greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

NIWA
Taihoro Nukurangi

Report Summary

Wellington Region climate change projections and impacts

Climate change report for Wellington Region

A climate change report[1] was produced by NIWA in 2017 for the Wellington Region, including high resolution projection maps of climate variables and commentary on impacts of climate change for the region.

Impacts of climate change for Wellington Region

- Autumn is likely to warm the most out of all seasons
- Annual temperature increases of up to 1°C by 2040 and up to 3°C by 2090
- Reduction in spring rainfall of up to 15% for eastern areas by 2090
- Increased risk of drought in Wairarapa
- Some areas may experience 70 more hot days (>25°C) per year by 2090

Implications of climate change for Wellington Region

- Warmer temperatures may allow different crops to be grown
- More droughts may limit pasture production and crop growth
- Sea level rise may impact coastal communities and infrastructure
- Changes to river flow and rainfall may have an impact on native biodiversity
- Current water supplies may be under pressure if there is no additional storage

Wellington and Wairarapa climate change overview

The Wellington Region is likely to warm significantly into the future. Rainfall may decrease in the east with a higher risk of drought, and increase in the west.

- Annual hot days (>25°C) may increase from 24 days now to 94 days by 2090 for Wairarapa, and from 6 days now to 26 days by 2090 for the west of the region.
- Frosts may decline from over 30 frosts per year in the high elevations of the Tararua Ranges to near zero frosts per year by 2090.
- Rainfall declines in the east by about 10% in spring, summer and autumn, and increases in the west in all seasons and by up to 15% in winter.
- Rare, large extreme rainfall events are likely to increase in intensity due to more moisture being held in a warmer atmosphere, but the future impact of ex-tropical cyclones is uncertain.
- Increase in drought risk is highest for inland Wairarapa.

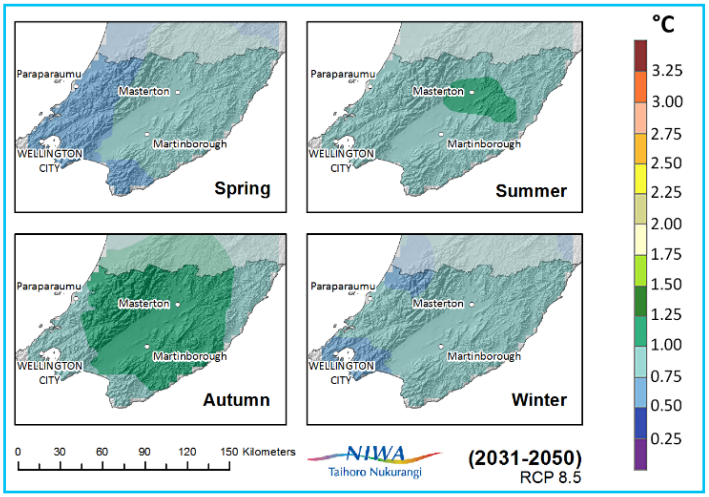
Global and New Zealand climate change

- The climate system is warming and most of the recent temperature increases are due to human greenhouse gas emissions[2].
- New Zealand has warmed by about 1°C since 1909, with more heat waves, fewer frosts, more rain in the south and west of New Zealand, less rain in the north and east of the North and South Islands, and a rise in sea level since 1900 of about 1.7 mm/yr [3].
- Wellington has experienced ~2.2 mm/yr of sea-level rise since the 1900s.
- Global sea-level rise will approx. be between 0.28 and 0.98m by 2100, compared with 1986-2005 average. This could possibly be significantly greater depending on the future behaviour of Antarctic ice sheets[2].
- Amplification of extreme events are likely (e.g. ex-tropical cyclones, drought, floods) with consequent economic losses.
- The Intergovernmental Panel on Climate Change (IPCC) produces global climate change reports. Climate model data from the Fifth Assessment Report, published in 2013, was used here[2]. The Sixth Assessment Report is due to be published in 2022.
- The IPCC uses scenarios (Representative Concentration Pathways, or RCPs) to provide climate change projections which cover different socio-political and environmental futures.
- RCP 2.6 is the 'carbon neutral' scenario. RCP 4.5 and 6.0 are mid-range scenarios, and RCP 8.5 is the 'business as usual' scenario.

Air temperature changes

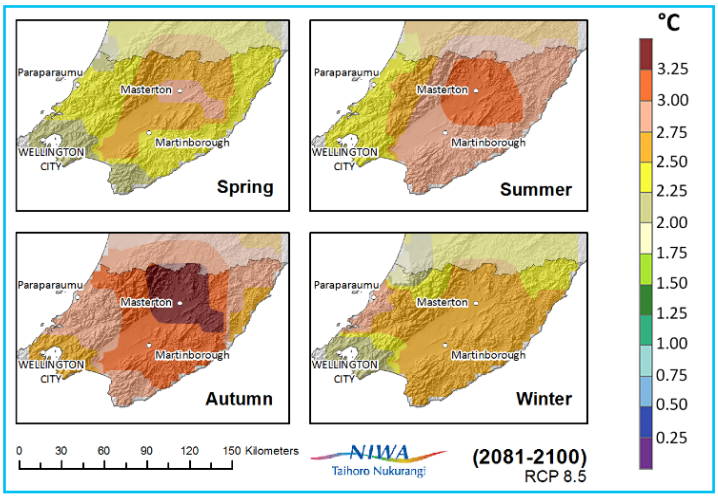
The maps below show the projected mean seasonal temperature for 2040 and 2090 for Wellington, compared to the seasonal average for 1995 for RCP 8.5, the 'business as usual' climate change scenario. All projections are based on a 20-year average, so 2040 is the average over 2031-2050 and 2090 is the average over for 2081-2100. The baseline period is the average over 1986-2005 (1995 for short).

2040



By 2040, Wellington is projected to warm by up to 1°C in all seasons except autumn, where over 1°C of warming is projected for most areas.

2090



By 2090, at least 2°C of warming is projected everywhere in all seasons, with up to 3.5C of warming projected around Masterton in autumn.

Ranges of uncertainty in temperature projections

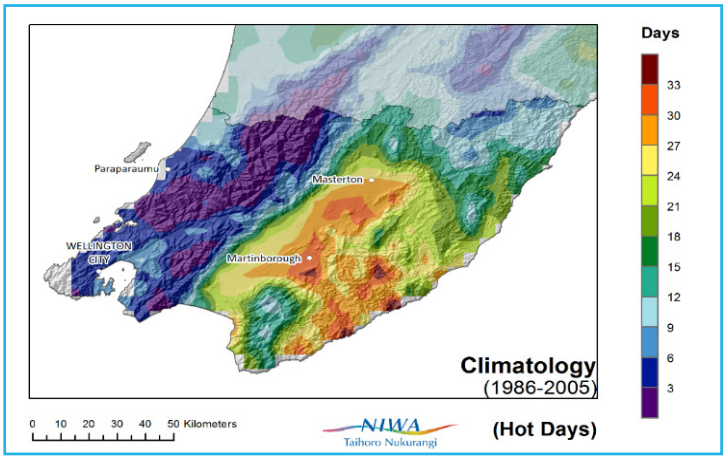
The table below shows projected changes in seasonal and annual mean temperature for the Wellington Region for 2040 and 2090, for two climate change scenarios – the 'business as usual' scenario (RCP 8.5) and a mid-range scenario (RCP 4.5). Changes are relative to 1995, and are based on dynamical downscaling of six regional climate models.

The number outside the brackets is the average of all climate models used to calculate the projections, and the bracketed numbers give the range (minimum and maximum) of all model results.

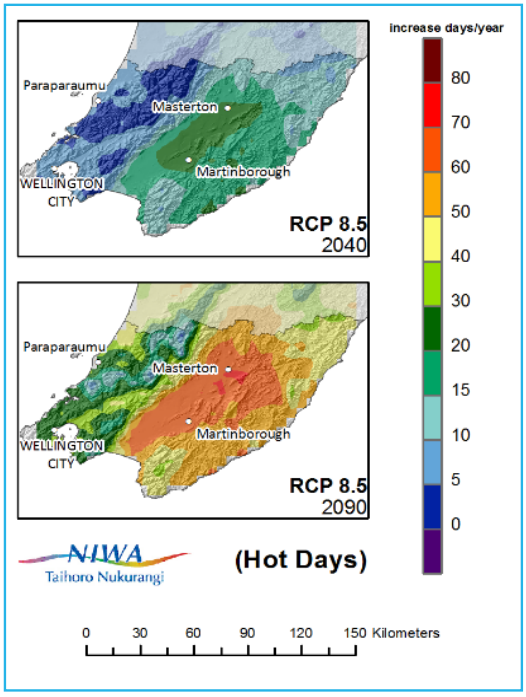
There is a range of uncertainty in the model results for each projection. For example, the average summer temperature under RCP 8.5 is likely to increase by 0.9°C by 2040, but the model estimates of summer temperatures range from 0.5°C to 1.3°C.

Change in temperature °C	Climate change scenario	Summer	Autumn	Winter	Spring	Annual
2040	RCP 8.5	**0.9** (0.5, 1.3)	**1.0** (0.8, 1.4)	**0.8** (0.6, 1.1)	**0.8** (0.5, 1.1)	**0.9** (0.6, 1.2)
	RCP 4.5	**0.8** (0.3, 1.1)	**0.9** (0.5, 1.2)	**0.7** (0.5, 0.9)	**0.7** (0.4, 0.9)	**0.8** (0.5, 1.0)
2090	RCP 8.5	**2.8** (1.9, 3.5)	**3.0** (2.2, 3.8)	**2.5** (1.9, 3.0)	**2.4** (1.9, 2.9)	**2.7** (2.0, 3.2)
	RCP 4.5	**1.3** (0.6, 2.0)	**1.4** (0.9, 1.9)	**1.1** (0.8, 1.6)	**1.2** (0.7, 1.6)	**1.2** (0.7, 1.7)

Current number of hot days



Changes to hot days



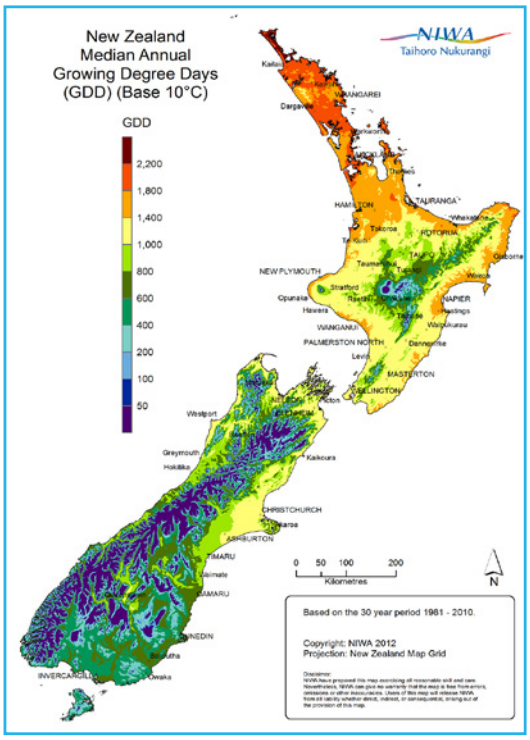
The map on the top shows the annual average number of hot days for the historical period (1986-2005). The maps on the bottom show the projected increases in annual 'hot days' (max temp >25°C) for 2040 and 2090, compared to the historical period, for the 'business as usual' RCP 8.5 scenario.

Currently, most of Wairarapa observes more than 24 hot days per year and the western Wellington Region experiences less than 6 hot days per year.

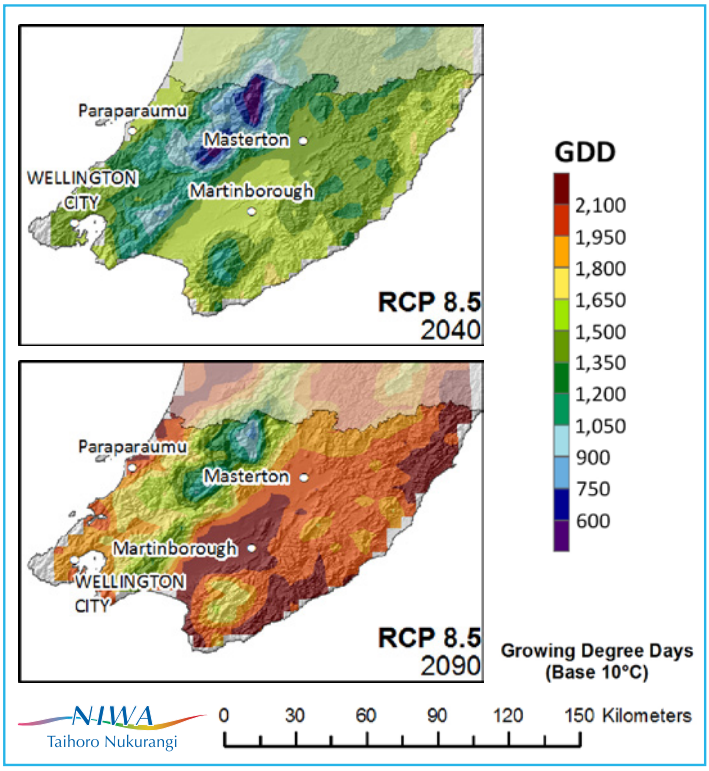
By 2040, 10-20 more hot days per year are expected for most of Wellington Region for the 'business as usual' RCP 8.5 scenario, but up to 30 more hot days are projected for inland Wairarapa.

By 2090, up to 70 more hot days are projected for most of Wairarapa and over 20 more hot days in the west.

Current number of growing degree days (base 10°C)



Future number of growing degree days



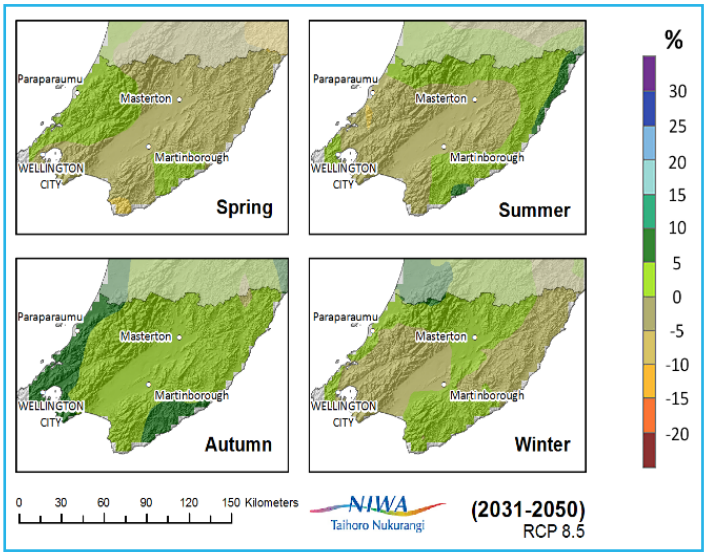
The map above shows the annual number of growing degree days (base 10°C) for 1981-2010. The maps on the bottom show the projected number of GDD (base 10°C) for 2040 and 2090, compared to the annual average for 1981-2010, for the 'business as usual' RCP 8.5 scenario.

Growing degree days is a measure of the growth of a plant and can be used to determine harvesting timing. The number of growing degree days is projected to increase throughout the region in the coming century, particularly in Wairarapa, which is projected to look similar to Northland of the present by the end of the 21st century.

Rainfall changes

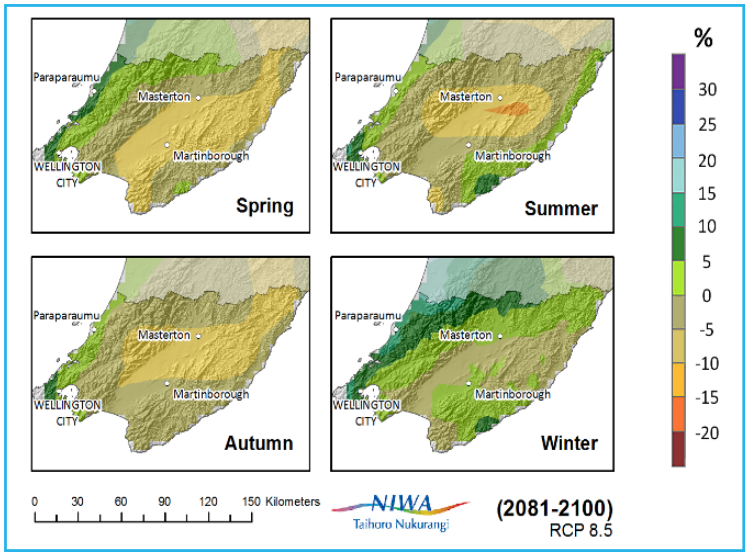
The maps below show the projected seasonal rainfall change for 2040 and 2090, compared to the seasonal average for 1995, for RCP 8.5, the 'business as usual' climate change scenario.

2040



By 2040, spring rainfall for the eastern Wellington Region is projected to decrease by 5%. Increases in rainfall of up to 10% are projected for the east coast in summer and the west and east coasts in autumn.

2090



By 2090, there is a drying signal across the east and a wetting signal in the west. Much of Wairarapa expects up to 10% less rainfall in spring, summer and autumn. Western rainfall increases in all seasons, and in winter, rainfall is expected to increase by up to 15% on the west coast.

Ranges of uncertainty in rainfall projections

The table below shows projected changes in seasonal and annual rainfall (in %) for Paraparaumu and Masterton for 2040 and 2090, for two climate change scenarios – the 'business as usual' scenario (RCP 8.5) and a mid-range scenario (RCP 4.5). Changes are relative to 1995 and are based on dynamical downscaling of six regional climate models. The number outside the brackets is the average of all climate models used to calculate the projections, and the bracketed numbers give the range (minimum and maximum) of all model results. Rainfall projections have large uncertainties. For example, average summer rainfall at Masterton under RCP 8.5 is likely to decrease by 10% by 2090, but estimates range from -19% to +5%.

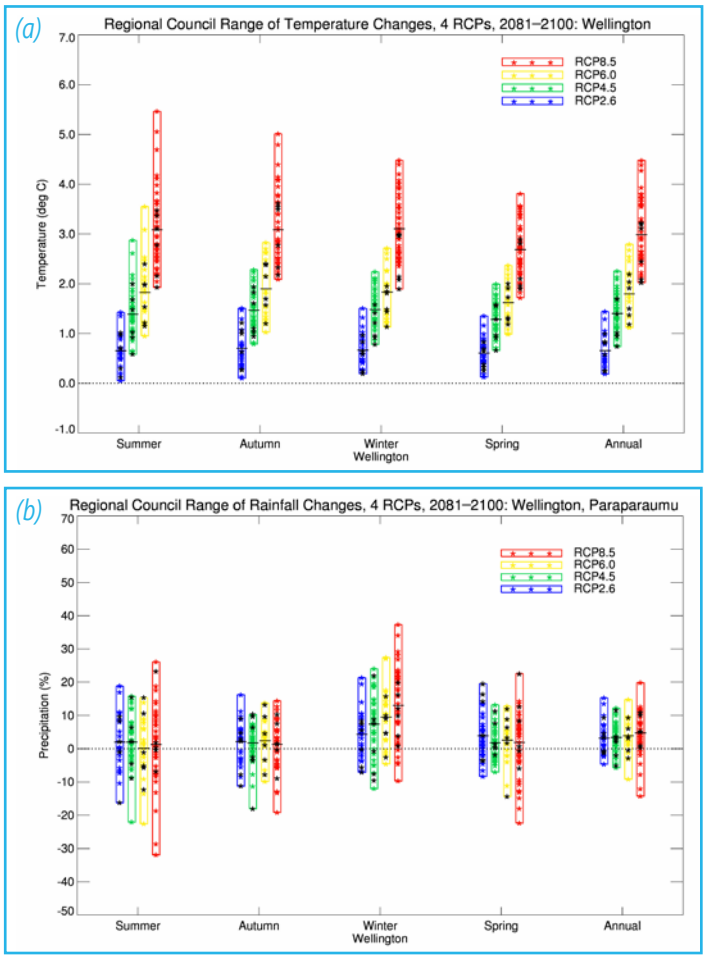
Change in rainfall (%)	Climate change scenario	Summer	Autumn	Winter	Spring	Annual
Paraparaumu 2040	RCP 8.5	**-3** (-12, 10)	**6** (-1, 13)	**0** (-9, 9)	**4** (-4, 12)	**2** (-4, 7)
	RCP 4.5	**0** (-15, 23)	**2** (-15, 17)	**4** (-4, 12)	**6** (-1, 11)	**3** (-3, 10)
Paraparaumu 2090	RCP 8.5	**3** (-7, 23)	**2** (-9, 10)	**10** (1, 20)	**6** (-6, 22)	**5** (0, 11)
	RCP 4.5	**2** (-9, 15)	**0** (-18, 10)	**3** (-10, 22)	**3** (-2, 11)	**2** (-5, 12)
Masterton 2040	RCP 8.5	**-4** (-17, 7)	**2** (-9, 12)	**0** (-4, 13)	**-2** (-11, 7)	**-1** (-8, 7)
	RCP 4.5	**-5** (-16, 23)	**1** (-11, 13)	**2** (-6, 9)	**0** (-9, 9)	**0** (-6, 10)
Masterton 2090	RCP 8.5	**-10** (-19, 5)	**-8** (-21, 4)	**0** (-9, 6)	**-7** (-13, -2)	**-6** (-12, 0)
	RCP 4.5	**-1** (-10, 17)	**-3** (-14, 12)	**0** (-9, 10)	**-5** (-9, 3)	**-2** (-9, 7)

Short return period extreme rainfalls (i.e. heavy rainfall events that typically occur once per year) may increase in the Wellington Region by 2090, particularly in coastal locations. Rare larger extreme rainfall events are likely to increase in intensity due to more moisture being held in a warmer atmosphere. Tropical cyclones are likely to increase in intensity and have higher rain rates but their frequency is projected to stay the same or decline, and it is uncertain how they will affect New Zealand.

How to manage uncertainty in climate projections

There is always some uncertainty in climate projections because the rate of climate change will depend on future global emissions of greenhouse gases, which in turn depend on social, economic and environmental policies and development. Incomplete scientific knowledge about some of the processes governing the climate, and natural year-to-year variability, also contributes to uncertainty in projections for the future.

The graphs below show the range of projections for air temperature (top) and rainfall (bottom) for Wellington Region and Paraparaumu, respectively, for 2090. There is a large range of possible outcomes, shown by the length of the bars and inset stars (which show individual model results). All temperature projections are above 0°C, indicating that all models under all scenarios project warming. The direction of change is much less certain for rainfall, with all bars crossing 0% change and some scenarios having very different model projections.



Range of model outcomes for temperature (a) and rainfall (b) for 2090

Some potential climate change implications and opportunities

- Native New Zealand plants and animals may change the ranges and altitudes they currently are found in as the climate warms and rainfall patterns change.
- Changes to timing of seasonal activities such as flowering, breeding, and migration may disrupt relationships between species.
- Some mitigation aspects of climate change might be disadvantageous to native species (e.g. with planting pine forests on dune habitats)
- Mean annual low flow of rivers is projected to decrease throughout the region and particularly in the east[6]. Mean annual flood is projected to increase in most parts of the region, particularly in the west.
- Changes to the hydrological regime in NZ rivers may impact the distribution of native species.
- Sea level rise and consequent coastal fortification (to prevent coastal erosion) will result in the loss of habitats.
- Sea level rise will result in different adaptation strategies for communities and infrastructure that are at risk of coastal inundation[5]. These strategies may include restricting coastal development and managed retreat.
- Due to the Cook Strait/Wellington area's small tidal range, sea level rise will have a greater influence on storm inundation and rates of coastal erosion than in other parts of New Zealand that have larger tidal ranges.
- Ocean acidification may impact the early developmental stages of shellfish in wild fisheries and aquaculture.
- Declining macronutrient levels in the oceans surrounding New Zealand may have impacts on the productivity of fisheries.

Some potential climate change implications and opportunities

- Increases in drought (particularly in Wairarapa) may reduce crop and pasture growth and cause greater plant mortality.
- Crops may be sown earlier in the growing season and will reach maturity faster due to higher temperatures.
- Due to warming temperatures, there may be opportunities to grow different crop species.
- Changes in temperature and rainfall may allow pest species to move into new habitats where they may outcompete NZ's native species.
- Tropical and subtropical pests (e.g. certain mosquito species) that currently occur as seasonal immigrants may become established in NZ with warmer temperatures.
- 'Sleeper' pests currently in New Zealand may affect primary industries due to change in host-pest relationships (e.g. increase in different pasture grass species, more heat-tolerant pests favoured).
- Cattle may be susceptible to increased heat stress.
- The number of days of very high and extreme forest fire danger are projected to increase by 100-150% by the 2090s for the Wellington Region.
- There will be impacts on human health due to a number of combined stressors that will be exacerbated by climate change (e.g. increase in hot days).

Greater Wellington Regional Council: Acting on climate change

With help from the community, the Greater Wellington Regional Council (GWRC) has developed a Climate Change Strategy that aligns and coordinates climate change actions across GWRC's responsibilities and operations. The strategy sets out the Council's commitment to taking a proactive approach to managing the risks associated with a changing climate, to reducing the emissions associated with its activities, and to enhancing the region's resilience by applying an adaptive pathways approach to its planning processes.

Some ongoing climate proofing projects are shown in the blue insert to the right.

References

1. Pearce, P.R., Fedaeff, N., Mullan, B., Sood, A., Bell, R., Tait, A., Collins, D., and Zammit, C. 2017. Climate change and variability – Wellington Region. NIWA Client Report for Greater Wellington Regional Council, 2017066AK. Available from www.gw.govt.nz/climate-change
2. Intergovernmental Panel on Climate Change Fifth Assessment Report (2013). Available from https://www.ipcc.ch/report/ar5/
3. Climate change projections for New Zealand (2016). Available from http://www.mfe.govt.nz/node/21990
4. Climate change effects and impacts assessment: A guidance manual for local government in New Zealand. Available from: http://www.mfe.govt.nz/publications/climate-change/climate-change-effects-and-impacts-assessment-guidance-manual-local-6
5. Coastal hazards and climate change: Guidance for local government. Ministry for the Environment, to be released mid-2017.
6. Impact of climate change on inflows to the Ruamahanga groundwater management zone (2016). NIWA Client Report for GWRC.

Ongoing climate-proofing projects led by GWRC

Flood Protection and River Link Project for the Hutt Valley

The Wellington Region Natural Hazards Management Strategy

Whaitua catchment modelling

GWRC Climate Change Strategy

Water Wairarapa

See GWRC's website for more information: www.gw.govt.nz/climate-change

GWRC Future Climate Summary Report

This summary report was written by NIWA for Greater Wellington Regional Council, and should be referenced as follows:

Pearce, P.R. 2017. Wellington Region climate change projections and impacts. NIWA Client Report for Greater Wellington Regional Council, 2017148AK.

Full report and video

More detailed information about Wellington Region's future climate can be found in the full report and accompanying video

Available from www.gw.govt.nz/climate-change

For more information

Visit our website: https://www.niwa.co.nz/our-science/climate

Petra Pearce
Climate Scientist

Email: Petra.Pearce@niwa.co.nz
Tel: +64 9 375 2052

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

NIWA
Taihoro Nukurangi
enhancing the benefits of New Zealand's natural resources