greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Climate and water resources Seasonal update

Summer 2017/2018 summary
Autumn 2018 outlook

March 2018

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Overview

Summer 2018

The entire country had a truly remarkable summer in 2018. The three monthly average temperature for the seven national climate-representative stations from NIWA was the hottest on record by a large margin for the country, with long-term records being broken virtually in every region. The Wellington Region was hit by drought throughout the Kapiti Coast and Wellington in December. This was followed by significant downpours in January over the Wairarapa and widespread heavy rain in February under the influence of two ex-tropical cyclones and other significant weather events. Many places had over three times the average rainfall in February, with bursts of concentrated heavy falls during short-lived significant events. The most impressive feature of summer was the humidity and lack of wind combined with high temperatures and heavy downpours, creating thermal conditions similar to what would be expected in the tropics. On 11 February Wellington had the highest dew point temperature ever recorded (22.0^{o}C), indicating an unprecedented degree of warmth/humidity, i.e., 'tropical air mass conditions'. Dew points of this magnitude are comparable to what would be expected in Darwin over summer.

Climate drivers

The El Niño - Southern Oscillation (ENSO) phenomenon has been in the La Niña phase. La Niñas are normally associated with slightly drier than average summers in the region, but this year the influence of two ex-tropical cyclones associated with other significant events resulted in a rainfall pattern mostly above average, except in the northern boundary of the region.

The Southern Annular Mode (SAM) has been positive virtually the entire summer, mostly associated with a blocking anticyclone to the east of New Zealand with anomalous northerly flow. This pattern brought significant humid air masses into our region, augmented by increased evaporation arising from very warm sea surface temperatures (SST) around New Zealand. The sea surface temperature in the Tasman Sea has been so warm that the event has been regarded as one of the most severe marine heat waves ever measured in this part of the world.

Climate outlook for summer 2017/2018

La Niña is now declining and the weather anomalies will continue to respond to the warm oceanic waters around New Zealand and the behaviour of the Southern Annular Mode. Most international climate models surveyed are suggesting that temperatures will remain above average, although not as anomalous as during the summer months. As a result of the persistence of warm waters, and a predominantly northerly or easterly flow, above average rainfall is also expected to continue throughout autumn, with a high chance of severe weather events and heavy downpours. This includes additional cases of ex-tropical cyclones, and easterly rainfall events.

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)

Contents

1. Climate drivers

1.1 El Niño – Southern Oscillation (ENSO)

La Niña is now declining, with atmospheric indicators suggesting that the equatorial and subtropical wind belts over the Pacific Ocean are returning to a pattern consistent with neutral ENSO conditions. The very short duration of this event has been unusual, but in New Zealand the anomalies experienced during the recent summer were significantly amplified by the marine heatwave in the Tasman Sea. Most climate models are predicting that ENSO will continue to revert back to the neutral phase during autumn, as shown by the Australian model POAMA below (Figure 1.1).

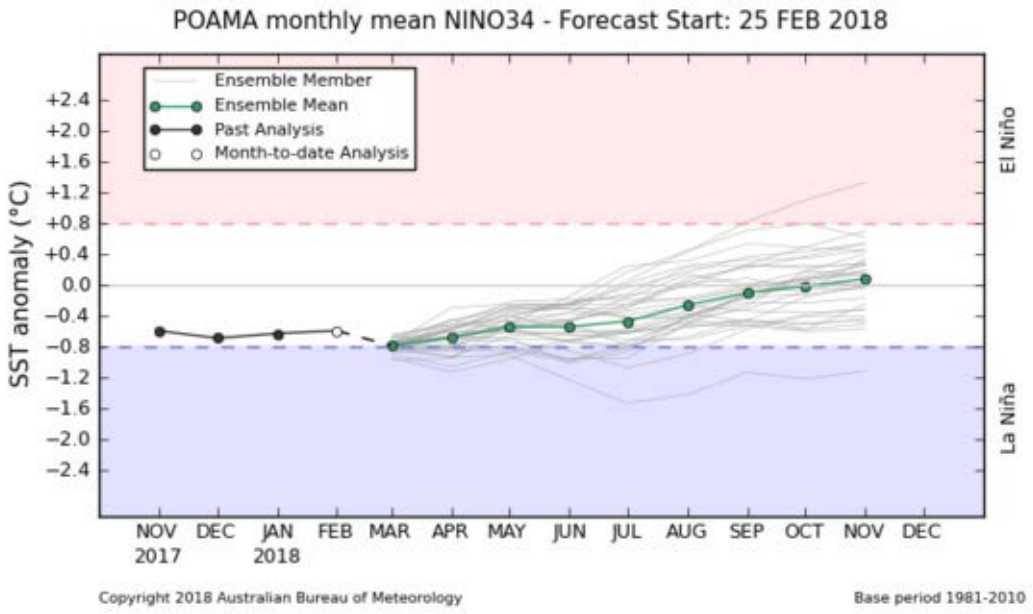


Figure 1.1: ENSO projections (in green) show ENSO is expected to return to the normal range during autumn. Source: Australian Bureau of Meteorology.

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 for 5 March 2018. The pattern shows weakening La Niña in the central Pacific as discussed above, while the waters around New Zealand remain significantly warmer than average.

The persistence of warm waters helps explain a warmer and more humid climate for our region. New Zealand is a relatively small landmass surrounded by water, and so the air and water anomalies tend to go hand in hand. Most climate models suggest that the positive SST anomalies around New Zealand will remain a recurrent feature during autumn.

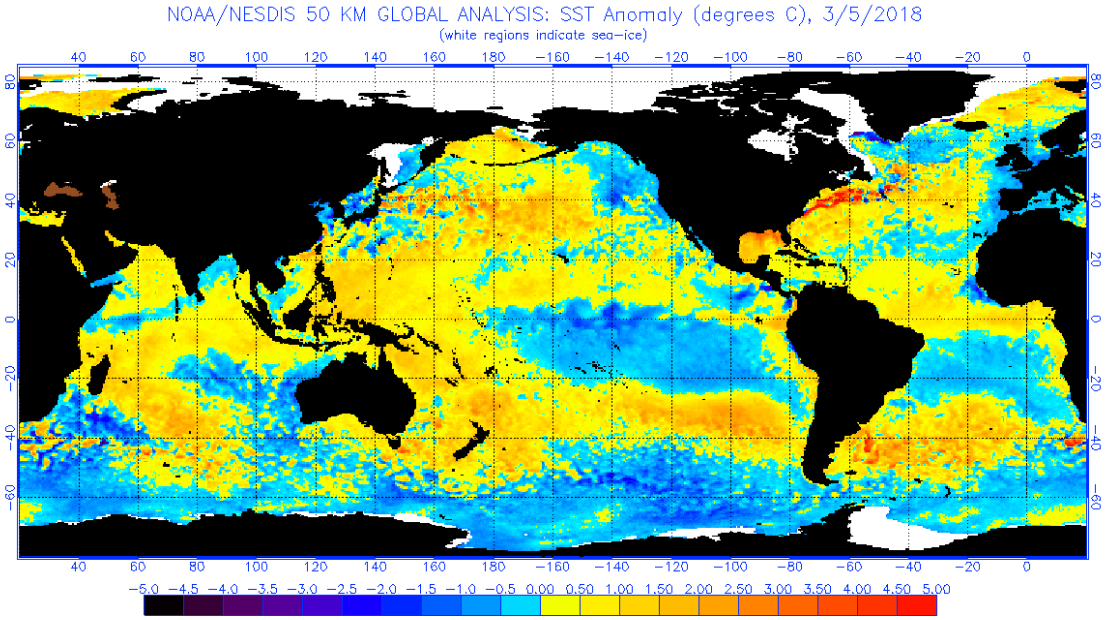


Figure 1.2: Sea surface temperature (SST) anomalies for 4 March 2018. Sea ice coverage is shown in white. La Niña is weakening in the Equatorial Pacific, with much warmer than average SST around New Zealand. The white patches around Antarctica show a much depleted sea ice extent, with near record-low extent for the coverage period during the satellite era (1979 to present). 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 the blocking high that formed during spring moved south-east of New Zealand over summer, establishing a significant north-easterly flow enhanced by the low pressure area to the northwest of the country. This pattern was accompanied by low pressures around Antarctica, associated with a persistent positive SAM.

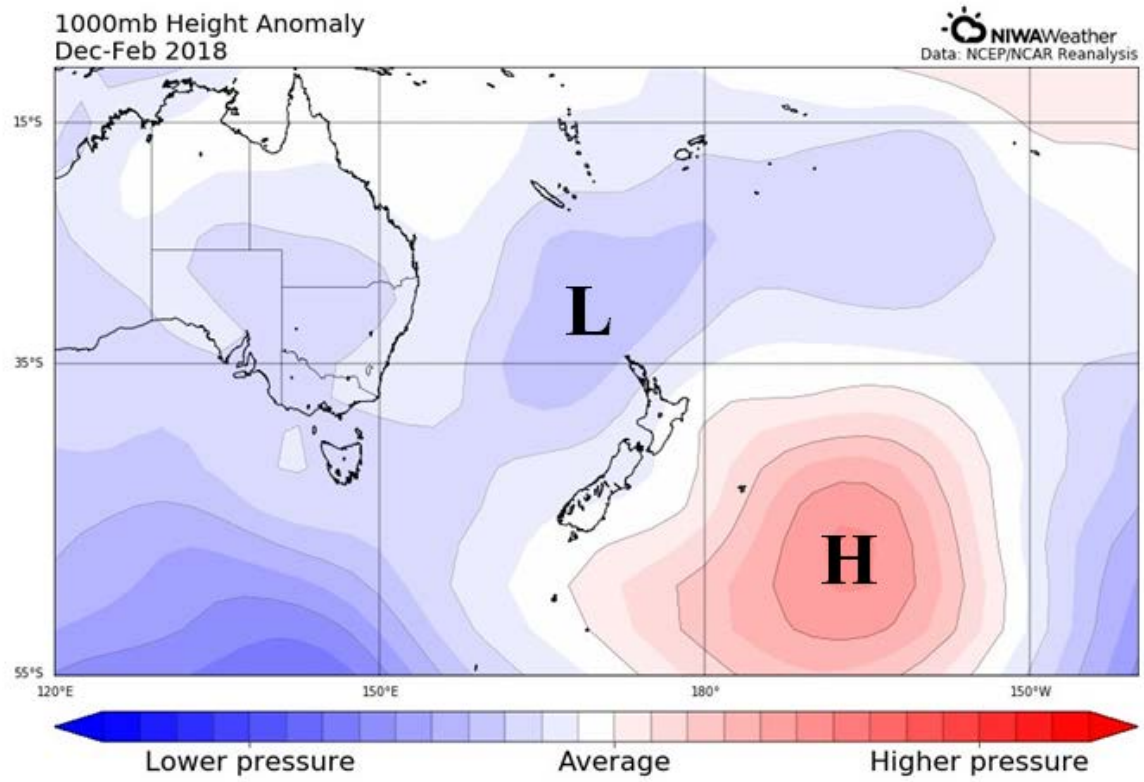


Figure 1.3: 1000 hPa height anomaly (equivalent to sea level pressure anomaly) for Dec-Feb 2018. The 'H' indicates the area of blocking high pressure south-east of New Zealand that led to a record warm summer, in tandem with the lower pressures (L) to the northwest of New Zealand. Source: NCEP Reanalysis, map courtesy of NIWA.

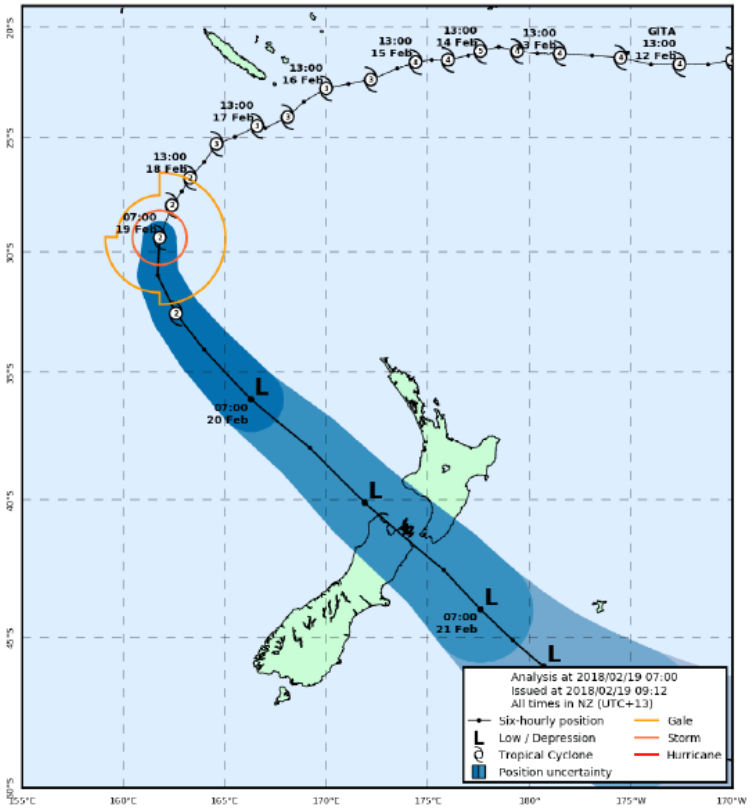
1.4 Tropical Cyclone activity

As a result of the above average water temperatures in the western Pacific, and as expected for a La Niña year, tropical cyclone activity was enhanced for the Pacific Islands. A couple of cyclones had a direct trajectory towards New Zealand in February.

The second one in particular, TC Gita, posed a serious threat to make landfall directly on the Kapiti Coast. While this didn't eventuate and the cyclone ended tracking towards the South Island, the Kapiti Coast was significantly impacted by coastal inundation as a result of high tides amplified by the tail of the storm a day after it first hit.

The cyclone also caused significant damage over the South Island, and contributed towards the impressive rainfall totals observed in February.

The forecast track during the final approach, and a hand drawn synoptic map of TC Gita, are seen in the figure below.



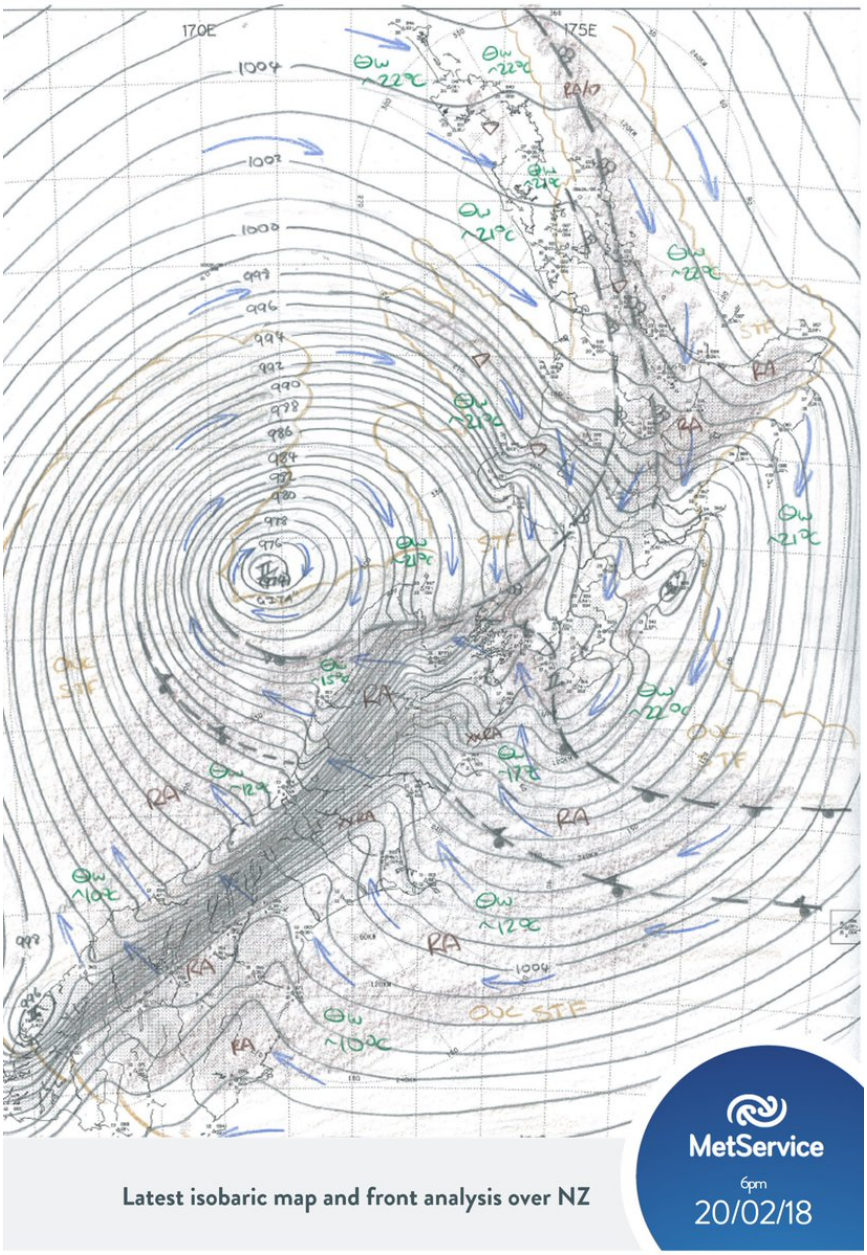


Figure 1.4: TC Gita's forecast trajectory towards New Zealand, and hand drawn synoptic chart for 20 February at 6pm local time, with the cyclone making a final approach towards the South Island with a central pressure of 974 hpa. Source: MetService.

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 much higher than average temperatures occurred around the entire region for both the maximum and minimum. Virtually everywhere the mean temperatures were either the hottest on record or close to being the hottest on record, including very long-term records such as for Masterton, which had the hottest on record summer for measurements starting in 1906. Wellington (Kelburn) had an impressive total of 17 hot days over summer (when the maximum temperature is greater than 25^{o}C), compared to the normal of only two.

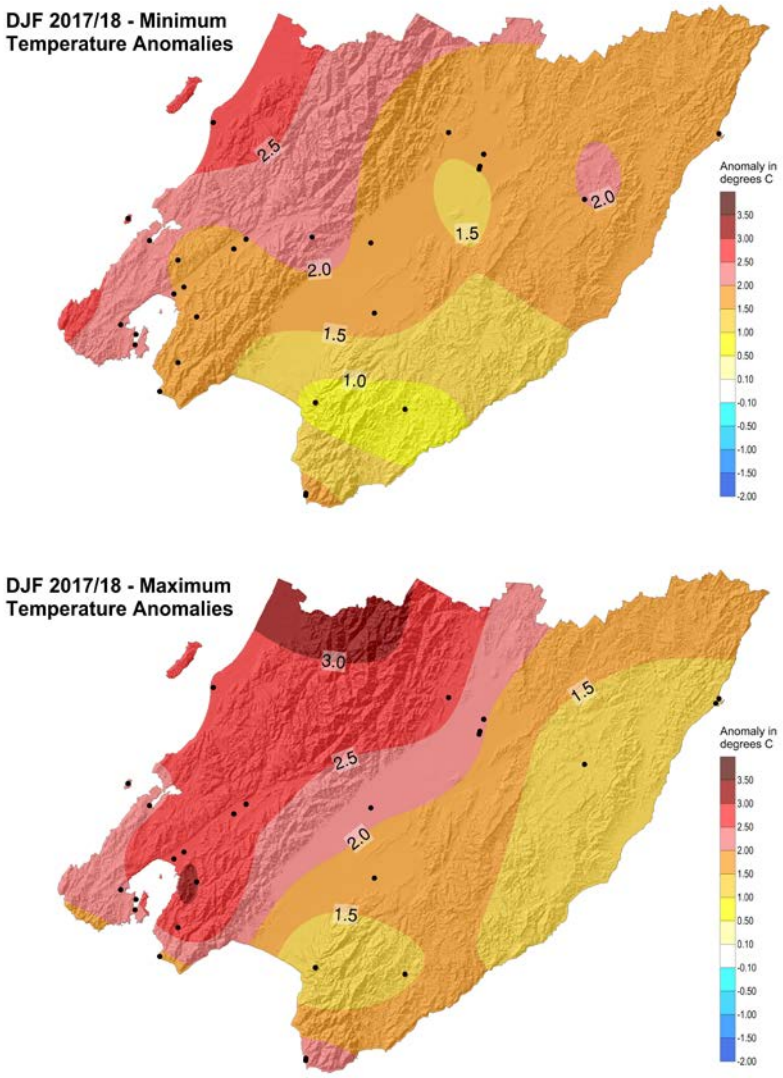


Figure 2.1: Daily Average Min and Max temperature anomalies for DJF 2018. All anomalies calculated against the 1981-2010 reference period. Source: GWRC, using station data from the GWRC, NIWA, MetService and NZ Rural Fire Authority networks.

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 weaker than normal wind speeds, in connection with the blocking anticyclone east of New Zealand that greatly reduced the normal flow of the westerly winds.

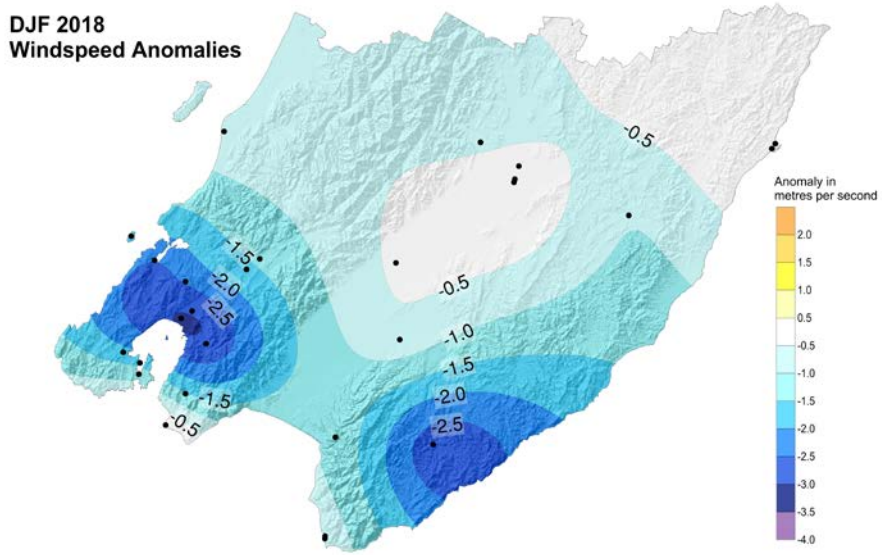


Figure 2.2: Daily mean wind anomalies (in m/s) for DJF 2018. All anomalies calculated against the 1981-2010 reference period. Source: GWRC, using station data from the GWRC, NIWA, MetService and NZ Rural Fire Authority networks.

2.3 Regional soil moisture

Figure 2.3 shows the 30 day soil moisture anomaly map for the region as at the beginning of autumn. Most of the region shows around or above normal soil moisture levels – a complete recovery from the drought conditions observed at the beginning of summer.

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)

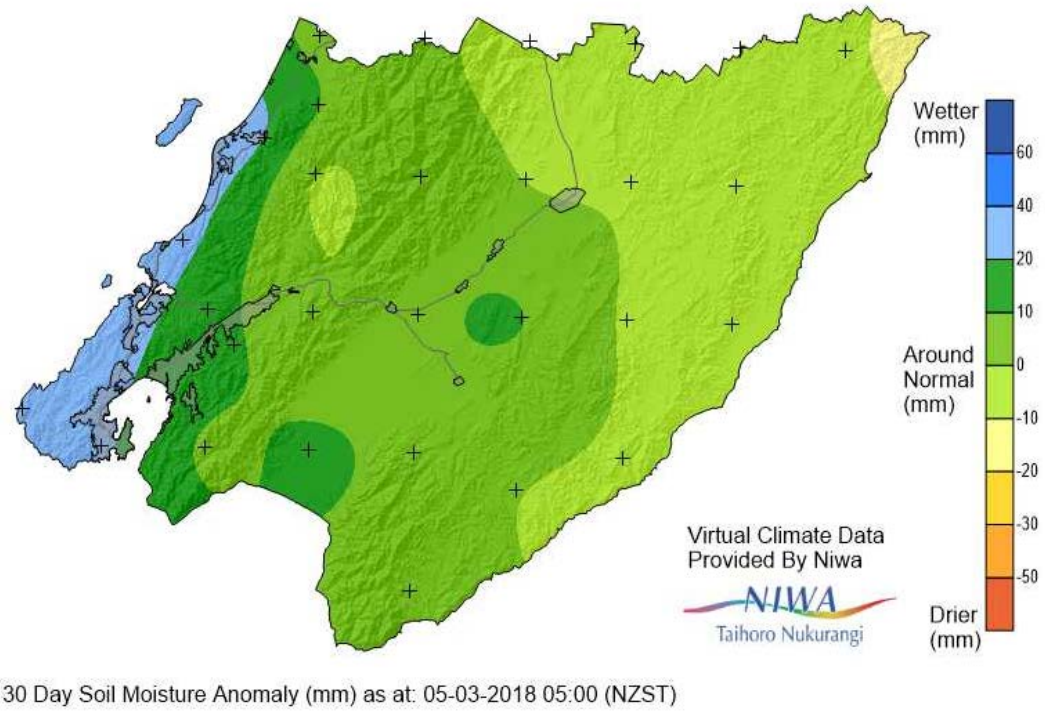
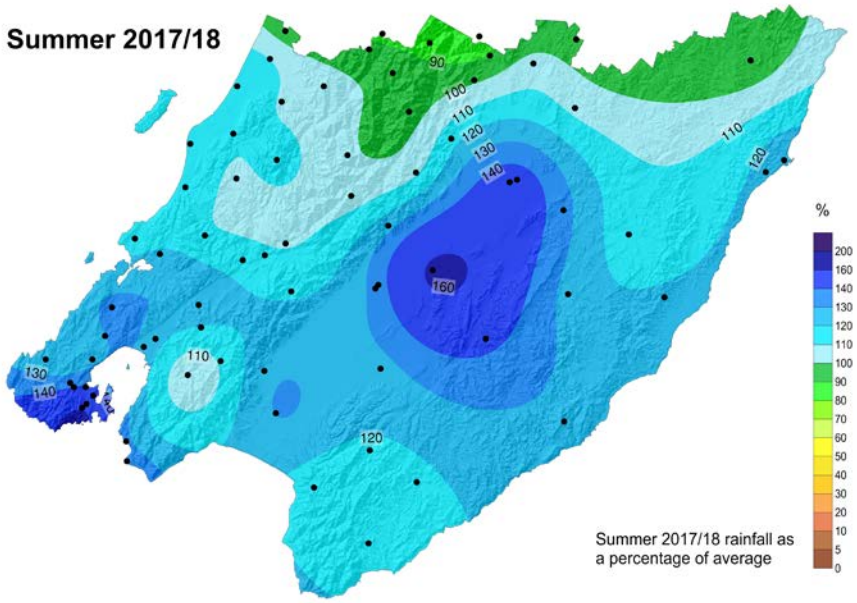


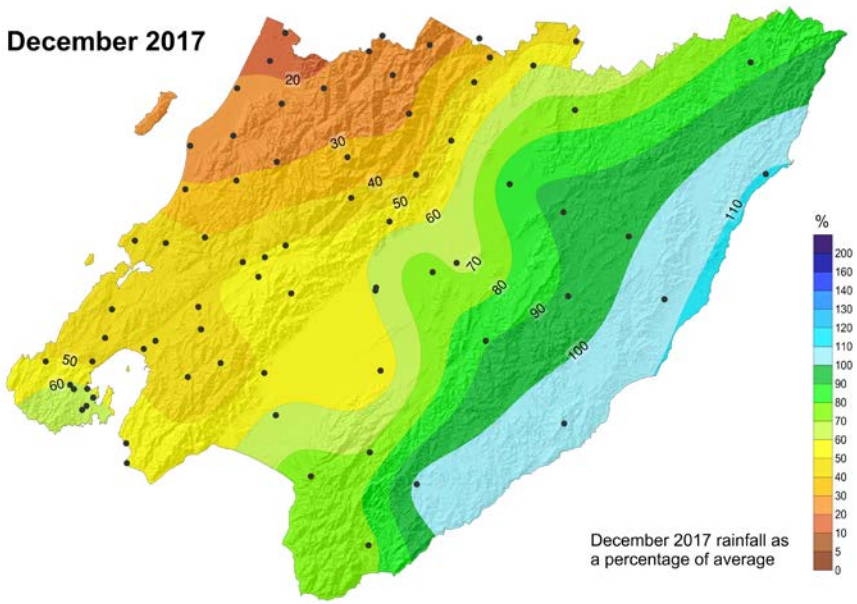
Figure 2.3: Thirty day Soil Moisture Anomaly ending 5 March 2018. Moisture levels show normal or above normal conditions for most of the region. Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. Note that this data is indirectly calculated by modelling 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 summer (and month by month) rainfall expressed as a percentage of the long-term average. We can see that although summer as a whole was wetter than average, December was extremely dry. January was wet in the Wairarapa and February was extremely wet almost everywhere except the north-eastern corner of the region.

The high rainfall in January was predominantly caused by thunderstorms and easterly weather events, while the February rainfall was significantly boosted by two tropical cyclones occurring at the beginning and towards the second half of the month.





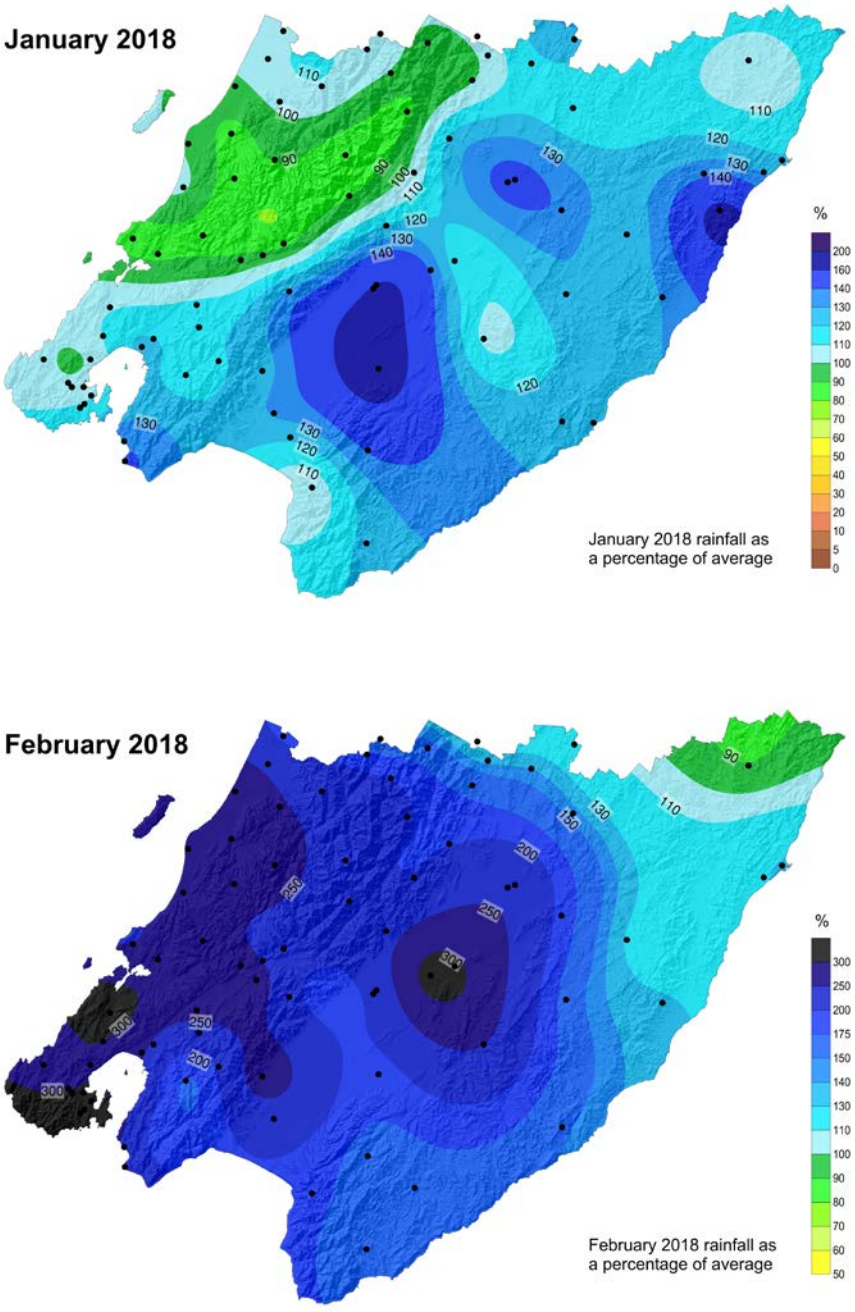


Figure 2.4: Rainfall for summer 2018 (upper panel) and accumulated month by month as a percentage of the long-term average. Rainfall was severely below average in December and above average in January and February, with near record accumulation in February due to the influence of ex tropical cyclones. Source: GWRC and NIWA.

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 in the graphs below are: mean temperature, number of hot days (summer only), mean wind, total number of sunshine hours, total rainfall and total number of rain days.

The climate change and variability summary for summer is:

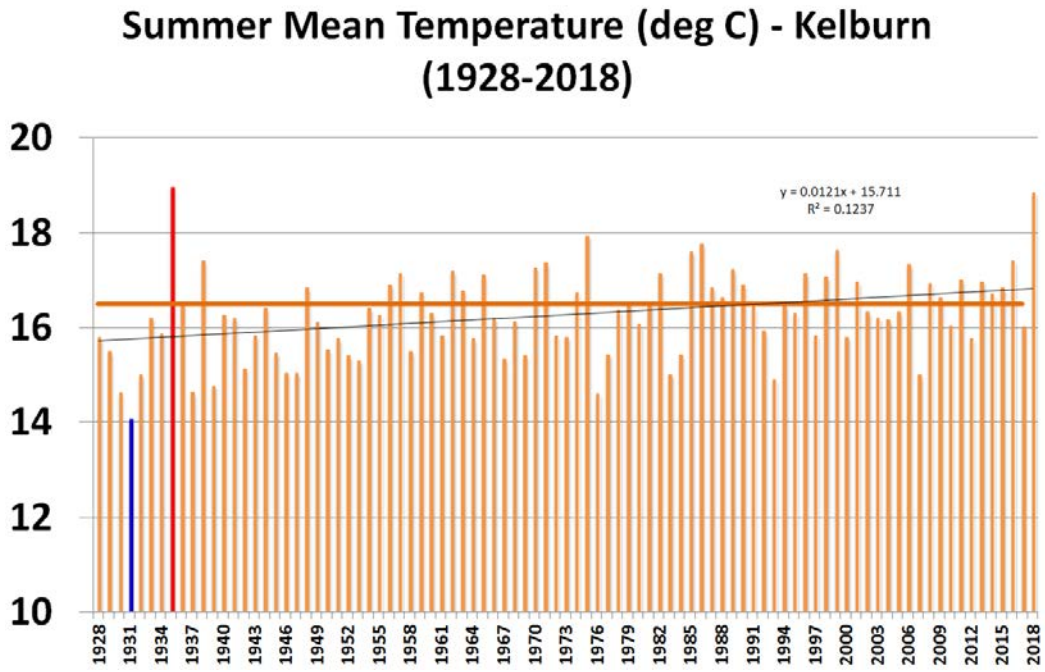
- There is a significant warming trend of about 1.2^{o}C per century in Kelburn for the period 1928-2018;

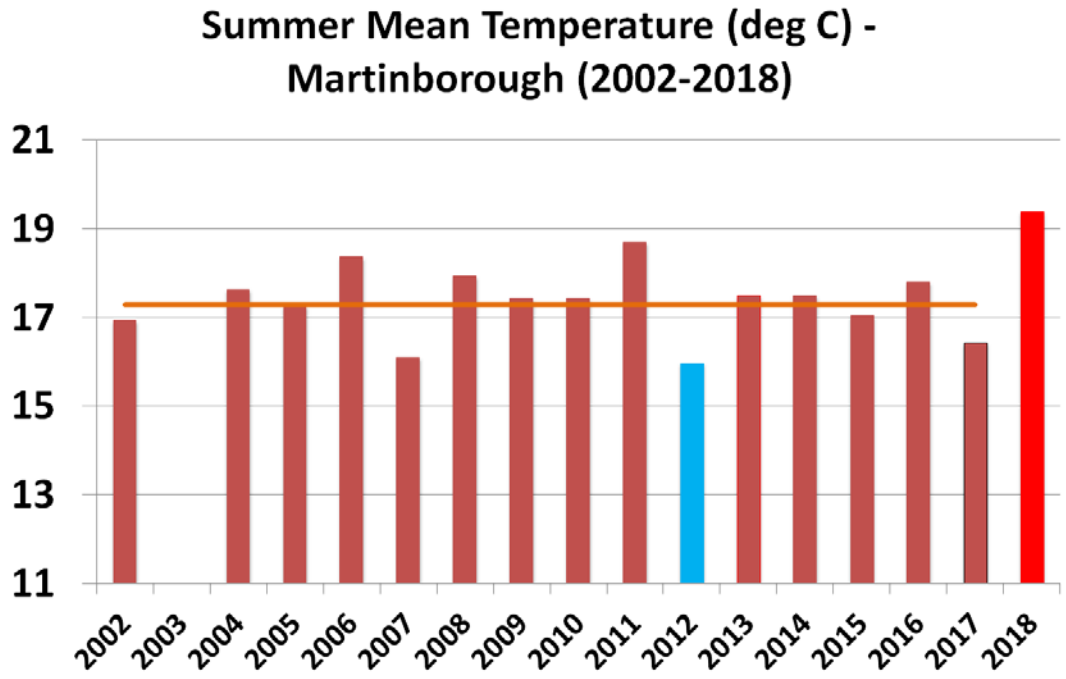
- Summer 2018 was the second hottest on record for Kelburn (since 1928) and the hottest on record for Martinborough (only data since 2002 available). For Masterton it was also the hottest summer on record for over a century of measurements starting from 1906 (not shown);

- The number of hot days for summer in Kelburn was the second highest on record, losing only to 1935. In Masterton the number of hot days was second equal highest for the shorter available period (1993-2018), with a strong positive trend of about a day increase per year;

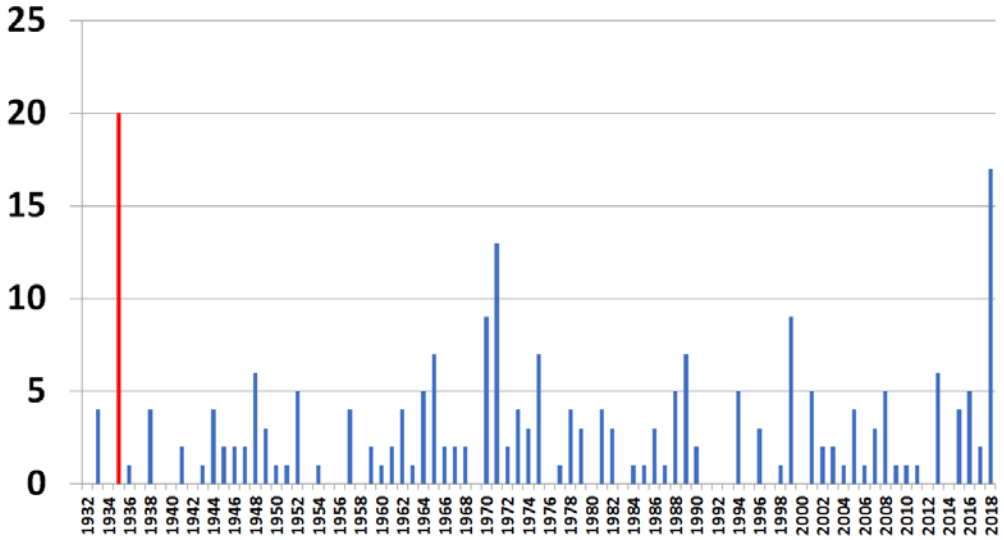
- Wind was slightly below average for Wellington airport. There has been a decreasing trend over the 1961-2018 period;

- Sunshine hours were near normal, rainfall was above normal, and rain days were normal to above for both Wellington and Wairarapa

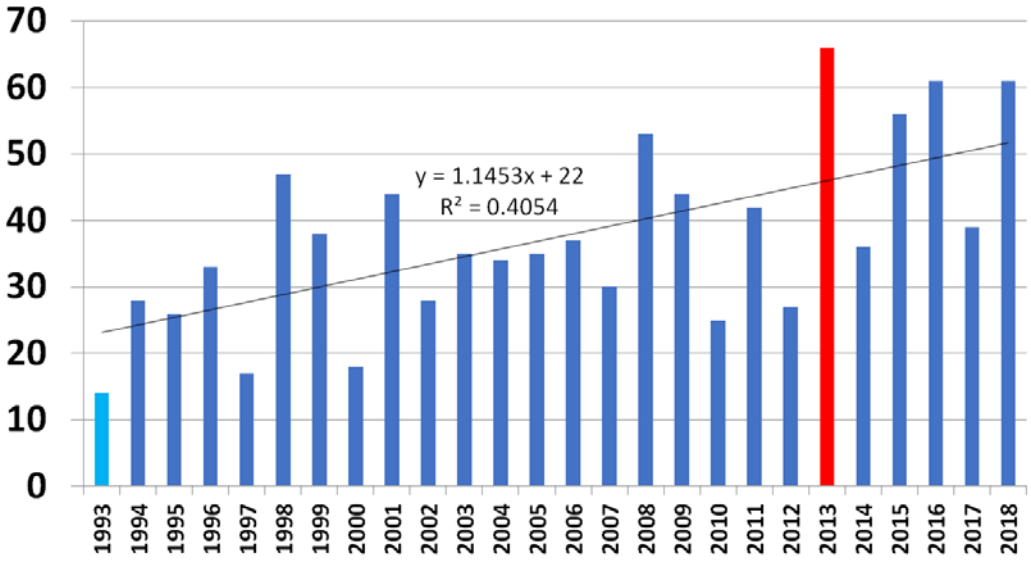

Summer Mean Temperature (deg C) - Kelburn (1928-2018)
y = 0.0121x + 15.711
R² = 0.1237
20
18
16
14
12
10
1928
1931
1934
1937
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018

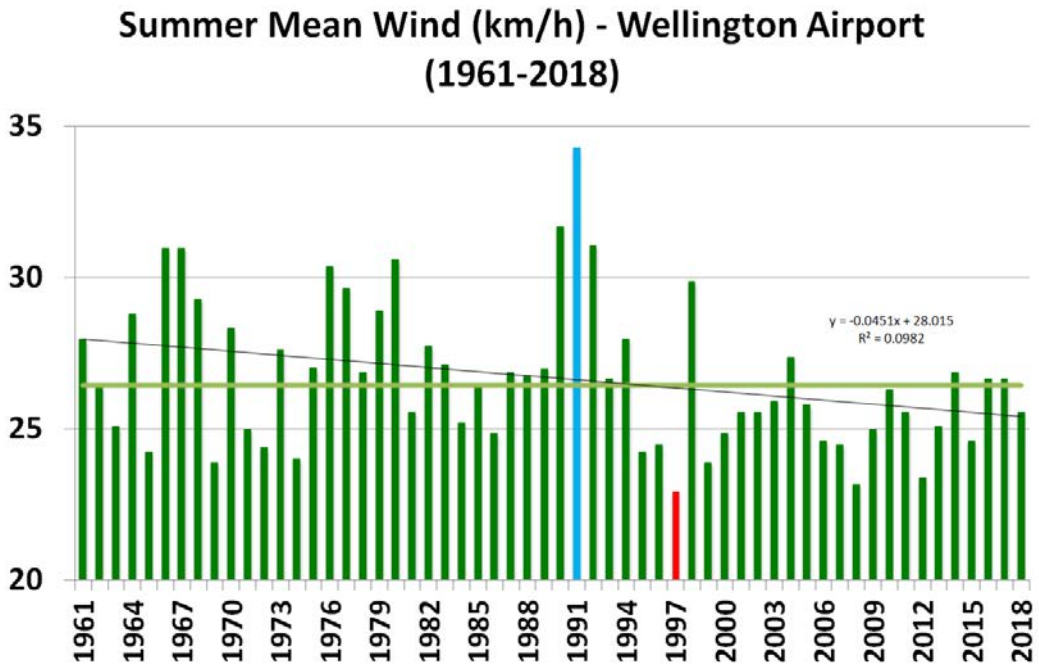

Summer Mean Temperature (deg C) - Martinborough (2002-2018)
21
19
17
15
13
11
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

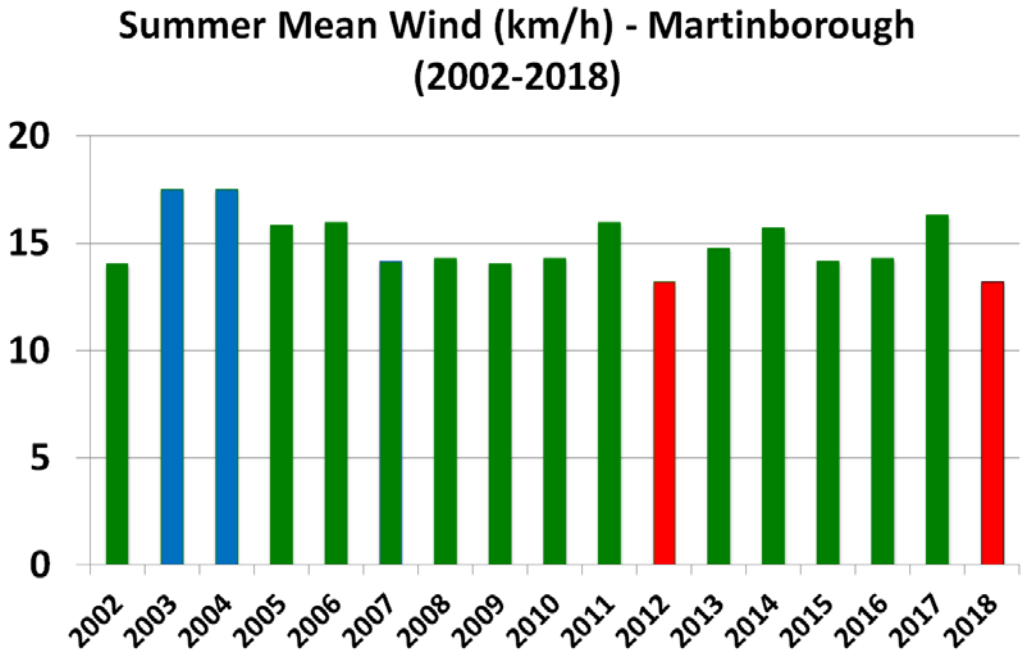
Summer number of days above 25C - Kelburn (1932-2018)

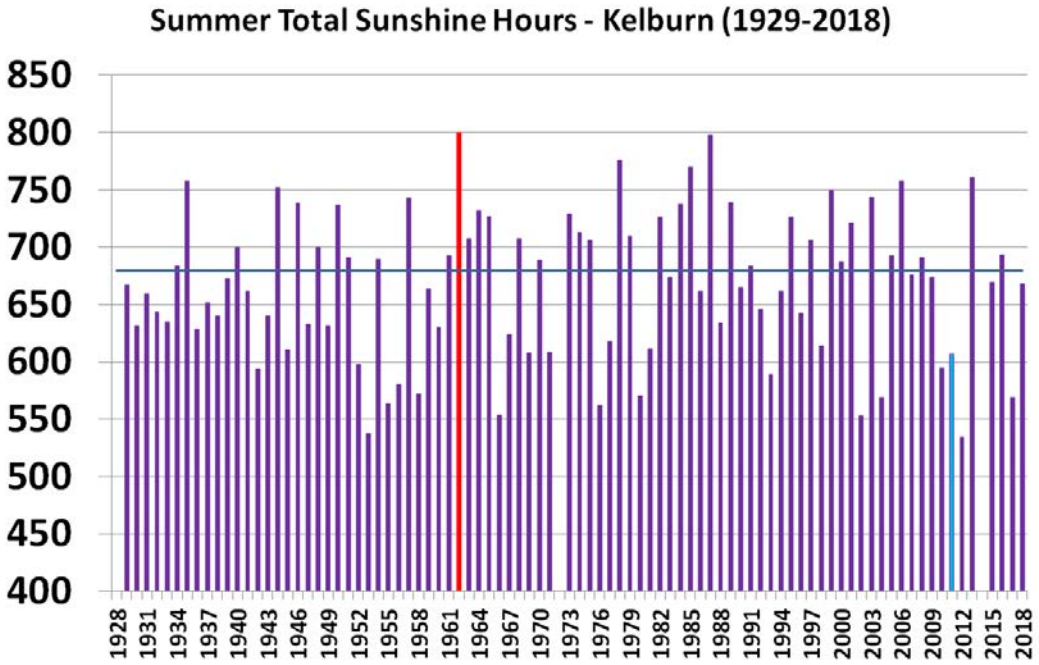


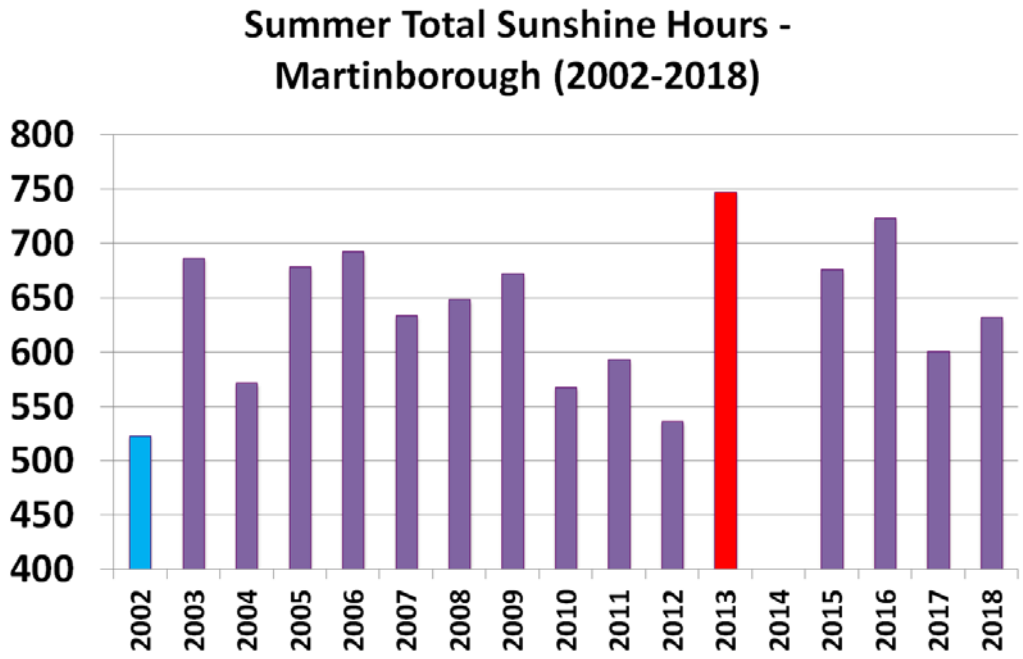
Summer number of days above 25C - Masterton (1993 - 2018)

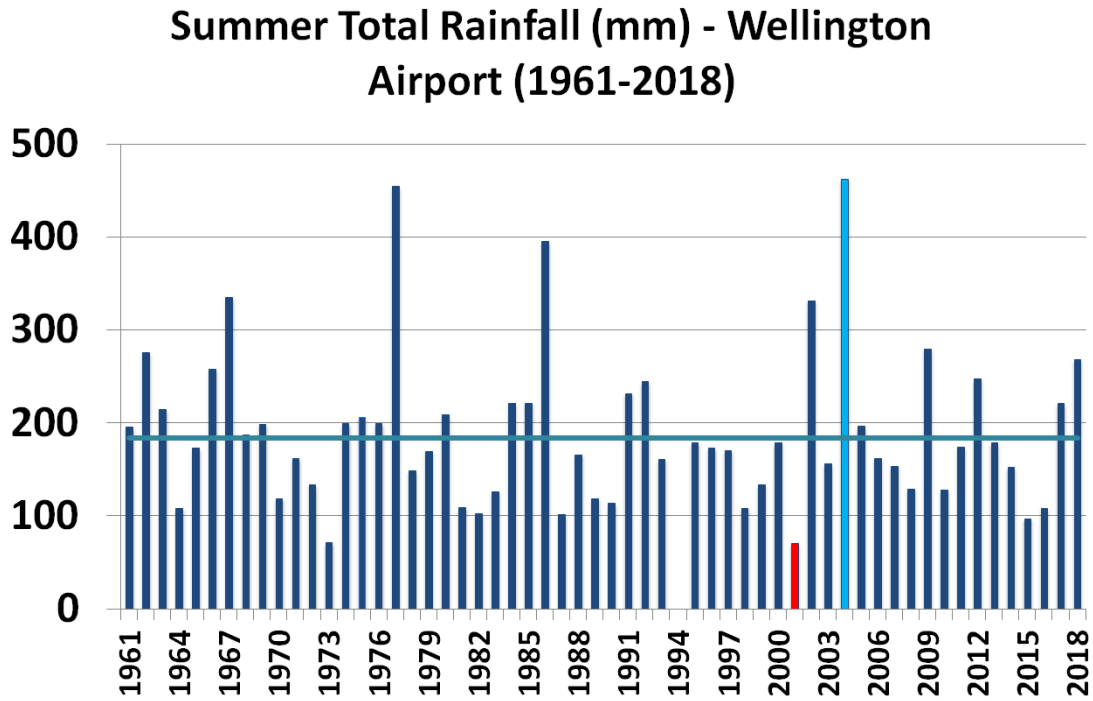


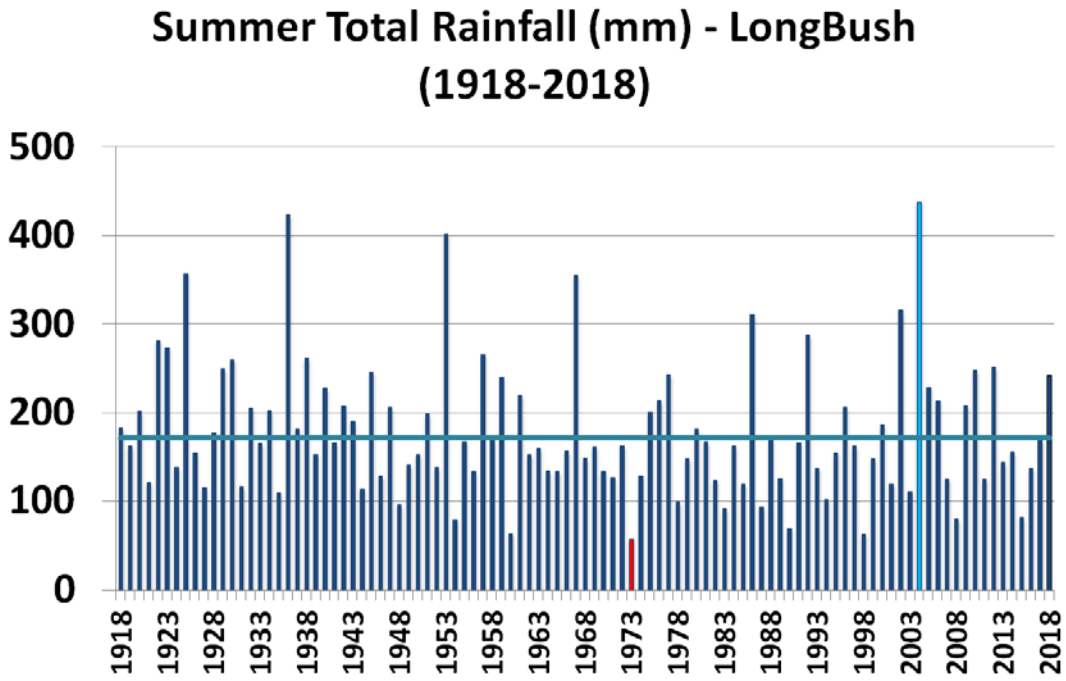

Summer Mean Wind (km/h) - Wellington Airport
(1961-2018)
35
30
25
20
y = -0.0451x + 28.015
R² = 0.0982
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018


Summer Mean Wind (km/h) - Martinborough
(2002-2018)
20
15
10
5
0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


Summer Total Sunshine Hours - Kelburn (1929-2018)
850
800
750
700
650
600
550
500
450
400
1928
1931
1934
1937
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018


Summer Total Sunshine Hours - Martinborough (2002-2018)
800
750
700
650
600
550
500
450
400
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


Summer Total Rainfall (mm) - Wellington Airport (1961-2018)
500
400
300
200
100
0
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018


Summer Total Rainfall (mm) - LongBush (1918-2018)
500
400
300
200
100
0
1918
1923
1928
1933
1938
1943
1948
1953
1958
1963
1968
1973
1978
1983
1988
1993
1998
2003
2008
2013
2018

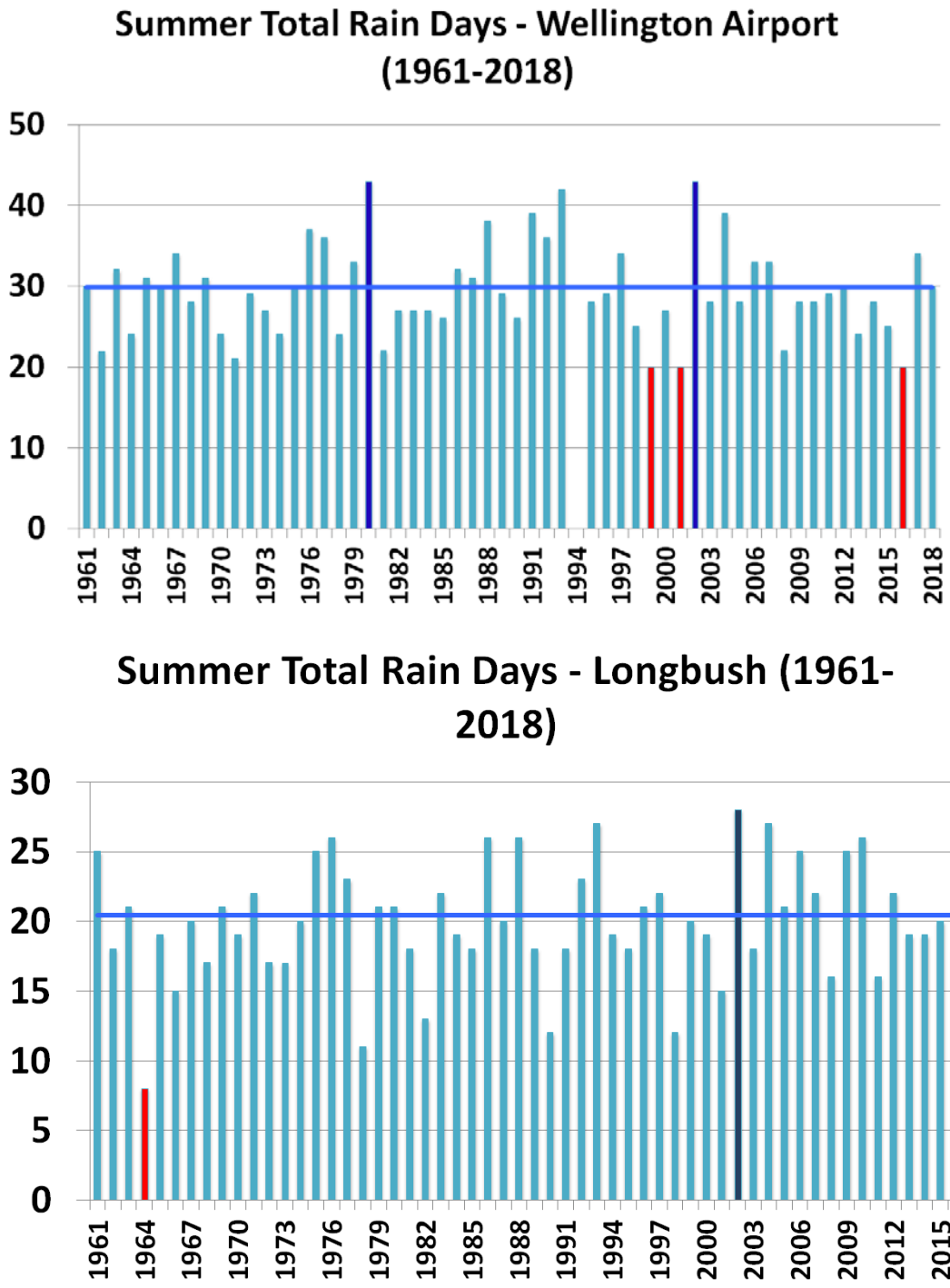


Figure 2.5: Climate change and variability graphs for summer in Wellington and the Wairarapa. The straight line shows the 1981-2010 average (when available). For all graphs, the bright red and blue bars show the extreme min and max values for each time series (red for warm, dry, sunny and calm and blue for cool, wet, cloudy and windy) Long-term trends are plotted only when statistically significant. The key variables shown are: mean temperature, number of hot days (summer only), mean wind, total number of sunshine hours, total rainfall and total number of rain days. Missing 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.

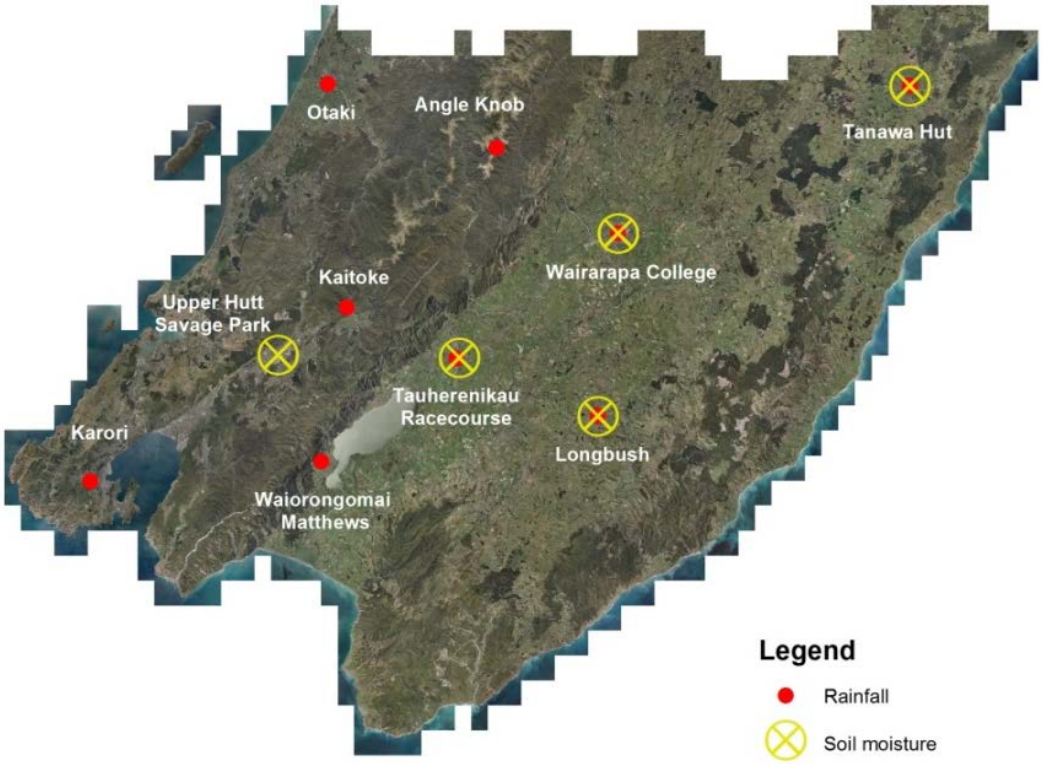


Figure 2.6: Map of GWRC rainfall and soil moisture monitoring locations

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

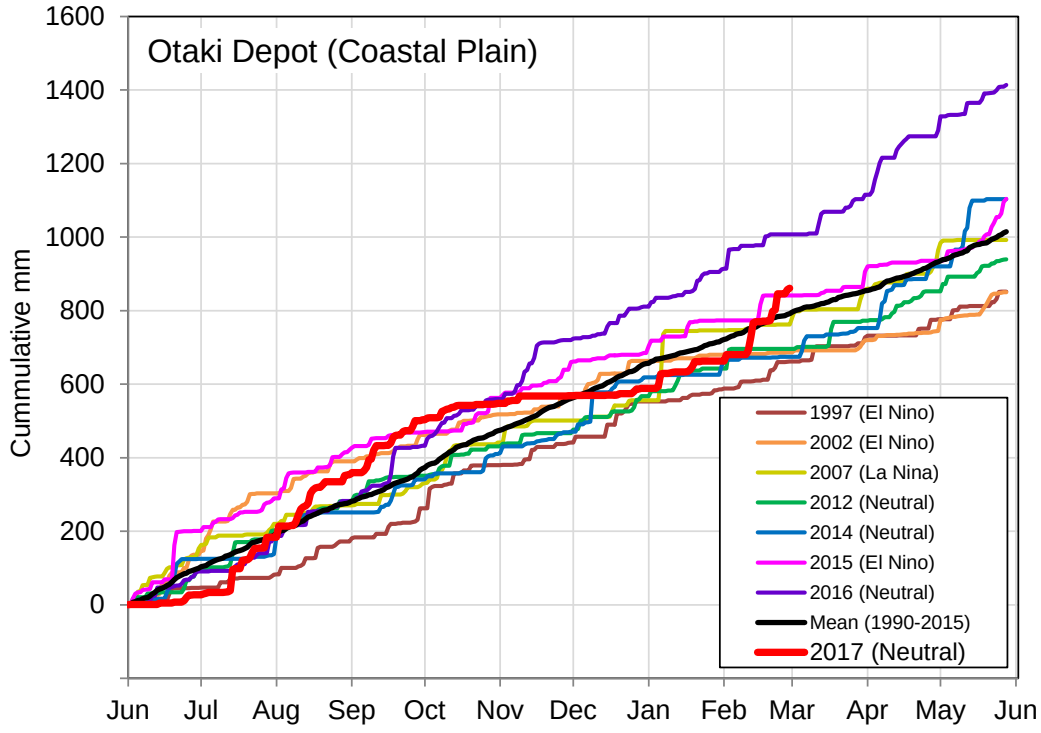
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year at several locations. For comparative purposes, cumulative plots for selected historic years with notably dry summers have been included as well as the site average.

Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa (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.

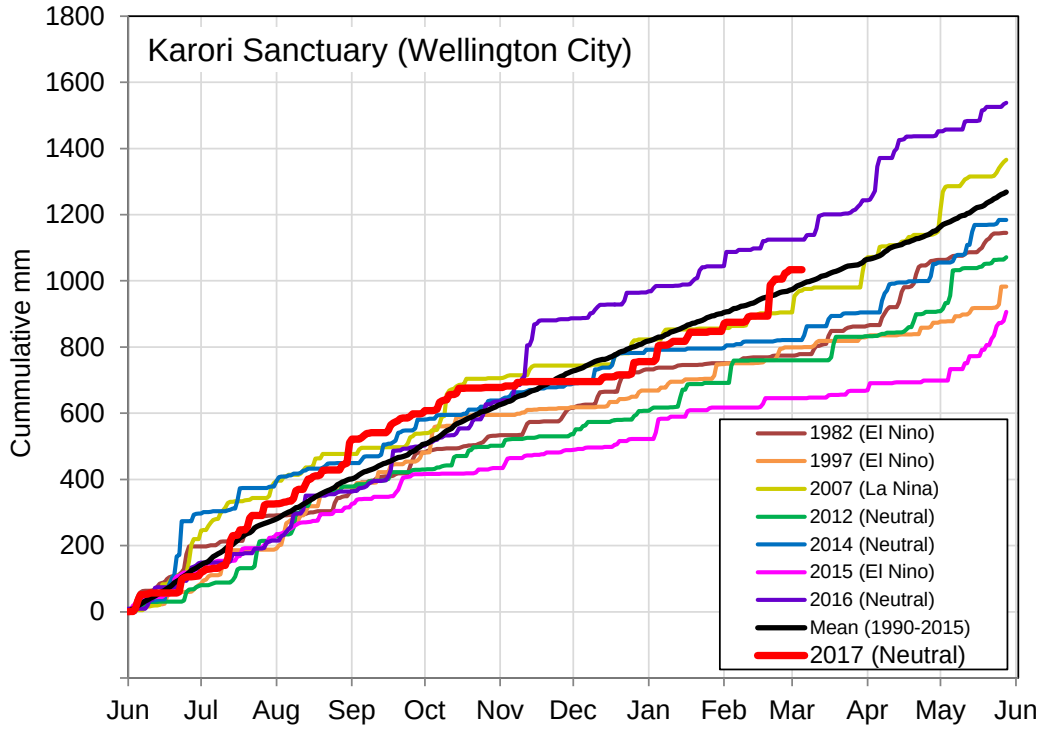
Overall, rainfall accumulations for the year starting in June 2017 (labelled 2017 on the plots) varied across the region when compared to average. Kapiti Coast, Hutt Valley and Wellington rainfall accumulations are currently sitting near average after the wet conditions that prevailed from July to October were followed by a very dry November and December and then a very wet end to summer.

Rainfall over the Wairarapa tended towards average at the end of summer with the exception of Tanawa Hut in the north-east where the current accumulated total is around 250mm (25%) below the average.

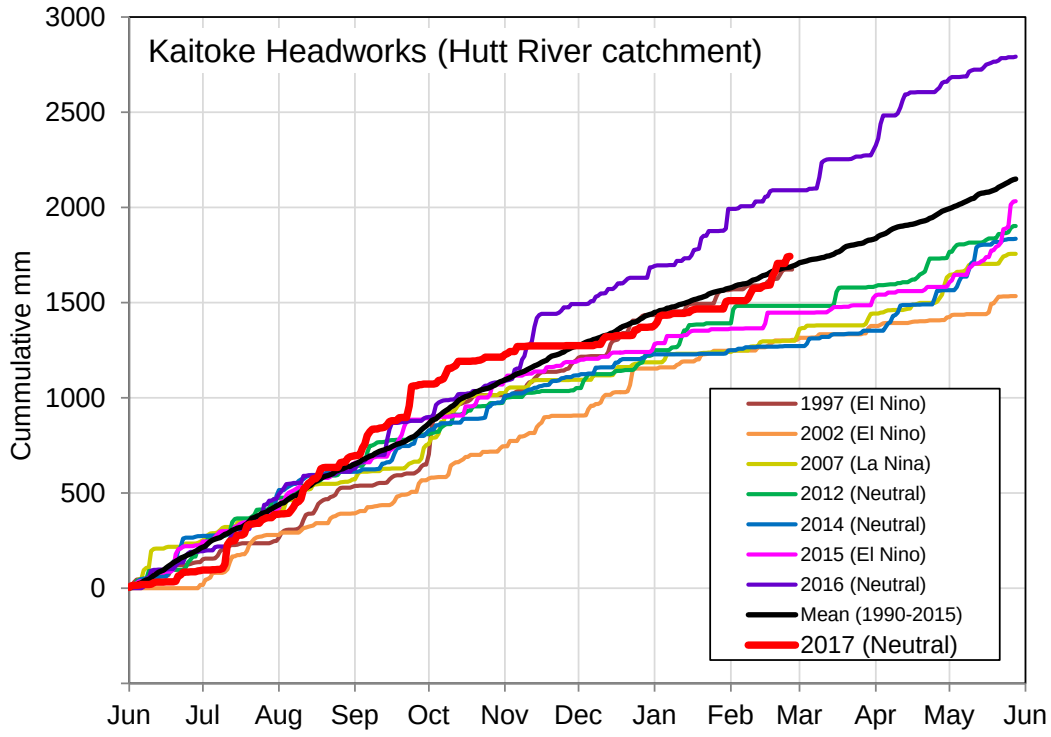
Kapiti Coast

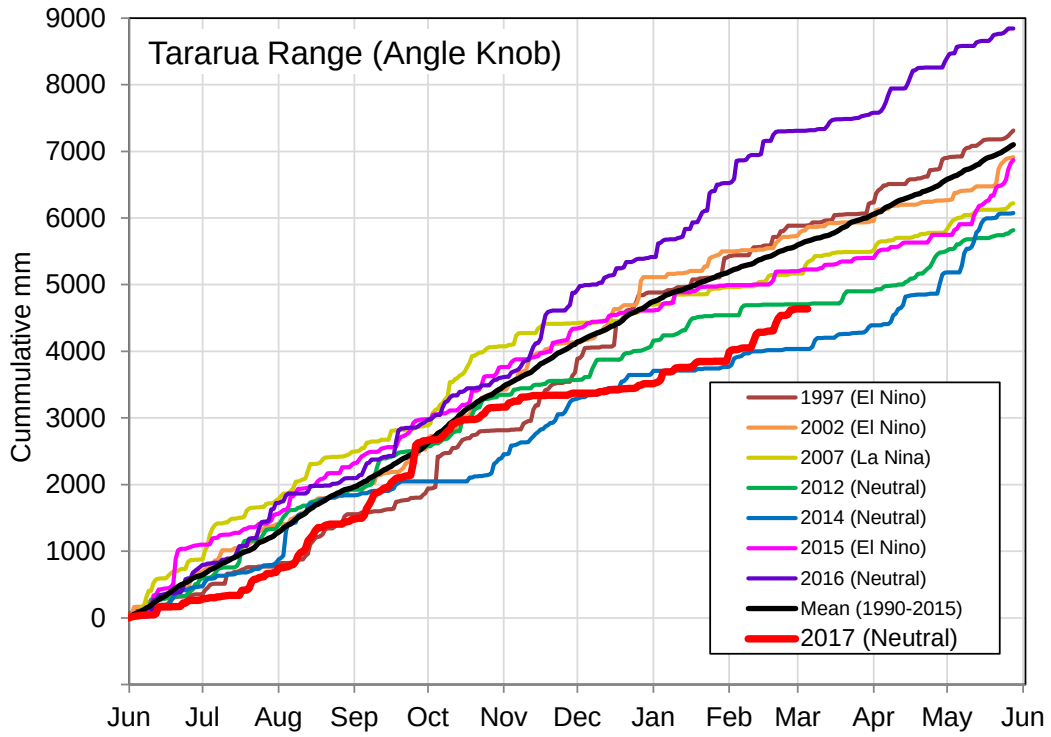


Southwest (Wellington city)

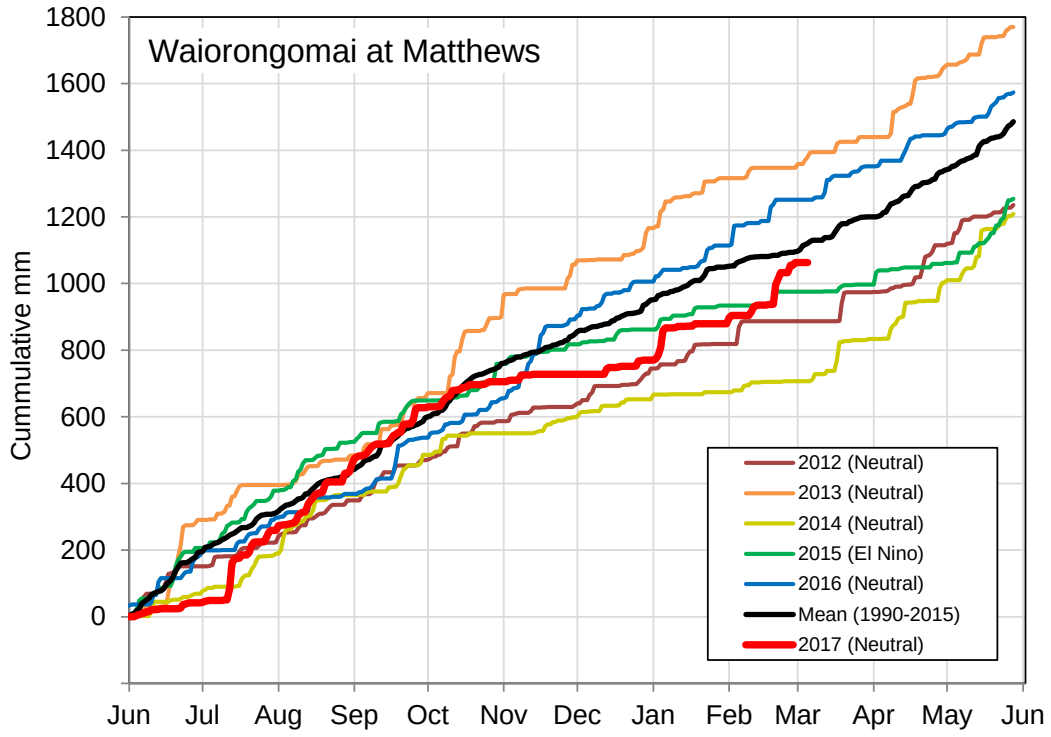


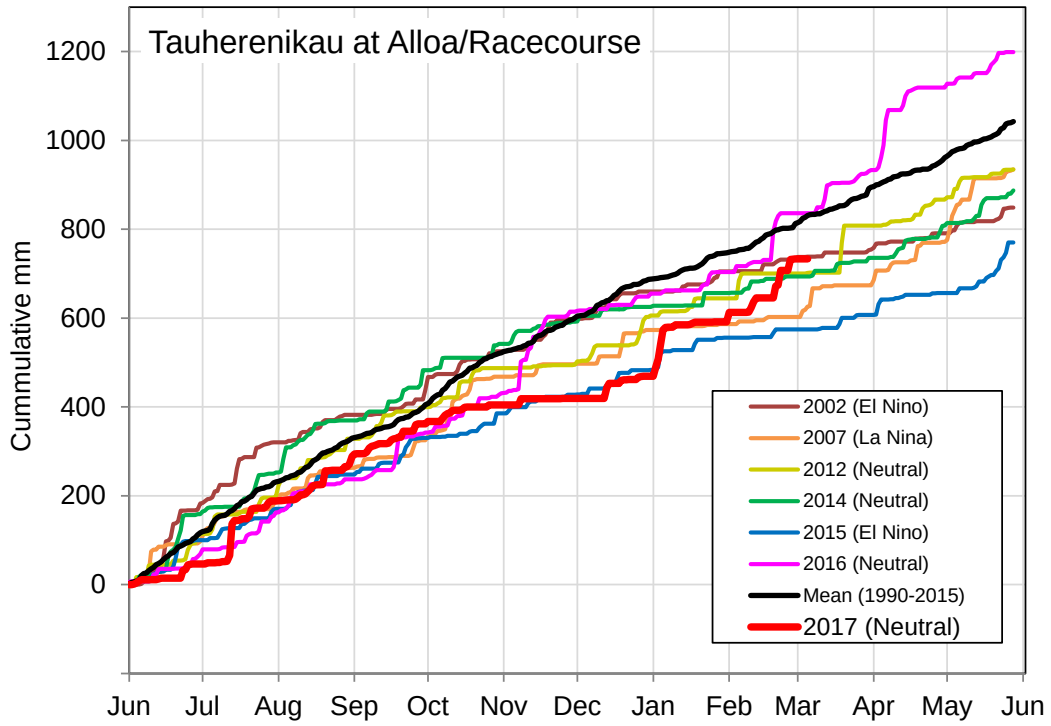
Hutt Valley and Tararua Range

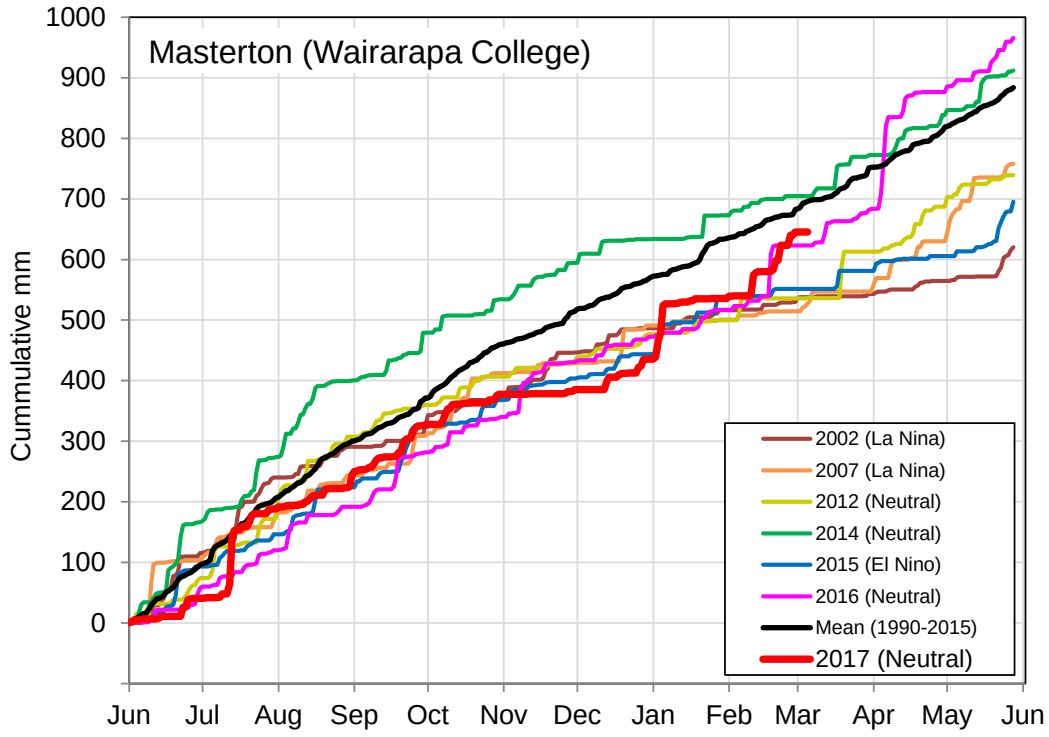


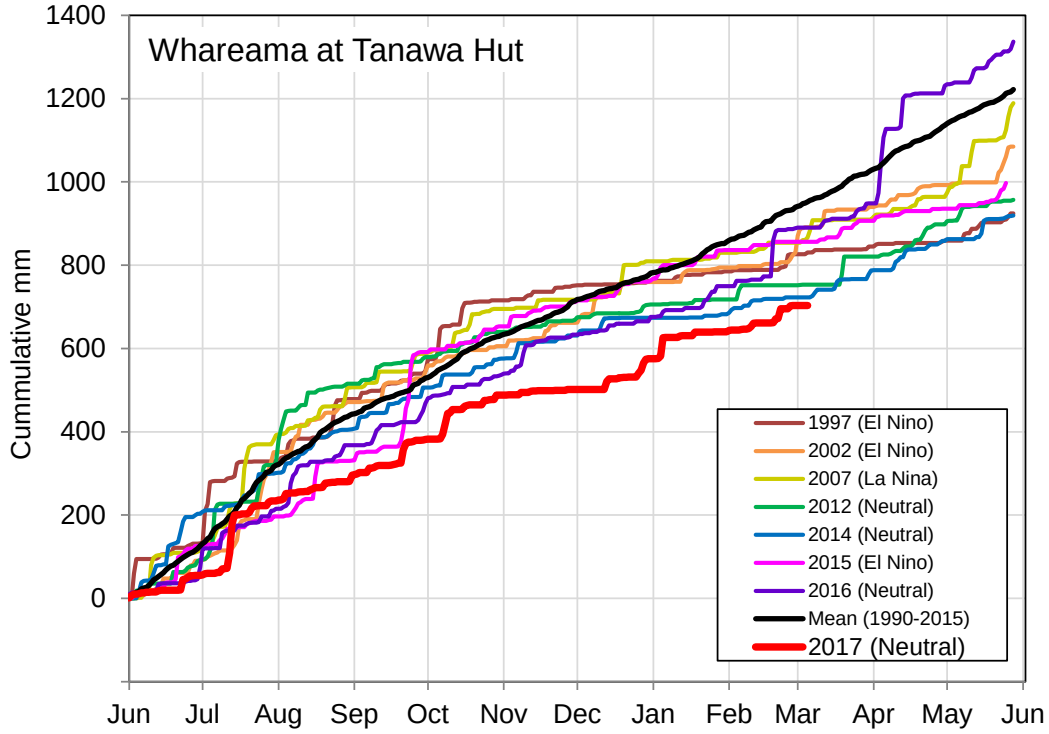


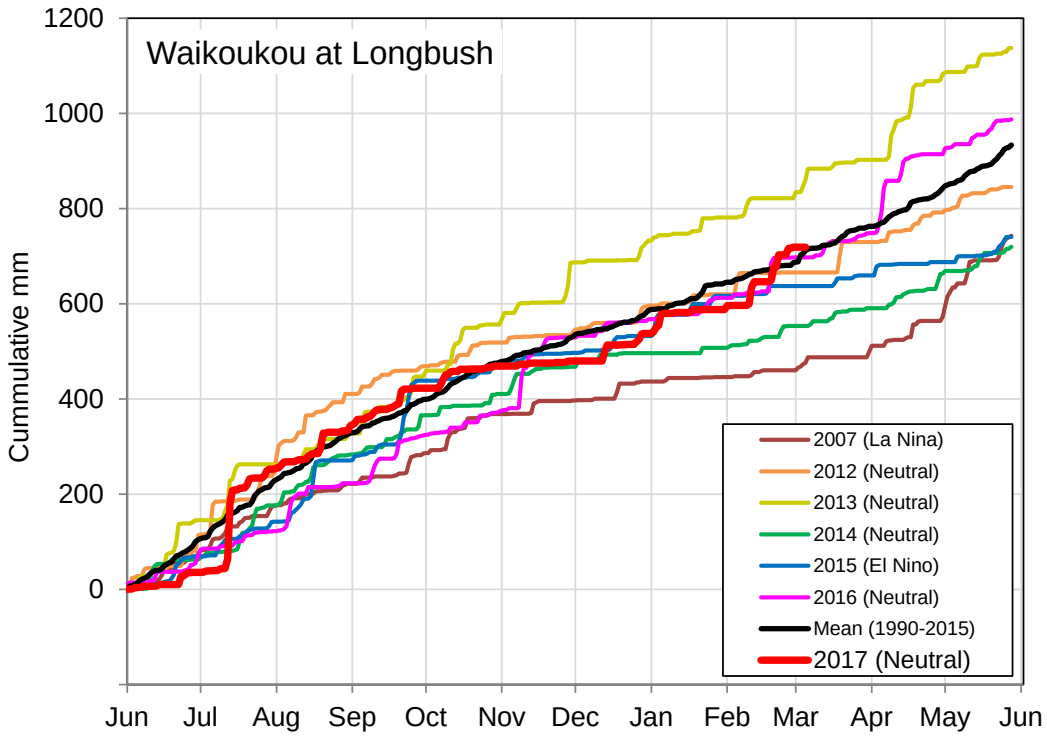
Wairarapa


Waiorongomai at Matthews
Cummulative mm
1800
1600
1400
1200
1000
800
600
400
200
0
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
2012 (Neutral)
2013 (Neutral)
2014 (Neutral)
2015 (El Nino)
2016 (Neutral)
Mean (1990-2015)
2017 (Neutral)


Tauherenikau at Alloa/Racecourse
Cummulative mm
1200
1000
800
600
400
200
0
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
2002 (El Nino)
2007 (La Nina)
2012 (Neutral)
2014 (Neutral)
2015 (El Nino)
2016 (Neutral)
Mean (1990-2015)
2017 (Neutral)


Masterton (Wairarapa College)
Cummulative 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 (La Nina)
2007 (La Nina)
2012 (Neutral)
2014 (Neutral)
2015 (El Nino)
2016 (Neutral)
Mean (1990-2015)
2017 (Neutral)


Whareama at Tanawa Hut
Cummulative mm
1400
1200
1000
800
600
400
200
0
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
1997 (El Nino)
2002 (El Nino)
2007 (La Nina)
2012 (Neutral)
2014 (Neutral)
2015 (El Nino)
2016 (Neutral)
Mean (1990-2015)
2017 (Neutral)



Live cumulative plots (updated daily): Real time graphs for cumulative rainfall are available online from 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 2017)

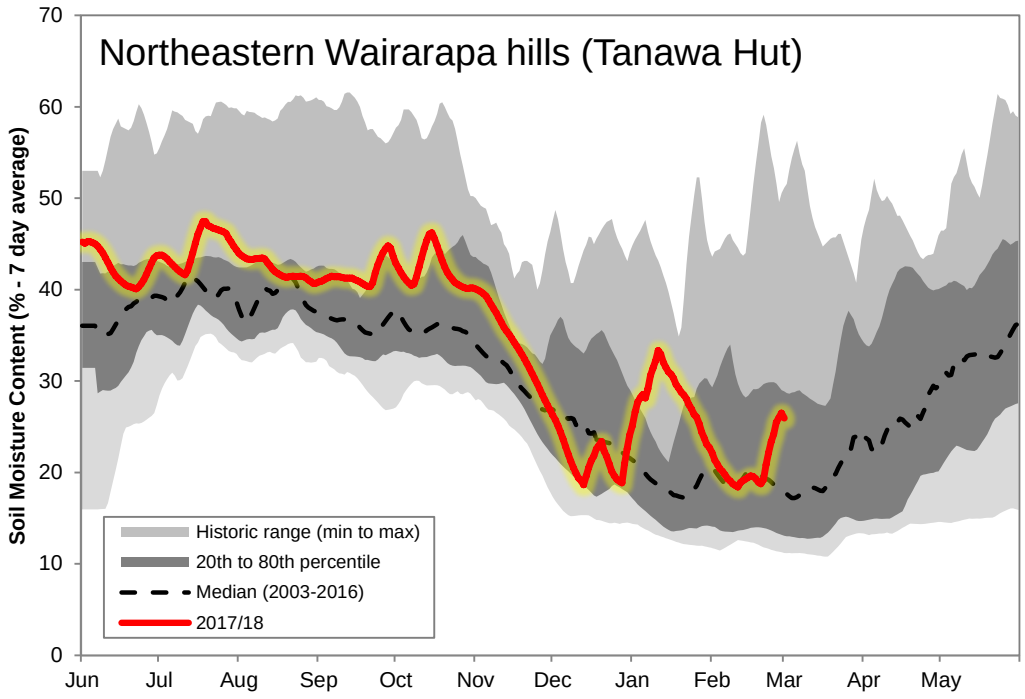
The following soil moisture graphs show the seven day rolling average soil moisture content (%) since 1 June 2017. This is plotted over an envelope of the range of historic recorded soil moisture data (and the median) at the site to provide an indication of how the current soil moisture compares with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

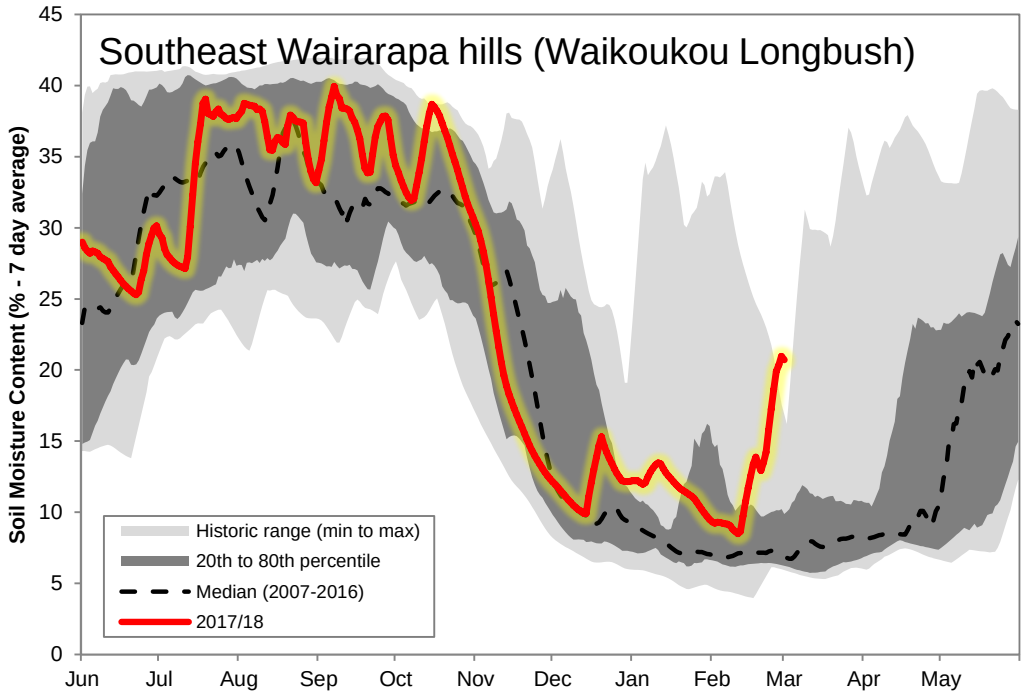
While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, the absolute moisture content (%) for any given site and date should not be considered accurate. Many of the GWRC soil moisture sites have not yet been fully calibrated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

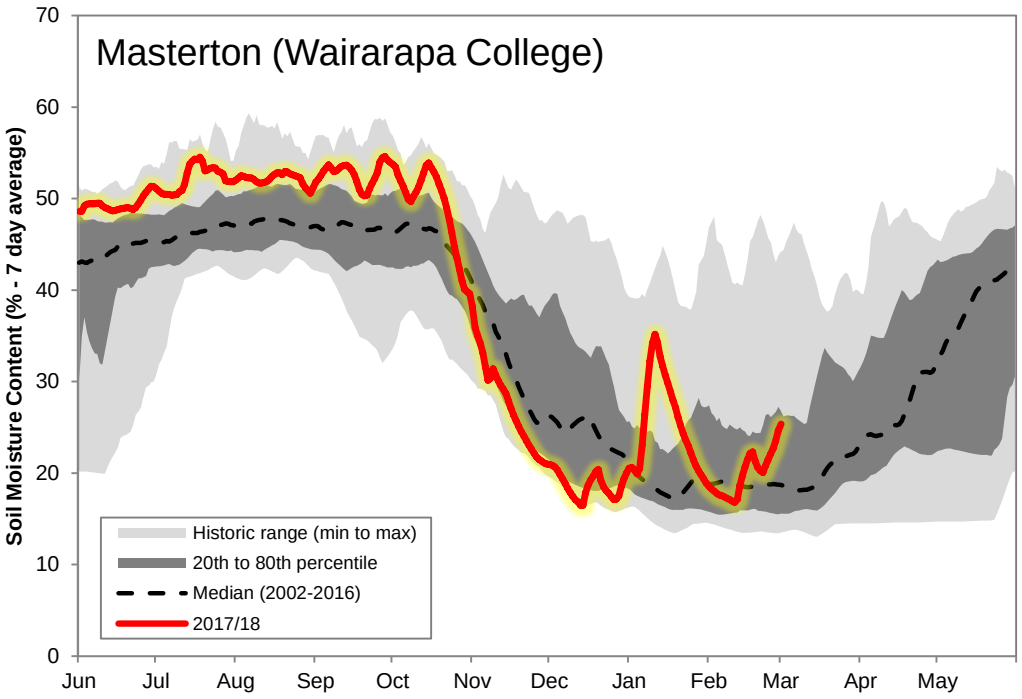
The soil moisture trend at all sites has been one of relatively high levels over winter and early spring before dropping sharply at the start of November as rainfall fell to well below average levels.

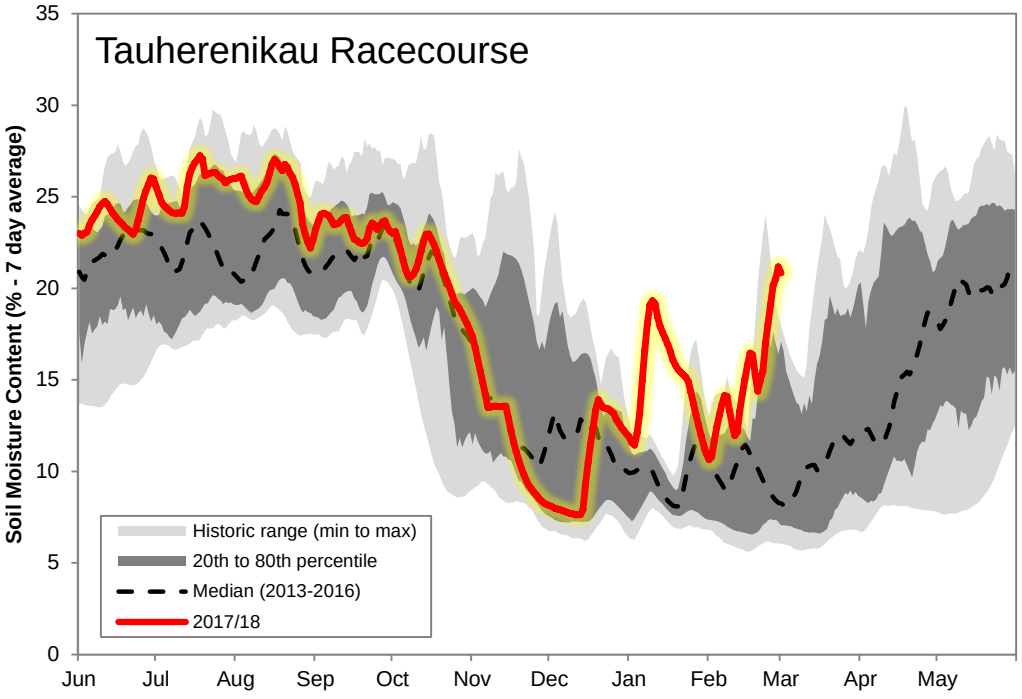
During December the regional soil moisture levels were very low but regular rainfall events since then have seen levels recover.

(a) Wairarapa

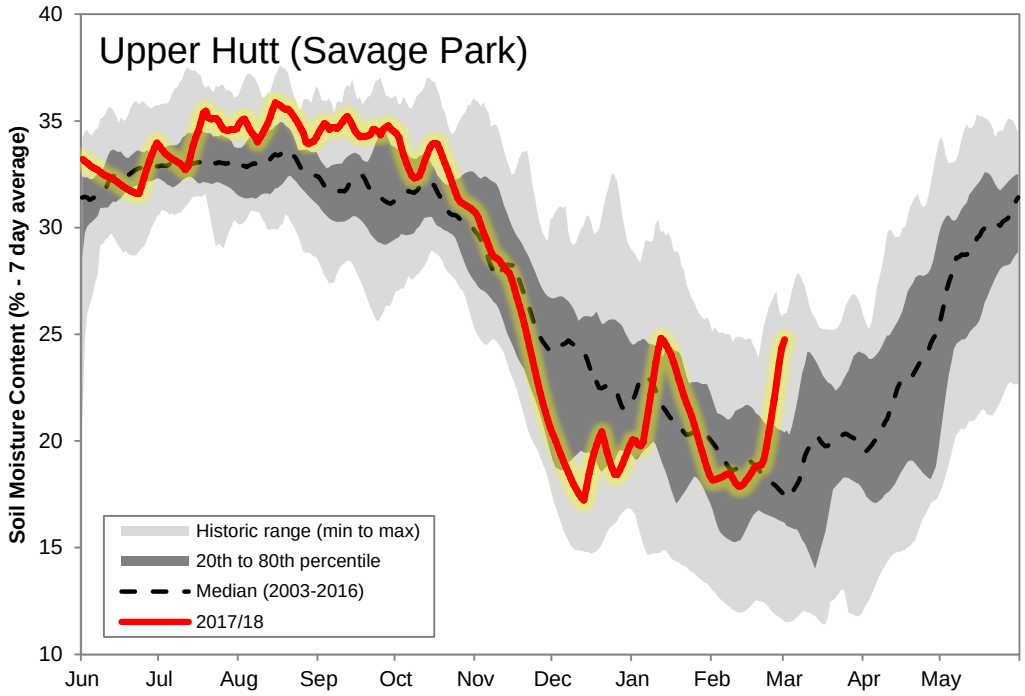

Northeastern Wairarapa hills (Tanawa Hut)
Soil Moisture Content (% - 7 day average)
70
60
50
40
30
20
10
0
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Historic range (min to max)
20th to 80th percentile
Median (2003-2016)
2017/18


Southeast Wairarapa hills (Waikoukou Longbush)
Soil Moisture Content (% - 7 day average)
45
40
35
30
25
20
15
10
5
0
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Historic range (min to max)
20th to 80th percentile
Median (2007-2016)
2017/18


Masterton (Wairarapa College)
Soil Moisture Content (% - 7 day average)
70
60
50
40
30
20
10
0
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Historic range (min to max)
20th to 80th percentile
Median (2002-2016)
2017/18


Tauherenikau Racecourse
Soil Moisture Content (% - 7 day average)
35
30
25
20
15
10
5
0
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Historic range (min to max)
20th to 80th percentile
Median (2013-2016)
2017/18

(b) Hutt Valley



Live soil moisture plots (updated daily): Real time "envelope" graphs for soil moisture are available online from 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 2018

- La Niña dying off, with warmer than normal sea surface temperatures around New Zealand persisting;
- Weaker westerlies, significant possibility of (heavy) easterly rainfall episodes;
- Warmer than average but not as anomalous as summer;
- Poorly distributed rainfall, but overall above average, influenced by significant weather events;
- Significant events developing from ex-tropical cyclones or tropical depressions remain possible.

Whaitua*	Variables	Climate outlook for autumn 2018
Wellington Harbour & Hutt Valley	Temperature:	Above average, chance of further hot spells for the remaining of March.
	Rainfall:	Average to above. Increased chance of significant (heavy) rainfall events.
Te Awarua-o-Porirua	Temperature:	Above average, chance of further hot spells for the remaining of March.
	Rainfall:	Average to above. Increased chance of significant (heavy) rainfall events.
Kapiti Coast	Temperature:	Above average, chance of further hot spells for the remaining of March.
	Rainfall:	Average to above. Increased chance of significant (heavy) rainfall events.
Ruamahanga	Temperature:	Above average, chance of further hot spells for the remaining of March.
	Rainfall:	Average to above. Increased chance of easterly rainfall events.
Wairarapa Coast	Temperature:	Above average.
	Rainfall:	Average to above. Increased chance of easterly rainfall events.

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

Note: Statistical rainfall projections for central Wairarapa via climate analogues is not shown for this report due to the lack of reliable climate analogues for the current configuration of the climate drivers.

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.

GWRC Climate mapping tools online

Daily Climate Maps

For real time daily climate anomaly maps (rainfall and soil moisture), go to:

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

Interactive climate change maps

For interactive climate change maps, go to:

1. GIS version

https://mapping1.gw.govt.nz/gw/ClimateChange/

2. Story map version

https://mapping1.gw.govt.nz/GW/ClimateChange_StoryMap/#