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Climate and Water Resources Summary for the Wellington Region

Summer 2018-2019 summary
Autumn 2019 outlook

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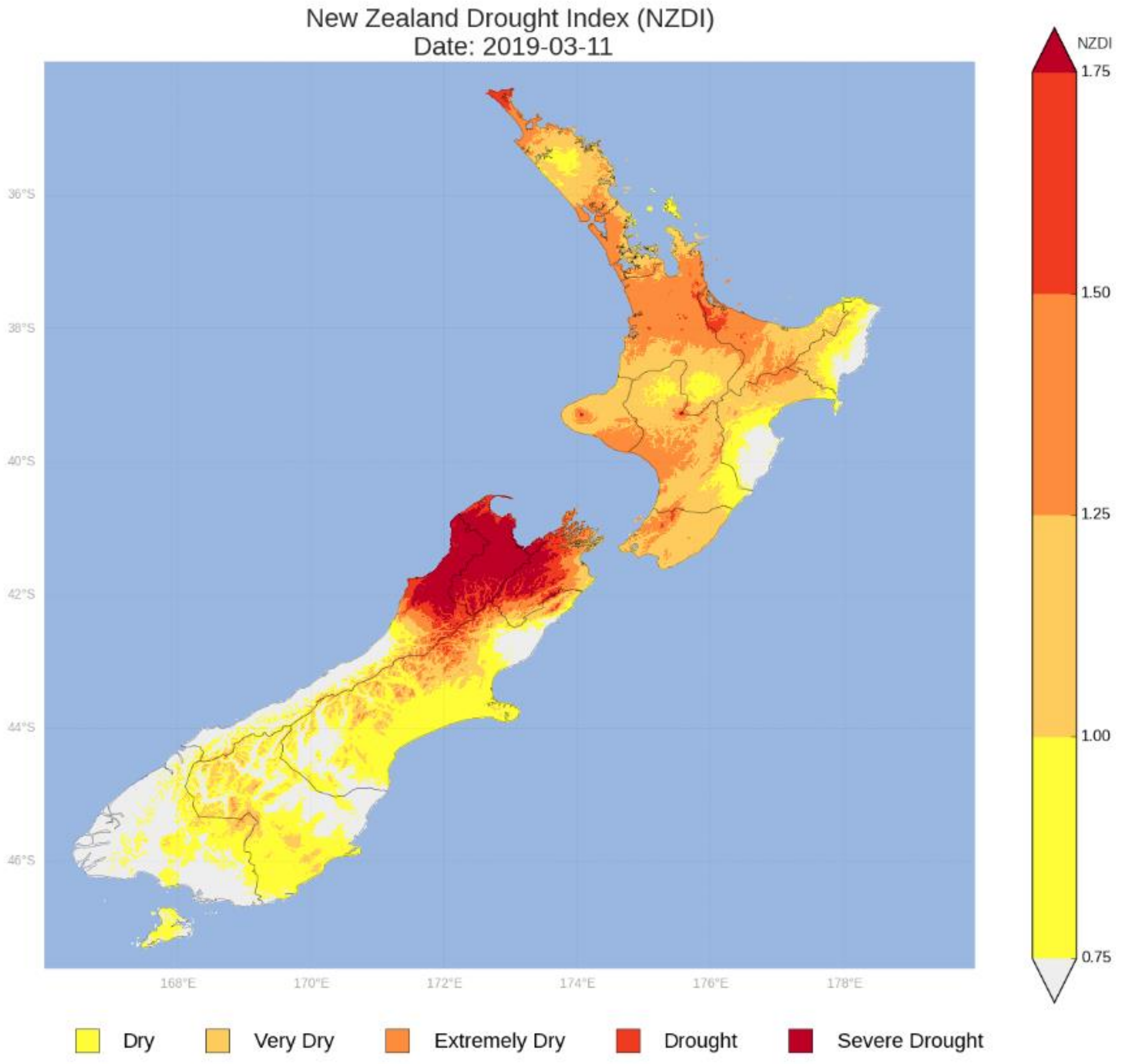


A view of the New Zealand drought monitoring index from NIWA, capturing the severity of the drought in the Tasman, Nelson and Marlborough areas early in March. The extreme fire season was a reminder that our climate is becoming more extreme, and less reliable. In January, Masterton had the lowest rainfall ever recorded this time of the year. Many thanks to NIWA for producing this map.

Overview

Summer 2018-2019

As predicted last year based on the state of the climate drivers, summer 2018-2019 was significantly warmer than average, even though less extreme and very different to the record hot summer of 2017-2018. Wellington and the Kāpiti coast had the 4^{th} hottest summer since 1927. For the Wairarapa, summer as a whole was amongst the top ten warmest, but January was the second warmest on record for Martinborough. Some extreme temperatures were very significant, with 30.3°C in Wellington on 29 January breaking the all-time record for Kelburn, for data since 1927. On the same day, Upper Hutt had a temperature of almost 34°C. At the same time, rainfall was extremely variable. December had rainfall almost three times the average in parts of the Wairarapa, whereas in January there was widespread lack of rain with only 6 mm falling in Masterton, the lowest ever measured in January at the measuring site. In the end, the summer average resulted as being just about normal in some areas, dry in the Kāpiti, and wet to the east of the Tararua ranges.

Climate drivers

A weak El Niño - Southern Oscillation (ENSO) phenomenon has developed, as predicted last year. But the event remains very weak, and not officially recognised by every research centre. Different centres use different activation thresholds. As such, the Bureau of Meteorology in Australia is still regarding the equatorial Pacific as being borderline neutral. Based on several models, the phenomenon is expected to either remain at similar levels to present over the next few months, or slightly intensify. At the same time, warm waters around New Zealand promote increased energy for potential severe weather events.

Climate outlook for autumn 2019

Even if the current El Niño phase remains active, statistically the ENSO has a low impact on our region during autumn. Based on the overall mixed signal from the climate drivers, we expect an alternating westerly/easterly regime. The warm water pattern means that heavy rainfall events are likely with possible flooding, in between longer drier periods. Temperatures are expected to remain normal to above average.

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 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 scenarios 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 borderline between El Niño and neutral over the next few months. If the event unfolds as predicted, it's unlikely to be intense. At this time of the year the ENSO impacts on the Wellington Region are statistically only minor.

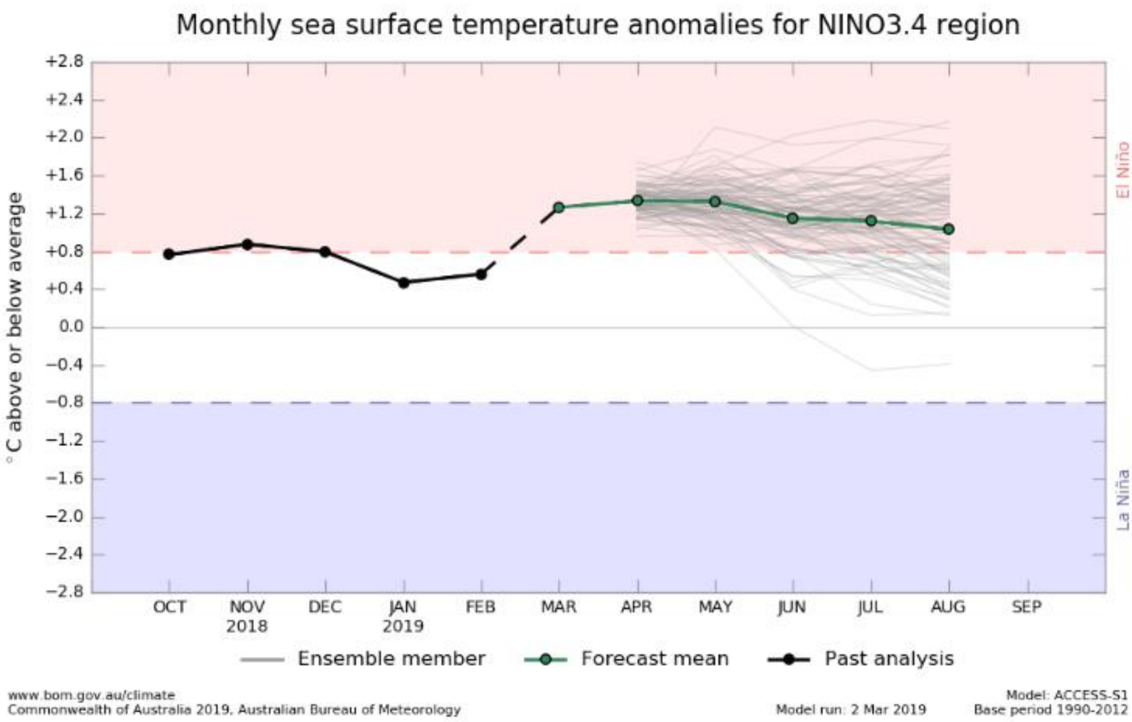


Figure 1.1: Averaged modelled projections (in green) show ENSO is expected to remain in a weak El Niño phase during the next few months. Source: Australian Bureau of Meteorology.

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 11 March 2019. The pattern shows warmer than normal waters around New Zealand, cold water south of Australia, and a fairly reduced sea ice cover around Antarctica (in white). The warm patch around New Zealand increases the chance of heavy rainfall events during the next three months.

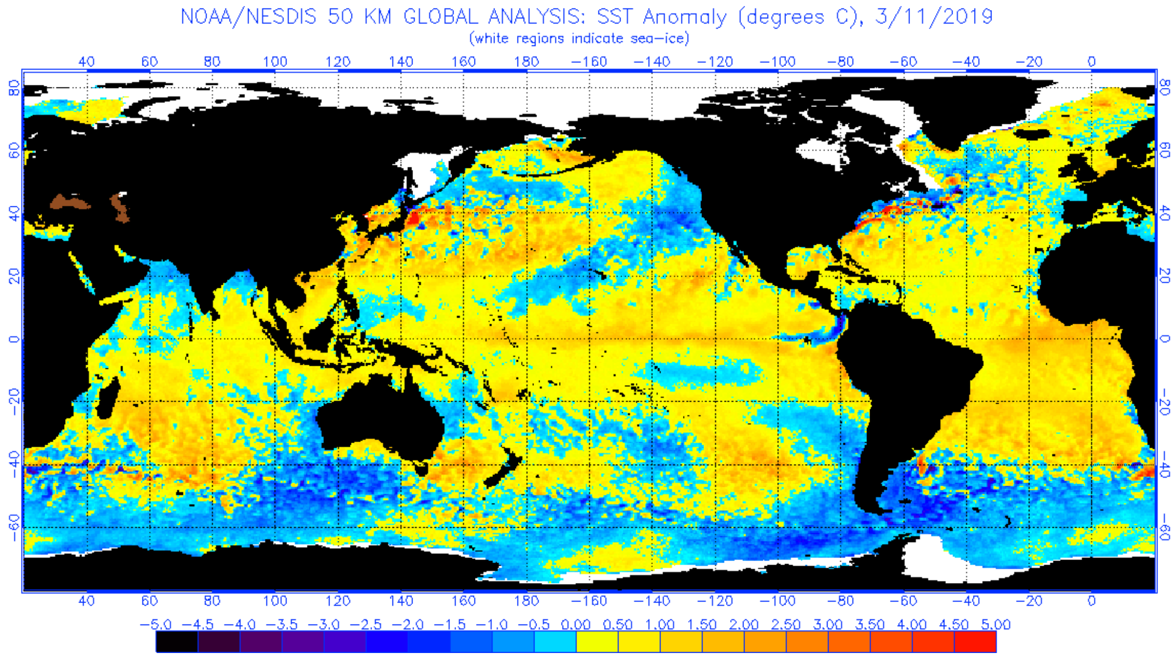


Figure 1.2: Sea surface temperature (SST) anomalies as of 11 March 2019. Sea ice coverage is shown in white. Waters around New Zealand remain warmer than average. The Equatorial Pacific is currently borderline between El Niño and neutral, and is expected to remain so over the next few months. Source: 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 positive during the summer season, with higher pressure than average around New Zealand and lower pressure to the south. This pattern helped explain the very dry and warm January that affected the region, and the lack of cold fronts from the south. The anomalous high pressure over the Tasman is also a typical atmospheric response to El Niño conditions, representing a significant change from the easterly pattern that had been observed during spring.

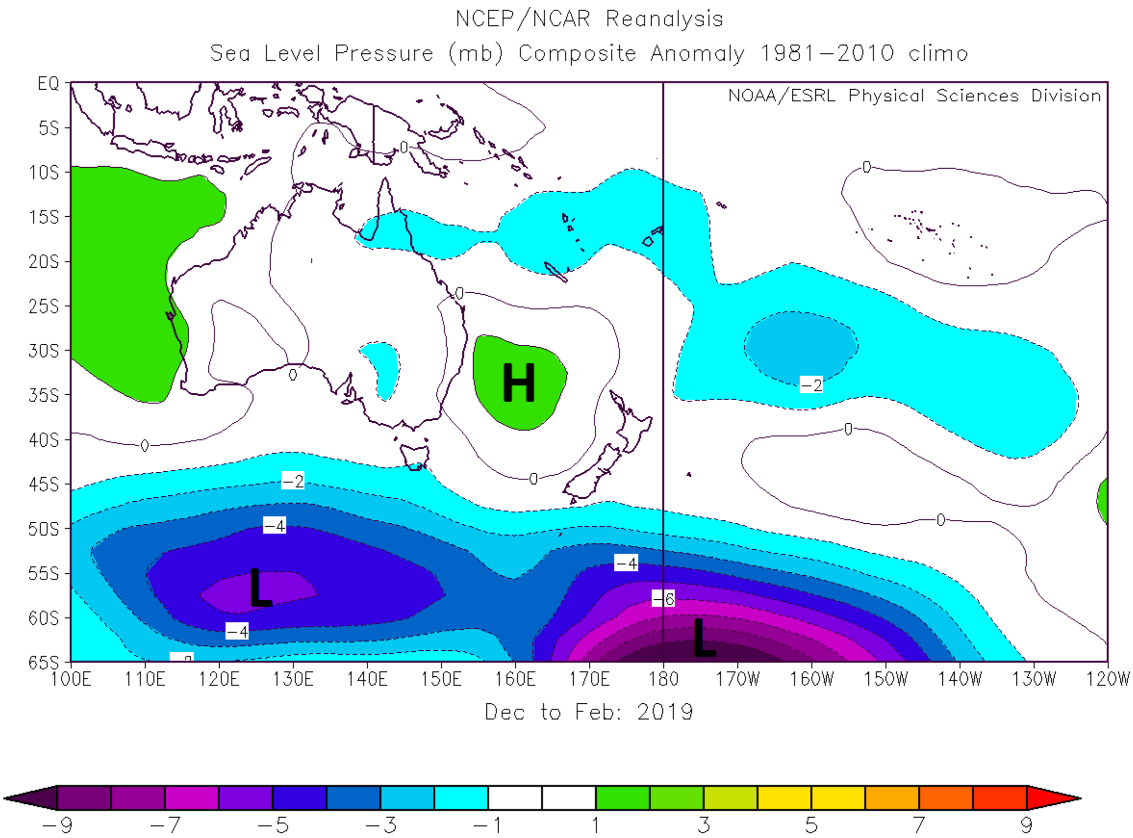


Figure 1.3: Mean sea level pressure anomaly (hPa) for DJF 2019. The 'H' indicates the area of above normal pressure over the Tasman Sea, followed by areas of low pressure (L) south of New Zealand. This pattern was associated with the positive phase of the Southern Annular Mode, with most fronts moving south of the country. This helps explain the anomalously warm and settled conditions, especially in January. 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).

We can see that warmer than average temperatures once again prevailed for the entire region, especially in the west and southern areas. The magnitude of the anomalies was greater for the maximum daytime temperatures, compared to the overnight temperatures.

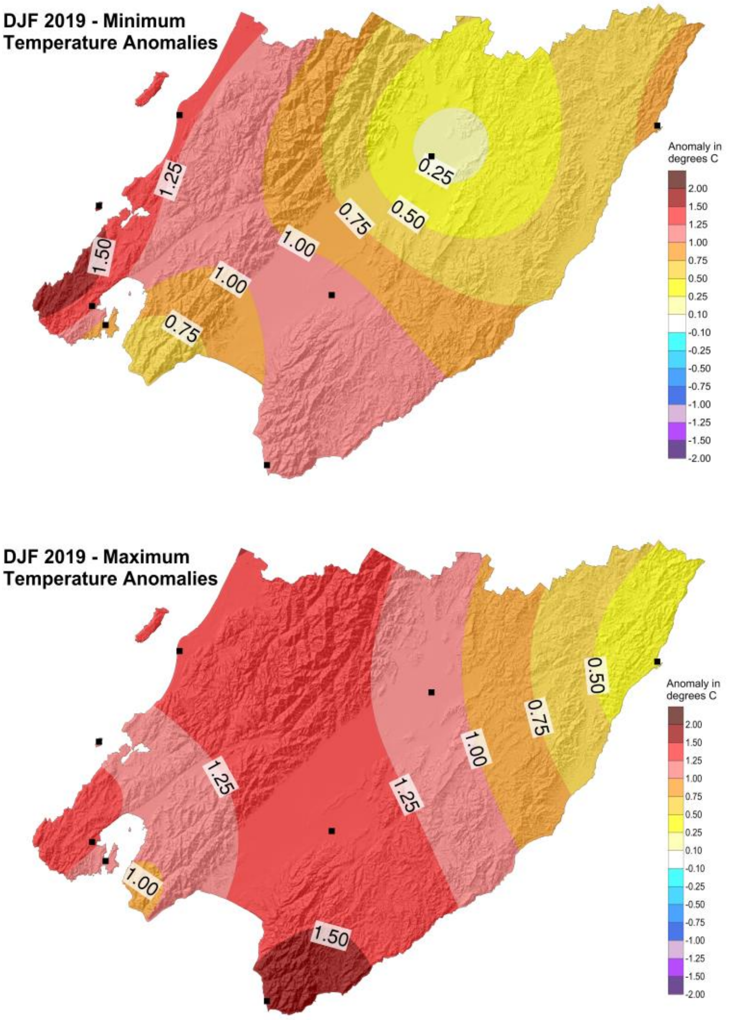


Figure 2.1: Daily Average Minimum and Maximum temperature anomalies for DJF 2019. All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from GWRC, NIWA, MetService and NZ Rural Fire Authority networks.

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 summer months, except around Castlepoint, where the anomalies were slightly positive.

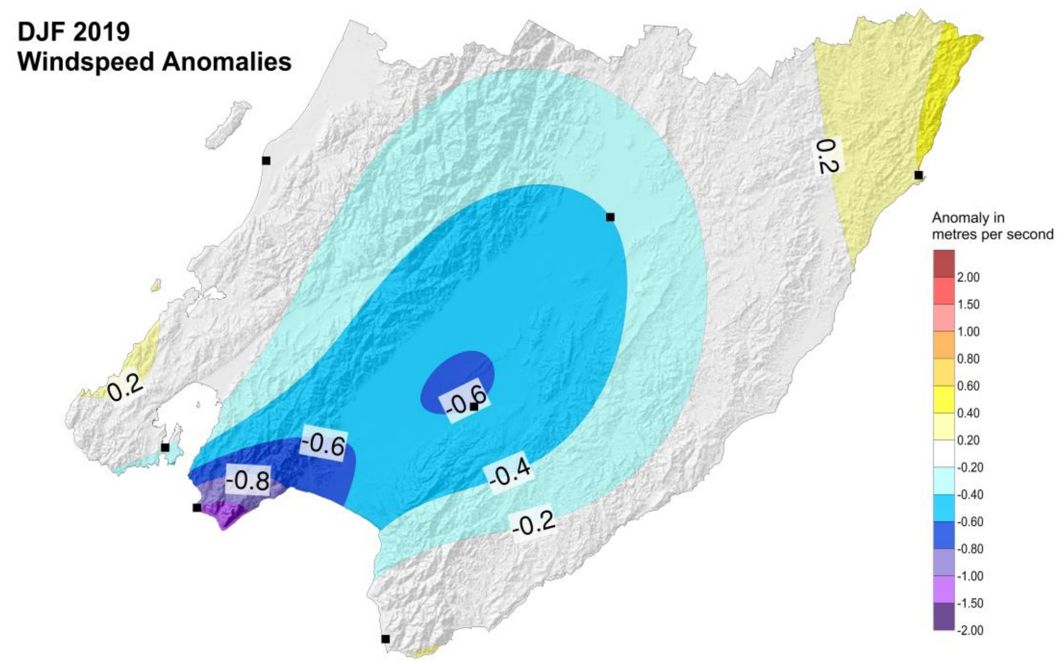


Figure 2.2: Daily mean wind anomalies (in m/s) for DJF 2019. All anomalies calculated against the 1981-2010 reference period. Source: GWRC, using station data from NIWA and MetService.

2.3 Regional soil moisture

Figure 2.3 shows the summer 2019 soil moisture anomaly map for the region, ranging from around 20mm below normal to 20mm above normal. The Wairarapa eastern hills experienced the highest summer soil moisture level.

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).

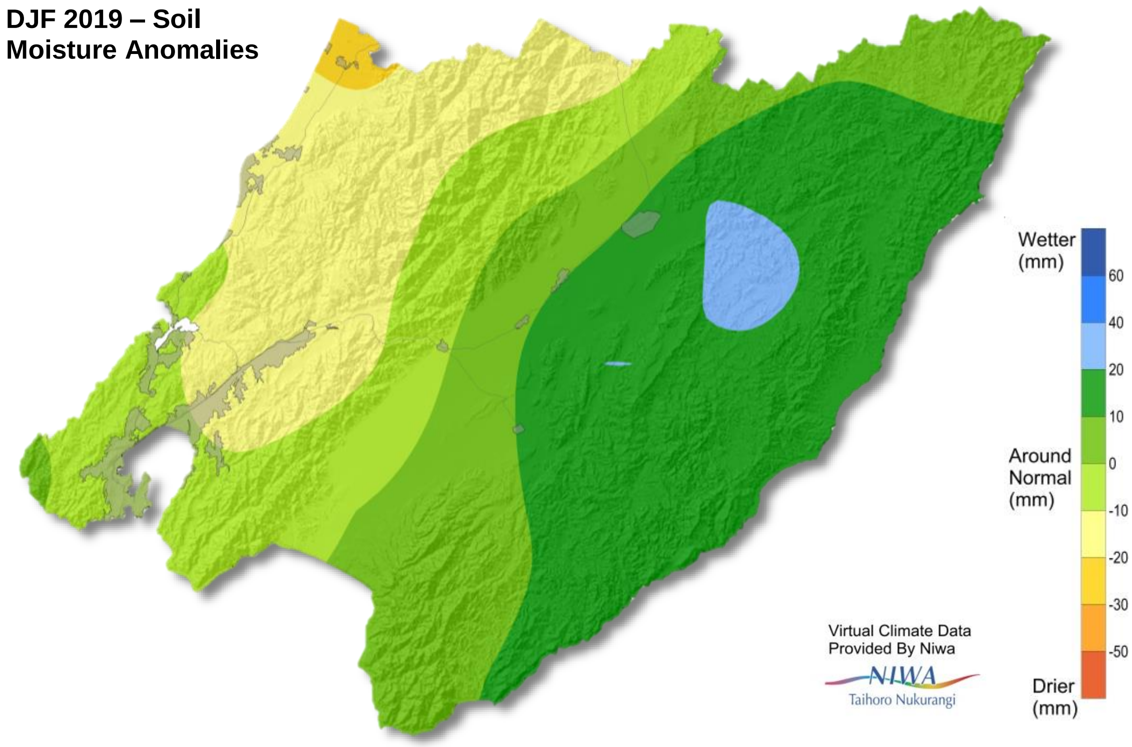


Figure 2.3: Summer (DJF 2019) soil moisture anomaly. Moisture levels show slightly below normal to slightly above normal conditions over the region. Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. ***Note that this data is indirectly calculated by modelling 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 month by month (and total summer) rainfall expressed as a percentage of the long-term average. Once again, the observed pattern was extremely variable, from month to month. December saw well above average rainfall, with almost three times the average in some areas of the Wairarapa, while January stood out in sharp contrast as an extremely dry month. On average, the full three monthly period resulted as close to normal in many parts of the Region, above normal on the eastern foothill of the Tararuas, and below average on the Kāpiti coast.

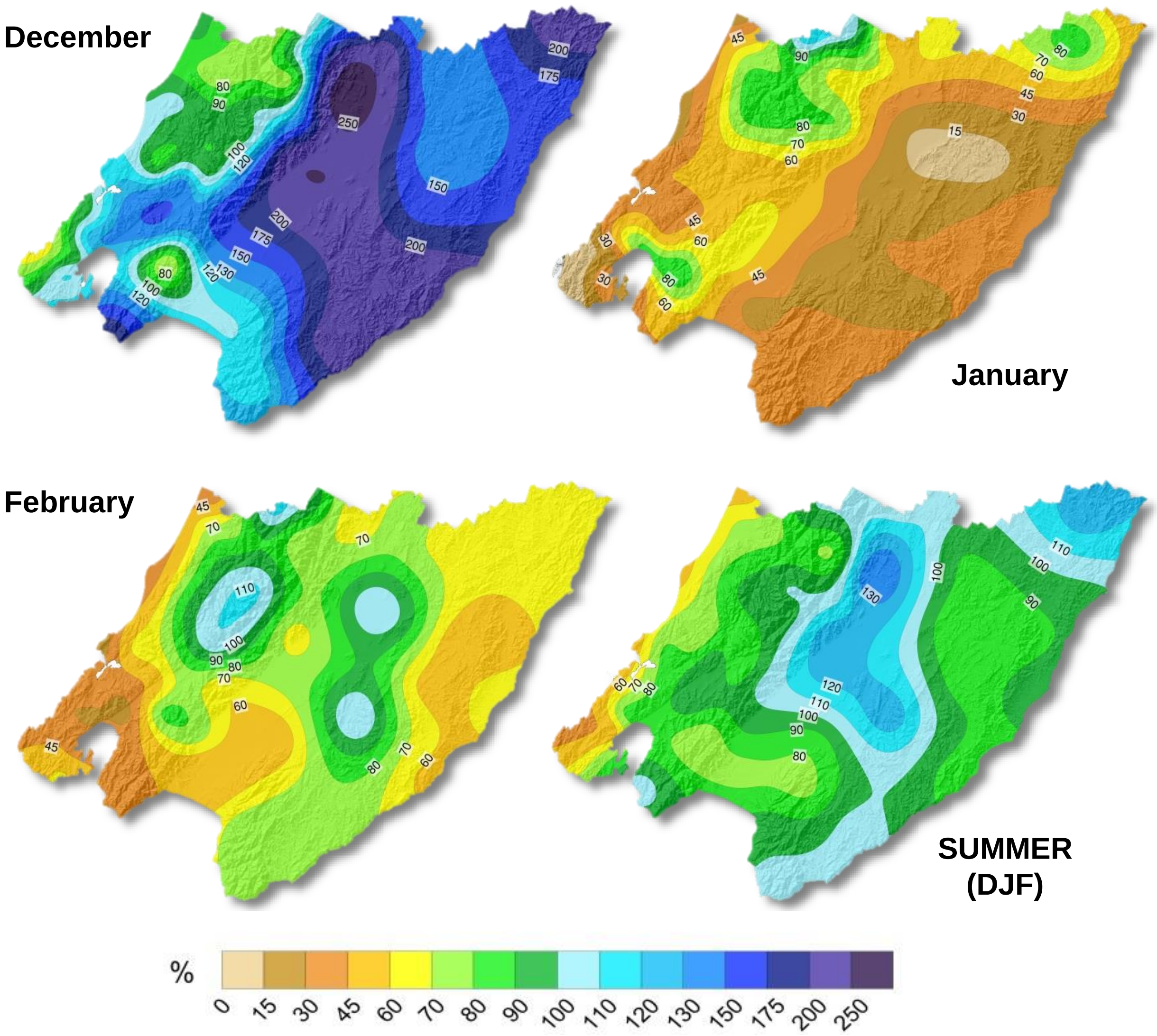


Figure 2.4: Rainfall for December, January, February and DJF 2018-2019 as a percentage of the long-term average. Rainfall was extremely variable; December was very wet, and January had record breaking low rainfall in the Wairarapa. Source: GWRC and NIWA.

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 (a sense 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) and wind speed (Wellington), meaning summer is getting hotter and less windy. The long-term reduction in wind speed in Wellington is fairly strong (a reduction rate of 17% per century);

- Summer 2019 temperatures were significantly above average for both Wellington and the Wairarapa, although not as extreme as in 2018;

- Sunshine hours were slightly above average for Wellington;

- Wind speed was below average (lowest on record for the Wairarapa, for shorter length of monitoring);

- Rainfall and rain days were below average in Wellington

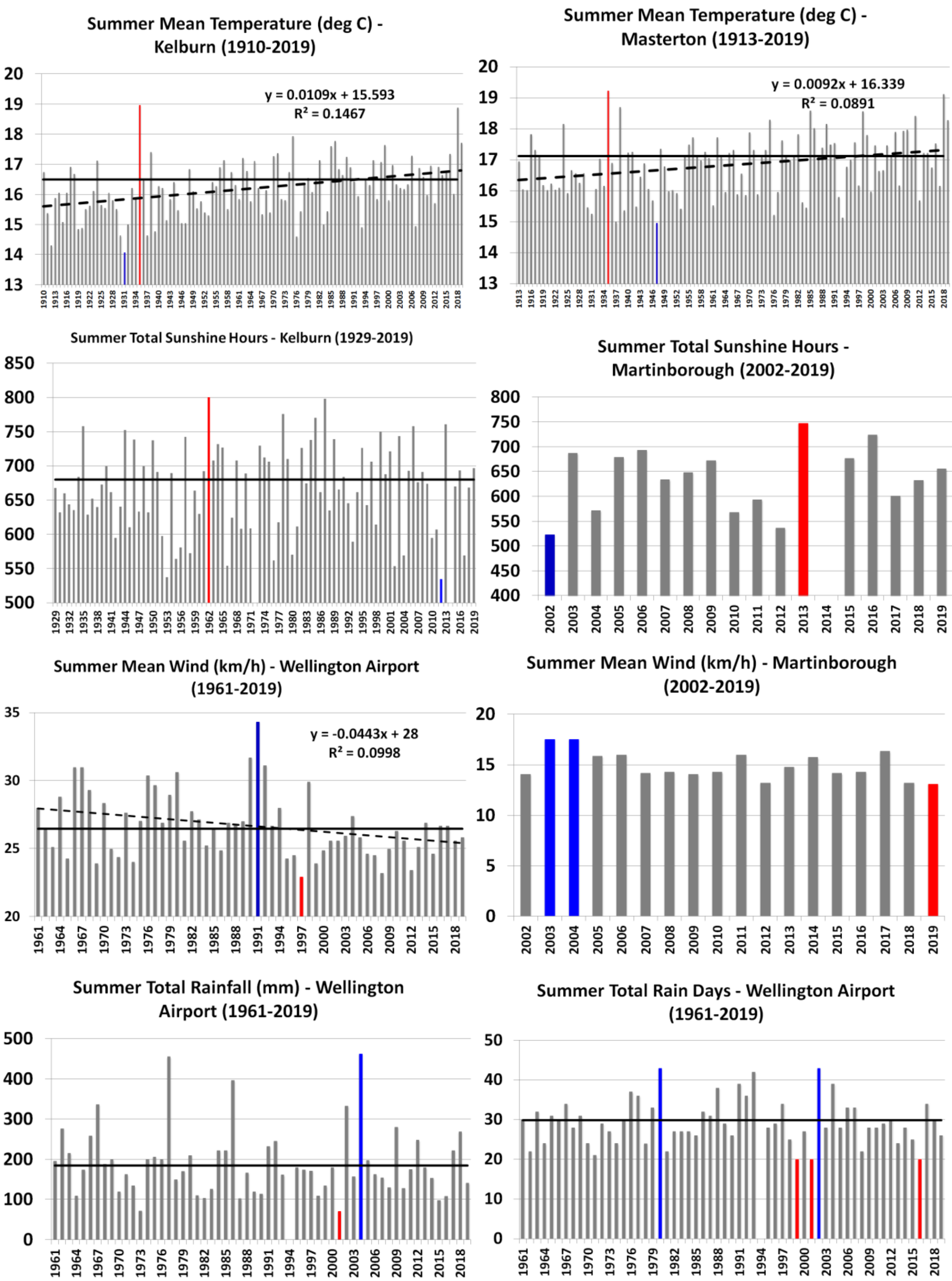


Figure 2.5: Climate change and variability graphs for summer in Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs,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

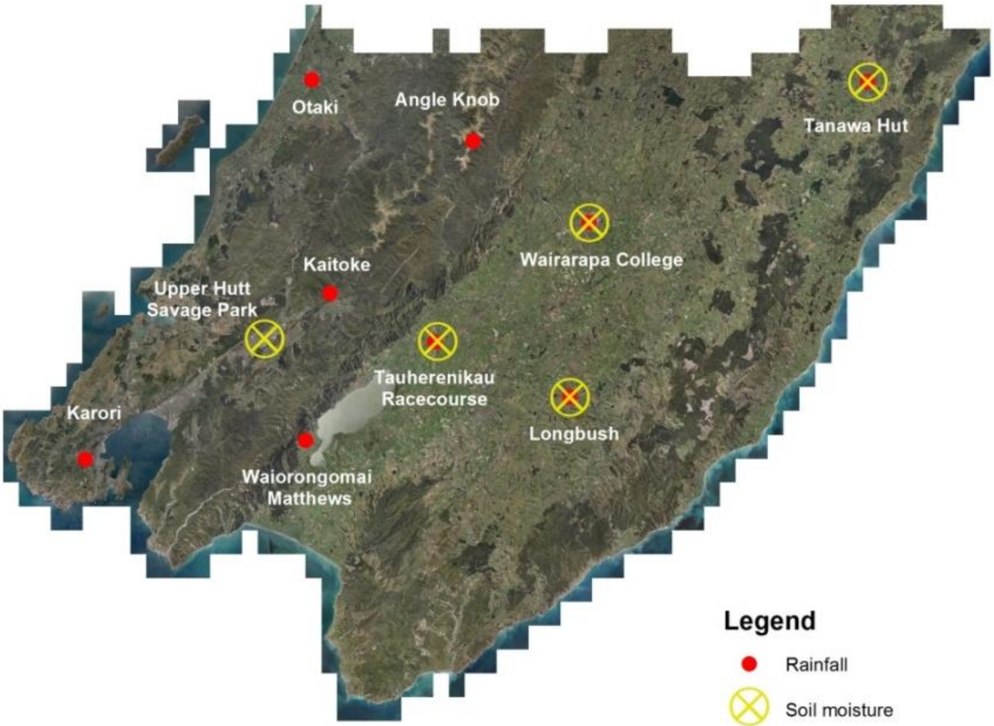


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

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

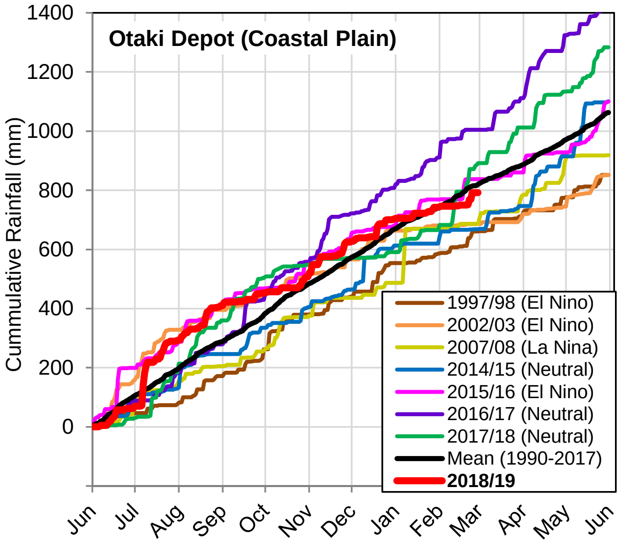
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year at several locations. For comparative purposes, cumulative plots for selected historic years with notably dry summers have been included as well as the site average.

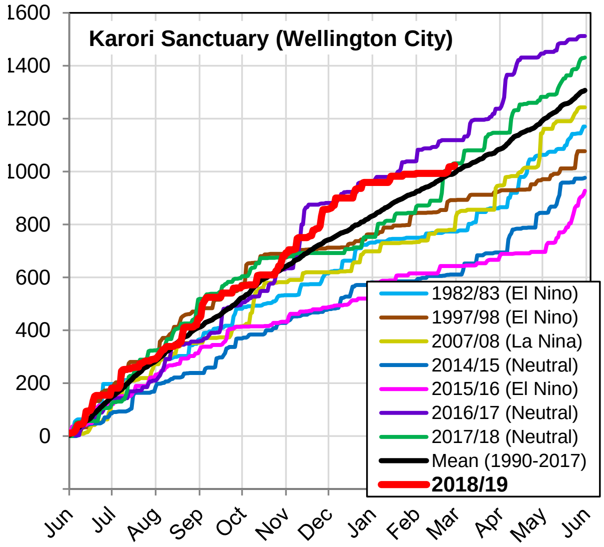
Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa have only been operating since the late 1990s so the period of data presented is limited to the last two decades. For each historical record plotted, an indication of ENSO climate state (El Niño, La Niña or neutral)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

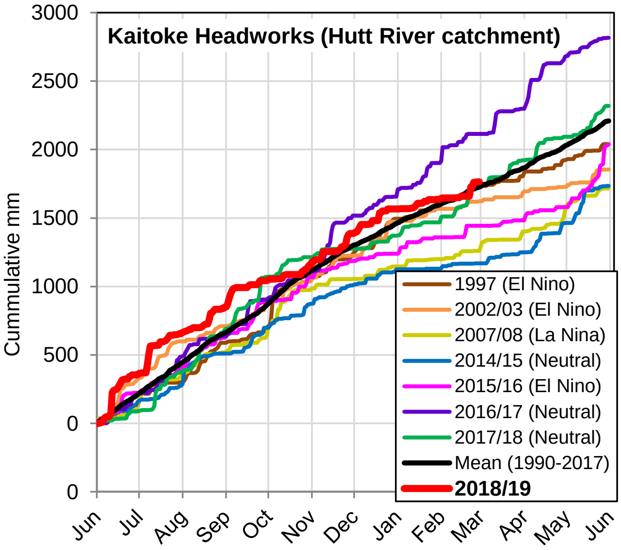
Overall, rainfall accumulations for the year starting in June 2018 (labelled 2018 on the plots) are currently trending from near average around Wellington and Kāpiti coast, to below average in the Tararua Ranges and above average in the Wairarapa. Parts of the Wairarapa received impressive amounts of rain during spring and early summer, allowing for a very significant hydrological supply ahead of an extremely dry period in January.

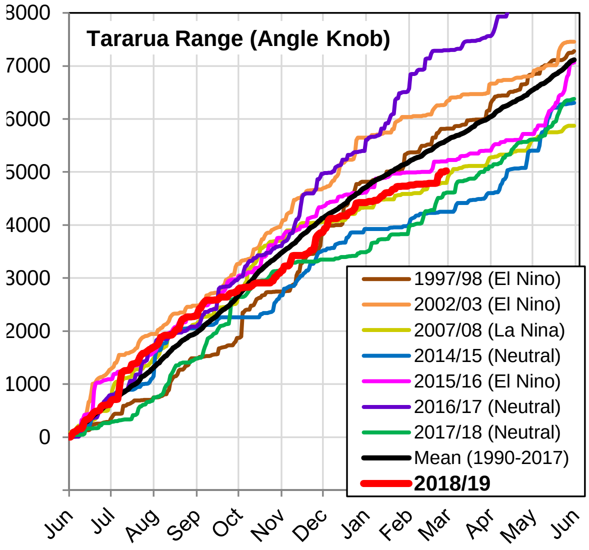
Kāpiti Coast and Southwest (Wellington city)



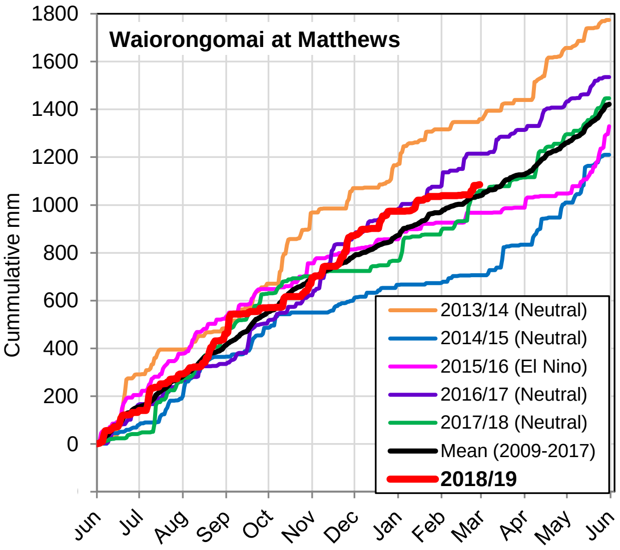


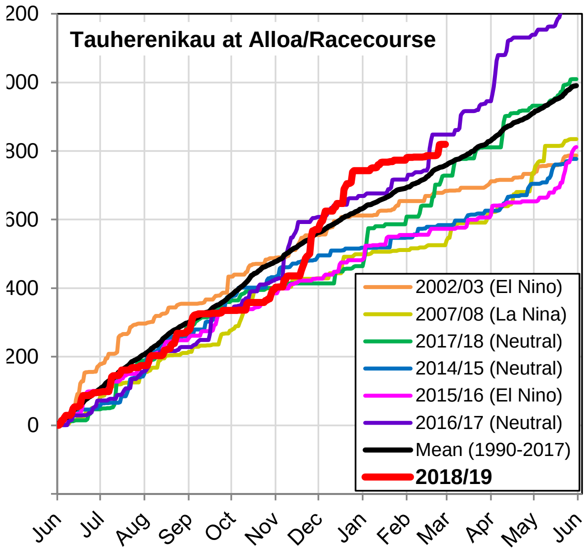
Hutt Valley and the Tararua Range

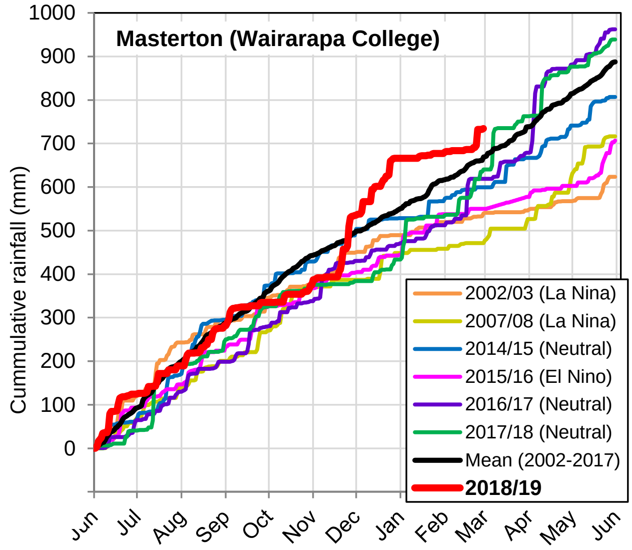


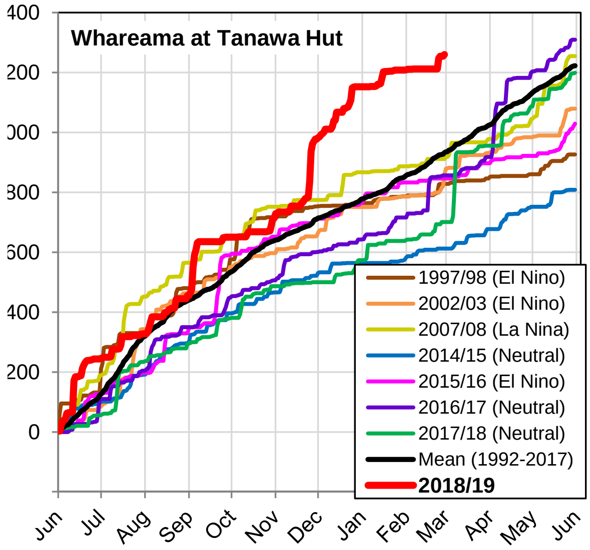


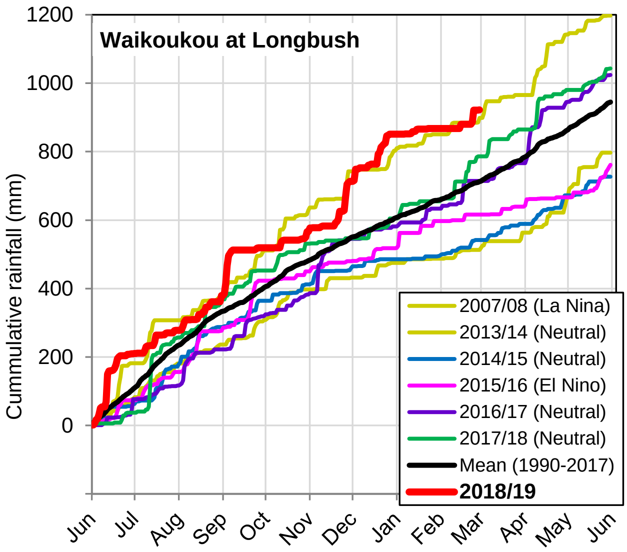
Wairarapa











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 2018)

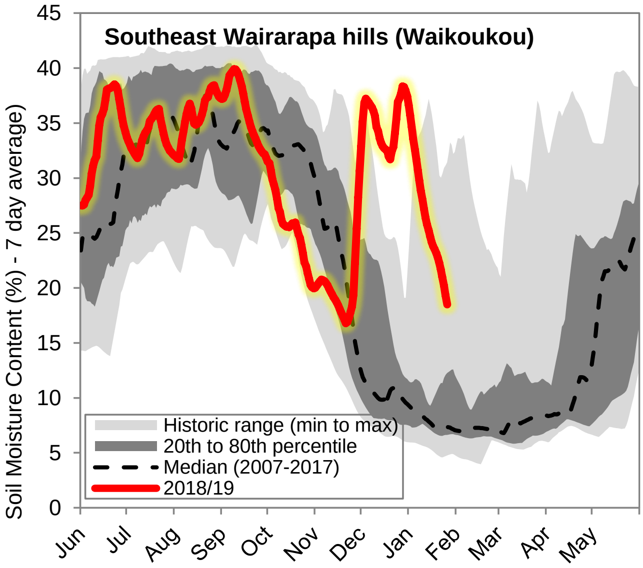
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2018. This is plotted over an envelope of the range of historic recorded data (and the median) at the site to provide an indication of how the current soil moisture compares with that for a similar period in past years.

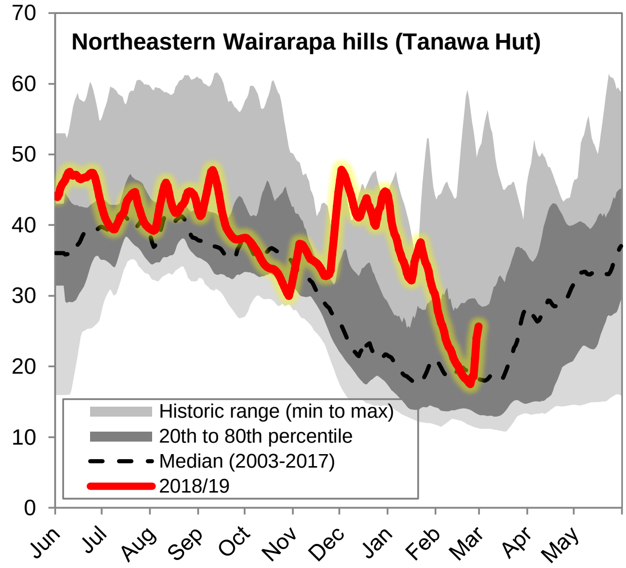
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated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

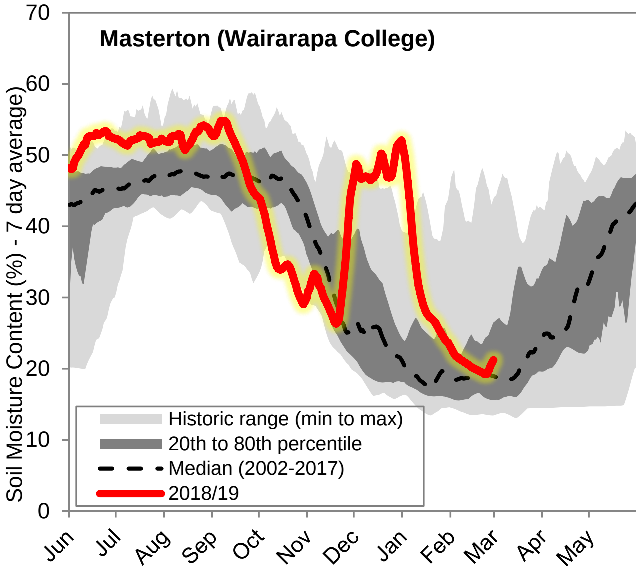
The soil moisture behaviour at the four sites in the Wairarapa had been tracking largely above average, after an exceptionally wet December. The abundant rainfall in spring and up to Christmas had generated a remarkable moisture surplus, which is only now back to normal levels. For Upper Hutt, however, the soil moisture is currently below average, after very dry conditions in January and February.

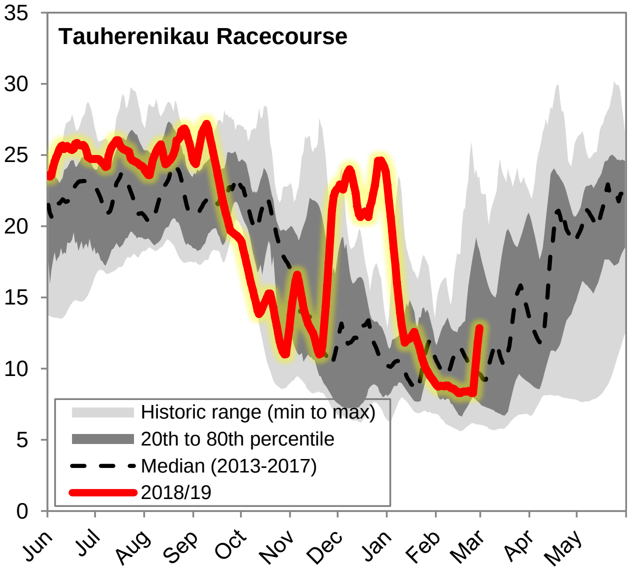
What is the Data Showing?

(a) Wairarapa

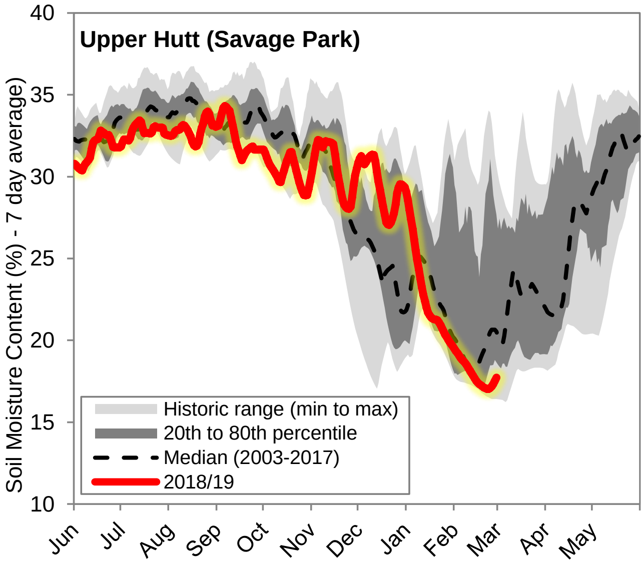








(b) Hutt Valley



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 autumn 2019

- ENSO likely remaining **borderline between El Niño and neutral**;
- Mixed **westerly/easterly regime at first, then westerlies.** Extreme rainfall events likely, with possible localised flooding (moderate confidence);
- **Small chance of influence of an ex-Tropical cyclone** being felt until the end of April;
- **Variable rainfall**: High month to month variability, possibly above average on the west coast (low confidence for rainfall totals);
- **Average to above**: Temperatures closer to normal autumn pattern, but remaining above long-term average (moderate confidence)

Whaitua*	Variables	Climate outlook for summer 2018/2019
Wellington Harbour & Hutt Valley	**Temperature:**	Average to above.
	Rainfall:	Average to above. Very variable month to month. Low confidence for average totals. Heavy rainfall events likely.
Te Awarua-o-Porirua	**Temperature:**	Average to above.
	Rainfall:	Average to above. Very variable month to month. Low confidence for average totals. Heavy rainfall events likely.
Kāpiti Coast	**Temperature:**	Average to above
	Rainfall:	Average to above. Very variable month to month. Low confidence for average totals. Heavy rainfall events likely.
Ruamāhanga	**Temperature:**	Average to above.
	Rainfall:	Average to below. Very variable month to month. Low confidence for average totals.
Wairarapa Coast	**Temperature:**	Average to above.
	Rainfall:	Average to below. Very variable month to month. Low confidence for average totals

*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 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