Greater Wellington
Te Pane Matua Taiao

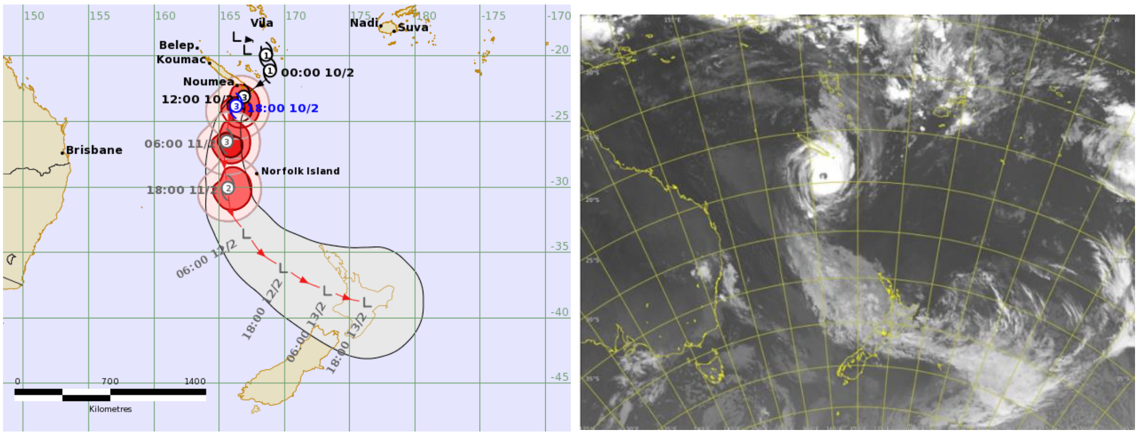
# Climate and Water Resources Summary for the Wellington Region

Summer 2022 summary

Autumn 2022 outlook

Release date: 31 March 2022

Environmental Science Department




Ex-tropical cyclone Dovi making a direct landfall in New Zealand was no doubt a major highlight of the season. The system's trajectory followed a remarkable atmospheric river formation (as seen on the satellite image), bringing significant tropical moisture into our region. Left: Cyclone's trajectory and prediction by the Fiji meteorological service; and right: satellite image showing the well-developed eye, and the moisture conveyer belt into New Zealand on 11 Feb 2022 at 9am local time. Images courtesy of Fiji Meteorological service and MetService.

**DISCLAIMER**

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# Overview

## Summer 2022

Summer 2022 was marked by very active weather systems bringing significant and widespread weather extremes in the Wellington region. We had a very wet December in the west, followed by an extreme dry January, only to be followed again by a record wet February due to the influence of ex-tropical cyclone (ex-TC) Dovi . The cyclone's landfall was spectacular and brought record rains to the Wairarapa, with some places receiving up to eight times the normal rain for the month. Masterton had a total of 556 mm of rain for the season, making this the wettest summer on record for data available since 1926. Maximum return periods for the cyclone rainfall reveal that this was a one in 80 year event for 48 hour rainfall, and ranging between one in 40 to one in 100 year event for durations between six and 24 hours. Record warm temperatures were also observed throughout the season, both averages and extremes. In February, record high temperatures (and humidity) were measured prior to landfall of ex-TC Dovi, to be then followed by record low temperatures as the cyclone moved to the east and pushed southerly gales into the region. Highest wind gusts on record were also measured in association with the cyclone tail for both Baring Head and Mt Kaukau (up to 160 km/h). All in all, it was a remarkable season of tropical humidity, prevailing easterly flow and weather extremes.

## Climate drivers

The La Niña phenomenon has now passed its peak, and most of the other climate drivers are about normal. But La Niña impacts, and in particular the easterly flow with warm waters around New Zealand, should still be present during most of autumn.

## Climate outlook for autumn 2022

Most international climate models are predicting that autumn in our region will be largely warmer than average, with sea surface temperatures (SSTs) expected to remain well above the climatological normal values around New Zealand. A blocking area of high pressure is expected to continue to persist to the east of the country, associated with easterly or north-easterly flows, and large oscillations between warm and humid air masses and colder southerlies. Rainfall is expected to be normal to above, typical of La Niña conditions during autumn. There is a very high chance that extreme weather events will continue to batter the region, both westerly and easterly events, depending on the orientation of the flow.

**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 the end of autumn. The influence of the La Niña easterly flow with warmer than average waters around New Zealand, however, should continue to impact our region over the remainder of the season.

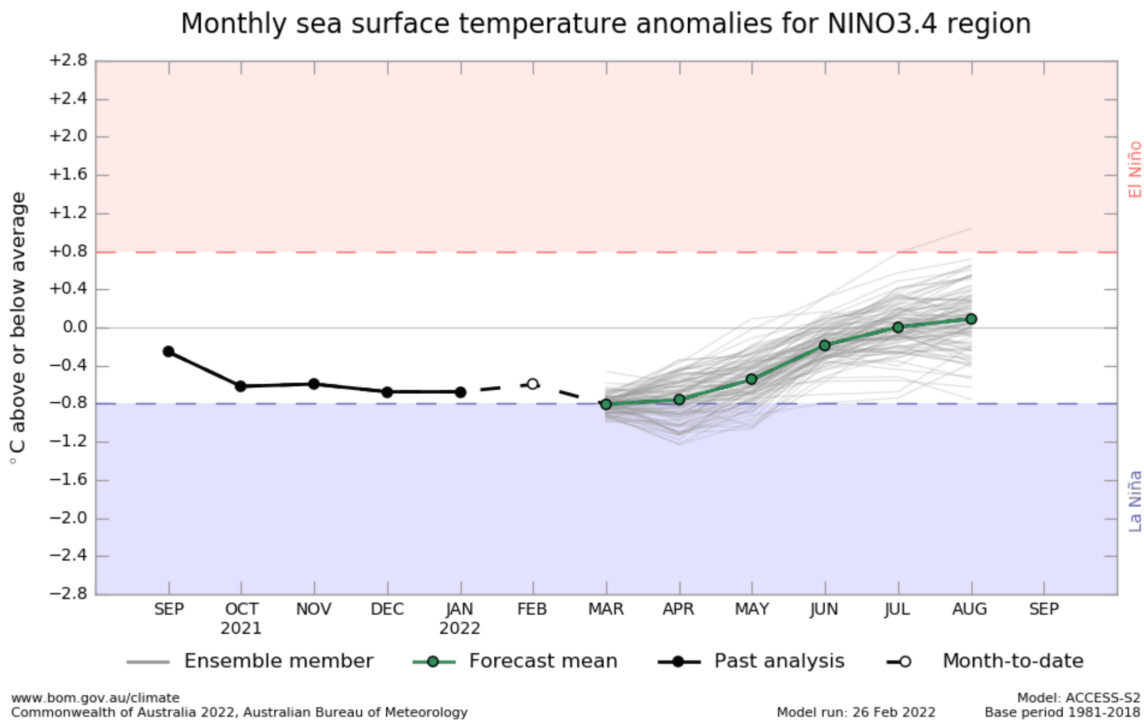



**Figure 1.1: Averaged modelled projections (in green) show that the current cold phase of the ENSO phenomenon is expected to slowly return to normal by the end of autumn.** Source: Australian Bureau of Meteorology.

## 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 12 March 2022.

The pattern shows a mature La Niña in the Equatorial Pacific (cold tongue), and warmer than average SSTs around New Zealand, especially to the north of the country and in the Tasman Sea. The sea ice extent (SIE, in white) is relatively small, as summer 2022 finished with the lowest on record SIE for the satellite era. Low SIE tends to be associated with a predominantly negative Southern Annular Mode (SAM), however, the SAM was only negative during the passage of ex-TC Dovi. During La Niñas, SAM tends to be positive, with ridges of high pressure dominating New Zealand. See below for additional discussions.

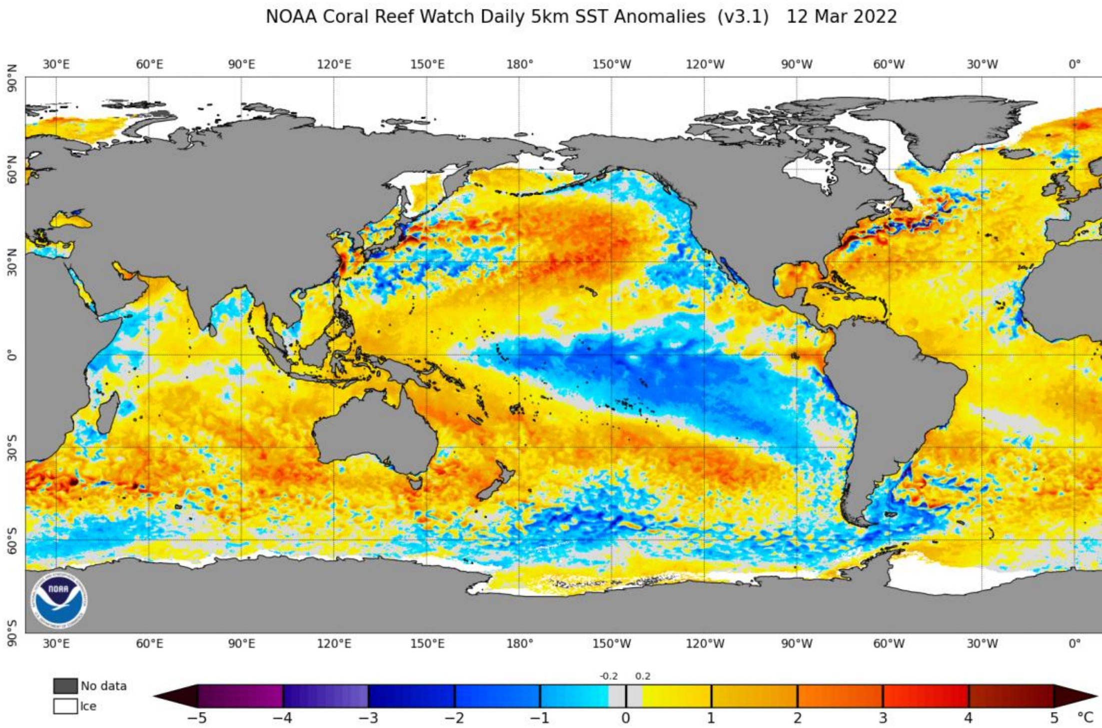



**Figure 1.2: Sea surface temperature (SST) anomalies as of 12 March 2022. Sea ice coverage is shown in white. Water temperatures around New Zealand are well above average to the west and north of the country. The Equatorial Pacific (ENSO) is showing a mature La Niña pattern (cold equatorial waters). The sea ice extent (in white) has been the lowest on record for the end of the summer season, during the satellite era.** 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 season. Even then, the prevailing north-easterly flow coupled with a marine heatwave around New Zealand meant that there was significant atmospheric moisture available for heavy rainfall events to develop. With the landfall of ex-TC Dovi in February, a very significant atmospheric river event formed (moisture conveyor belt), dumping exceptional amounts of rain in our region. Additional atmospheric river events also formed early in February and in December, battering the Wellington region as we stayed within the convergence area of the synoptic flow clashing between the Pacific and the Tasman Sea, as discussed below.

Figure 1.3 shows that the summer sea level pressure pattern was characterised by a combination of high pressures to the south and east of New Zealand, and a monsoonal subtropical low around New Caledonia. This pattern brought a substantial north-easterly flow into the country, creating a very humid summer set up with warm oceanic temperatures and high background humidity levels. These acted to channel water vapour from the tropics into New Zealand during extreme weather events such as the landfall of ex-TC Dovi, and further atmospheric river events in December and February.

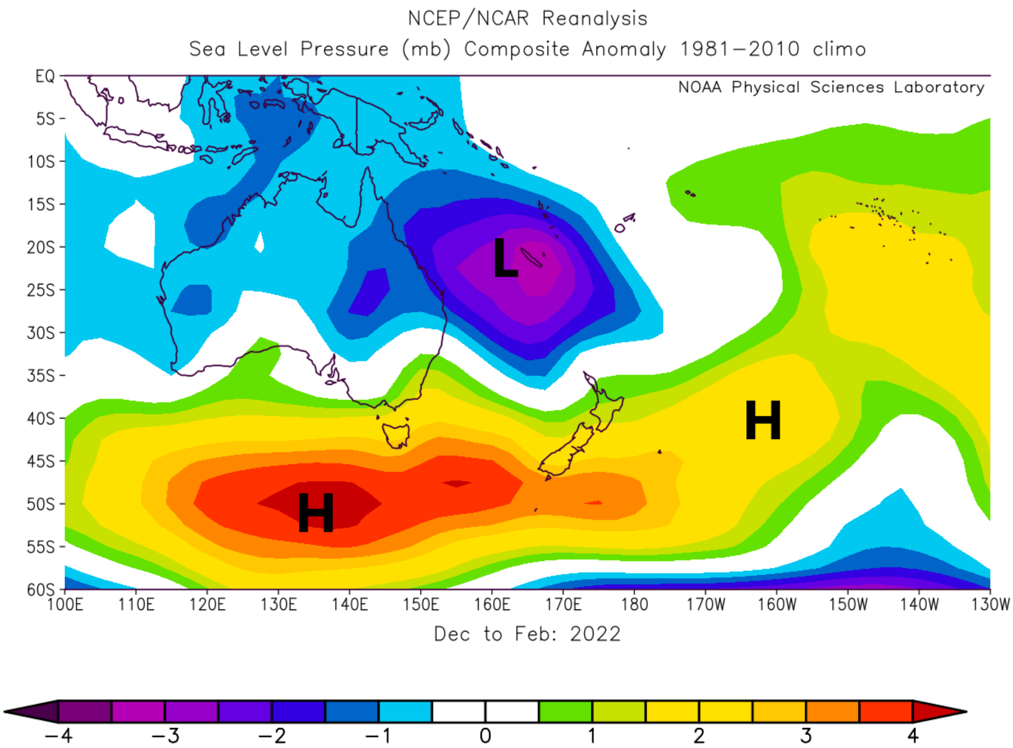



**Figure 1.3: Mean sea level pressure anomaly map (hPa) for summer 2022. The 'H' indicates the centre of the anomalous high pressure areas mostly to the south of Australia and New Zealand. This pattern was associated with a positive Southern Annular Mode, and a predominant easterly flow over New Zealand. The very active subtropical 'monsoon' to the north is indicated by the anomalous low over New Caledonia.** 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 that the summer season was warmer than normal throughout the entire region, especially in regards to the minimum (night-time) temperatures. This pattern fits well with elevated humidity levels and high rainfall, as observed through summer. The Kāpiti Coast was proportionally warmer than the rest of the region, which is expected for a La Niña with predominant north-easterly flow.

**Minimum Temperature anomaly (Celsius)**

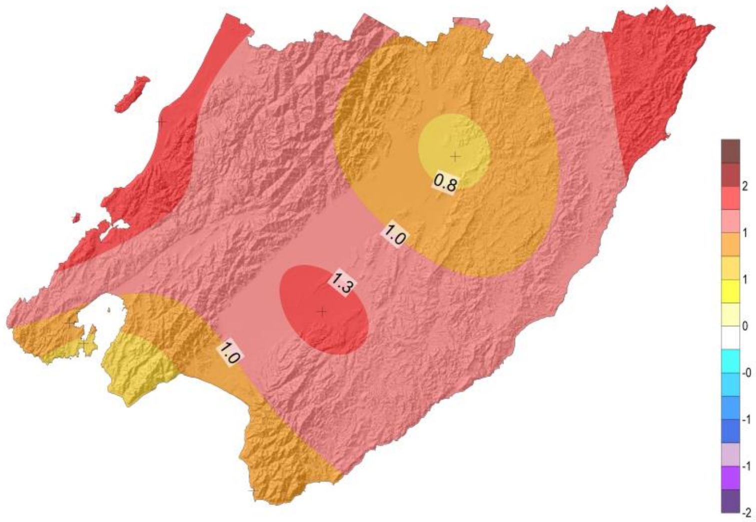
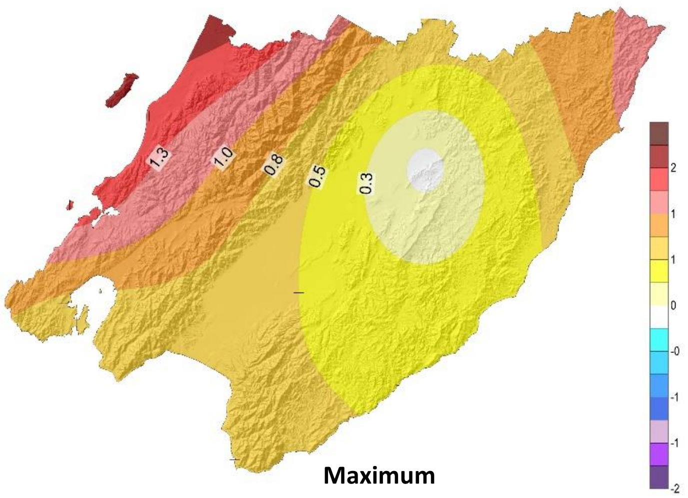


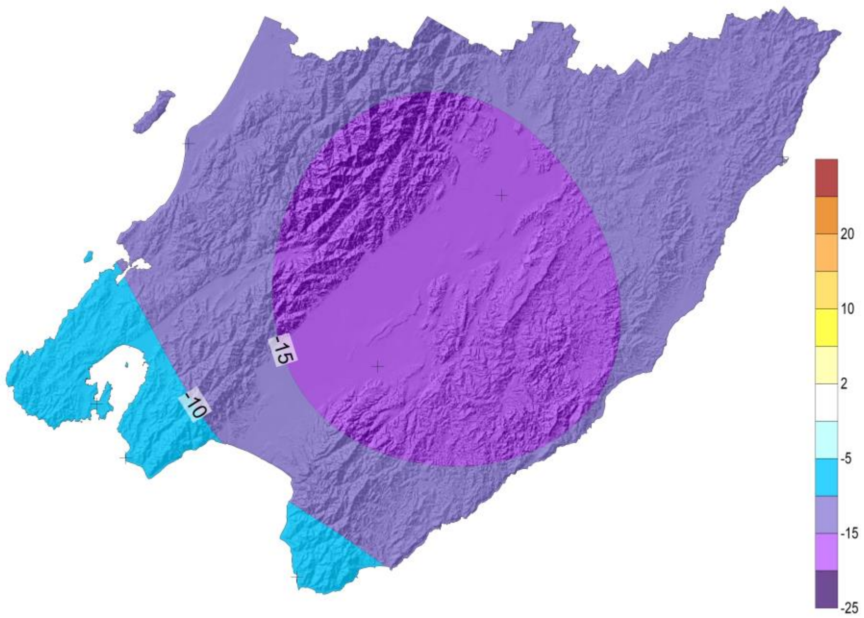

**Figure 2.1: Daily Average Minimum and Maximum temperature anomalies (in degrees Celsius) for DJF 2022. All anomalies calculated against the 1981-2010 reference period.** Source: GWRC, using station data from GWRC, NIWA and MetService networks.




**Maximum Temperature anomaly (Celsius)**

## 2.2 Regional wind

Figure 2.2 shows the mean seasonal wind anomalies (against the 1981-2010 reference period). All of the region experienced well below average wind speeds, particularly in the interior (greater than 15% reduction). This pattern was associated with a reduction of the frequency of westerlies, as a result of La Niña. Very humid, subtropical air masses dominated the region during a good portion of summer, resulting in some dramatic extreme weather events. The lack of wind helped facilitate this moisture convergence by creating more favourable conditions for ascending air, which is a requirement for heavy rainfall under unstable, humid air masses.




**DJF 2022**
**Wind speed Anomalies (%)**

**Figure 2.2: Daily mean wind anomalies (as percentage departure from the average) for DJF 2022. A very strong negative signal is present for the entire region, consistent with the La Niña easterly flow. 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 above normal for most of the Wairarapa at the time of the autumn equinox. With continuing La Niña conditions and warm SSTs around New Zealand, persistent wet conditions are expected, although oscillating between extremes of wet and dry periods.

**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

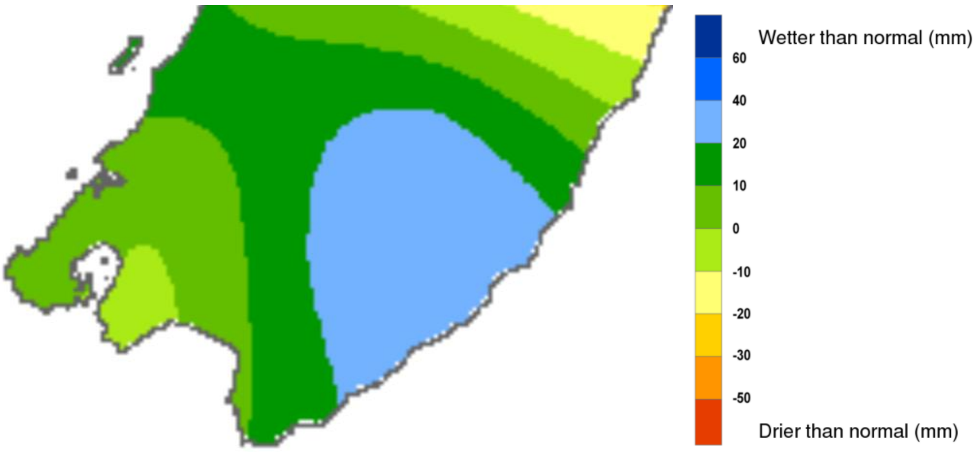



**Figure 2.3: Daily soil moisture anomaly as at 20 March 2022. Most of the region shows above average soil moisture levels.** Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. *Note that this data is indirectly calculated by modelling and interpolation 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. Rainfall during December was over twice the average rainfall in most areas except some southern areas and parts of the Tararua Ranges. January was very dry across much of the region. Parts of the region had only 20-30% of average January rainfall. February rainfall was significantly above average throughout the region and 700% above average in the central Wairarapa, due to the 12 of February event.

The overall seasonal pattern for summer showed significantly above average due to the wet December and 12th of February storm event.

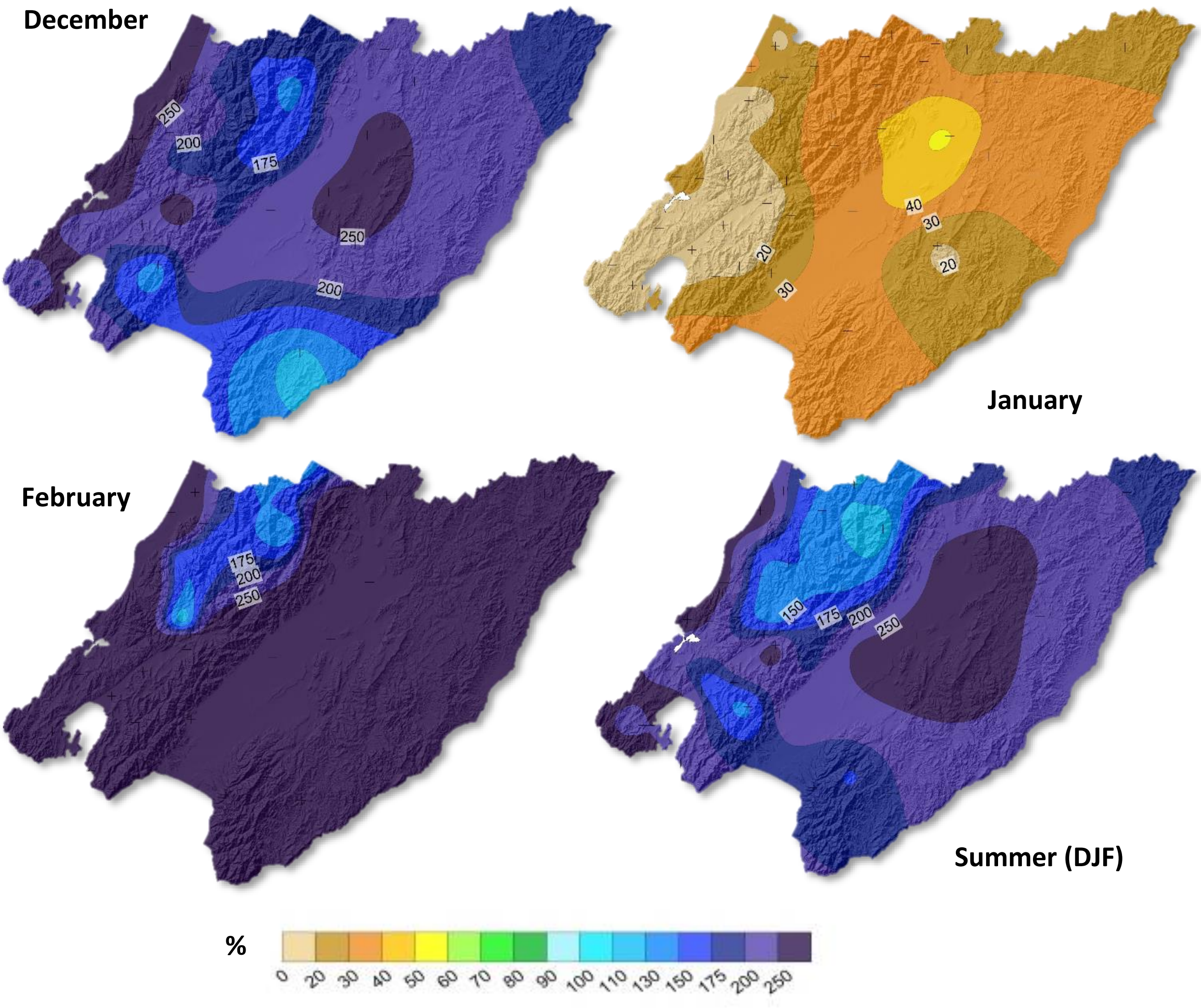



**Figure 2.4: Rainfall for December (upper left), January (upper right), February (lower left) and Summer DJF (lower right) 2022 as a percentage of the long-term average.** Source: GWRC

## 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.

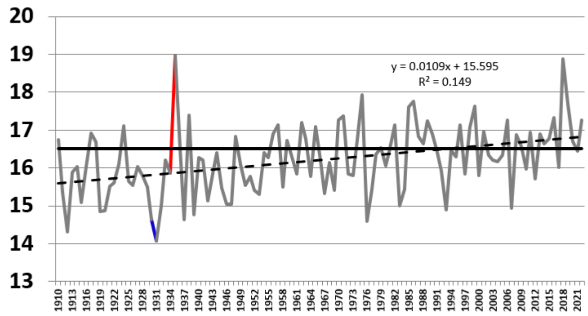
An analysis of linear trends associated with climate change is plotted onto the graph only when the trends are statistically different from zero at the 99% confidence level.

The climate change and variability summary for summer is as follows:

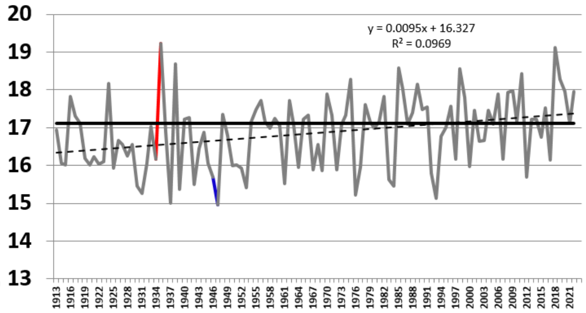
- Statistically significant trends are seen only for temperature and wind, meaning that summer is getting warmer as a result of ongoing climate change, and less windy on average in Wellington. The long-term summer warming trend is about one degree per century for both Wellington and Masterton;
- Summer 2022 temperatures were moderately above average for both Wellington and the Wairarapa;
- Sunshine hours were below average, particularly in the Wairarapa under the influence of easterly flows;
- Seasonal average wind speed was well below average;
- Seasonal rainfall was the highest on record for both Wellington and the Wairarapa. Number of rain days was about normal for Wellington, and highest on record for the Wairarapa.

# What is the data showing?

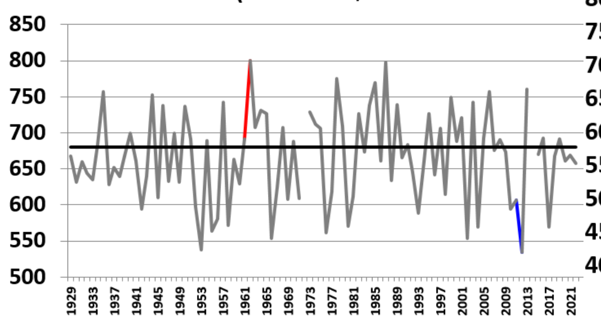
Summer Mean Temperature (deg C) - Kelburn (1910-2022)



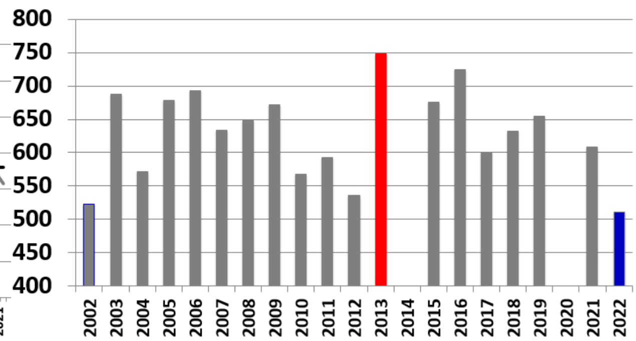

Summer Mean Temperature (deg C) - Masterton (1913-2022)



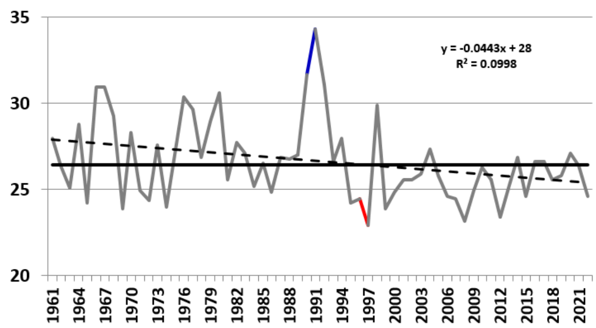

Summer Total Sunshine Hours - Kelburn (1929-2022)



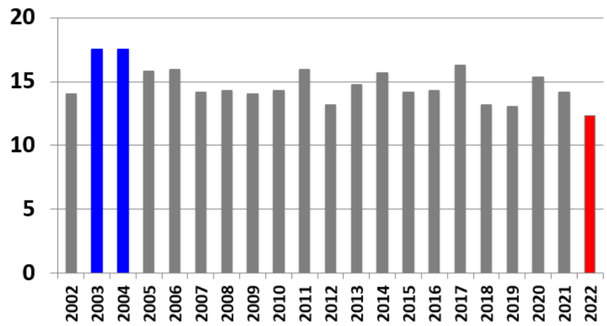

Summer Total Sunshine Hours - Martinborough (2002-2022)




Summer Mean Wind (km/h) - Wellington Airport (1961-2022)




Summer Mean Wind (km/h) - Martinborough (2002-2022)



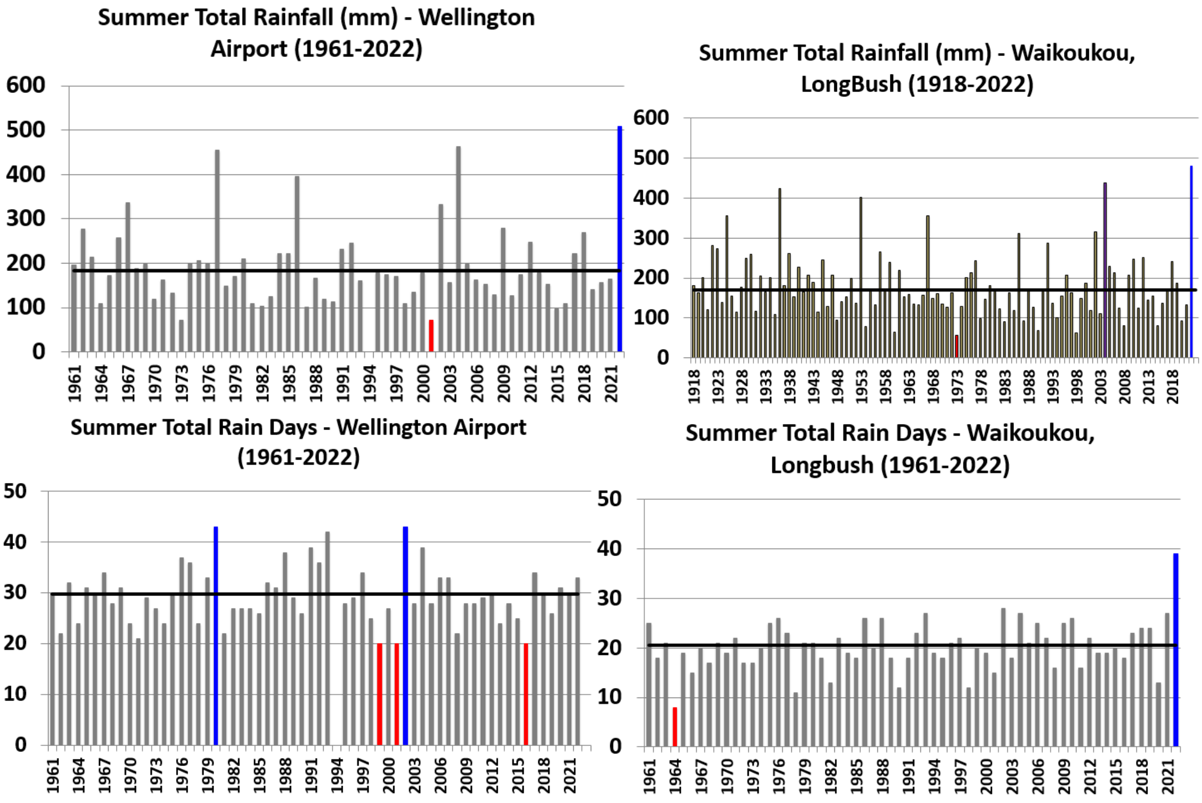



**Figure 2.5: Climate change and variability graphs for summer in Wellington and the Wairarapa.** The thick horizontal line shows the 1981-2010 average (where available), and the dashed line shows the linear trend. Trends are plotted only when statistically significant at 99% confidence level. For all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

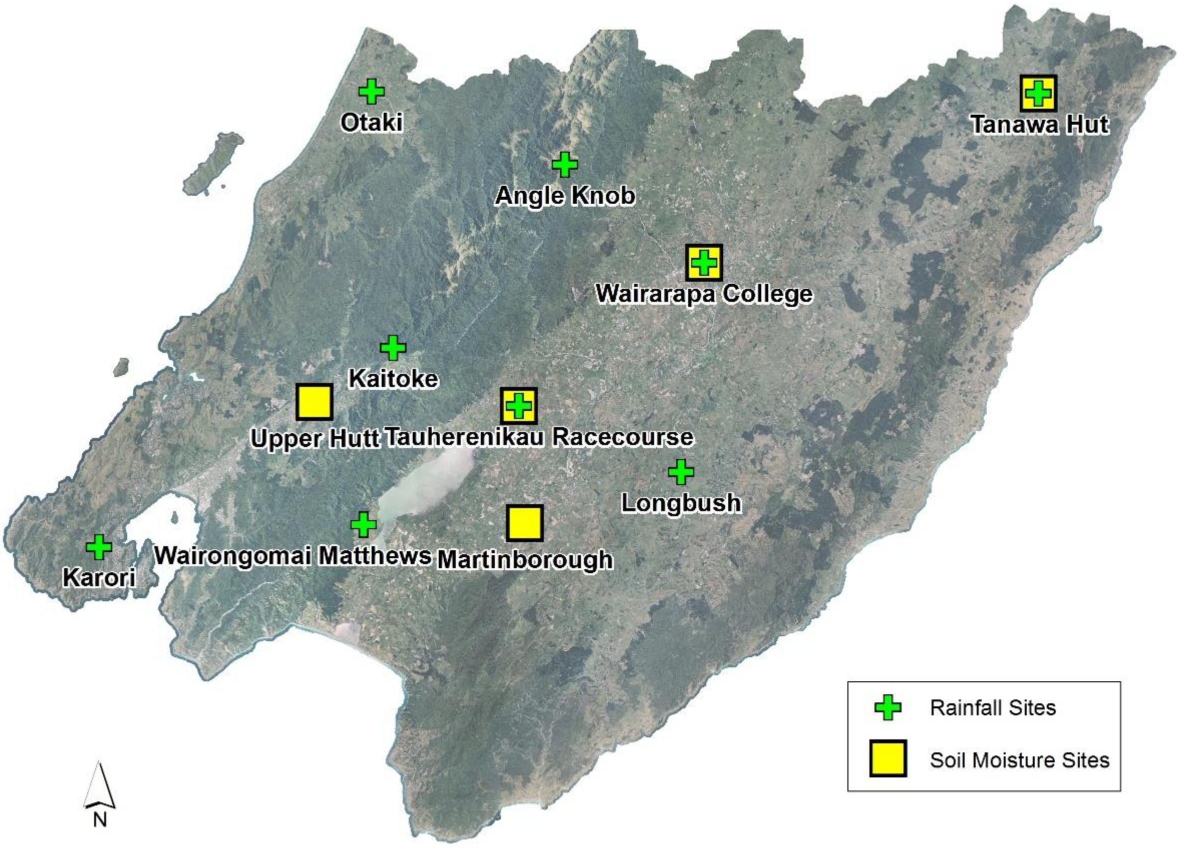



**Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations**

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

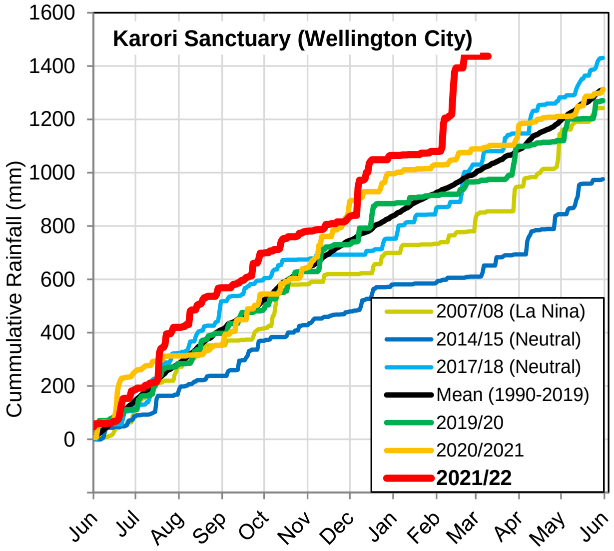
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year at several locations. For comparative purposes, cumulative plots for selected historic years with notably dry years have been included as well as the site average.

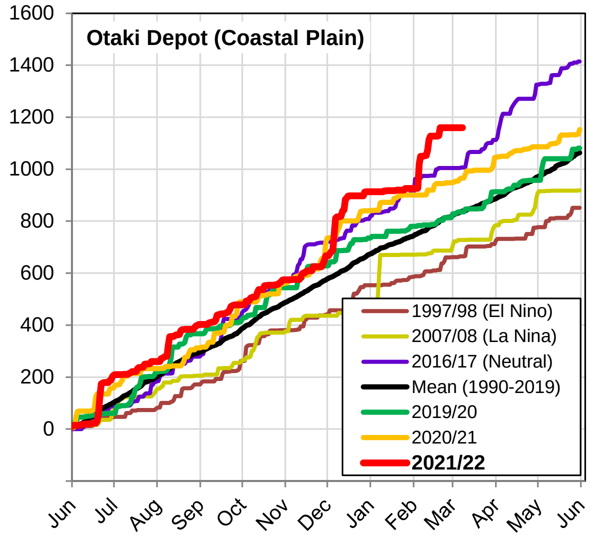
Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa have only been operating since the late 1990s so the period of data presented is limited to the last two decades. For each historical record plotted, an indication of ENSO climate state (El Niño, La Niña or neutral)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

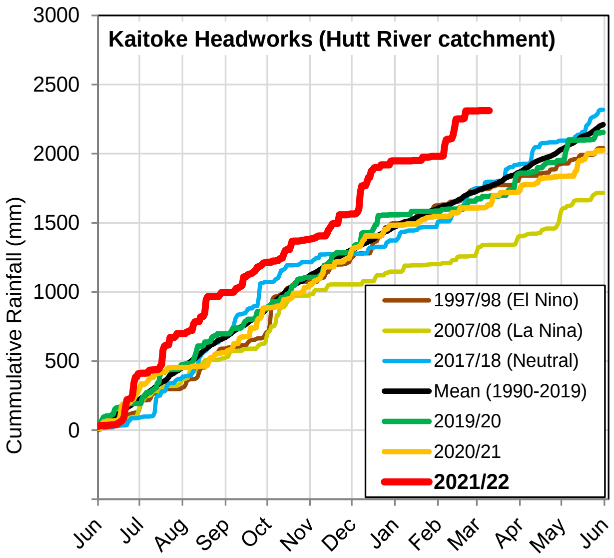
Overall, total rainfall accumulations in most areas have ended the summer season significantly above the average line, the exceptions being the Tararua Range. The very wet conditions experienced during December and February are evident as a sharp upwards movement on the rainfall accumulation graphs.

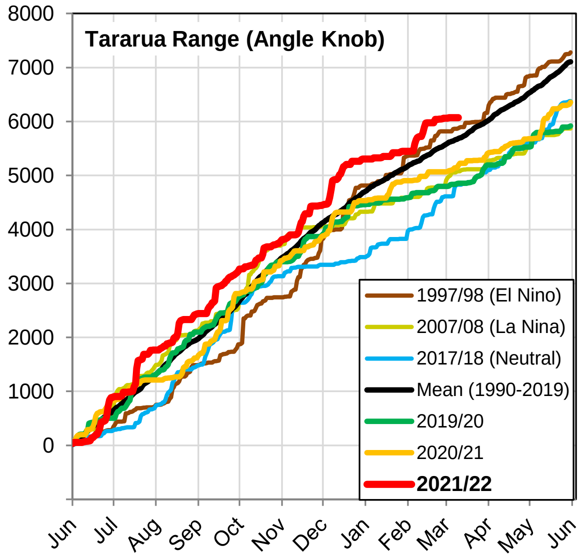
### Kāpiti Coast and Southwest (Wellington City)



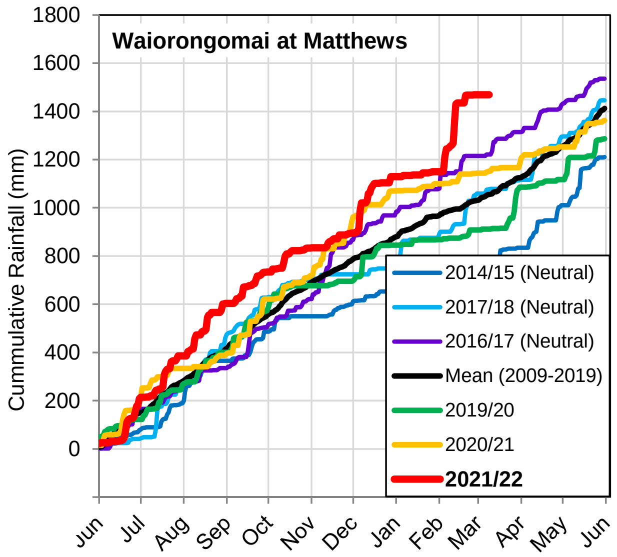



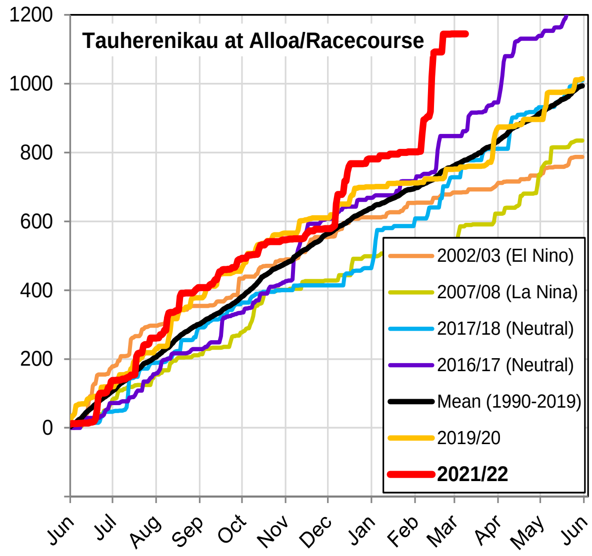

### Hutt Valley and the Tararua Range



## Wairarapa


Waiorongomai at Matthews
Cummulative Rainfall (mm)
1800
1600
1400
1200
1000
800
600
400
200
0
2014/15 (Neutral)
2017/18 (Neutral)
2016/17 (Neutral)
Mean (2009-2019)
2019/20
2020/21
2021/22
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun


Tauherenikau at Alloa/Racecourse
1200
1000
800
600
400
200
0
2002/03 (El Nino)
2007/08 (La Nina)
2017/18 (Neutral)
2016/17 (Neutral)
Mean (1990-2019)
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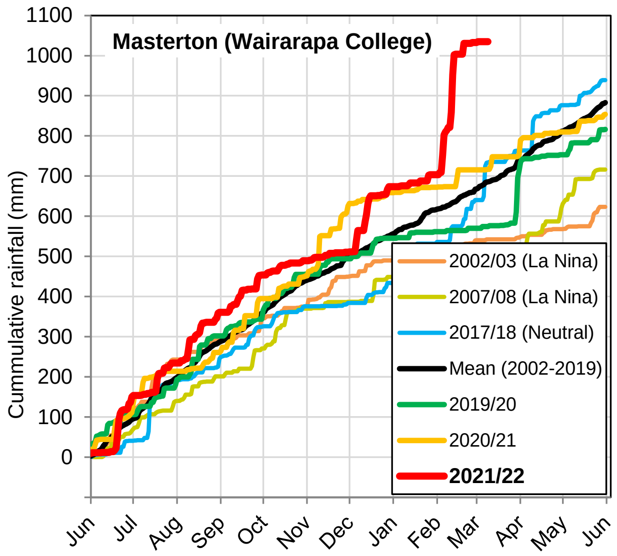
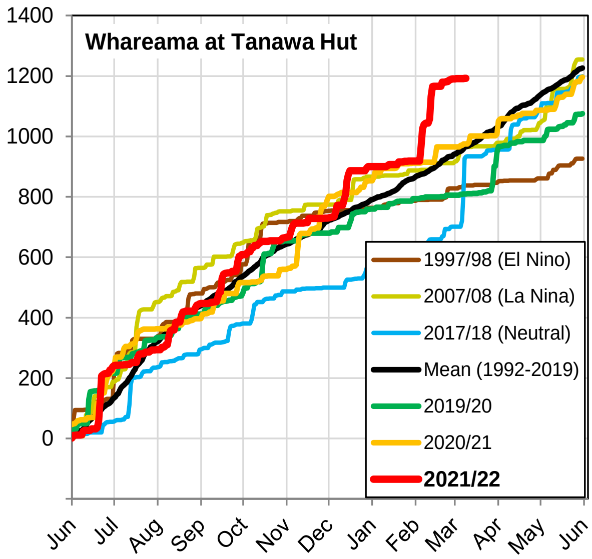
2021/22
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun


Masterton (Wairarapa College)
Cummulative rainfall (mm)
1100
1000
900
800
700
600
500
400
300
200
100
0
2002/03 (La Nina)
2007/08 (La Nina)
2017/18 (Neutral)
Mean (2002-2019)
2019/20
2020/21
2021/22
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun


Whareama at Tanawa Hut
1400
1200
1000
800
600
400
200
0
1997/98 (El Nino)
2007/08 (La Nina)
2017/18 (Neutral)
Mean (1992-2019)
2019/20
2020/21
2021/22
Jun
Jul
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Mar
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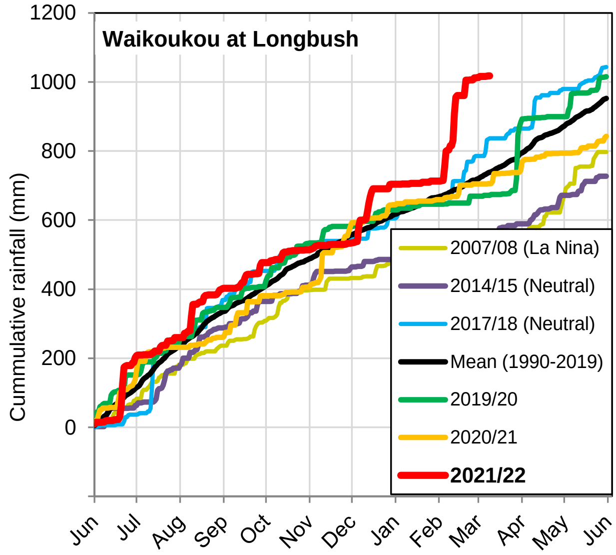



**Live cumulative plots (updated daily):** Real-time graphs for cumulative rainfall are available online at GWRC's environmental data webpage (http://graphs.gw.govt.nz/). Select a rainfall monitoring site, then choose *Cumulative Historic* from the *Interval* selector, then optionally change the period from the last 12 months to the hydrological year (July – June) as required

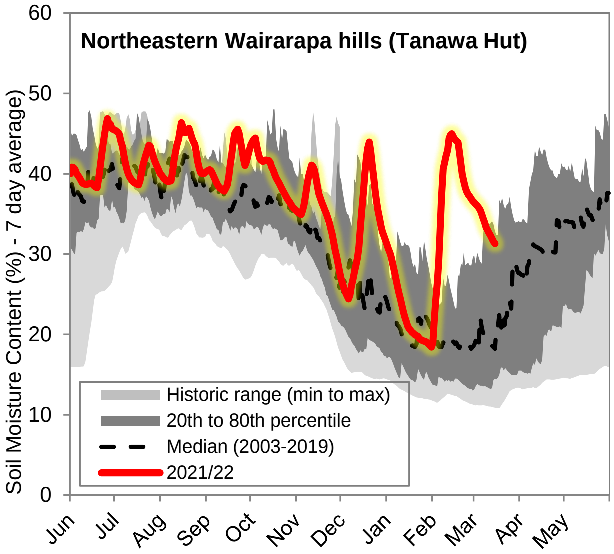
### 2.6.2 Soil moisture content (since 1 June 2021)

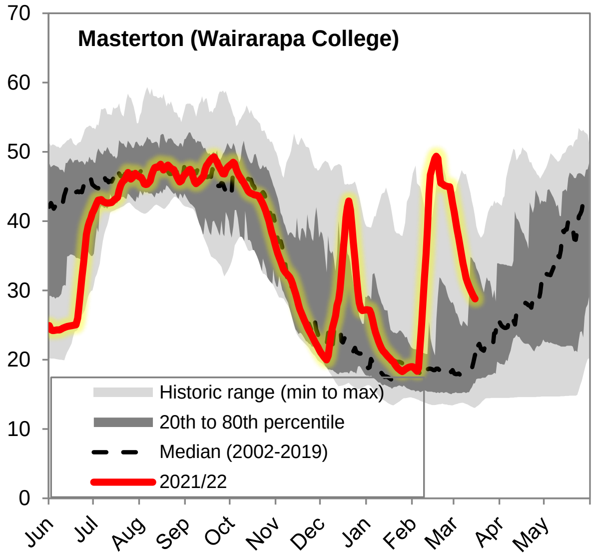
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2021. This is plotted over an envelope of the range of historic recorded data (and the median) at the site to provide an indication of how the current soil moisture compares with that for a similar period in past years.

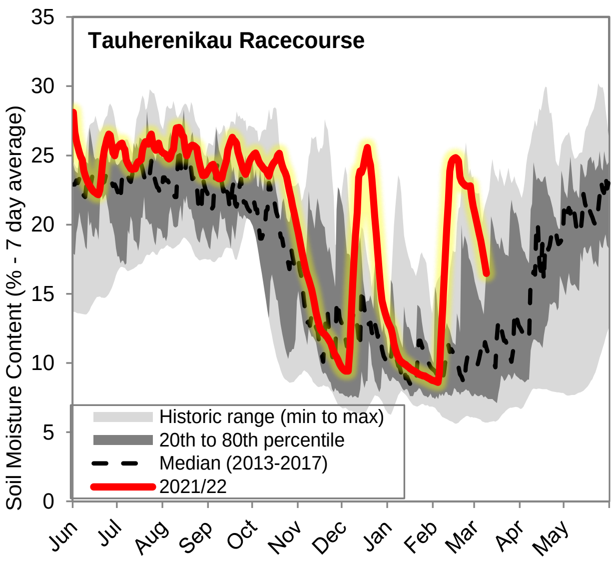
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated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

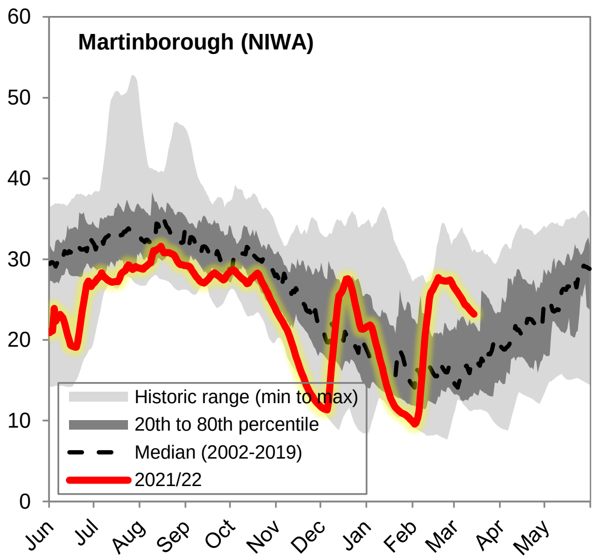
The cycle of a wet December, followed by a dry January and wet February is evident in the soil moisture graphs, particularly for the Masterton and northeastern Wairarapa Hills

## Wairarapa




**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 2022

- La Niña is expected to continue to influence the weather patterns until at least the start of winter, with increased frequency of easterly flows;
- Sea Surface Temperatures are expected to remain warmer than average for the Tasman Sea and north of New Zealand, bringing higher levels of humidity to the country;
- A variable rainfall pattern alternating between drier periods and extreme heavy rainfall events, with high chances of flooding (high confidence);
- Total seasonal rain above average in the west, and about average for the rest of the region (low confidence);
- Above average temperatures, cold events more likely as south-easterlies.

| Whaitua* | Variables | Climate outlook for autumn 2022 |
|---|---|---|
| Wellington Harbour & Hutt Valley | **Temperature:** | Above average; cold events surging as south-easterlies. |
| | **Rainfall:** | Average to above, with low confidence for the total seasonal accumulation. High month to month variability with a dry start. High chance of extreme rainfall events. |
| Te Awarua-o-Porirua | **Temperature:** | Above average; cold events surging as south-easterlies. |
| | **Rainfall:** | Average to above, with low confidence for the total seasonal accumulation. High month to month variability with a dry start. High chance of extreme rainfall events. |
| Kāpiti Coast | **Temperature:** | Above average; cold events surging as south-easterlies. |
| | **Rainfall:** | Above average, with low confidence for the total seasonal accumulation. High month to month variability with a dry start. High chance of extreme rainfall events. |
| Ruamāhanga | **Temperature:** | Above average; cold events surging as south-easterlies. |
| | **Rainfall:** | About average, with low confidence for the total seasonal accumulation. High month to month variability with a dry start. High chance of extreme rainfall events. |
| Wairarapa Coast | **Temperature:** | Above average; cold events surging as south-easterlies. |

| | | |
|---|---|---|
| | **Rainfall:** | About average, with low confidence for the total seasonal accumulation. High chance of extreme rainfall events. |

*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:** https://www.gw.govt.nz/environment/environmental-data-hub/climate-monitoring/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)**

https://www.gw.govt.nz/assets/Documents/2017/06/Climate-Change-and-Variability-report-Wlgtn-Regn-High-Res-with-Appendix.pdf

- **Main climate drivers report (Climate Modes) (NIWA 2018)**
  https://www.gw.govt.nz/assets/Documents/2021/10/GWRC-climate-modes-full-report-NIWA-3-Sep-2018-compressed.pdf

- **Climate change extremes report (NIWA 2019)**

https://www.gw.govt.nz/assets/Documents/2021/11/GWRC-NIWA-climate-extremes-FINAL3.pdf

### **Climate Portals**

- **GWRC Climate change impacts webpage**

https://www.gw.govt.nz/environment/climate-change/impacts-on-our-region/

- **GWRC Seasonal climate hub**
  https://www.gw.govt.nz/environment/environmental-data-hub/climate-monitoring/