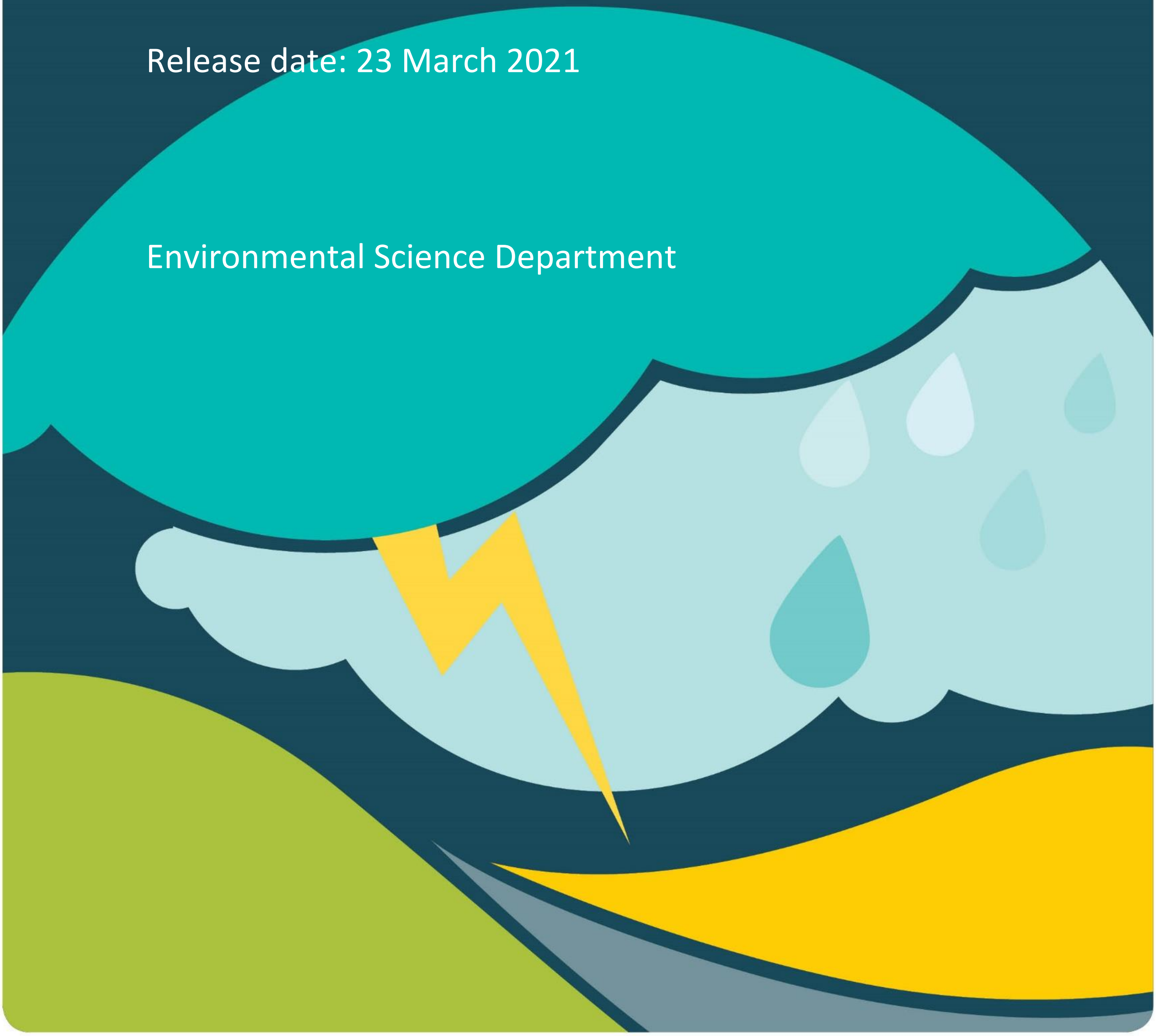
Climate and Water Resources Summary for the Wellington Region

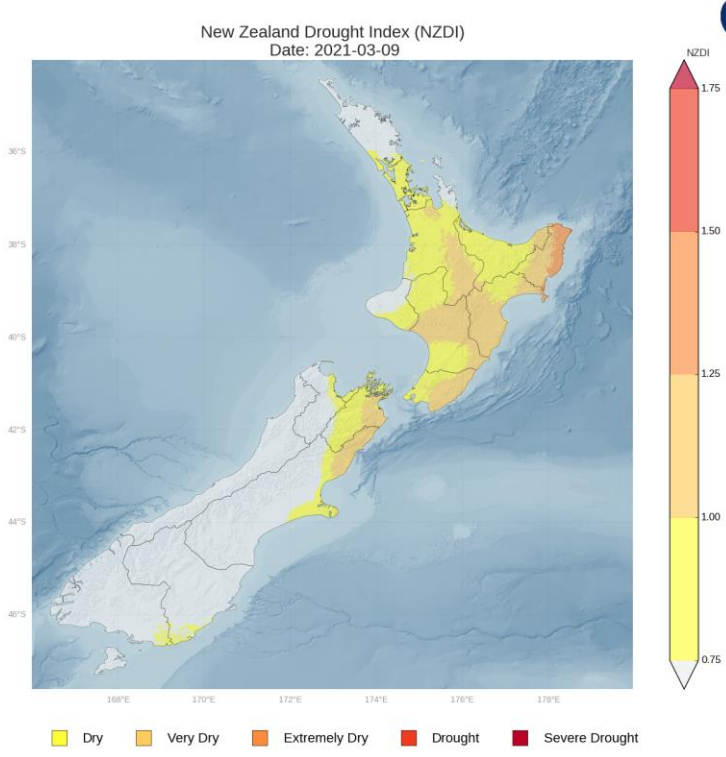
Summer 2021 summary

Autumn 2021 outlook

Release date: 23 March 2021

Environmental Science Department





It was a very variable La Niña summer. The season started unusually green, after the rainiest spring on record in Wellington. This was followed by a mostly dry January and February. As a result, most of the region was showing either dry or very dry conditions early in March, according to the New Zealand Drought Monitor from NIWA. We can see that currently most of the North Island follows the same dry pattern, but not nearly as severe as this time last year.

Overview

Summer 2021

Summer 2021 highlighted a very unusual La Niña pattern. Under normal La Niña summers, we tend to observe a consistent north-easterly flow with warmer than average temperatures, greater humidity and thunderstorms inland. This year, we had a remarkable alternation between cold south-westerlies and warm north-easterlies, accompanied by large variations in temperature and rainfall. These extremes have more or less cancelled each other out over the three-monthly period, and the seasonal temperature was just about average. During a heat spike in late January, Masterton reached the hottest temperature on record, with 35.6°C on the 27th (records since 1906). In Paraparaumu, the minimum temperature of 3.1°C recorded on the 18th of February was the second equal lowest on record, for measurements starting in 1953. The total January rainfall in Masterton (6mm) was the second lowest for January (records since 1926). The drought monitor index from NIWA shows that, as of mid-March, most of the region was either dry or very dry.

Climate drivers

The La Niña phenomenon is now slowly dissipating, and most of the other climate drivers are about normal. Even though La Niña is weakening, its influence is still predicted to be felt during most of autumn. This means that we can still expect a somewhat frequent incursion of easterly flows, and a reduced westerly frequency. Some models are also predicting that La Niña might linger in the background and return again in the second half of the year.

Climate outlook for autumn 2021

Most international climate models are predicting that autumn in our region will have a near normal rainfall and temperature pattern for the seasonal average, although subjected to higher than normal fluctuations throughout the season, oscillating between westerly and easterly flows. A blocking area of high pressure is expected to become relatively persistent to the south-east of the country. This could lead to a moderating easterly flow 'slowing down' the westerly fronts at times. On average, autumn temperatures are predicted to be about normal to slightly above average. A less windy than average season is expected as a result of the residual La Niña influence, with colder than average nights inland, and possible early frosts. Rainfall may sit about normal for the seasonal average, but the season starts very dry in March, and may gradually return to a more normal autumn rainfall pattern, with a high chance of heavy rainfall events in April and May.

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 slowly become neutral towards winter. La Niña has been weaker than originally predicted, with a mixed and variable influence over our summer weather patterns. A high degree of interchange between westerly fronts and easterly, blocked flows, should continue during most of autumn.

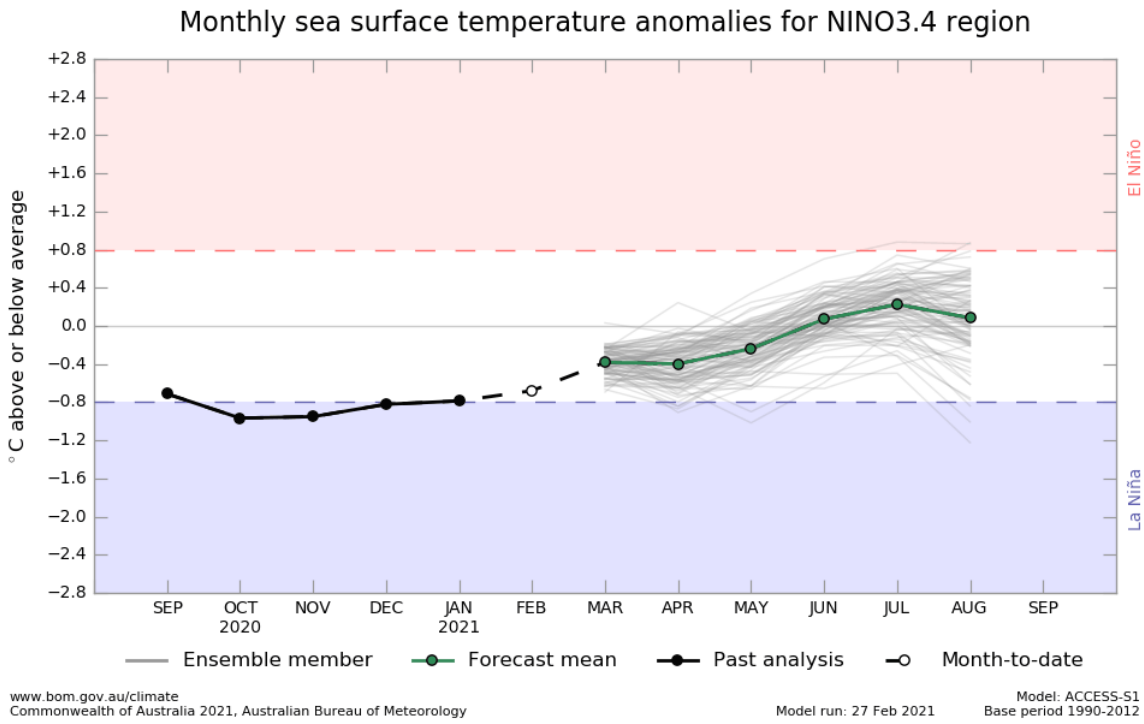


Figure 1.1: Averaged modelled projections (in green) show that ENSO is expected to slowly return to normal during autumn. Source: Australian Bureau of Meteorology.

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 13th March 2021.

The pattern shows a decaying La Niña phenomenon in the Equatorial Pacific, and warmer than average SSTs east of New Zealand. The Tasman Sea and the south-eastern Australian region show a variable pattern with several eddies of colder than normal water, implying a more pronounced westerly flow and transient fronts to the west of New Zealand. In fact, most of the southern part of Australia had colder than average temperatures in summer, and is expected to continue to experience colder than average flow into autumn. New Zealand, caught between this pattern and the warmer waters to the east, had mostly near normal temperatures and rainfall, as a seasonal average. However, this “normal” seasonal pattern was subjected to a much larger variability than normal, caused by the frequent oscillation between easterly and westerly flows during summer.

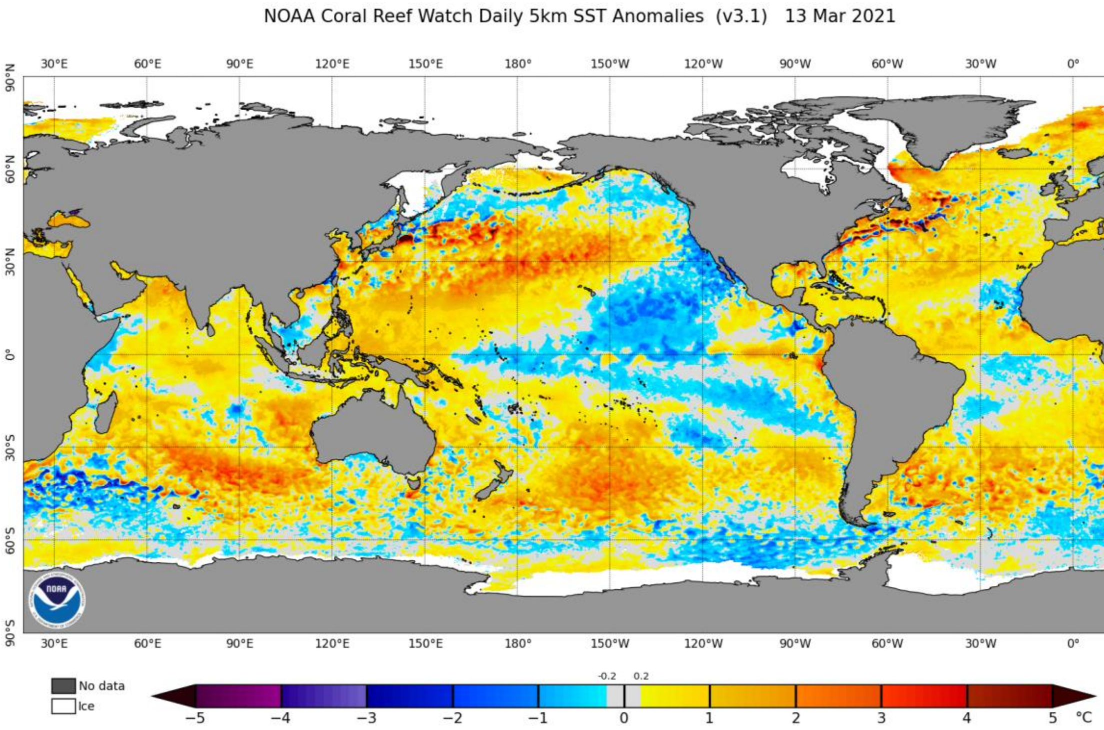


Figure 1.2: Sea surface temperature (SST) anomalies as of 13 March 2021. Sea ice coverage is shown in white. Water temperatures around New Zealand are about average. We can see warmer waters to the east, and pockets of cooler waters in the Tasman Sea. The Equatorial Pacific (ENSO) is showing a decaying La Niña pattern. The sea ice extent (in white) was below average until mid-February, but it has started to abruptly expand since, turning to above average as of mid-March. This pattern could indicate the effect of a stronger westerly flow around Antarctica. 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 in summer, as expected for a La Niña event, with mainly below average rainfall in the Wellington Region. Figure 1.3 shows that the summer sea level pressure pattern was characterised by a combination of high pressures to the south and low pressure east of New Zealand. A small high pressure anomaly about the north-western corner of New Zealand is also seen. Overall, this complex pattern helps explain our variable and unusual La Niña summer, with New Zealand remaining in between different clashing forces of air flow, coming about from the various pressure anomalies.

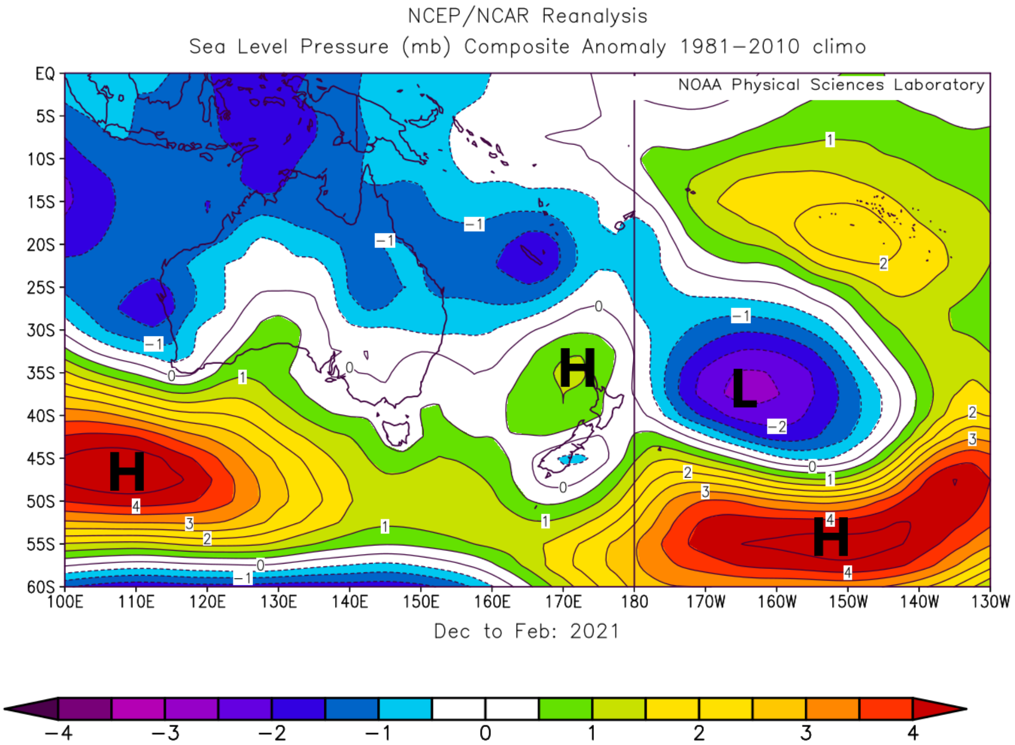


Figure 1.3: Mean sea level pressure anomaly map (hPa) for summer 2021. The 'H' indicates the central position of the anomalous high pressure areas mostly to the south of Australia and New Zealand. This pattern was associated with a positive Southern Annular Mode, and a variable wind flow over New Zealand. 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 and MetService (all meteorological stations indicated by dots).

In general, we can see a pattern of colder than average night time minimum temperatures and warmer than average day time maximum temperatures throughout the region, especially inland. This pattern tends to correlate with below average rainfall and reduced cloud cover typical of a positive Southern Annular Mode, as discussed earlier.

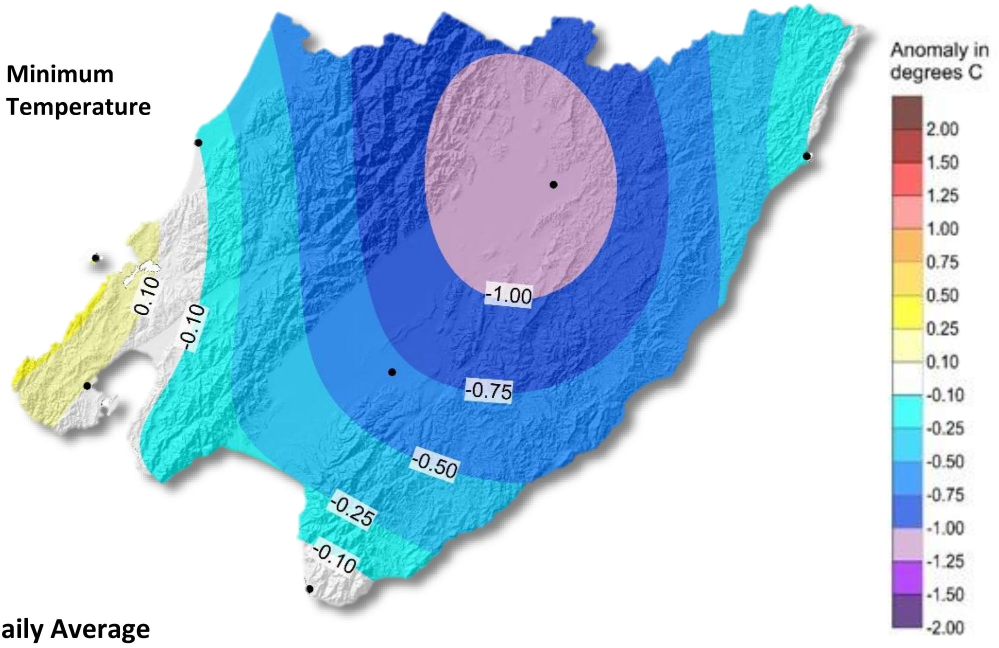
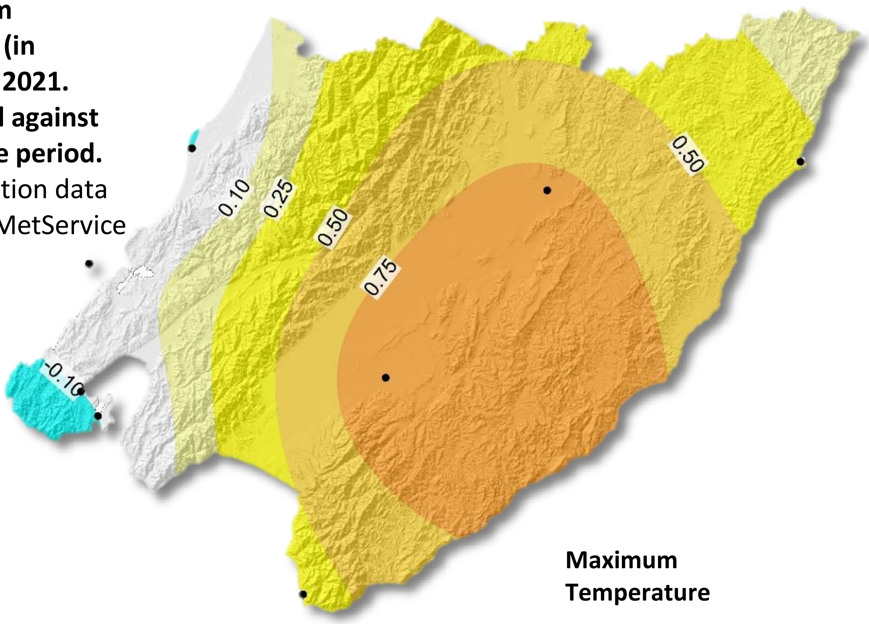


Figure 2.1: Daily Average Minimum and Maximum temperature anomalies (in degrees Celsius) for DJF 2021. All anomalies calculated against the 1981-2010 reference period. Source: GWRC, using station data from GWRC, NIWA and MetService networks.



2.2 Regional wind

Figure 2.2 shows the mean seasonal wind anomalies (against the 1981-2010 reference period). Most of the region experienced below average wind speeds, particularly in the interior. This pattern was associated with a slight reduction of the frequency of westerlies, as a result of La Niña. Lower wind speeds correspond to a reduced mixing in the atmosphere, and the result is a greater temperature variation during day and night earlier observed in Figure 2.1. During the day, the solar radiation can warm the surface air layer more efficiently, under low wind conditions. Whereas at night, under low wind conditions there will be more longwave radiation lost into space, with consequently greater cooling (in the absence of cloud cover).

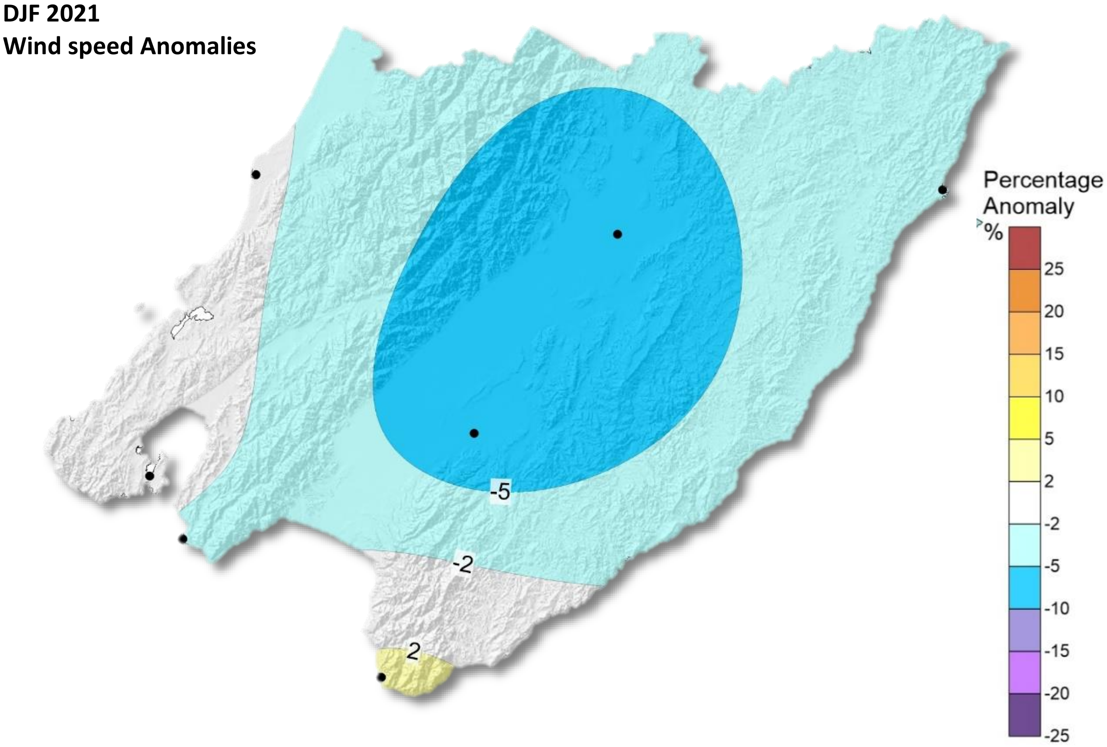


Figure 2.2: Daily mean wind anomalies (as percentage departure from the average) for DJF 2021. All anomalies calculated against the 1981-2010 reference period.
Source: GWRC, using station data from NIWA and MetService

2.3 Regional soil moisture

Figure 2.3 shows that the soil moisture levels were below normal for most of the region at the beginning of autumn. With the demise of La Niña, there is an expectation of a more normal autumn rainfall pattern lessening the risk of returning to the drier conditions seen last year.

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

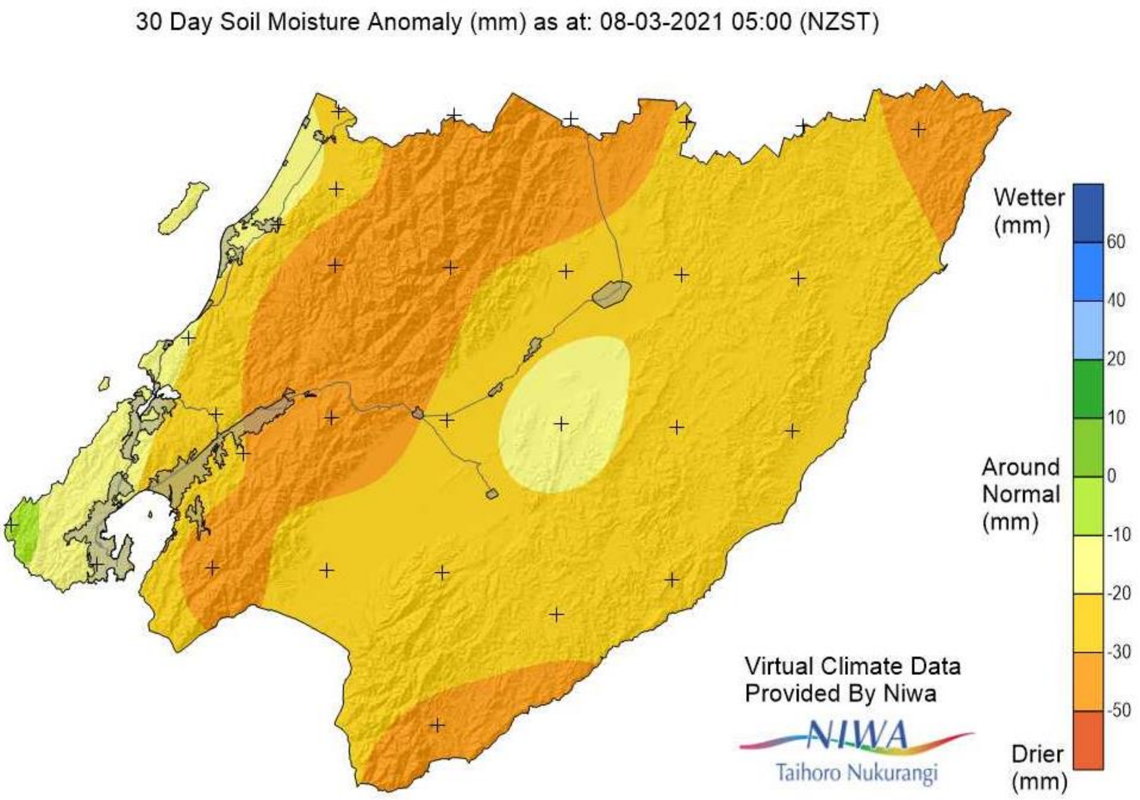
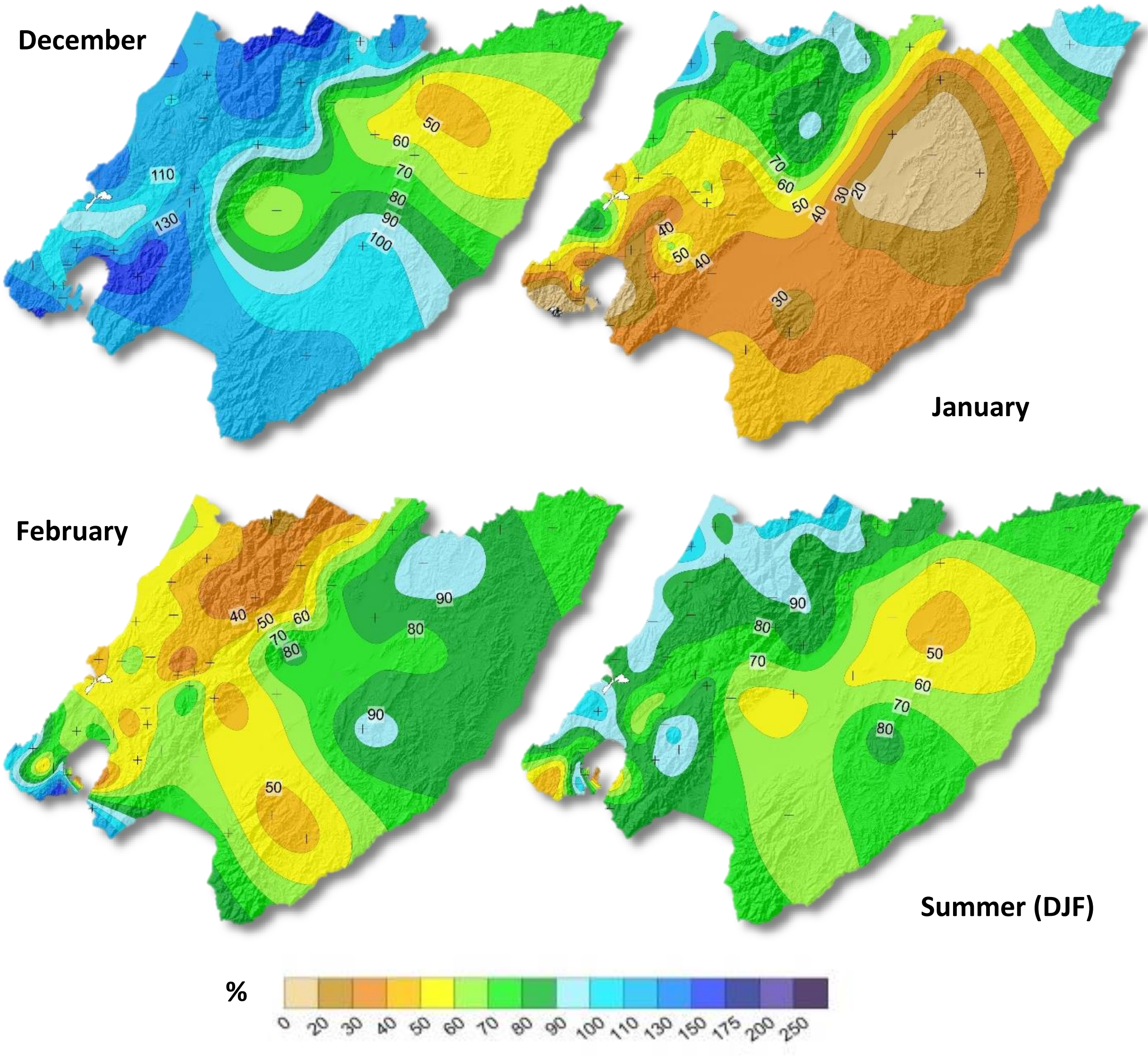


Figure 2.3: 30 Day soil moisture anomaly as at 8th March 2021. Most of the region shows below average soil moisture levels. Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. *Note that this data is indirectly calculated by modelling and interpolation techniques, 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. Rainfall during December was average to above average in western and southern areas and below average to the northeast. January and February were very dry across much of the region. Some parts of the Wairarapa had only 20-30% of average January rainfall.

The overall seasonal pattern for summer showed near average conditions to the west and below average conditions to the east.


December

January

February

Summer (DJF)

Figure 2.4: Rainfall for December (upper left), January (upper right), February (lower left) and Summer DJF (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 from zero at 99% confidence level.

The climate change and variability summary for summer is:

- Statistically significant trends are seen only for temperature and wind, meaning that summer is getting warmer as a result of ongoing climate change, and less windy on average in Wellington. The long-term summer warming trend is about one degree per century for both Wellington and Masterton

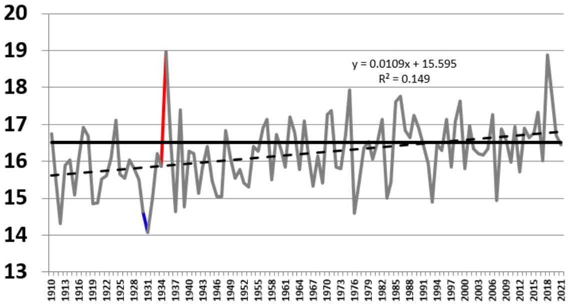
- Summer 2021 temperatures were about average for both Wellington and the Wairarapa

- Sunshine hours were close to average

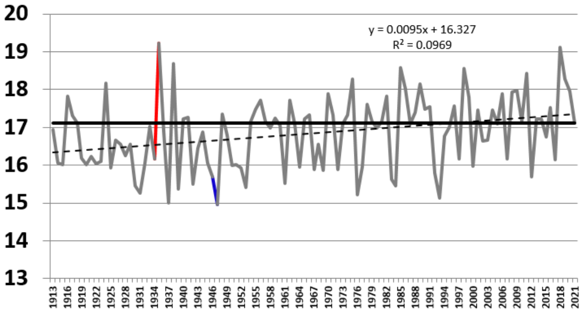
- Seasonal average wind speed was about normal for Wellington

- Seasonal rainfall was below average, and number of rain days was about normal, for Wellington.

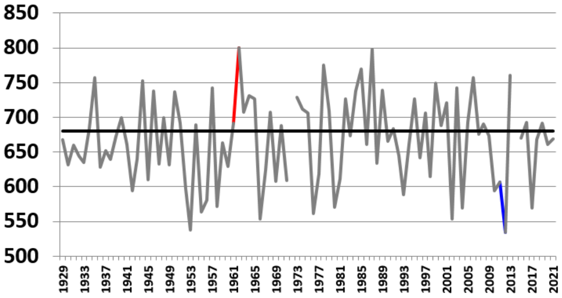
What is the data showing?



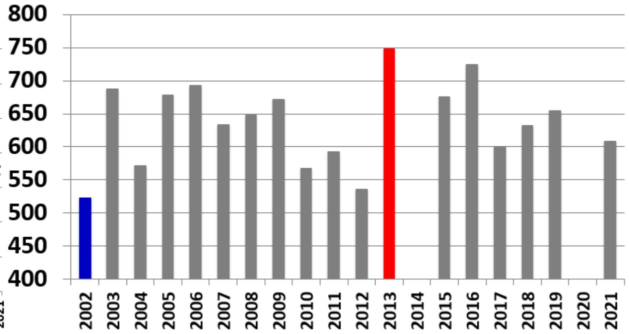
Summer Mean Temperature (deg C) - Kelburn (1910-2021)



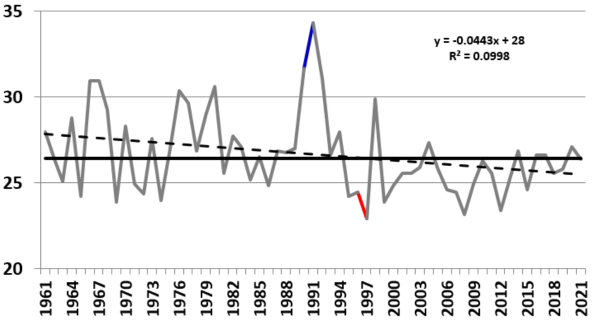
Summer Mean Temperature (deg C) - Masterton (1913-2021)



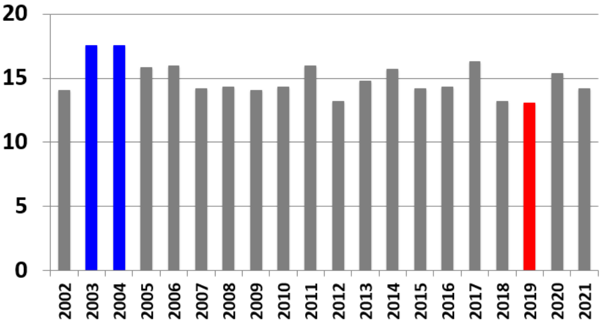
Summer Total Sunshine Hours - Kelburn (1929-2021)



Summer Total Sunshine Hours - Martinborough (2002-2021)



Summer Mean Wind (km/h) - Wellington Airport (1961-2021)



Summer Mean Wind (km/h) - Martinborough (2002-2021)

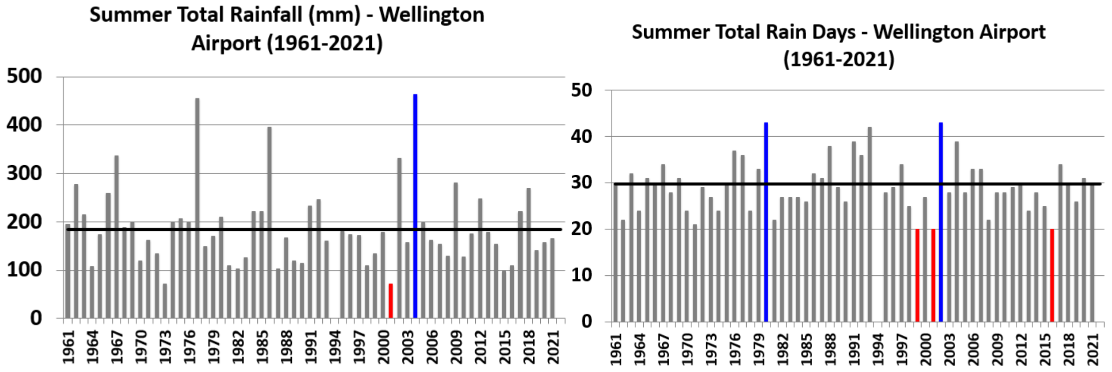


Figure 2.5: Climate change and variability graphs for spring in Wellington and the Wairarapa. The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all graphs,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

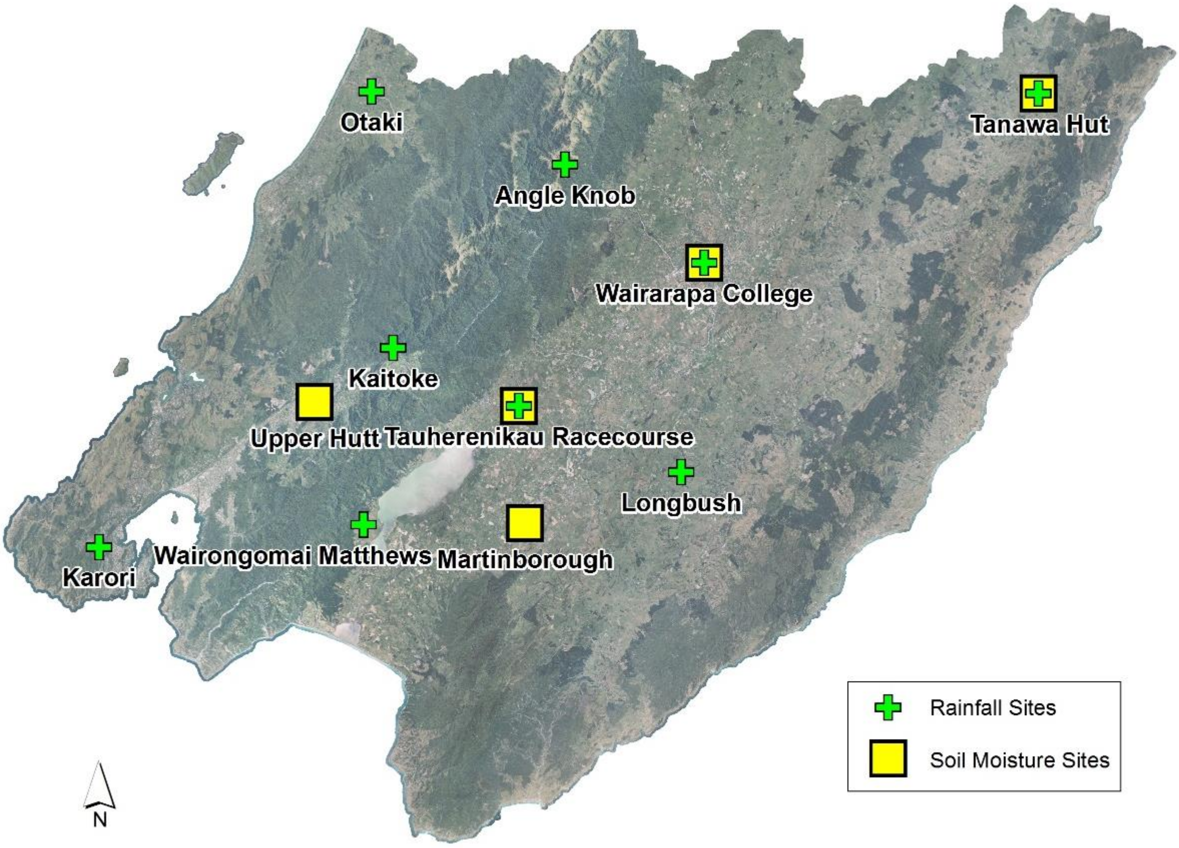


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

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

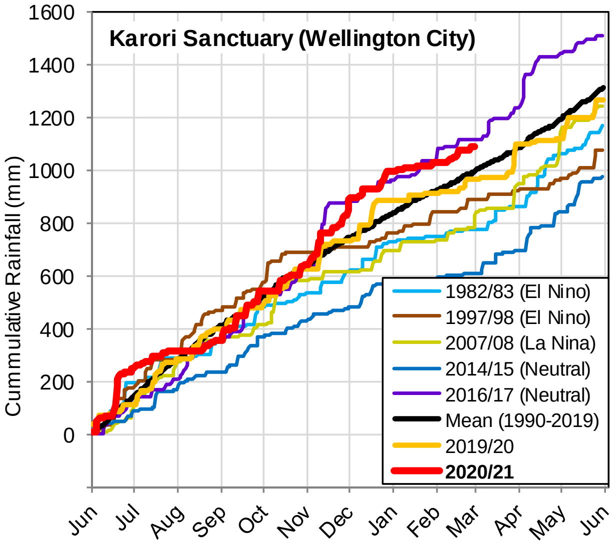
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year at several locations. For comparative purposes, cumulative plots for selected historic years with notably dry years have been included as well as the site average.

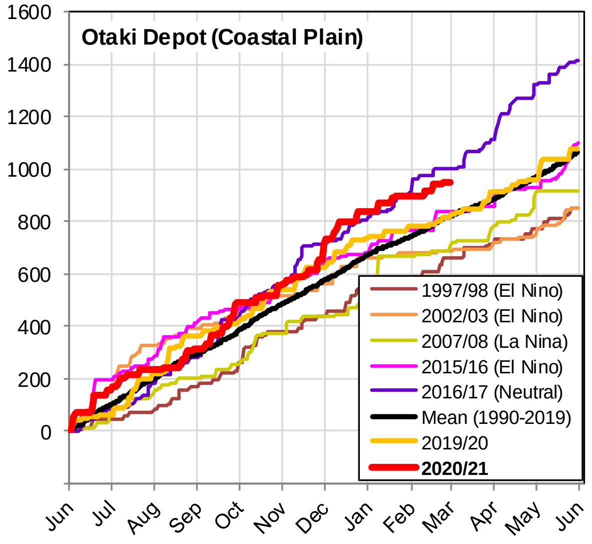
Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa have only been operating since the late 1990s so the period of data presented is limited to the last two decades. For each historical record plotted, an indication of ENSO climate state (El Niño, La Niña or neutral)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

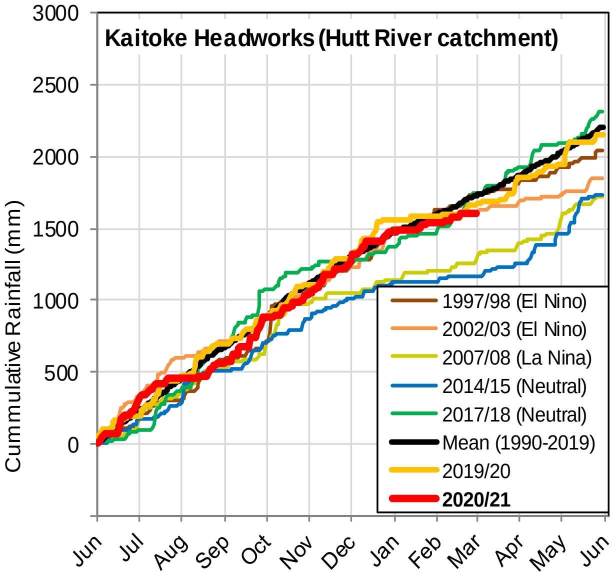
Overall, total rainfall accumulations in most areas have ended the summer season above the average line, the exceptions being the Tararua Range and south eastern hill country. The very wet conditions experienced during November are evident as a sharp upwards movement on the rainfall accumulation graphs.

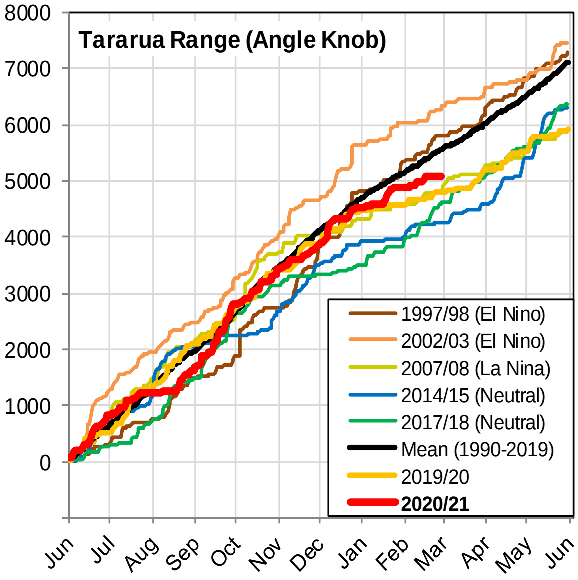
Kāpiti Coast and Southwest (Wellington City)



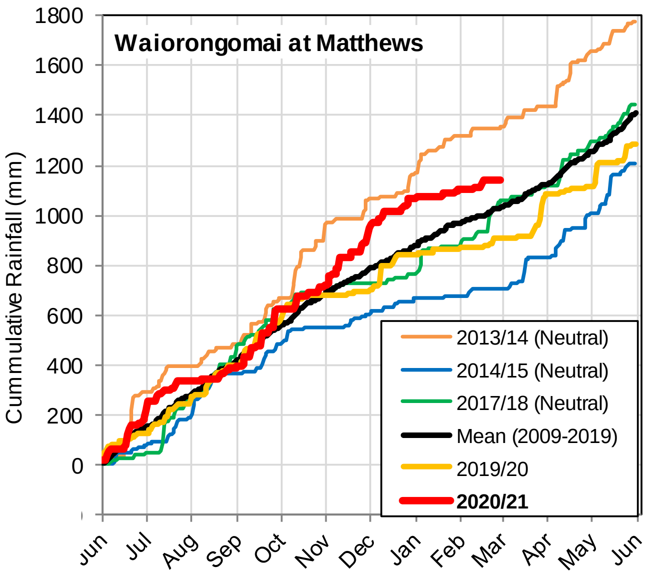


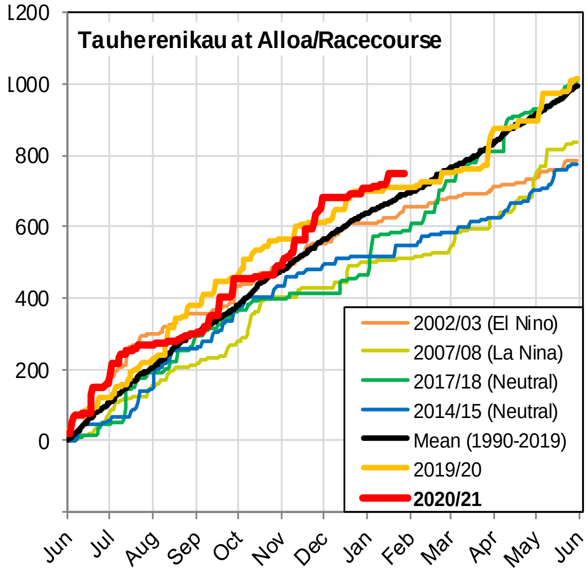
Hutt Valley and the Tararua Range

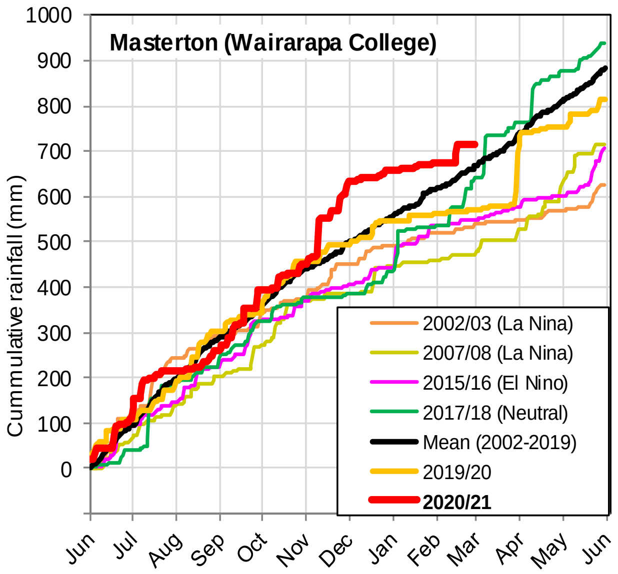


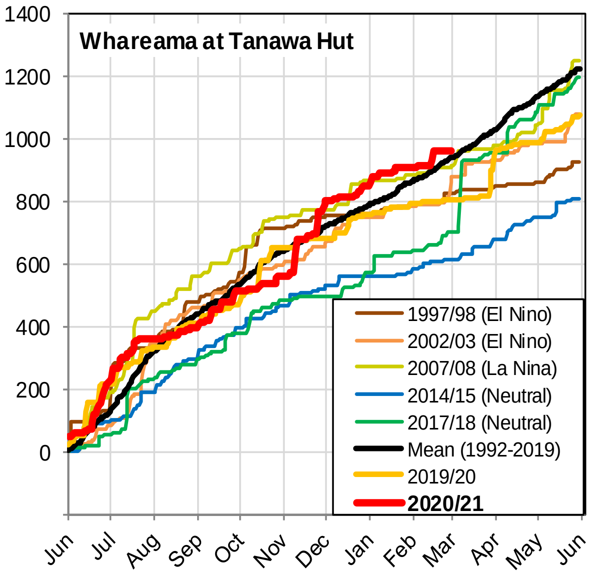


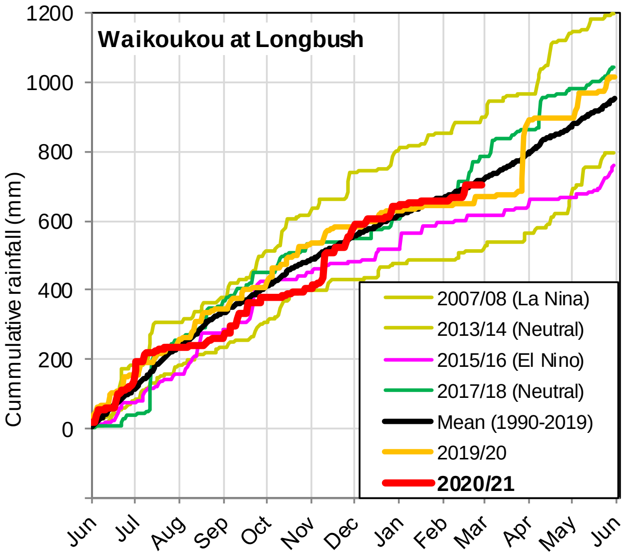
Wairarapa


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)
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)
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)
2015/16 (El Nino)
2017/18 (Neutral)
Mean (2002-2019)
2019/20
2020/21


Whareama at Tanawa Hut
1400
1200
1000
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)
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

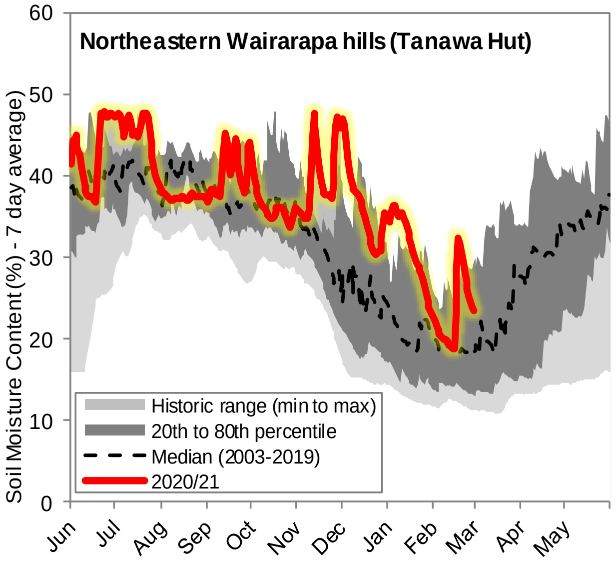
2.6.2 Soil moisture content (since 1 June 2020)

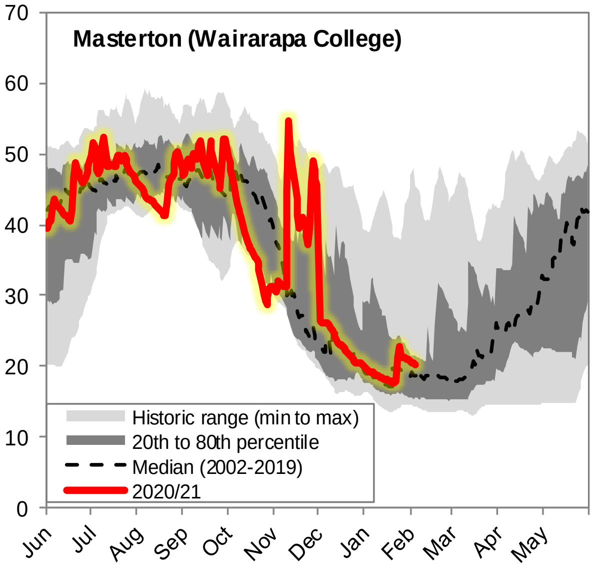
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2020. This is plotted over an envelope of the range of historic recorded data (and the median) at the site to provide an indication of how the current soil moisture compares with that for a similar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

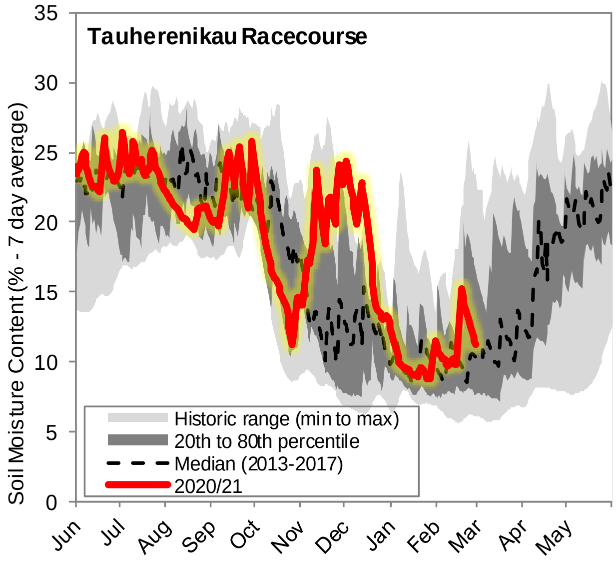
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated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

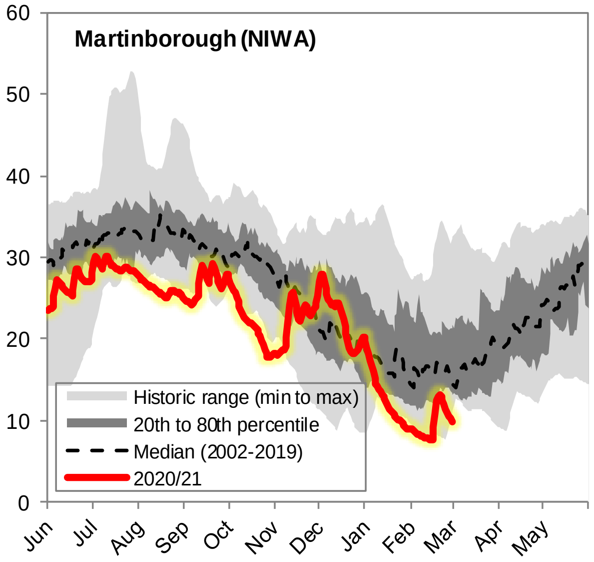
The cycle of a wet December, followed by a dry January and February is evident in the soil moisture graphs, particularly for the Masterton and Martinborough monitoring sites.

Wairarapa

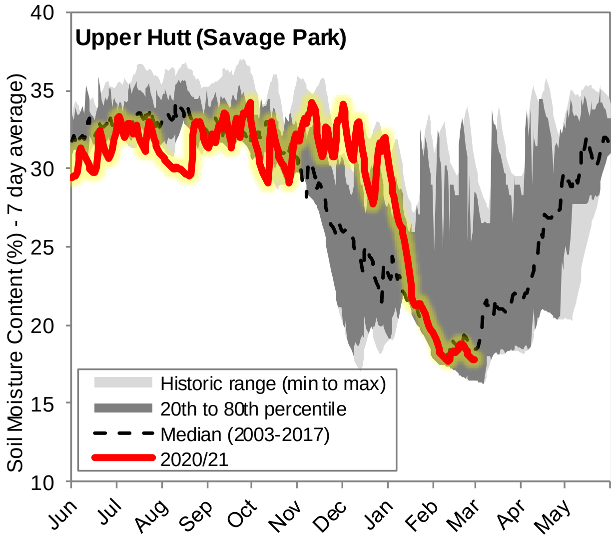

Northeastern Wairarapa hills (Tanawa Hut)
Soil Moisture Content (%) - 7 day average)
60
50
40
30
20
10
0
Historic range (min to max)
20th to 80th percentile
Median (2003-2019)
2020/21
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May


Masterton (Wairarapa College)
70
60
50
40
30
20
10
0
Historic range (min to max)
20th to 80th percentile
Median (2002-2019)
2020/21
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May


Tauherenikau Racecourse
Soil Moisture Content (% - 7 day average)
35
30
25
20
15
10
5
0
Historic range (min to max)
20th to 80th percentile
Median (2013-2017)
2020/21
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May


Martinborough (NIWA)
60
50
40
30
20
10
0
Historic range (min to max)
20th to 80th percentile
Median (2002-2019)
2020/21
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May

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 autumn 2021

- La Niña is expected to continue to weaken, but still influence the autumn pattern with occasional easterly flows, blocking high pressures, and reduced frequency of westerlies;
- Sea Surface temperatures are expected to remain variable, with warmer than average waters east of New Zealand;
- A variable rainfall pattern starting out dry at the beginning of the season and progressing towards closer to normal as the season progresses;
- High chance of heavy rainfall events in April and May, including easterly events;
- Average to above average temperature, but colder than average at night inland, with possible early frosts.

Whaitua*	**Variables**	**Climate outlook for autumn 2021**
Wellington Harbour & Hutt Valley	**Temperature:**	Average to above.
	Rainfall:	About average, with low confidence for the total seasonal accumulation. Starts very dry, high month to month variability. High chance of extreme rainfall events in April and May.
Te Awarua-o-Porirua	**Temperature:**	Average to above.
	Rainfall:	About average, with low confidence for the total seasonal accumulation. Starts very dry, high month to month variability. High chance of extreme rainfall events in April and May.
Kāpiti Coast	**Temperature:**	Above average daytime, below average night time.
	Rainfall:	Average to above, with low confidence for the total seasonal accumulation. High chance of extreme rainfall events in April and May.
Ruamāhanga	**Temperature:**	Above average daytime, below average night time.
	Rainfall:	Average to below, with low confidence for the total seasonal accumulation. Starts very dry, high month to month variability. High chance of extreme rainfall events in April and May.
Wairarapa Coast	**Temperature:**	Average to above.
	Rainfall:	Average to below, with low confidence for the total seasonal accumulation. Starts very dry, high month to month variability. High chance of extreme rainfall events in April and May.

*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

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/