greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Climate and Water Resources Summary for the Wellington Region

Spring 2019 summary

Summer 2020 outlook

Release date: 19 December 2019

Environmental Science Department

The Southern Alps tinted by smoke and dust from the Australian bushfires, during spring. This is a stark reminder of our climate crisis, and that the atmosphere is global and has no boundaries. Smoke from the fires was detected in Patagonia in South America, and as far as the middle of the Atlantic Ocean. Photo courtesy of Stuff: https://www.stuff.co.nz/travel/travel-troubles/117907806/how-australias-bushfires-turned-new-zealands-snowcapped-glaciers-red

Overview

Spring 2019

Spring was a season of contrasts for the Wellington Region. After a record warm winter, spring started with colder than average temperatures in September and October (-2.8^{o}C in Upper Hutt on 4th October was the 3rd lowest on record), changing again to record warm early in November, as an unprecedented level of ‘early heat’ affected some parts of the North Island. It was the hottest November on record for New Zealand as a whole, and the second hottest November on record for Wellington, which also had the hottest on record average nighttime maximum temperature. Masterton, on the other hand, had the highest daytime monthly average temperature ever recorded for November.

Climate drivers

The El Niño - Southern Oscillation (ENSO) has been neutral, and so other climate drivers have had a greater influence throughout our spring. As discussed in our previous reports, the phenomenon known as Southern Stratospheric Warming had a significant impact throughout spring, promoting a much more active than normal westerly wind flow around mid-latitudes. For New Zealand, this meant constant fronts coming from the Tasman Sea, smoke particles arriving from the Australian bushfires, severe thunderstorms, and flooding on the western coast.

Climate outlook for summer 2020

Even though the Sudden Stratospheric Warming has now dissipated, the Southern Annular Mode remains predominantly negative, and the westerly belt around midlatitudes remains significantly more active than normal for this time of the year. While we had a more settled period during most of November and early December, predominantly unsettled westerly flow is still expected to last at least until the end of the year. The expectation is that once this ‘residue’ circulation pattern from spring settles, the local warm Sea Surface Temperatures will help develop a humid and hot summer season, with high likelihood of heatwaves and thunderstorms.

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 summer climate pattern.

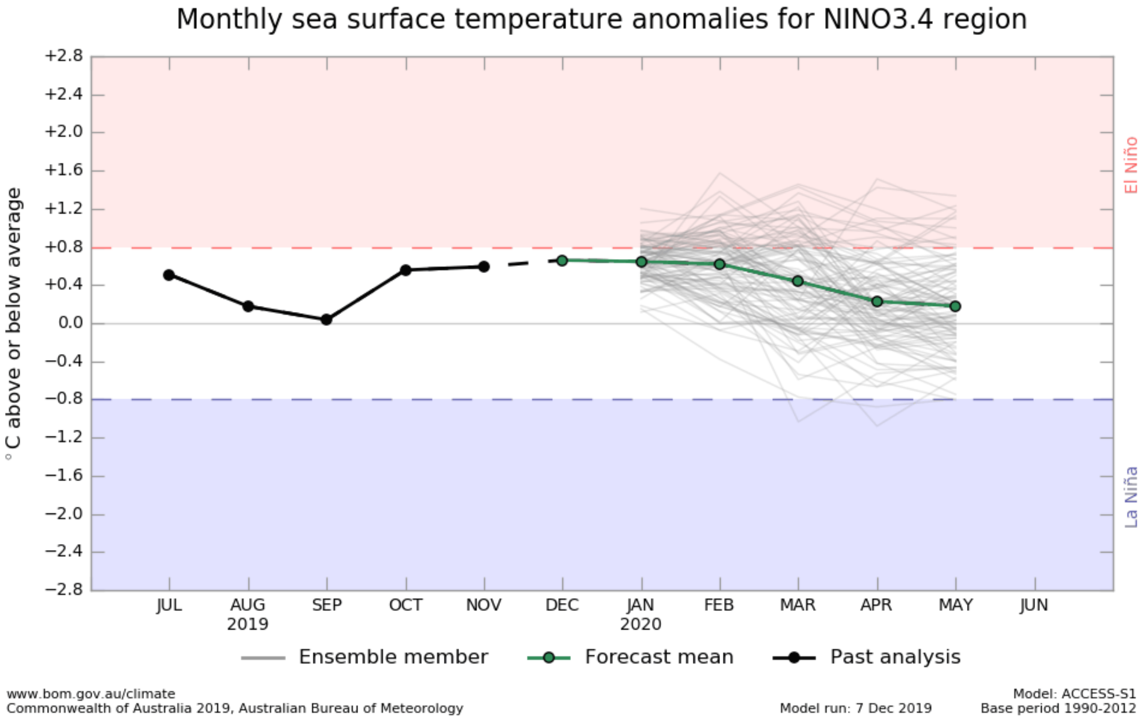


Figure 1.1: Averaged modelled projections (in green) show ENSO is expected to remain in a neutral phase for the time being. Source: Australian Bureau of Meteorology.

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 9 December 2019. The pattern shows warmer than normal waters east of New Zealand, cold water south of Australia, and normal to cool waters around the South Island and south Tasman Sea.

The sea ice cover around Antarctica is shown in white. Satellite measurements show that the ice extension remains well below average for this time of the year, continuing the pattern of ice reduction observed over the last few years.

The warm SST patch to the northeast of New Zealand is getting warmer. Statistically, this increases the chance of heavy rainfall events during the next three months. This pattern also increases the chance that a marine heatwave may form again around New Zealand, as the summer season progresses. If this happens, the summer temperatures could be significantly above normal.

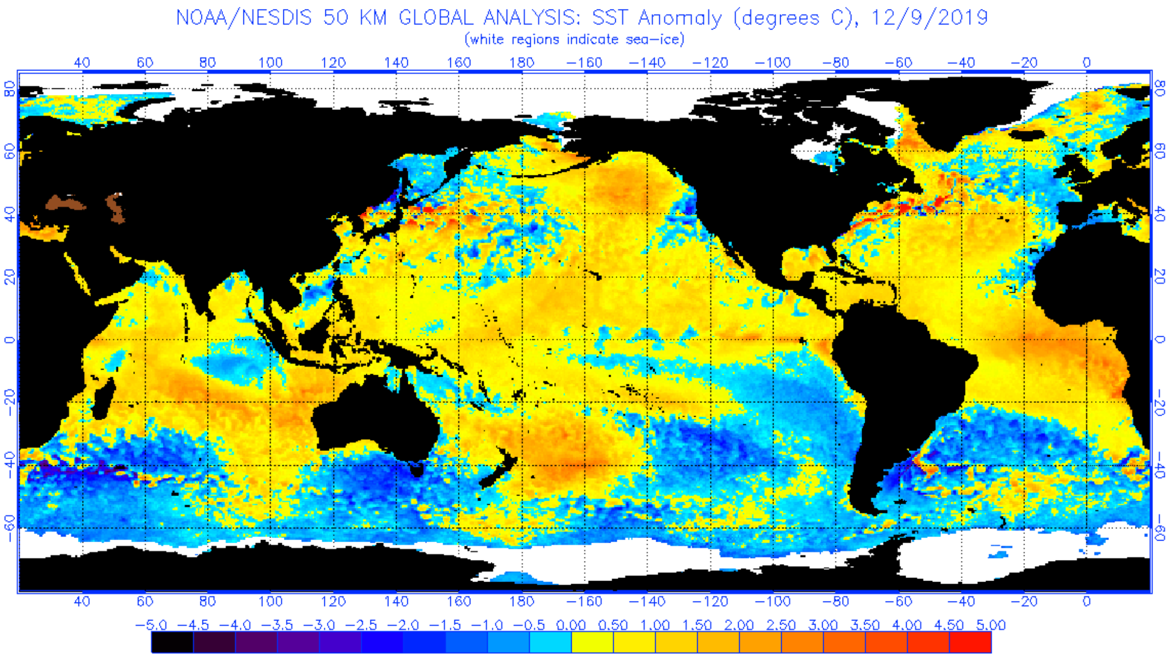


Figure 1.2: Sea surface temperature (SST) anomalies as of 9 December 2019. Sea ice coverage is shown in white. Waters around New Zealand remain warmer than average to the east, with the chance of another marine heatwave event this summer. The Equatorial Pacific (ENSO) is currently neutral, and is expected 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 spring 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, leading to a "collision" between northerly and southerly flows onto the country, which contributes to instability. The unsettled weather and westerly winds associated with the low pressure area was particularly enhanced during November, which was about 5% windier than average in Wellington. This was also associated with the Sudden Stratospheric Warming discussed at the beginning of the report.

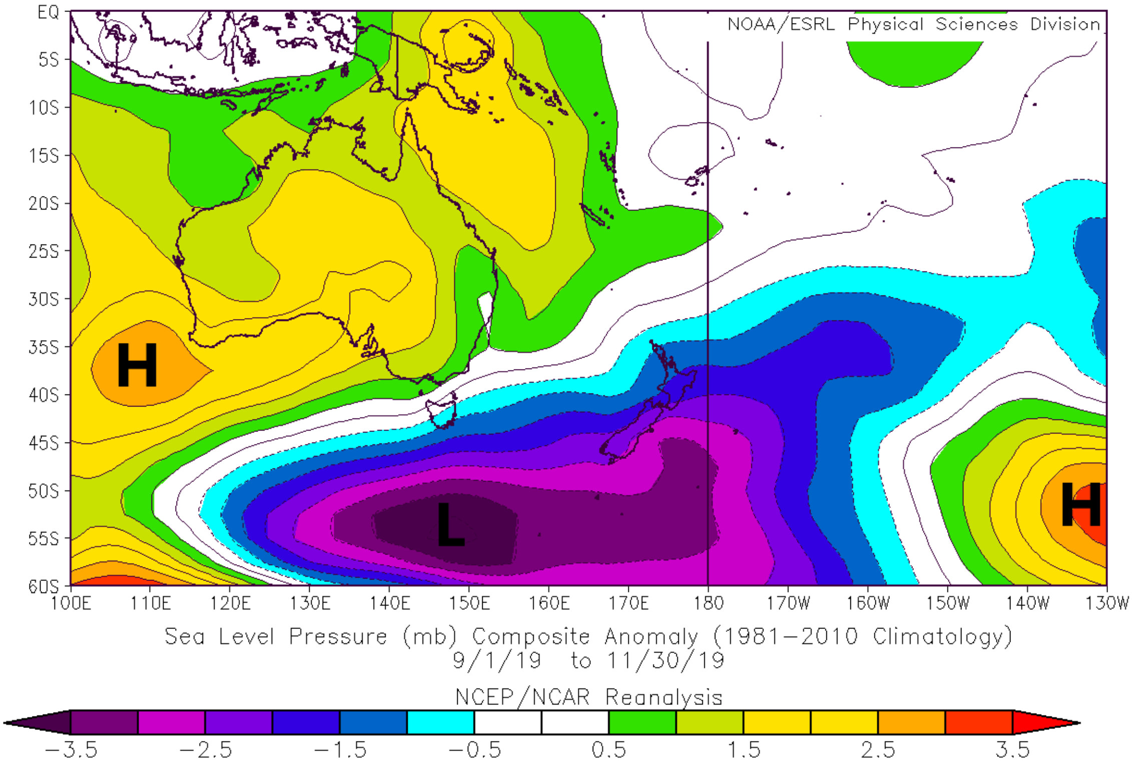


Figure 1.3: Mean sea level pressure anomaly (hPa) for spring (September, October, November) 2019. The 'H' indicates the position of the blocking highs on the far east of New Zealand and west of Australia, and the 'L' indicates the average low pressure southwest of New Zealand. This pattern was associated with the negative phase of the Southern Annular Mode, which was significantly pronounced this spring, leading to a more unsettled weather pattern around the 40 degree latitude band. This circulation anomaly was also associated with the rare phenomenon known as Sudden Stratospheric Warming, which is a part of the natural climate variability. The Stratospheric warming of Antarctica produced an early break down of the polar vortex, and a consequent greater exposure of mid-latitudes to very cold air masses displacing from the southern polar region. 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 from winter into spring, especially over the eastern coast for maximum temperatures. Masterton continued to experience cooler than average nighttime temperatures, also highlighting a local feature of the airport meteorological station.

SON 2019 – Minimum Temperature Anomalies

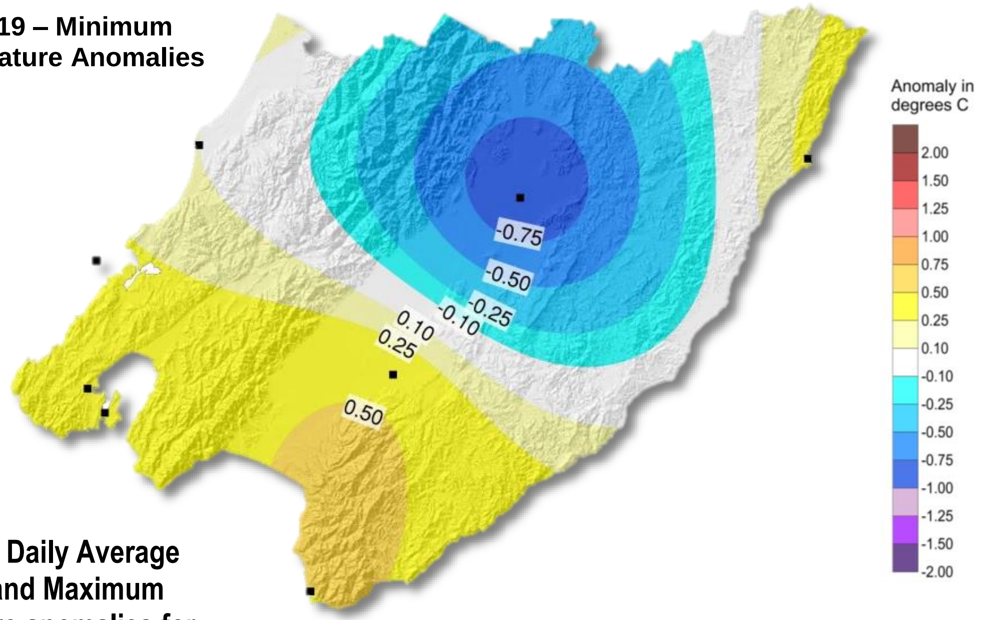
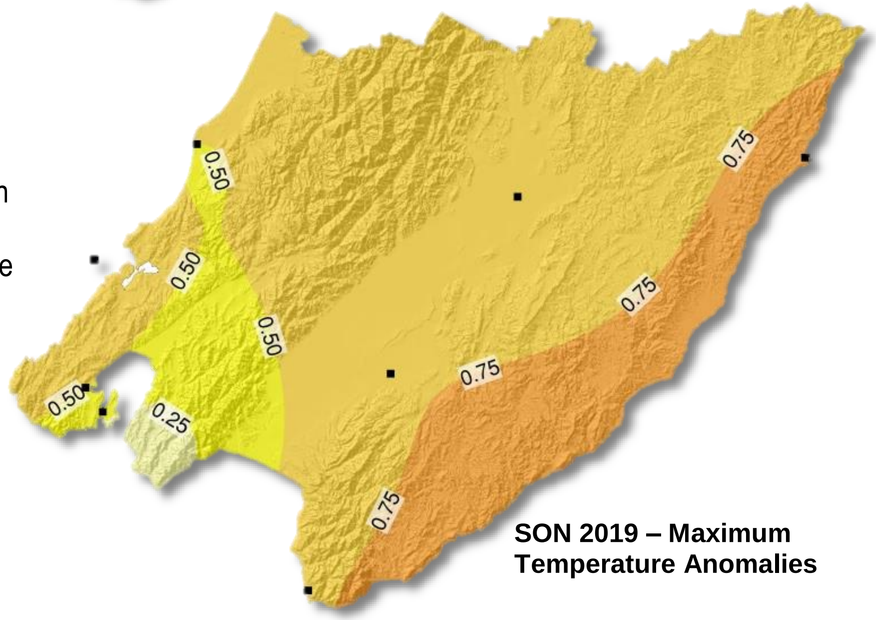


Figure 2.1: Daily Average Minimum and Maximum temperature anomalies for SON 2019.
All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from GWRC, NIWA, MetService and NZ Rural Fire Authority networks.



SON 2019 – Maximum Temperature Anomalies

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. The region experienced slightly lower than normal wind speeds, with a reduction of up to 10% around Masterton. We note, however, that in November the average wind speed was about 5% greater than average in Wellington.

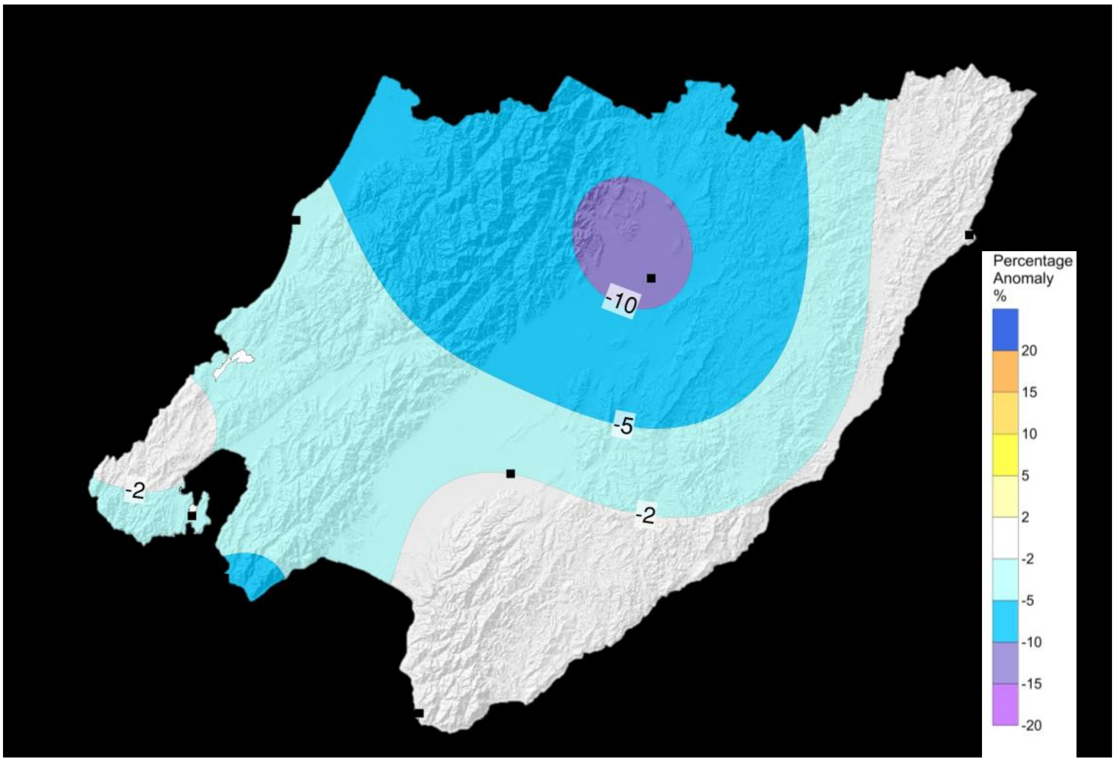


Figure 2.2: Daily mean wind anomalies (as percentage departure from the average) for SON 2019. All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from NIWA and MetService.

2.3 Regional soil moisture

Figure 2.3 shows that the soil moisture levels for the region were above normal on the west coast and below normal on the eastern coast as at the beginning of summer. This pattern reflects the vigorous westerly regime that dominated the atmospheric circulation during spring, in connection to the negative SAM discussed before.

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).

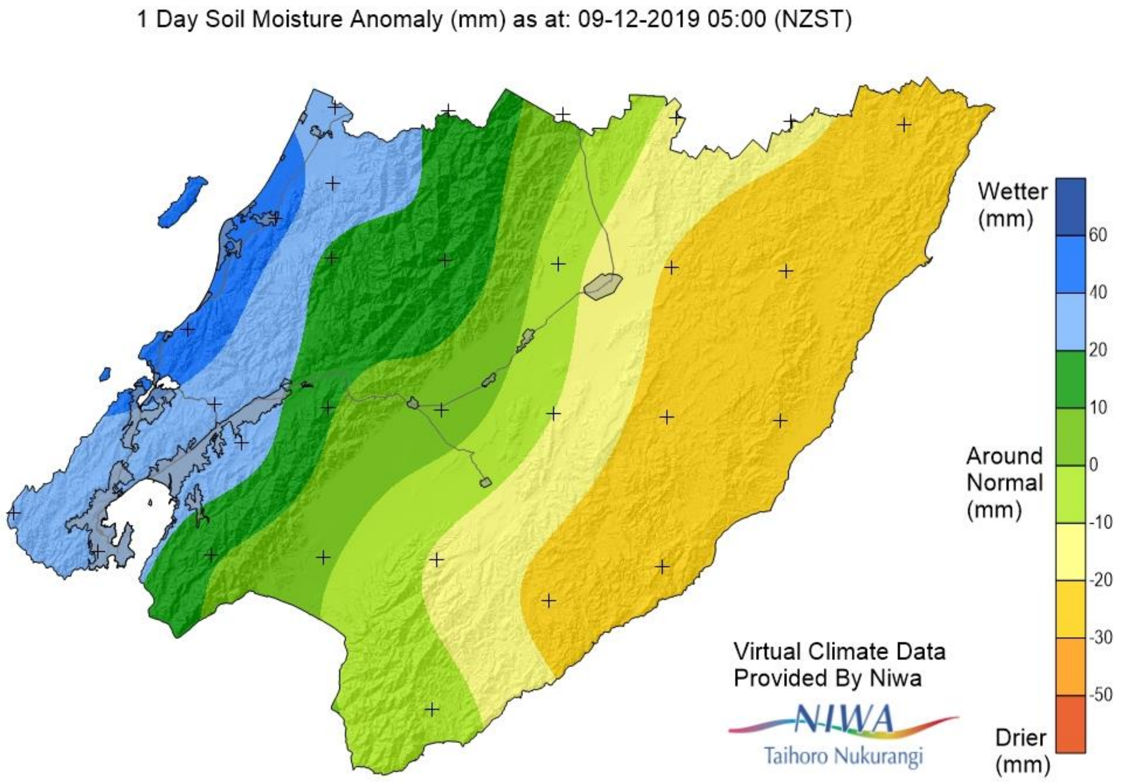


Figure 2.3: Daily Soil moisture anomaly on 9th Dec 2019. A clear pattern of above average moisture to the west, and below average to the east, is seen. This pattern reflects the vigorous westerly wind regime that dominated most of the season. Source: GWRC, using selected Virtual Climate Station Network (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. Rainfall in September and November was below average to the east, and above average to the west in November. October, on the other hand, had a completely opposite pattern with much above average rainfall in the eastern Wairarapa.

Rainfall over the entire winter season ended up being near average to slightly below average across the whole region.

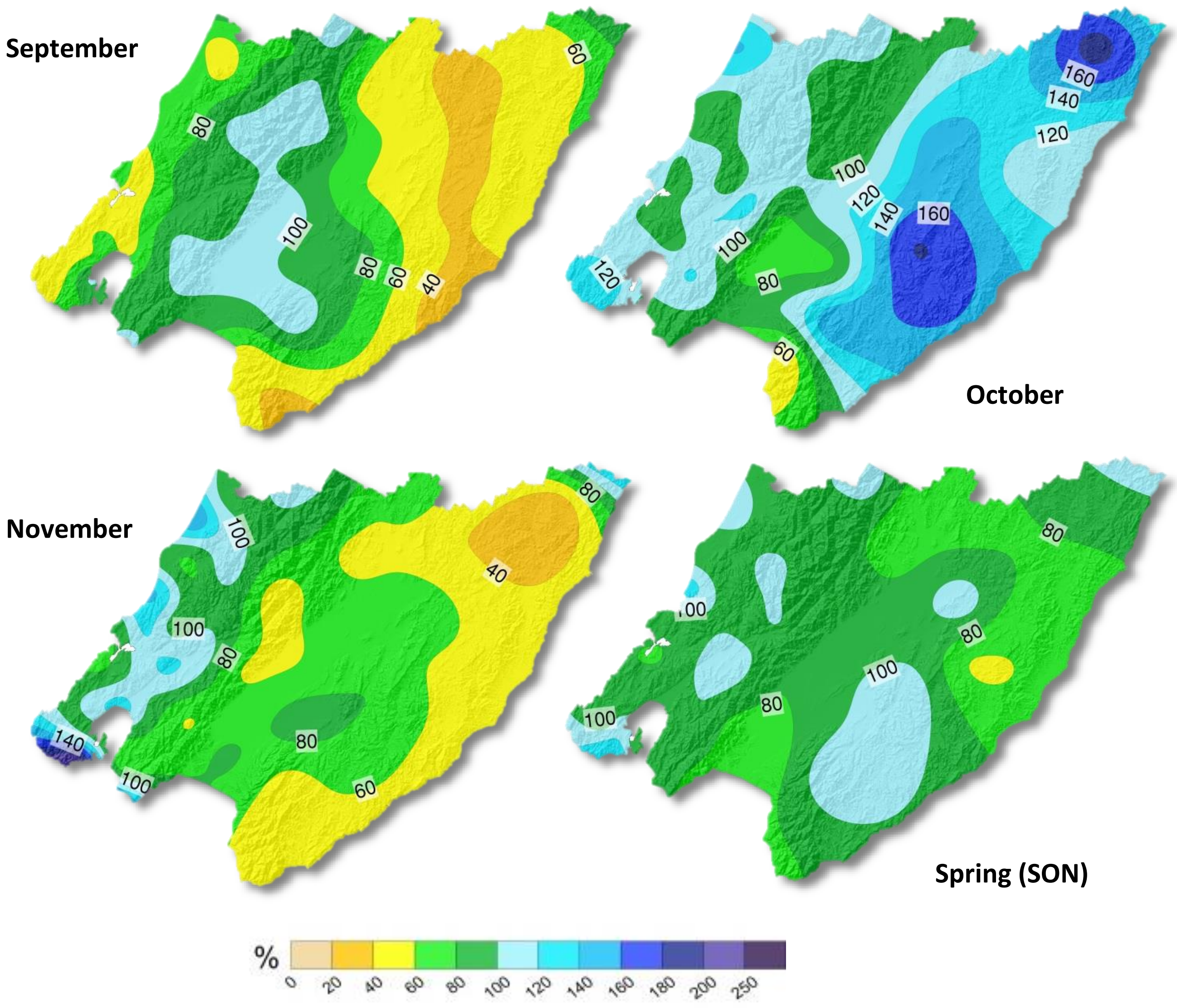


Figure 2.4: Rainfall for September (upper left), October (upper right), November (lower left) and SON (lower right) 2019 as a percentage of the long-term average. Spring as a whole had a pattern of near average to slightly below average rainfall. Source: GWRC and NIWA.

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 (ie, extreme hot/dry), and blue indicates seasons that were colder, wetter, cloudier and windier than average (ie, 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 summer is:

- Statistically significant trends are seen only for temperature (Wellington and Masterton) and wind (Wellington), meaning spring is getting warmer and less windy in general. The long-term warming is about half a degree per century in both Wellington and Masterton;
- Spring 2019 temperatures were above average for both Wellington and the Wairarapa, and slightly warmer than those observed in 2018;
- Sunshine hours were well above average for Wellington, with a sharp increase compared to last year’s spring;
- Wind speed was slightly below average for Wellington, comparable to what was observed last spring.

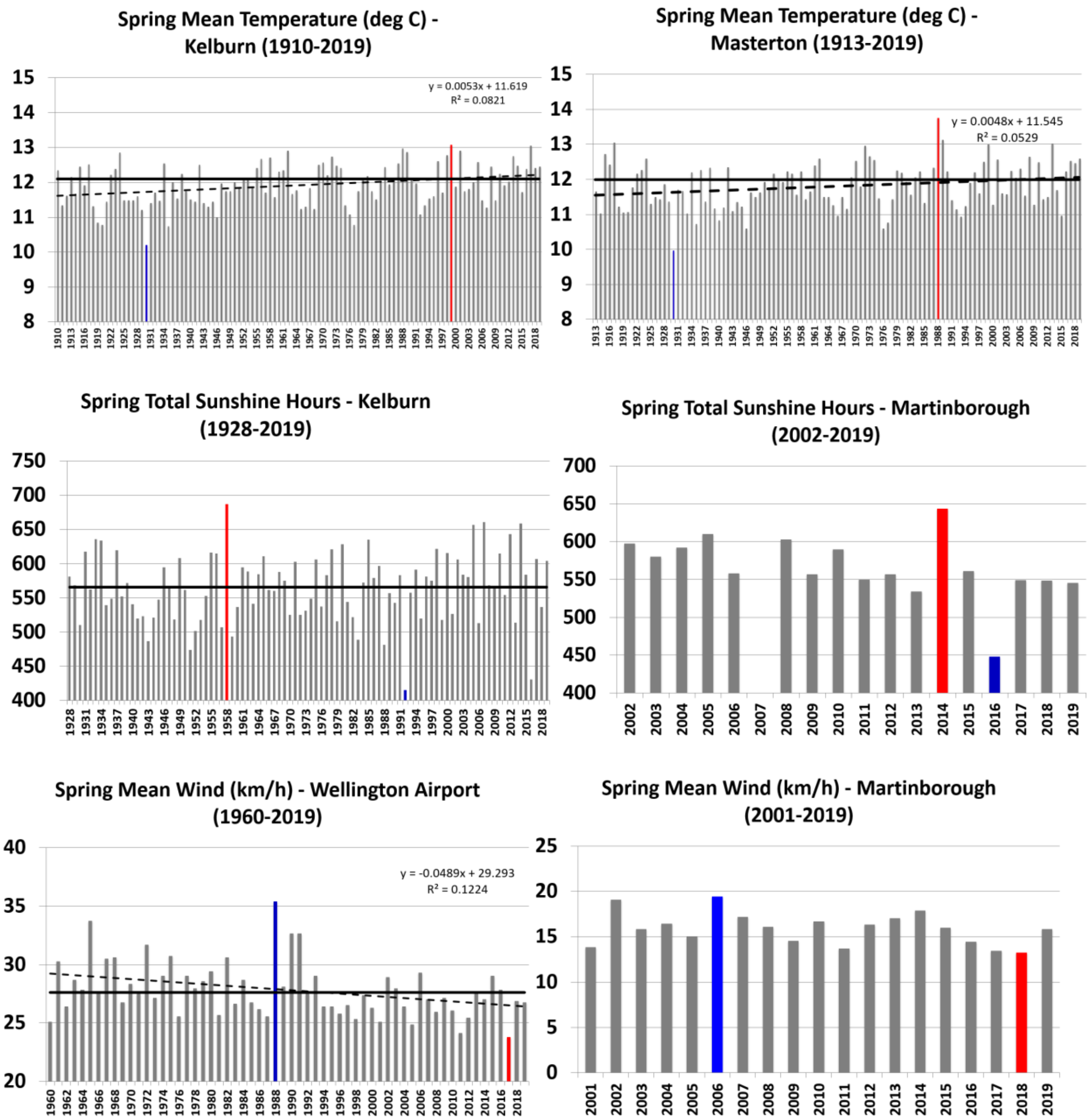


Figure 2.5: Climate change and variability graphs for spring in Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs,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

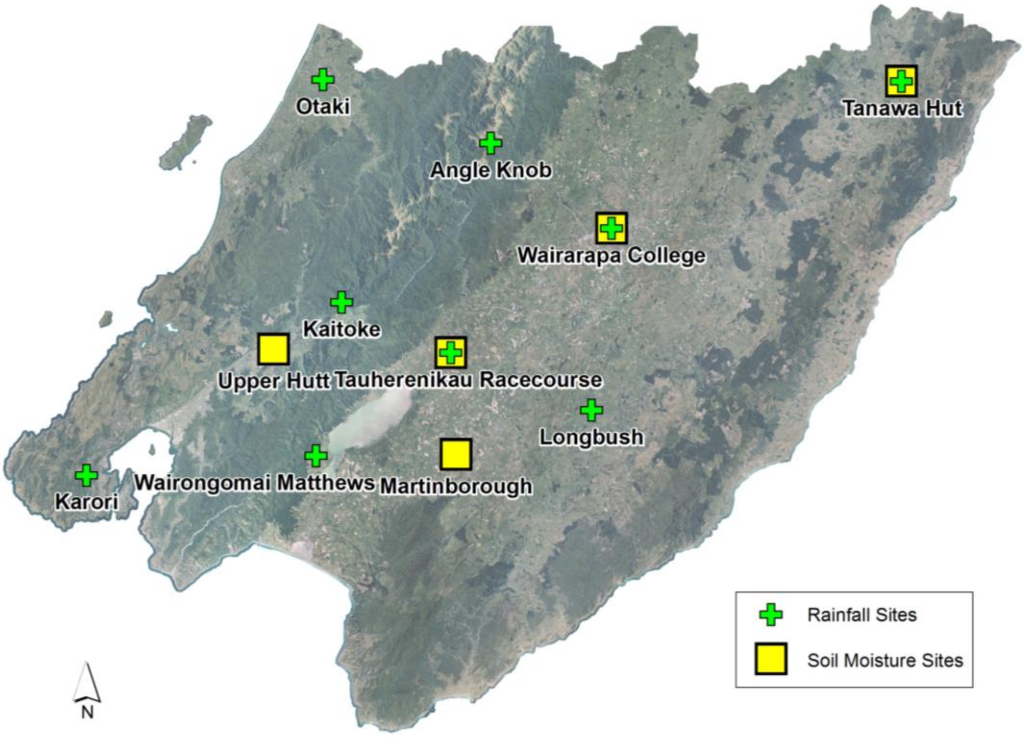


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

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

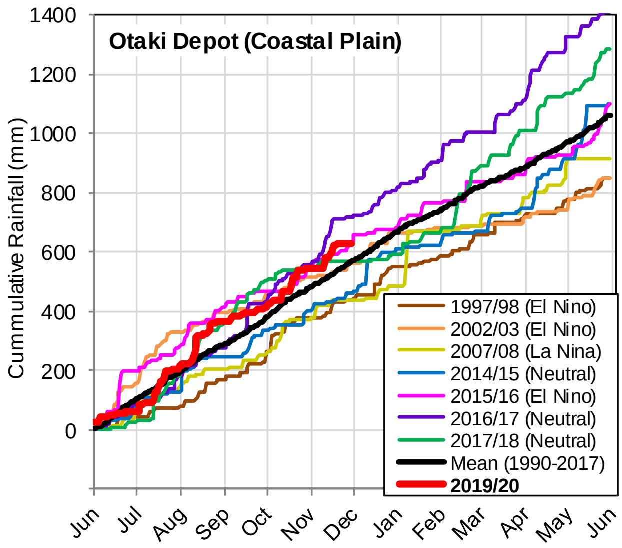
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year at several locations. For comparative purposes, cumulative plots for selected historic years with notably dry summers have been included as well as the site average.

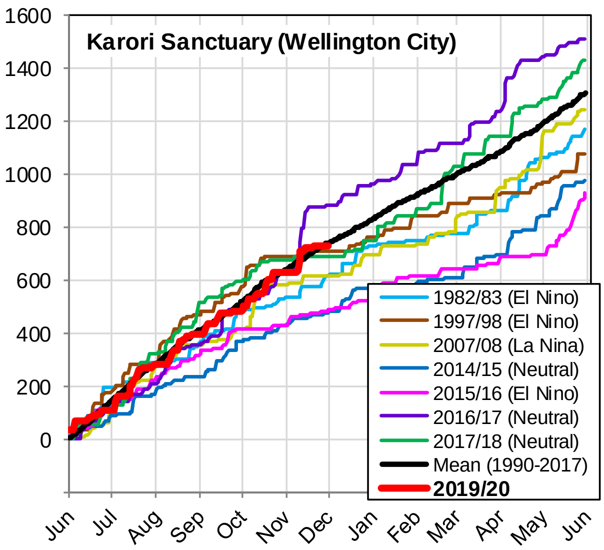
Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa have only been operating since the late 1990s so the period of data presented is limited to the last two decades. For each historical record plotted, an indication of ENSO climate state (El Niño, La Niña or neutral)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

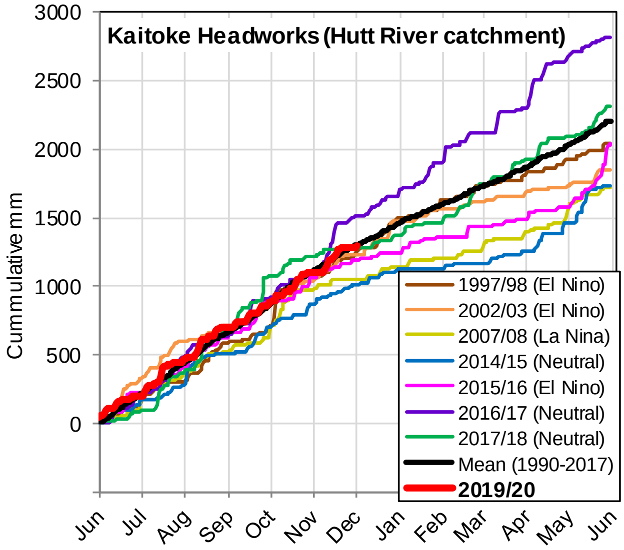
Overall, total rainfall accumulations since June have been about average or slightly above average for all regions, with most areas following the average quite closely. At Tauherenikau, a large rainfall accumulation over late winter meant that the total accumulation curve remained above average for most of spring, but approaching the average towards the end of the season.

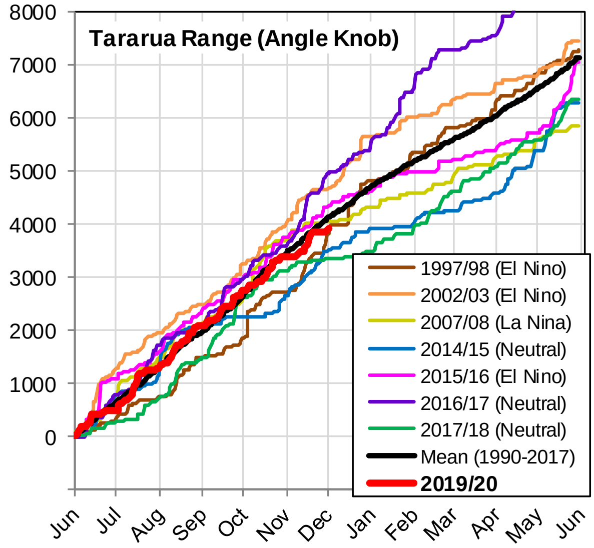
Kāpiti Coast and Southwest (Wellington city)



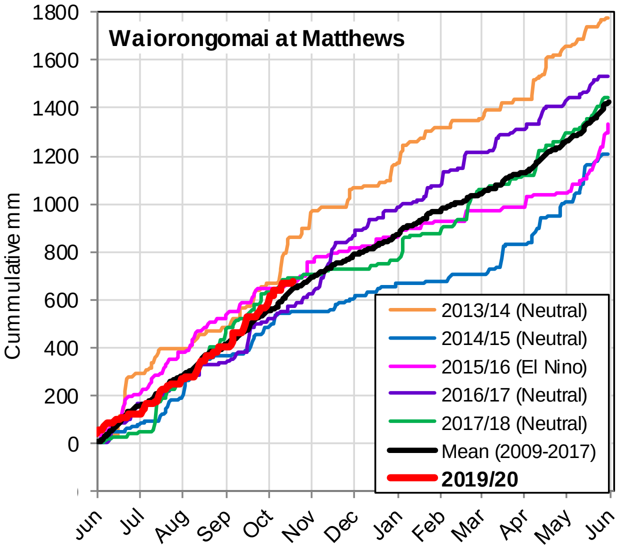


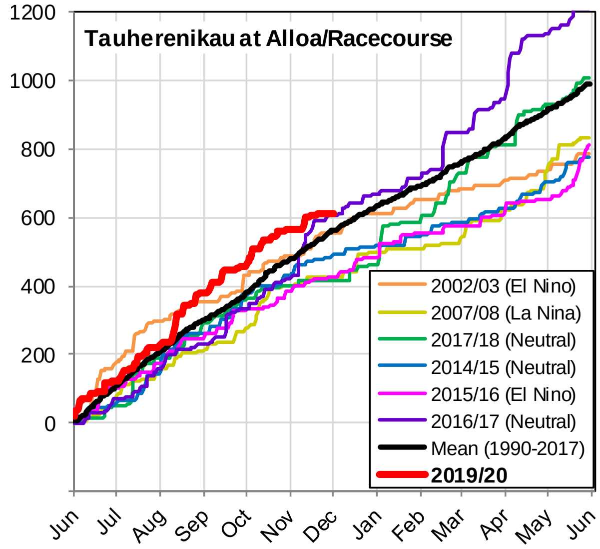
Hutt Valley and the Tararua Range

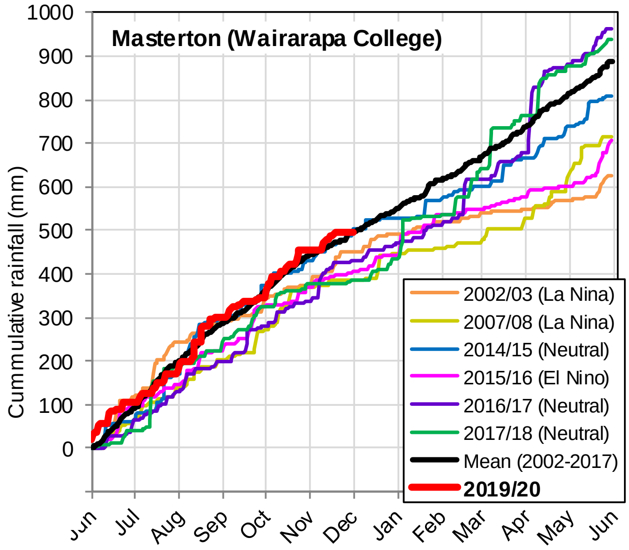


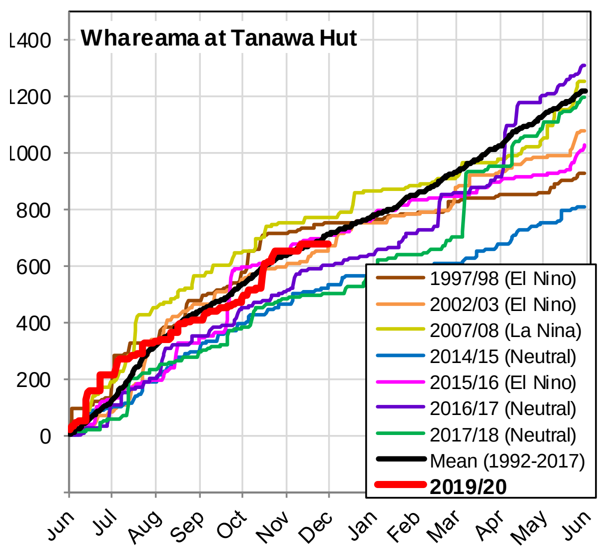


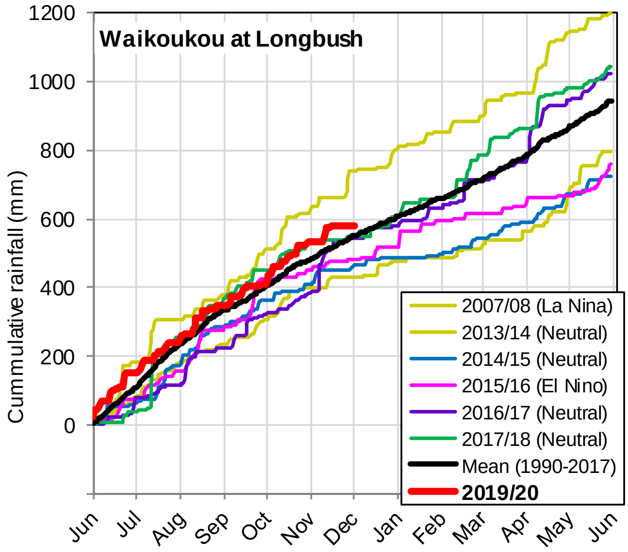
Wairarapa











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)

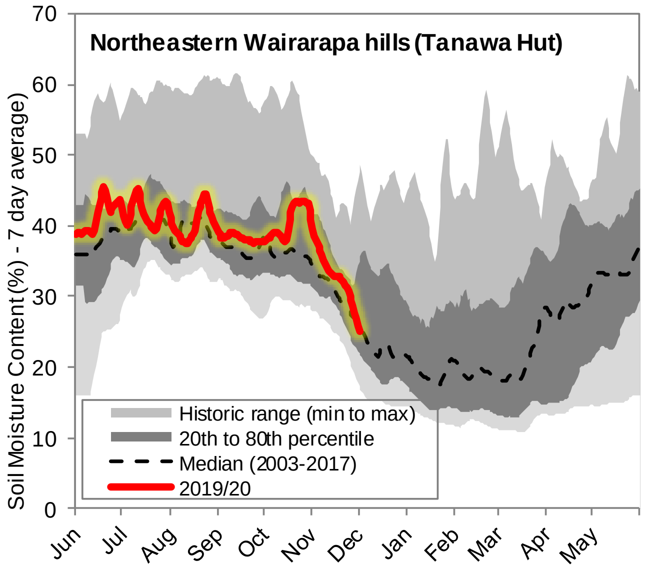
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2019. This is plotted over an envelope of the range of historic recorded data (and the median) at the site to provide an indication of how the current soil moisture compares with that for a similar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

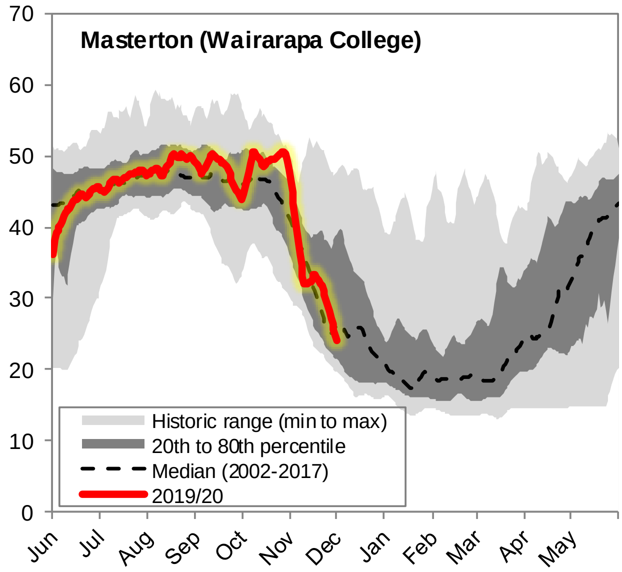
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated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

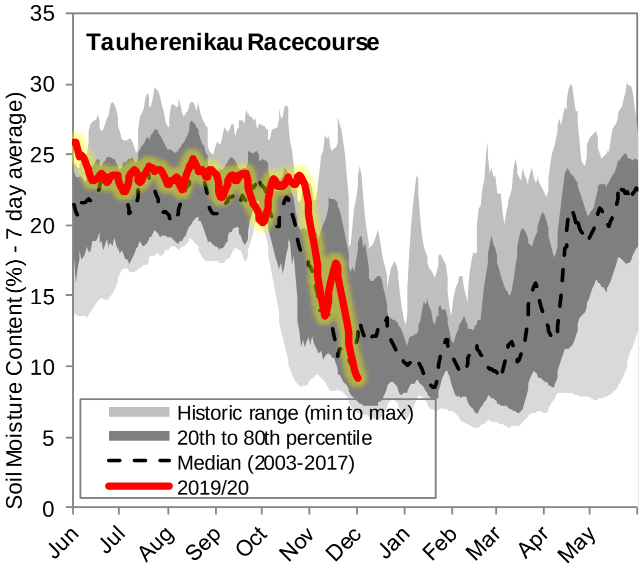
Soil moisture levels at the end of spring have been around average for Masterton and the northeastern Wairarapa Hills, and below average further south, around Martinborough and Tauherenikau. The Upper Hutt area was slightly above average.

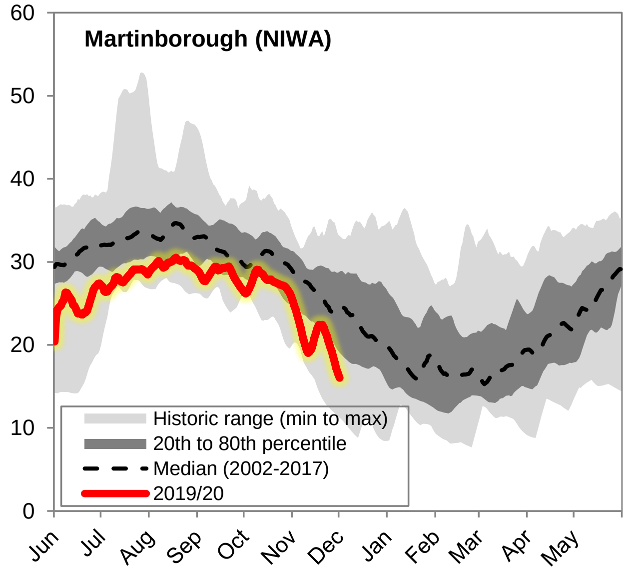
What is the Data Showing?

(a) Wairarapa

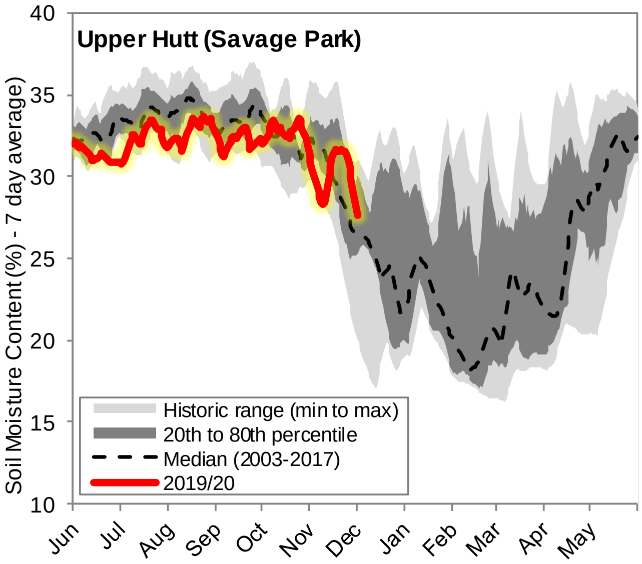








(b) Hutt Valley



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 summer 2020

- ENSO (El Niño – Southern Oscillation) is expected to remain neutral;
- Sea Surface temperatures around New Zealand warming up, and well above average to the east. Conditions favourable for a possible repetition of marine heatwave conditions this summer;
- Vigorous westerly regime gradually giving way to northeasterly flows later in the season;
- Warmer than average, but variable. Heat waves likely.
- Mixed rainfall anomalies. Chance of dry conditions in the Wairarapa, possibly breaking down later in the season;
- High chance of heavy rainfall events and thunderstorms in the west. Significant easterly events possible later in the season

Whaitua*	Variables	Climate outlook for summer 2020
Wellington Harbour & Hutt Valley	**Temperature:**	Above average, but variable.
	Rainfall:	Low confidence for seasonal average, highly variable. Heavy rainfall events likely.
Te Awarua-o-Porirua	**Temperature:**	Above average, but variable.
	Rainfall:	Low confidence for seasonal average, highly variable. Heavy rainfall events likely.
Kāpiti Coast	**Temperature:**	Above average, but variable.
	Rainfall:	Average to above. Heavy rainfall events likely.
Ruamāhanga	**Temperature:**	Above average. Heatwaves likely.
	Rainfall:	Average to below. Chance of thunderstorms and easterly events later in the season.
Wairarapa Coast	**Temperature:**	Above average. Heatwaves likely.
	Rainfall:	Below average. Chance of thunderstorms and easterly events later in the season.

*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: 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/

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/