



Climate and water resources Seasonal update

Spring 2017 summary
Summer 2017/2018 outlook

December 2017

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Overview

Spring 2017

After a cool and wet winter, spring saw a remarkable change in the climatic patterns with record warm and dry conditions establishing over the region. In November most of the region had less than 30% the normal rainfall. The media release below offers a hydrological summary of the November figures (<http://www.gwrc.govt.nz/november-s-big-dry-breaks-rainfall-records/>).

In Wellington, spring as a whole was the warmest and least windy on record for a long period of measurements available (starting 1928 for Kelburn's temperature). Large blocking anticyclones (i.e., very large and slow moving high pressure areas) have brought a succession of unseasonably warm and stable days both in the west and in the Wairarapa, during a time which should normally have been the windiest period of the year in Wellington.

Climate drivers

The El Niño - Southern Oscillation (ENSO) phenomenon had been neutral but is now officially within La Niña threshold. Even though the event is not strong, the atmosphere has now shifted into a circulation pattern (winds, high pressure centres, etc.) that is producing significant impacts over New Zealand.

The normal La Niña impacts have been strengthened by the establishment of a vigorous blocked flow around the Southern Hemisphere, resulting in much warmer than normal temperatures (enhanced by background global warming), weaker westerly flow and abundant influence of high pressure centres bringing stable weather and isolated (at times severe) thunderstorms inland.

The Southern Annular Mode (SAM) has been predominately positive, also contributing to the stable and warm weather pattern, with an area of low pressure to the north of New Zealand associated with northerlies as expected during La Niña years. Sea ice extent around Antarctica has been less than normal for this time of the year, although not as anomalous as last year.

Climate outlook for summer 2017/2018

Based on La Niña and the state of the other climate drivers, and taking into account the influence of background global warming, we expect a warmer than normal summer with weaker westerlies, and more light southerlies and north-easterly episodes. Rainfall is expected to be below normal especially for the southern half of the region. In the north and Wairarapa there is a higher chance of influence from thunderstorms and occasional easterly heavy rainfall events typical of La Niña years.

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

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1. Climate drivers

1.1 El Niño – Southern Oscillation (ENSO)

Although the ENSO phenomenon had been slightly on the cool or La Niña side for a while, the water temperature anomaly has only now reached full La Niña conditions in the Equatorial Pacific. This La Niña is expected to remain in place only until the beginning of autumn (Figure 1.1), and is not predicted to be a particularly severe event, even though significant environmental impacts have been observed over the world (e.g. bushfires in California).

La Niñas are a normal climate variability phenomenon where the subtropical trade winds are enhanced over the Pacific Ocean. This brings colder bottom water to the surface, causing the surface ocean to cool. The cooler equatorial ocean absorbs more heat from the atmosphere, often causing a slowdown of the global warming effect on the global average temperatures during La Niña years. However, the oceanic temperatures tend to increase around New Zealand with enhanced transport of tropical currents towards the south in the Tasman Sea. As a result, New Zealand is more prone to record warming events during La Niñas even though La Niña itself is a cooling event.

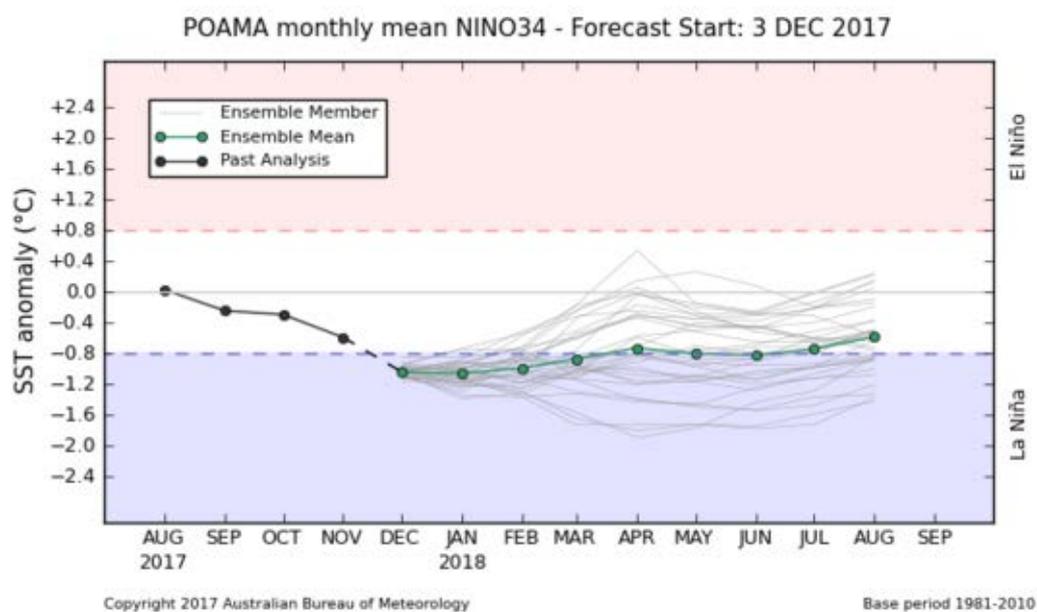


Figure 1.1: ENSO projections (in green) show conditions have now reached La Niña and are expected to remain so for a brief period only until early autumn. Source: Australian Bureau of Meteorology.

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 for 4 December 2017. The pattern shows a well-established La Niña in the central Pacific as discussed above, while the waters around New Zealand appear as one of the warmest anomalies for the entire planet.

This warm water condition is related to the persistent blocking highs during spring, with increased solar radiation input available to warm the ocean. As New Zealand is a relatively small landmass surrounded by water, the atmospheric temperature anomalies tend to be greatly influenced by the water temperatures, and so the air and water anomalies tend to go hand in hand.

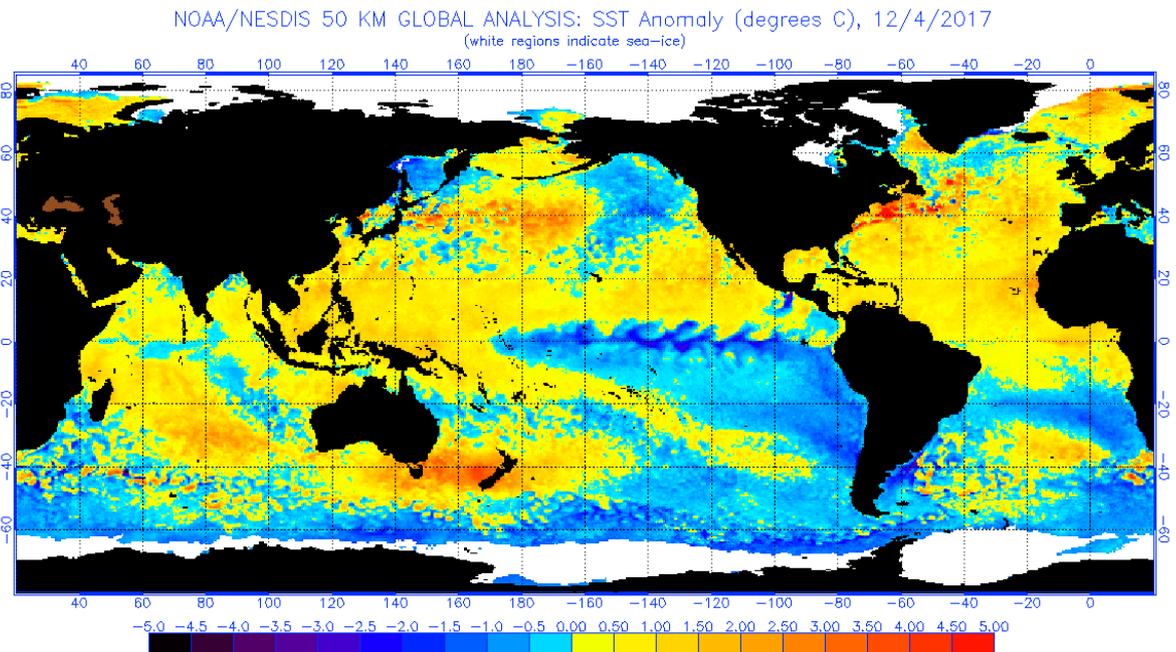


Figure 1.2: Sea surface temperature (SST) anomalies for 4 Dec 2017. Sea ice coverage is shown in white. A well-defined La Niña is seen in the Equatorial Pacific, with much warmer than average SST around New Zealand. Source: NOAA.

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 an impressive blocking high pressure was established around and over New Zealand in association with a positive SAM.

As discussed earlier, this blocking explains the extreme climate anomalies observed over New Zealand, as it virtually stopped any potential cold front from affecting the country over a very long period. This type of blocking tends to be more common during La Niña years, even though the persistence was too severe to be explained by La Niña alone.

NCEP/NCAR Reanalysis
Sea Level Pressure (mb) Composite Anomaly 1981–2010 climo

NOAA/ESRL Physical Sciences Division

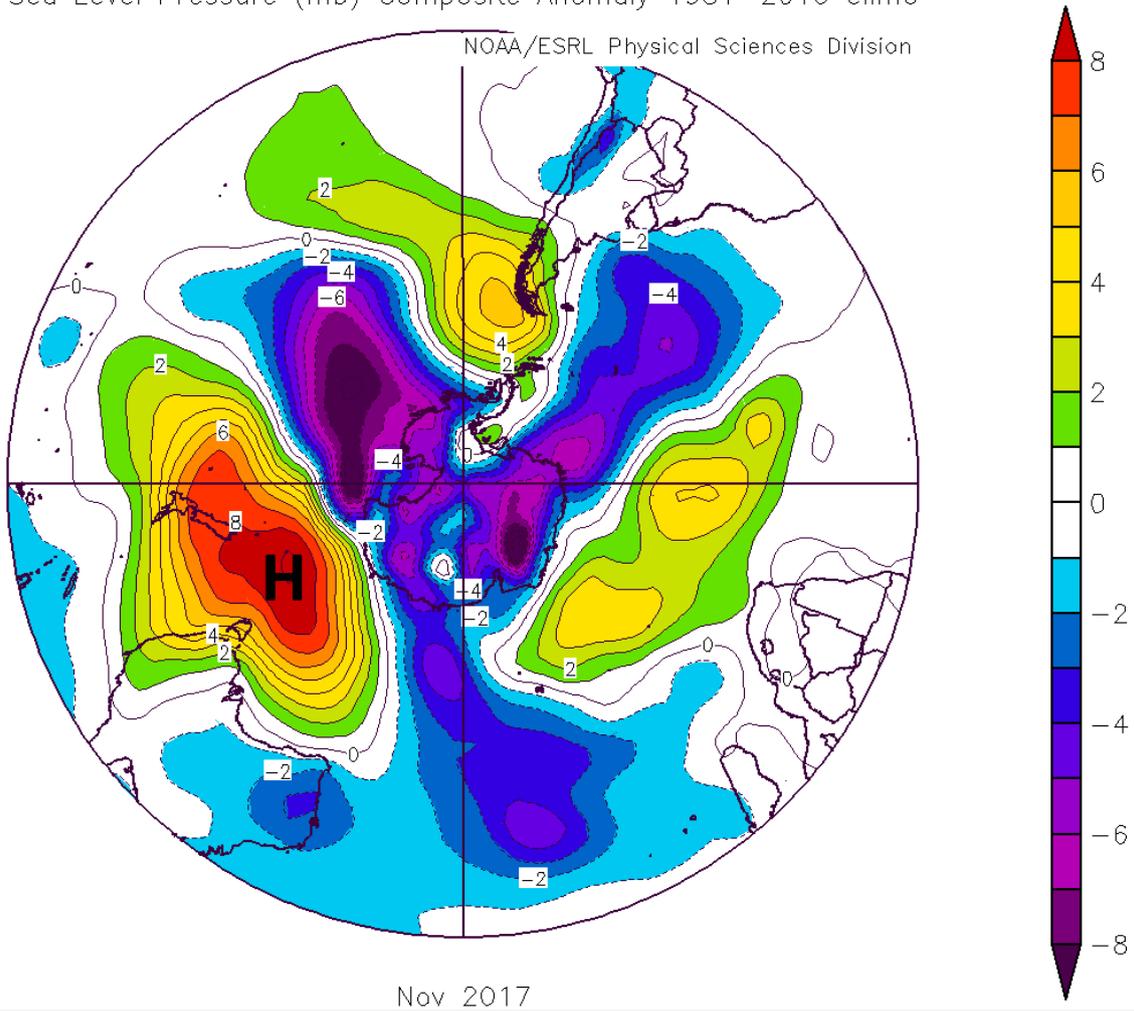


Figure 1.3: Sea level pressure anomalies for November 2017. The 'H' indicates the area of blocking high pressure around New Zealand that has led to a record warm and dry spring. Source: NCEP Reanalysis.

2. What is the data showing?

2.1 Regional temperature

Figure 2.1 shows the 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).

We can see that above average temperatures occurred around most of the region for both the maximum and minimum, especially the max (day time) temperatures. The maximum temperatures also showed a clear pattern with greater anomalies in the west, and closer to normal in the east. This is typical of La Niña years. For Kelburn (Wellington) the average temperature for spring (i.e. mean max and min combined) was the highest on record for measurements since 1928.

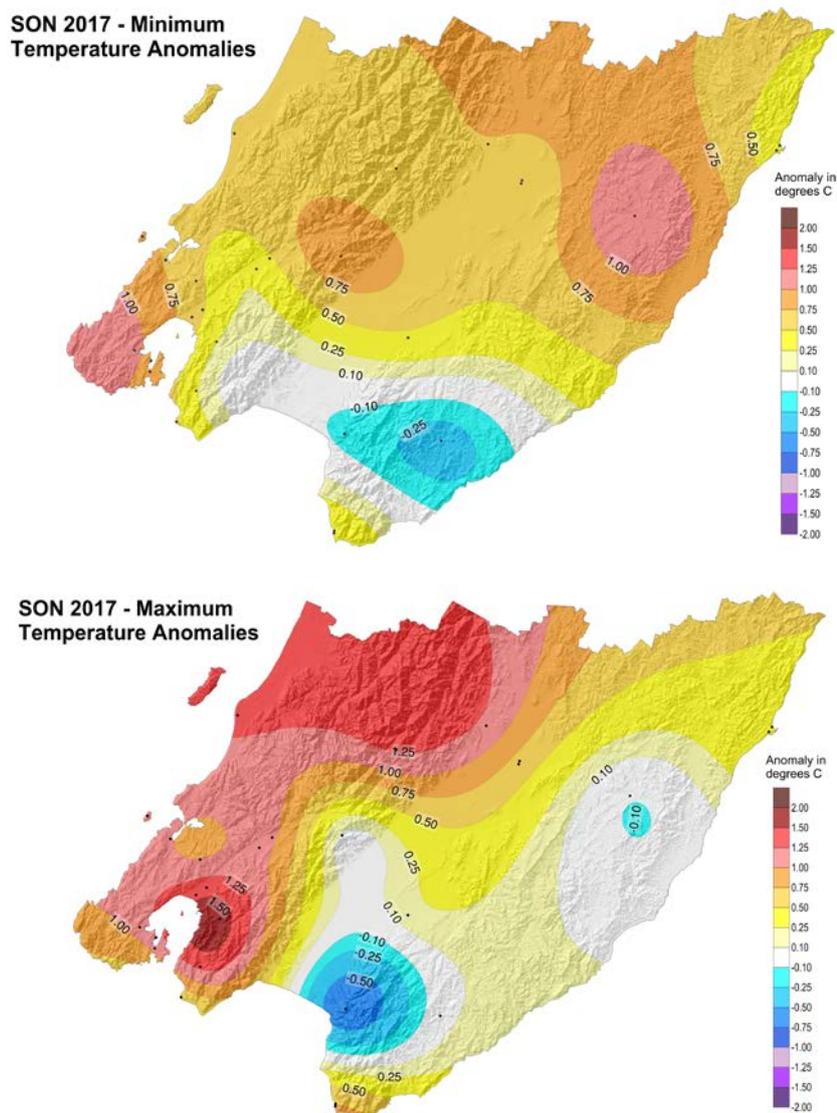


Figure 2.1: Daily Average Min and Max temperature anomalies for SON 2017. All anomalies calculated against the 1981-2010 reference period. Source: GWRC, using station data from the GWRC, NIWA, MetService and NZ Rural Fire Authority networks.

2.2 Regional wind

Figure 2.2 shows the mean wind anomalies (against the 1981-2010 reference period) based on a similar network of stations as shown for temperature. We can see that most of the region had a pattern of much weaker than normal wind speeds, in connection with the blocking anticyclone that dominated a good portion of the second half of the season. For Wellington airport, spring was the least windy on record since 1960.

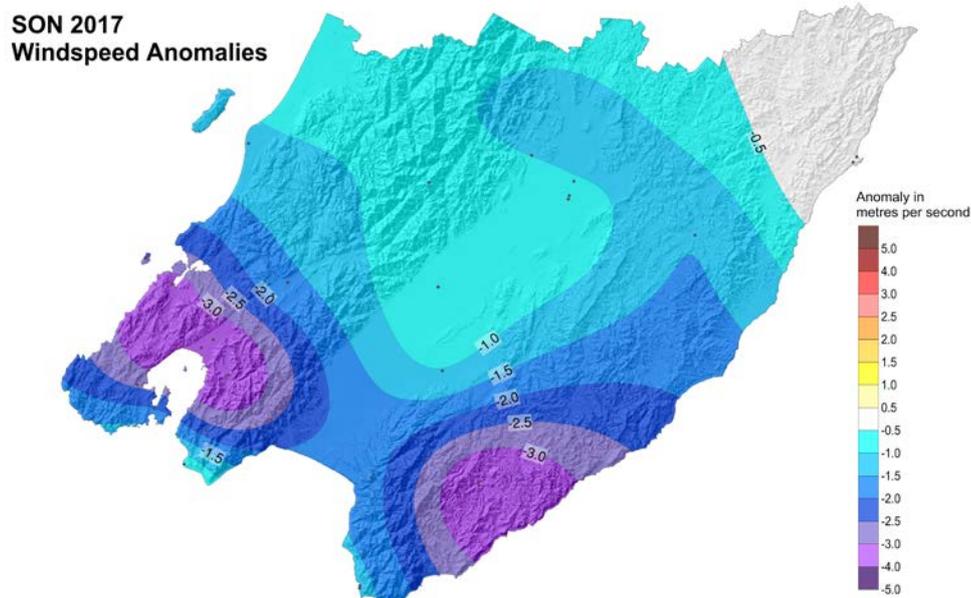


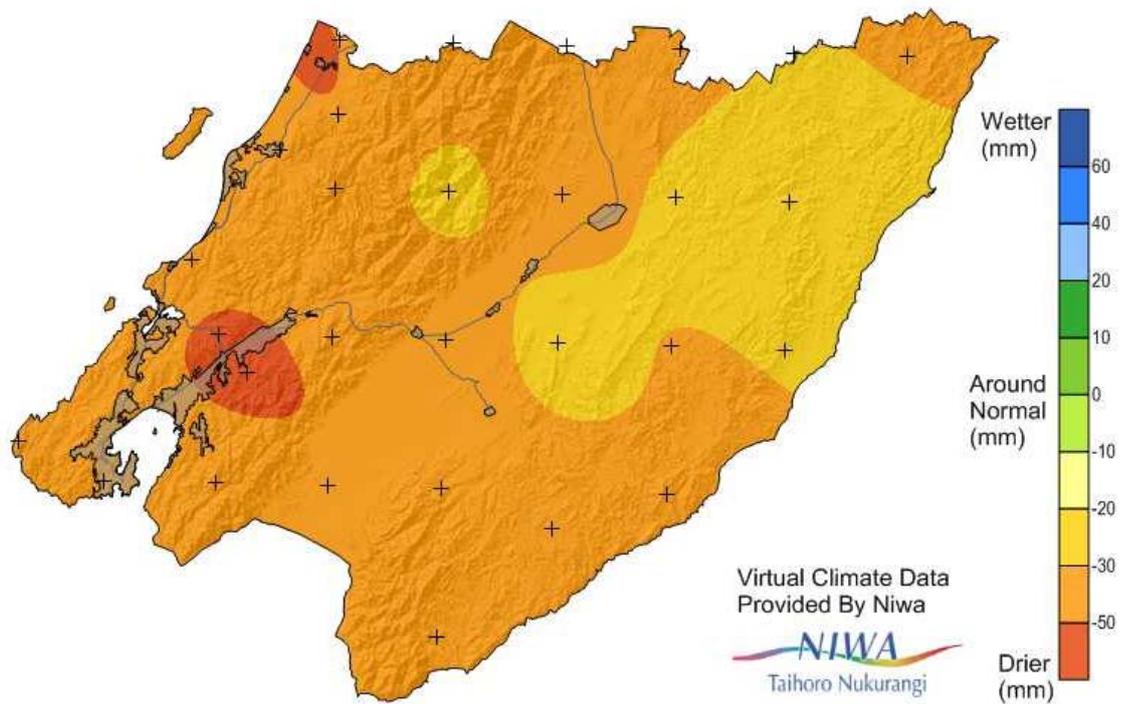
Figure 2.2: Daily mean wind anomalies (in m/s) for SON 2017. All anomalies calculated against the 1981-2010 reference period. Source: GWRC, using station data from the GWRC, NIWA, MetService and NZ Rural Fire Authority networks.

2.3 Regional soil moisture

Figure 2.3 shows the 30 day Soil Moisture Anomaly map for the region as at the end of spring. Most of the region shows below average soil moisture as a result of the severe climate anomalies observed in November.

It is too soon to make inferences about drought conditions, as a persistent severe dryness would need to be observed for at least three consecutive months. The latest drought index data from NIWA (as of 19 December) suggests that the region is extremely dry but not in drought as yet for most of the Wairarapa. The drought index from NIWA is available from <https://www.niwa.co.nz/climate/information-and-resources/drought-monitor>

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



30 Day Soil Moisture Anomaly (mm) as at: 02-12-2017 15:00 (NZST)

Figure 2.3: Thirty day Soil Moisture Anomaly ending 2 December 2017. Moisture levels show below normal conditions for most of the region, especially in the south. 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 should only be used for a general indication of the spatial variability.

2.4 Regional rainfall

Figure 2.4 shows the regional spring and November rainfall expressed as a percentage of the long-term average. The entire region had below average seasonal rainfall, especially in the south, largely influenced by the severely dry November pattern. The asterisk (upper panel) shows the location of the reference rainfall station (Waikoukou farm) used to produce the climate analogues rainfall projection for the Wairarapa (see Section 3). The farm had about 84% of the 1981-2010 rainfall average over the spring period (individual measurements can differ from the exact map contour due to the interpolation technique used and localised nature of rainfall).

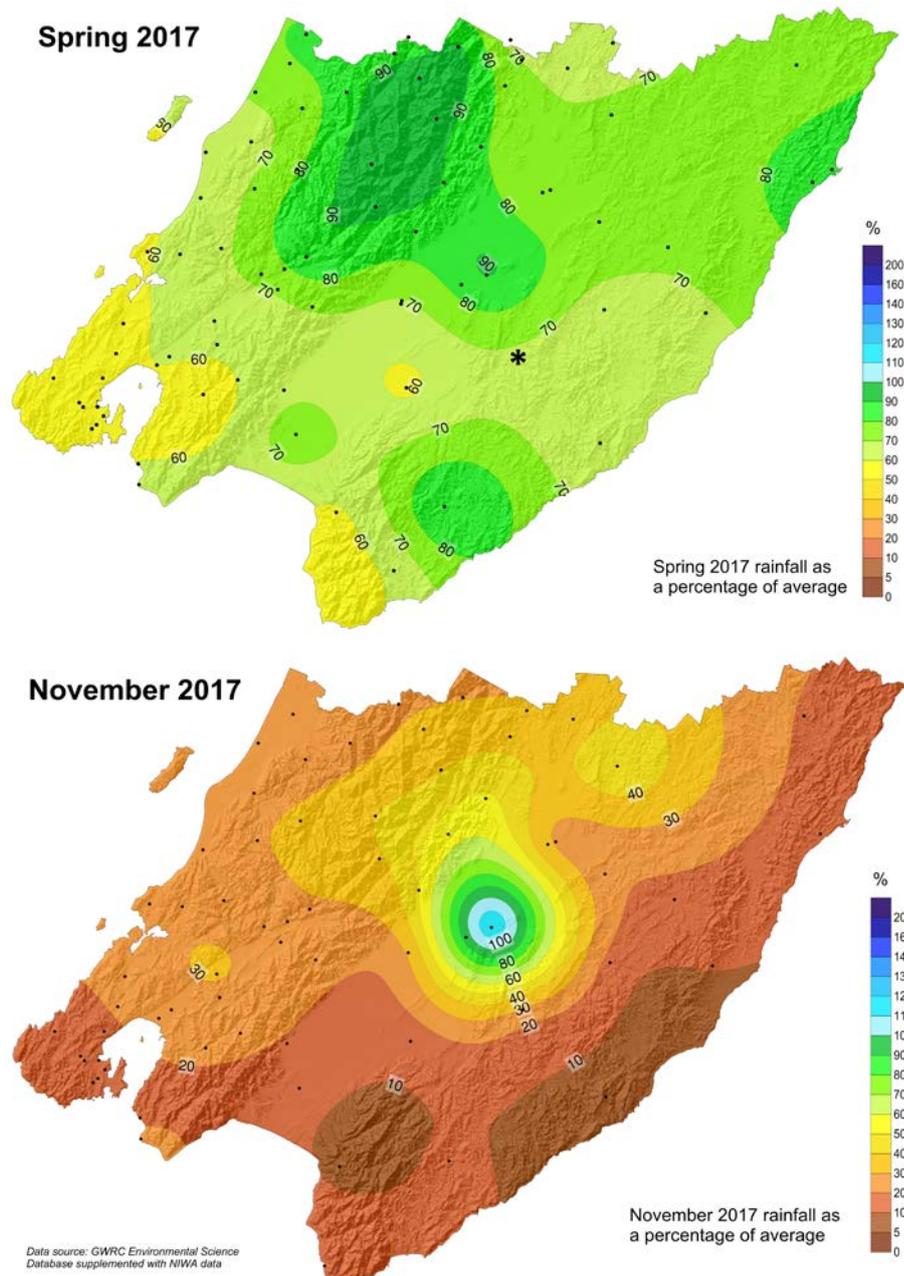


Figure 2.4: Rainfall for spring 2017 (upper panel) and November 2017 (lower panel) as a percentage of the long-term average. Rainfall was below average rainfall for the entire region in spring, largely due to severe dry pattern in November. The asterisk (upper panel) shows the location of the rainfall time series at Waikoukou, Longbush, used for the climate analogues rainfall projection (see Section 3). Source: GWRC and NIWA.

2.5 Climate change and variability indicators

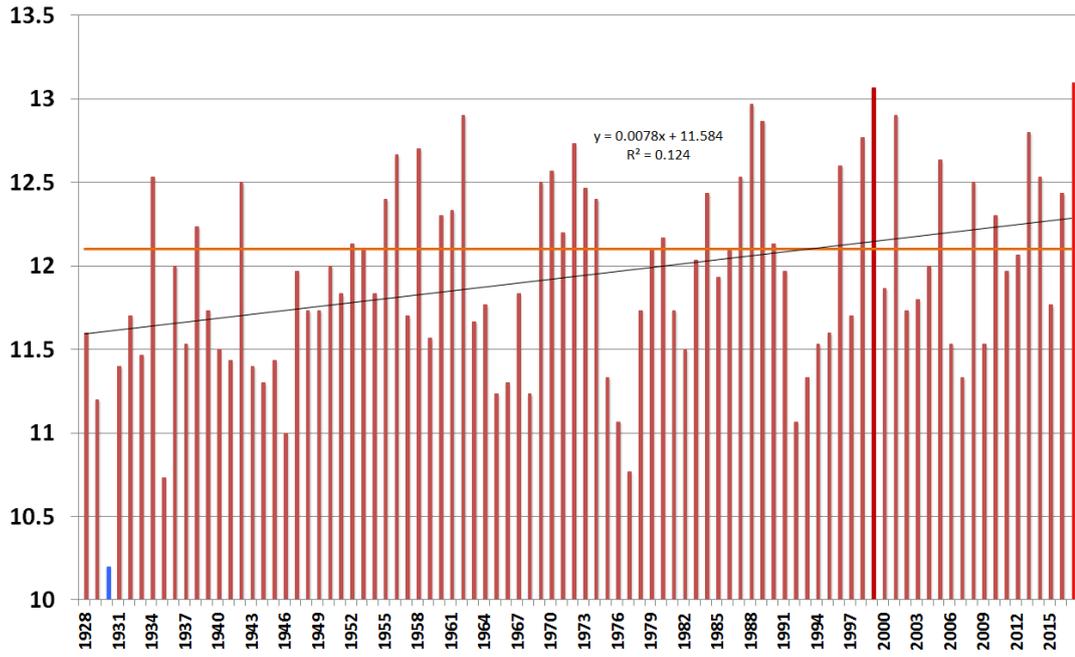
The figures below (Figure 2.5) show the seasonal climate change and variability summary graphs for Wellington and the Wairarapa represented by key reference climate stations chosen based on length of data record and availability.

The key variables shown in the graphs below are: mean temperature, mean wind, total number of sunshine hours, total rainfall and total number of rain days.

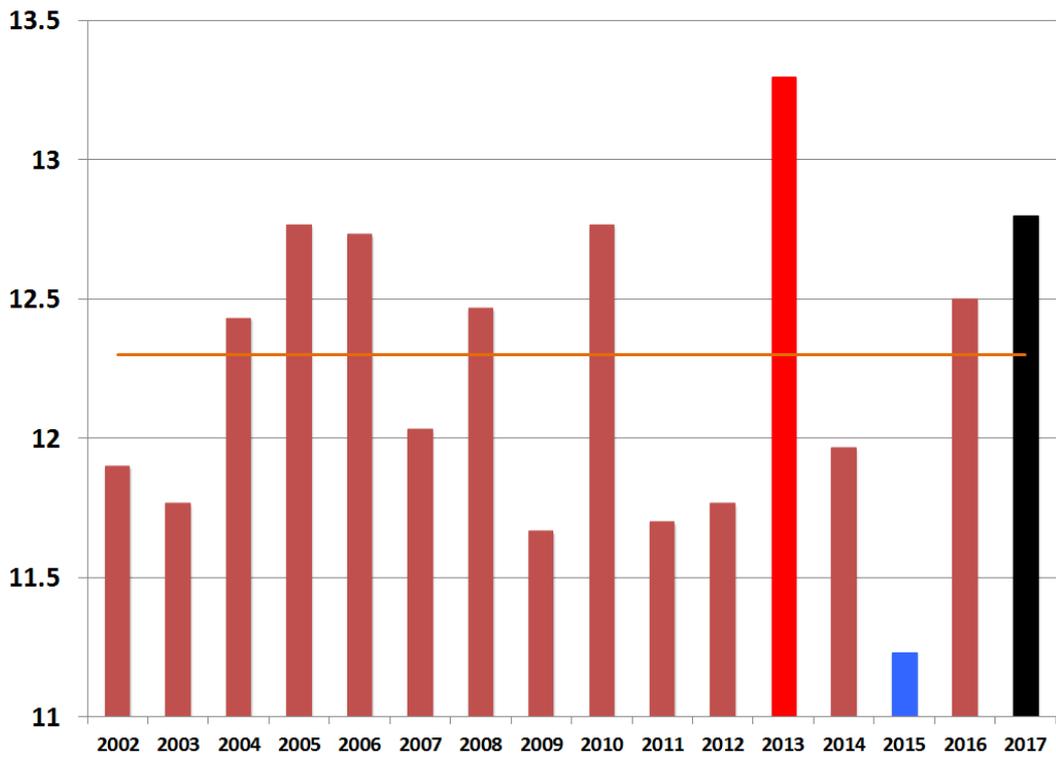
The climate change and variability summary for spring is:

- There is a significant warming trend of about 0.8°C per century in Wellington;
- There is a significant decreasing trend in mean wind speed of about 18% per century in Wellington;
- There are no significant trends in rainfall;
- The Wairarapa temperature data is too short to infer significant trends;
- Spring 2017 was the hottest and the least windy on record for Wellington;
- Spring 2017 was the least windy on record for the Wairarapa;
- Spring 2017 rainfall was very low for both Wellington and the Wairarapa

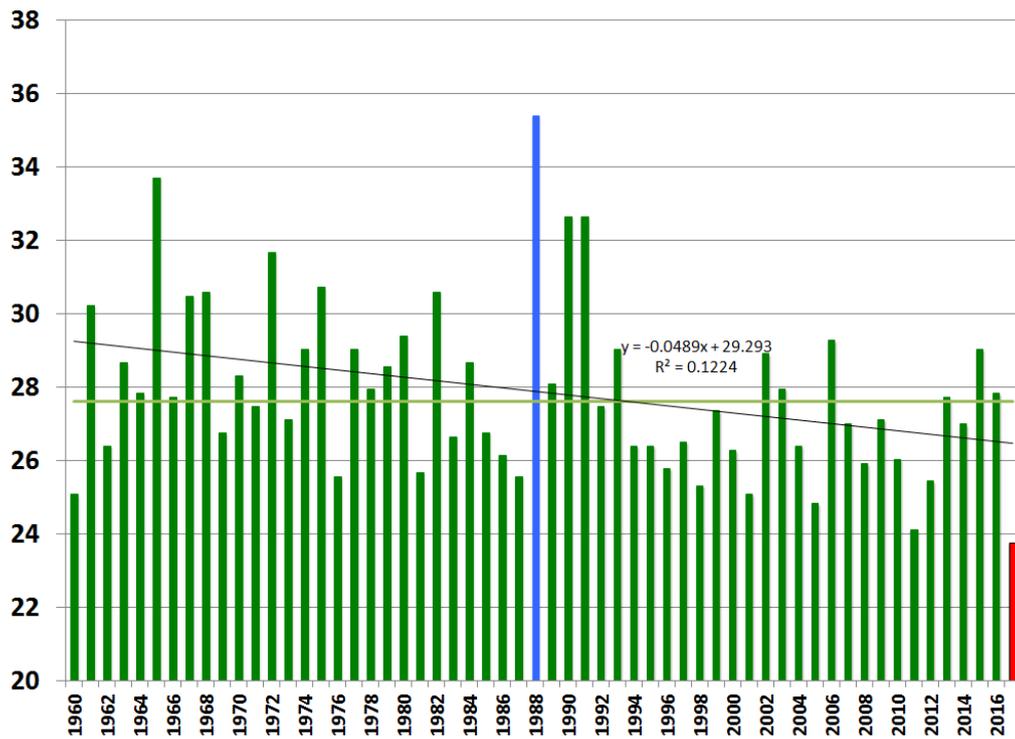
Spring Mean Temperature (deg C) - Kelburn (1928-2017)



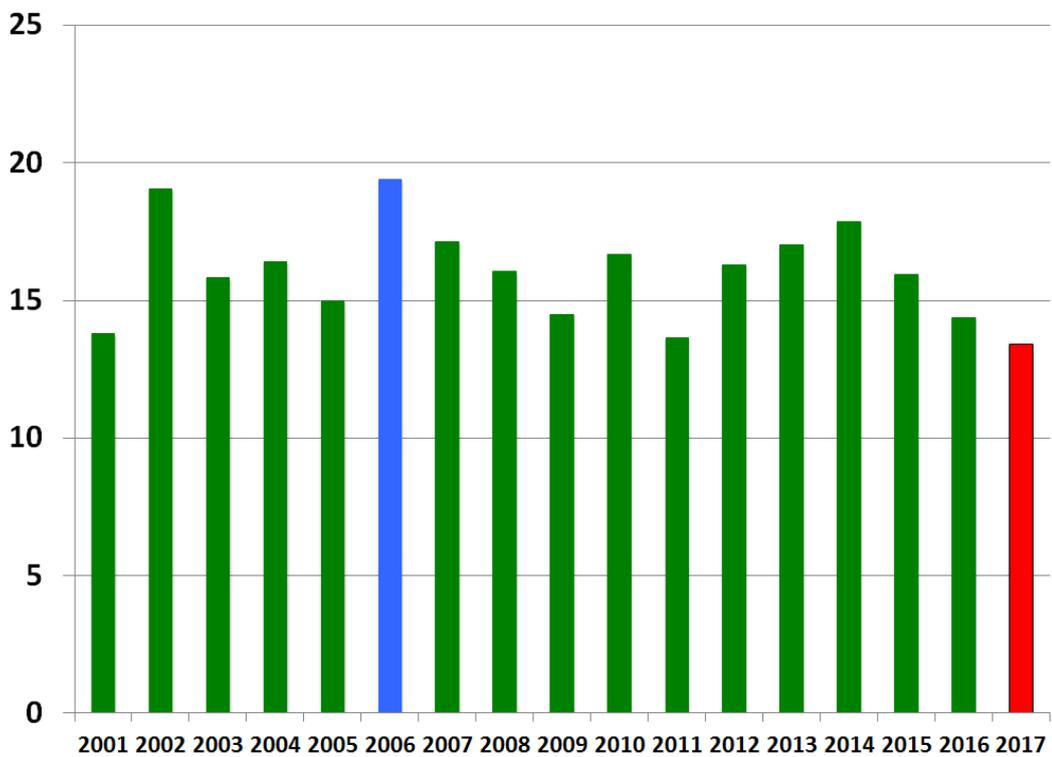
Spring Mean Temperature (deg C) - Martinborough (2002-2017)



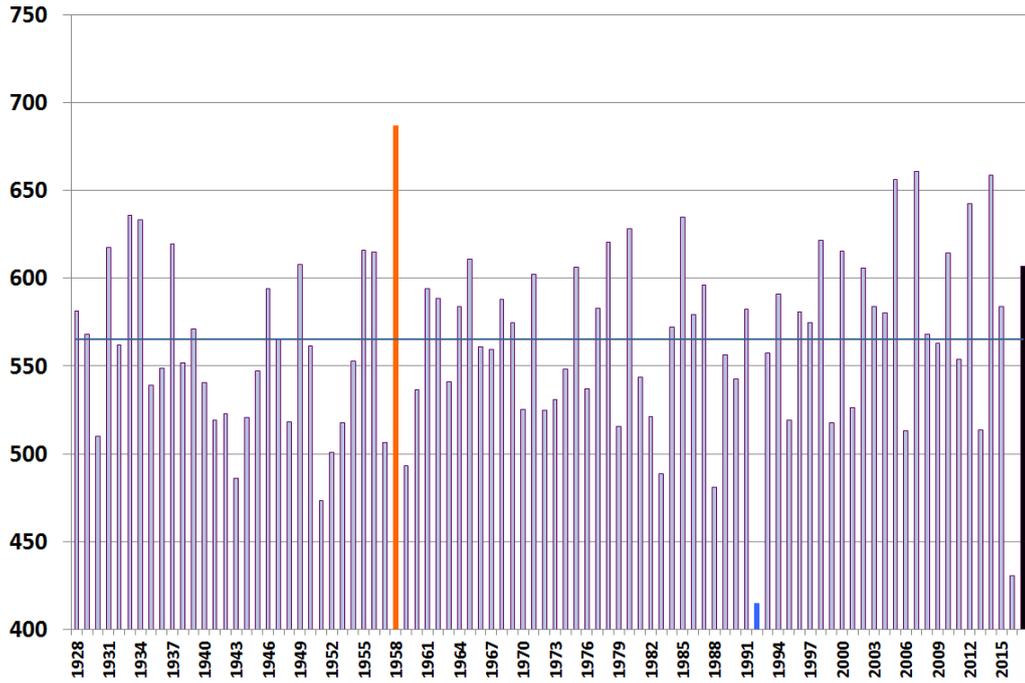
Spring Mean Wind (km/h) - Wellington Airport (1960-2017)



Spring Mean Wind (km/h) - Martinborough (2001-2017)



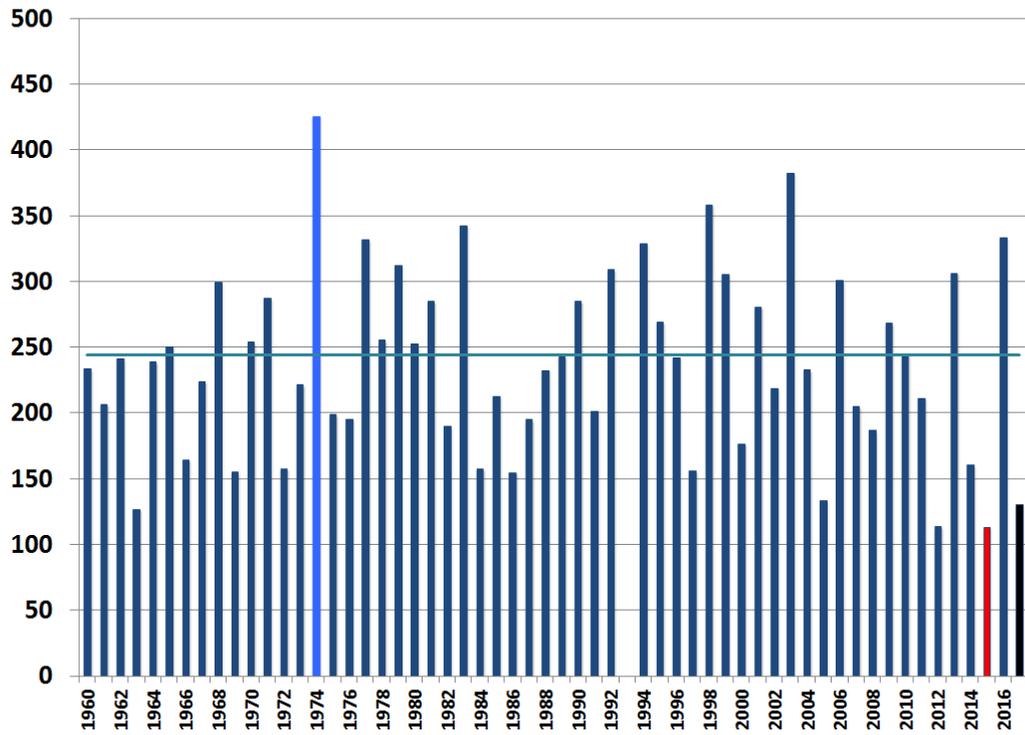
Spring Total Sunshine Hours - Kelburn (1928-2017)



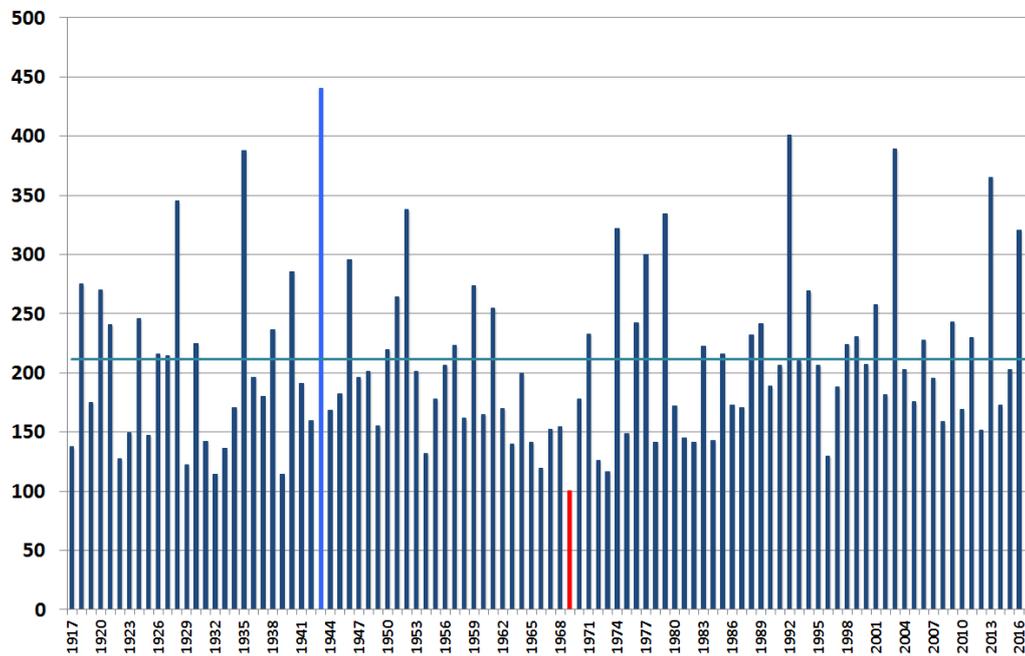
Spring Total Sunshine Hours - Martinborough (2002-2017)



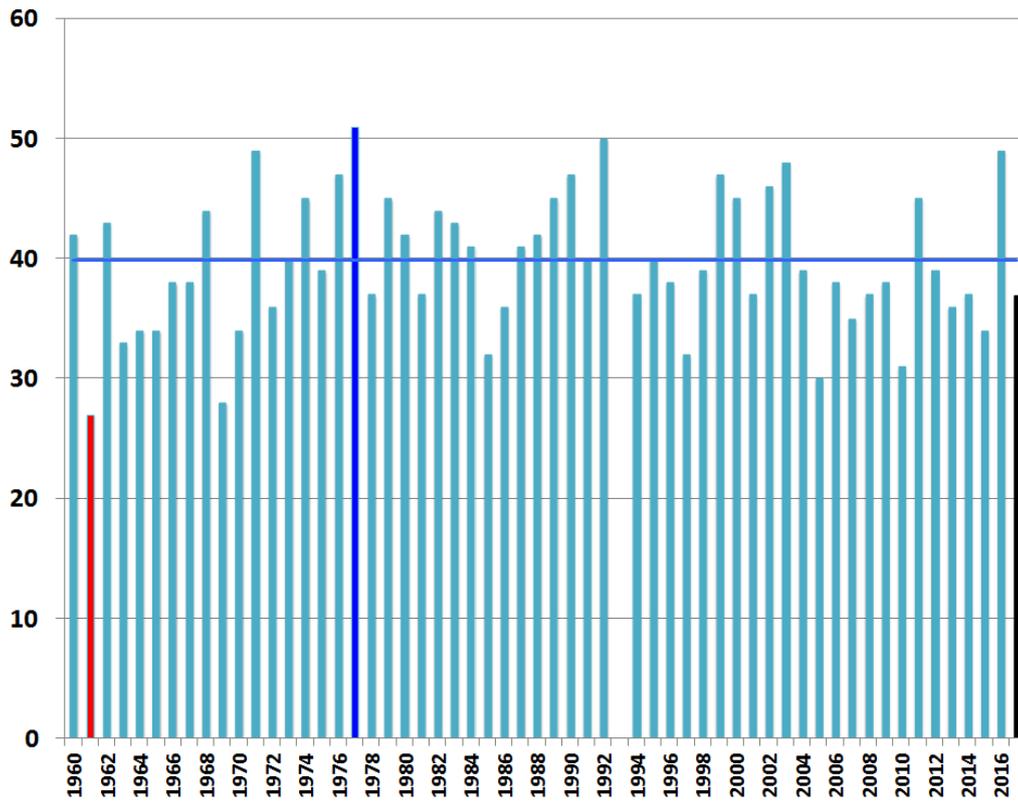
Spring Total Rainfall (mm) - Wellington Airport (1960-2017)



Spring Total Rainfall (mm) - LongBush (1917-2017)



Spring Total Rain Days - Wellington Airport (1960-2017)



Spring Total Rain Days - Longbush (1960-2017)

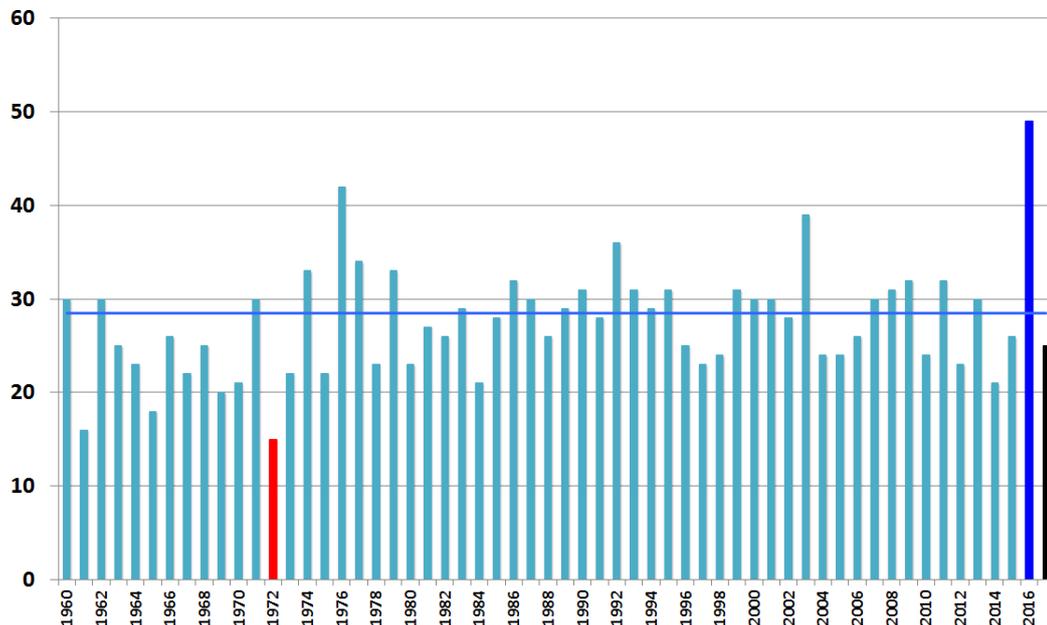


Figure 2.5: Climate change and variability graphs for spring in Wellington and the Wairarapa. The straight line indicates the 1981-2010 average (when available). Black indicates the current year. Red and blue indicate extreme years. Long-term trends are plotted only when statistically significant. The key variables shown are: mean temperature, mean wind, total number of sunshine hours, total rainfall and total number of rain days. An absence of bars means that no reliable mean seasonal data was available for that particular year.

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.

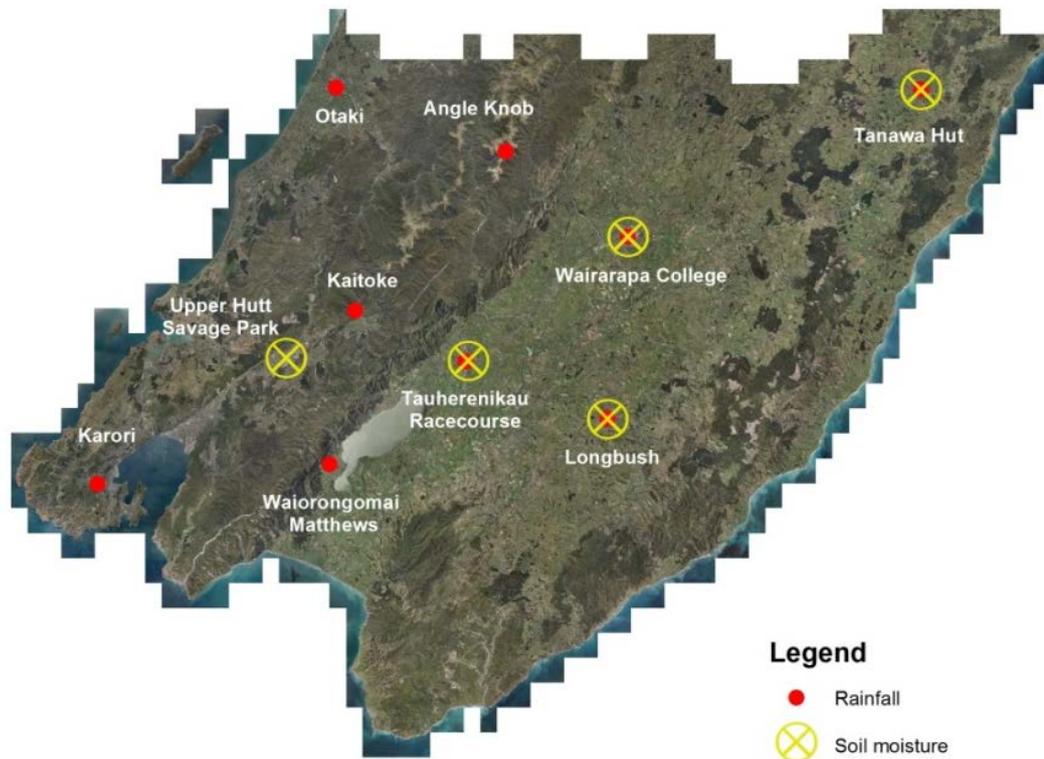


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

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

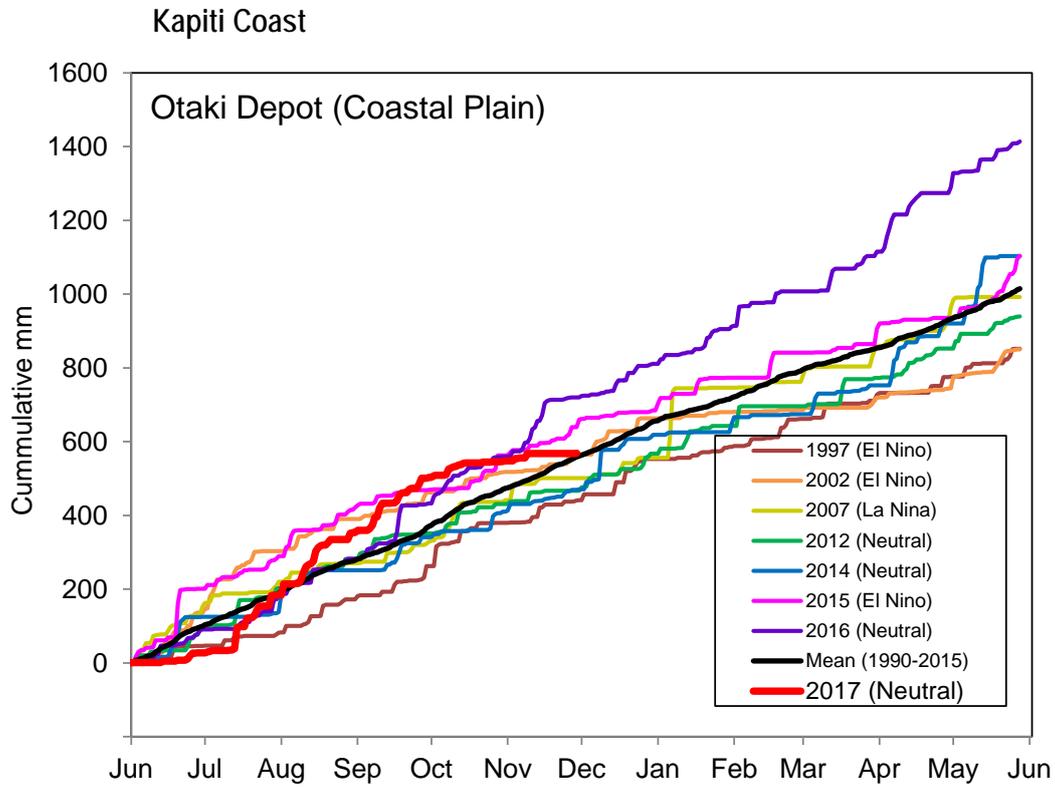
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year for several years. For comparative purposes, cumulative plots for selected historic years with notably dry summers in the Wairarapa have been included, as well as the site average.

Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa (i.e., not Tararua Range gauges installed for flood warning purposes) 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 satellite and VCN data already presented.

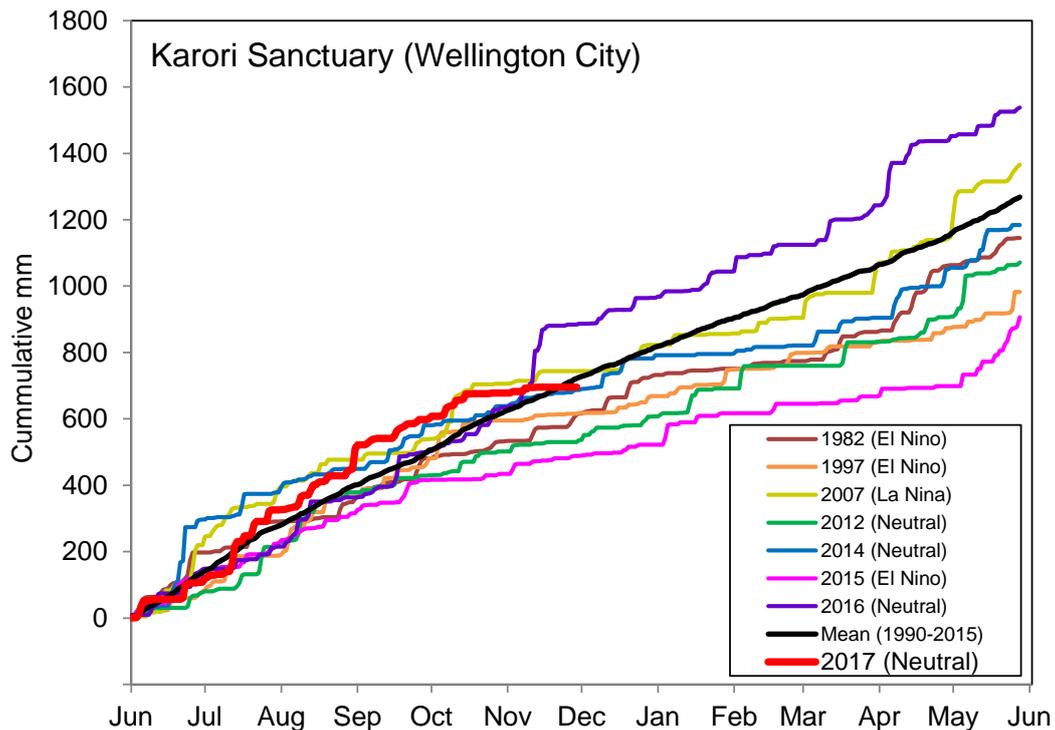
Overall, accumulations for the year starting in June 2017 (labelled 2017 on the plots) have been variable across the region. Kapiti Coast, Hutt Valley and Wellington rainfall accumulations are currently around average after a wet winter.

Rainfall over the Wairarapa is slightly different at all gauge sites but all are tending below average at the end of spring. Tauherenikau, Masterton and Tanawa Hut are currently at the lowest accumulations of all the years plotted.

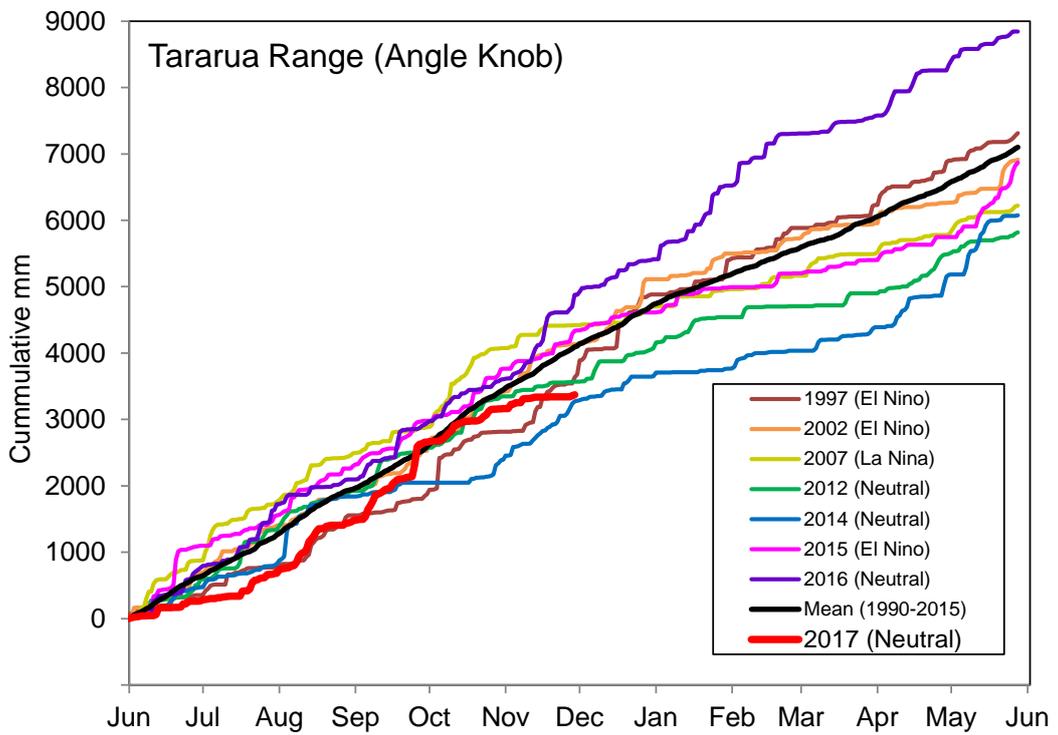
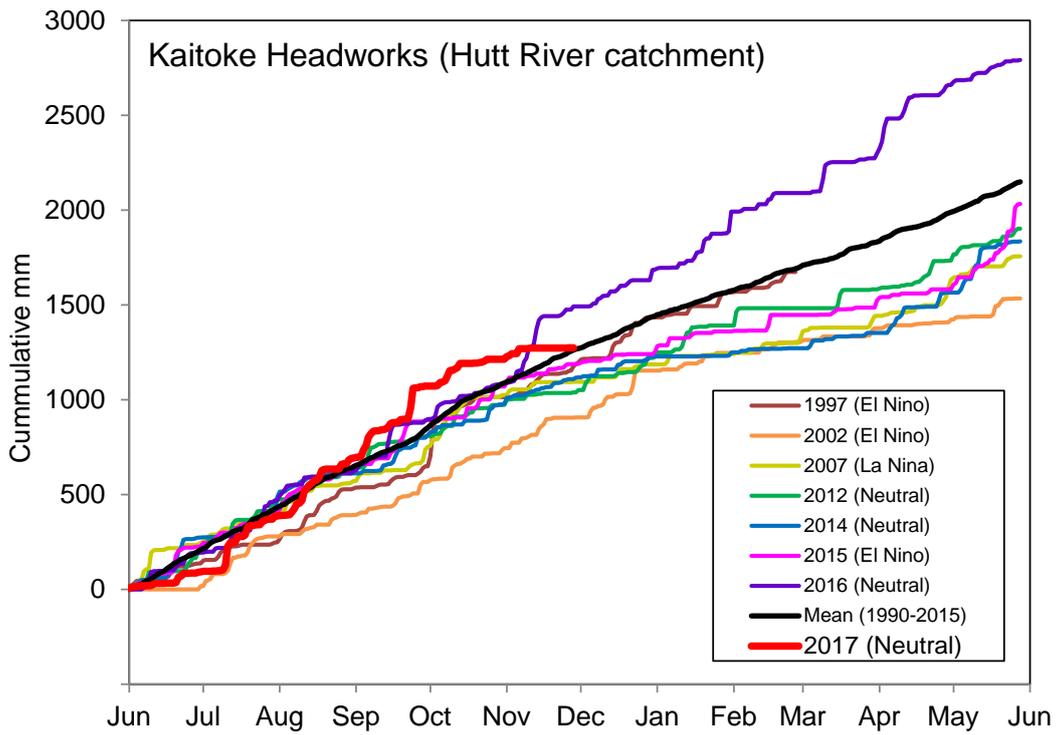
The 14-16 July rain event added 128mm and 163mm respectively to Tanawa Hut and Waikoukou, and without this total both sites would be well below average.



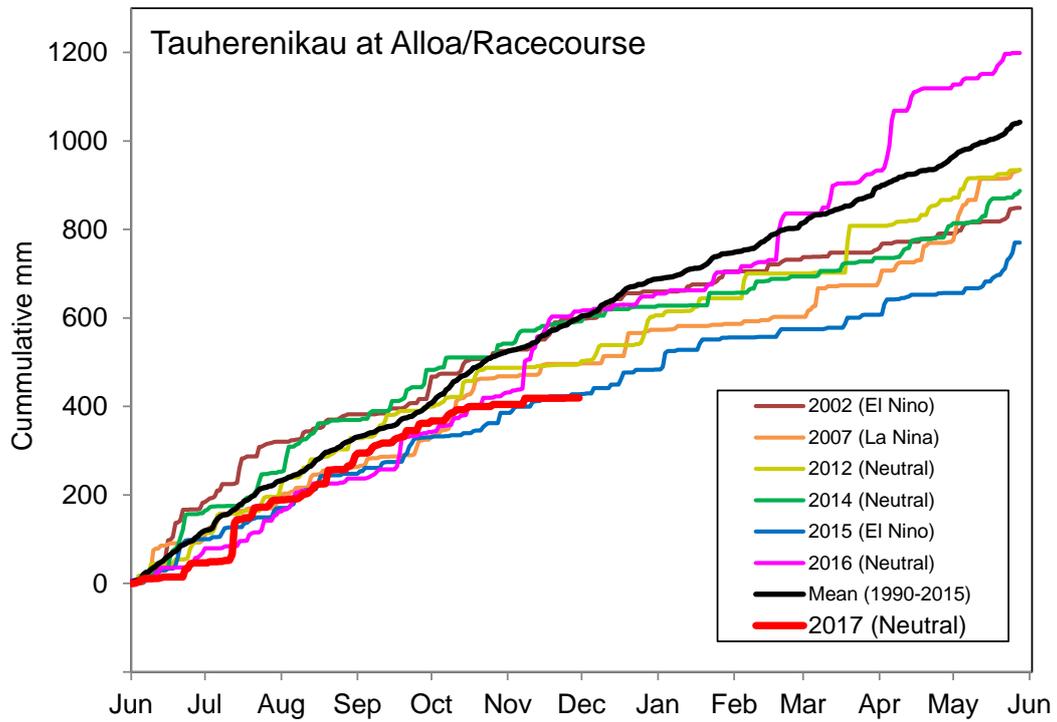
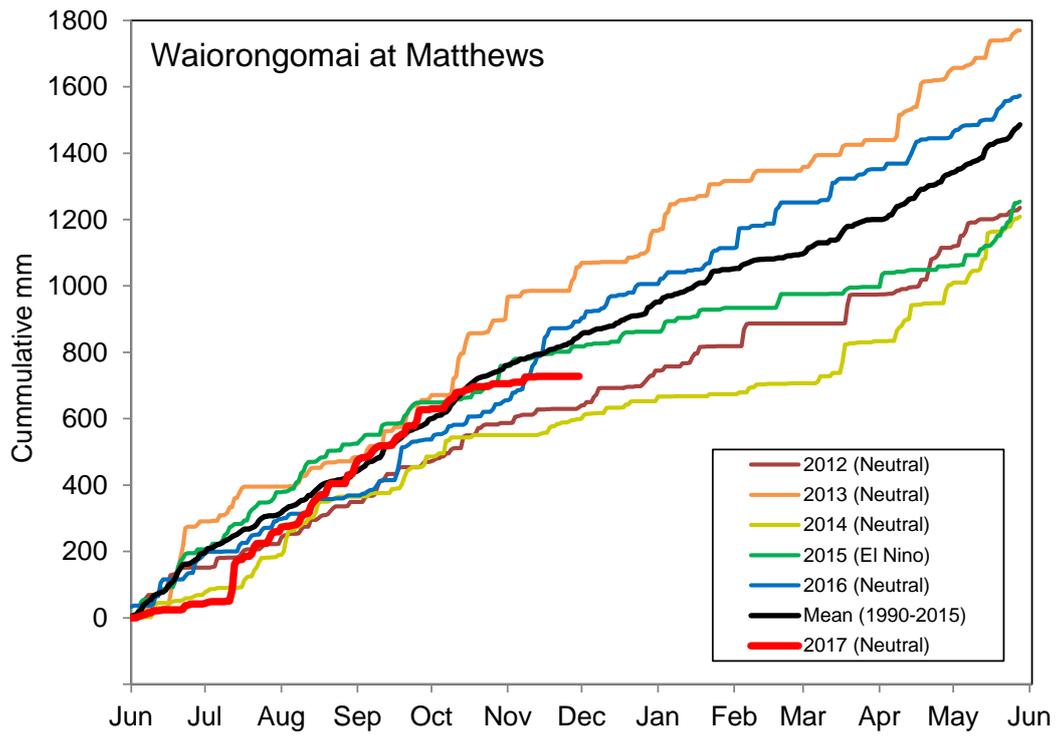
Southwest (Wellington city)

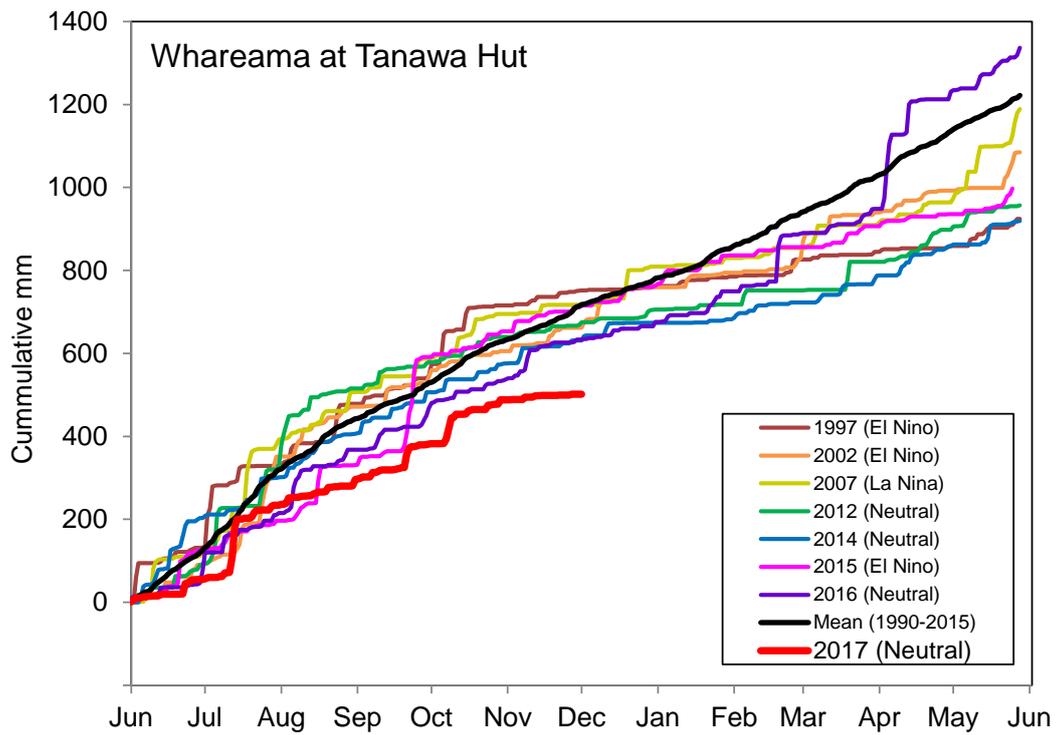
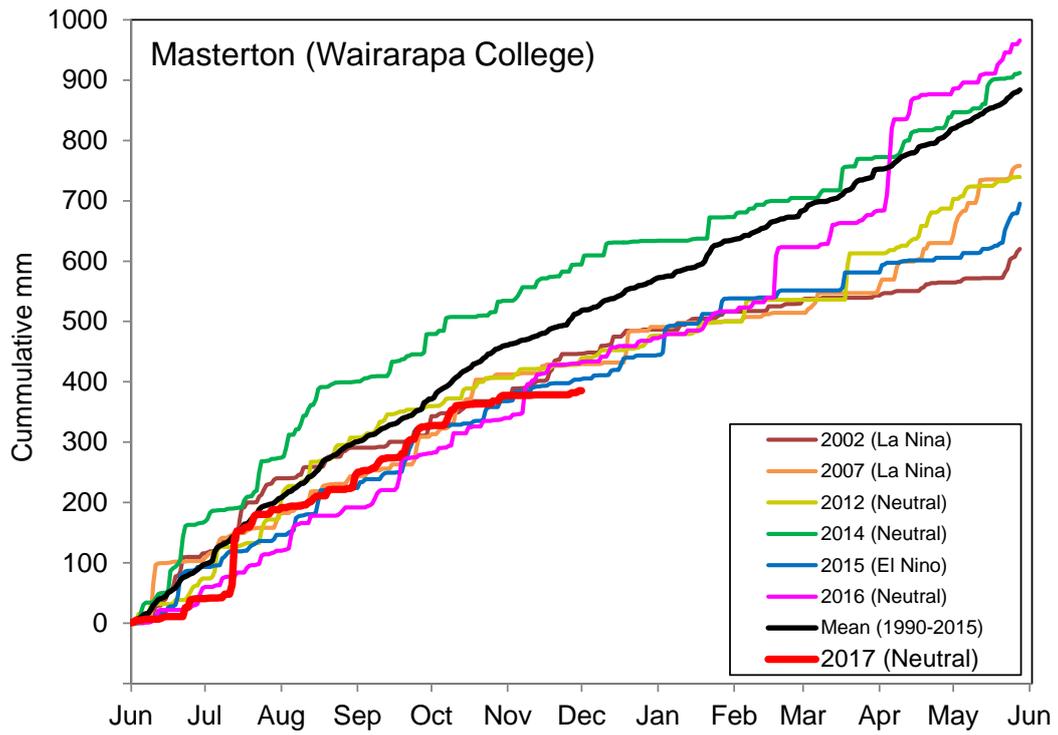


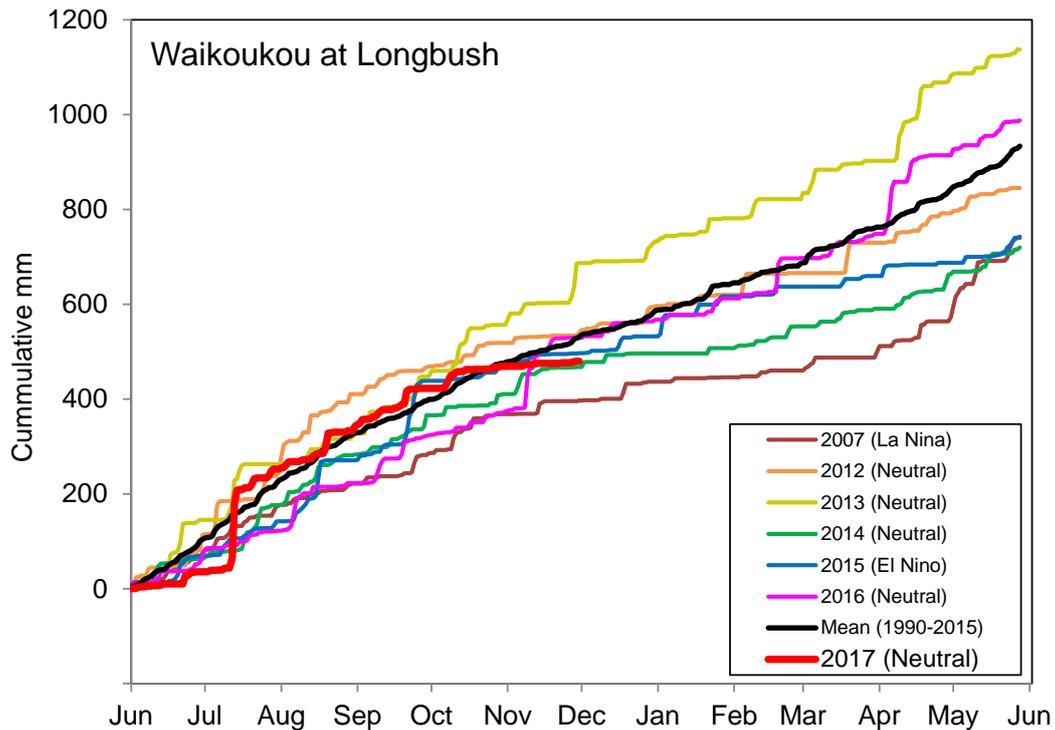
Hutt Valley and Tararua Range



Wairarapa







2.6.2 Soil moisture content (since 1 June 2017)

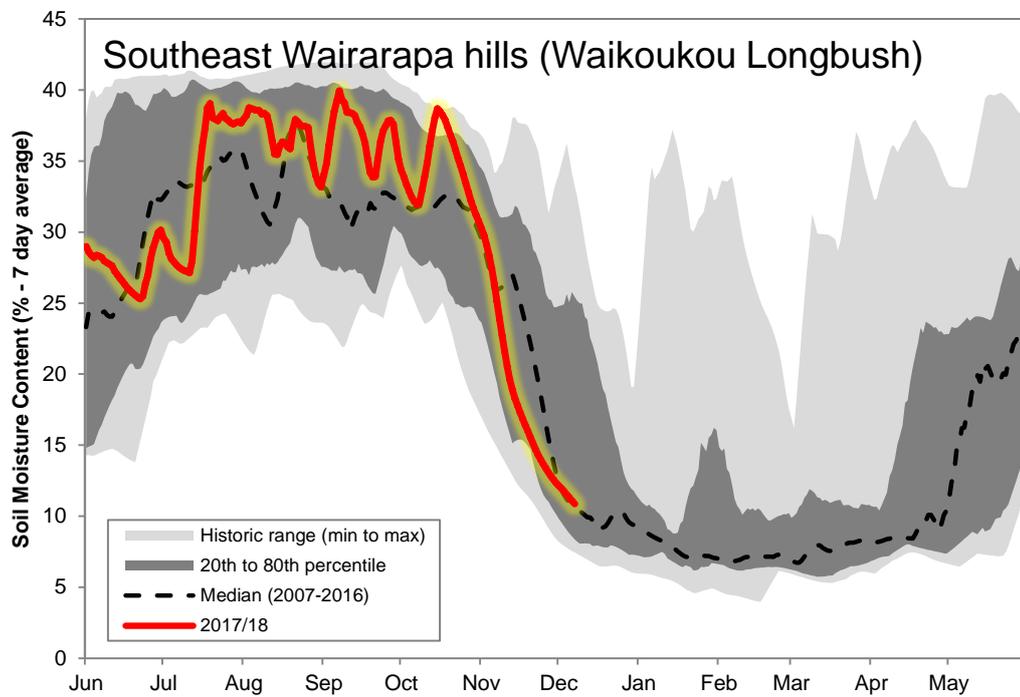
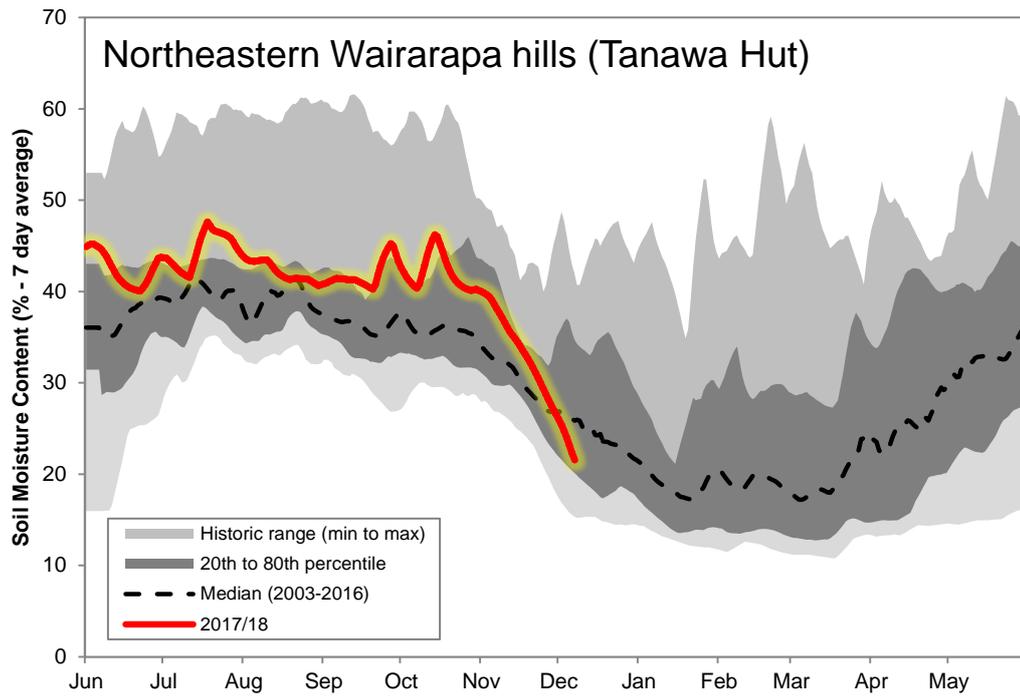
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2017. This is plotted over an envelope of the range of historic recorded soil moisture data (and the median) at the site to provide an indication of how the current soil moisture compares with that for a similar period in past years.

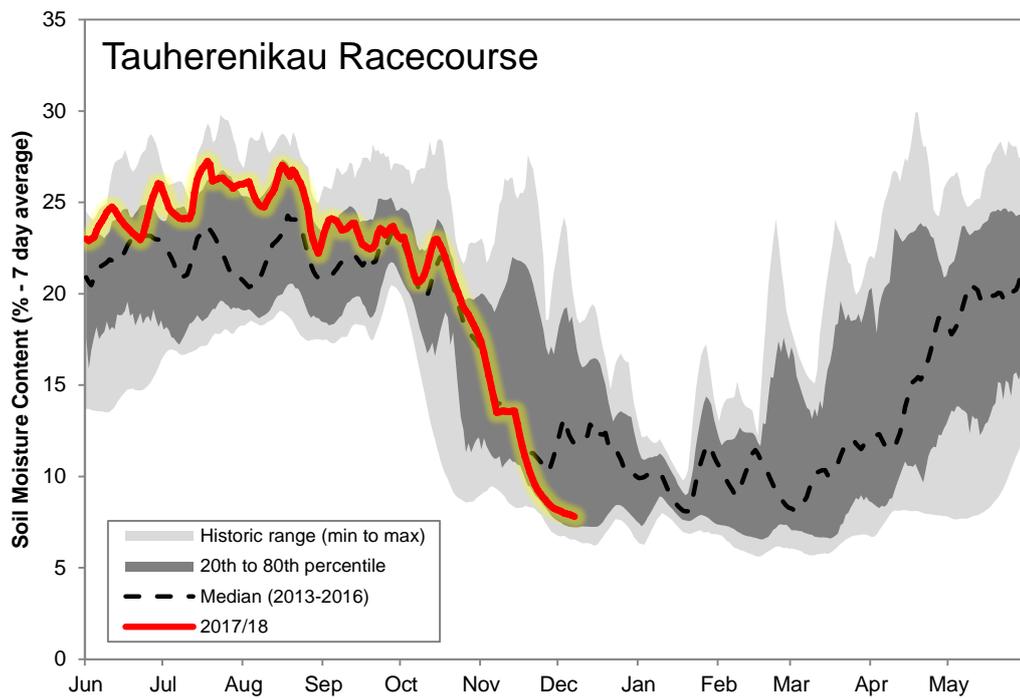
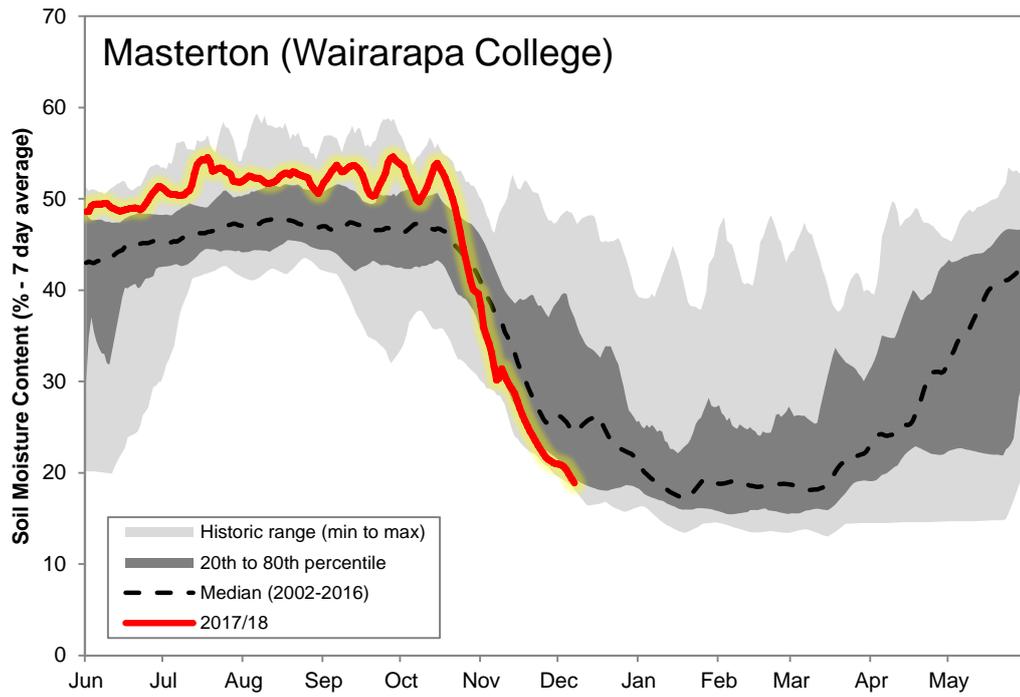
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated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

The soil moisture trend at all sites has been one of relatively high levels over winter and early spring before dropping sharply at the start of November as rainfall fell to well below average levels.

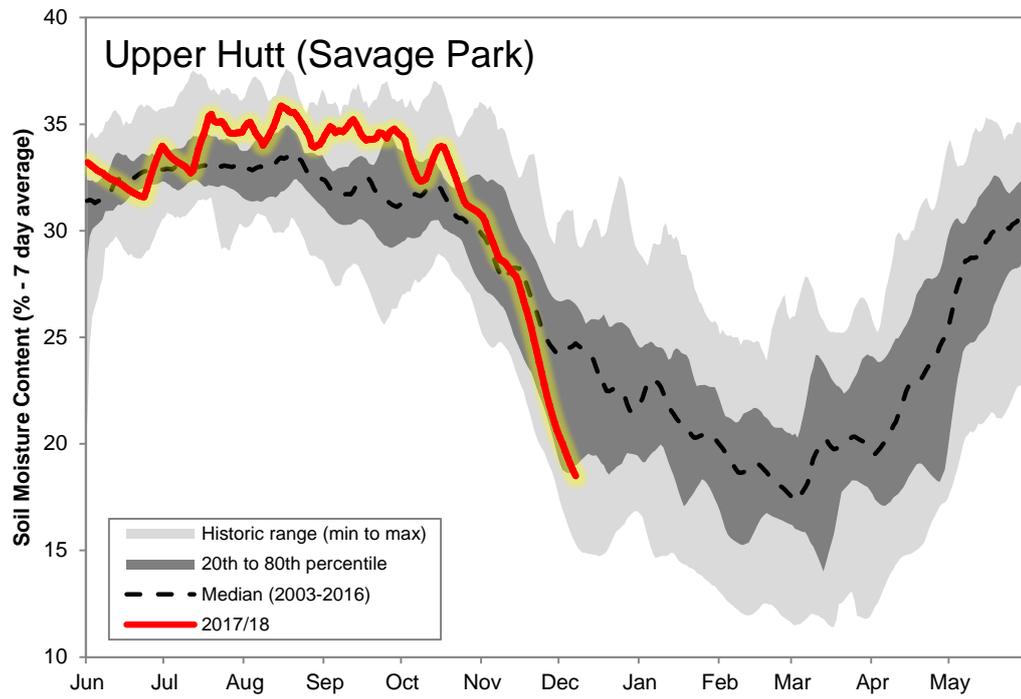
Heading into the start of the summer season regional soil moisture levels are quite low.

(a) Wairarapa





(b) Hutt Valley



3. Outlook for summer 2017/2018

- La Niña summer, with very warm oceanic waters around New Zealand, blocking high pressures and occasional influence of tropical moisture-bearing systems from the north;
- Weaker westerlies, light southerlies and north-easterly episodes;
- Warmer than average with high chance of heat waves;
- Below average rainfall, poor spatial and temporal distribution;
- Isolated thunderstorms and heavy rainfall events from ex-tropical cyclones or tropical depressions are possible and can bring significant accumulations in a short period of time.

Whaitua *	Variables	Climate outlook for summer 2017/2018
Wellington Harbour & Hutt Valley	Temperature: Rainfall:	Above average, increased chance of heat waves Below average.
Te Awarua-o-Porirua	Temperature: Rainfall:	Above average, increased chance of heat waves Below average.
Kapiti Coast	Temperature: Rainfall:	Above average, increased chance of heat waves Below average.
Ruamahanga	Temperature: Rainfall:	Above average, increased chance of heat waves. Average or below, drier in the south. Isolated areas benefiting from thunderstorms and easterly rainfall events typical of La Niña. Climate analogues for the central-eastern area (Longbush): 59 to 92% of the 1981-2010 average, with 75% most likely – see graph below
Wairarapa Coast	Temperature: Rainfall:	Average or above. Average or below, drier in the south. Isolated areas benefiting from thunderstorms and easterly rainfall events typical of La Niña.

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

Statistical rainfall projections for central Wairarapa via climate analogues

This is a new, experimental analysis that gives the likely rainfall range for the coming season based on ‘climate analogues’. In this technique, a long and reliable rainfall time series (ideally 100 years of data) is used as a reference to find how much it rained during years in which the ENSO and oceanic temperatures around New Zealand behaved similarly to what is actually happening in the current year. Below we give details of the ‘analogue’ years used, the area of validity and the previous scores. The analogue years will change from time to time depending on the behaviour of the climate drivers.

Likely DJF rainfall range: 59% to 92% (75% most likely) of the 1981-2010 average (see Figure 3.1). Confidence: LOW (no perfect analogue and climate change signal).

Current analogue years: 1983/1984, 1988/1989, 1998/1999, 2007/2008, 2010/2011. The current analogue years represent La Niña summers.

Area of validity: This projection has been prepared based on long-term rainfall data for Waikoukou (Longbush). The station is strategically located in central-eastern Wairarapa, where rainfall can be regarded as an average of inland conditions (see Figure 2.4 under main body of report). As such, the projected range should be valid for most of the area south of Masterton and eastern of Lake Wairarapa, excluding the coast.

Previous Scores: SON predicted: 65% to 111% (88% most likely), using different analogue years; SON actual observation: 84% of the 1981-2010 average. Hence, the observed conditions for SON **fell within** the predicted range using climate analogues.

Note to users: If you have historical rainfall data measured in your property within the area of validity, you can calculate the most likely (actual) rainfall in mm by directly applying the percentage range to your own long-term average. If you live outside the validity area, you can still calculate the average (or ideally the median) and standard deviation of the observed rainfall during previous years using the climate analogues provided, to determine your own likely range for the current season. This projection is a statistical guidance and assumes that previous years’ rainfall behaviour will more or less repeat, which may not be necessarily true, even less so in light of climate change. Hence, these projections should be used with caution and as general guidance of where the climate might be heading. The forecast should be interpreted together with the text discussed in the whitua tables above. GWRC accepts no responsibility for the accuracy of these forecasts.

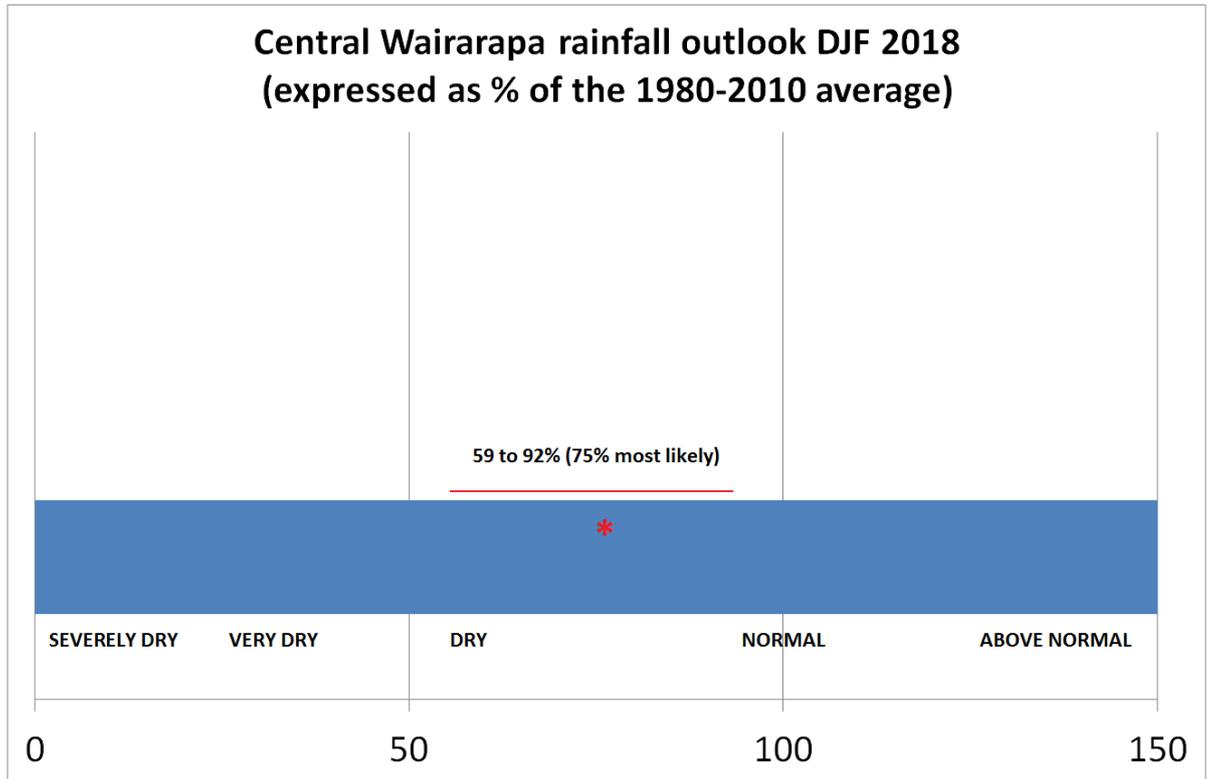


Figure 3.1: Climate analogue statistical rainfall projection using data for Waikoukou, Longbush (see Figure 2.4 for exact location), expressed as percentage range of likely seasonal rainfall compared to the 1981-2010 average. Due to the erratic behaviour of the climate drivers as well as the impacts of climate change there is low confidence in the most likely value for this prediction.

Acknowledgments

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