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REGIONAL COUNCIL
Te Pane Matua Taiao

Climate and Water Resources Summary for the Wellington Region

Summer 2020 summary

Autumn 2020 outlook

Release date: 2 April 2020

Environmental Science Department

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A prominent feature of the summer 2020 was the ongoing dryness, as seen in this photo of the Wairarapa taken on 27th February. The entire North Island, and half of the South Island, were extremely dry. The large spatial extent of the event, and the fact that the 'climate influencers' are not particularly active, are a stark reminder of the effects of climate change on our landscape. Climate projections for mid-century show that even if we contain global warming under 1.5-2 degrees, the average summer could be as dry as this year. This suggests that the current conditions may, in fact, become the new normal by 2040.

Overview

Summer 2020

Summer 2020 was quite remarkable in some ways, and unremarkable in others. It was once again a season of contrasts, with a strong westerly flow keeping the weather dry and cool for the most part, even though the average seasonal temperatures ended up ranging from normal around the coastal areas to above normal for the Wairarapa. The most prominent feature was the rainfall, which started above average in December and was followed by less than 20% the monthly average for both January and February in parts of the Wairarapa. This dry spell was associated with a large scale drought event affecting the entire North Island and parts of the South Island, with Northland being the worst hit area. MPI eventually declared the drought a large scale adverse event on 12th March, which was the first time this classification was given since 2013.

Climate drivers

The climate drivers (influencers) were mostly neutral throughout summer, making it difficult to explain the reasons for the drought. 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. This flow influenced most of the summer, helping to shelter the country from northeasterly flows which would have helped to provide humid flows for rainfall and thunderstorms inland. The situation only slowly started to revert back to normal in March, culminating with a remarkable rainfall event at the end of the month in the Wairarapa, with about 250mm recorded on the east coast. This extreme event will be discussed in our next report.

Climate outlook for autumn 2020

The current atmospheric set up points to neutral climate influencers, without any phenomenon in particular influencing the long-term outlook either way, except for the ongoing effects of global warming. As such, we expect the remainder of autumn and beginning of winter to have temperatures ranging between normal and above normal. Rainfall should be subject to large month to month variations with high chance of further extreme rainfall events on both the east and west coasts. There is low confidence for the total seasonal rainfall accumulation.

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).

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 autumn climate pattern.

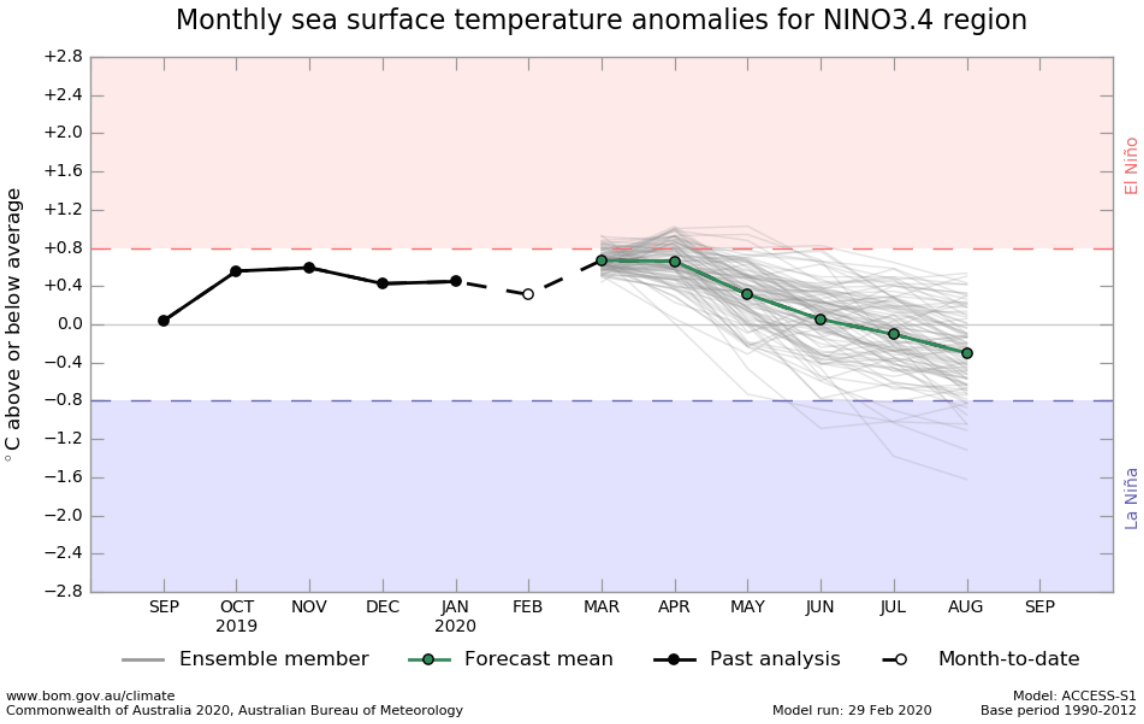


Figure 1.1: Averaged modelled projections (in green) show ENSO is expected to remain in a neutral phase for the time being. Source: Australian Bureau of Meteorology.

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 March 2020. The pattern shows warmer than normal waters north of New Zealand and colder than normal south of the country, with a mixed neutral signal in the Equatorial Pacific Ocean.

The sea ice cover around Antarctica was below normal, but recovered somehow in February (even though we can see patches of very little ice immediately south of New Zealand).

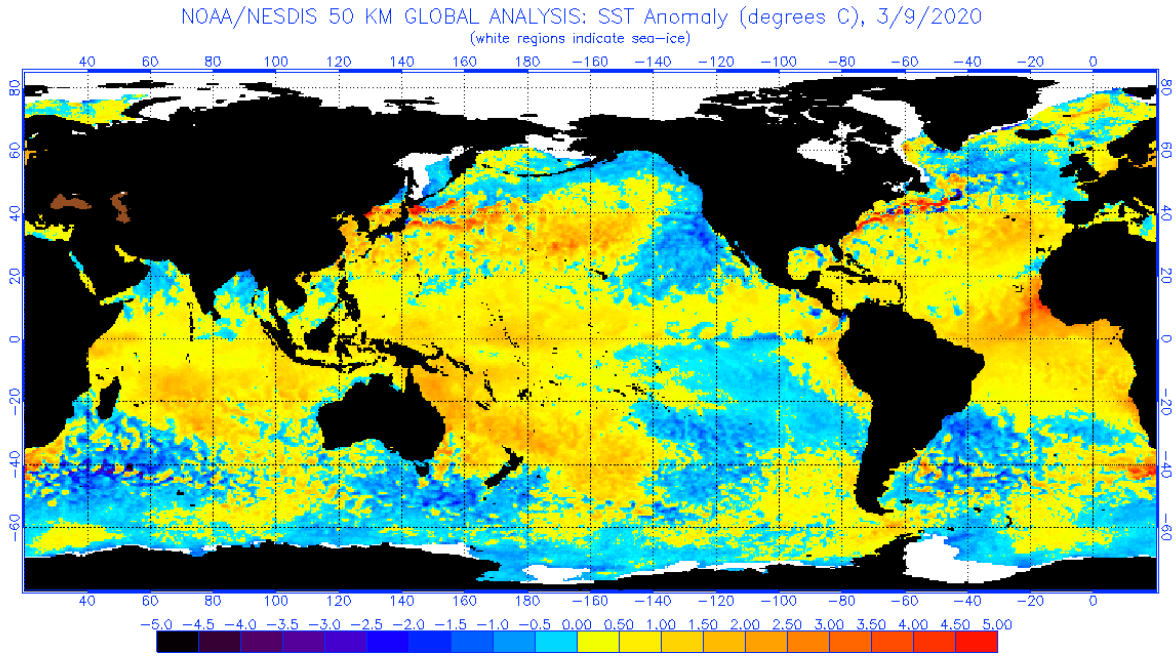


Figure 1.2: Sea surface temperature (SST) anomalies as of 9 March 2020. Sea ice coverage is shown in white. Waters around New Zealand are warmer than average in the Tasman Sea and north of the country, and cooler than average to the south. The Equatorial Pacific (ENSO) is currently neutral, and is expected 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 summer pattern was characterised by high pressure anomalies north of New Zealand, and low pressure south the country. This set up has contributed to strengthen the westerly flow, shifting and confining the rain-bearing systems to the southern part of the South Island. For the North Island, the close proximity of the high pressure cell helps explain the greater intensity of the drought around Northland, even though the SAM was in fact mostly negative, and tending neutral towards the end of the summer.

As a reminder, the SAM has been predominantly negative since the onset of the enhanced westerly pattern later in spring, in connection to the Sudden Stratospheric Warming discussed in previous reports. It is difficult to explain the overall drought development on the North Island based on the traditional climate influencers alone, and it is worth noting that the dry summer pattern is consistent with climate change projections.

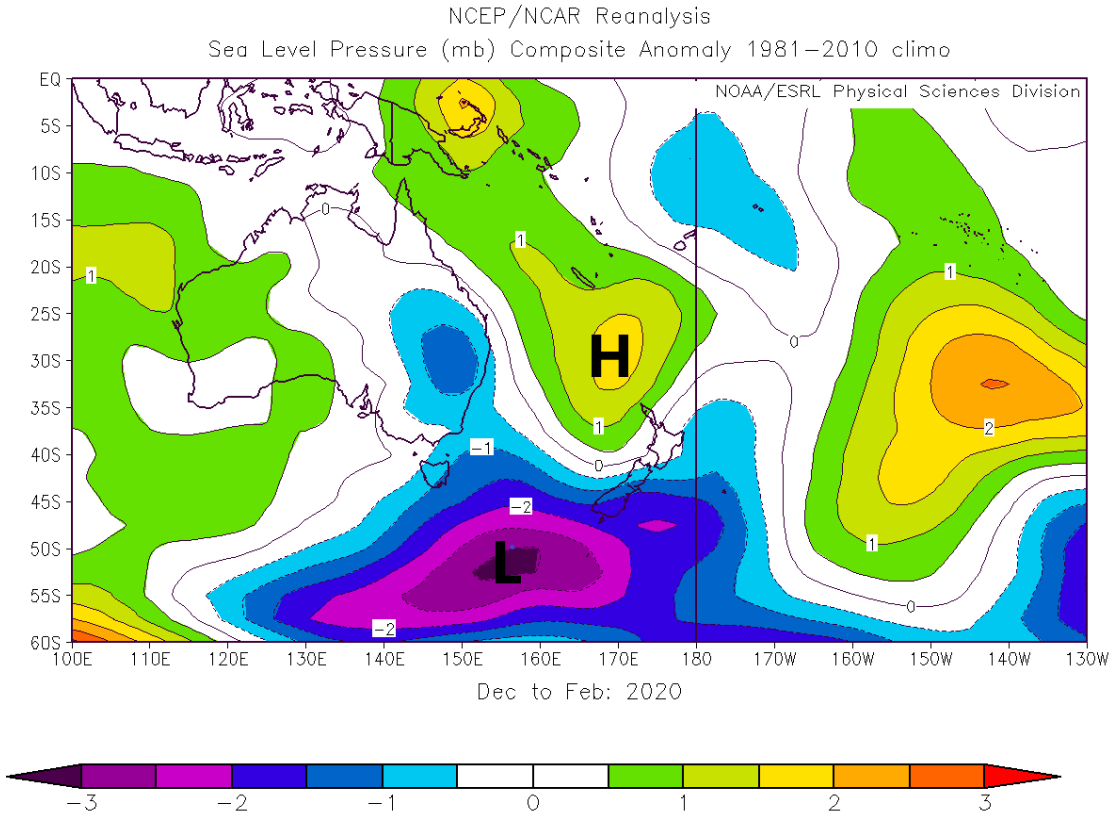


Figure 1.3: Mean sea level pressure anomaly (hPa) for summer (December, January, February) 2020. The 'H' indicates the position of the blocking high close to Northland (explaining the dry pattern), and the 'L' indicates the average low pressure southwest of New Zealand. This pattern was associated with the negative phase of the Southern Annular Mode, which tended neutral later in the season. 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).

Slightly 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.

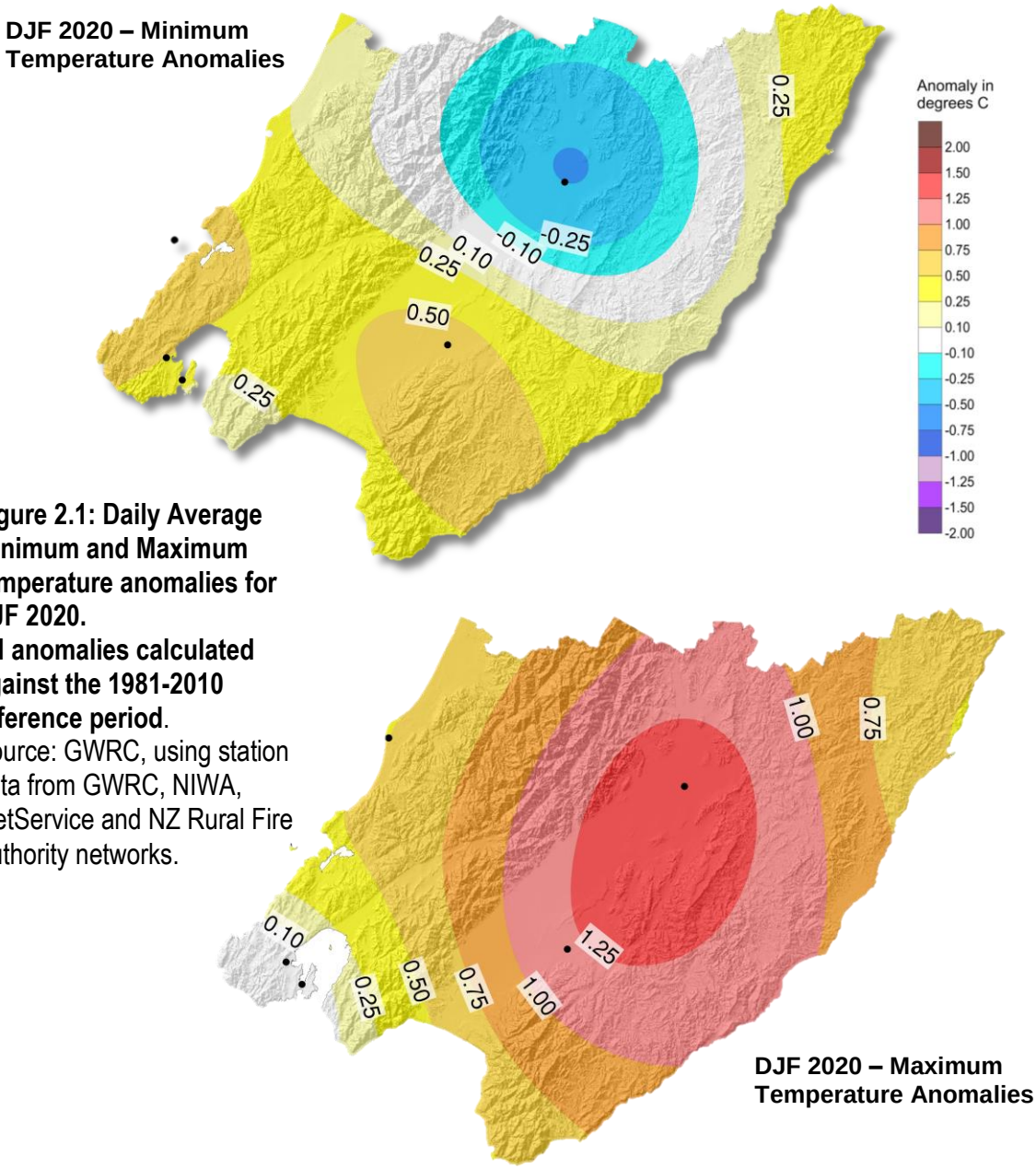


Figure 2.1: Daily Average Minimum and Maximum temperature anomalies for DJF 2020.
All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from GWRC, NIWA, MetService and NZ Rural Fire Authority networks.

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. The region experienced slightly higher than normal wind speeds near the coastal areas (between 2 and 10% above average), as a result of the increased westerly flow discussed earlier.

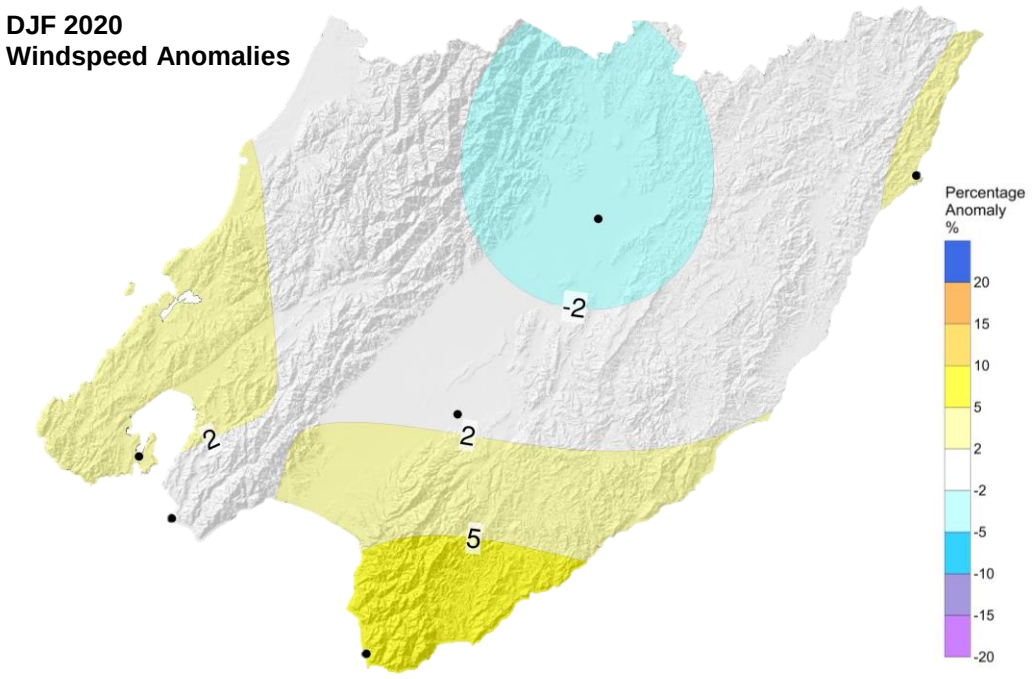


Figure 2.2: Daily mean wind anomalies (as percentage departure from the average) for DJF 2020. All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from NIWA and MetService.

2.3 Regional soil moisture

Figure 2.3 shows that the soil moisture levels were below normal for the entire region at the end of summer. This pattern reflected the vigorous westerly regime that dominated the atmospheric circulation, 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).

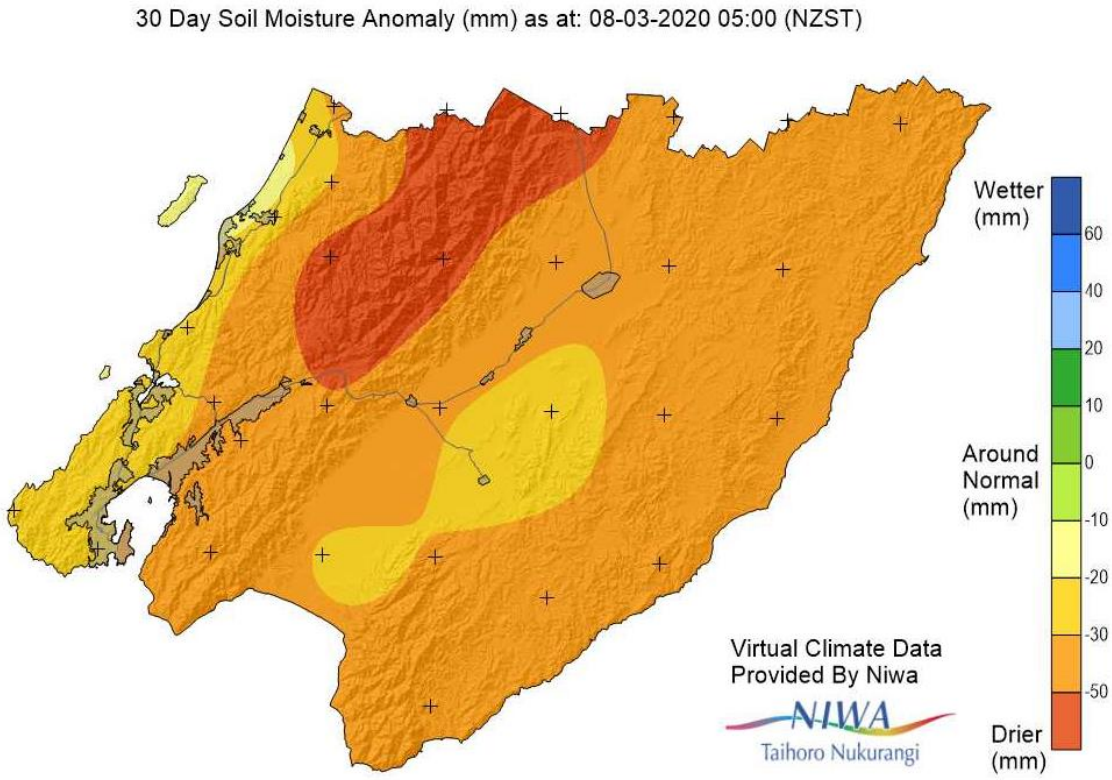


Figure 2.3: 30 Day soil moisture anomaly as at 8th March 2020. The whole region had below normal soil moisture. Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. ***Note that this data is indirectly calculated by modelling and interpolation techniques, 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. December was the wettest month compared to normal, with areas in the south and west well above average. Rainfall in January and February was below average across the entire region with more extreme dry conditions experienced to the east.

Rainfall over the entire summer season ranged from 50 percent of average in the east to near normal in parts of the west coast.

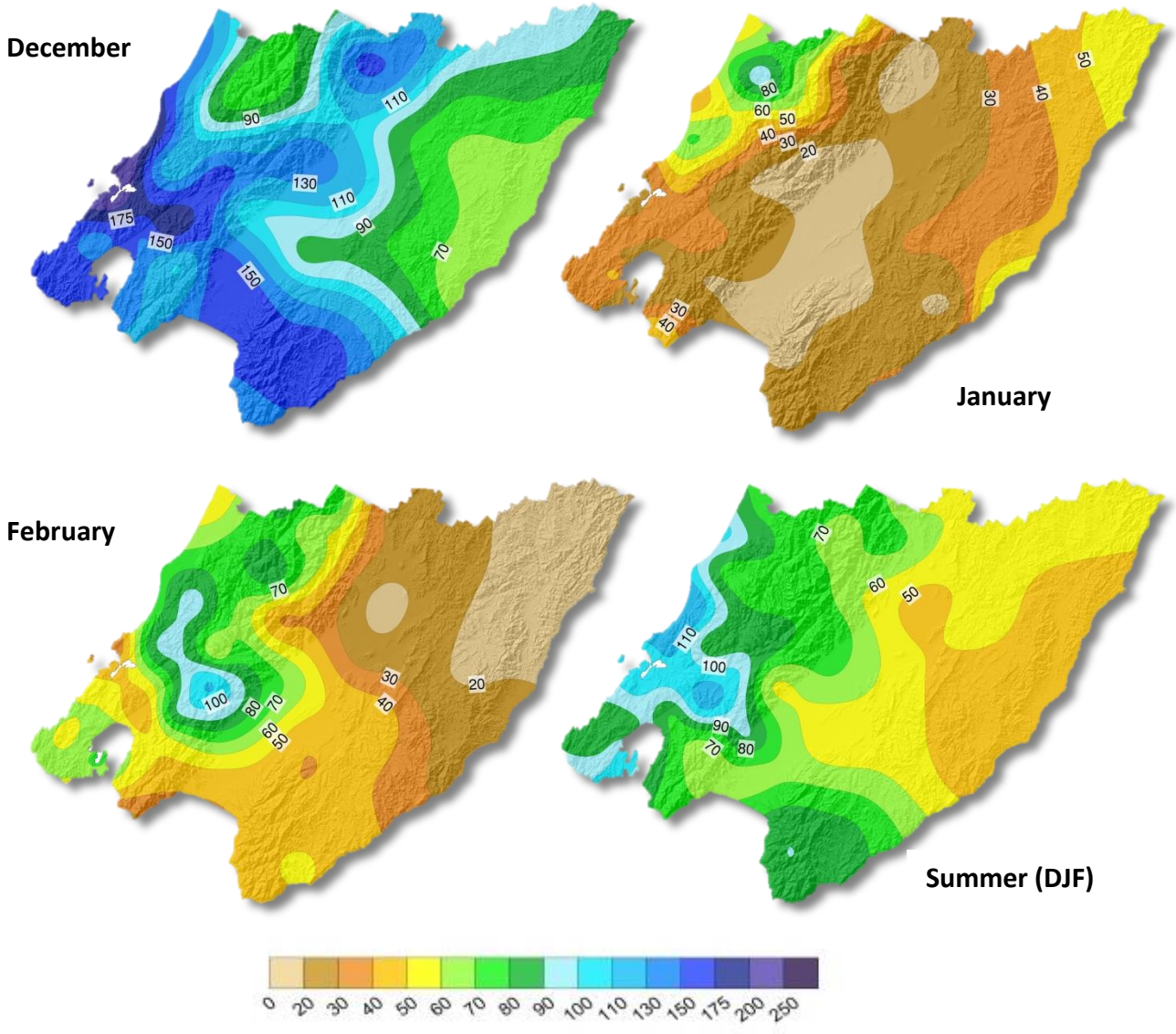


Figure 2.4: Rainfall for December (upper left), January (upper right), February (lower left) and Summer-DJF (lower right) 2019-20 as a percentage of the long-term average. Summer as a whole had a pattern of near average rainfall in the west to below average in the Wairarapa. Source: GWRC.

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 summer is:

- Statistically significant trends are seen only for temperature (Wellington and Masterton) and wind (Wellington), meaning summer is getting warmer and less windy in general. The long-term warming is about one degree per century in both Wellington and Masterton;

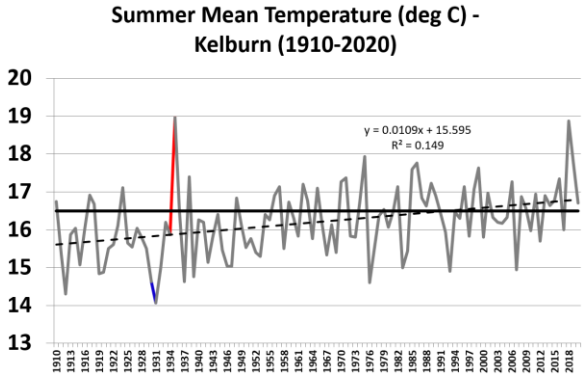
- Summer 2020 temperatures were above average for both Wellington and the Wairarapa, more so for Masterton;

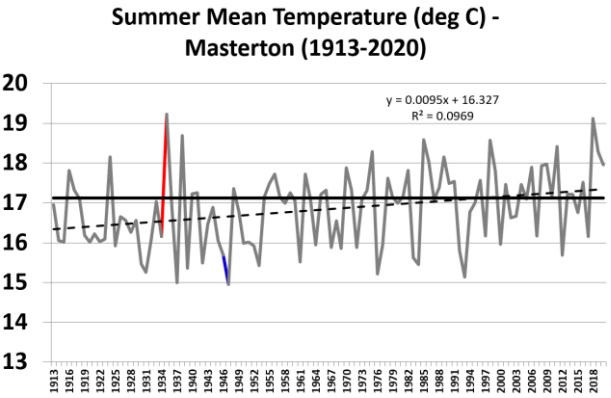
- Sunshine hours were well slightly below average for Wellington (data not available for Martinborough, graph shown for data ending in 2019);

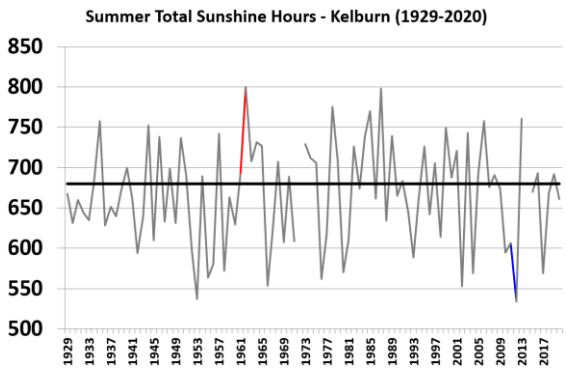
- Wind speed was slightly above average for Wellington;

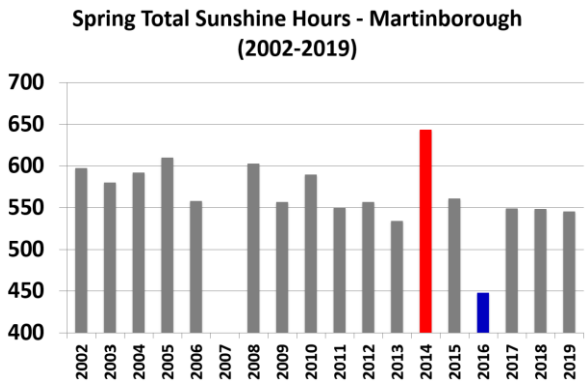
- Rainfall was below average in Wellington and well below average in the Wairarapa;

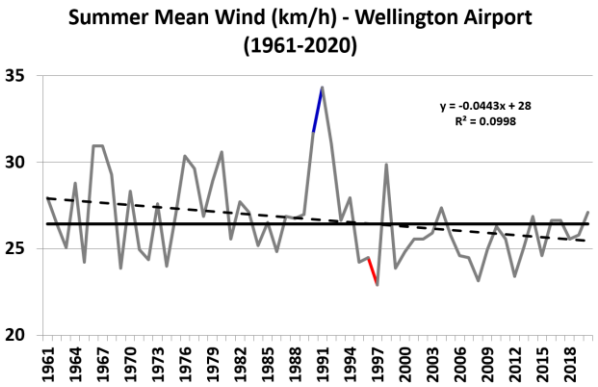
- Total rain days was about normal in Wellington and well below average in the Wairarapa.

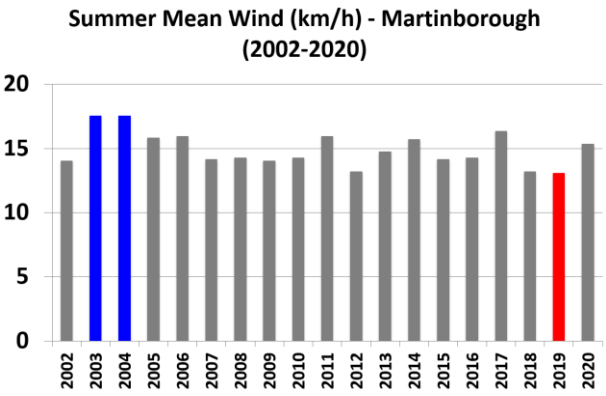

Summer Mean Temperature (deg C) - Kelburn (1910-2020)
y = 0.0109x + 15.595
R² = 0.149

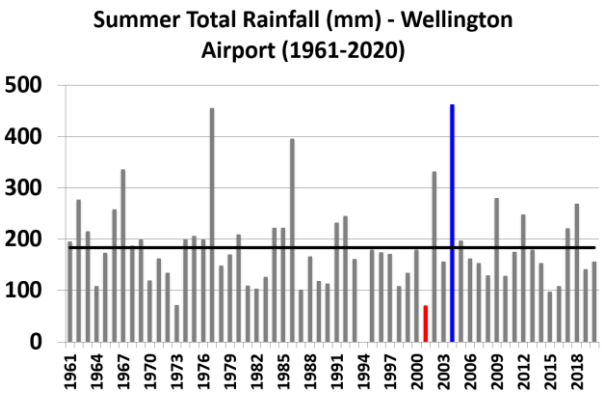

Summer Mean Temperature (deg C) - Masterton (1913-2020)
y = 0.0095x + 16.327
R² = 0.0969

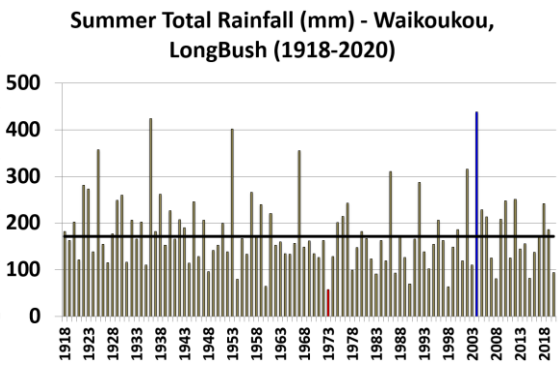

Summer Total Sunshine Hours - Kelburn (1929-2020)


Spring Total Sunshine Hours - Martinborough (2002-2019)


Summer Mean Wind (km/h) - Wellington Airport (1961-2020)
y = -0.0443x + 28
R² = 0.0998


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


Summer Total Rainfall (mm) - Wellington Airport (1961-2020)


Summer Total Rainfall (mm) - Waikoukou, LongBush (1918-2020)

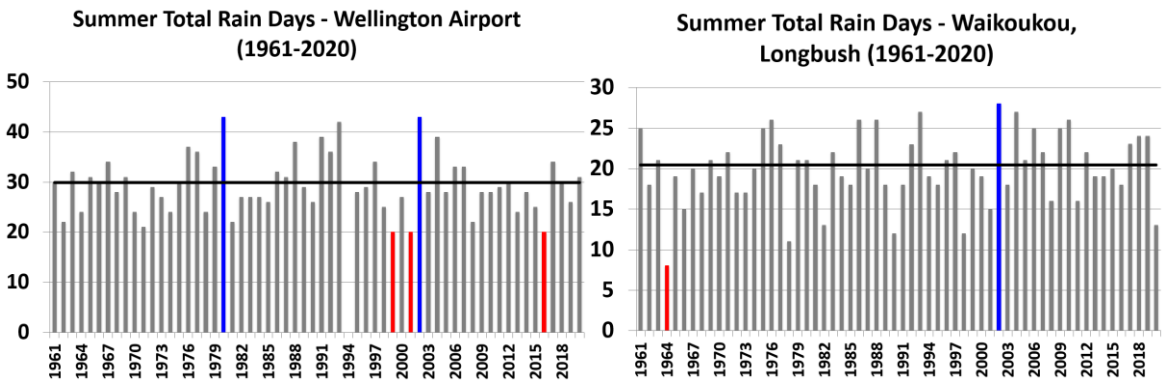


Figure 2.5: Climate change and variability graphs for summer in Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs,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

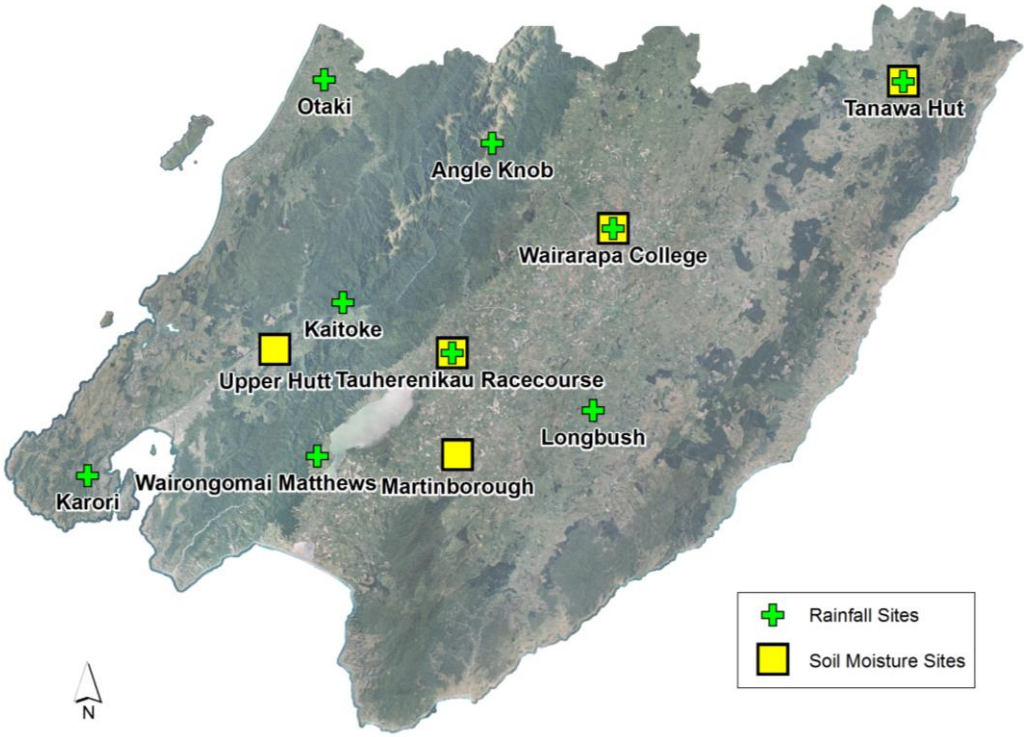


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

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.

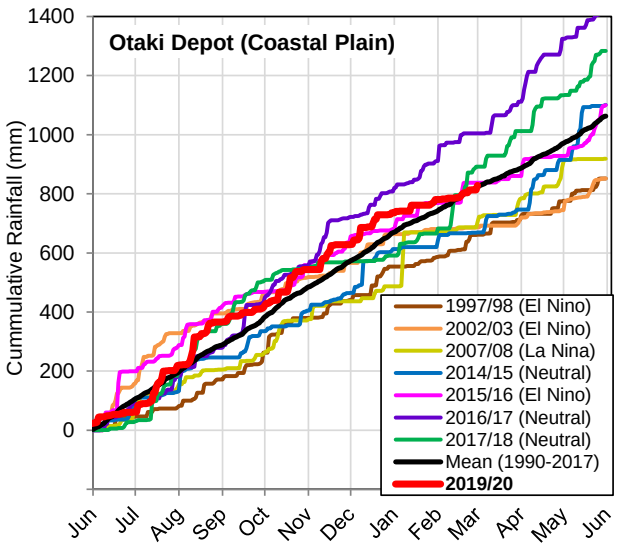
Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa have only been operating since the late 1990s so the period of data presented is limited to the last two decades. For each historical record plotted, an indication of ENSO climate state (El Niño, La Niña or neutral)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

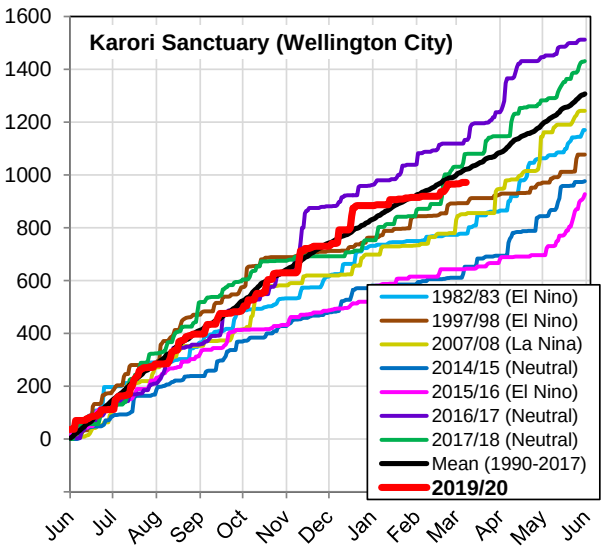
GWRC does not operate a rain gauge in the southern-most parts of the Wairarapa Valley that is suitable for presenting data in this report. This means that we cannot be confident that the rainfall patterns seen elsewhere extend to this part of the region other than the VCSN data already presented.

Overall, total rainfall accumulations since June have been about average over the Kāpiti Coast, Southwest and Hutt catchment parts of the region.

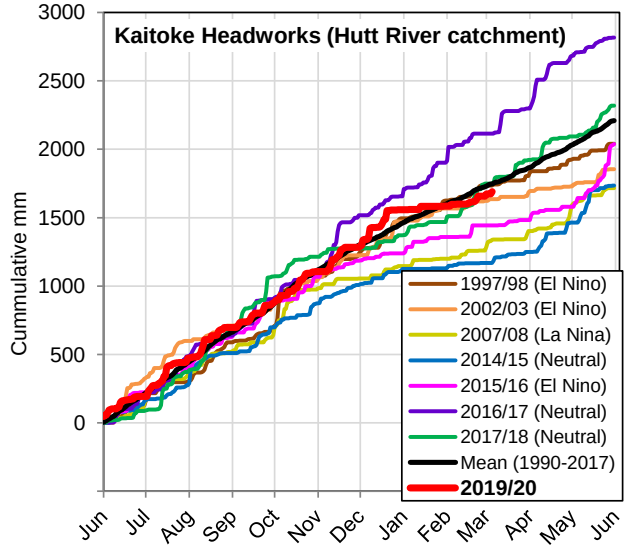
Rainfall accumulation at sites across the Wairarapa have flattened off markedly since the end of December. A one in a 50-year extreme rainfall event (about 250 mm) brought significant recovery to the eastern Wairarapa late in March. This event will be discussed in our next report.

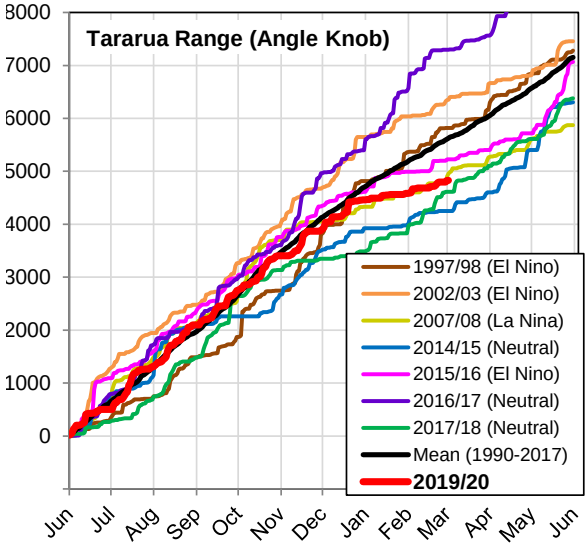
Kāpiti Coast and Southwest (Wellington city)



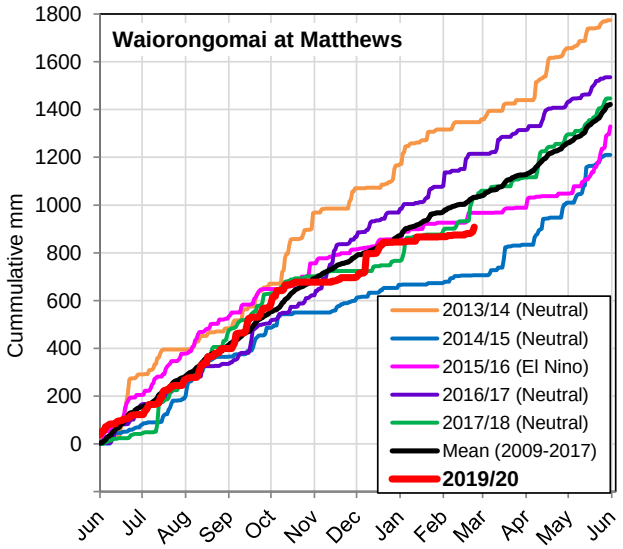


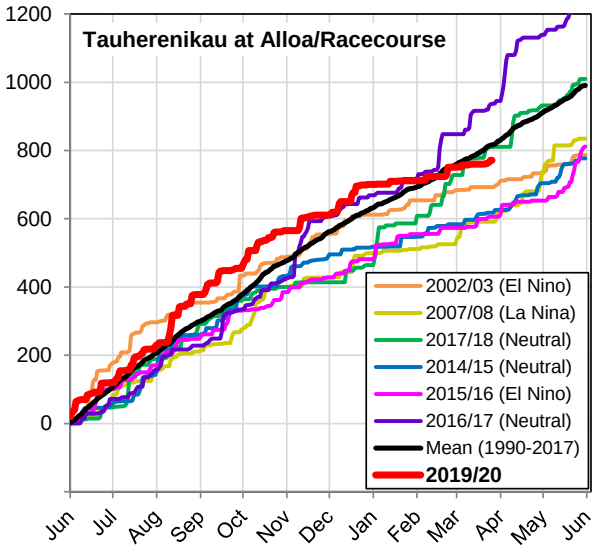
Hutt Valley and the Tararua Range

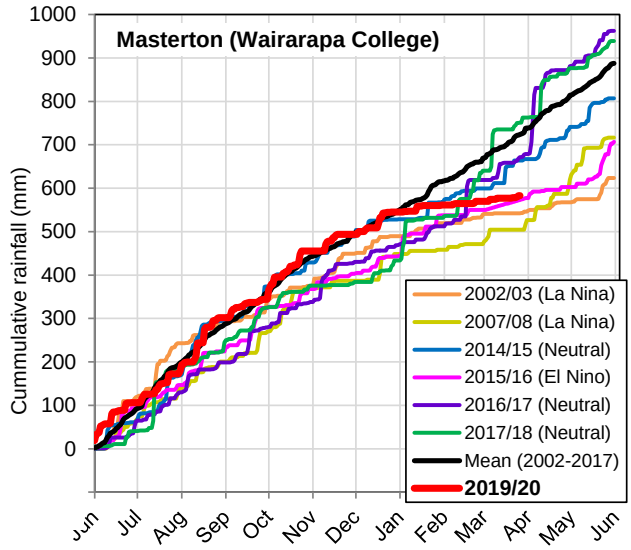


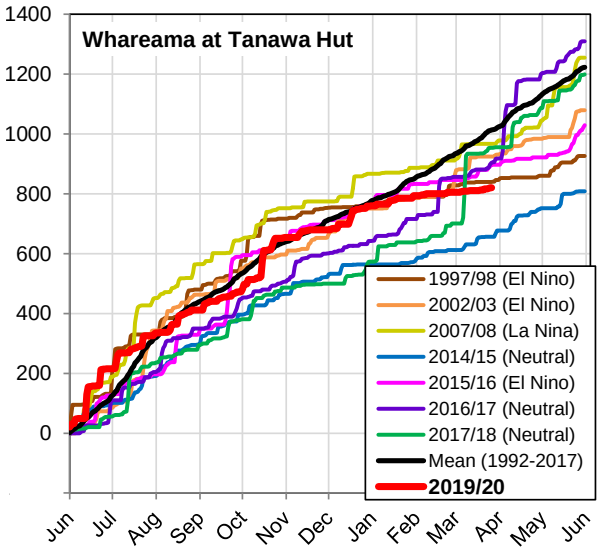


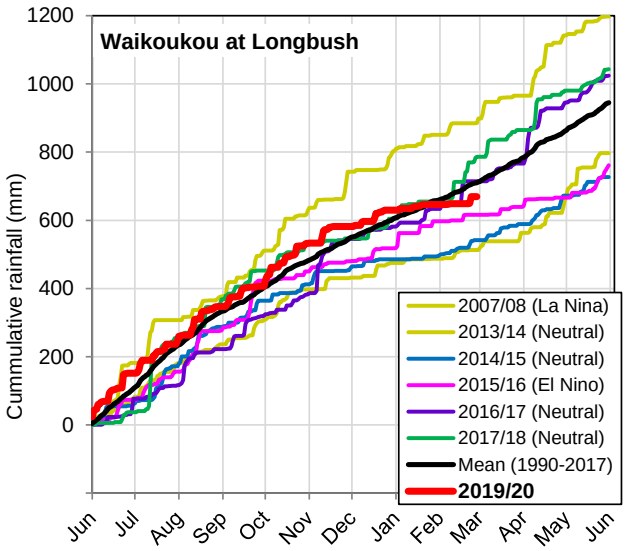
Wairarapa











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.

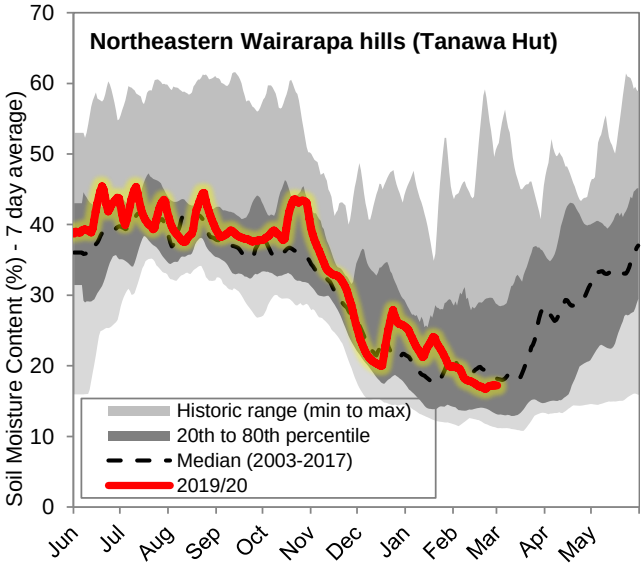
2.6.2 Soil moisture content (since 1 June 2019)

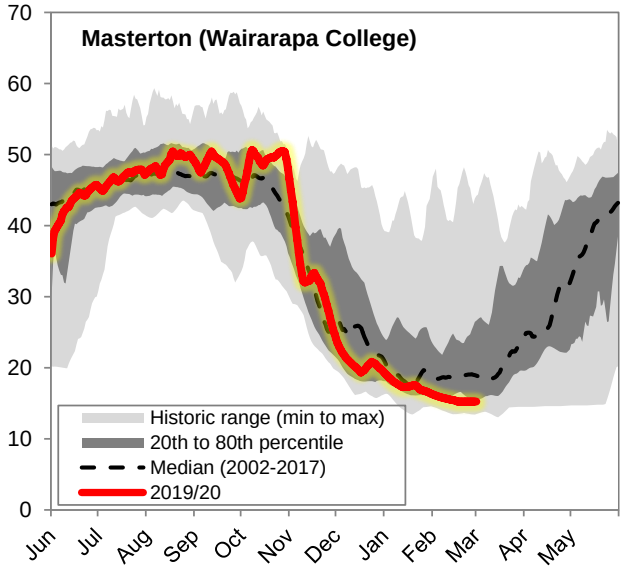
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2019. This is plotted over an envelope of the range of historic recorded data (and the median) at the site to provide an indication of how the current soil moisture compares with that for a similar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

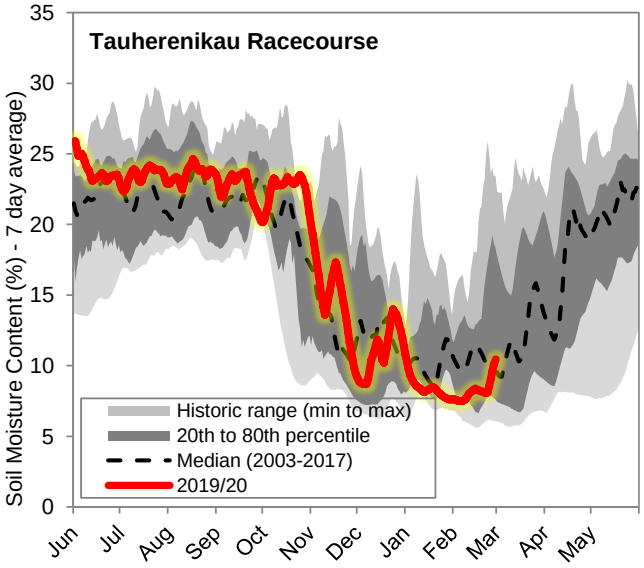
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated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

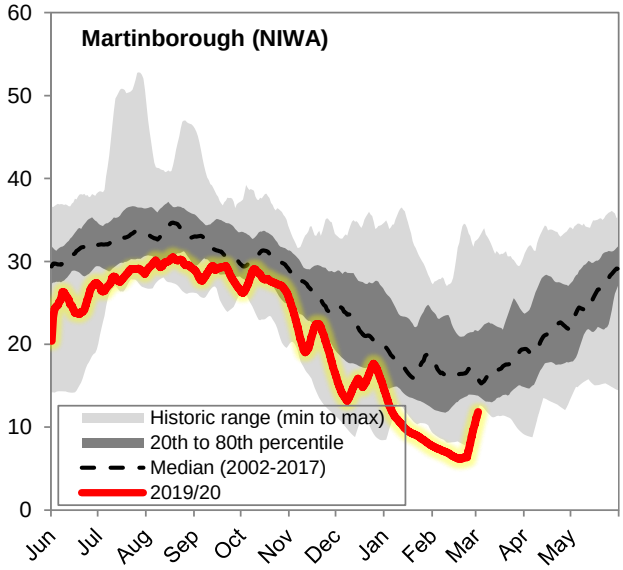
Soil moisture levels were tracking at around average levels until the end of December 2019. Masterton and Martinborough soil moisture reached very low levels towards the end of summer.

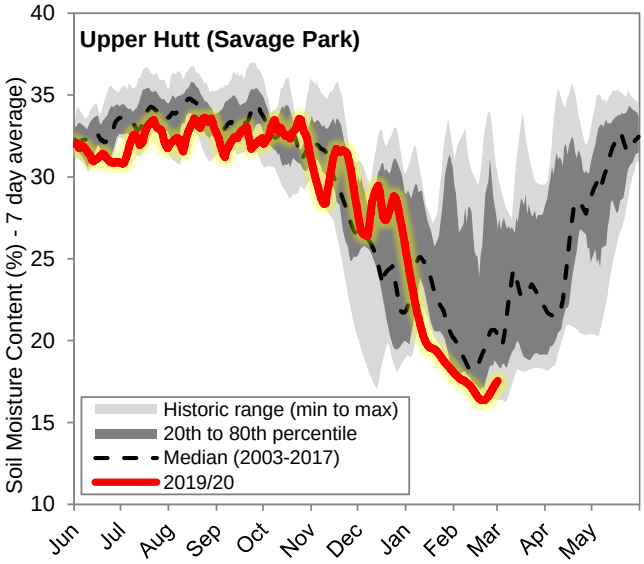
(a) Wairarapa









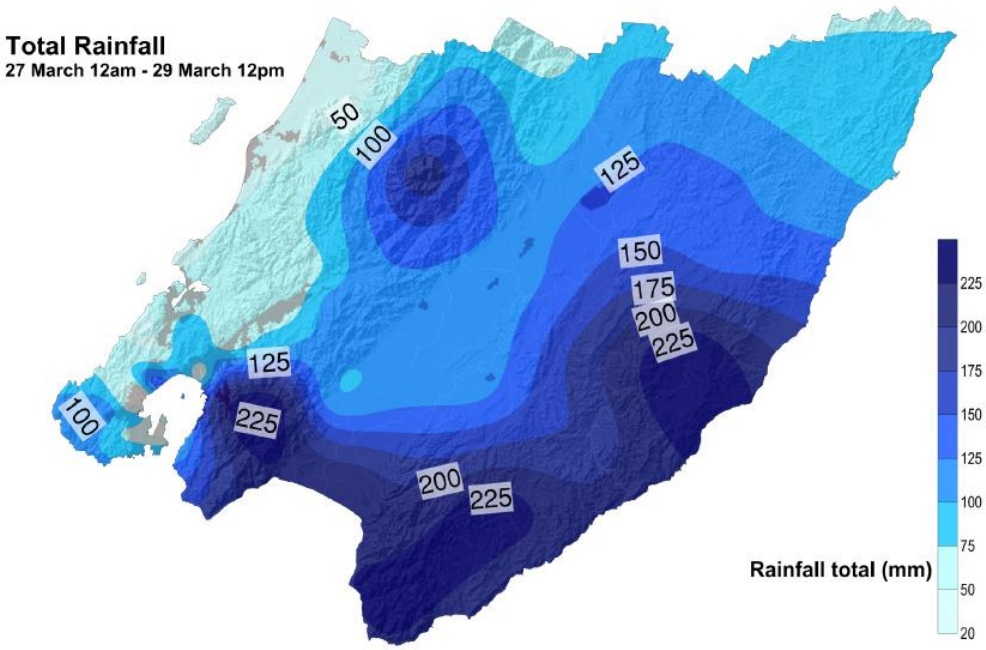


(b) Hutt Valley

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.

Preliminary analysis into March: The map below shows the total accumulated precipitation during the (easterly) extreme rainfall event that took place at the end of March. As mentioned earlier, this event had return periods of a one in a 50 year event in some areas. The impacts of this beneficial rainfall on the ongoing dry spell over the North Island and Wairarapa are still being assessed, and will be discussed in our next report. For real time updates, please refer to our drought monitor webpage:

https://www.gw.govt.nz/drought-check/



Total rainfall (mm) from 12 am 27 March to 12 pm 29 March. Source: GWRC.

3. Outlook for autumn and early winter 2020

- ENSO (El Niño – Southern Oscillation) is expected to remain neutral;
- Sea Surface temperatures around New Zealand about normal to slightly cooler than normal in the south;
- High chance of heavy rainfall events (both east and west coasts);
- Temperatures normal to above normal;
- Low confidence for total seasonal rainfall accumulation, high month-to-month variability;
- Wairarapa drought conditions ameliorated by a more favourable easterly regime. Large scale circulation likely oscillating between easterly and westerly flow during the season.

Whaitua*	Variables	Climate outlook for autumn 2020
Wellington Harbour & Hutt Valley	**Temperature:**	Average to above.
	Rainfall:	Low confidence for seasonal average. Heavy rainfall events likely.
Te Awarua-o-Porirua	**Temperature:**	Average to above.
	Rainfall:	Low confidence for seasonal average. Heavy rainfall events likely.
Kāpiti Coast	**Temperature:**	Average to above.
	Rainfall:	Low confidence for seasonal average. Heavy rainfall events likely.
Ruamāhanga	**Temperature:**	Average to above.
	Rainfall:	Low confidence for seasonal average. Heavy rainfall events likely.
Wairarapa Coast	**Temperature:**	Average to above.
	Rainfall:	Low confidence for seasonal average. Heavy rainfall events likely.

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

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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/