Climate Change Scenarios

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Preface

What is the purpose and objectives of this guideline?

Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan underscores the imminent challenge of a projected 3.5°C (or more) temperature increase by 2110 under a high emissions scenario (RCP8.5). To align with this directive, all projects within Auckland Council must adhere to a statistical downscaled temperature projection of 3.8°C.

However, the Plan lacks specificity regarding the technical assumptions guiding its various components, resulting in inconsistencies in how different sectors within the council and CCOs approach their climate adaptation initiatives. This guideline seeks to address this by promoting a standardised implementation of Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan, ensuring a cohesive approach across the council group. It also furnishes projections, sourced from NIWA's climate projections for Auckland (Pearce et al., 2020), encompassing temperature, high-intensity rainfall, and sea-level rise.

This guideline serves as a foundational framework, facilitating the effective operationalisation of Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan. It establishes a critical link between the Plan and the Auckland Council's regulatory and asset owners' "control" tools, such as the family of documents including the Stormwater Code of Practice (SWCoP), Auckland Transport Code of Practice (ATCOP), Codes of Practice Water and Wastewater, etc. By providing a consistent set of technical assumptions and requirements, this document becomes an integral component integrated into the council's standards and codes of practice family, mandating uniformity and application of the technical requirements (referenced in this document) in practice.

The successful realisation of the Plan's core adaptation goal, aiming to "adapt to the impacts of climate change by ensuring we plan for the changes we face under our current emissions pathway," hinges on the adequate and consistent implementation of this guideline. It is essential for both the Auckland Council and Industry to adopt and adhere to this document.

It is noteworthy that this document primarily caters to professionals, designers, developers, and regulators, offering technical design guidance to support Auckland Council's asset ownership, infrastructure operations, and regulatory functions.

Future revisions

Auckland Council intends to provide future revisions to this guideline periodically in response to changes in good practice, legislation, policies, technologies, national standards, and feedback from industry.

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1.0 Introduction

1.1 Why do we need to use consistent climate change projections across Auckland Council?

Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan states that we will plan for our current emissions pathway, which will result in an average warming of '3.5 degrees or more by 2110'. Further information on specific technical assumptions is not provided in the Plan. As a result, different parts of the council group, in progressing their climate adaptation work, may have already adopted their own assumptions.

NIWA produced climate change projections for the Auckland region in 2020 (Pearce et al. (2020)). This report contains maps and tabular data, and the spatial datasets are available on Geomaps.

This guideline gives projections to be used across the Auckland Council group for temperature, high intensity rainfall and sea-level rise.

1.2 What are climate scenarios?

Scenario-based climate projections (including sea-level rise) for the IPCC Fifth Assessment Report (AR5) (2013) were based on four representative climate futures, known as representative concentration pathways (RCPs). These futures were represented by a radiative forcing of warming that could be reached in 2100, ranging from 2.6, 4.5, 6.0 to 8.5 Watts/m^2 of additional climate forcing[1] since the pre-industrial era. More information about RCPs can be found in Pearce et al. (2020). The baseline for the downscaled AR5 projections for New Zealand is 1995 (average over 1986-2005).

IPCC's Sixth Assessment Report (AR6) shifted to a new integrated set of future representative scenarios, based on shared socio-economic pathways (SSPs), comprising socio-economic assumptions and changes that influence future emissions trajectories. These scenarios, which complement the RCPs, span a wide range of plausible societal and climate futures from a 1.5°C best-estimate warming to over 4°C warming by 2100. More information about SSPs can be found here.

NIWA climate projections for Auckland (Pearce et al., 2020) use the RCP scenarios, whereas the NZ SeaRise sea-level rise projections (released in 2022) use the SSP scenarios. Updated NIWA projections, to be released in 2024, will use the SSP scenarios. This guideline will be updated following the release of the downscaled AR6 projections for New Zealand.

[1] Radiative or climate forcing is the increase in the difference between incoming (downward) and outgoing (upward) energy (in Watts per square metre) for the Earth's atmosphere, due to a change in an external driver of climate change, such as a change in the concentration of carbon dioxide, volcanic aerosols or albedo (land surface reflectance).

Local government must have regard to the National Adaptation Plan (Ministry for the Environment, 2022a) when making or changing regional policy statements, regional plans, or district plans. The National Adaptation Plan recommends:

- Using the best available data for the middle-of-the-road scenario (SSP2-4.5 or RCP4.5) and the fossil-fuel intensive development scenario (SSP5-8.5 or RCP8.5)
- Screening hazard and risk assessments for longer-term coastal impacts up to 2130 (SSP5-8.5 or RCP8.5)

The National Adaptation Plan recommends local governments should use these climate change scenarios at a minimum. However, where possible, local governments are encouraged to use the full range of relevant scenarios. Ministry for the Environment (2022c) provides guidance around the use of climate scenarios under the Resource Management Act.

The following scenarios are described in the National Adaptation Plan guidance note (Ministry for the Environment, 2022b).

1.2.1 Middle-of-the-road scenario

This scenario (SSP2-4.5 or RCP4.5) reflects moderate emissions and implementation of current global emissions reduction policy settings. It represents limiting the rise in global air temperature to 2.7°C by 2100.

By 2100, Aotearoa could see air temperature increase by an average of 1.6°C (or a range of 1.03-2.26°C), and sea-level rise by an average 0.57 metres (or a range of 0.44-0.78 m), before any vertical land movement is included.

1.2.2 Fossil-fuel intensive scenario

This scenario (SSP5-8.5 or RCP8.5) broadly aligns with emissions-reduction practice over the past few decades. It reflects high emissions, limited mitigation measures and no global emissions reduction policy settings. This scenario represents a rise in global air temperature to 4.4°C by 2100.

By 2100, Aotearoa could see air temperature increase by an average of 3.1°C (or a range of 2.20-4.05°C), and sea-level rise by an average 0.83 m (or a range of 0.67-1.09 m), before any vertical land movement is included.

2.0 Climate change and sea-level rise projections for Auckland

2.1 Temperature

Pearce et al. (2020) provide downscaled temperature projections for Auckland using both statistical and dynamical downscaling methods (Tables 3-1 and 3-2 in Pearce et al., 2020).

Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan states that Auckland faces a future of 3.5°C (or more) of warming under a high emissions pathway (RCP8.5) by 2110. This value is the average of the regionally averaged statistical and dynamical downscaled projections provided in Pearce et al. (2020) (3.8°C (statistical) and 3.3°C (dynamical)). To follow the direction set by Te Tāruke-ā-Tāwhiri, projects should use a temperature value of at least 3.5°C. Therefore, the statistical downscaled projection value of 3.8°C should be used.

For more detail on temperature projections for other scenarios and time periods, refer to the statistical downscaled projections in Table 3-1 in Pearce et al. (2020).

2.2 Rainfall

2.2.1 Average rainfall

As rainfall is highly spatially variable across the Auckland region (Figure 1), a regional rainfall average should not be used for planning purposes. Rainfall projections with climate change are available as maps in Pearce et al. (2020) or GIS layers on Geomaps.

2.2.2 High intensity rainfall

Technical publication 108 (TP108, Auckland Regional Council, 1999) describes how to calculate local-scale 24-hour rainfall depths and intensities under the present climate. For future climate scenarios, both an adjusted dimensionless profile and adjusted 24-hour depths should be used. The adjusted dimensionless profile as well as adjustment factors for specified temperature increases are provided in the Stormwater Code of Practice (Auckland Council). Rainfall adjustment factors are based on projected change in Auckland's mean annual temperature (as outlined in Section 2.1 above) as well as the 24-hour augmentation factors in Table 4-3 of Pearce et al. (2020) and replicated below in Table 1.

Table 1: Percentage change factors per degree of warming to project rainfall depths based on the current climate to a future climate scenario. These numbers represent the best estimate based on currently available information. From Pearce et al.

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

2.3 Sea-level rise

Ministry for the Environment (2022b) updated the recommended sea-level rise projections from the previous set of projections recommended by Ministry for the Environment (2017) (the coastal hazards guidance manual)[2]. These new projections were published by the NZSeaRise project in 2022 at 2 km intervals around New Zealand's coastline using the SSP scenarios.

Table 2 provides projections of absolute sea-level rise for the Auckland region. The baseline for these projections is 1995-2014 (2005), compared with the 1995 baseline for the atmospheric projections. The reason for this is that the sea-level rise projections use the IPCC AR6 whereas the currently available atmospheric projections use the IPCC AR5 (as stated above, NIWA will release AR6 atmospheric projections in 2024). Table 2 presents the medium confidence projections from NZSeaRise which go out to 2150. Low confidence projections out to 2300 are available on the NZSeaRise website.

[2] Ministry for the Environment has updated the 2017 coastal hazards guidance manual, which is due to be released in early 2024. This forthcoming publication will supersede the interim guidance (MfE, 2022b).

Table 2. Auckland region sea-level rise projections. 50th percentile for SSPs except H+ (83rd percentile). Medium confidence projections from NZSeaRise. Projections excluding VLM.

	SSP2-4.5	SSP3-7.0	SSP5-8.5	SSP5-8.5 H+
2005	0	0	0	0
2030	0.11	0.11	0.11	0.15
2040	0.16	0.16	0.18	0.23
2050	0.22	0.24	0.26	0.33
2060	0.28	0.31	0.34	0.44
2070	0.35	0.4	0.44	0.58
2080	0.42	0.5	0.56	0.74
2090	0.5	0.61	0.69	0.91
2100	0.58	0.74	0.84	1.11
2110	0.67	0.84	0.95	1.31
2120	0.74	0.96	1.09	1.5
2130	0.82	1.08	1.22	1.69

The projections published on NZSeaRise include vertical land movement (VLM). VLM is an important consideration when planning future coastal activities as subsiding land increases the rate of relative sea-level rise, whereas land undergoing uplift may experience slower rates of relative sea-level rise. The rates of VLM vary within Auckland region, as shown in Figure 1. However, most of the region is undergoing subsidence (blue shades). Figure 2 shows the difference between the projections for absolute sea-level rise and projections including VLM.

For work undertaken at a local scale (e.g. beach scale), sea-level rise projections including VLM should be used, which can be accessed from the NZSeaRise website. Consideration should also be given to the error margin and quality of this data in defining the rate of VLM in the area.

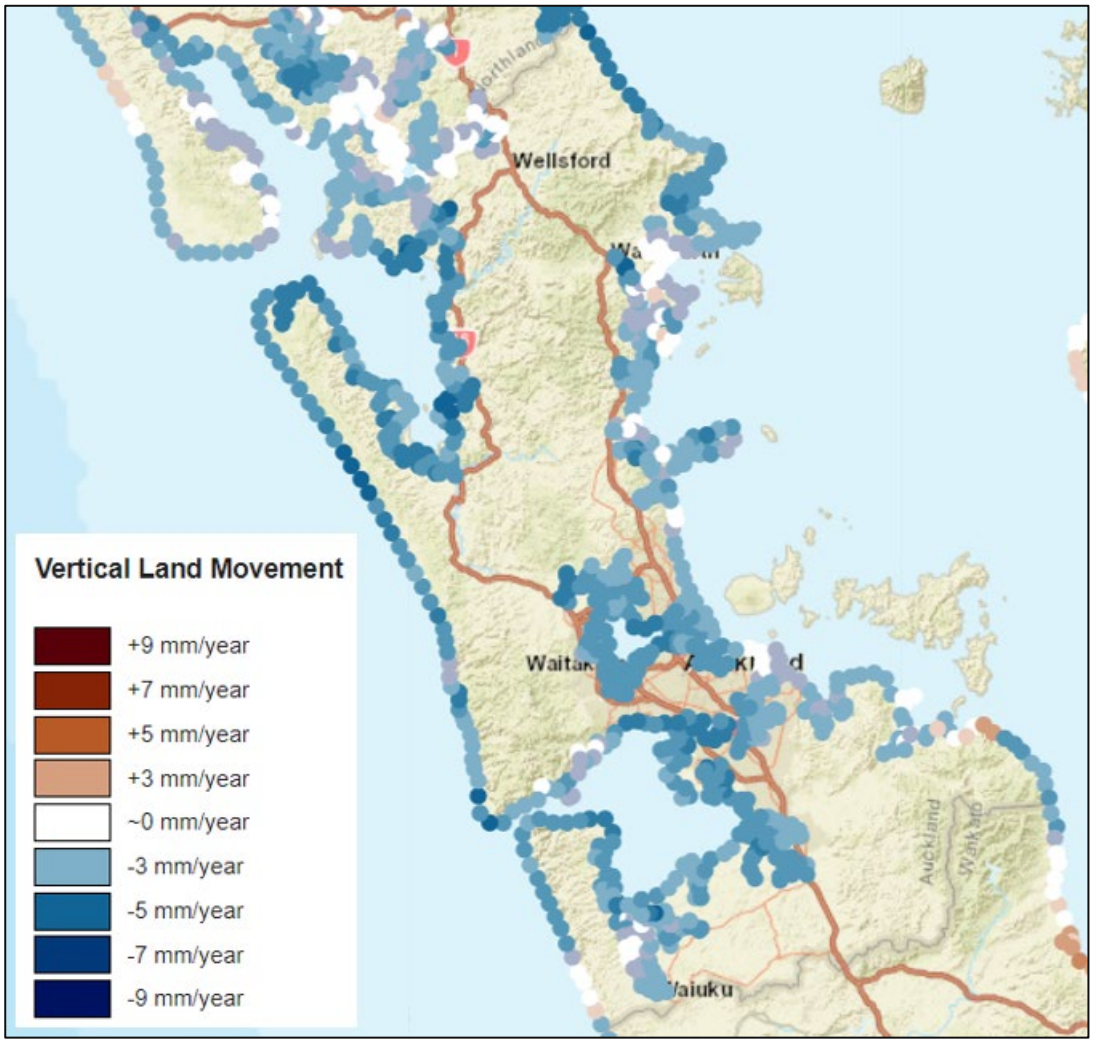

Figure 1:Vertical Land Movement rates across Auckland. For location-specific VLM rates refer to NZSeaRise online tool. Source: NZSeaRise (www.searise.nz)

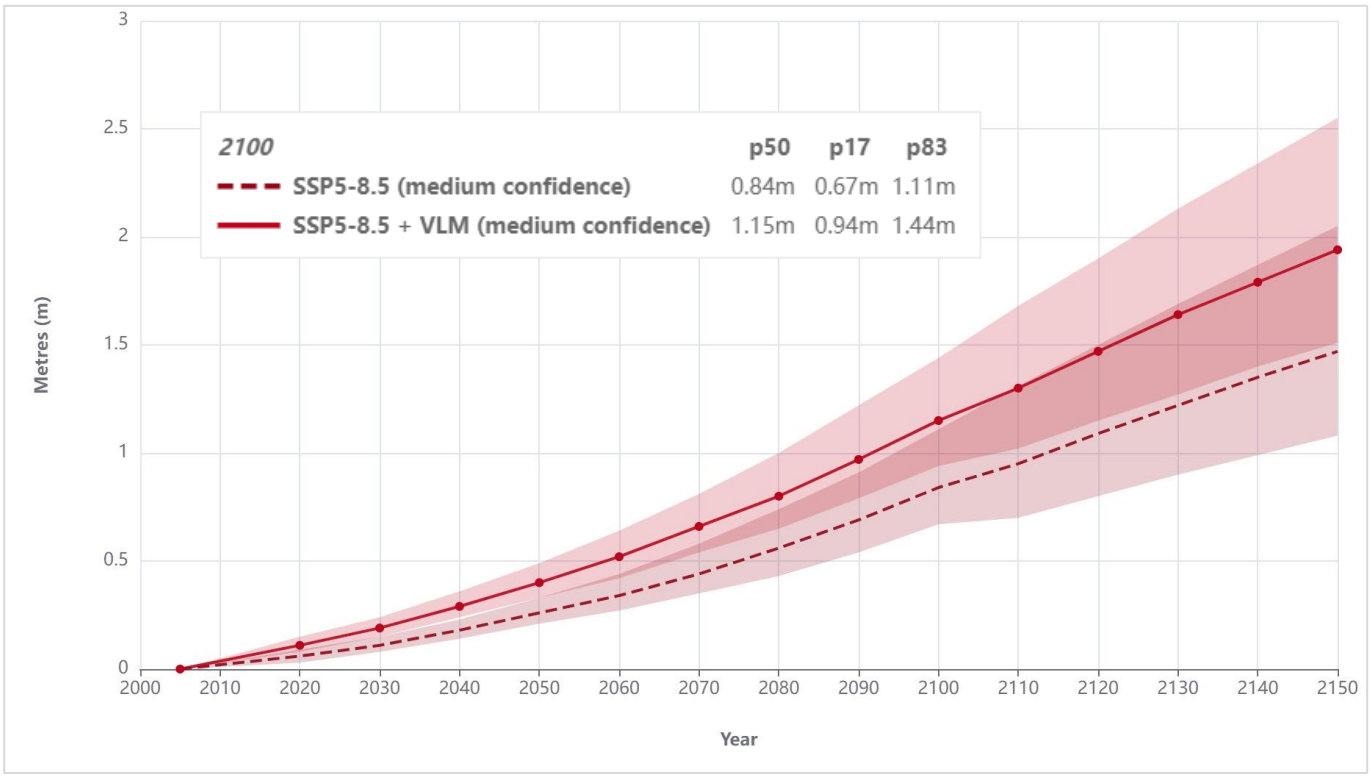

Figure 2: Example from NZSeaRise showing SSP5-8.5 projections for a central Auckland location.

The dashed line and associated shaded area are for absolute sea-level rise projections, and the solid line and associated area are for sea-level rise projections including vertical land movement. The dashed/solid red line is the 50th percentile (p50), the top of the shaded area is the 83rd percentile (p83, or SSP5-8.5 H), and the bottom of the shaded area is the 17th percentile (p17). The inset legend shows projections for 2100.

3.0 Next steps

This first version of Auckland Council's climate scenarios guideline gives projections and scenarios to be used across the council group for temperature, high intensity rainfall and sea-level rise. In 2024, this guideline will be updated to include information on which scenarios to use for different activity and development types in Auckland. In the interim, for coastal activities, the guidance published by Ministry for the Environment (2022b) can be used (Table 3 in Ministry for the Environment, 2022b).

4.0 References

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