greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

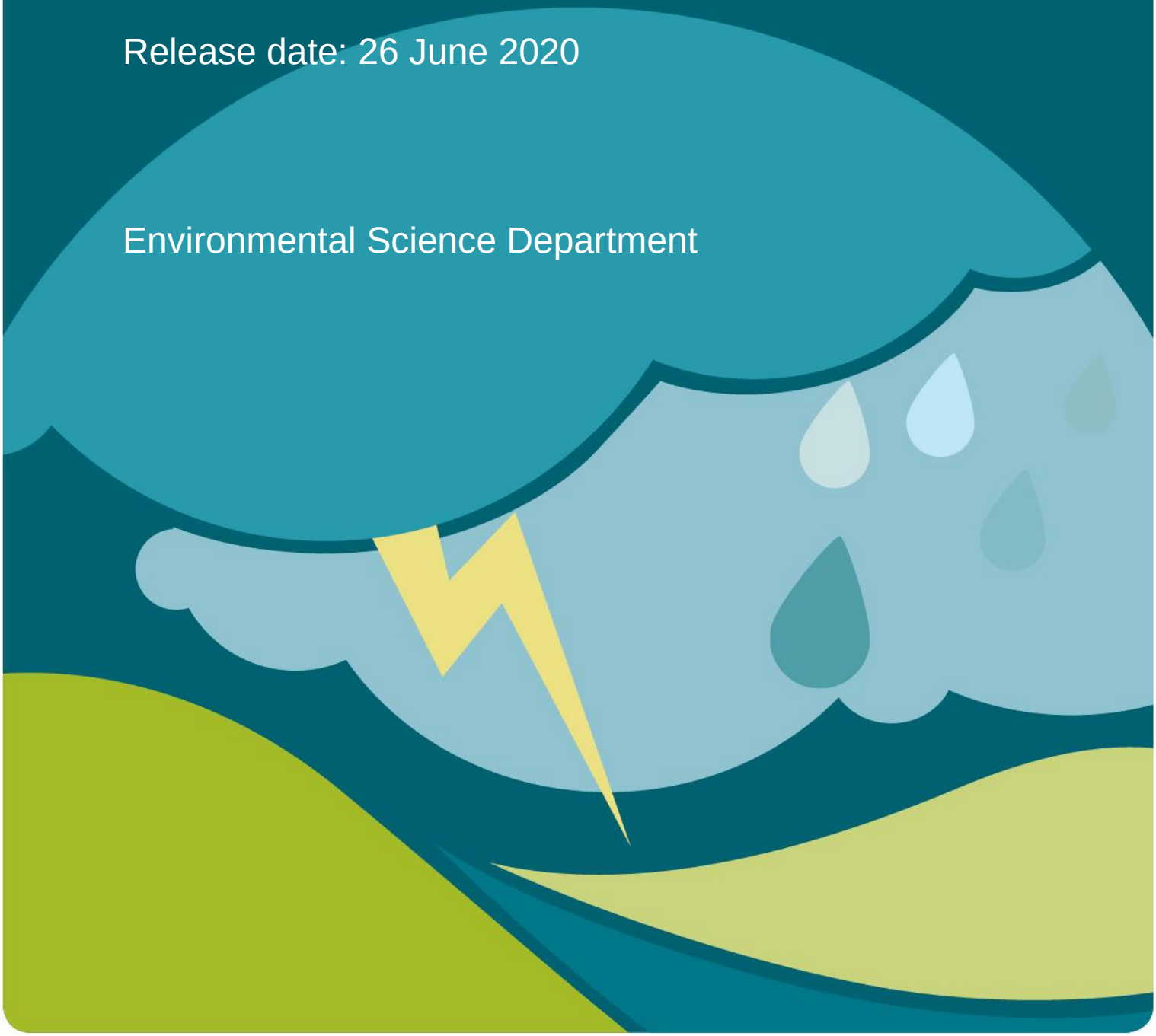
Climate and Water Resources Summary for the Wellington Region

Autumn 2020 summary

Winter 2020 outlook

Release date: 26 June 2020

Environmental Science Department



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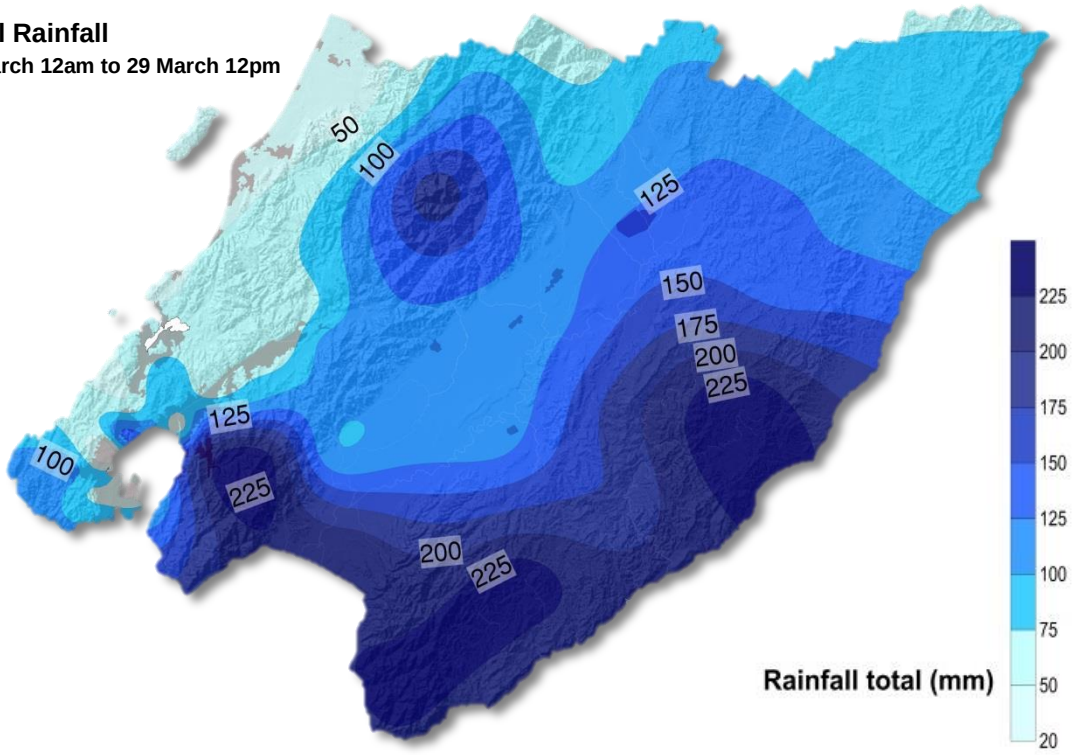
Total Rainfall
27 March 12am to 29 March 12pm



As New Zealand went into lockdown to respond to Covid19, mother nature had a meteorological surprise for our region. In the first weekend of lockdown in late March, it was a great relief for the Wairarapa to have heavy rainfall finally arriving. In just over 48 hours the eastern and southern hills received over 225mm of rain, corresponding to almost three times the long-term monthly average in some locations. Statistically, an event like this for the eastern hills is expected to happen only once every 50 years.

Overview

Autumn 2020

Autumn 2020 was dominated by the severe drought that affected most of the North Island. An upper level trough arrived late in March during the first weekend into lockdown responding to COVID-19, producing abundant rainfall over the Wairarapa. For some areas this was a one in 50-year return period event, and resulted in the highest accumulation on record for March. Due to the southerly component, the event was also accompanied by very low maximum temperatures on 28 March. This was followed by a warm and very dry April, with only 4mm of rainfall recorded in Masterton for the entire month, corresponding to the lowest on record (data since 1926). As a result, while the drought was broken and soil moisture returned to more normal levels, the recovery hasn't been sustained. Meanwhile, an offshore extratropical cyclone caused a quite high coastal swell on April 15th on the southern coast, with wave heights near 5.5 metres measured near Baring Head. The event produced significant inundation on the southern Wellington city bay area. Overall, temperatures were near normal for Wellington and above normal for the Wairarapa during the season. For Wellington, it was the second sunniest autumn in the nearly 100 years that records have been kept. Hence, our weather contributed for a less depressing lockdown period!

Climate drivers

The climate drivers (influencers) were mostly neutral throughout autumn, and so the weather anomalies can be explained by a combination of natural climate variability and background global warming. The Sea Surface Temperature has been warmer than normal to the east of New Zealand, and a blocking high pressure anomaly has been consistently keeping the cold air trapped in the Tasman Sea, causing much colder periods in Australia compared to what we have experienced in New Zealand so far this season.

Climate outlook for winter 2020

The ENSO phenomenon is expected to remain neutral during winter, possibly achieving La Niña status into spring. Meanwhile, the Indian Ocean Dipole is expected to be borderline between normal and negative. These conditions suggest a possible transition into a more easterly regime as the season progresses. Based on international climate models, a predominance of high pressure is expected, with warmer than normal daytime temperatures and normal frost occurrence during clear and calm nights. Rainfall is expected to be near average in the west, and possibly below in the eastern Wairarapa.

Live regional climate maps (updated daily): Daily updated climate maps of regional rainfall and soil moisture are provided on GWRC's environmental data webpage (graphs.gw.govt.nz/#dailyClimateMaps).

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1. Climate drivers

1.1 El Niño – Southern Oscillation (ENSO)

The ensemble projections of the Australian climate model below show that the ENSO phenomenon is predicted to be borderline between neutral and La Niña over the next few months. This suggests that the weather patterns may slowly transition into a more easterly regime towards the end of the season.

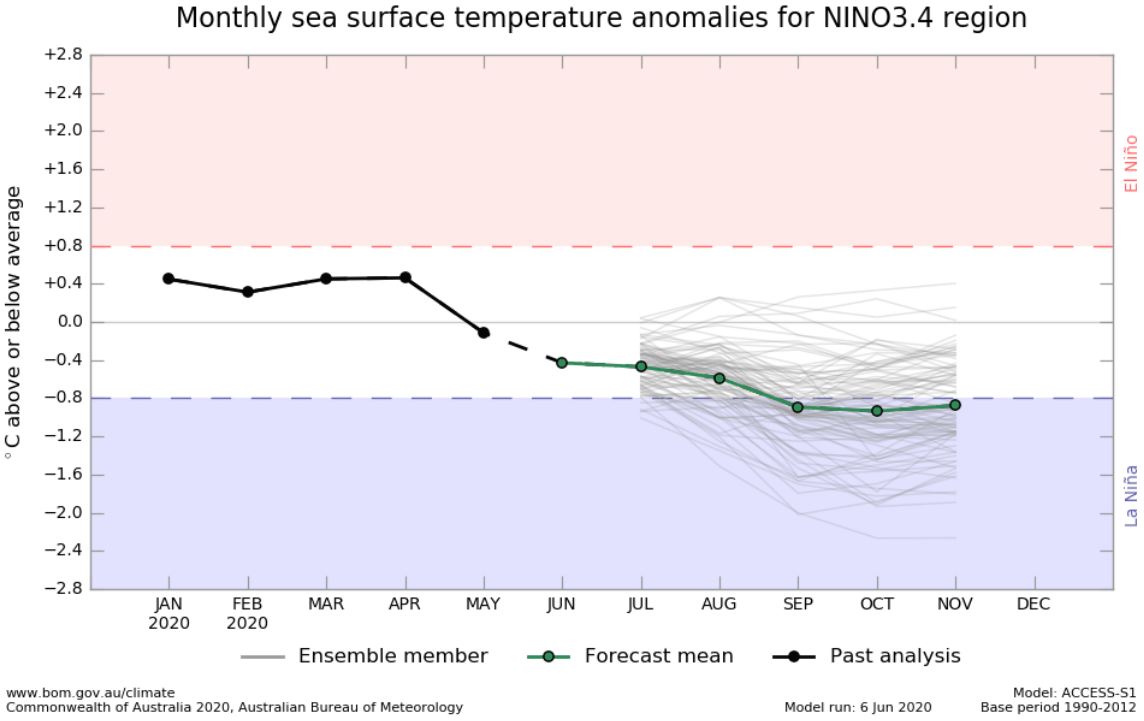


Figure 1.1: Averaged modelled projections (in green) show ENSO is expected to remain in a neutral phase during winter. Source: Australian Bureau of Meteorology.

1.2 Sea Surface Temperature anomalies

The Sea Surface Temperature (SST) anomalies and the total sea ice extent (in white) are shown in Figure 1.2 as of 8 June 2020. The pattern shows warmer than normal waters over the Tasman and east of New Zealand, and colder than normal south of Australia. A slight La Niña signature is starting to emerge in the Equatorial Pacific Ocean. The sea ice cover around Antarctica has largely recovered compared to the same period last year, and is now around normal.

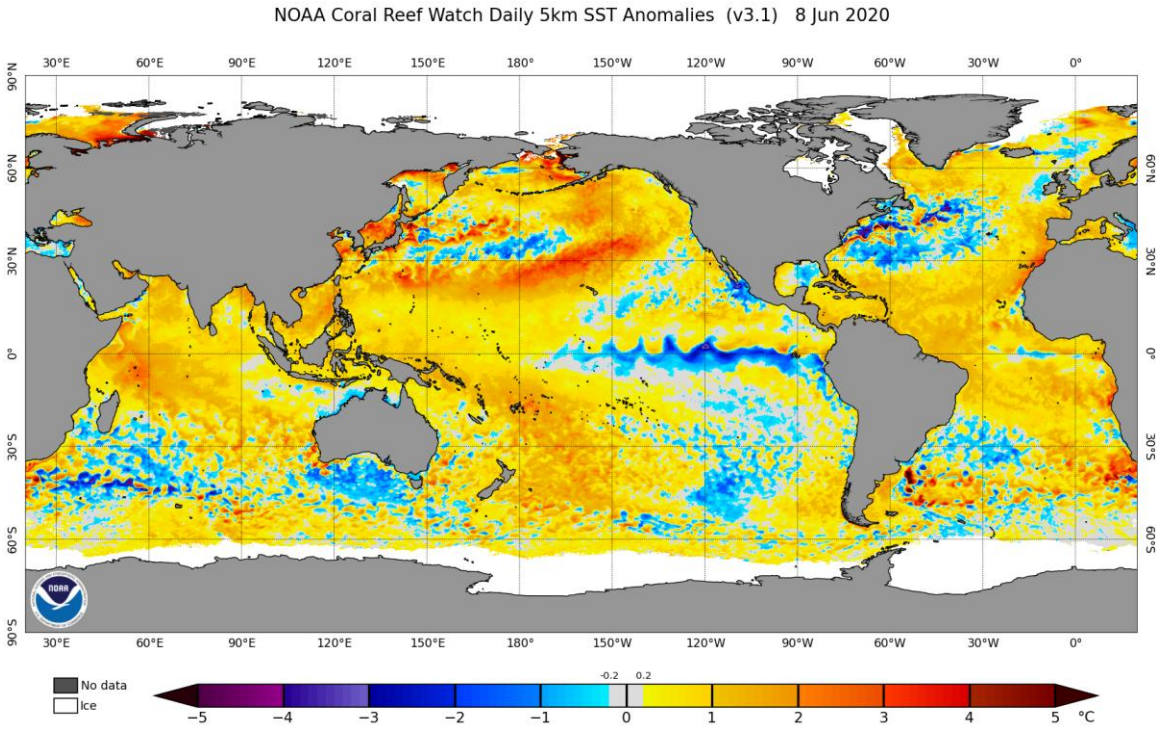


Figure 1.2: Sea surface temperature (SST) anomalies as of 8 June 2020. Sea ice coverage is shown in white. Waters around New Zealand are warmer than average in the Tasman Sea and east of the country, and cooler than average to the south of Australia, where a strong south-westerly wind pattern has caused snow and frosts in Victoria . The Equatorial Pacific (ENSO) is starting to show a slight La Niña tendency, but is still expected to remain mostly neutral over the winter season. Source: NOAA.

1.3 Southern Annular Mode (SAM)

The SAM is the natural pressure oscillation between mid-latitudes and the Antarctic region. Normally, positive SAM is associated with high pressures around the North Island, keeping the weather stable and dry/cloud-free (especially in summer), whereas the opposite is expected when the SAM is in the negative phase.

Figure 1.3 shows that the autumn pattern was characterised by a blocking high pressure east of New Zealand, and low pressure south of Australia. This set up has contributed to strengthen the north-westerly flow, shifting and confining the rain-bearing systems away from the country. The most notable exception was the Wairarapa rainfall event at the end of March, when a cut-off-low (i.e. a cold vortex of low pressure up in the high atmosphere) managed to break through the blocking and create a quite significant extreme weather event (one in 50-year return period). In fact, for Waikoukou (Longbush), with over 100 years of continuous monitoring, we had an exceptional situation with March having the highest total rainfall on record and April having the lowest. The odds that this would happen by pure chance, over 100 years of data, would be very low.

Hence, we have an example of potential climate change impacts increasing the natural climate variability. Another recent example is the Auckland drought, with the driest autumn on record in 2020 just after the wettest autumn on record in 2017.

The SAM is now back to a stronger positive phase pattern, which should contribute to a predominance of high pressures over New Zealand into the winter season, possibly increasing further if La Niña starts developing into spring.

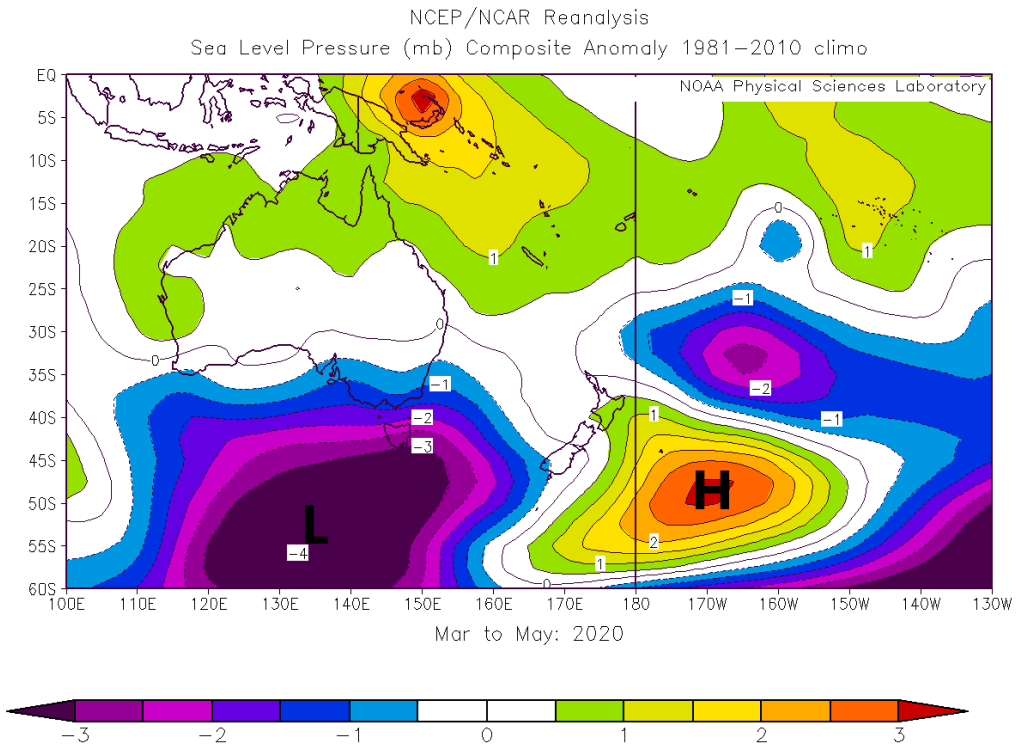


Figure 1.3: Mean sea level pressure anomaly (hPa) for autumn (March, April, May) 2020. The 'H' indicates the position of the blocking high east of New Zealand (explaining the dry pattern), and the 'L' indicates the low pressure associated with the cold and stormy area south of Australia. This pattern was associated with the returning positive phase of the Southern Annular Mode (SAM). Source: NCEP Reanalysis.

2. What is the data showing?

2.1 Regional temperature

Figure 2.1 shows the seasonal minimum and maximum temperature anomalies (against the 1981-2010 reference period) for the region based on all monitoring sites available from GWRC, NIWA, MetService and New Zealand Rural Fire Authority (all meteorological stations indicated by dots).

Warmer than average temperatures continued for the region, especially for maximum temperatures in the Wairarapa. Masterton continued to experience cooler than average nighttime temperatures, also highlighting the influence of the dry conditions facilitating the radiative cooling at night.

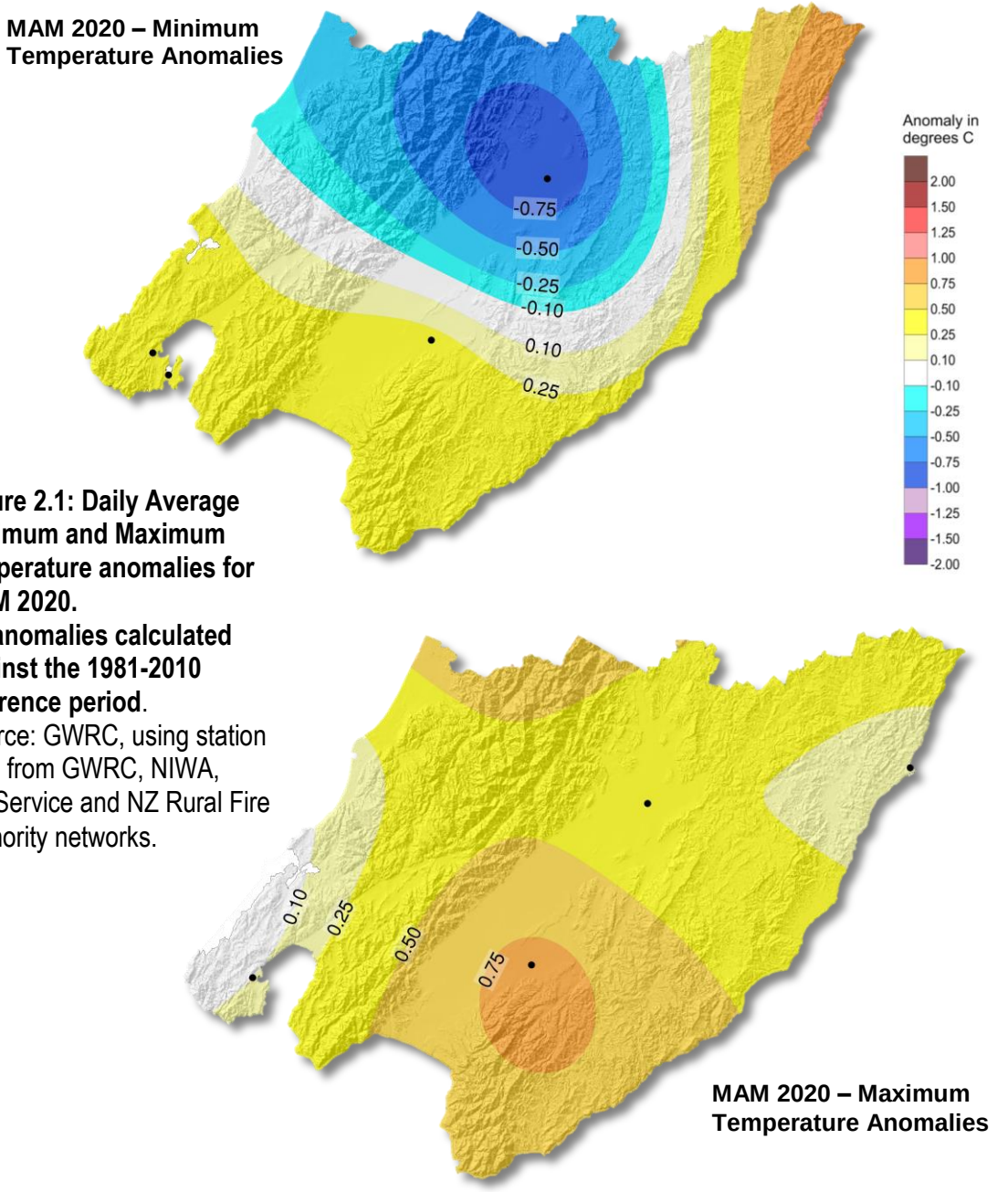


Figure 2.1: Daily Average Minimum and Maximum temperature anomalies for MAM 2020.
All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from GWRC, NIWA, MetService and NZ Rural Fire Authority networks.

2.2 Regional wind

Figure 2.2 shows the mean seasonal wind anomalies (against the 1981-2010 reference period) based on a smaller network of stations than for temperature. Virtually all the region experienced below average wind speeds, as a result of the influence of the blocking anticyclone east of New Zealand.

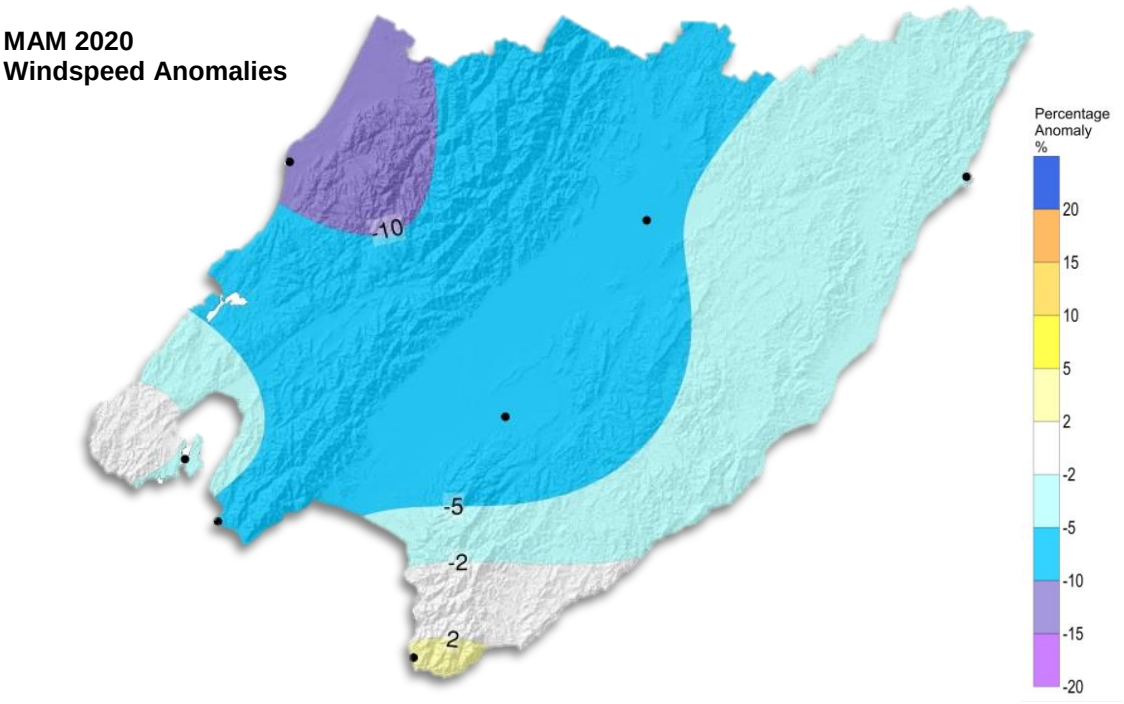


Figure 2.2: Daily mean wind anomalies (as percentage departure from the average) for MAM 2020. All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from NIWA and MetService.

2.3 Regional soil moisture

Figure 2.3 shows that the soil moisture levels were back to normal for most of the region at the end of autumn. This pattern reflected the significant recharge occurring during the late March event, as well as more constant follow up rainfall in May, under the influence of a somewhat prolonged easterly flow.

Live regional climate maps (updated daily): Climate maps for regional rainfall and soil moisture (updated daily) are provided online at GWRC's environmental data webpage (graphs.gw.govt.nz/#dailyClimateMaps).

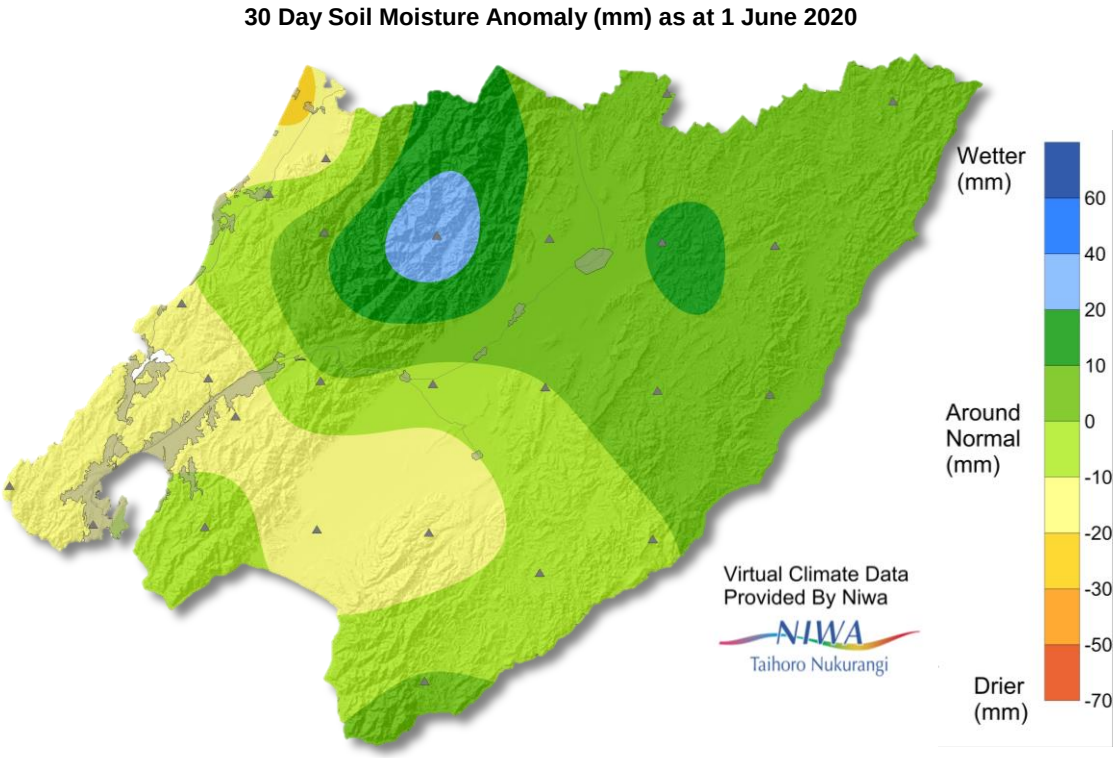


Figure 2.3: 30 Day soil moisture anomaly as at 1st June 2020. Most of the region shows a good recovery of moisture levels compared to the beginning of autumn. Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. ***Note that this data is indirectly calculated by modelling and interpolation techniques, and does not necessarily reflect the results obtained by direct measurements. This map only provides a general indication of the spatial variability.***

2.4 Regional rainfall

Figure 2.4 shows the regional monthly winter rainfall expressed as a percentage of the long-term average. March was very wet compared to normal but most of the month's rainfall fell over between the 27th and the 29th. Rainfall in April was well below average with very low rainfall totals across the whole region but particularly in the Wairarapa. Rainfall totals returned to near normal during May. For some areas of the Wairarapa with very long rainfall records extending over 100 years of data, we had the exceptional contrast of the wettest on record March followed by the driest on record April. The probability that this would happen for consecutive months purely given by chance, without climate change, would be very low.

Rainfall over the entire autumn season was near normal as the high rainfall of March and low rainfall of April were evened out over the three month period.

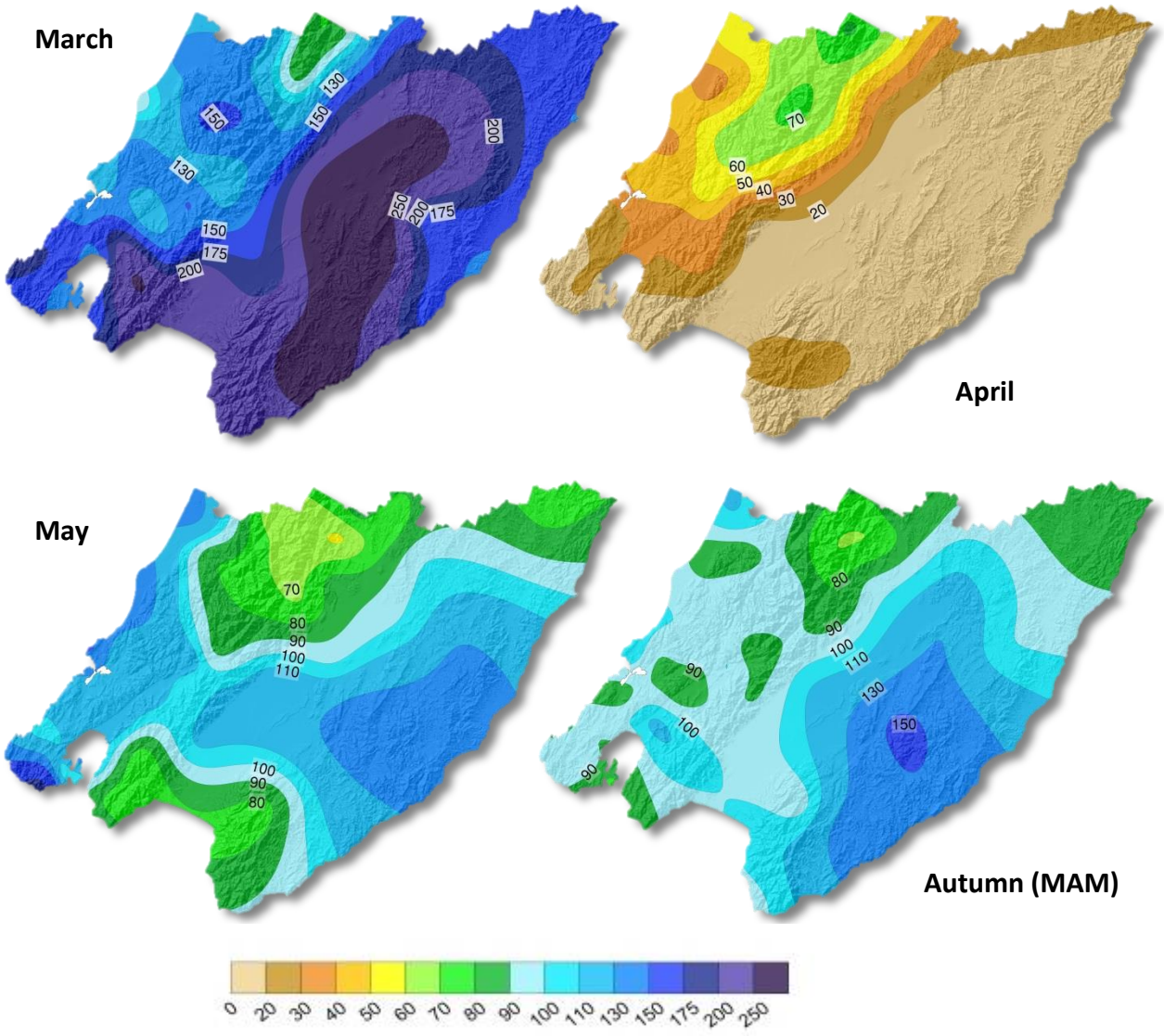


Figure 2.4: Rainfall for March (upper left), April (upper right), May (lower left) and Autumn-MAM (lower right) 2020 as a percentage of the long-term average. Source: GWRC.

2.5 Climate change and variability indicators

The graphs below (Figure 2.5) show summaries of seasonal climate change and variability for Wellington and the Wairarapa using reference climate stations, chosen based on length of data record and availability.

The key climate variables shown are: mean temperature, total sunshine hours, mean wind, total rainfall and total number of rain days (above 0.1 mm). Temperature measurements go back to the 1910s, allowing for a meaningful analysis of climate change trends. Most other variables also have long periods of measurement greater than 50 years, except sunshine hours and wind for the Wairarapa; these are only available for less than two decades, which is a very short period climatologically and doesn't allow for an analysis of trends.

The red and blue bars show the extreme years of the entire measurement period. Red indicates seasons that were warmer, drier, sunnier and less windy than average (i.e., extreme hot/dry), and blue indicates seasons that were colder, wetter, cloudier and windier than average (i.e., extreme cold/wet). The reference climatological average (1981-2010) is shown by a horizontal bar where available. The maps use the same scale except for wind which is much lower over the Wairarapa.

An analysis of linear trends associated with climate change is plotted onto the graph only when the trends are statistically significant at 99% level according to the Student's *t*-test.

The climate change and variability summary for autumn is:

- Statistically significant trends are seen only for temperature (Wellington and Masterton), meaning that autumn is getting warmer as a result of ongoing climate change. The long-term trend is about one degree per century in both Wellington and Masterton;

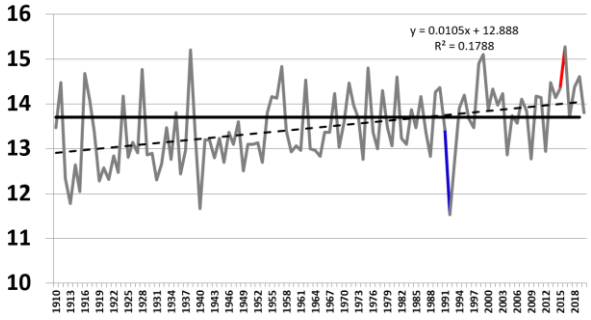
- Autumn 2020 temperatures were above average for the Wairarapa and near average for Wellington;

- Sunshine hours was the second highest on record for Wellington, highlighting the influence of the blocking anticyclone and dry weather;

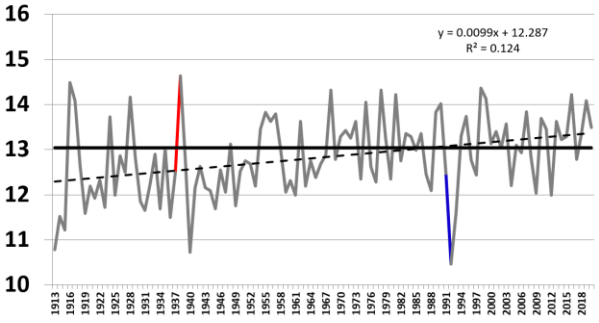
- Seasonal average wind speed was about normal;

- Seasonal rainfall was about average in Wellington and well above average in the Wairarapa (largely shaped by the late March storm event), with below average number of rain days in Wellington and normal in the Wairarapa.

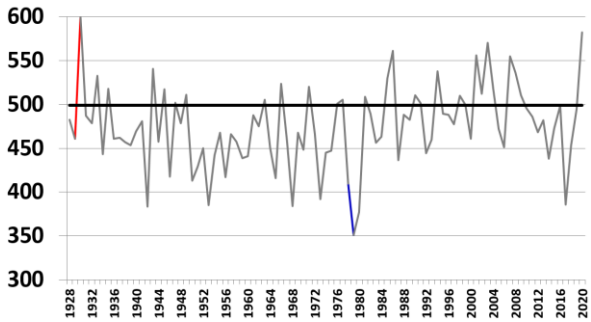
Autumn Mean Temperature (deg C) - Kelburn (1910-2020)



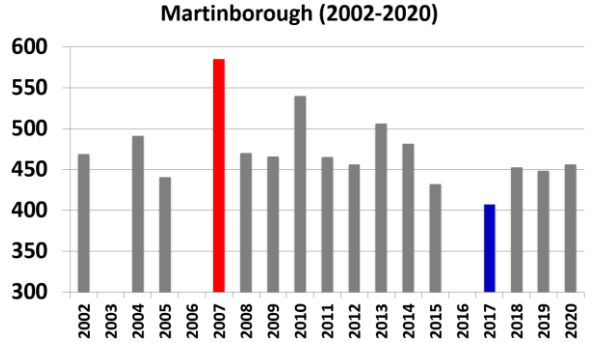
Autumn Mean Temperature (deg C) - Masterton (1913-2020)



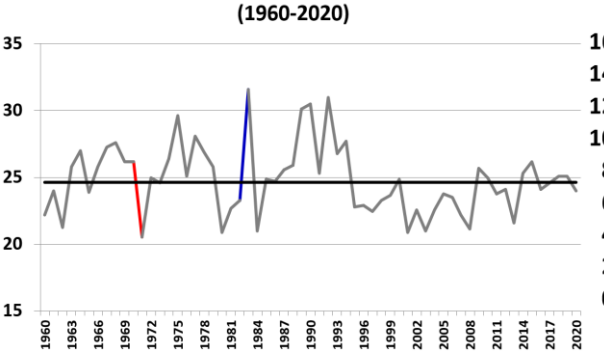
Autumn Total Sunshine Hours - Kelburn (1928-2020)



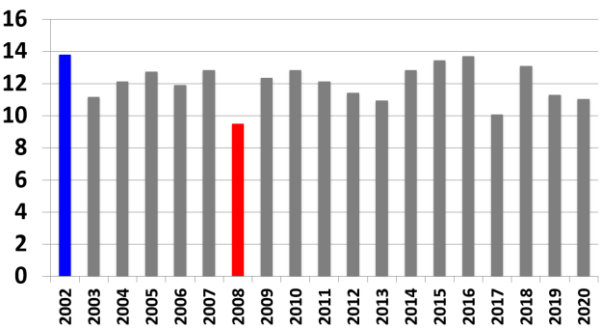
Autumn Total Sunshine Hours - Martinborough (2002-2020)



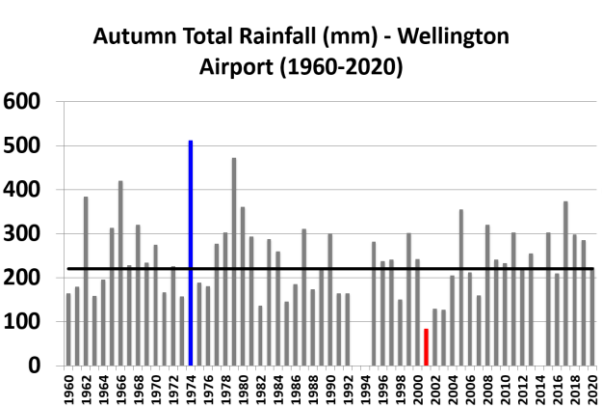
Autumn Mean Wind (km/h) - Wellington Airport (1960-2020)



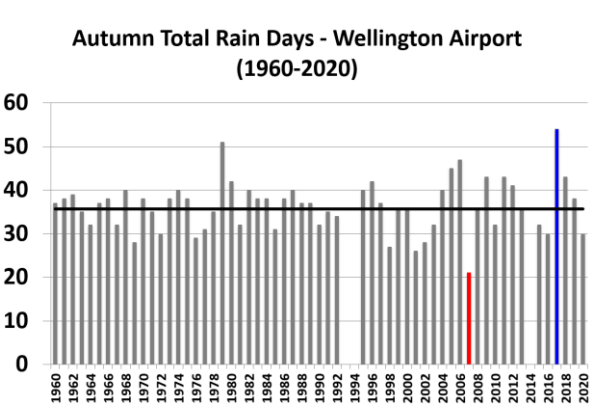
Autumn Mean Wind (km/h) - Martinborough (2002-2020)



Autumn Total Rainfall (mm) - Wellington Airport (1960-2020)



Autumn Total Rain Days - Wellington Airport (1960-2020)



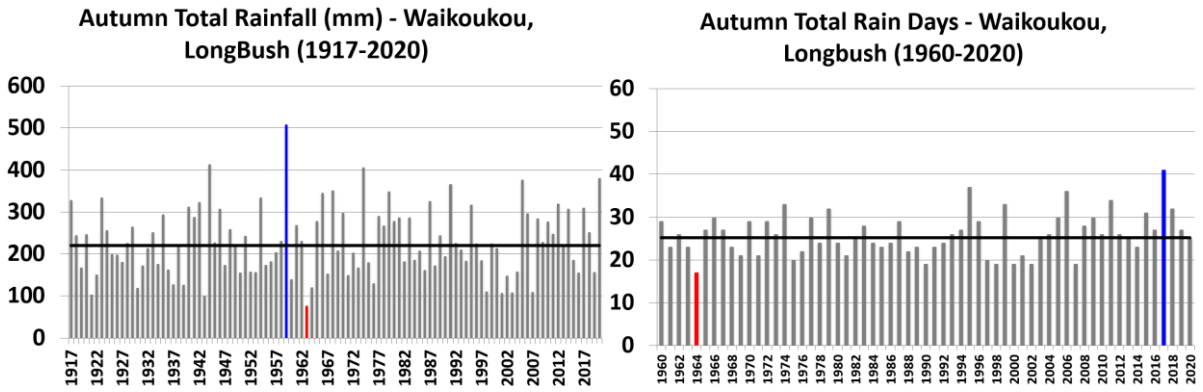


Figure 2.5: Climate change and variability graphs for autumn in Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs, the bright red and blue bars show the extreme min and max values for each time series (red for warm, dry, sunny and calm and blue for cool, wet, cloudy and windy). The key variables shown are: mean temperature, total number of sunshine hours, mean wind speed, total rainfall and total number of rain days (>0.1mm). Missing bars means that no reliable mean seasonal data was available for that particular year. The last bar of each graph shows the last available data for the currently analysed season, unless there are missing data.

2.6 Observed rainfall and soil moisture conditions for selected sites

Figure 2.6 shows the location of selected GWRC rainfall and soil moisture monitoring sites. Plots of accumulated rainfall and soil moisture trends are provided in the following pages.

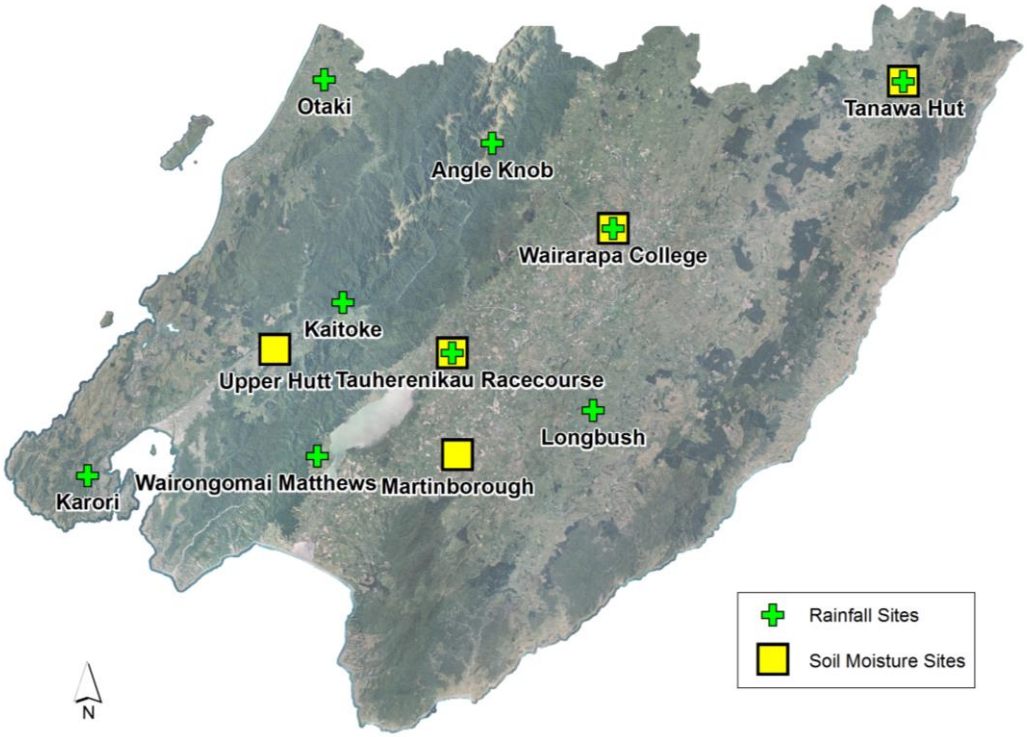


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

2.6.1 Rainfall accumulation for hydrological year (1 June to 31 May)

The following rainfall plots show total rainfall accumulation (mm) for the hydrological year at several locations. For comparative purposes, cumulative plots for selected historic years with notably dry years have been included as well as the site average.

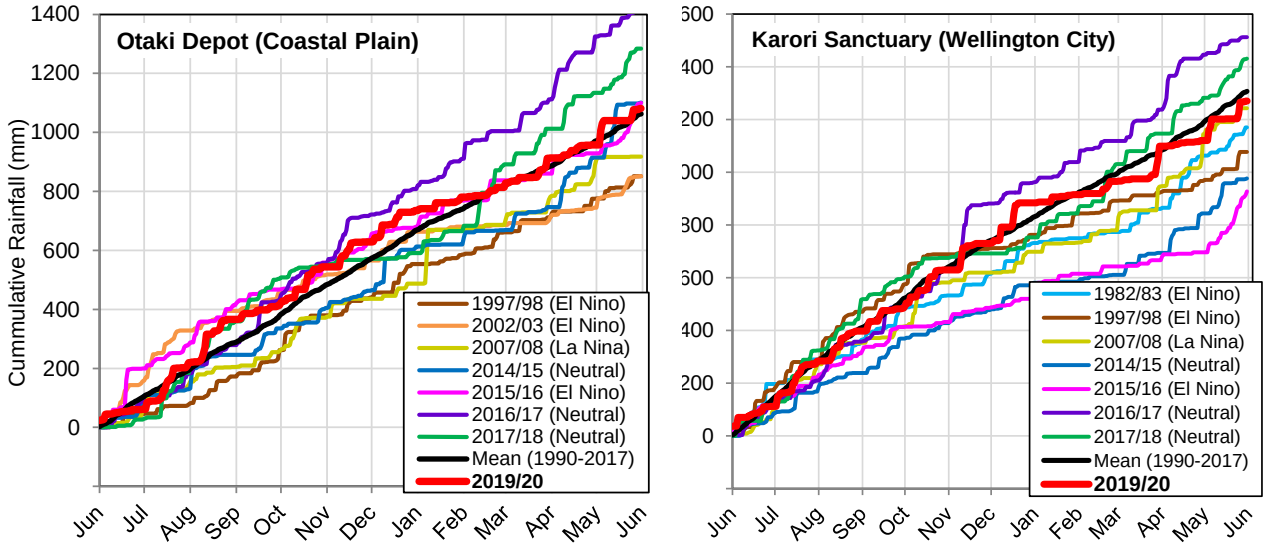
Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa have only been operating since the late 1990s so the period of data presented is limited to the last two decades. For each historical record plotted, an indication of ENSO climate state (El Niño, La Niña or neutral) at that time is also given.

GWRC does not operate a rain gauge in the southern-most parts of the Wairarapa Valley that is suitable for presenting data in this report. This means that we cannot be confident that the rainfall patterns seen elsewhere extend to this part of the region other than the VCSN data already presented.

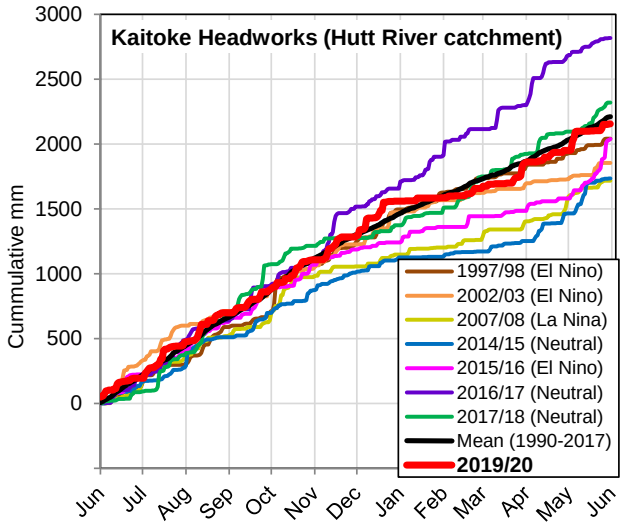
Over the entire year total rainfall accumulations have been about average in many parts of the Region.

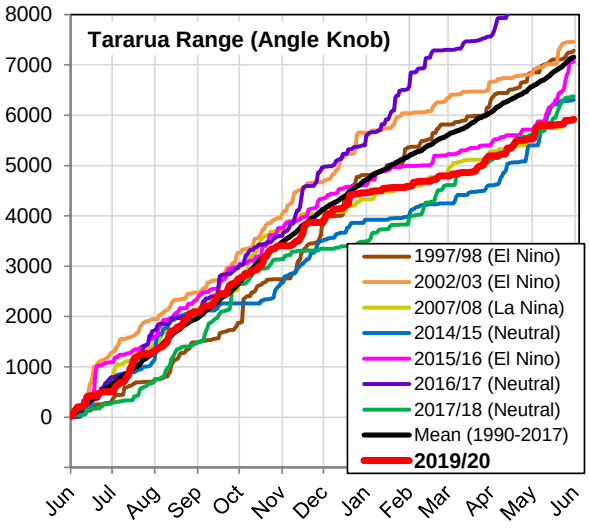
Lower than normal accumulation is evident at Wairarapa rain gauges in particular from December to April. A significant deficit was still observed at the end of June for the high elevation areas of the Tararuas (Angle Knob), and for the eastern Wairarapa.

Kāpiti Coast and Southwest (Wellington city)

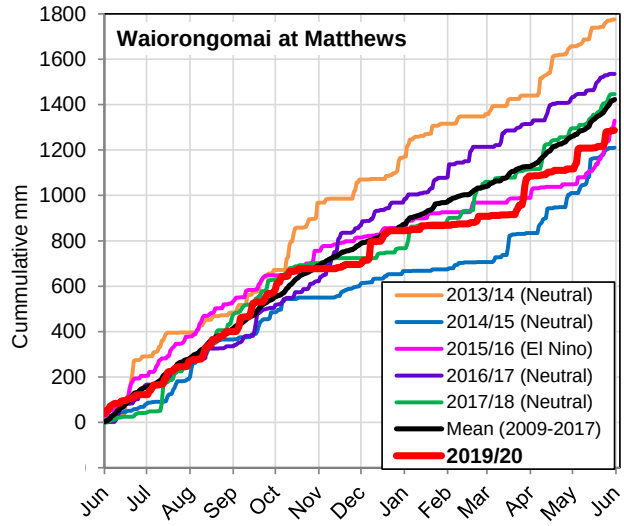


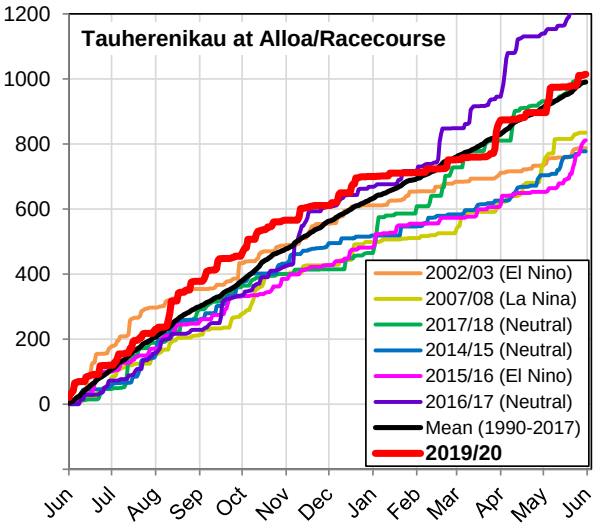
Hutt Valley and the Tararua Range

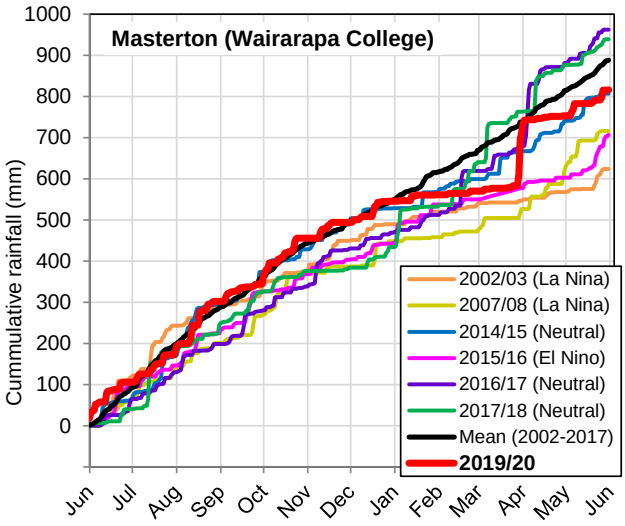


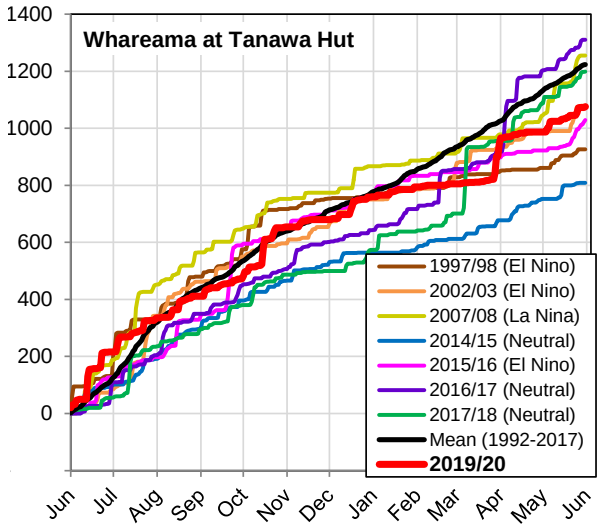


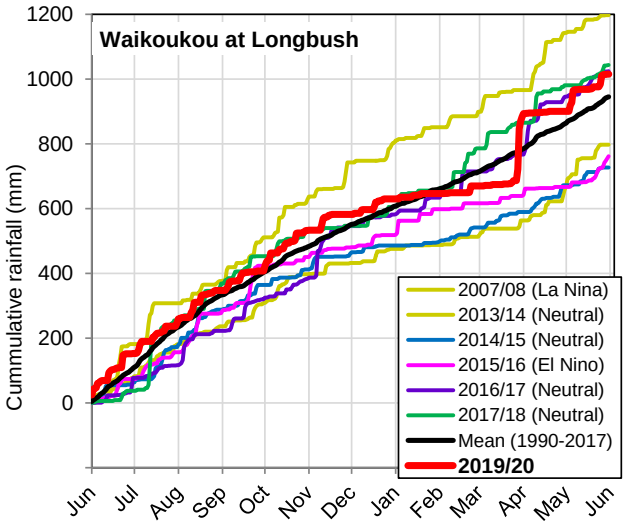
Wairarapa











Live cumulative plots (updated daily): Real-time graphs for cumulative rainfall are available online at GWRC's environmental data webpage (http://graphs.gw.govt.nz/). Select a rainfall monitoring site, then choose *Cumulative Historic* from the *Interval* selector, then optionally change the period from the last 12 months to the hydrological year (July – June) as required.

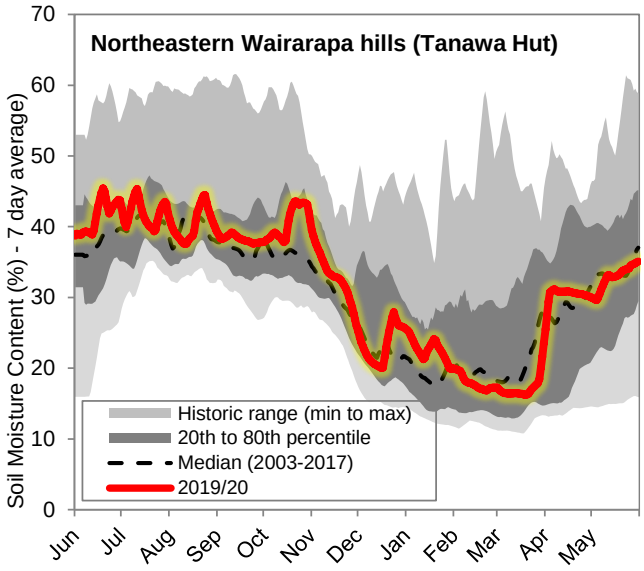
2.6.2 Soil moisture content (since 1 June 2019)

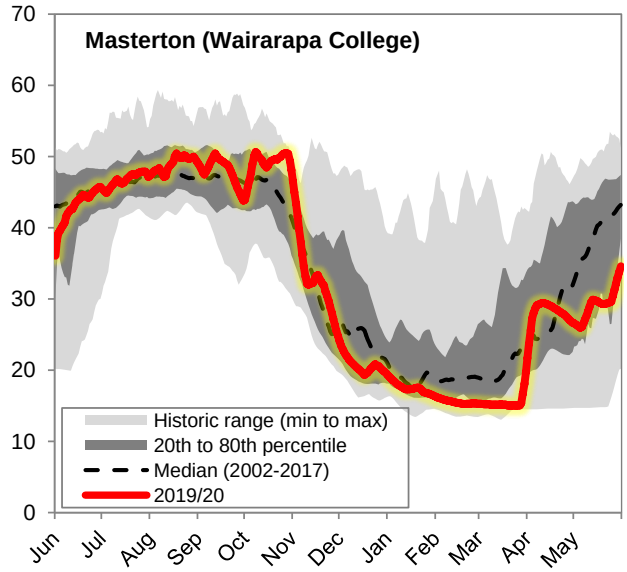
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2019. This is plotted over an envelope of the range of historic recorded data (and the median) at the site to provide an indication of how the current soil moisture compares with that for a similar period in past years.

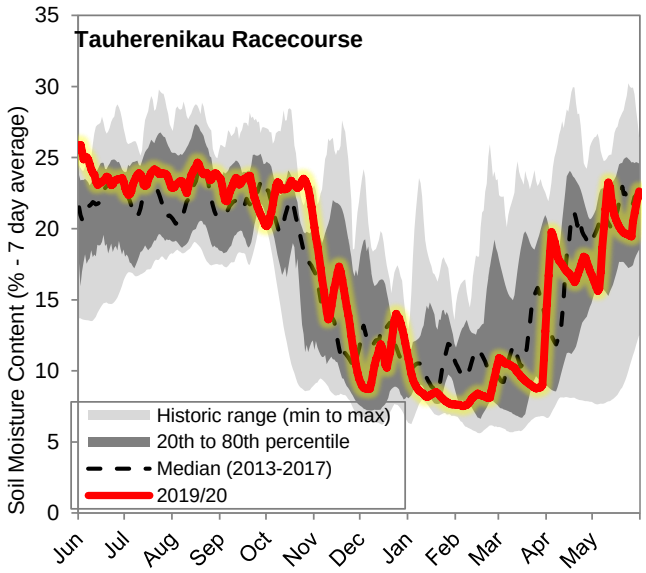
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated to provide accurate absolute measures of soil moisture.

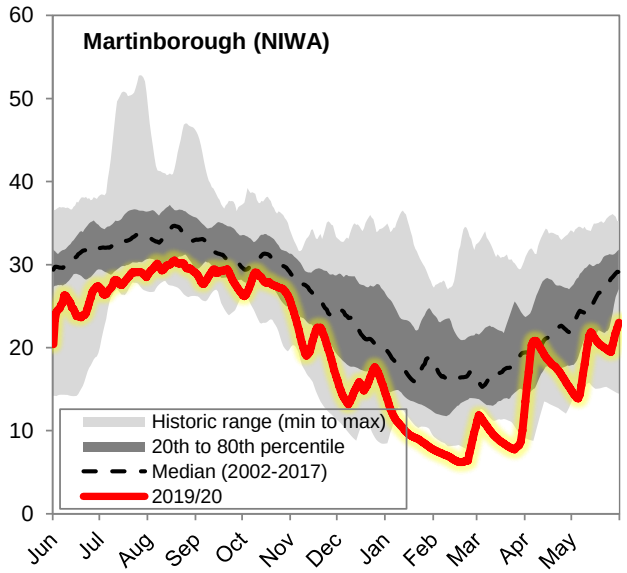
Soil moisture levels were below average most of the year at Martinborough and during summer/autumn at many sites.

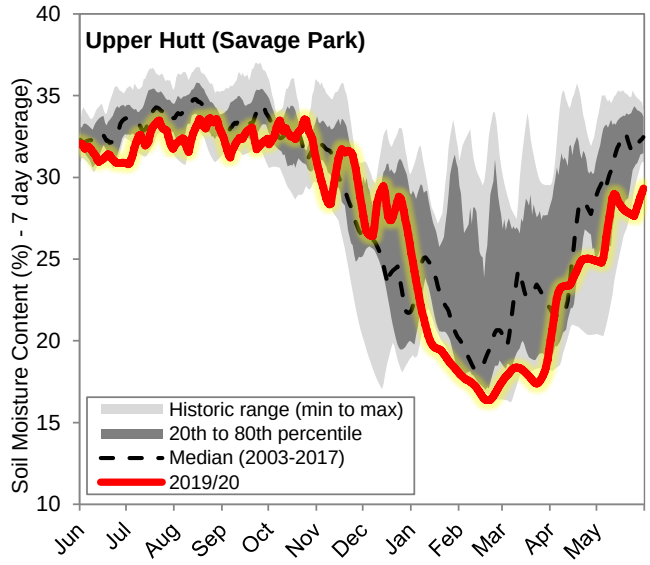
(a) Wairarapa











(b) Hutt Valley

Live soil moisture plots (updated daily): Real-time "envelope" graphs for soil moisture are available online at GWRC's environmental data webpage (http://graphs.gw.govt.nz/). Select a soil moisture monitoring site, then choose *Envelope Graph* from the *Interval* selector, then optionally change the period from the last 12 months to the hydrological year (July – June) as required.

3. Outlook for winter and early spring 2020

- ENSO (El Niño – Southern Oscillation) is expected to be neutral in winter, tending to a possible La Niña into spring;
- Sea Surface temperatures around New Zealand are expected to remain mostly above average, especially to the east of the country;
- Warmer than normal daytime, with closer to average nighttime temperatures and normal winter frosts during periods of high pressure;
- High chance of sporadic heavy rainfall events;
- Normal to above rainfall in the west and normal to below in the Wairarapa coast. Low confidence for total seasonal accumulation, high month-to-month variability

Whaitua*	Variables	Climate outlook for winter 2020
Wellington Harbour & Hutt Valley	**Temperature:**	Above average daytime, but colder nights and inland frosts during persistent high pressure flows.
	Rainfall:	About normal, low confidence for seasonal total. Heavy rainfall events likely, in between longer dry periods.
Te Awarua-o-Porirua	**Temperature:**	Above average daytime, but colder nights and inland frosts during persistent high pressure flows.
	Rainfall:	About normal, low confidence for seasonal total. Heavy rainfall events likely, in between longer dry periods.
Kāpiti Coast	**Temperature:**	Above average daytime, but colder nights and inland frosts during persistent high pressure flows.
	Rainfall:	Normal to above. Heavy rainfall events likely, in between longer dry periods.
Ruamāhanga	**Temperature:**	Above average daytime, but colder nights and frosts during persistent high pressure flows.
	Rainfall:	About normal, low confidence for seasonal total. Heavy easterly rainfall events possible.
Wairarapa Coast	**Temperature:**	Above average daytime, but colder nights and inland frosts during persistent high pressure flows.
	Rainfall:	Normal to below, low confidence for seasonal total. Heavy easterly rainfall events possible.

*See http://www.gw.govt.nz/assets/Environment-Management/Whaitua/whaituamap3.JPG for whaitua catchments

Acknowledgments

We would like to thank NIWA for providing selected VCSN data points for the calculation of the regional soil moisture map and for supplementing the rainfall percentage maps in data sparse areas.

Online resources

GWRC online climate mapping tools

Live regional climate maps (updated daily): Climate maps for regional rainfall and soil moisture (updated daily) are provided online at GWRC's environmental data webpage (graphs.gw.govt.nz/#dailyClimateMaps)

Drought check: http://www.gwrc.govt.nz/drought-check/

Interactive climate change and sea level rise maps: This webpage provides easy to plot climate change mapping that illustrates the predicted future impacts of climate change in the Wellington Region. Maps are available for every season, for mid (2040) and late century (2090). A total of 21 climate variables can be plotted, for every greenhouse gas emission scenario modelled by the IPCC. Dynamical downscaling provided by NIWA: https://mapping1.gw.govt.nz/gw/ClimateChange/

Key Reports

Main climate change report (NIWA 2017)

http://www.gw.govt.nz/assets/Climate-change/Climate-Change-and-Variability-report-Wlgtn-Regn-High-Res-with-Appendix.pdf

Main climate drivers report (Climate Modes) (NIWA 2018)

http://www.gw.govt.nz/assets/Our-Environment/Environmental-monitoring/Environmental-Reporting/GWRC-climate-modes-full-report-NIWA-3-Sep-2018-compressed.pdf

Climate change extremes report (NIWA 2019)

https://www.gw.govt.nz/assets/Climate-change/GWRC-NIWA-climate-extremes-FINAL3.pdf

GWRC Main Climate Portals

GWRC Climate change webpage

http://www.gw.govt.nz/climate-change/

GWRC Seasonal climate variability and water resources webpage

http://www.gw.govt.nz/seasonal-climate-and-water-resource-summaries-2/