flooding and groundwater rise
- Coastal erosion – beach and cliff erosion
- Compounding hazards (river + sea)
- Tsunami inundation

Generally, these coastal hazards and coastal hazard drivers are considered more complex to consider in coastal hazard assessments than projected SLR. For example, future coastal erosion will be a function of both SLR and other climate change effects (e.g. rainfall intensity, catchment runoff, waves, storm sequencing and sediment supply) that interact and feedback in complex ways. It is also considered, that by the end of the century, SLR will increasingly become the dominant contributor to coastal hazard events and to changes to the coastal environment. However, these hazards must still be assessed as part of a coastal hazard assessment (Policy 24 of the New Zealand Coastal Policy Statement).

Policy 24 of the NZ Coastal Policy Statement (NZCPS) (Department of Conservation, 2010) takes a risk-based approach to managing coastal hazards. It states:

Identify areas in the coastal environment that are potentially affected by coastal hazards (including tsunami), giving priority to the identification of areas at high risk of being affected. Hazard risks, over at least 100 years, are to be assessed having regard to:

a) physical drivers and processes that cause coastal change including sea level rise;
b) short-term and long-term natural dynamic fluctuations of erosion and accretion;
c) geomorphological character;
d) the potential for inundation of the coastal environment, taking into account potential sources, inundation pathways and overland extent;
e) cumulative effects of sea level rise, storm surge and wave height under storm conditions;
f) influences that humans have had or are having on the coast;
g) the extent and permanence of built development; and
h) the effects of climate change on:
    1. *matters (a) to (g) above;*
    2. *storm frequency, intensity and surges; and*
    3. *coastal sediment dynamics;*

taking into account national guidance and the best available information on the likely effects of climate change on the region or district.

Tsunami, although being a low probability event, has the potential to be high impact and therefore needs to be considered (Policy 13.3 of the RPS and Policy 224 of the NZCPS). SLR may increase the wave height and ability of tsunami waves to travel inland, therefore increasing the impact of any tsunami that occurs.

8 Monitoring and review of this guideline

Climate change science and adaptation policy are rapidly changing fields, so it is anticipated that guidance in this space will continue to evolve. In response, WRC will endeavour to keep this guideline 'live' and commit to reviewing it at least annually to ensure that the latest policy and scientific information is incorporated as quickly as possible.

We welcome your feedback!

Please email your feedback to info@waikatoregion.govt.nz and reference the Regional Resilience team or phone 0800 800 401 to be put in touch with a member of the team.

9 Glossary

This list is not exhaustive, further definitions can be found in the National Climate Change Risk Assessment glossary, MFE Climate glossary or the IPCC glossary.

Adaptation - WRC define adaptation in the Waikato Climate Position Statement 2023 - Adaptation means anticipating and proactively responding to climate change impacts that are already happening or are expected to happen, reducing exposure to physical climate risks and avoiding any future activities that increase the exposure to physical climate risks.

Adaptive capacity - The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC, 2014c as cited by MfE, 2021).

Cascading effects (of climate change) - Effects that flow on from a primary hazard to compound and affect other systems in a dynamic sequence (MfE, 2022).

Climate - The narrow definition is the average weather. More rigorously, the statistical description of the mean and variability of quantities over months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system (IPCC, 2014 as cited by MfE, 2022).

Climate change - A change in the state of the climate identified (e.g., through statistical tests) by changes or trends in the mean and/or the variability of its properties, and that persists for an extended period, typically decades to centuries. Includes natural internal climate processes or external climate forcings such as variations in solar cycles, volcanic eruptions and persistent anthropogenic changes in the atmosphere or in land use (IPCC, 2014 as cited by MfE, 2022)

Climate scenario - A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g. rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts but are used to provide a view of the implications of developments and actions. Climate-related scenarios are intended to provide an opportunity for entities to develop their internal capacity to better understand and prepare for the uncertain future impacts of climate change.

Climate projection - The simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases (GHGs) and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario, which is in turn based on assumptions about, for example, socio-economic and technological developments that may or may not be realised (IPCC, 2014 as cited by MfE, 2020).

Compound hazards and stressors - Cumulative hazards which will become more significant as adaptation thresholds are reached, e.g., for a coastal area, a persistent wet season (high groundwater, lower field capacity) is followed by a coastal storm on the back of sea-level rise coincident with intense rainfall, leading to compound flooding (MfE, 2019 as cited by MfE, 2022).

Exposure - The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected (IPCC, 2022).

Hazard - The potential occurrence of a 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 (IPCC, 2014 as cited by MfE, 2022). In this guideline, it usually refers not only to climate-related events (such as floods or heatwaves) but also evolving trends or their gradual physical impacts (IPCC, 2014 as cited by MfE, 2022).

Impacts (consequences, outcomes) - The consequences of realised risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather/climate events), exposure, and vulnerability. Impacts generally refer to effects on lives, livelihoods, health and well-being, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure. Impacts may be referred to as consequences or outcomes, and can be adverse or beneficial (IPCC, 2022).

Intergovernmental Panel on Climate Change (IPCC) - Intergovernmental Panel on Climate Change – a scientific and intergovernmental body under the auspices of the United Nations.

Mātauranga Māori - Mātauranga Māori or Māori knowledge has many definitions that cover belief systems, epistemologies, values, and knowledge both in a traditional and contemporary sense. Mātauranga Māori incorporates knowledge, comprehension and understanding of everything visible and invisible existing in the universe (MfE, 2019 as cited by MfE, 2022).

Mitigation - In the context of climate change, a human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Natural hazard risk – the probability or likelihood of specified negative consequence to life, well-being, property, economic activity, environmental or other specified values, due to a particular hazard or group of hazards. Three levels of risk are identified in the Waikato Regional Policy Statement:

- **Intolerable:** risk which cannot be justified, and risk reduction is essential e.g. residential housing being developed in a primary hazard zone;
- **Tolerable:** risk within a range that a community can live with so as to secure certain net benefits. It is a range of risk that is not regarded as negligible or as something to ignore, but rather as something to be kept under review and reduced if possible; and
- **Acceptable**: risk which is minor, and the cost of further reducing risk is largely disproportionate to the benefits gained e.g. residential housing being developed beyond coastal setbacks.

Probability – Chance or likelihood that an event will happen, or hazard magnitude be exceeded (MfE, 2017).

Radiative forcing - The change in energy flux in the atmosphere caused by natural or anthropogenic factors of climate change as measured by W/m^2. Incoming energy (from the sun) – outgoing energy = radiative forcing.

Representative concentration pathway (RCP) - Scenario of future radiative forcings from greenhouse gases (MfE, 2024a).

Residual risk - The risk that remains (and may continue to rise) in unmanaged form, after risk management and adaptation policies have been used to adapt to climate change and more frequent hazards, and for which emergency response and other actions must be maintained, or limits to adaptation addressed. Policy interventions and adaptation plans will need to reconcile changing residual risks with changing (evolving) societal perceptions of tolerable risk. (MfE, 2022)

Resilience - The capacity of social, economic and environmental systems to cope with a hazardous event, trend or disturbance by responding or reorganising in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation (IPCC, 2014 as cited by MfE, 2022).

Risk - The potential for consequences where something of value is at stake and where the outcome is uncertain, recognising the diversity of values. Risk is often represented as probability or likelihood of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. It also refers to the potential, when the outcome is uncertain, for adverse consequences on lives, livelihoods, health, ecosystems and species, economic, social and cultural assets, services (including environmental) and infrastructure. Risk results from the interaction of vulnerability, exposure and hazard. To address the evolving impacts of climate change, it can also be defined as the interplay between hazards, exposure and vulnerability (IPCC, 2014 as cited by MfE, 2022).

Risk assessment - The qualitative or quantitative process of identifying, analysing and evaluation risk, with several entry points for communication, engagement, monitoring, and review (ISO, 2018 as cited by MfE, 2021).

Scenario analysis - A process for systematically exploring the effects of a range of plausible future events under conditions of uncertainty. Engaging in this process helps an entity to identify its climate-related risks and opportunities and develop a better understanding of the resilience of its business model and strategy (MFE, 2024a).

Sensitivity - the degree to which a system is affected, either adversely or beneficially, by climate related stimuli. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g. damages caused by an increase in the frequency of coastal flooding due to SLR (IPCC, 2001).

Shared socio-economic pathway (SSP) - Global emissions scenarios developed by the IPCC, that include gross domestic product, population size, urbanisation, economic collaboration, and human and technological development (MfE, 2024a).

Uncertainty - A state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour (IPCC, 2014c as cited by MfE, 2021).

Vulnerability - The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm, and lack of capacity to cope and adapt (IPCC, 2014 as cited by MfE, 2022).
Assessing vulnerability is broader than conventional risk assessments; it includes indirect and intangible consequences on the four wellbeings, and adaptive capacity (e.g., communities, whānau, hapū and iwi may be resourceful but may lack the resources, insurance access and mandate or
capacity to adapt) (MfE, 2019 as cited by MfE, 2022).

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Appendix One: Climate change projections for territorial authorities in the Waikato region

The following tables show the projected changes to eight key climate variables compared to the 1995-2014 baseline period for each territorial authority in the Waikato region. Projections are provided for mid-century (2040-2060) and end-century (2080-2099) for three SSP scenarios.

For the SSP scenarios, the value presented is the change from the baseline period. The change is an increase, unless indicated with "-" for a decrease.

The values presented in the tables were extracted from the NIWA climate projections dataset (downloaded July 2025 by WRC).

Table 16 Climate change projections for Hamilton City

Hamilton City							
	Baseline	Mid-Century			End-Century		
		SSP 2-4.5	SSP 3-7.0	SSP 5-8.5	SSP 2-4.5	SSP 3-7.0	SSP 5-8.5
Avg Daily Air Temp (°C)	10.2	1.1	1.4	1.5	2	3	3.8
Number of Hot Days (>25°C)	38.4	29.0	36.9	37.8	51.1	77.4	96.6
Number of Frost Days (<0°C)	12.3	-5.0	-5.3	-6.4	-8.1	-10.4	-11.5
Total Rainfall (mm) (% change)	1164.3	-2.7	-3.1	-5.7	-3.8	-7.5	-6.9
Number of Very Rainy Days (>25mm)	7.8	0.6	0.5	0.6	0.7	0.7	0.9
Number of Dry Days (<1mm)	237.5	-0.3	-1.0	1.5	2.7	7.7	7.9
Number of Windy Days (>10m/s)	71.9	-6.09	-7.19	-8.81	-10.97	-16.85	-17.37
Drought exposure (PED, mm)	142.8	36.3	40.9	53.7	65.9	82.1	95.5

Table 17 Climate change projections for Hauraki District

Hauraki District							
	Baseline	Mid-Century			End-Century		
		SSP 2-4.5	SSP 3-7.0	SSP 5-8.5	SSP 2-4.5	SSP 3-7.0	SSP 5-8.5
Avg Daily Air Temp (°C)	9.5	1.1	1.4	1.5	2.0	3.0	3.9
Number of Hot Days (>25°C)	32.3	28.3	36.7	39.2	52.2	79.3	100.8
Number of Frost Days (<0°C)	10.0	-4.2	-5.2	-6.0	-7.3	-9.0	-9.7
Total Rainfall (mm) (% change)	1446.5	-1.3	-1.7	-5.1	-3.7	-7.5	-5.3
Number of Very Rainy Days (>25mm)	13.2	-0.2	0.0	-0.6	-0.3	-0.9	-0.2
Number of Dry Days (<1mm)	235.9	-1.1	-1.1	0.6	1.5	7.2	7.2
Number of Windy Days (>10m/s)	41.8	-4.1	-4.4	-5.6	-6.9	-10.6	-10.9
Drought exposure (PED, mm)	128.8	29.2	37.3	50.6	58.9	78.4	87.8

Table 18 Climate change projections for Matamata-Piako District

Matamata-Piako District Council							
	Baseline	Mid-Century			End-Century		
		SSP 2-4.5	SSP 3-7.0	SSP 5-8.5	SSP 2-4.5	SSP 3-7.0	SSP 5-8.5
Avg Daily Air Temp (°C)	9.7	1.1	1.4	1.5	2.0	3.0	3.9
Number of Hot Days (>25°C)	32.3	29.7	38.6	40.7	54.1	82.0	102.8
Number of Frost Days (<0°C)	9.8	-4.4	-5.3	-6.0	-7.2	-8.8	-9.4
Total Rainfall (mm) (% change)	1259.9	-0.5	-1.5	-3.8	-2.6	-6.5	-4.5
Number of Very Rainy Days (>25mm)	10.0	0.3	0.4	0.2	0.5	0.1	0.7
Number of Dry Days (<1mm)	242.5	-1.5	-2.1	-0.7	1.4	6.1	6.3
Number of Windy Days (>10m/s)	56.3	-5.1	-5.5	-7.0	-9.0	-13.5	-13.8
Drought exposure (PED, mm)	143.6	29.3	37.2	47.6	58.3	77.6	90.1

Table 19 Climate change projections for Ōtorohanga District

Ōtorohanga District Council							
	Baseline	Mid-Century			End-Century		
		SSP 2-4.5	SSP 3-7.0	SSP 5-8.5	SSP 2-4.5	SSP 3-7.0	SSP 5-8.5
Avg Daily Air Temp (°C)	9.7	1.1	1.4	1.5	2.0	3.0	3.9
Number of Hot Days (>25°C)	20.6	22.4	29.8	30.5	41.6	69.3	88.1
Number of Frost Days (<0°C)	19.8	-6.9	-7.9	-9.0	-11.6	-15.1	-17.4
Total Rainfall (mm) (% change)	1695.1	-1.9	-2.4	-5.3	-3.6	-7.3	-7.1
Number of Very Rainy Days (>25mm)	16.4	-0.1	0.0	-0.6	-0.1	-0.6	-0.7
Number of Dry Days (<1mm)	221.8	-0.4	-0.3	0.8	2.4	7.1	6.6
Number of Windy Days (>10m/s)	47.7	-3.6	-4.4	-5.5	-6.9	-10.6	-11.0
Drought exposure (PED, mm)	57.2	25.7	23.4	31.7	37.3	53.3	56.8

Table 20 Climate change projections for Rotorua Lakes District

Rotorua Lakes District Council							
	Baseline	Mid-Century			End-Century		
		SSP 2-4.5	SSP 3-7.0	SSP 5-8.5	SSP 2-4.5	SSP 3-7.0	SSP 5-8.5
Avg Daily Air Temp (°C)	9.6	1.2	1.4	1.6	2.1	3.2	4.0
Number of Hot Days (>25°C)	11.4	17.2	24.1	26.0	34.9	63.6	84.9
Number of Frost Days (<0°C)	28.9	-9.9	-11.4	-12.8	-17.0	-22.1	-25.5
Total Rainfall (mm) (% change)	1297.2	-1.9	-1.7	-4.0	-1.4	-5.8	-1.6
Number of Very Rainy Days (>25mm)	11.5	0.7	0.4	0.1	0.6	0.4	1.1
Number of Dry Days (<1mm)	241.5	1.0	1.4	2.0	3.5	9.2	9.4
Number of Windy Days (>10m/s)	1.2	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2
Drought exposure (PED, mm)	140.0	33.7	36.0	55.9	60.8	86.6	96.4

Table 21 Climate change projections for South Waikato District

South Waikato District Council							
	Baseline	Mid-Century			End-Century		
		SSP 2-4.5	SSP 3-7.0	SSP 5-8.5	SSP 2-4.5	SSP 3-7.0	SSP 5-8.5
Avg Daily Air Temp (°C)	9.5	1.2	1.4	1.5	2.0	3.1	4.0
Number of Hot Days (>25°C)	14.6	20.8	28.4	29.7	40.5	69.4	90.6
Number of Frost Days (<0°C)	19.6	-7.9	-9.1	-10.2	-13.0	-16.5	-18.1
Total Rainfall (mm) (% change)	1480.1	-0.6	-1.9	-3.7	-2.7	-6.3	-4.3
Number of Very Rainy Days (>25mm)	13.1	0.4	0.4	0.0	0.4	-0.1	0.4
Number of Dry Days (<1mm)	231.1	-0.5	-0.5	0.0	2.2	6.7	6.4
Number of Windy Days (>10m/s)	14.0	-1.4	-1.4	-1.8	-2.3	-3.3	-3.4
Drought exposure (PED, mm)	86.1	29.8	34.8	41.5	45.6	67.7	75.3

Table 22 Climate change projections for Taupo District

Taupo District Council							
	Baseline	Mid-Century			End-Century		
		SSP 2-4.5	SSP 3-7.0	SSP 5-8.5	SSP 2-4.5	SSP 3-7.0	SSP 5-8.5
Avg Daily Air Temp (°C)	9.7	1.2	1.4	1.5	2.0	3.1	4.0
Number of Hot Days (>25°C)	10.5	14.3	19.2	20.9	28.3	52.5	69.6
Number of Frost Days (<0°C)	44.9	-11.7	-13.8	-15.3	-20.9	-28.2	-33.9
Total Rainfall (mm) (% change)	1375.3	0.0	-1.5	-4.3	-2.3	-6.1	-3.8
Number of Very Rainy Days (>25mm)	11.7	0.7	0.6	0.2	0.5	0.3	0.9
Number of Dry Days (<1mm)	231.8	0.7	1.6	2.8	3.5	8.7	8.2
Number of Windy Days (>10m/s)	16.1	-0.8	-1.0	-1.4	-1.5	-2.4	-3.1
Drought exposure (PED, mm)	111.0	27.1	33.8	46.0	45.1	73.0	75.1

Table 23 Climate change projections for Thames-Coromandel District

Thames-Coromandel District Council							
	Baseline	Mid-Century			End-Century		
		SSP 2-4.5	SSP 3-7.0	SSP 5-8.5	SSP 2-4.5	SSP 3-7.0	SSP 5-8.5
Avg Daily Air Temp (°C)	8.5	1.1	1.3	1.5	1.9	2.9	3.8
Number of Hot Days (>25°C)	17.3	22.5	30.2	33.0	45.3	72.7	96.0
Number of Frost Days (<0°C)	6.0	-2.9	-3.7	-4.1	-4.7	-5.6	-5.9
Total Rainfall (mm) (% change)	2258.2	-1.9	-2.0	-6.0	-4.7	-7.9	-5.9
Number of Very Rainy Days (>25mm)	24.4	-1.2	-1.0	-2.2	-2.1	-3.5	-3.0
Number of Dry Days (<1mm)	223.9	-1.3	-1.9	-0.4	1.9	6.8	6.1
Number of Windy Days (>10m/s)	14.1	-1.8	-1.8	-2.2	-2.8	-4.1	-4.3
Drought exposure (PED, mm)	89.0	30.2	38.1	44.1	55.3	73.5	80.7

Table 24 Climate change projections for Waikato District Council

Waikato District Council							
	Baseline	Mid-Century			End-Century		
		SSP 2-4.5	SSP 3-7.0	SSP 5-8.5	SSP 2-4.5	SSP 3-7.0	SSP 5-8.5
Avg Daily Air Temp (°C)	9.1	1.1	1.3	1.4	1.9	2.9	3.8
Number of Hot Days (>25°C)	26.7	27.4	35.8	36.8	50.3	77.4	96.9
Number of Frost Days (<0°C)	6.6	-3.0	-3.5	-4.0	-4.6	-5.8	6.3
Total Rainfall (mm) (% change)	1280.9	-2.2	-2.5	-5.5	-3.8	-7.8	-8.1
Number of Very Rainy Days (>25mm)	9.1	0.4	0.5	0.1	0.5	0.4	0.5
Number of Dry Days (<1mm)	226.7	-0.4	-0.7	1.4	2.2	8.0	9.1
Number of Windy Days (>10m/s)	82.7	-7.0	-8.2	-9.8	-12.4	-19.7	-20.0
Drought exposure (PED, mm)	126.0	34.4	36.8	49.5	60.4	77.5	88.5

Table 25 Climate change projections for Waipa District

Waipa District Council							
	Baseline	Mid-Century			End-Century		
		SSP 2-4.5	SSP 3-7.0	SSP 5-8.5	SSP 2-4.5	SSP 3-7.0	SSP 5-8.5
Avg Daily Air Temp (°C)	10.2	1.1	1.4	1.5	2.0	3.0	3.9
Number of Hot Days (>25°C)	32.0	27.5	35.7	36.4	49.2	76.3	95.6
Number of Frost Days (<0°C)	16.5	-6.6	-7.3	-8.5	-10.7	-13.6	-15.1
Total Rainfall (mm) (% change)	1331.1	-1.9	-2.9	-5.5	-3.8	-7.5	-7.0
Number of Very Rainy Days (>25mm)	10.4	0.3	0.4	0.0	0.5	0.3	0.4
Number of Dry Days (<1mm)	233.2	-0.3	-0.7	0.9	2.4	7.3	7.3
Number of Windy Days (>10m/s)	80.5	-6.0	-7.4	-9.2	-11.4	-17.7	-18.1
Drought exposure (PED, mm)	103.5	32.5	36.4	46.3	55.5	70.4	84.1

Table 26 Climate change projections for Waitomo District

Waitomo District Council							
	Baseline	Mid-Century			End-Century		
		SSP 2-4.5	SSP 3-7.0	SSP 5-8.5	SSP 2-4.5	SSP 3-7.0	SSP 5-8.5
Avg Daily Air Temp (°C)	8.8	1.1	1.3	1.4	1.9	3.0	3.8
Number of Hot Days (>25°C)	12.7	19.4	26.7	26.7	37.3	66.4	84.7
Number of Frost Days (<0°C)	11.8	-4.9	-5.6	-6.2	-7.9	-9.7	-10.8
Total Rainfall (mm) (% change)	1940.1	-1.6	-1.9	-4.2	-4.0	-8.1	-7.4
Number of Very Rainy Days (>25mm)	19.9	0.0	0.0	-0.6	-0.7	-1.2	-1.2
Number of Dry Days (<1mm)	212.9	-0.6	-0.9	0.0	2.6	7.4	6.6
Number of Windy Days (>10m/s)	58.8	-3.9	-4.8	-6.4	-7.8	-11.9	-12.9
Drought exposure (PED, mm)	41.6	21.1	20.2	23.7	27.2	47.7	46.4

Appendix Two: Additional information on climate change risks for Māori

Impacts on the Māori economy

Studies by the Ministry for Primary Industries (MPI) shows that Māori groups (whānau, hapū, iwi, communities, business entities) have economic, social, and cultural systems strongly tied to the environment. Nearly half the Māori asset base is invested in climate-sensitive industries such as forestry, agriculture, fishing, and tourism. This heavy reliance means that much of the Māori business economy is directly exposed to climate hazards like drought, biosecurity risks, and severe weather. Climate-induced changes in growing conditions, water availability, and resource health can have immediate effects on productivity and income for Māori land trusts, incorporations, and businesses.

Many Māori entities also have a collective structure and long-term outlook, which means their investment decisions must balance intergenerational wellbeing, environmental stewardship, and commercial returns. Revenue generated from whenua Māori often supports marae, cultural revitalisation, and social initiatives—so disruptions caused by climate events can ripple through to social and cultural outcomes as well.

Broader social, economic, and cultural impacts on Māori communities are expected to be disproportionate, due to a higher proportion of remote, isolated, or marginal land, and often lower average household incomes. The vulnerability of Māori land assets is also heightened by historical land alienation, limited infrastructure, and greater exposure to weather extremes.

Key differences and complications for Māori in preparing for climate change include:

- Additional compliance required under legislation such as the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992, which can add complexity to management and reporting.
- Governance and management restrictions under Te Ture Whenua Māori Act 1993, which seeks to retain whenua Māori in collective ownership but may limit access to finance, reduce flexibility, and increase administrative burdens.
- Statutory restrictions imposed by the Māori Land Court can make it harder to sell, relocate, or leverage Māori land assets, slowing access to capital or investment needed for adaptation or diversification.
- A disproportionate amount of Māori land is remote, of lower productive value, or more exposed to flood, drought, and coastal hazards, increasing vulnerability and limiting options for risk reduction.
- Many Māori enterprises are smaller or have limited reserves, making them less able to absorb losses or invest in adaptation infrastructure compared to mainstream agribusiness or corporations.

These factors restrict the ability and speed with which Māori businesses and their communities can make strategic decisions to adapt to climate change. The need to balance collective aspirations, maintain cultural integrity, and work within legislative constraints requires careful, often innovative, approaches to adaptation and resilience.

Opportunities do exist. Māori are increasingly active in carbon forestry, eco-tourism, and sustainable resource management, and are drawing on mātauranga Māori to guide responses. However, ongoing

support for capacity building, access to tailored finance, better integration of mātauranga and technical advice, and enabling regulatory settings are required to unlock the full adaptation potential of Māori economic development.

More information on the impacts of climate change to Māori businesses and communities is available in the Manaaki Whenua Landcare Research report, "He huringa āhuarangi, he huringa ao: a changing climate, a changing world" (2021).

Impacts on Māori communities

Climate change is expected to amplify existing vulnerabilities in many Māori communities, with frequent and more intense weather events posing a serious threat to critical infrastructure and services. Flooding, storms, drought, and other climate extremes increase the likelihood of disruptions to lifeline services such as roads, bridges, electricity, and telecommunications. In remote and isolated areas—where many Māori communities and marae are located—these impacts can result in extended isolation, delayed emergency response, and greater economic hardship.

Coastal Māori communities, including those on river mouths and low-lying land, face particular challenges from sea-level rise, high tides, and coastal inundation. These changes accelerate erosion and threaten marae, papakāinga, urupā, wāhi tapu, and other cultural landmarks located near the coast or on riverbanks. The loss of intertidal food gathering areas and the disruption of customary fisheries diminish not only food security but also cultural and spiritual connections to place.

Freshwater access is another significant concern. Increased drought and shifting rainfall patterns put stress on water supply systems—many of which are small-scale, marae-based, or community-managed. This may reduce the reliability and quality of potable water for households and marae, affecting hauora and daily life.

Climate change can also compound existing social and economic inequities. Many Māori communities are already facing challenges such as limited access to high-quality infrastructure, fewer financial resources for recovery, and greater barriers to insurance and investment. Loss of income from land or water-based activities can impact the ability of whānau to support marae operations, maintain buildings, or pass on mātauranga Māori.

Barriers to adaptation persist. Māori communities may struggle to access technical information, expertise, and funding necessary for effective adaptation. The complexity of climate science, limited local data or inaccessibility of external support can create significant obstacles. Moreover, centralised decision making or one-size-fits-all adaptation programmes often overlook unique community needs and the value of mātauranga Māori.

Partnership is essential. Supporting Māori communities to build climate capability, participate fully in governance, and co-design adaptation strategies is critical. Collaborative approaches—grounded in mutual respect, resource sharing, and valuing both mātauranga Māori and scientific knowledge—will result in better and more enduring outcomes for Māori and the wider region.

The impact of climate change on Māori identity and wellbeing

Climate change has deep implications for Māori identity, community resilience, and the capacity to maintain cultural continuity. The Ministry for the Environment and Stats NZ report, "Our atmosphere and climate 2020" uses the Whare Tapawhā model to explain how Māori wellbeing is interconnected with te taiao (the environment), encompassing taha wairua (spiritual), taha hinengaro (mental and emotional), taha tinana (physical), and taha whānau (family and social wellbeing).

Figure 10 Whare Tapawhā model of Māori wellbeing (Stats NZ & Ministry for the Environment, 2020)

The report also highlighted that climate change has the potential to threaten traditional resource management practices connected to Māori identity and wellbeing. Climate change disrupts each of these pillars. Tohu (environmental signs)—essential for guiding the timing of planting, gathering, and hunting—are becoming less predictable, which challenges daily life and can erode confidence in mātauranga Māori. Flooding and erosion endanger marae, urupā, and other culturally significant places, undermining both physical gathering spaces and spiritual connections to place. Loss of taonga species affects not only diets but also the tikanga and ceremonial practices associated with them, weakening identity and the ability to maintain manaakitanga (hospitality) for visitors.

Reduced availability of kai, such as tuna, kūtai, and other customary foods, limits the ability of marae to uphold manaakitanga, eroding both practical and symbolic expressions of mana. As taonga species and cultural sites are lost or compromised, the transmission of mātauranga and tikanga to future generations is put at risk—threatening the resilience, continuity, and cultural integrity of hapū and iwi Māori.

Overall, climate change can be seen as a direct threat to the intergenerational transfer of knowledge, the exercise of rangatiratanga and kaitiakitanga, and the ongoing vitality of Māori identity and wellbeing. Protecting the links between people, place, and knowledge is vital for supporting Māori adaptation and resilience in a changing climate.

Climate hazards for Hapori Māori (Māori communities) – Te Puni Kōkiri

Under the National Adaptation Plan (NAP), Te Puni Kōkiri undertook a comprehensive assessment of the socio-economic and climate vulnerability facing Māori. Their report, Understanding Climate Hazards for Hapori Māori, highlights the disproportionate exposure of Māori communities to climate risks and the structural barriers that hinder effective adaptation.

The associated report – 'Understanding Climate Hazards for Hapori Māori' stresses the need for tailored and place-based policy interventions that address not only climate hazards, but also underlying social and economic vulnerabilities. It calls for an approach that upholds Māori rights and interests, supports tino rangatiratanga (self-determination), and actively integrates Māori principles into all stages of adaptation. Te Puni Kōkiri emphasises that meaningful engagement with hapori Māori, investment in local capability, and co-design of solutions are critical to building long-term resilience.

The report identifies a suite of analytical tools and frameworks—such as the Rauora Framework, Me Tū ā-Uru, and CEFA—that enable policy makers and practitioners to integrate mātauranga Māori and science, identify climate risks, and plan responses that suit local conditions. The Rauora Framework, for instance, provides a Māori worldview foundation for adaptation, prioritising balance, interconnectedness, and collective wellbeing.

Detailed spatial mapping within the report shows that Māori households face heightened exposure to a wide array of climate hazards—especially heatwaves, droughts, extreme hot days, prolonged wet spells, extreme rainfall events, and sea-level rise. The mapping also pinpoints regions and communities that are likely to require the most support, allowing agencies and councils to target adaptation funding and support where it is needed most.

Ultimately, Te Puni Kōkiri's findings reinforce the importance of recognising hāpori Māori as knowledge holders and partners in climate adaptation. Supporting Māori-led monitoring, building local climate literacy, and resourcing iwi and hapū to participate in planning and governance will help close equity gaps and strengthen collective resilience across the Waikato and Aotearoa.

Appendix Three: Additional resources for a te ao Māori approach to climate change adaptation

Rauora framework

The Rauora framework developed by Ihirangi for the National Iwi Chairs Forum, provides a Māori-centred set of values and principles to guide climate action. It emphasises the importance of balance, interconnectedness, and intergenerational equity. Rauora challenges standard adaptation approaches by requiring climate solutions to restore the mauri of people, place, and the wider taiao. The framework encourages local action that is responsive to both historic context and contemporary realities, supporting the exercise of mana, tino rangatiratanga, and mātauranga Māori. Rauora is already informing local and national policy, shaping how agencies partner with iwi and hapū to co-design adaptation responses that work for each community's unique whakapapa and future aspirations.

The Rauora framework *"provides an insightful introduction and concise explanation of an evolving and expansive indigenous lens, which centres Māori language and cultural concepts that acknowledge ancient narratives, historic colonial and contemporary contexts of Māori lives and Traditional Ecological Knowledge (TEK) systems. This framework outlines a set of cohesive cultural values and principles from which to approach climate action. It promotes transformative action as a means through which resilience can be strengthened. The principles of balance, interconnectedness, working together and inter-generational equity are outlined and complemented by a set of Māori values."*

Ngā Kōrero Āhuarangi me te Ōhanga: Climate Economic and Fiscal Assessment 2023 (CEFA)

Ngā Kōrero Āhuarangi me te Ōhanga: Climate Economic and Fiscal Assessment 2023 (CEFA)

This report is a national report that analyses the economic and fiscal implications of climate change for Aotearoa. It provides a robust, evidence-based framework for understanding how climate risks, costs, and opportunities affect different sectors, including Māori collectives and enterprises. CEFA highlights both direct and indirect costs for Māori, from asset exposure and insurance to infrastructure, health, and livelihoods. It also points to the need for investment in adaptation, new technologies, and capability building. CEFA's data and projections are informing central and local government policy, as well as iwi and hapū investment and planning decisions.

Me Tū ā-Uru Me Tū ā-Uru: for a flourishing and abundant environment 2023

Me Tū ā-Uru Me Tū ā-Uru: for a flourishing and abundant environment 2023

Me Tū ā-Uru is an action plan and research programme developed by the Biological Heritage National Science Challenge. It is designed to address interconnected crises such as climate change, biodiversity decline, and poverty, recognising that solutions must be holistic and locally driven. Me Tū ā-Uru is structured around the values of whanaungatanga (relationships), utu (balance and reciprocity), mātauranga (knowledge and worldviews), and mana and rangatiratanga (authority and leadership). The plan provides practical guidance for governance, community engagement, and policy, with specific focus on supporting Māori and hapū to design and implement adaptation and restoration initiatives in ways that protect te taiao and support wellbeing.

Deep South National Science Challenge - changing with our climate

The Deep South National Science Challenge supports the largest Māori-led research programme on climate change ever undertaken in Aotearoa. Its Vision Mātauranga projects are driven by iwi, hapū, whānau, and Māori business, exploring the implications of climate change for Māori society and wellbeing. Projects investigate a range of issues including coastal hazards, food security, resource management, adaptation strategies, and opportunities for leadership. This work supports both local and national policy, building the evidence base and showcasing practical examples of Māori-led innovation and resilience in climate adaptation.