greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

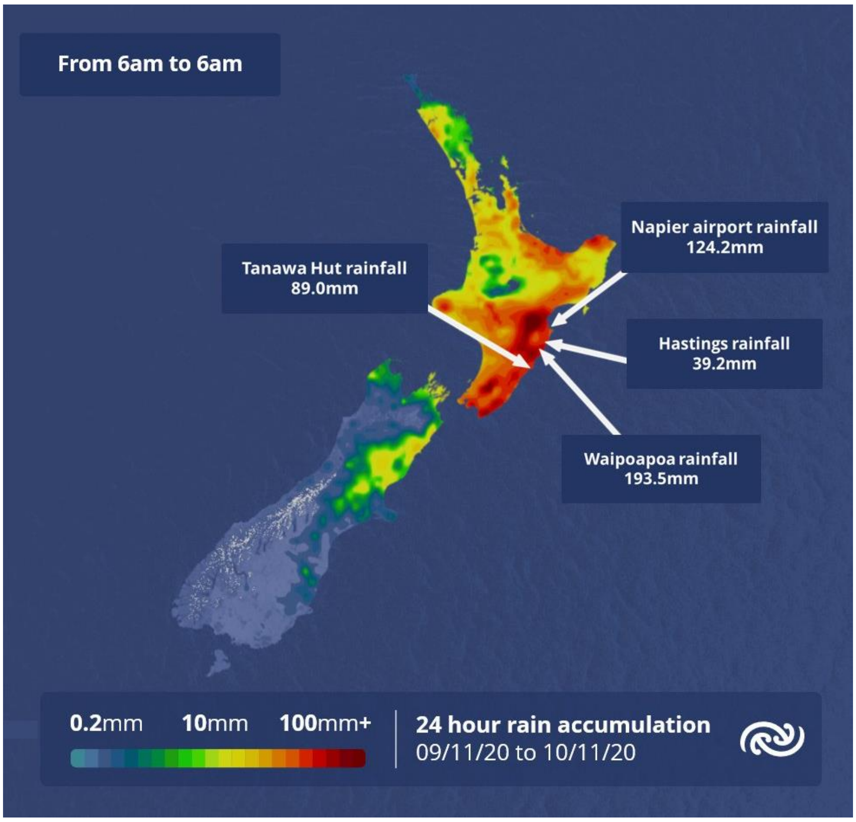
Climate and Water Resources Summary for the Wellington Region

Spring 2020 summary

Summer 2021 outlook

Release date: 22 December 2020

Environmental Science Department



The Napier flooding event starting on the evening of the 9th of November is a timely reminder of the severe consequences that extreme weather events can have in our community.

This highly disruptive event was Napier's second wettest day on record, with 124 mm accumulated at Napier airport, and impressive 242 mm recorded at Nelson Park. This is all the more impressive considering that records started in 1870, and that this one day total equates to 463% of the rainfall normally expected during November

With a La Niña summer ahead, the risks of extreme heat, high humidity with easterly rainfall events, and possible ex-Tropical cyclones increases significantly for the Wellington Region. Our thanks to MetService for making the rainfall map available.

Overview

Spring 2020

Spring 2020 was very variable in the Wellington Region. The circulation oscillated between a persistent westerly flow and some easterly flows with heavy rainfall. It was the rainiest spring on record for Wellington, and the third wettest spring on record for Masterton, for records going back to near a century. For the Kāpiti coast, spring was also the third warmest on record. Several records of warm night-time minimum temperatures were broken across the region, and Upper Hutt had the second highest wind gust on record at the end of September (westerly flow), with almost 100 km/h. Rainfall was largely above normal in September and November, and well below normal in October. All in all, it was another remarkable season of climate variability and weather extremes.

Climate drivers

A La Niña phenomenon is now approaching the mature phase, and influencing the weather in New Zealand. La Niña tends to be associated with warmer waters around New Zealand and winds from the north-easterly quadrant, especially during summer. The increased easterly flow in November suggests that the atmosphere circulation has already coupled with the oceanic La Niña. However, each ENSO event is unique, and this year we are experiencing a much higher variability than normal, with a constant alternation between westerly and easterly flows. Although spring as a whole was only slightly windier than average for Wellington and less windy than normal for Masterton, September saw fierce sustained westerlies and was the windiest since 1990 for the capital.

Climate outlook for summer 2021

Summer 2021 is expected to continue to experience a La Niña development, warmer than normal Sea Surface Temperatures north of New Zealand, a neutral Indian Ocean Dipole, and a predominantly positive Southern Annular Mode. These drivers combined imply significantly higher chances of a hotter than normal season, with more tropical humidity and increased chances of influence by ex-tropical cyclones (either directly or indirectly). A variable rainfall pattern is expected, with increased chances of thunderstorms in the Wairarapa. The caveat to this pattern is that the climate variability has been extremely high, and so the oscillation between westerlies and easterlies has potential to persist until later in the season, when the warm weather should get more settled.

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 continue its maturity into a La Niña event over summer, losing strength towards autumn 2021.

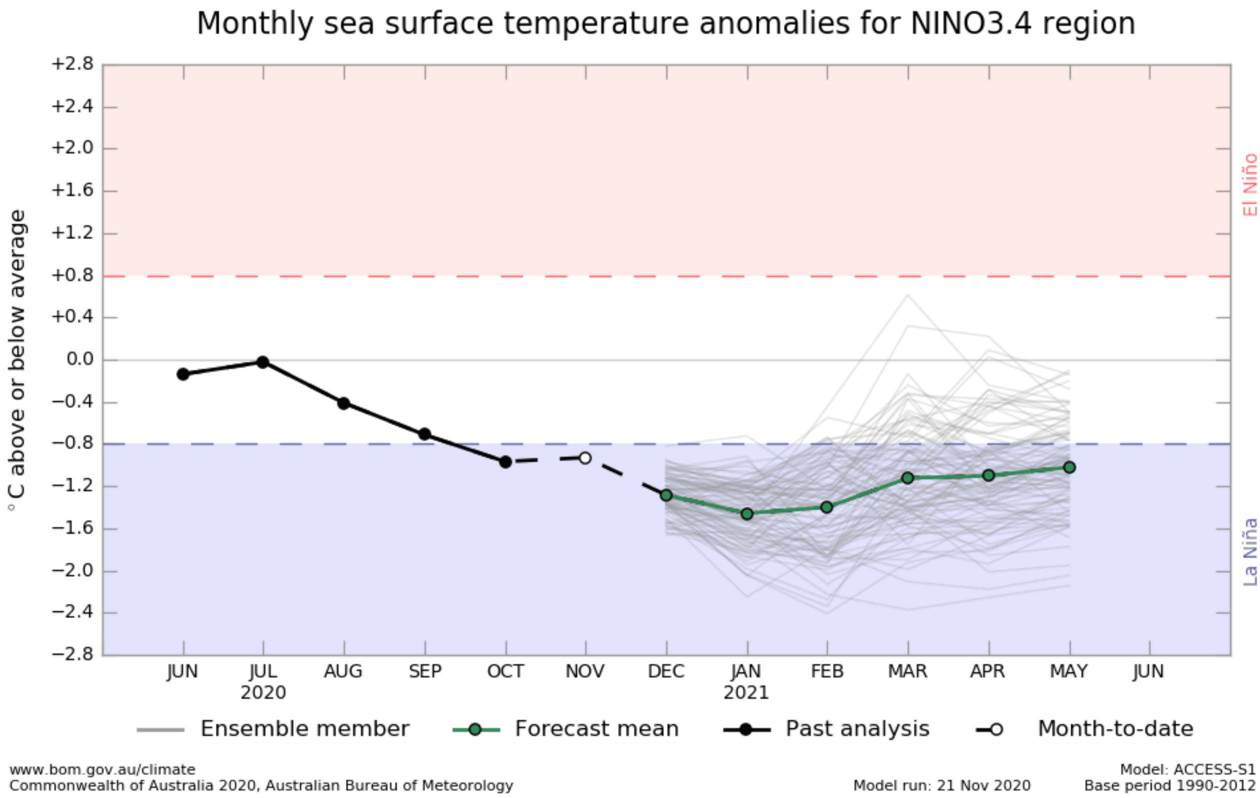


Figure 1.1: Averaged modelled projections (in green) show ENSO is expected to remain in a negative phase (La Niña) during summer. Source: Australian Bureau of Meteorology.

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 2 December 2020.

The pattern shows warmer than normal waters over the Tasman and north of New Zealand, and colder than normal south of Australia. Locally there was a tongue of cold water on the east coast of both islands of New Zealand in early December, which was amplifying the sea breezes with a chilly swim experience, but this feature is expected to dissipate and be replaced by warm waters in the New Year.

A well-developed La Niña signature is seen in the Equatorial Pacific Ocean. This may further enhance the warming waters around New Zealand later in the season, and potentially create marine heatwaves.

The sea ice cover around Antarctica has largely recovered compared to the same period last year, and is now around normal.

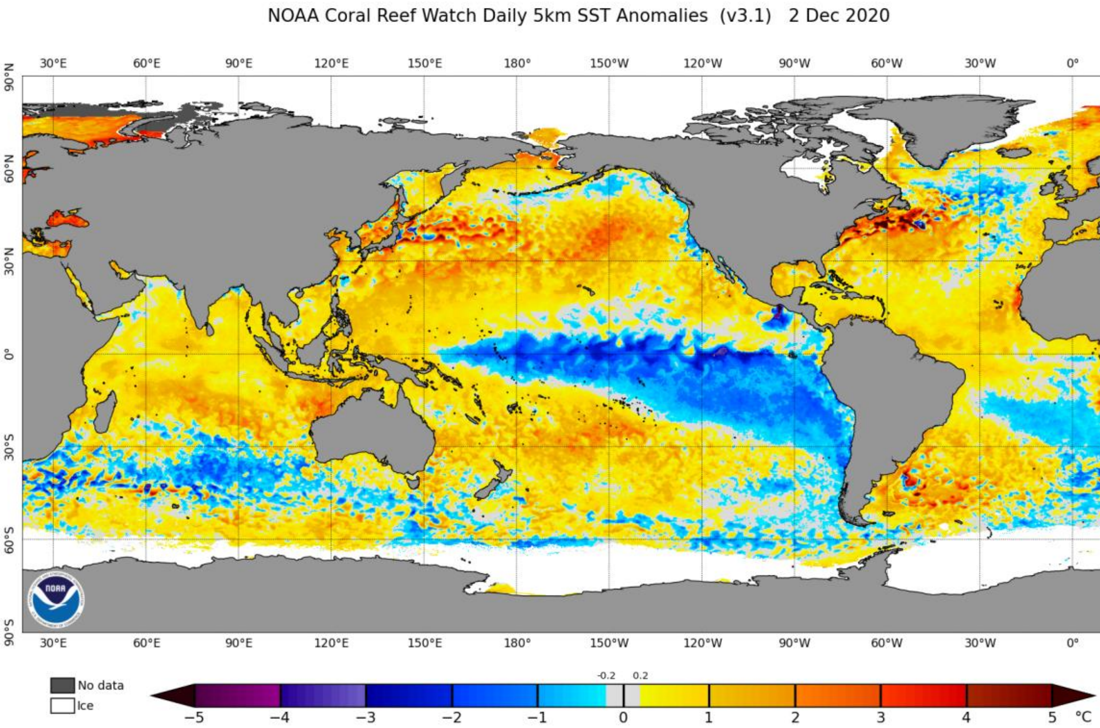


Figure 1.2: Sea surface temperature (SST) anomalies as of 2 December 2020. Sea ice coverage is shown in white. Waters around New Zealand are warmer than average in the Tasman Sea and north-east of the country, and remain cooler than average to the south of Australia. The Equatorial Pacific (ENSO) is showing a well-developed La Niña pattern. It is expected that warmer north-easterly flows will prevail around New Zealand, bringing more thunderstorms and potentially more ex-tropical cyclones this summer. 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.

The SAM has been predominantly positive since mid-October, as expected during a La Niña development. Figure 1.3 shows that the spring pattern was characterised by high pressures both to the east and to the west of New Zealand.

This unusual set up has contributed to a mixed flow oscillating between westerlies and easterlies, being itself a reflection of the variable weather patterns observed during the season.

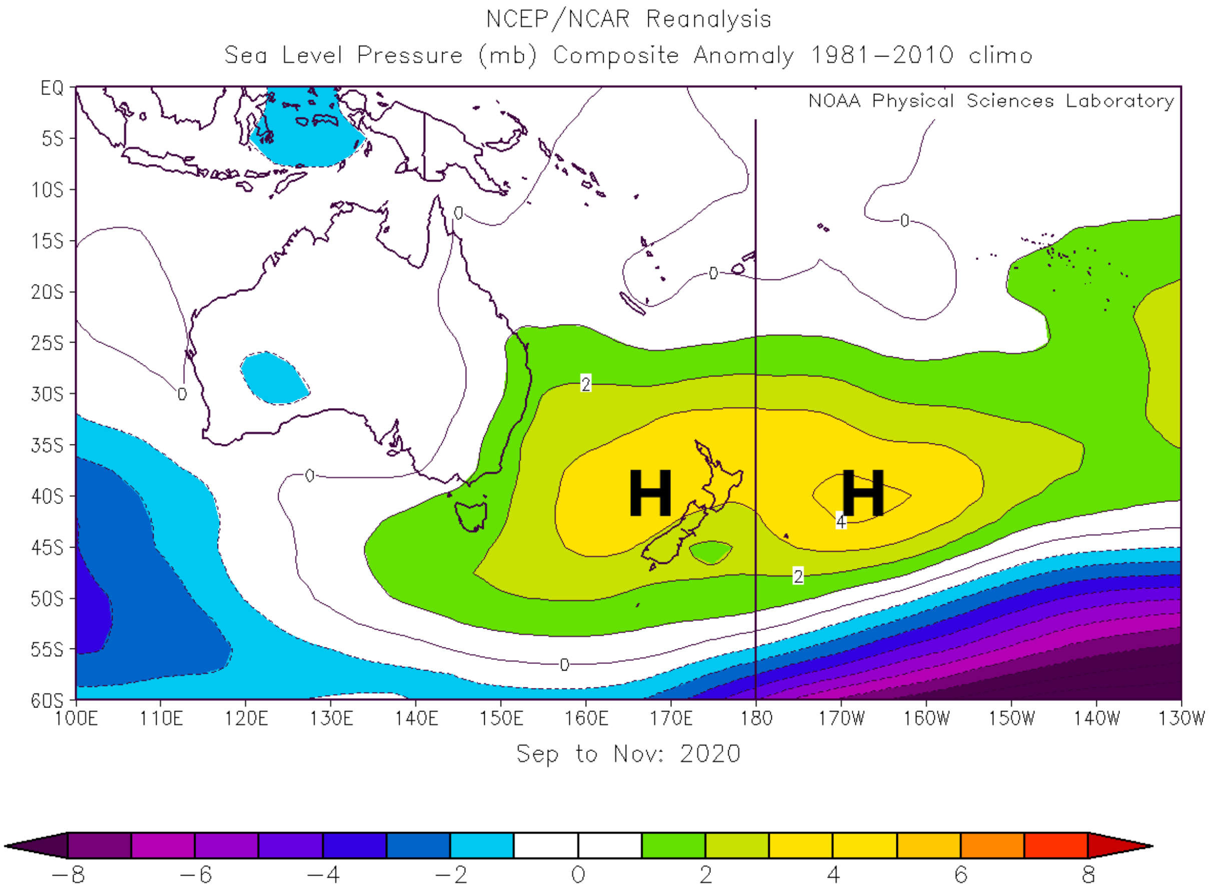


Figure 1.3: Mean sea level pressure anomaly map (hPa) for spring 2020. The 'H' indicates the central position of the anomalous high pressure areas to the east and west of New Zealand. This pattern was associated with the alternation between westerlies and easterlies so predominant during spring. Source: NCEP Reanalysis.

2. What is the data showing?

2.1 Regional temperature

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

Warmer than average temperatures continued for the region, with Martinborough and the Kāpiti coast being relatively warmer than the rest of the region. Differently to the southern Wairarapa, Masterton had an average temperature almost exactly matching the long-term average.

SON 2020 – Minimum Temperature Anomalies

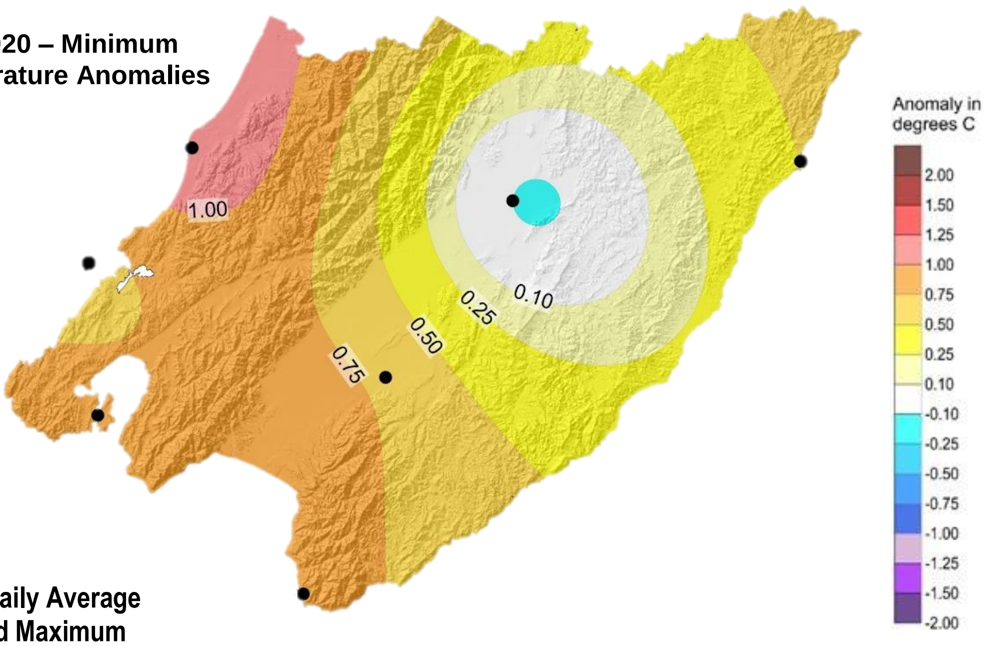
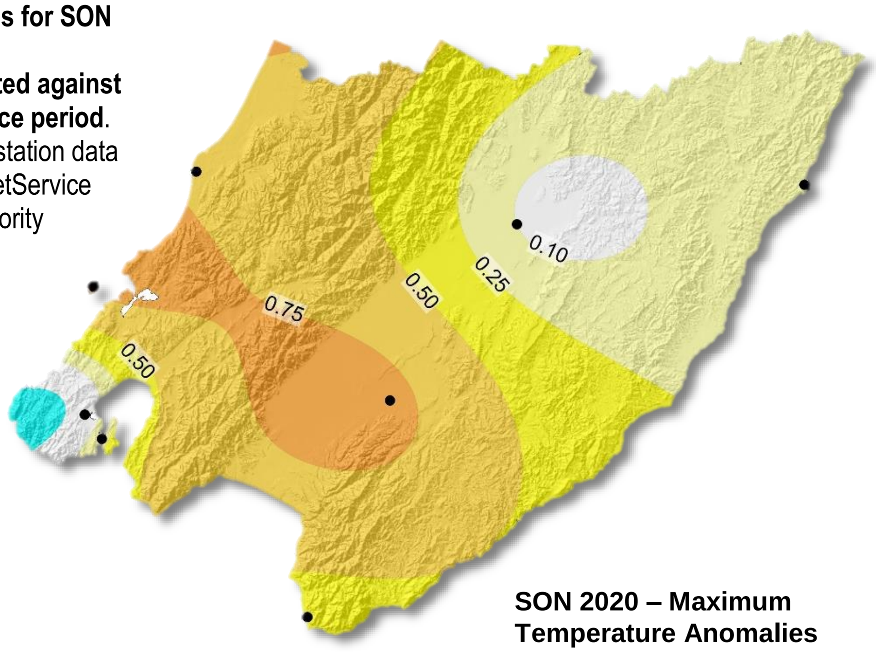


Figure 2.1: Daily Average Minimum and Maximum temperature anomalies for SON 2020.
All anomalies calculated against the 1981-2010 reference period. Source: GWRC, using station data from GWRC, NIWA, MetService and NZ Rural Fire Authority networks.



SON 2020 – 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. Virtually all the coastal areas of the region experienced above average wind speeds, except Masterton and Paraparaumu which had slightly weaker than average wind speeds. September had a fierce westerly regime, and was the windiest since 1990 for Wellington.

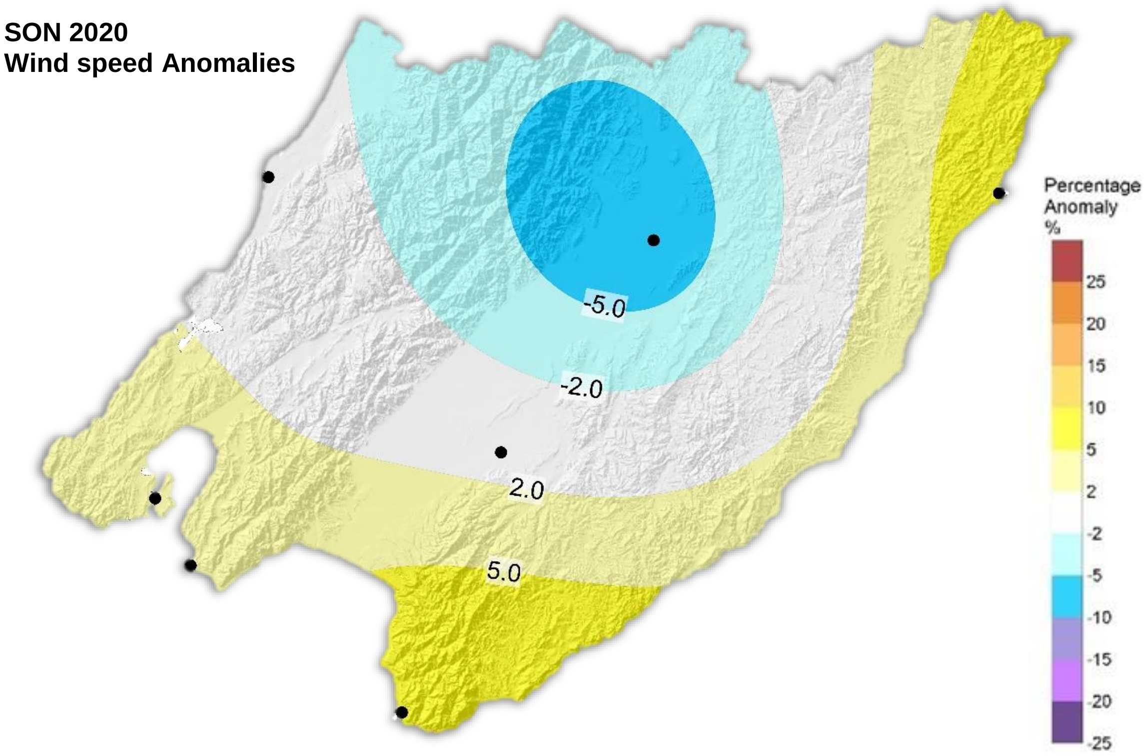


Figure 2.2: Daily mean wind anomalies (as percentage departure from the average) for SON 2020. All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from NIWA and MetService

2.3 Regional soil moisture

Figure 2.3 shows that the soil moisture levels were normal or above normal for most of the region at the beginning of summer. With warmer temperatures predicted ahead, and the possibility of long dry spells, it's possible that this pattern will revert to drier than normal as the season progresses.

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 http://graphs.gw.govt.nz/#dailyClimateMaps

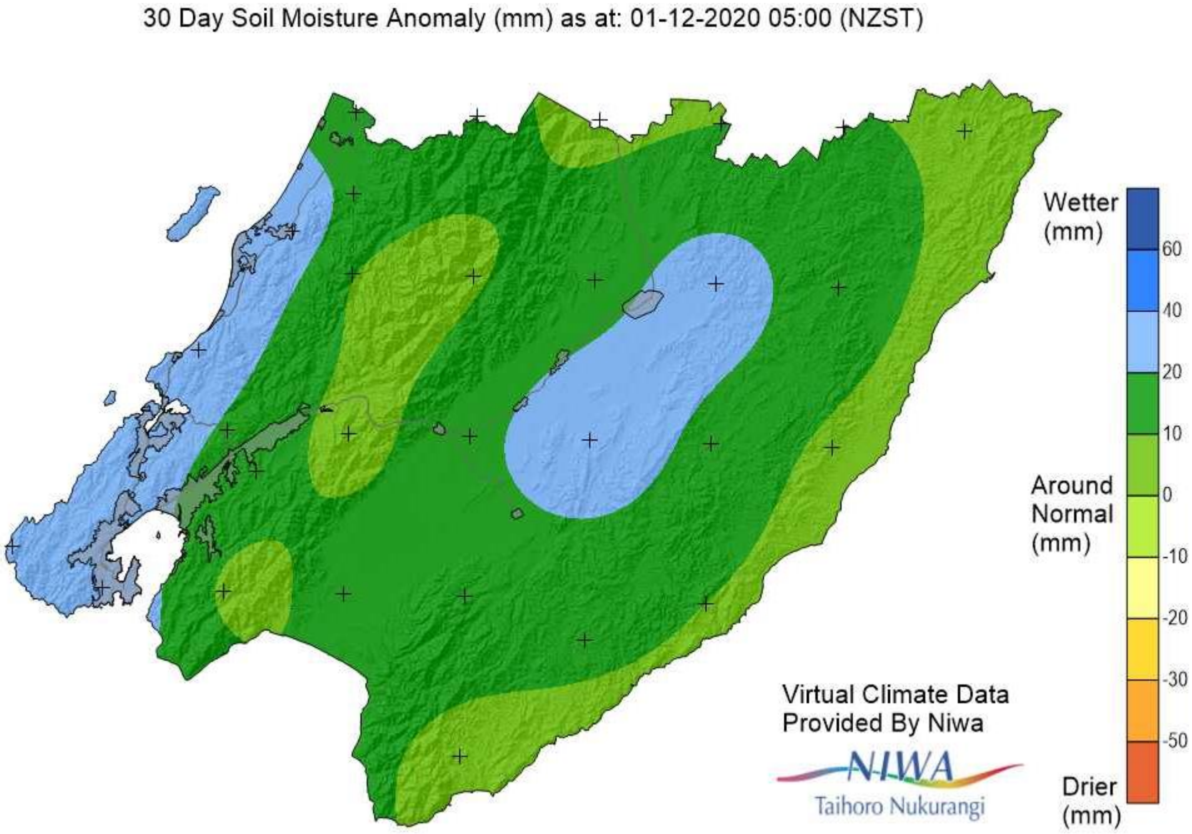


Figure 2.3: 30 Day soil moisture anomaly as at 1st December 2020. Most of the region shows above average soil moisture levels. Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. *Note that this data is indirectly calculated by modelling and interpolation 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 spring rainfall expressed as a percentage of the long-term average. September was very wet across the entire region, but particularly so to the northwest. October saw very dry conditions with the Wairarapa and Eastern hill areas falling down to around 40% of the monthly average.

November was exceptionally wet with totals in excess of 250% of normal recorded in many places.

The overall seasonal pattern for spring was above average, with Wellington having the wettest spring on record, and Masterton having the third wettest spring on record for over 100 years of continuous measurements.

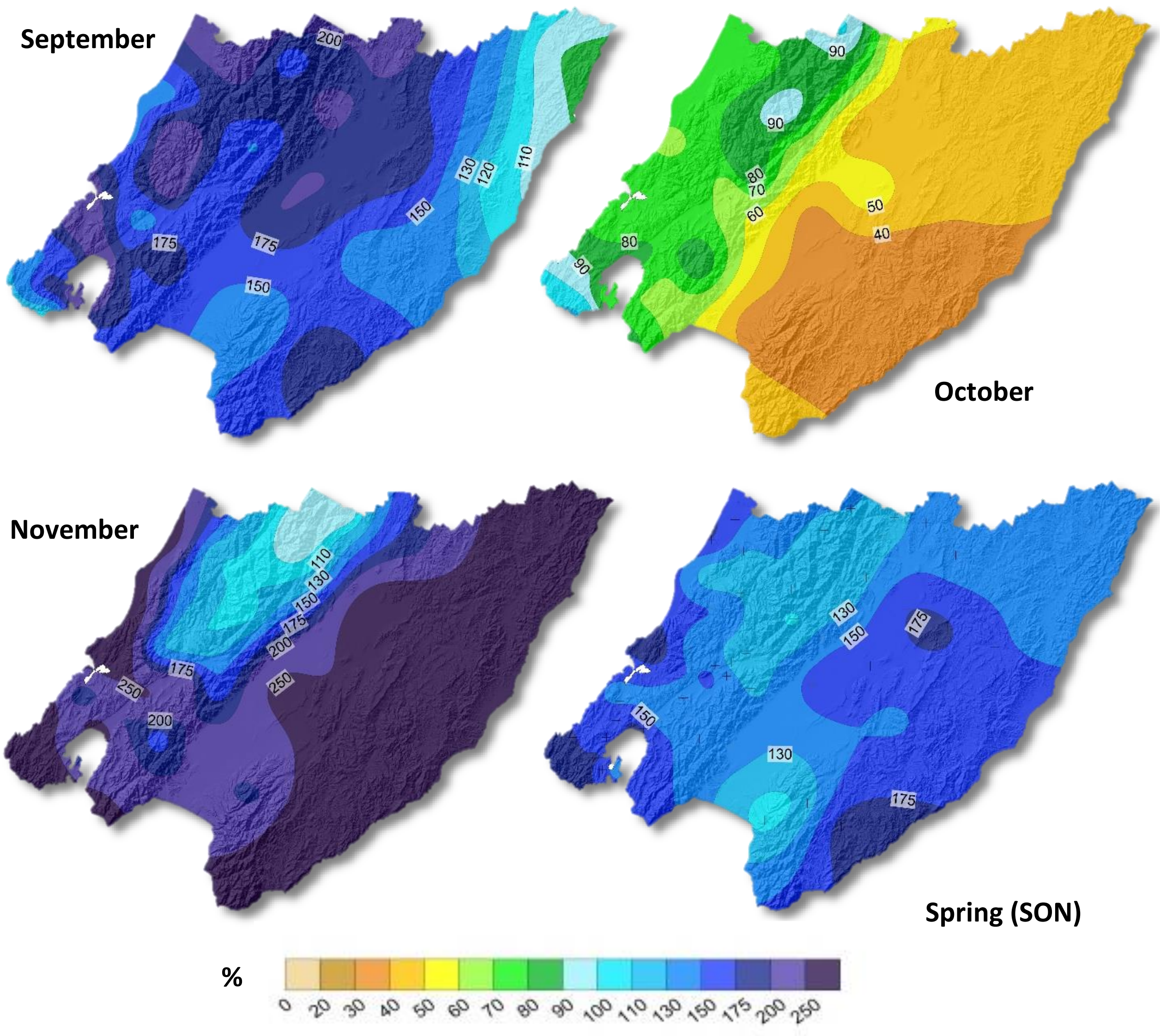


Figure 2.4: Rainfall for September (upper left), October (upper right), November (lower left) and Spring SON (lower right) 2020 as a percentage of the long-term average. Source: GWRC

2.5 Climate change and variability indicators

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

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

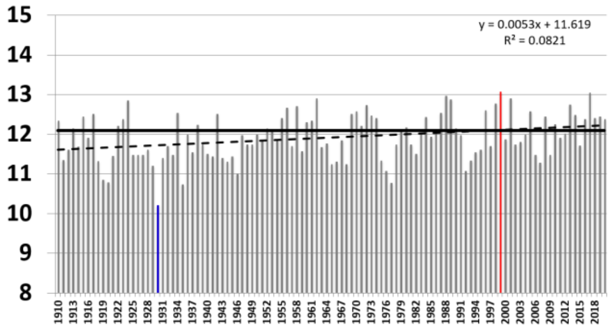
The red and blue bars show the extreme years of the entire measurement period. Red indicates seasons that were warmer, drier, sunnier and less windy than average (i.e., extreme hot/dry), and blue indicates seasons that were colder, wetter, cloudier and windier than average (i.e., extreme cold/wet). The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

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.

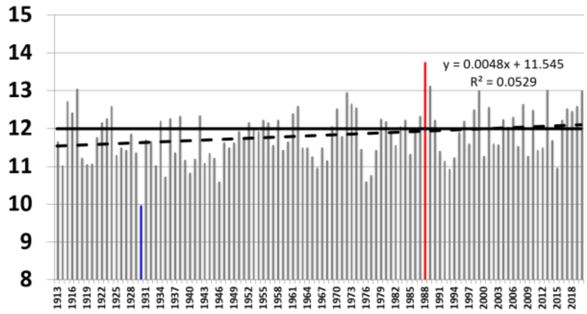
The climate change and variability summary for spring is:

- Statistically significant trends are seen only for temperature and wind, meaning that spring is getting warmer as a result of ongoing climate change, and less windy on average in Wellington. The long-term spring warming trend is about 0.5 degrees per century for both Wellington and Masterton, which is half the trend observed for every other season
- Spring 2020 was warmer than average for both Wellington and the Wairarapa
- Sunshine hours were well below average, reflecting a very wet season
- Seasonal average wind speed was slightly above normal
- Seasonal rainfall and number of rain days were well above normal. Kelburn had the wettest spring on record and for Wellington Airport spring 2020 was the second wettest on record. For Masterton, spring was the third wettest on record.

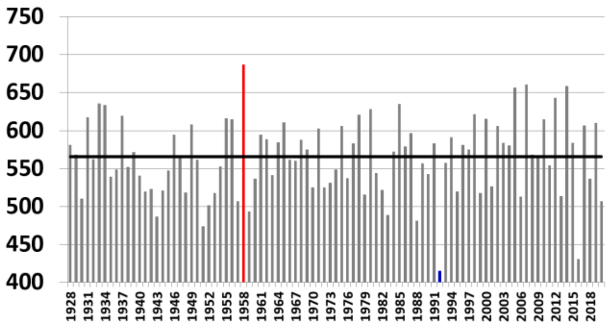
Spring Mean Temperature (deg C) - Kelburn (1910-2020)



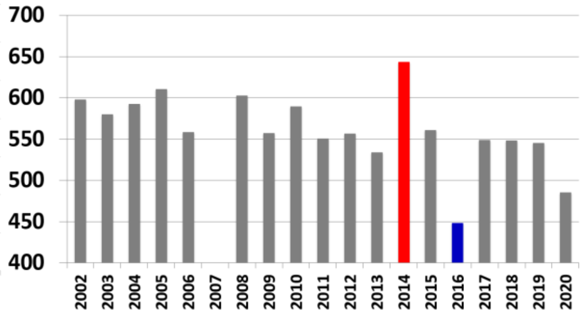
Spring Mean Temperature (deg C) - Masterton (1913-2020)



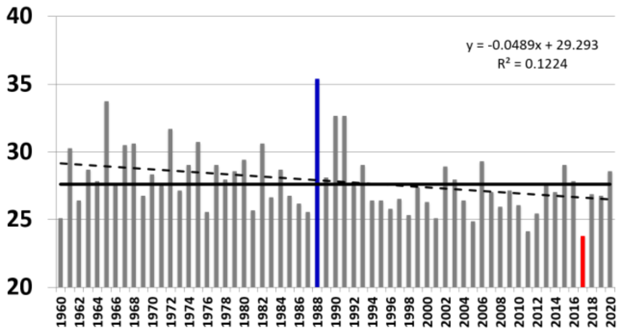
Spring Total Sunshine Hours - Kelburn (1928-2020)



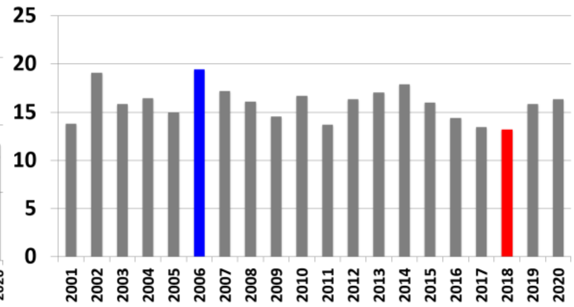
Spring Total Sunshine Hours - Martinborough (2002-2020)



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



Spring Mean Wind (km/h) - Martinborough (2001-2020)



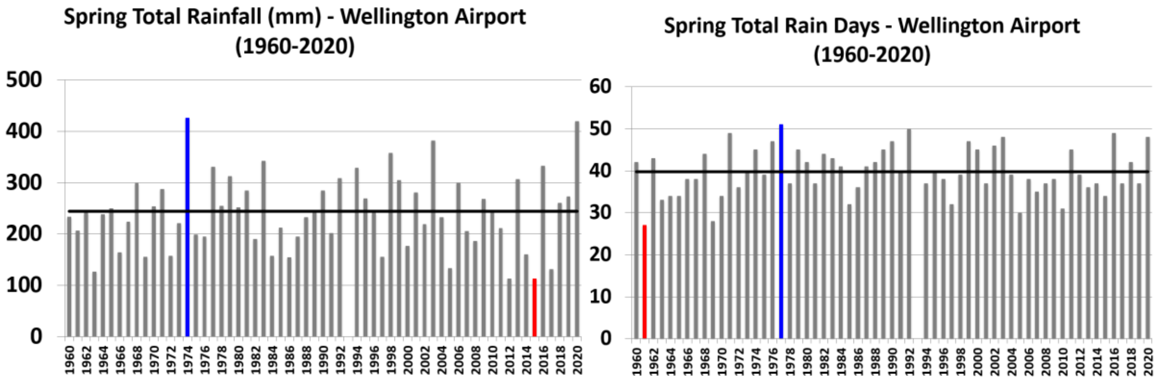


Figure 2.5: Climate change and variability graphs for spring in Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs,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

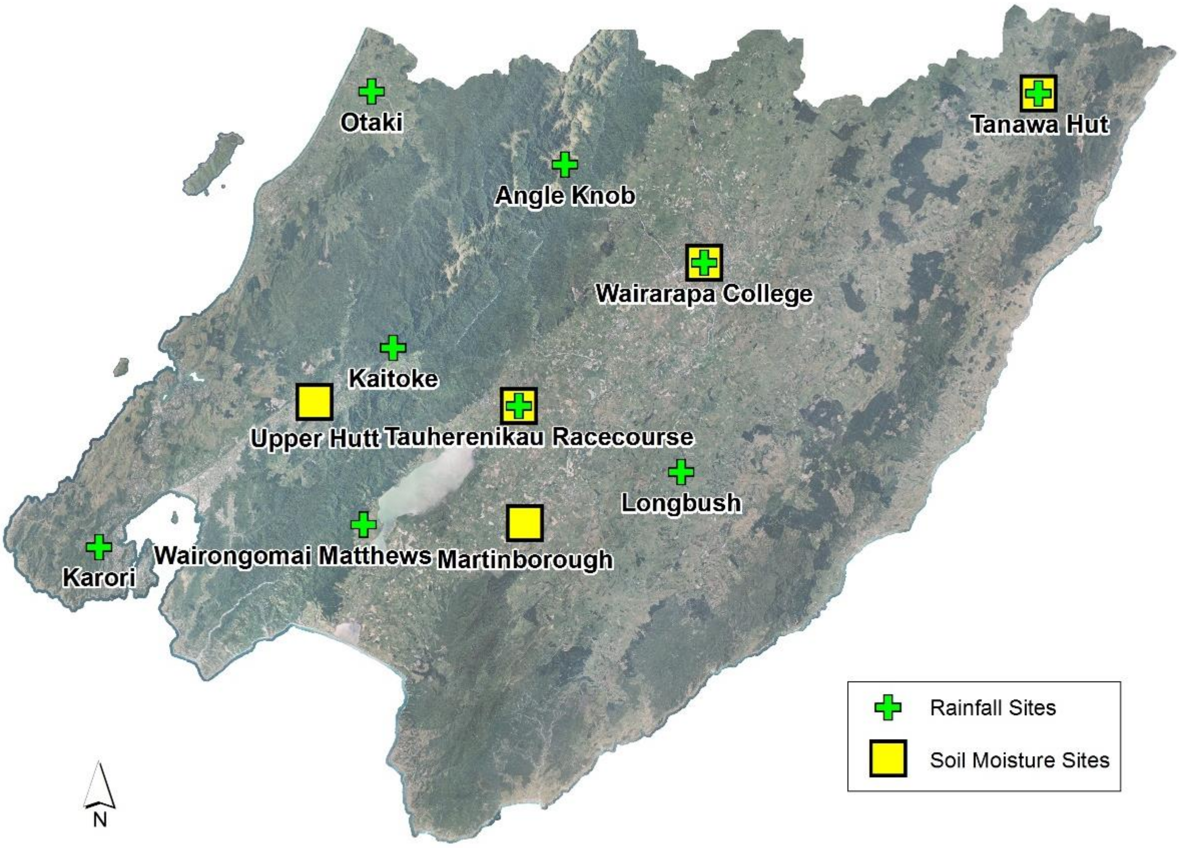


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

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

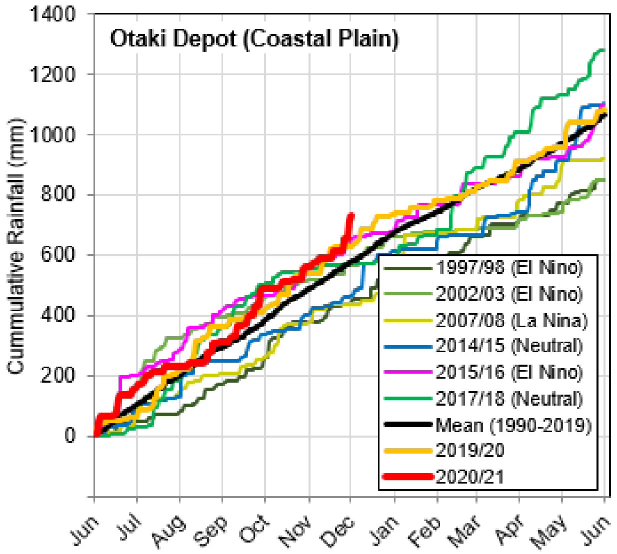
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year at several locations. For comparative purposes, cumulative plots for selected historic years with notably dry years have been included as well as the site average.

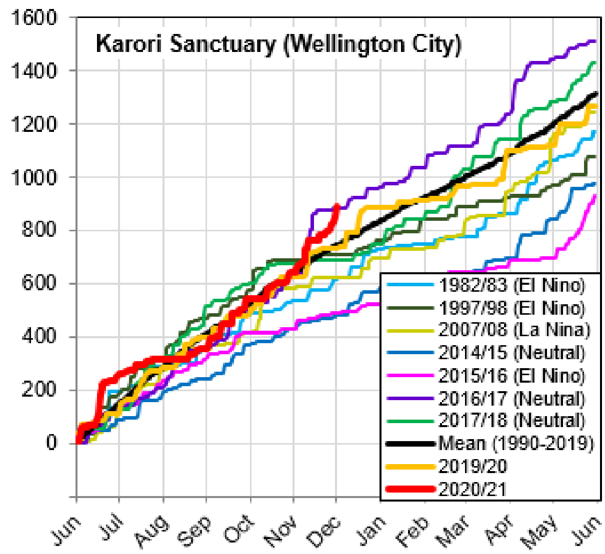
Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa have only been operating since the late 1990s so the period of data presented is limited to the last two decades. For each historical record plotted, an indication of ENSO climate state (El Niño, La Niña or neutral)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

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

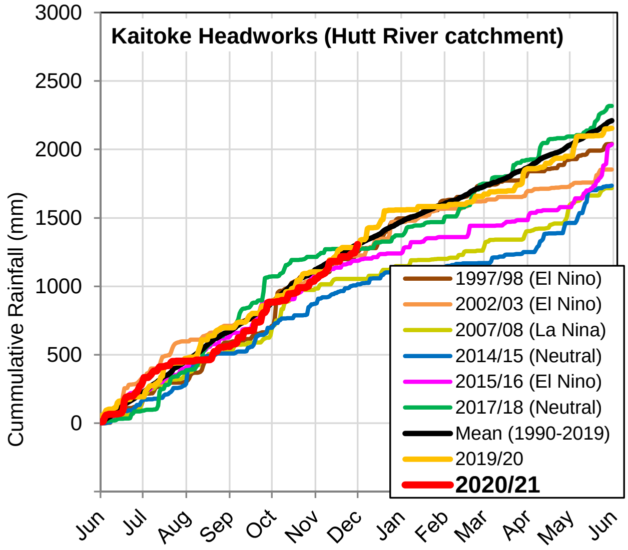
Overall, total rainfall accumulations in most areas have ended the spring season above the average line, the exceptions being the Tararua Range and foothills. The very wet conditions experienced during November are evident as a sharp upwards movement on the rainfall accumulation graphs.

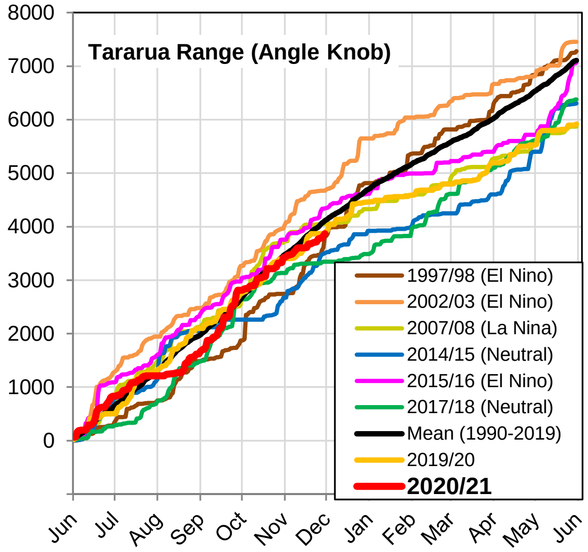
Kāpiti Coast and Southwest (Wellington City)



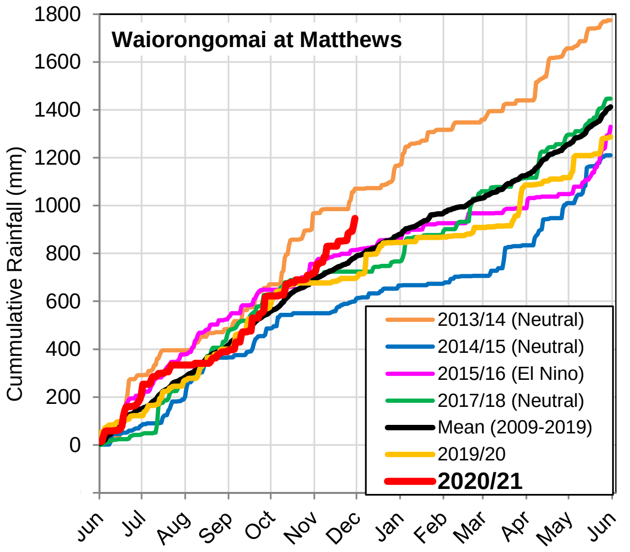


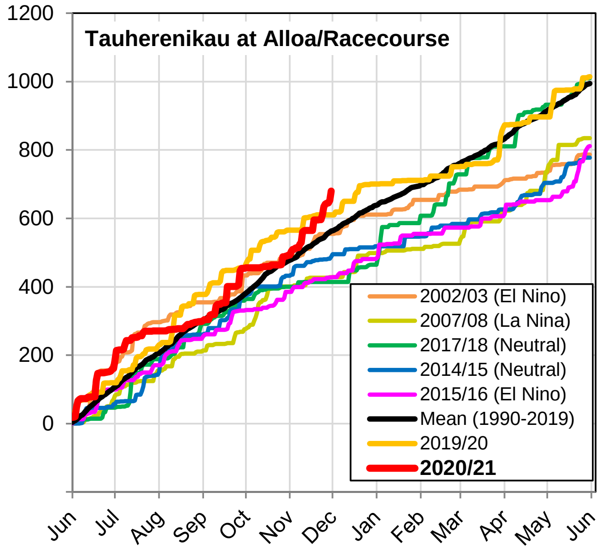
Hutt Valley and the Tararua Range

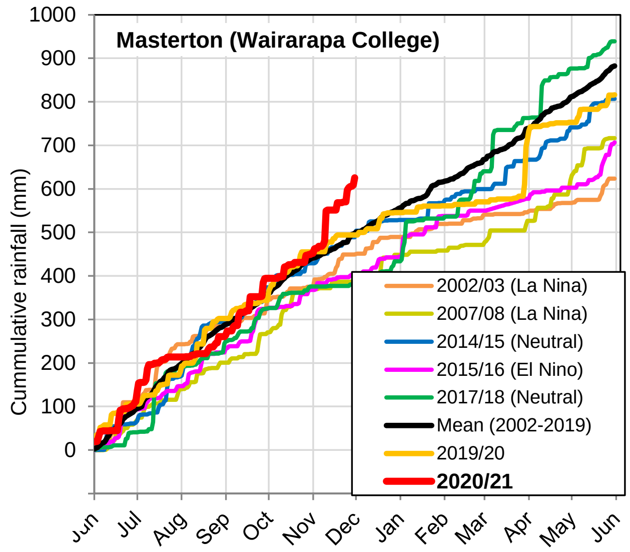


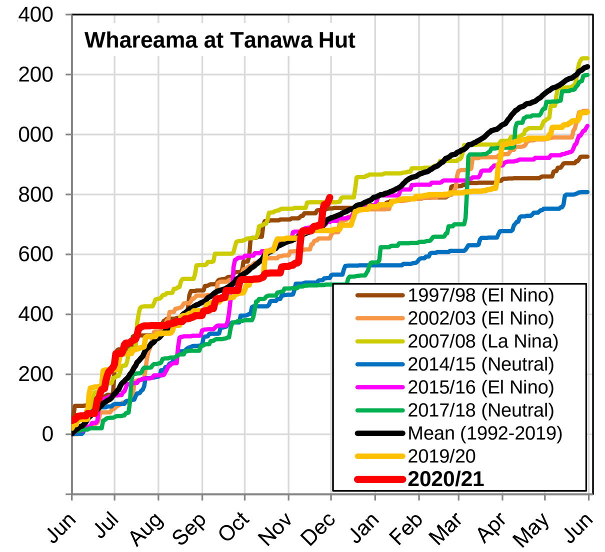


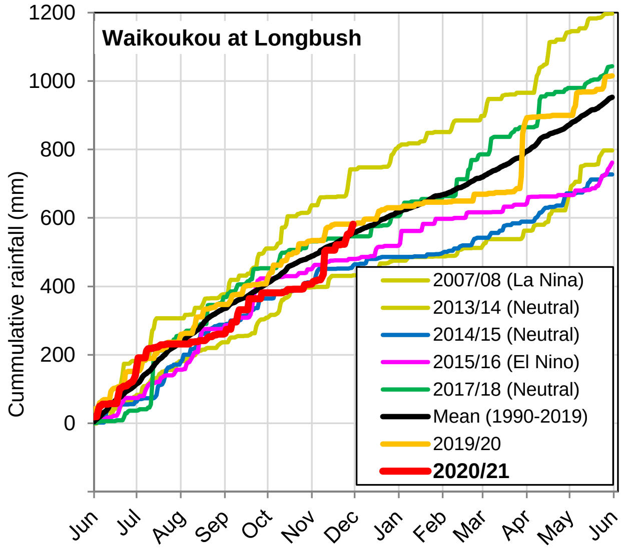
Wairarapa


Waiorongomai at Matthews
Cummulative Rainfall (mm)
1800
1600
1400
1200
1000
800
600
400
200
0
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
2013/14 (Neutral)
2014/15 (Neutral)
2015/16 (El Nino)
2017/18 (Neutral)
Mean (2009-2019)
2019/20
2020/21


Tauherenikau at Alloa/Racecourse
1200
1000
800
600
400
200
0
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
2002/03 (El Nino)
2007/08 (La Nina)
2017/18 (Neutral)
2014/15 (Neutral)
2015/16 (El Nino)
Mean (1990-2019)
2019/20
2020/21


Masterton (Wairarapa College)
Cummulative rainfall (mm)
1000
900
800
700
600
500
400
300
200
100
0
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
2002/03 (La Nina)
2007/08 (La Nina)
2014/15 (Neutral)
2015/16 (El Nino)
2017/18 (Neutral)
Mean (2002-2019)
2019/20
2020/21


Whareama at Tanawa Hut
400
200
000
800
600
400
200
0
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
1997/98 (El Nino)
2002/03 (El Nino)
2007/08 (La Nina)
2014/15 (Neutral)
2015/16 (El Nino)
2017/18 (Neutral)
Mean (1992-2019)
2019/20
2020/21



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

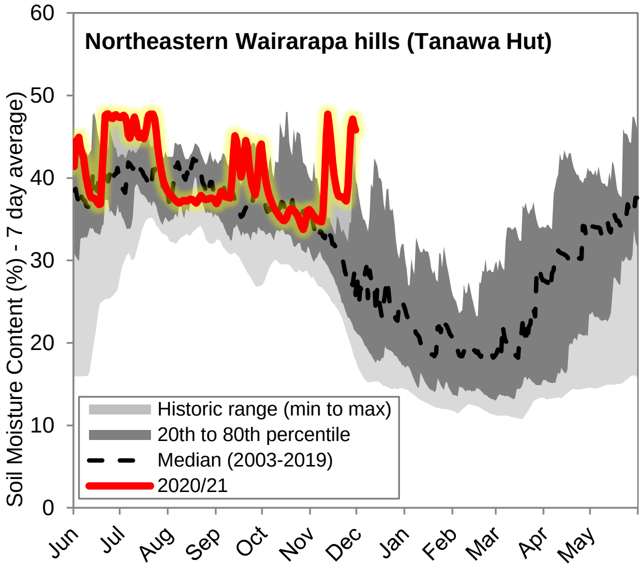
2.6.2 Soil moisture content (since 1 June 2020)

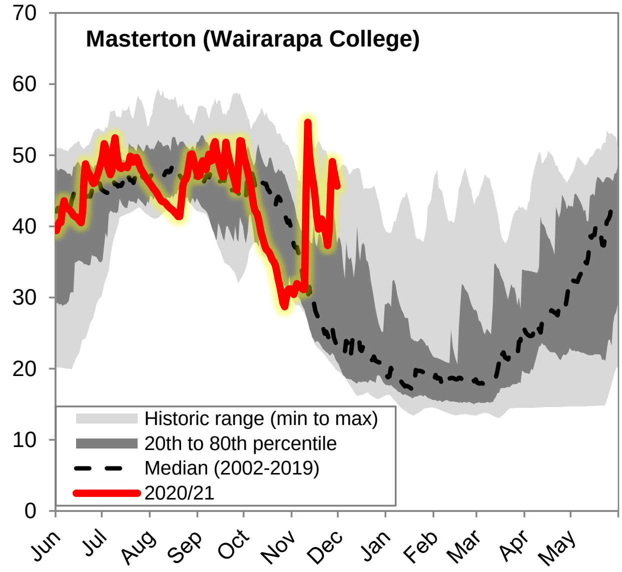
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2020. This is plotted over an envelope of the range of historic recorded data (and the median) at the site to provide an indication of how the current soil moisture compares with that for a similar period in past years.

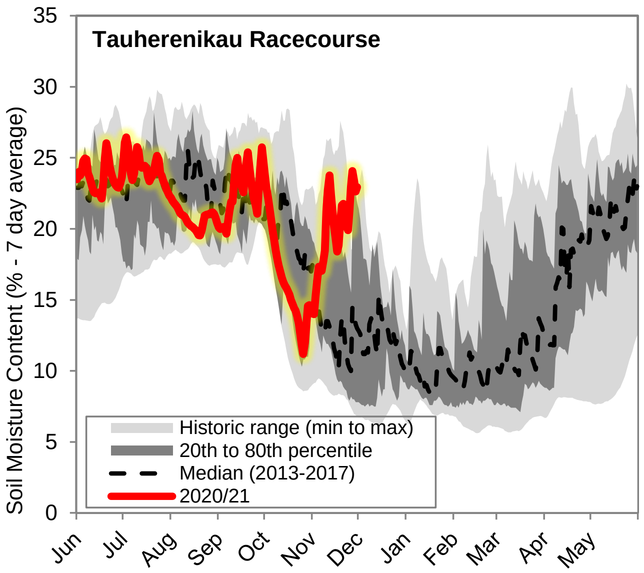
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated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

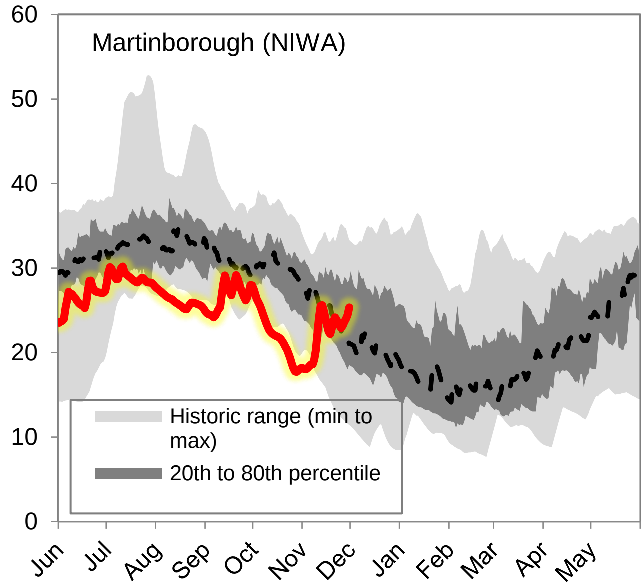
The cycle of a wet September, followed by a very dry October, and then followed by an exceptionally wet November is evident in the soil moisture graphs, particularly for the Masterton and Tauherenikau Racecourse monitoring sites.

Wairarapa

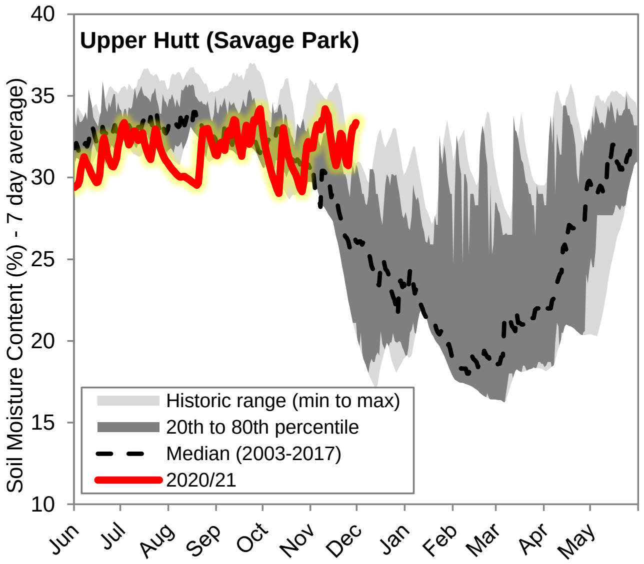








Upper Hutt



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 2021

- A La Niña is expected to continue to mature during the summer season, and start to weaken in autumn;
- Sea Surface temperatures north of New Zealand are expected to remain above average, with increased chances of marine heatwaves. As of early December, a localised tongue of cold water was affecting the eastern coast with a chilly swim experience, but this feature is expected to give place to warm waters;
- Warmer than average air temperatures, with likely heat waves;
- Normal to below average rainfall. Low confidence for total seasonal accumulation, high month-to-month variability;
- Increased chances of influence by ex-tropical cyclones (directly or indirectly), and increased chances of thunderstorms in the Wairarapa

Whaitua*	Variables	Climate outlook for summer 2021
Wellington Harbour & Hutt Valley	**Temperature:**	Above average. High chance of heat waves.
	Rainfall:	Average to below, low confidence for seasonal total. High month to month variability. Greater likelihood of humid weather in general, with north-easterly flows.
Te Awarua-o-Porirua	**Temperature:**	Well above average. High chance of heat waves.
	Rainfall:	Average to below, low confidence for seasonal total. High month to month variability.
Kāpiti Coast	**Temperature:**	Well above average. High chance of heat waves.
	Rainfall:	Average to below, low confidence for seasonal total. High month to month variability.
Ruamāhanga	**Temperature:**	Above average. High chance of heat waves.
	Rainfall:	Average to below, low confidence for seasonal total. High month to month variability. Greater likelihood of thunderstorms and humid weather in general, with north-easterly flows.
Wairarapa Coast	**Temperature:**	Near average, with cool sea breezes.
	Rainfall:	Average to below, low confidence for seasonal total. High month to month variability.

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

Acknowledgements

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

Online resources

GWRC online climate mapping tools:

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

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

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

Key Reports:

- **Main climate change report (NIWA 2017)**
http://www.gw.govt.nz/assets/Climate-change/Climate-Change-and-Variability-report-Wlgtn-Regn-High-Res-with-Appendix.pdf

- **Main climate drivers report (Climate Modes) (NIWA 2018)**
http://www.gw.govt.nz/assets/Our-Environment/Environmental-monitoring/Environmental-Reporting/GWRC-climate-modes-full-report-NIWA-3-Sep-2018-compressed.pdf

- **Climate change extremes report (NIWA 2019)**
https://www.gw.govt.nz/assets/Climate-change/GWRC-NIWA-climate-extremes-FINAL3.pdf

Climate Portals

- **GWRC Climate change webpage**
http://www.gw.govt.nz/climate-change/

- **GWRC Seasonal climate hub**
http://www.gw.govt.nz/seasonal-climate-hub/