Zone 3: Regional snapshot of projected climate changes and hazards

Eastern lower North Island (Te Ika ā Māui) extends from Hicks Bay (Wharekahika) to Palliser Bay (Te Waha o te Ika ā Māui) and back to the Ruahine and Kaweka ranges. Includes Gisborne, Hawke's Bay and the Wairarapa catchment of Wellington.

Hazard	RCP 4.5	RCP8.5	Extra information
Higher mean temperatures: air and water	**2040:** Annual average air temp to increase 0.7-0.9˚C; Coastal sea-surface temps to increase ~1.1˚C (6% change).	**2040:** Annual average air temp to increase 0.8-1.1˚C; Coastal sea-surface temps to increase ~1.5˚C (9% change).	- Summer air temperature to warm the most; Spring air temperature the least. - Daily maximum air temperature is expected to increase faster than overnight daily minimum temperature. - Tasman Sea (Zones 2-3) expected to show the largest absolute sea temperature change: warming to exceed 1.3˚C (RCP4.5, ~2100) or 3.1˚C (RCP8.5, ~2100).
	2090: Annual average air temp to increase 1.3-1.4˚C; Coastal sea-surface temps to increase ~1.3˚C (8% change).	**2090:** Annual average air temp to increase 2.8-3.1˚C; Coastal sea-surface temps to increase ~3.3˚C (20.5% change).	
Heatwaves: increasing frequency and magnitude	**2040:** Increase 5-15 more hot days/year (>25˚C). Highest in Wairarapa. 6 day increase for Wellington (12days/year), 19 day increase for Masterton (50days/year). *Heatwaves >25˚C (3 consecutive days)*: Wellington, +2days (3/year); Masterton, +16days (32/year)	**2040:** Increase 5-25 more hot days/year (>25˚C). Highest in Wairarapa. *Heatwaves >25˚C (3 consecutive days)*: Wellington, +2days (3/year); Masterton, +17days (33/year). *Extreme Heatwaves* >30˚C (3 consecutive days): Masterton, 1/year.	- No data available yet for *Heatwaves >25˚C (3 consecutive days)* or *Extreme Heatwaves* >30˚C *(3 consecutive days)*. - 40-100% increase in hot days (>25˚C) across New Zealand (RCP4.5, ~2050). - 40-300% increase in hot days (>25˚C) across New Zealand (RCP4.5, ~2100).
	2090: Increase 5-25 more hot days/year (>25˚C). Highest in Wairarapa and Hawke's Bay. 10 day increase for Wellington (16days/year), 30 day increase for Wairarapa (61days/year). *Heatwaves >25˚C (3 consecutive days)*: Wellington, +4days (5/year); Masterton, +30days (61/year) *Extreme Heatwaves* >30˚C (3 consecutive days): Masterton, 2/year	**2090:** Increase 30-40 more hot days/year (>25˚C). Highest in Wairarapa (>60days/year). Extreme hot days/year (>30˚C) to increase +20 for Wairarapa (21.5days/year) and +3 for Wellington (3days/year). *Heatwaves >25˚C (3 consecutive days)*: Wellington, +15days/year; Masterton, +67days/year *Extreme Heatwaves* >30˚C (3 consecutive days): Masterton, +11days/year.	
More and longer dry spells and droughts	**2040:** 5-8 more dry days/year. Increased Potential Evapotranspiration Deficit (PED) of 50-100mm in most areas. The annual potential evapotranspiration deficit (PED) exceeding 300mm (very dry conditions) increases throughout the region, except for highest Tararua Range altitudes. Greater Wellington territory: *3day dry spells*: Wellington +4days (185days/year), Masterton +7days (177days/year). *5day dry spells*: Wellington +6days (125days/year), Masterton +7days (121days/year). *10day dry spells*: Wellington +6days (33days/year), Masterton +9 (37days/year).	**2040:** Dry days/year and PED projections are the same as above for RCP4.5. The annual probability of PED exceeding 300mm (very dry), except for high altitudes in the Tararua Ranges. Increased PED Low river flow thresholds reached earlier in the year (>40days earlier than present for central North Island). Greater Wellington territory: *3day dry spells*: Wellington +8days (189days/year). *5day dry spells*: Wellington +7days (126days/year). *10day dry spells*: Wellington +5days (32days/year).	- The frequency of dry days (<1mm precipitation) increases with time and RCP. - Climate drought severity is projected to increase. - Drought probability up 50-70%. - Time spent in drought to increase 5-20%.
	2090: 5-15 more dry days/year. Increase of PED 100-150mm for most areas. The annual PED exceeding 300mm (very dry	**2090:** 10-20 more dry days/year. Increase in PED of 150-200mm for most areas.	

	conditions) increases throughout the region, except for highest Tararua Range altitudes. For the Wairarapa PED >300mm increases 40-60% and 60-80%. Greater Wellington territory: *3day dry spells*: Wellington +9days (190days/year), Masterton +10days (180days/year). *5day dry spells*: Wellington +10days (129days/year), Masterton +7days (121days/year). *10day dry spells*: Wellington +4days (31days/year), Masterton +2 (30days/year).	Drought probability up 50-70%. Time spent in drought increases 5-20%. Low river flow thresholds reached earlier in the year (>40days earlier than present for central North Island). Decrease of 5% or more in relative humidity.	
Changes in climate seasonality with longer summers and short winters	**2040:** Warming greatest in summer and autumn. Warming least in winter and spring.	**2040:** Warming greatest in summer and autumn. Warming least in winter and spring.	- Spring and autumn frost-free land to at least triple by 2080 (RCP8.5, ~2100). - Up to 60 more hot days (>25˚C) by 2090 (RCP8.5, ~2100)
	2090: Warming greatest in summer and autumn. Warming least in winter and spring.	**2090:** Warming greatest in summer and autumn. Warming least in winter and spring.	
Increasing fire-weather conditions: harsher, prolonged season	**2040:** Increased fire risk. Increase in days with very high and extreme fire danger index from around 0-400%. *Seasonal Severity Rating*: Taupo, increase of 30-50%. Lower North Island, increase of 20-30%. Wellington and East Cape, increase of <20%.	**2040:** Increased fire risk. Increase in days with very high and extreme fire danger index. *Seasonal Severity Rating*: Lower North Island areas, increase of +100-150%. Remainder of North Island areas, increase of +30-50% *Very High + Extreme Fire Danger*: Potential for significantly increased number of days of fire risk.	- Fire season length to increase (RCP4.5 & RCP8.5, ~2100). - Fire season to start earlier and/or finish later (RCP4.5 & RCP8.5, ~2100). - Fire climate severity is likely to rise significantly with climate change in many parts of the country as a result of increases in temperature, wind speed and lower rainfall and/or humidity.
	2090: Increased fire risk. Increase in days with very high and extreme fire danger index from around 0-700%. *Seasonal Severity Rating*: Central North Island areas, increase of +20-40%. Wellington, no change. *Very High + Extreme Fire Danger*: Central and eastern areas, increase of +50%.	**2090:** Increased fire risk. Increase in days with very high and extreme fire danger index. 44-48 more days of fire risk. Wellington has the highest risk increase of 89%. *Seasonal Severity Rating*: Central and lower North Island, increase of >50%. *Very High + Extreme Fire Danger*: Most areas, increase of >150%. East Cape, increase of <50%	
Increased storminess and extreme winds and rainfall	**2040:** Extreme wind speeds increase up to 10%. Intensity of (ex)tropical cyclones projected to increase. Rainfall events see righthand column.	**2040:** Extreme wind speeds increase up to 10%. Frequency of extreme winds is likely to increase in winter and decrease in summer. Mean westerly flow of wind to increase ~20% in spring and ~70% in winter; decrease by ~20% in summer and autumn. Intensity of (ex)tropical cyclones projected to increase. Rainfall events see righthand.	- Increases in extreme wind (esp. for southern North Island). - Increases in rainfall intensity projected everywhere. - Moderately extreme daily precipitation (99th percentile of wet days) increases. Very extreme daily precipitation increases in frequency. - Short duration (1-in-100-year, 1hour duration) extreme rainfalls increase +13.6% for every 1˚C increase. Long duration rainfall events (1-in-2-year, 120hour duration) increase +4.8% for every 1˚C increase.
	2090: Poleward shift of mid-latitude and possible small reduction in frequency. The most severe ex-tropical cyclones are expected to be stronger.	**2090:** Poleward shift of mid-latitude and possible small reduction in frequency. The most severe ex-tropical cyclones are expected to be stronger.	

	Intensity of (ex)tropical cyclones projected to increase. Rainfall events see righthand column.	Frequency of extreme winds is likely to increase in winter and decrease in summer. Intensity of (ex)tropical cyclones projected to increase. Occurrence conditions conducive to storm development is projected to increase by 3-6%, relative to the period 1970-2000. Rainfall events see righthand column.	
Change in mean annual rainfall	**2040:** Minimal change in annual rainfall, most change seen at seasonal scale. Reduction in rainfall in winter and spring, and small increases in summer. Greater Wellington territory: minimal change in annual wet days and wet spells.	**2040:** Small reduction in annual rainfall. Largest decreases in winter and spring. Greater Wellington territory: decrease in annual wet days and wet spells. Annual rain-days: *>10mm*, Wellington -0.1days (35.9days/year), Masterton +0days (20days/year). *>20mm*, Wellington +0.9days (14.9days/year), Masterton +0.2days (4.2days/year). *>30mm*, Wellington +0.7days (7.7days/year), Masterton 0.3days (1.3days/year). Annual number of wet-day spells >1mm rain/day: *3-day wet spells*: Wellington -6 (65days/year), Masterton -3 (74days/year). *5-day wet spells*: Wellington -3 (23days/year), Masterton -1 (26days/year). *10-day wet spells*: Wellington 0 (2days/year), Masterton -1 (0days/year).	- The largest rainfall changes by ~2100 will be seasonal rather than annually.
	2090: Minimal change in annual rainfall, most change seen at seasonal scale. Small decrease in annual rainfall. Largest decrease in winter and spring (e.g. spring, -6% Gisborne, -5% Napier). Greater Wellington territory: decrease in annual wet days and wet spells. Annual number of wet day spells >1mm rain/day: *3-day wet spells*: Wellington -11 (60days/year); Masterton -12 (65days/year). *5-day wet spells*: Wellington -6 (20days/year); Masterton -8 (19days/year). *10-day wet spells*: Wellington -1 (1day/year); Masterton -1 (0days/year).	**2090:** Annual rainfall decrease of 5-15%. Decreases in all seasons esp. summer and winter. Greater Wellington territory: decrease in annual wet days and wet spells. Annual rain-days: *>10mm*, Wellington -0.1days (35.9days/year), Masterton -0.8days (19.2days/year). *>20mm*, Wellington +0.9days (14.9days/year), Masterton +0.2days (4.2days/year). *>30mm*, Wellington +0.7days (7.7days/year), Masterton +0.2days (1.2days/year). Annual number of wet-day spells >1mm rain/day: *3-day wet spells*: Wellington -6 (65days/year). *5-day wet spells*: Wellington -3 (23days/year). *10-day wet spells*: Wellington 0 (2days/year).	
	2040: Decrease of 10-25 of frost days.	**2040:** Decrease of 10-25 of frost days.	

Reducing frost, snow and ice cover	**2090:** Decrease of 10-25 of frost days.	**2090:** Decrease of 25-50 frost days for central North Island. Frost-free. Peak snow accumulation projected to decline by 32-79% at 1000m and 6-51% at 2000m. Snow days/year reduce by 30days or more. Tararua Ranges will experience at least 60 fewer nights >5˚C..	- Much of NZ (outside of alpine areas) to become frost-free under RCP8.5, ~2100 scenario. - Number of frost days decrease is greatest in the coldest regions. - Overall mean decreases in snowline elevation duration (exceeding 3 months) and decreases in snow water equivalence projected to be significant (refer to Zones 4-6 for Southern Alps comparison). - No information about snow water equivalent/snow amounts is available yet from IPCC AR5 downscaling yet.
Increasing hail severity or frequency	- No information available on hail. MfE suggest a potential increase in storm intensity, local wind extremes and thunderstorms. - See also information above for *Increased storminess and extreme winds and rainfall*.		
River and flow changes in frequency and magnitude in rural and urban areas	**2040:** Mean annual flood occurrence stays the same or slightly increases in some areas.	**2040:** Mean annual flood occurrence increases in western areas; decreases in central North Island.	- Lower river flows in summer will raise water temperature and exacerbate water quality problems, such as increased algae growth (all RCPs and time frames). - No research yet on changes to large flood flows and return periods – highly uncertain at this point (all RCPs and time frames). - Increases in Mean Annual Flood occurrence affect most agricultural areas, with only slight reductions in other areas. Percentage increases tend to be greater for the more extreme RCPs (i.e. RCP8.5) and late century (i.e. ~2100).
	2090: Mean annual flood occurrence decreases in most areas.	**2090:** Mean annual flood occurrence increases; though increases less than projected for Zone 2. Significantly large increases for southern Hawke's Bay area.	
Coastal and estuarine flooding: increasing persistence, frequency and magnitude	**2040:** 0.24m SLR	**2040:** 0.28m SLR; 0.37m under RCP8.5+ (allows for ice sheet instability).	- Rising sea levels are expected to cause salinization of groundwater and coastal wetlands. - Exposure to extreme storm tides will increase with further sea-level rise. - Extreme sea levels that are expected to be reached once every 100 years (on average) at present-day MSL, will occur at least once per year or more (on average) by 2050-2070 and will occur earlier in areas will smaller tidal ranges. - Wellington Harbour exhibits the highest SLR in New Zealand, due to the higher subsidence present in the lower North Island.
	2090: 0.55m SLR	**2090:** 0.79m SLR; 1.05m under RCP8.5+ (allows for ice sheet instability).	
Sea-level rise and salinity stresses on brackish and aquifer systems and coastal lowland rivers	**2040:** SLR trends as per above.	**2040:** SLR trends as per above.	- No information about projections for salinization of aquifers, except that this will increase under higher levels of SLR. - Changes to salinity will also depend on rainfall and runoff patterns.
	2090: SLR trends as per above.	**2090:** SLR trends as per above.	
Increasing coastal erosion: cliffs and beaches	- Land subsidence will exacerbate the effects of SLR. - Highly variable erosion, depends on geology, tidal range, geomorphology and exposure. - Areas with small tidal range more sensitive to erosion than large tidal range. Eastern coasts and Wellington more sensitive.		
Increasing landslides and coastal erosion	- Increase in landslides and erosion with increasing rainfall intensity. Increased fire risk will exacerbate soil erosion. - Increased risk of earthflow erosion. Increased rainfall and temperature (impacting evapotranspiration) may affect earthflow erosion. - Increased risk of gully erosion (exacerbated by increased rainfall) - Increased risk of sheet erosion (exacerbated by increased rainfall and runoff) - Bank erosion may increase with increasing river flows. - Wind erosion may increase in susceptible areas, particularly in areas which will become drier and windier.		
Marine heatwaves: more persistent high	**2040:** Southwest Pacific summer sea temperature (SST) increases by ~0.8˚C.	**2040:** Southwest Pacific SST increases by ~1.0˚C.	- Marine heatwaves projected to increase in frequency and intensity with ongoing atmospheric and ocean

summer sea temperatures	**2090:** Southwest Pacific Sea SST increases by ~1.1˚C. Tasman Sea SST exceeds ~3.0˚C.	**2090:** Southwest Pacific Sea SST increases by ~2.5˚C. Tasman Sea SST exceeds ~3.1˚C.	warming (i.e. RCP4.5 & RCP8.5 for ~2050 & ~2100). - Proportional SST warming of 16-20% for most New Zealand marine areas. - Warming lowest in southern waters.
Ocean chemistry changes: nutrient cycling and pH change	**2040:** pH: 7.98 for SW Pacific (decrease of 0.12). No significant decrease in surface macronutrient concentrations and net primary production. Particle flux change: -0.9%	**2040:** pH: 7.93 for SW Pacific (decrease of 0.18). No significant decrease in surface macronutrient concentrations and net primary production. Particle flux change: -4.7%	- Reduction in surface mixed layer depth, macronutrients, net primary production, chlorophyll-a. Reductions increase with time and RCP. - Largest macronutrient declines in the eastern Chatham Rise and sub-Antarctic waters. - Largest increase in dissolved iron in subtropical waters.
	2090: pH: 7.98 for SW Pacific (decrease of 0.12). Mixed layer depth to decrease by a mean of 6m. Significant decrease of surface macronutrient concentrations. Net primary production to decrease ~1.2%. Particle flux change: -2.6%	**2090:** pH: 7.77 for SW Pacific (decrease of 0.33). Decreases in surface mixed layer depth (15%), macronutrients (7.5-20%), net primary production (4.5%), and particle flux (12%). Particle flux change: -8.9%	
International influences	**Findings from Royal Society report on Climate Change Implications for NZ (non-specific timeframes, region or RCP)** - All aspects of food security are potentially affected by climate change, including food access, utilisation, and price stability. - Climate change over the 21st Century is projected to increase the displacement of people. - Climate change can indirectly increase risks of violent conflicts in the form of civil war and intergroup violence by amplifying well-documented drivers of these conflicts such as poverty and economic shocks. - The impacts of climate change on critical infrastructure and the territorial integrity of many states are expected to influence national security policies. - While NZ agriculture could benefit from increasing global commodity prices in the long term, there are many negatives. - We gain significant revenue from long-haul tourism which could be reduced if the acceptability of long-haul travel, and costs of fossil fuels, are affected by climate change.		
Useful resources: Wellington Region climate change extremes and implications (Pearce et al. 2019)			