greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

# Climate and water resources Seasonal update

Summer 2017 summary
Autumn 2017 outlook

March 2017

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# Overview

## Summer 2017

Summer 2017 was highly unusual in the Wellington region. The weather was very windy and unsettled most of the time and particularly so in January, with colder than average temperatures, record low sunshine hours and very high number of windy days with record breaking gusts over 145 km/h in some areas. An assessment of number of ‘beach days’ in January showed January 2017 to have had the lowest number of beach days on record over the last 30 years.

## Reason for the cold and unsettled weather

New Zealand is highly influenced by the oceanic temperatures, and the Sea Surface Temperature (SST) around the country was much colder than average during almost the entire season. The waters had been warm until the end of spring, and climate models did not predict the shift to colder SST that prevailed and intensified throughout the season. One of the key climate drivers that affect New Zealand, the Southern Annular Mode (SAM), remained strongly negative during the season. This led to an unusually high number of very active fronts and westerly storms crossing our region, more resembling a ‘cool/windy spring’ pattern than summer. The ENSO phenomenon in the Pacific Ocean remained neutral and did not influence the summer weather patterns, but now there is a 50% chance of an El Niño developing in the second half of the year. This would be an unusual development, given that we already had a very strong El Niño in 2015/2016. An accurate seasonal outlook would require correct prediction of how the SSTs will evolve around New Zealand over the next couple of months. Unfortunately this is difficult to predict and climate models struggle to get it right. Current monitoring shows that the cold waters that prevailed throughout summer are quickly being replaced by warmer than average waters from the sub-tropics north of New Zealand. The best model guidance suggests that this pattern will persist and influence the autumn weather pattern, increasing the odds of close to average or warmer than average temperatures.

## Climate outlook for autumn 2017

Normal to above average temperatures and around to below average rainfall. Greater likelihood of extreme weather events, including heavy rainfall alternated by prolonged dry and warm spells. A combination of unusual weather patterns, unsettled climate drivers and climate change impacts means that there is low confidence in this projection.

# Contents

# 1. Climate drivers

## 1.1 El Niño – Southern Oscillation (ENSO)

The ENSO phenomenon remains neutral, but now there is a 50% chance of a new El Niño developing by the second half of the year (Figure 1.1). This would be an unusual development given that we already had a strong El Niño in 2015/2016. Statistically speaking the ability to predict ENSO is low this time of the year, but confidence will grow if this forecast persists in the next few months.

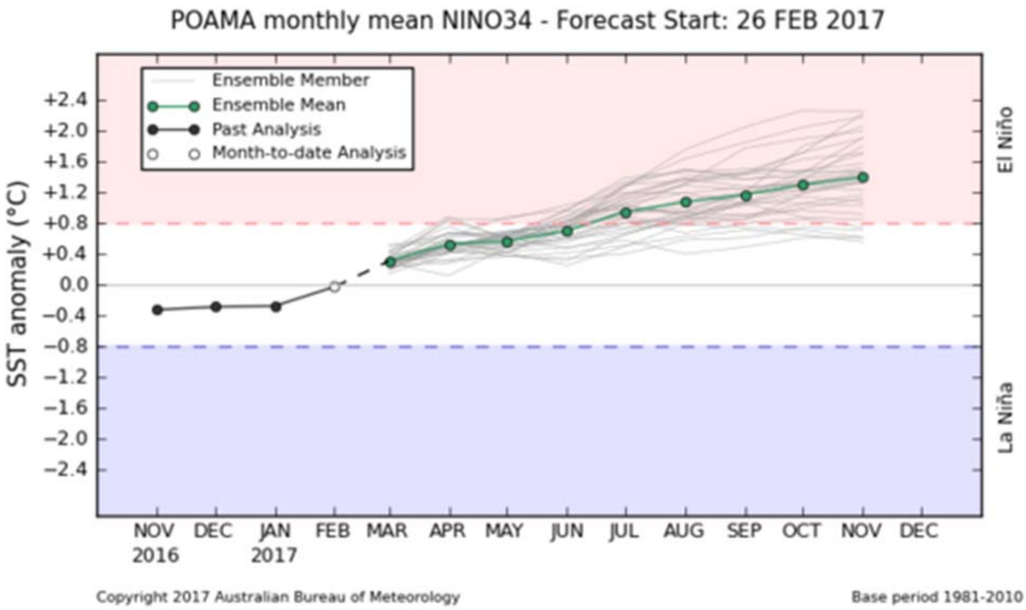



Figure 1.1: ENSO projections until November 2017 show conditions are tracking towards a new El Niño. There is currently an El Niño alert in place according to the Australian Bureau of Meteorology, but caution should be taken as the statistical reliability of this forecast is relatively low this time of the year. Source: Australian Bureau of Meteorology.

## 1.2 Sea ice extent and oceanic temperatures

The oceanic temperature anomalies (i.e., SSTs) and the total sea ice extent (in white) are shown in Figure 1.2 for 2 March 2017. The Antarctic sea ice extent for summer has been the lowest on record for the satellite era, starting in 1979. This represents a drastic reversal from the increased sea ice extent that had been observed in the Southern Hemisphere in previous years. The warm SSTs in Figure 1.2 to the north of Antarctica show this reversal. Both the sea ice and the SSTs tend to respond to the Southern Annular Mode, with less sea ice and colder SSTs around New Zealand when the SAM is negative. This combination may help explain the unusually stormy summer pattern observed in 2017. The fact that Antarctic sea ice is now declining for the first time adds further evidence and concerns to the advancing stages of climatic changes, and particularly as New Zealand will be very sensitive to any changes happening around Antarctica due to our exposure to the Southern Ocean. Much of these mechanisms remain poorly understood, and the ESci department is currently commissioning a new study to address these effects on our regional climate.

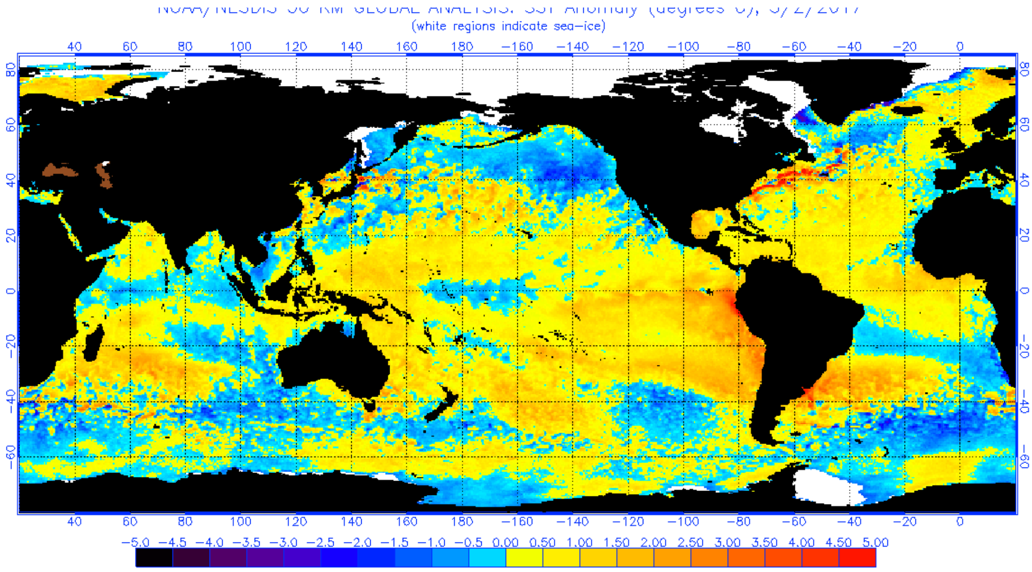



Figure 1.2: Sea surface temperature anomalies for 2 March 2017. Sea ice coverage is shown in white. Colder than average waters are seen to the south of New Zealand, and warmer than average waters are seen to the north of New Zealand and between New Zealand and Antarctica. Source: NOAA.

## 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 of New Zealand, keeping the weather stable and dry/cloud-free, whereas the opposite is expected when the SAM is in the negative phase. Figure 1.3 shows that the SAM was highly negative in summer (corridor of low pressure areas indicated by ‘L’), helping explain the abnormal stormy and cold season in our region. Note that the anomalous low to the south of New Zealand has been the strongest in the whole hemisphere.

As discussed in Section 1.1, ENSO remains neutral at the moment, but if a new El Niño develops later in the year a predominantly negative SAM pattern might prevail over the longer term, which would reinforce the existing potential for increased westerly winds. Unfortunately it is not normally possible to predict the future behaviour of the SAM at the seasonal scale, unless there is a strong El Niño or La Niña event occurring.

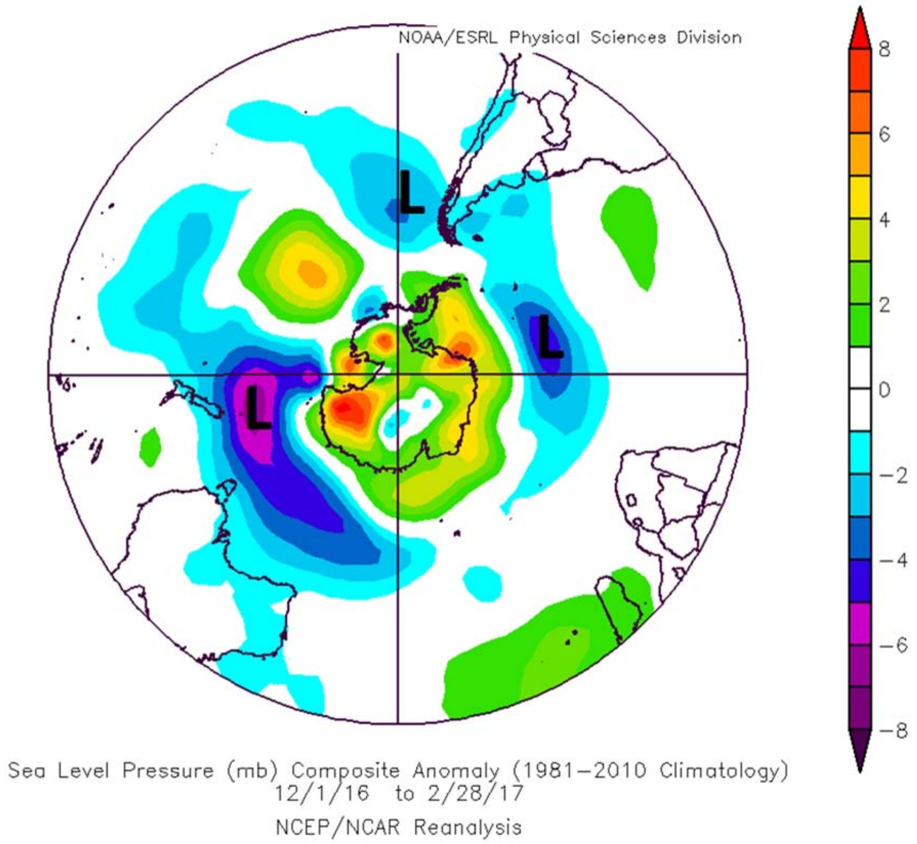



Figure 1.3: Sea level pressure anomalies for DJF 2017. The negative SAM affecting New Zealand with unstable weather and above average rainfall is shown by the very deep trough south of New Zealand depicted by 'L'. Source: NCEP Reanalysis.

# 2. What is the data showing?

## 2.1 Satellite-derived drought stress indices (vegetation health)

Figure 2.1 shows the satellite-derived "vegetation drought-stress" index (associated with vegetation health) for the week ending 25 February 2017. As a result of a very stormy summer most of the region remains "stress-free", even more so compared to early December which is highly unusual post summer. The Wairarapa coast area, which was under heavy water stress about a year ago, now appears as the area with the least water stress for the entire region.

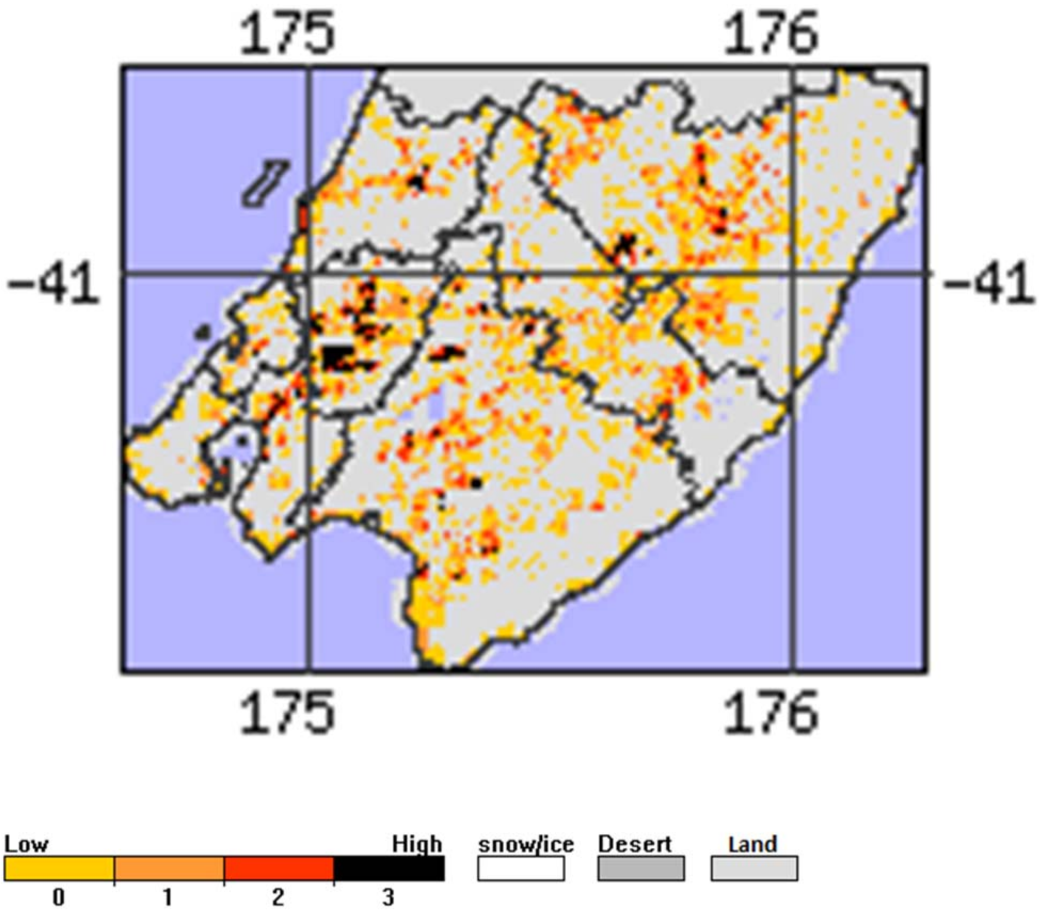



Figure 2.1: Satellite-derived "Vegetation drought-stress" index for the week ending 25 February 2017. Drought index scale shows the potential drought risk: 0 (moderate or no stress), 1 (severe stress), 2 (extreme stress), 3 (exceptional stress). The index is relative to a 25 year period base climatology of how healthy (or green) the vegetation is looking. Source: NOAA/USA, resolution 4km.

## 2.2 Soil moisture assessment

Figure 2.2 shows the latest soil moisture anomaly for the region, as of 11 March 2017. Most of the region's soil moisture is estimated to be around average (i.e., anomalies between -10 and +10 mm). The slight dry area over the Tararuas could be due to modelling uncertainty over elevated terrain. Overall this map confirms the pattern captured by satellite in the earlier section, showing slightly wetter than normal conditions on the Wairarapa coast.

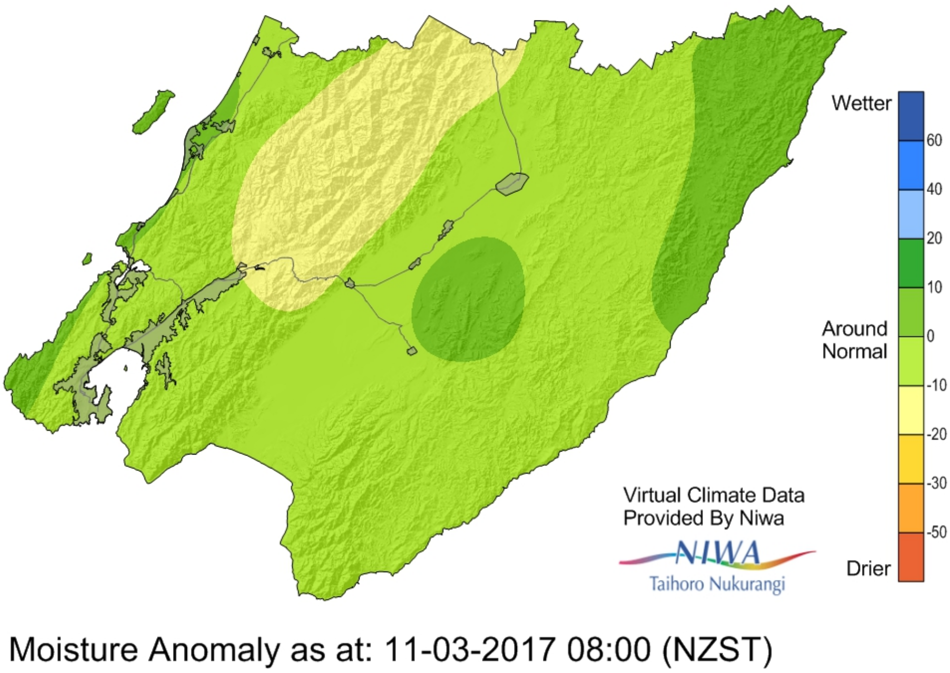



Figure 2.2: Soil moisture anomaly for 11 March 2017. Moisture levels show near normal conditions for most of the region. Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. Note that this data is indirectly calculated by modelling and interpolation techniques, and does not necessarily reflect the results obtained by direct measurements (compare with section 2.4). This map should only be used for a general indication of the spatial variability.

## 2.3 Regional rainfall

Figure 2.3 shows the regional summer rainfall expressed as a percentage of the long-term average. Most of the region shows greater than average rainfall totals with only the eastern Wairarapa showing totals below average at around 80 to 100% of normal. Summer rainfall totals in the Ruamahanga valley were largely in the 100 to 120% range.

The high peaks of the Tararua range in the headwaters of the Ruamahanga and Otaki river catchments saw totals around 160 to 200% of normal for this time of year.

The asterisk shows the location of the reference rainfall station (Waikoukou farm) used to produce the climate analogues rainfall projection (see section 3). The farm had 99% of the 1980-2010 rainfall average.

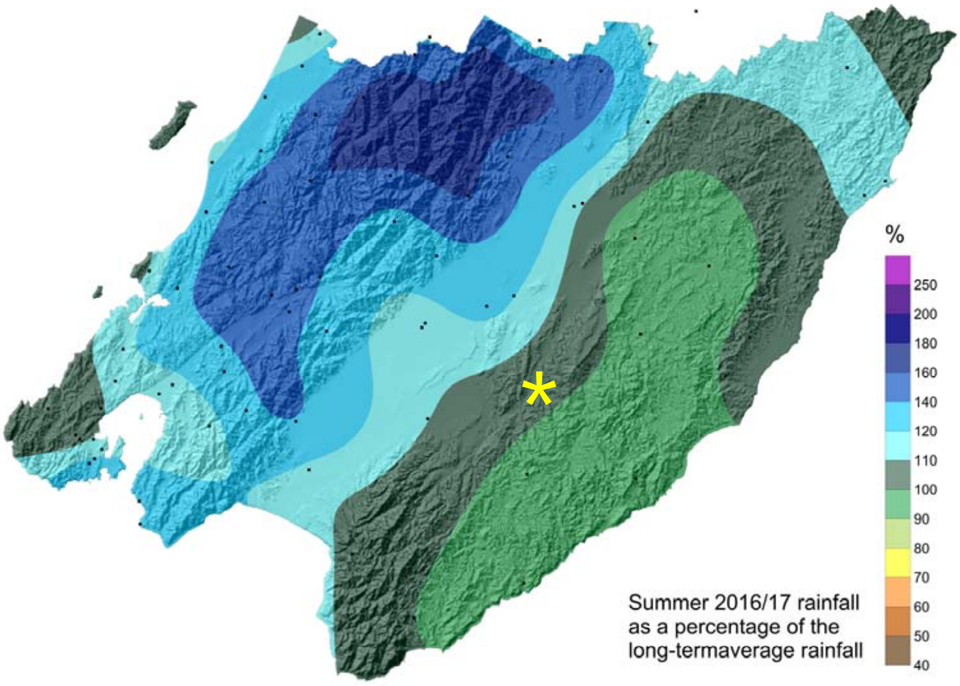



Figure 2.3: Rainfall for summer 2016/17 as a percentage of the long-term average. Above average rainfall is seen for most of the region. The asterisk shows the location of the rainfall time series at Waikoukou, Longbush, used for the climate analogues rainfall projection (see Section 3). Source: GWRC.

## 2.4 Observed rainfall and soil moisture conditions for selected sites

Figure 2.4 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.

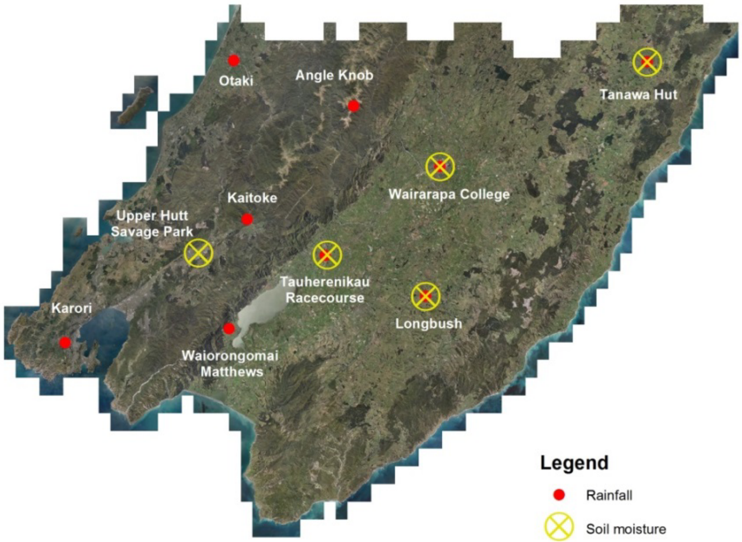


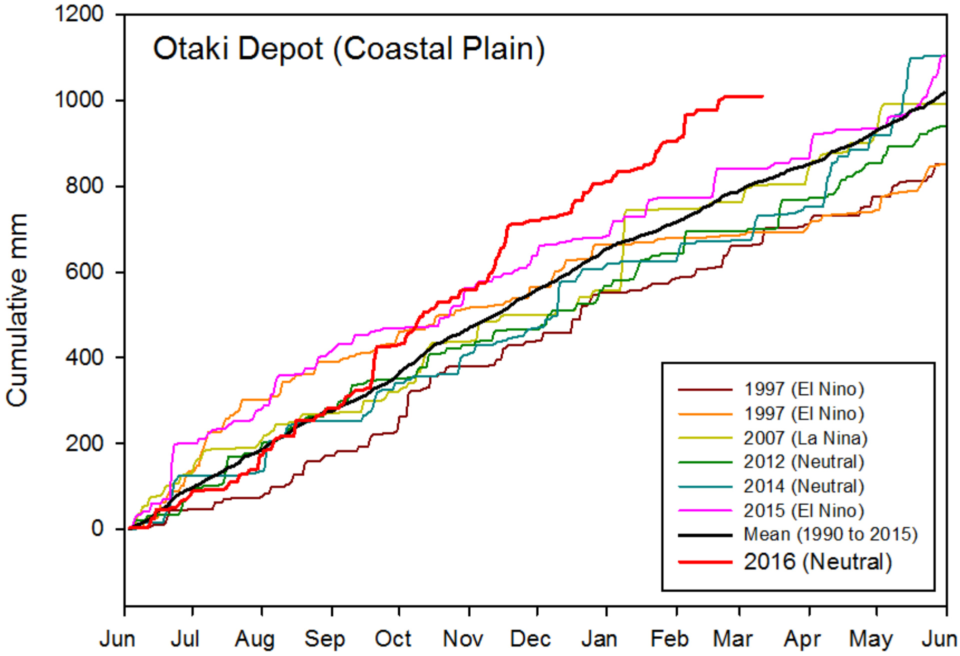

Figure 2.4: Map of GWRC rainfall and soil moisture monitoring locations

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

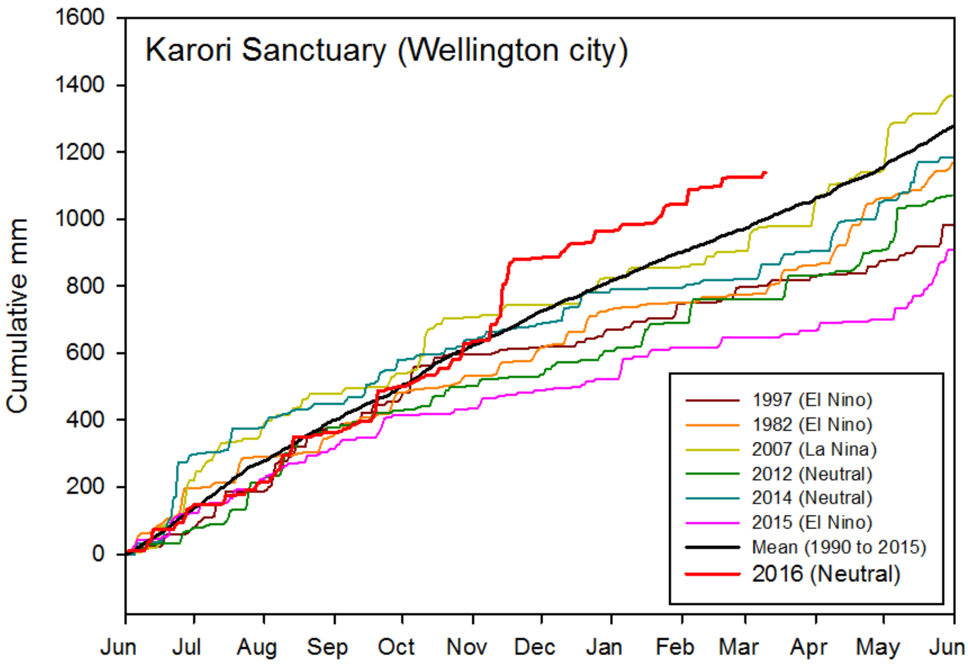
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year for several years. For comparative purposes, cumulative plots for selected historic years with notably dry summers in the Wairarapa have been included, as well as the site average. Many of the GWRC telemetered 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 somewhat constrained to the past 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 since mid-winter 2016 have been about average in the Wairarapa and well above those seen in recent dry years. This is mainly thanks to a significant event in mid-February this year in which over 100 mm fell over two days. Accumulations in the western part of the region, around the southwest coast (Wellington city) and the Tararua Range, are much higher than average, due in part to very significant rainfall in late spring but also regular top ups since then.

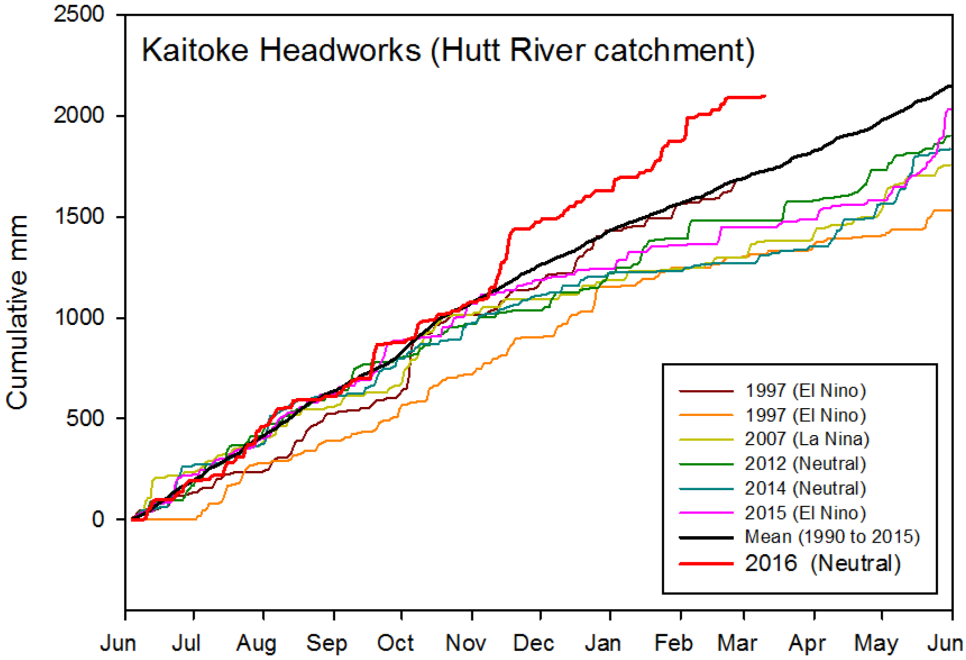
Kapiti Coast

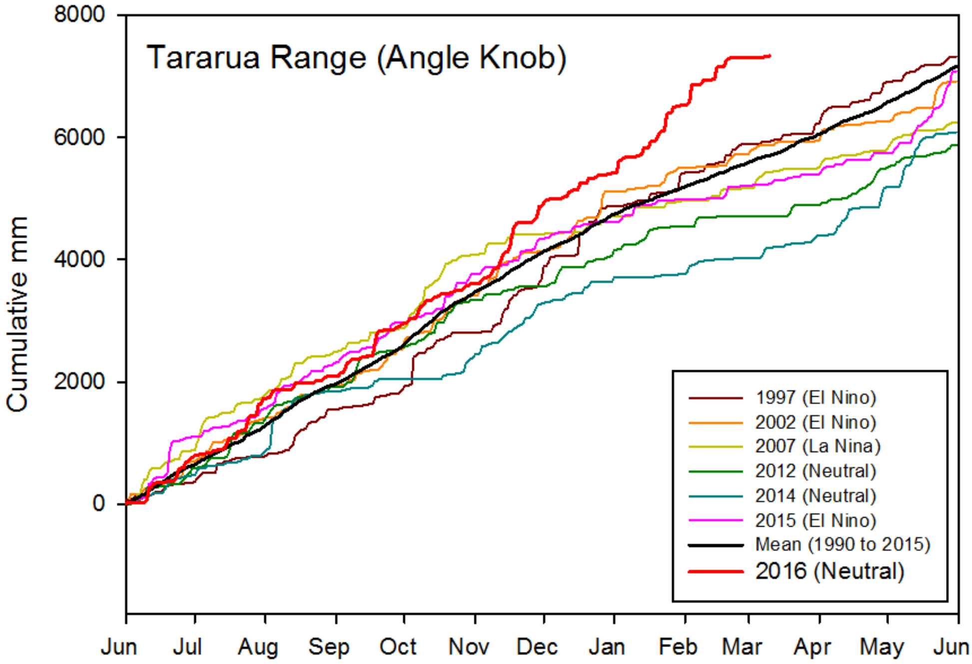



Southwest (Wellington city)

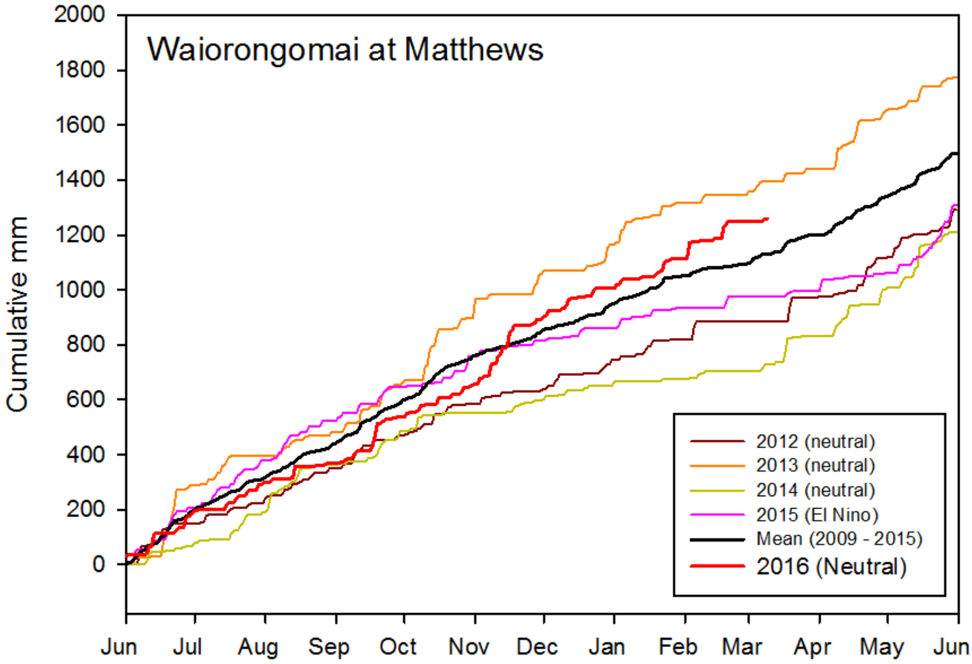


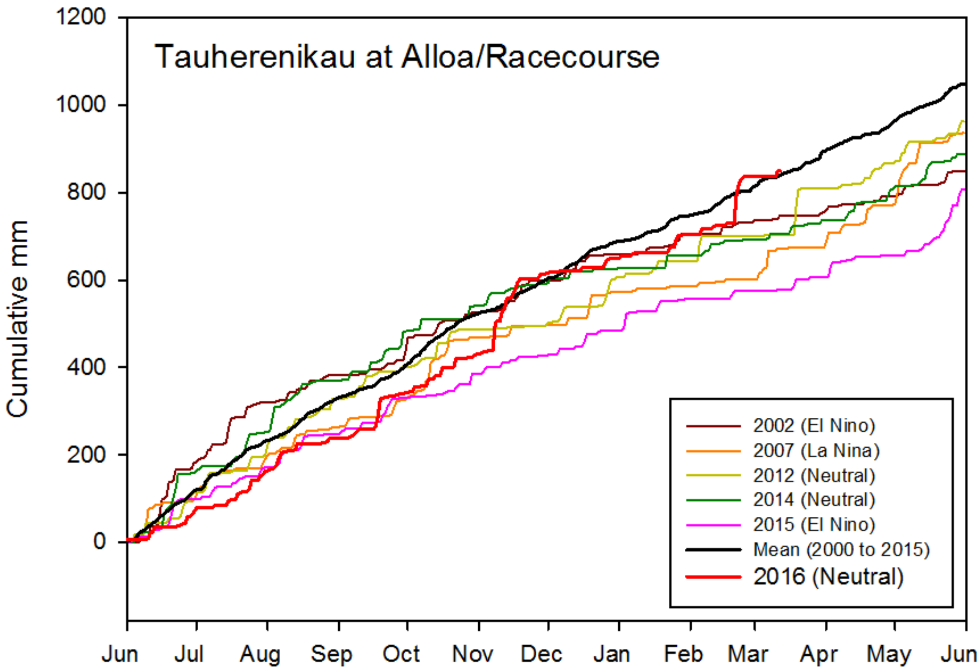
Hutt Valley and Tararua Range

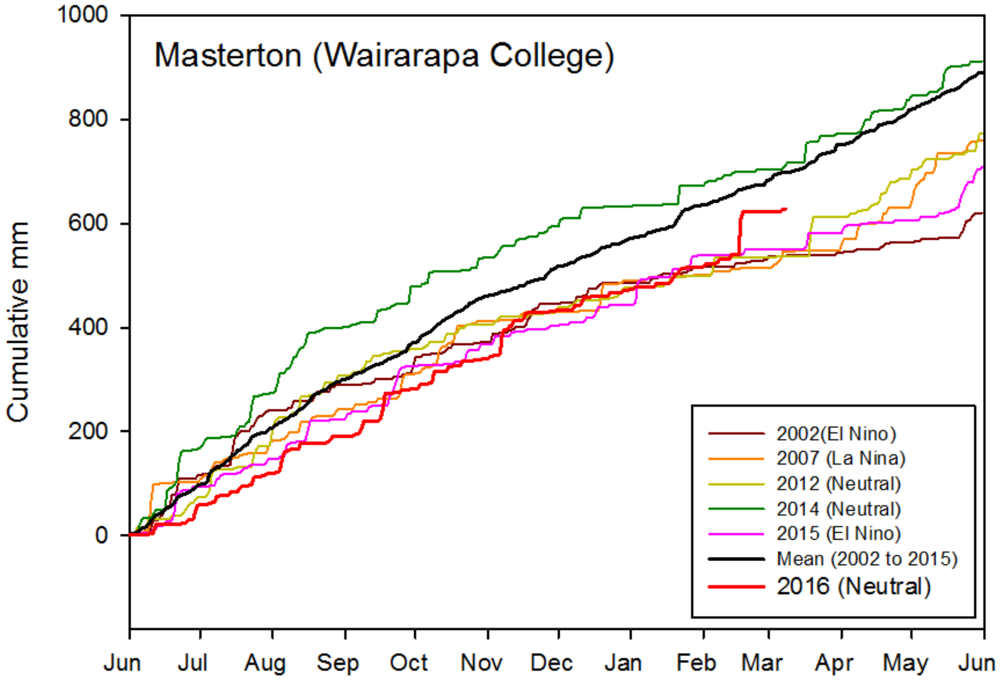


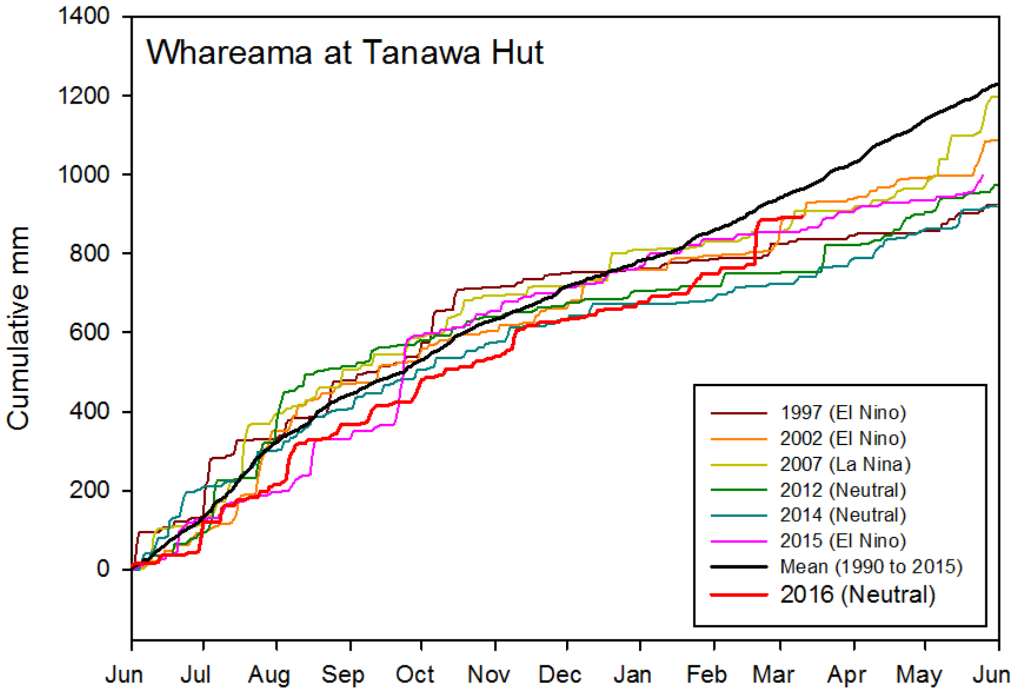



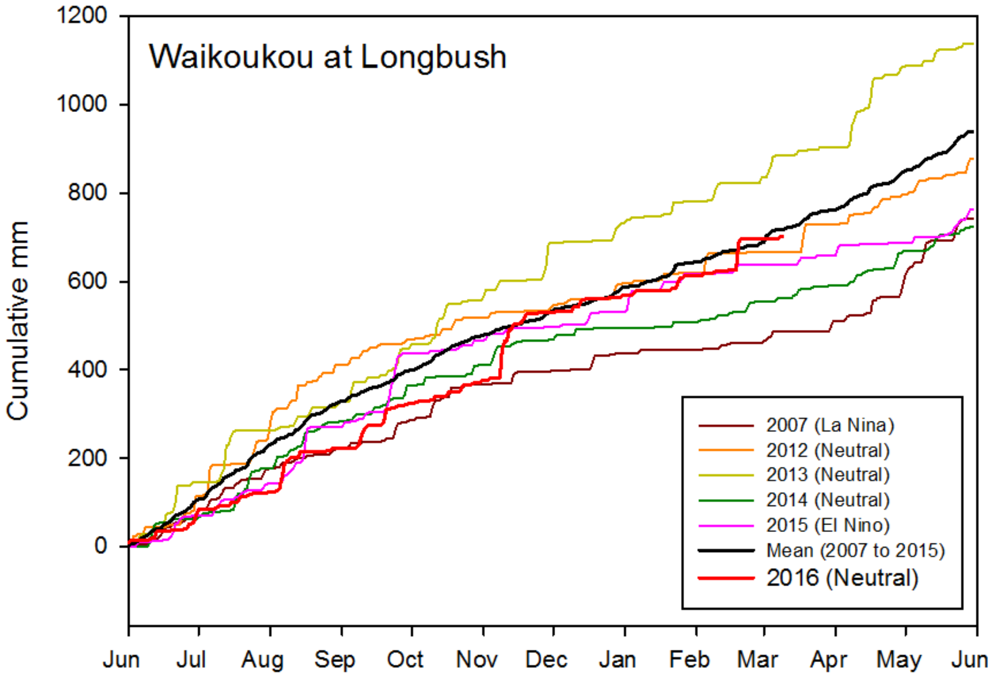
Wairarapa


Waiorongomai at Matthews
Cumulative mm
2000
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)
Mean (2009 - 2015)
2016 (Neutral)


Tauherenikau at Alloa/Racecourse
Cumulative 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)
Mean (2000 to 2015)
2016 (Neutral)


Masterton (Wairarapa College)
Cumulative mm
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)
Mean (2002 to 2015)
2016 (Neutral)


Whareama at Tanawa Hut
Cumulative 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)
Mean (1990 to 2015)
2016 (Neutral)

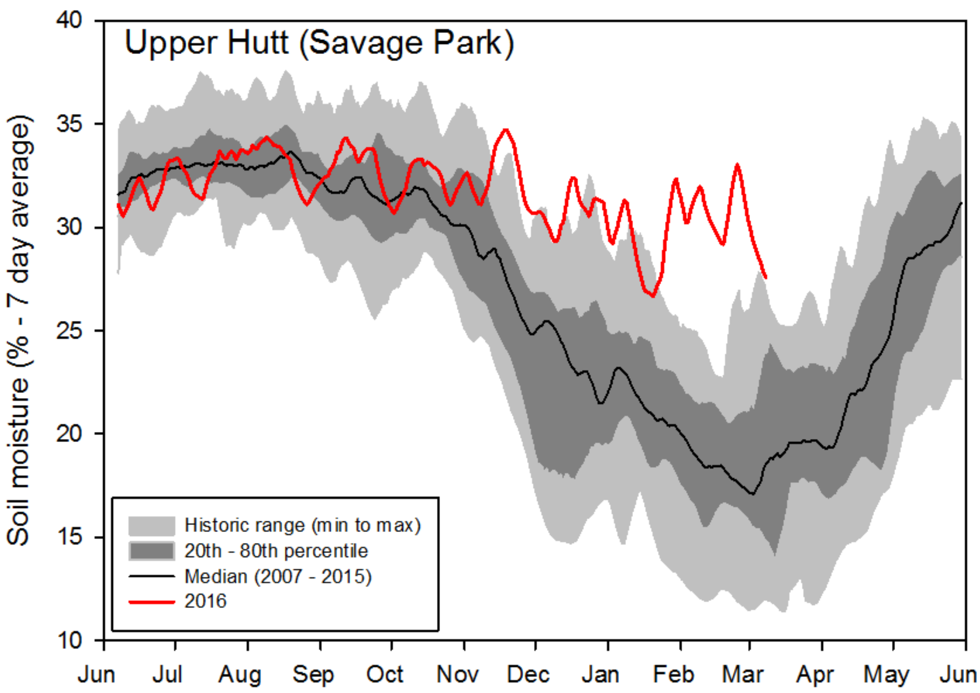

Waikoukou at Longbush
Cumulative mm
1200
1000
800
600
400
200
0
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
2007 (La Nina)
2012 (Neutral)
2013 (Neutral)
2014 (Neutral)
2015 (El Nino)
Mean (2007 to 2015)
2016 (Neutral)

### 2.4.2 Soil moisture content (1 June to 31 May)

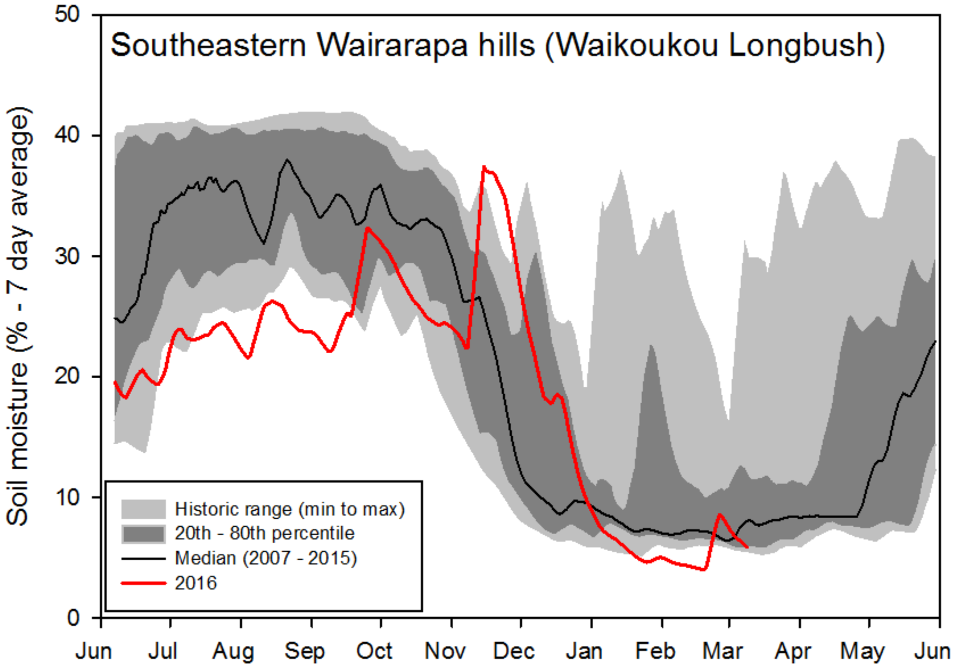
The soil moisture plots show seven day rolling average soil moisture (%) for the hydrological year. An envelope plot of the historic range of data (and site mean) is also provided to give an indication of how the current soil moisture compares with that for a similar time of the season in past years. While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, they do not provide the absolute moisture content (%) as many of the GWRC soil moisture sites have not yet been fully calibrated.

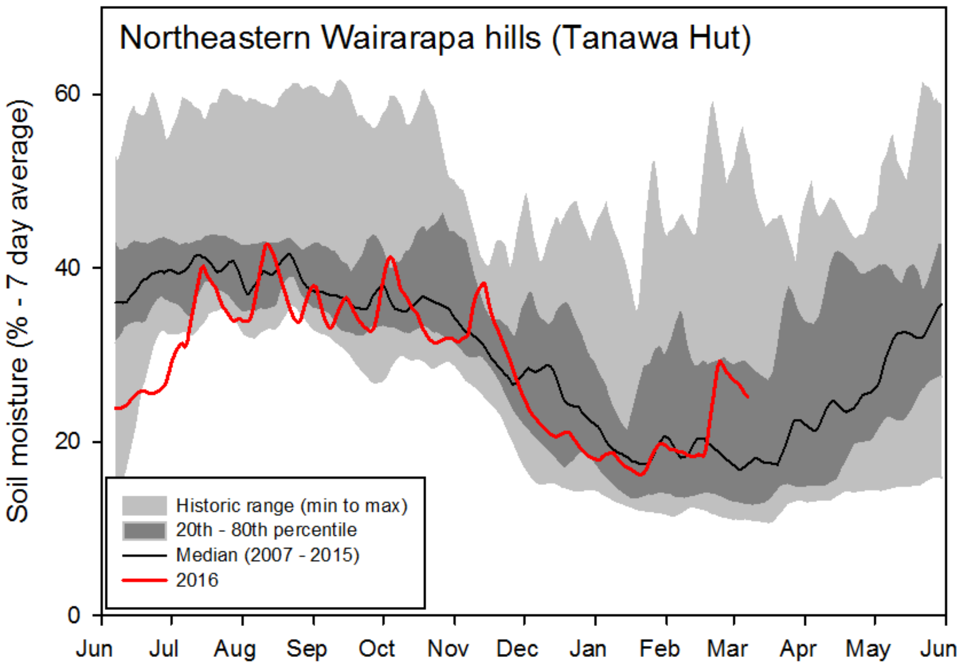
Soil moisture levels in the western part of the region are much higher than normal for this time of year. In fact, data from the Upper Hutt site indicates moisture levels have declined very little since mid-winter and have been at (or near) record highs throughout summer (based on monitoring since 2003). Soils in the Wairarapa had about average moisture levels for most of the summer but, as a result of the significant February rainfall, are now (in early autumn) well above average. The exception is the monitoring record for southeastern Wairarapa hills (Waikoukou Longbush) where soils appeared to be exceptionally dry through late January and February and did not get quite the same moisture replenishment from the February rainfall that seemed to occur elsewhere.

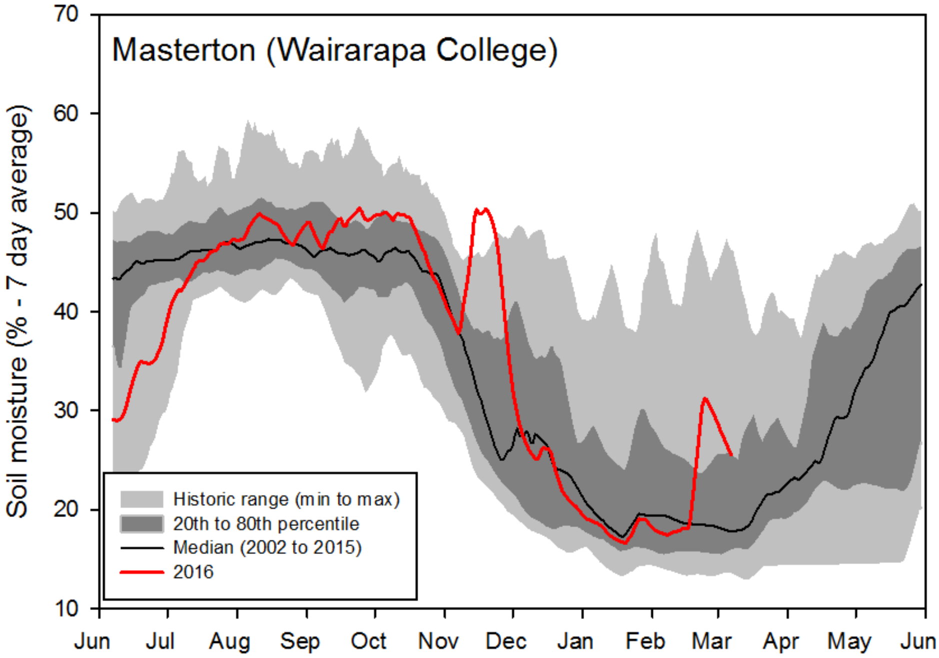
Hutt Valley

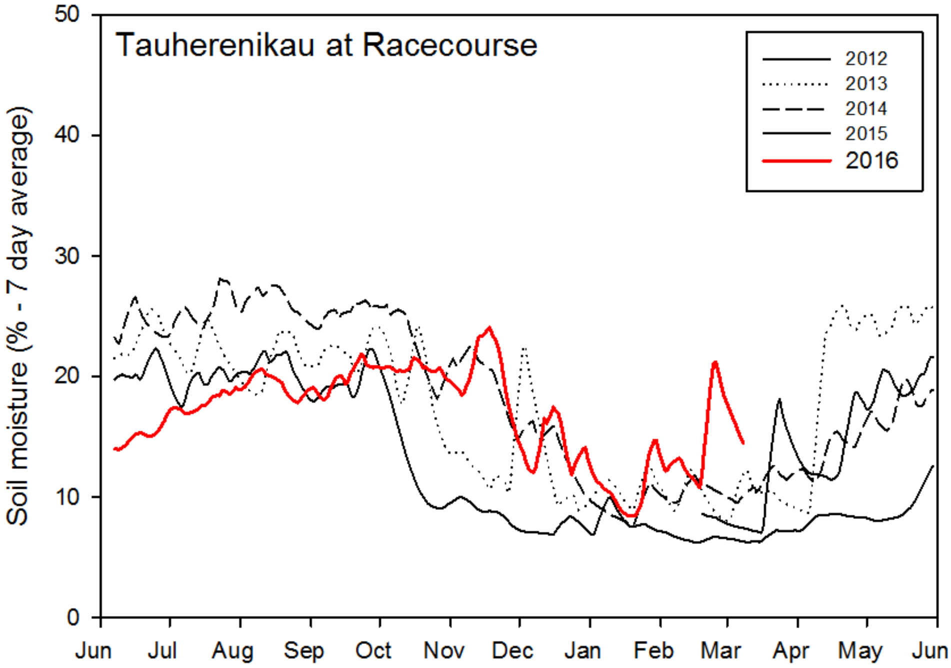


## Wairarapa


Southeastern Wairarapa hills (Waikoukou Longbush)
Soil moisture (% - 7 day average)
0
10
20
30
40
50
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Historic range (min to max)
20th - 80th percentile
Median (2007 - 2015)
2016


Northeastern Wairarapa hills (Tanawa Hut)
Soil moisture (% - 7 day average)
0
20
40
60
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Historic range (min to max)
20th - 80th percentile
Median (2007 - 2015)
2016


Masterton (Wairarapa College)
Soil moisture (% - 7 day average)
70
60
50
40
30
20
10
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Historic range (min to max)
20th to 80th percentile
Median (2002 to 2015)
2016


Tauherenikau at Racecourse
Soil moisture (% - 7 day average)
50
40
30
20
10
0
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
2012
2013
2014
2015
2016

## 3. Outlook for autumn 2017

- ENSO to remain neutral, but 50% risk of El Niño developing in the second half of the year;
- Warm sea surface temperatures to the north of New Zealand seem to be breaking the cold pattern, increasing the chances of average to warmer than average compared to the relative cold pattern dominant in summer;
- Variable rainfall, at or below average with irregular spatial and temporal distribution;
- Statistical rainfall projection for central Wairarapa: 67 to 88% of 1980-2010 average, with 78% most likely (see next page for details)

| **Whaitua*** | **Variables** | **Climate outlook for autumn 2017** |
|---|---|---|
| Wellington Harbour & Hutt Valley | Temperature: | Average to above, greater variability of warm and cool temperatures. |
| | Rainfall: | Average to below, long dry periods alternated by heavy rainfall events. |
| Te Awarua-o-Porirua | Temperature: | Average to above, greater variability of warm and cool temperatures. |
| | Rainfall: | Average to below, long dry periods alternated by heavy rainfall events. |
| Kāpiti Coast | Temperature: | Average to above, greater variability of warm and cool temperatures. |
| | Rainfall: | Average to below, long dry periods alternated by heavy rainfall events. |
| Ruamāhanga | Temperature: | Average to above, greater variability of warm and cool temperatures. |
| | Rainfall: | Average to below. Long dry periods alternated by heavy rainfall events. Most likely range for the central-eastern area (Longbush) based on climate analogues: 67 to 88% of the 1981-2010 average, with 78% most likely – see graph below |
| Wairarapa Coast | Temperature: | Average to above, greater variability of warm and cool temperatures. |
| | Rainfall: | Average to below, long dry periods and irregular distribution. Heavy easterly rainfall events possible. |

*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 product 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 MAM rainfall range: 67% to 88% (78% most likely)** of the 1980-2010 average (see Figure 3.1). Confidence: LOW (very small sample and difficulty to find a previous year that largely matches the current pattern).

**Current analogue years:** 1967, 1993, 1994, 2004. It is very rare to have a strong El Niño followed by a neutral year as currently observed. The current analogue years were chosen based on this rare behaviour.

**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 2.3 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:** DJF predicted: 61% to 227% (144% most likely), using the same analogue years; DJF actual observation: 99% of the 1981-2010 average. Hence, the observed conditions for JJA **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 whaitua tables above. GWRC accepts no responsibility for the accuracy of these forecasts.

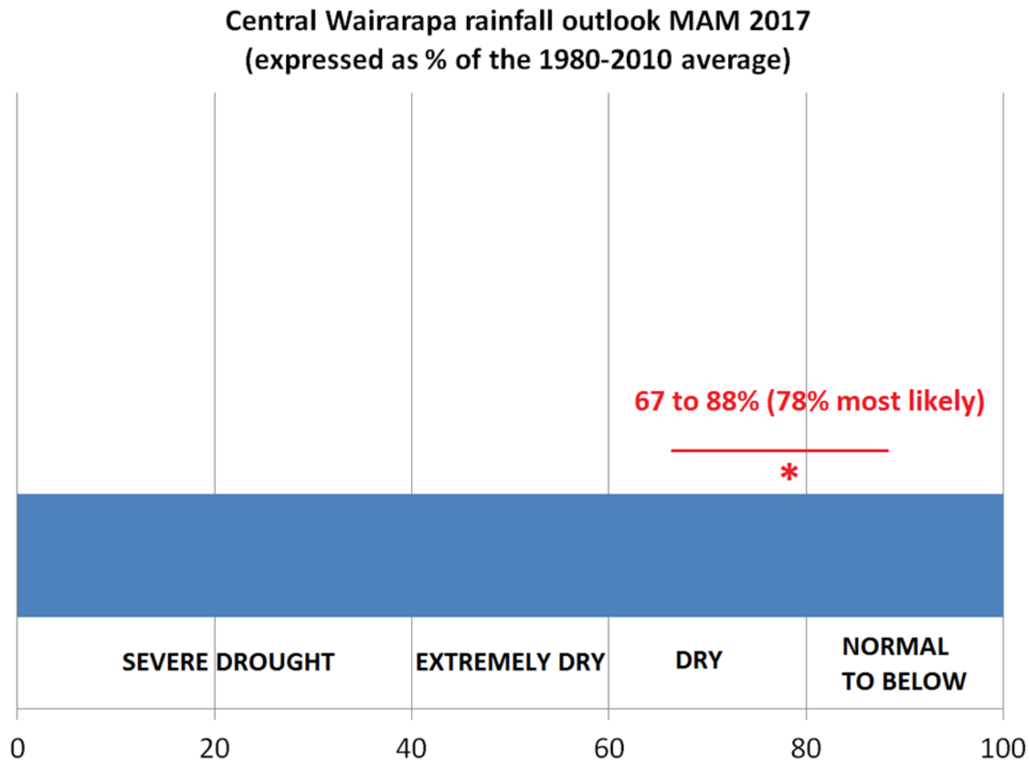



Figure 3.1: Climate analogue statistical rainfall projection using data for Waikoukou, Longbush (see Figure 2.3 for exact location), expressed as percentage range of likely autumn rainfall compared to the 1980-2010 average. Due to the unusual behaviour of the climate drivers as well as the impacts of climate change there is low confidence in the most likely value for this prediction. This statistical prediction is in agreement with the latest seasonal climate outlook released by NIWA, which is also predicting normal to below average rainfall for the Wairarapa (https://www.niwa.co.nz/climate/seasonal-climate-outlook/seasonal-climate-outlook-march-2017-may-2017)

## Acknowledgments

We would like to thank NIWA for providing selected VCSN data points for the calculation of the regional soil moisture map, and the National Oceanic and Atmospheric Administration (NOAA/USA) for making available the satellite-derived drought indices.