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REGIONAL COUNCIL
Te Pane Matua Taiao

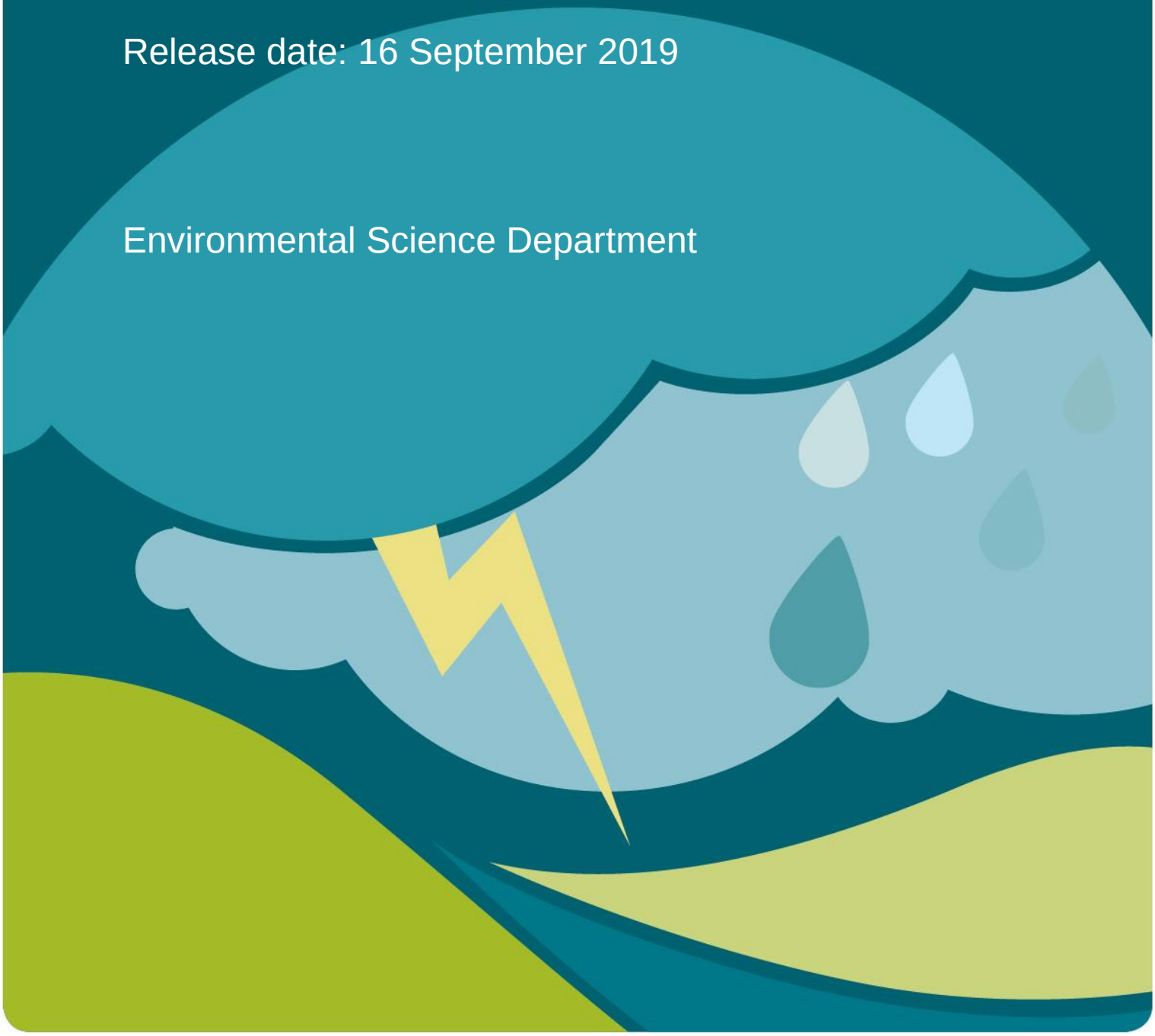
Climate and Water Resources Summary for the Wellington Region

Winter 2019 summary

Spring 2019 outlook

Release date: 16 September 2019

Environmental Science Department



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A very revealing satellite image showing a vigorous southwesterly flow over New Zealand. The blocking effect of the South Island meant that Wellington had a gorgeous winter day, with the relative humidity dropping to near 25%. At the same time, other parts of the country bore the brunt of many clouds and showers. Our many thanks to MetService for making this image available.

Overview

Winter 2019

Winter temperatures were well above average for most of the west and southern coastal areas, and closer to normal in the Wairarapa and east coast. We had the second hottest winter on record for Ngawi (measurements since 1972), and the third hottest winter on record for Wellington and the Kapiti coast. For Wellington, data goes back to 1927.

Total winter rainfall was average to below average around eastern and southern areas and slightly above average everywhere else. Most of the region was also slightly less windy than normal during this season.

Climate drivers

A weak El Niño - Southern Oscillation (ENSO) has now basically dissipated. Its influences on the winter pattern would have been quite minor, with the background warming of local Sea Surface Temperatures (SST) likely being the most important factor. Based on several models, the ENSO phenomenon is expected to remain neutral for the remaining of the year. Coastal waters around New Zealand have cooled down and are near normal, but waters to the east and northeast of the country remain warmer than average.

The Southern Annular Mode (SAM) has been predominantly in the negative phase during winter, and is expected to continue to oscillate between normal and negative into spring. Negative SAM during this time of the year is normally associated with unsettled weather and more westerlies around NZ.

Climate outlook for Spring 2019

In light of the climate drivers, the expectation is that the unfolding spring season will be characterised by relatively long periods of southerly flow, and unsettled weather, in between warmer spells. We expect near normal temperatures for the seasonal average, with periods of cold outbreaks associated with the negative phase of the Southern Annular Mode. Late frosts and snow are still possible until early November. Rainfall is expected to be about normal, possibly above average in some areas, for the total seasonal accumulation. There is a high chance of concentrated periods of heavy rainfall both in the west and in the Wairarapa (easterly events).

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).

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 has been provided by NIWA(https://mapping1.gw.govt.nz/gw/ClimateChange/).

Contents

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 remain neutral over the next few months. Therefore, ENSO should not be a significant player in the unfolding spring climate pattern.

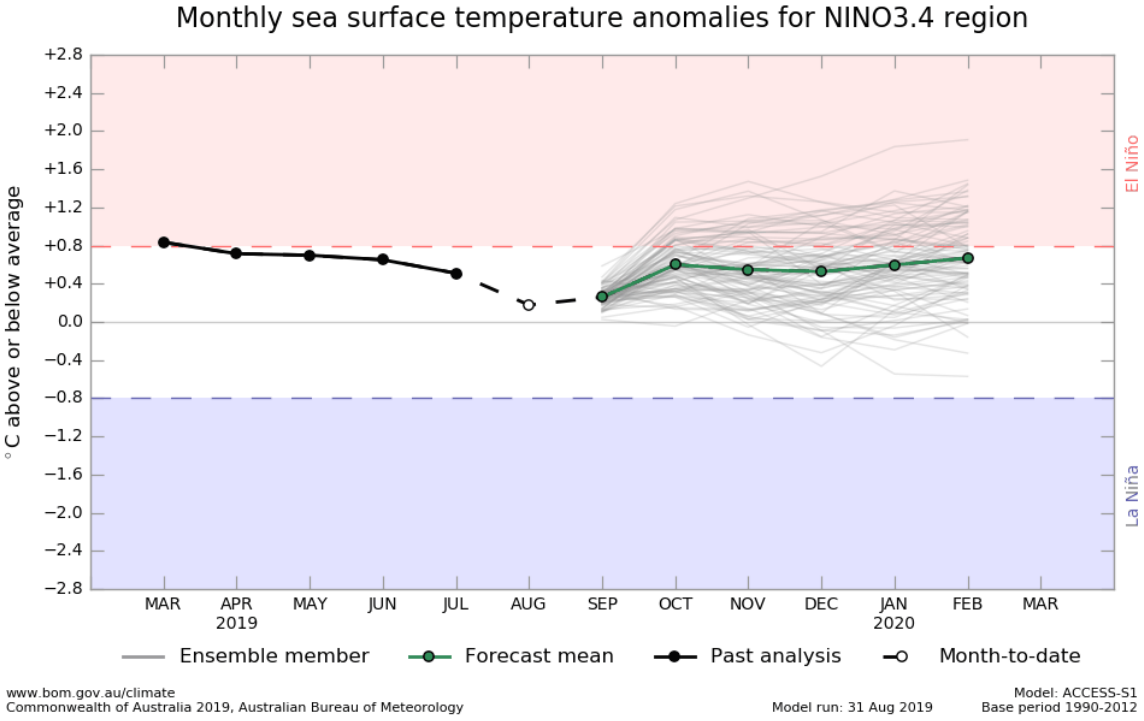


Figure 1.1: Averaged modelled projections (in green) show ENSO is expected to remain in a neutral phase until early 2020. Source: Australian Bureau of Meteorology.

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 5 September 2019. The pattern shows warmer than normal waters east of New Zealand, cold water south and north of Australia, and normal to cool waters around New Zealand directly.

The sea ice cover around Antarctica is also shown in white. Satellite measurements show that the ice extension remains well below average for this time of the year, which should be the time of maximum propagation to the north.

The warm SST patch to the northeast of New Zealand slightly increases the chance of heavy rainfall events during the next three months.

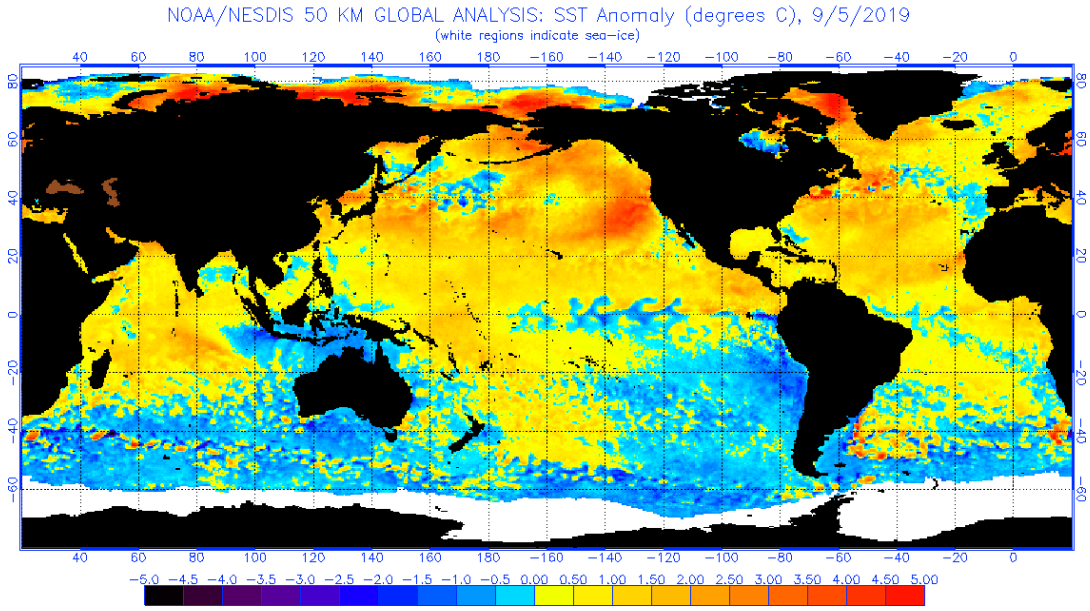


Figure 1.2: Sea surface temperature (SST) anomalies as of 5 September 2019. Sea ice coverage is shown in white. Waters around New Zealand remain warmer than average to the east. The Equatorial Pacific is currently neutral, and is expected to remain so over the next few months. Source: NOAA.

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 SAM was predominantly negative during the winter season, with a low pressure area to the south of New Zealand extending towards the North Island. Blocking high pressures are seen over Australia and to the east of New Zealand, creating a "collision" between northerly and southerly flows into the country, which contributes to instability. The unsettled weather and westerly winds associated with the low pressure area was particularly enhanced during August, and is expected to continue into spring.

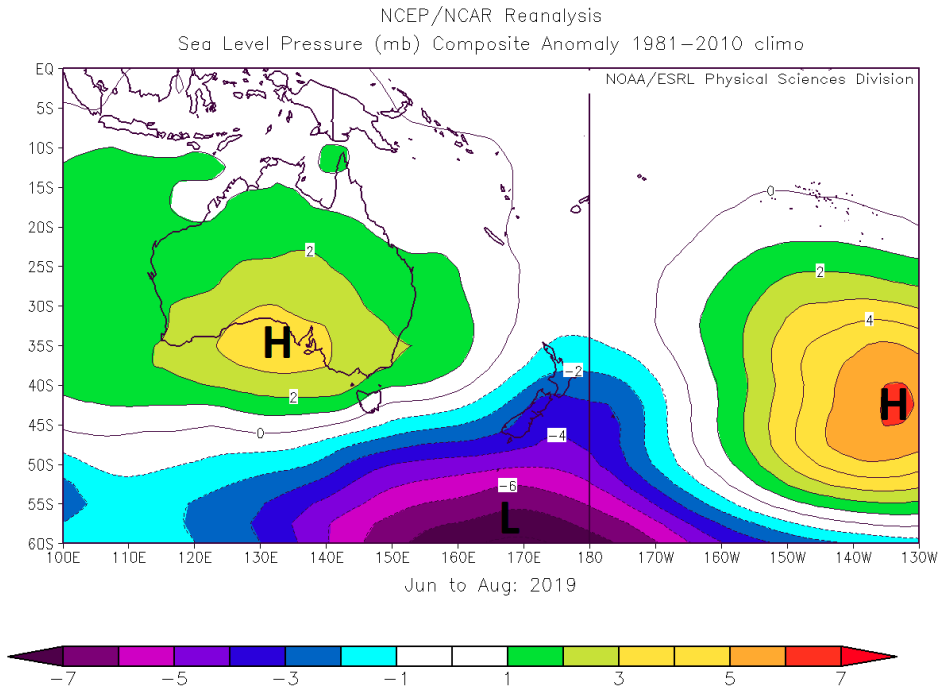


Figure 1.3: Mean sea level pressure anomaly (hPa) for JJA 2019. The 'H' indicates the position of the blocking high east of New Zealand and over Australia, and the 'L' indicates the average low pressure south of New Zealand. This pattern was associated with the negative phase of the Southern Annular Mode, which was significantly pronounced in August leading to a more unsettled weather pattern. 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 to prevail for the region during winter, especially over the coastal areas. The magnitude of the anomalies was slightly greater for the maximum daytime temperatures. We can also see that Masterton had cooler than average nighttime temperatures, which was likely caused by nocturnal radiative cooling under calm nights and clear skies.

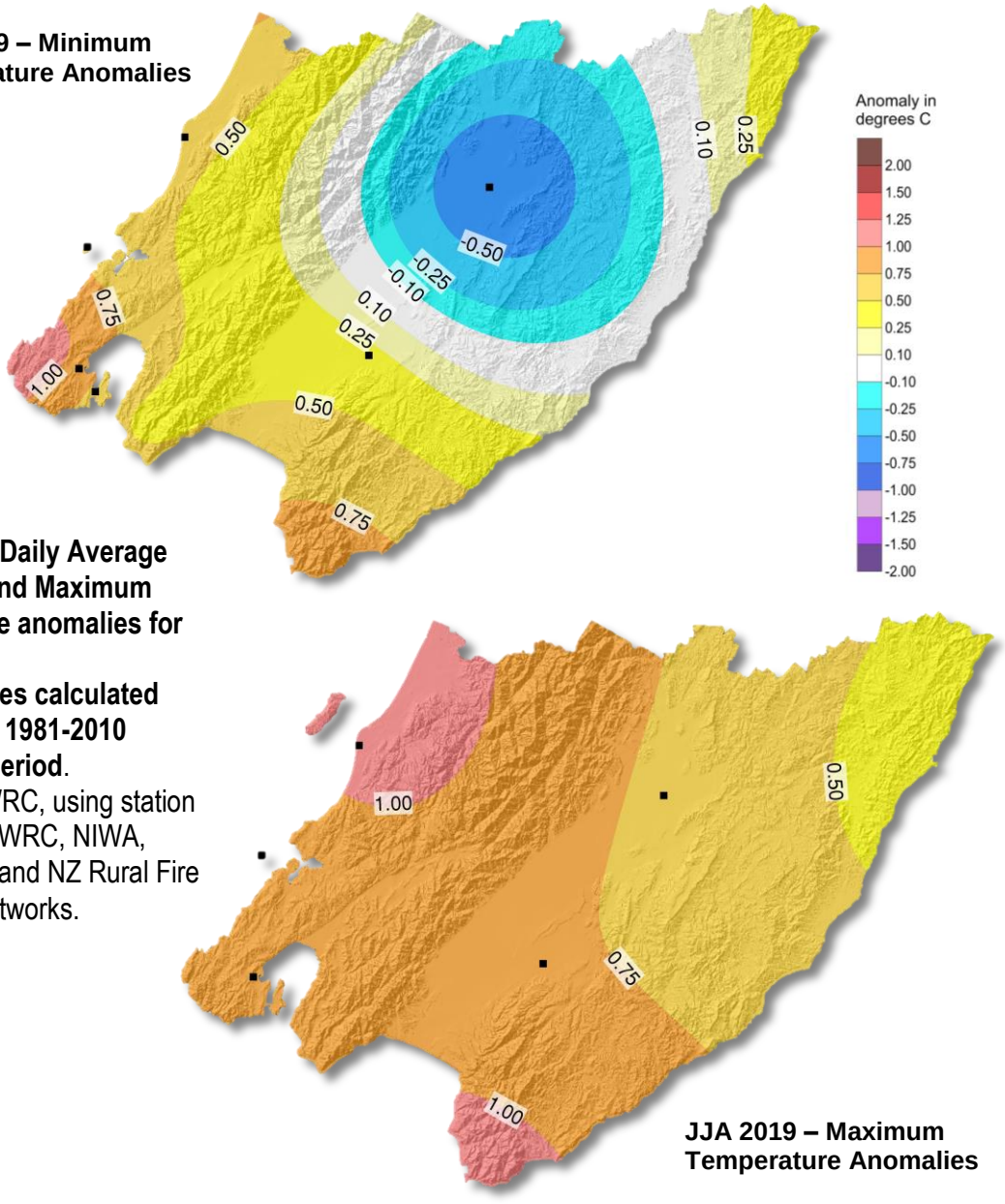


Figure 2.1: Daily Average Minimum and Maximum temperature anomalies for JJA 2019.
All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from GWRC, NIWA, MetService and NZ Rural Fire Authority networks.

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. We can see that the region had a pattern of lower than normal wind speeds over the season, except around the southern coast (Ngawi), where the anomalies were slightly positive (ie, slightly windier than normal).

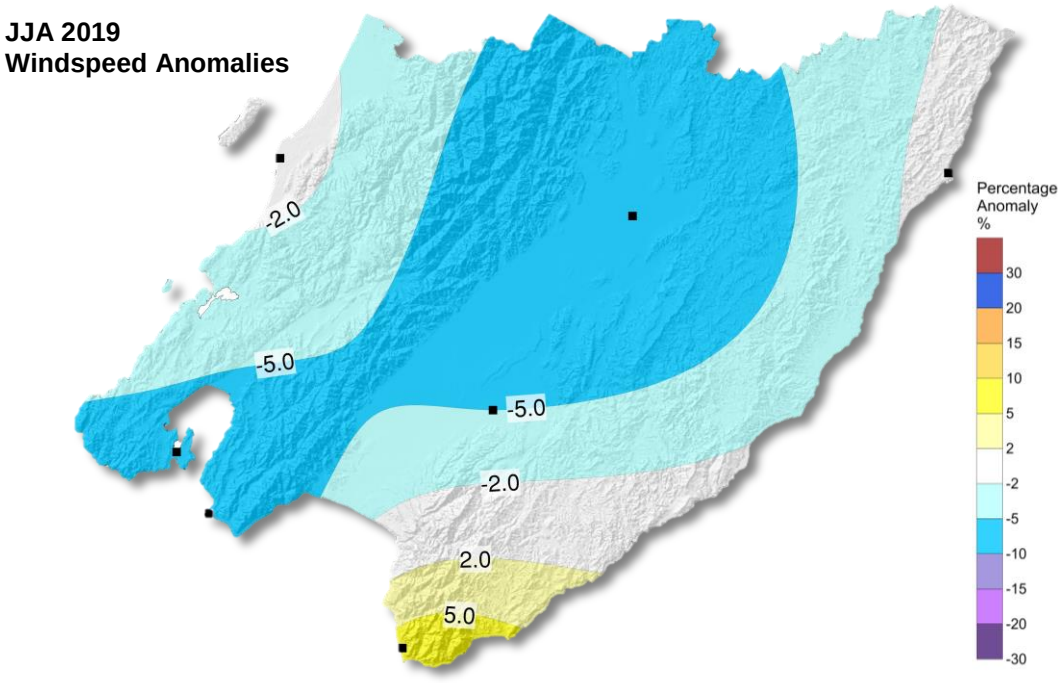


Figure 2.2: Daily mean wind anomalies (in percentage departure from the average) for JJA 2019. All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from NIWA and MetService.

2.3 Regional soil moisture

Figure 2.3 shows that the soil moisture levels for the region were around normal as of the beginning of spring.

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).

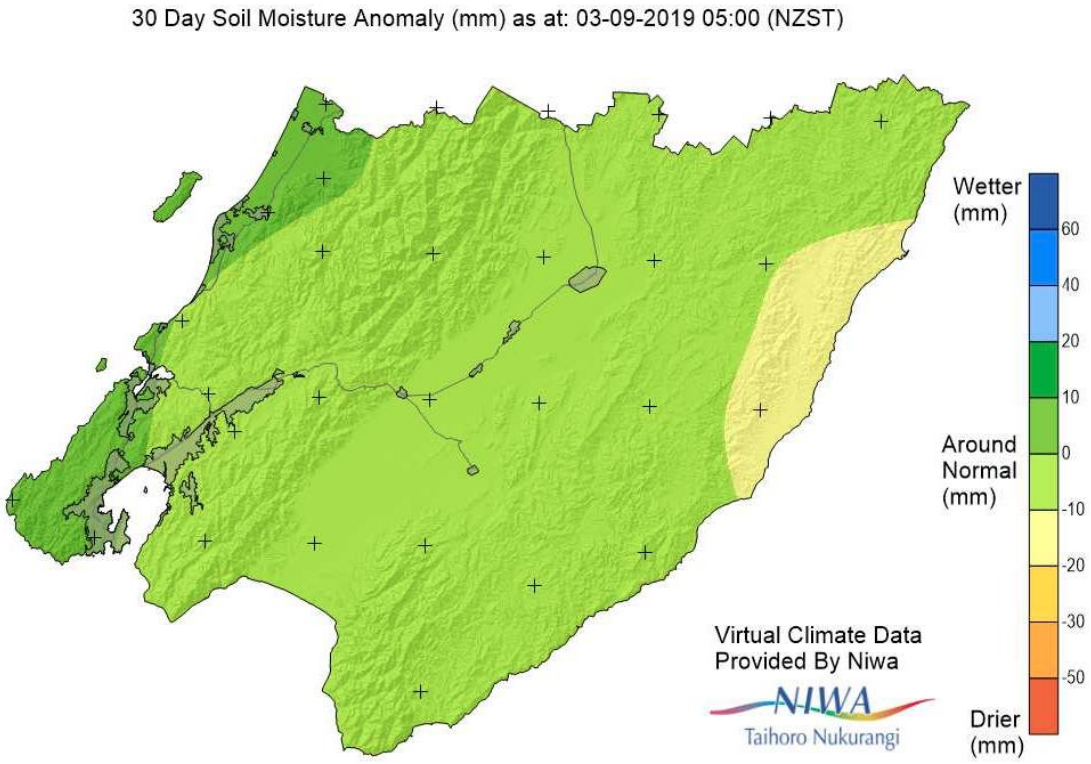


Figure 2.3: 30 Day Soil moisture anomaly up to 3 September 2019. Moisture levels show near normal conditions for most of the region. Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. ***Note that this data is indirectly calculated by modelling and interpolation techniques, and does not necessarily reflect the results obtained by direct measurements. This map should only be used for 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. Rainfall in June was below average to the west, south and east, with the Wairarapa valley and eastern hills receiving above average rainfall.

July and August rainfall showed similar patterns with wetter than average conditions to the west, the Tararua Range and parts of the Wairarapa valley.

Rainfall over the entire winter season showed average to below average conditions along the eastern and southern coasts, with the remainder of the region slightly above average.

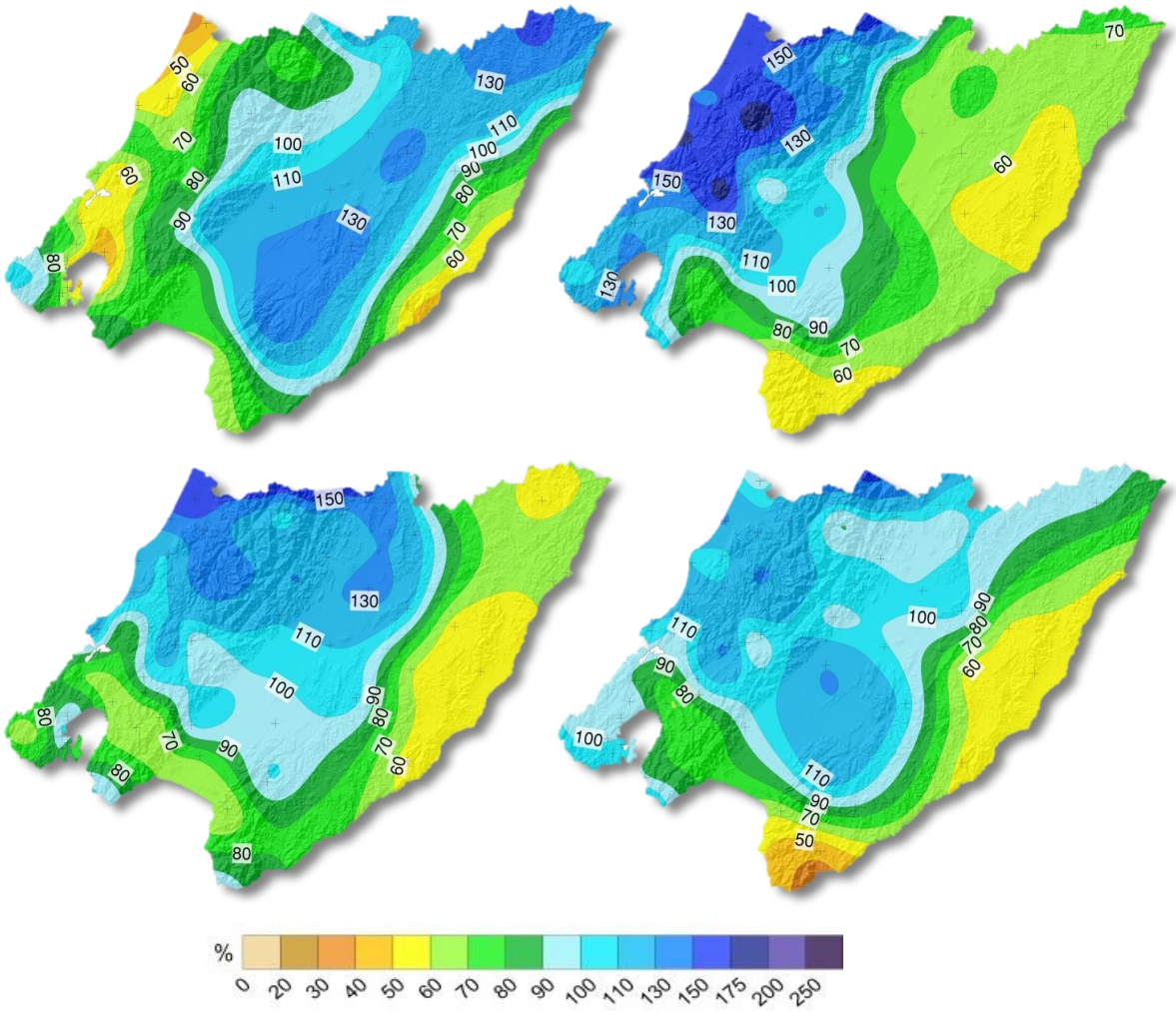


Figure 2.4: Rainfall for June (upper left), July (upper right), August (lower left) and JJA (lower right) 2019 as a percentage of the long-term average. Winter as a whole ranged from below average around the eastern and southern coasts to slightly above average everywhere else. Source: GWRC and NIWA.

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 (a sense of extreme hot/dry), and blue indicates seasons that were colder, wetter, cloudier and windier than average (an indication of extreme cold/wet). The reference climatological average (1981-2010) is shown by a horizontal bar where available.

All maps are grouped together for convenience of style, using the same scale between Wellington and Wairarapa whenever possible (except for wind which is much lower over the Wairarapa). The last bar in all graphs is the season covered in this report; unless there are data missing (in which case a blank space is shown).

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 summer is:

- Statistically significant trends are seen only for temperature (Wellington and Masterton), meaning winter is getting warmer both in Wellington and Wairarapa. The long-term warming is about 1.3 degrees per century in Wellington, and 1.2 degrees per century in Masterton;

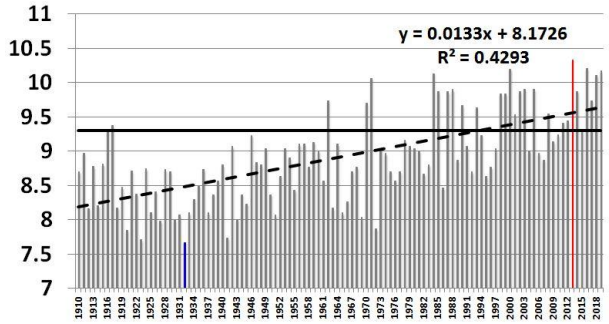
- Winter 2019 temperatures were above average for both Wellington and the Wairarapa, comparable to those observed in 2018. For Wellington, winter 2019 was the third hottest on record (strictly 4th hottest on record once the correction for the seven national reference stations is applied);

- Sunshine hours were well above average for Wellington, with a sharp contrast compared to winter last year;

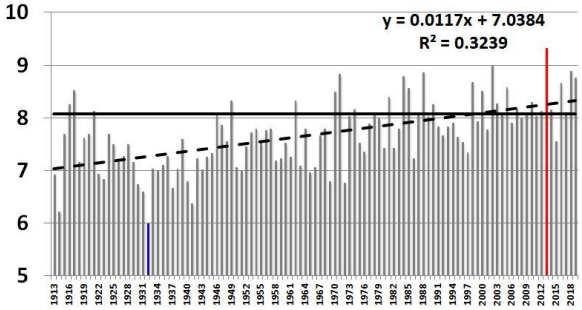
- Wind speed was below average for both Wellington and the Wairarapa;

- Rainfall and rain days were average to below average, except rain days for the Wairarapa which were above average.

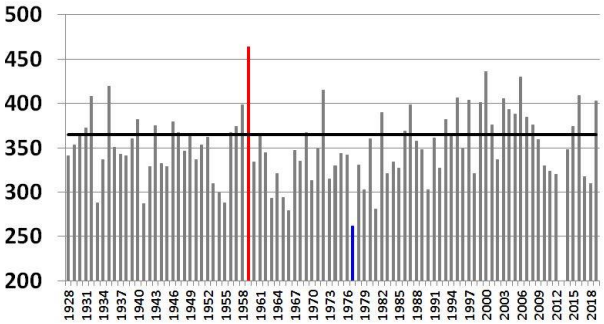
Winter Mean Temperature (deg C) - Kelburn (1910-2019)



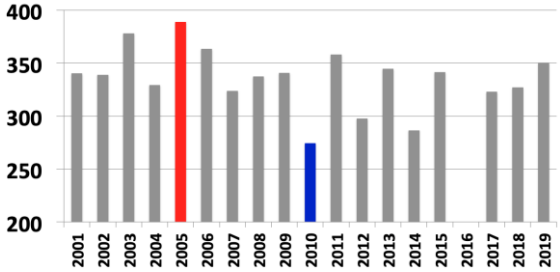
Winter Mean Temperature (deg C) - Masterton (1913-2019)



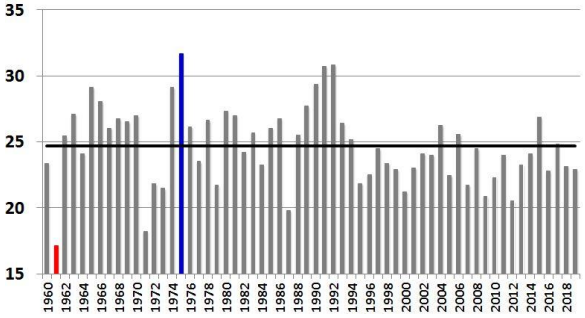
Winter Total Sunshine Hours - Kelburn (1928-2019)



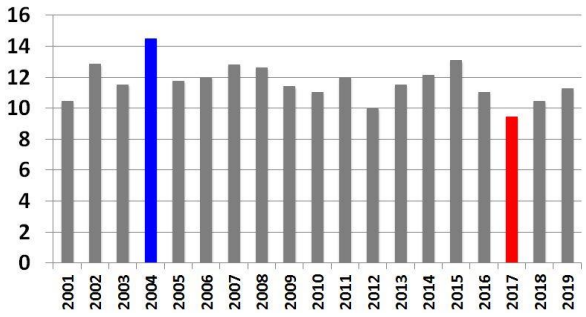
Winter Total Sunshine Hours - Martinborough (2001-2019)



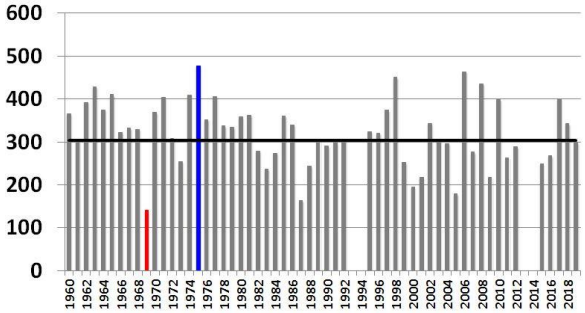
Winter Mean Wind (km/h) - Wellington Airport (1960-2019)



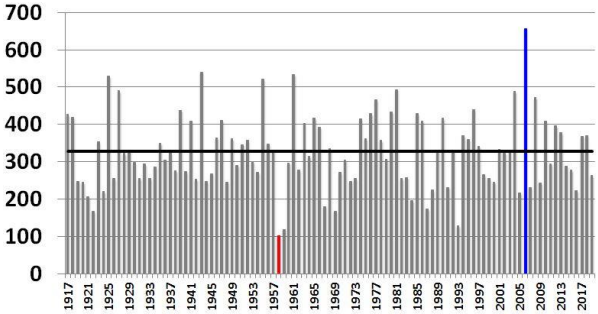
Winter Mean Wind (km/h) - Martinborough (2001-2019)



Winter Total Rainfall (mm) - Wellington Airport (1960-2019)



Winter Total Rainfall (mm) - Waikoukou, LongBush (1917-2019)



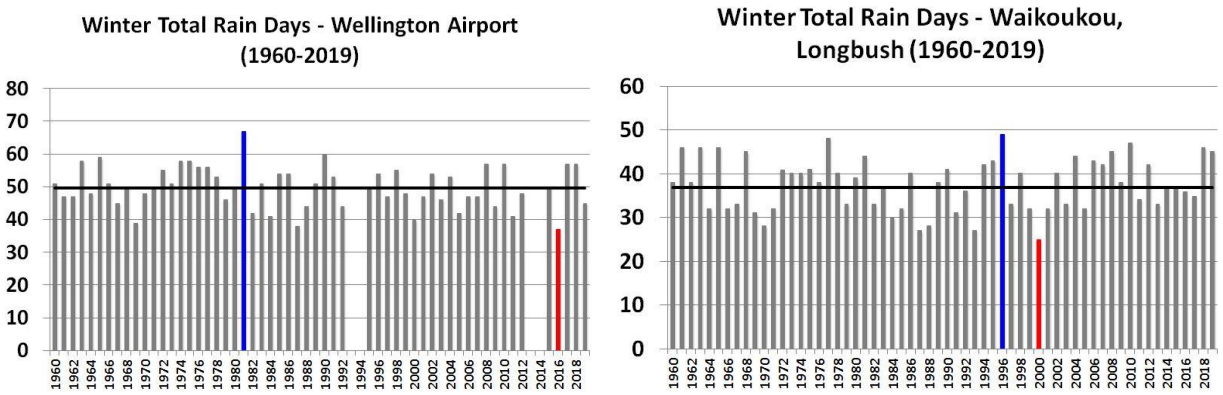


Figure 2.5: Climate change and variability graphs for winter in Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs, 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.

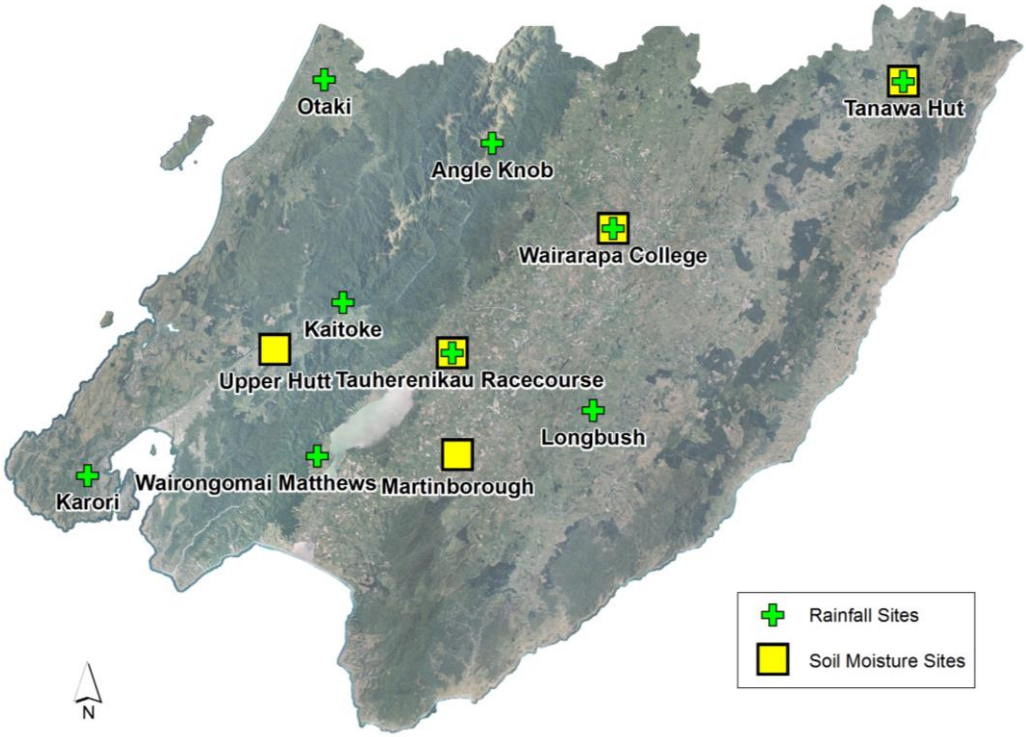


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

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

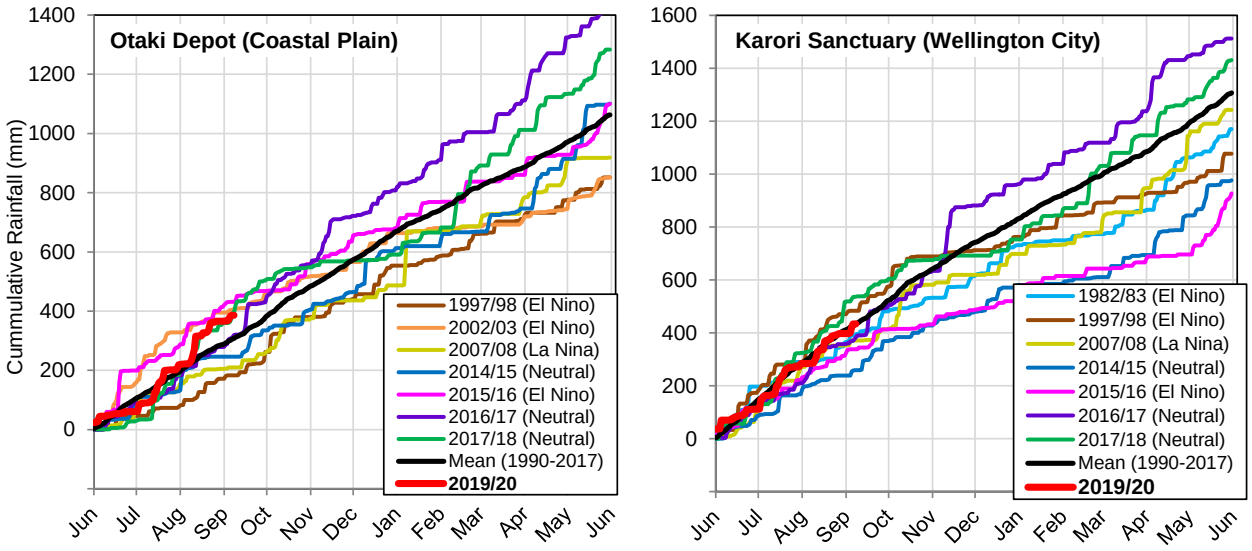
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year at several locations. For comparative purposes, cumulative plots for selected historic years with notably dry summers have been included as well as the site average.

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.

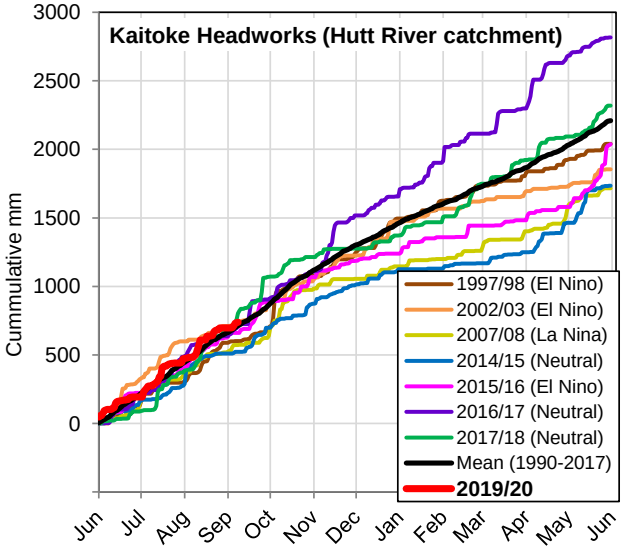
GWRC does not operate a rain gauge in the southern-most parts of the Wairarapa Valley that is suitable for presenting data in this report. This means that we cannot be confident that the rainfall patterns seen elsewhere extend to this part of the region other than the VCSN data already presented.

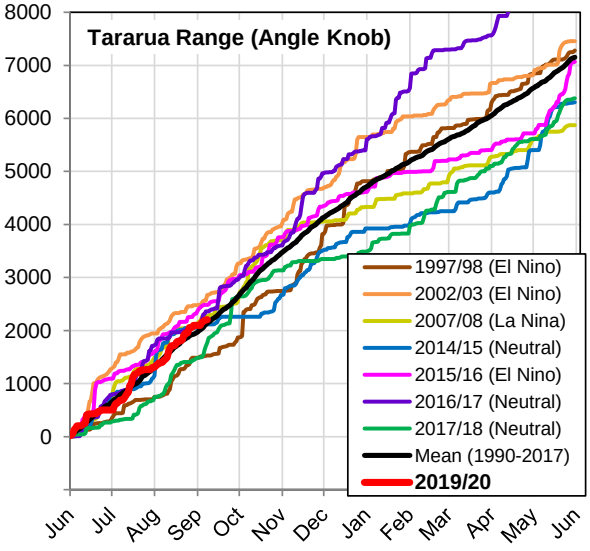
Overall, rainfall accumulations for the first three months of the June 2019 to May 2020 year are largely trending around average, with the exception of Otaki and Tauherenikau where large rainfall events in August bumped the accumulations up above average.

Kāpiti Coast and Southwest (Wellington city)

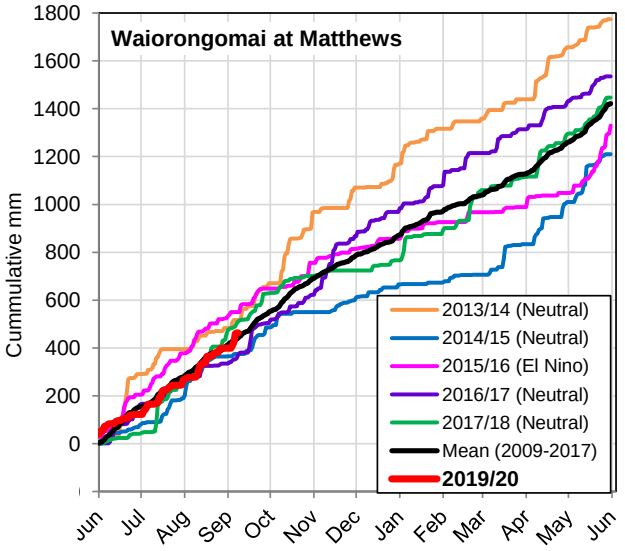


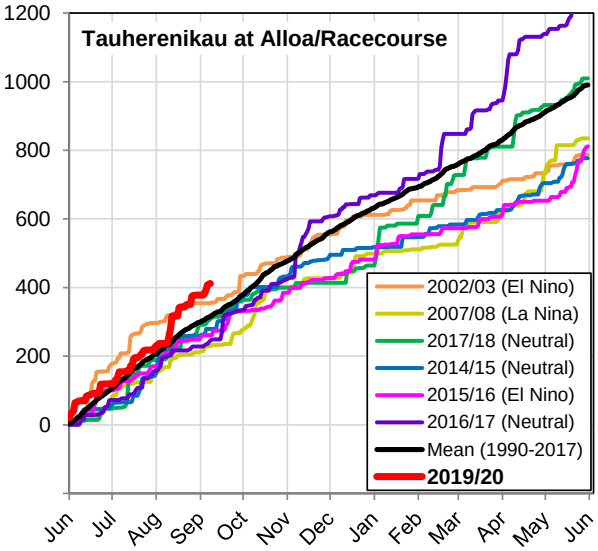
Hutt Valley and the Tararua Range

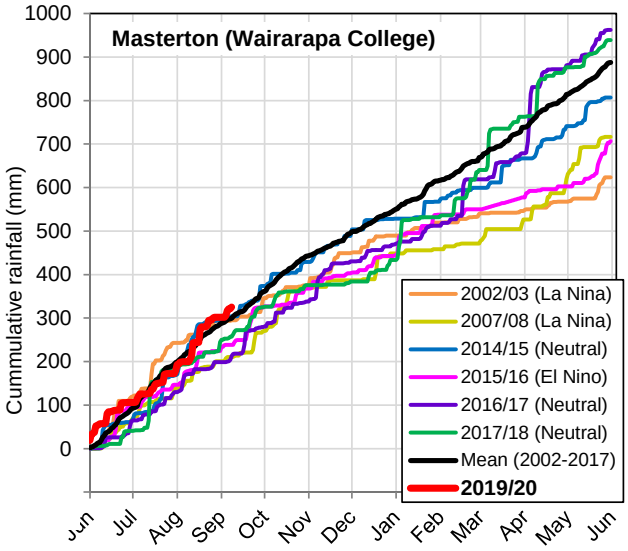


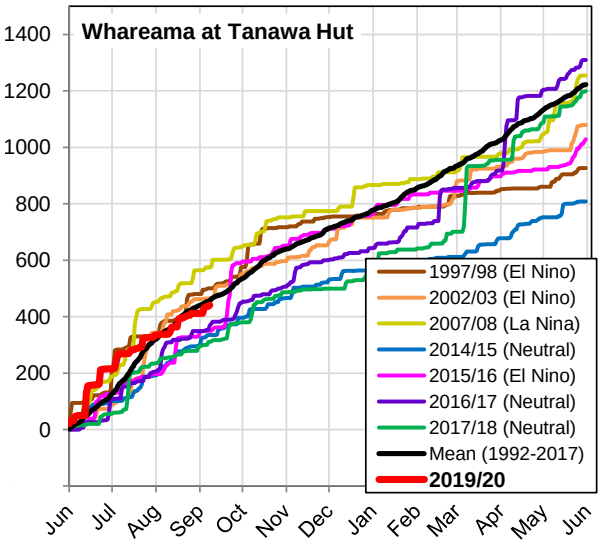


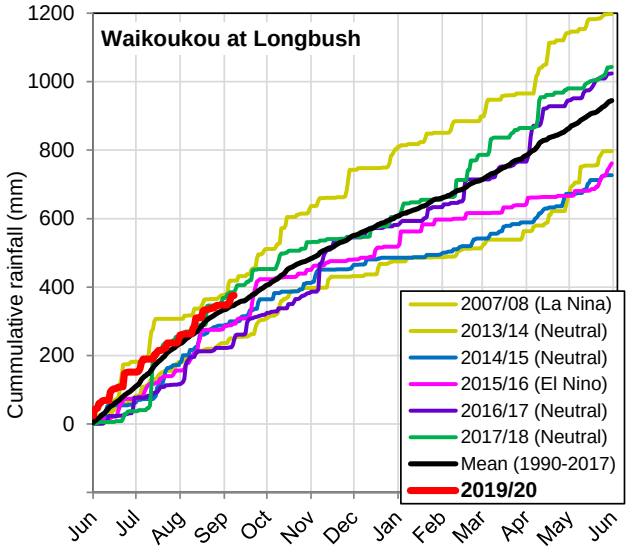
Wairarapa











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.

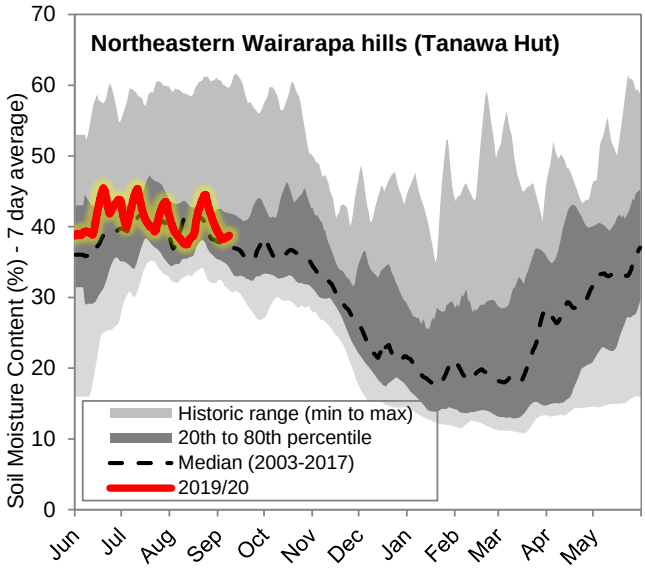
2.6.2 Soil moisture content (since 1 June 2019)

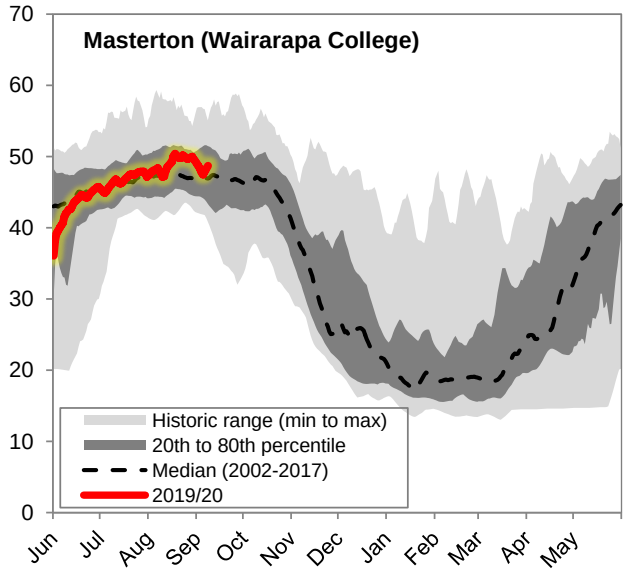
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2019. This is plotted over an envelope of the range of historic recorded data (and the median) at the site to provide an indication of how the current soil moisture compares with that for a similar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

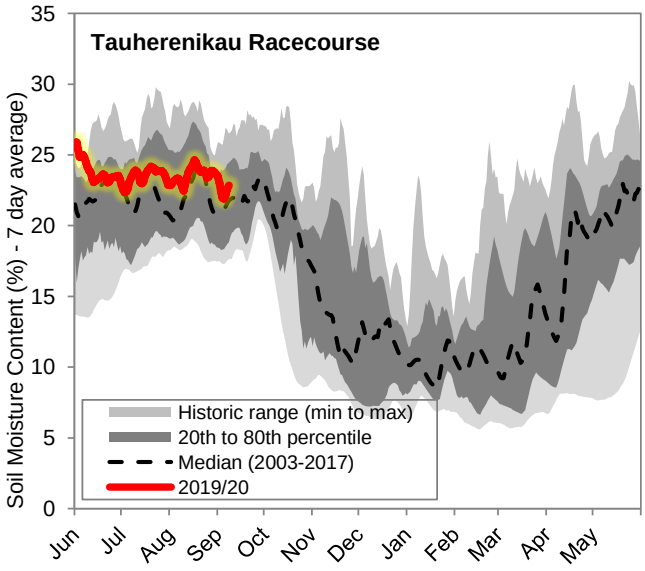
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated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

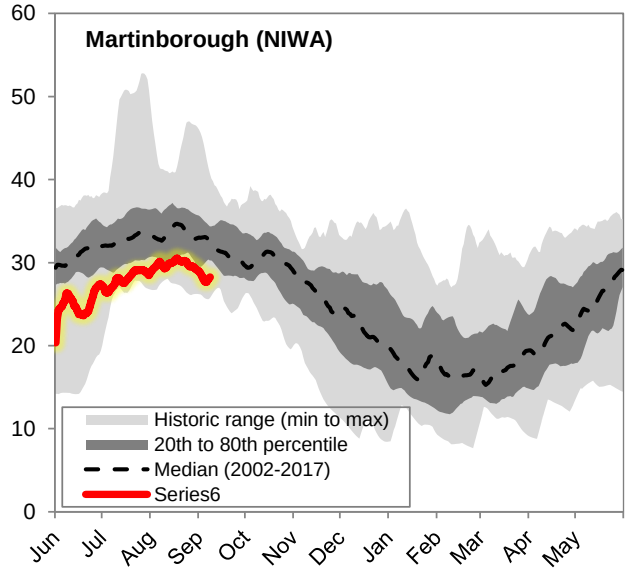
Soil moisture levels in the north-east Wairarapa, Masterton and Tauherenikau have been at near average conditions for the first three months of the 2019/20 hydrological year (JJA). Martinborough and Upper Hutt show slightly lower than average conditions.

(a) Wairarapa

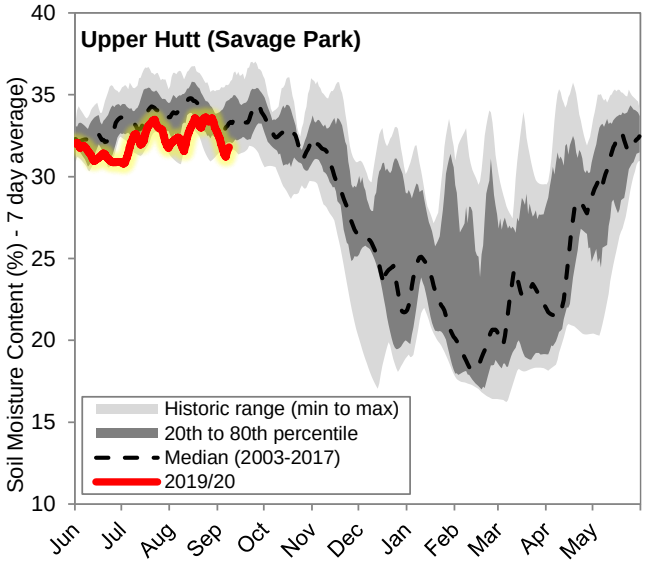








(b) Hutt Valley



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 spring 2019

- ENSO (El Niño – Southern Oscillation) is expected to remain **neutral**;
- Sea Surface temperatures around New Zealand remaining near average, with warmer than average waters to the east;
- **A variable season**: frequent westerly and southerly regime, with fronts and instability in between longer settled periods. Temperatures about normal on average, but high chance of cold outbreaks, with possible snow and frosts, until early November;
- **Variable rainfall**: High month to month variability. Total seasonal accumulation likely normal or possibly above average (low confidence for rainfall totals).

Whaitua*	Variables	Climate outlook for spring 2019
Wellington Harbour & Hutt Valley	**Temperature:**	About average. High chance of cold outbreaks and southerly flow in between longer settled periods.
	Rainfall:	Average to above. Heavy rainfall events likely.
Te Awarua-o-Porirua	**Temperature:**	About average. High chance of cold outbreaks and southerly flow in between longer settled periods.
	Rainfall:	Average to above. Heavy rainfall events likely.
Kāpiti Coast	**Temperature:**	About average. High chance of cold outbreaks and southerly flow in between longer settled periods.
	Rainfall:	Average to above. Heavy rainfall events likely.
Ruamāhanga	**Temperature:**	About average. High chance of cold outbreaks and southerly flow in between longer settled periods. .
	Rainfall:	Average to above. Heavy rainfall events likely.
Wairarapa Coast	**Temperature:**	About average. High chance of cold outbreaks and southerly flow in between longer settled periods.
	Rainfall:	About average, high month to month variability.

*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.

Appendix

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: Easy to plot climate change mapping, available for every season, for mid and late century. A total of 21 climate variables can be plotted, for every greenhouse gas emission scenarios modelled by the IPCC. Dynamical downscaling provided by NIWA: https://mapping1.gw.govt.nz/gw/ClimateChange/

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/

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