greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Climate and water resources Seasonal update

Spring 2016 summary
Summer 2017 outlook

December 2016

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Overview

Spring 2016

Spring brought a very welcome rainfall recharge into most of the Wellington region. This followed a large scale climatic pattern that caused above average rainfall in most of the country, and our region was one of the wettest spots in New Zealand. November was the wettest month by far, receiving near three times the historical rainfall average and record-breaking daily and monthly totals in several areas including Wellington (Kelburn), which had the highest November and spring rainfall totals since records began in 1928. The rainfall distribution was irregular with highly concentrated heavy falls, pressuring our infrastructure and civil defence response during the heaviest episodes. While this irregular nature with possibility of heavy bursts was predicted, the total accumulation far superseded the projections based on the initial climate analogues proposed for central Wairarapa (now revised). A small portion of the north eastern Wairarapa coast however remained drier than average as predicted. Temperatures as a whole were slightly above average and highly variable. In association with the above average rainfall pattern, the Wellington region has also recorded very low sunshine hours, with only about 60% of the theoretical possible number of sunshine hours being observed in some areas such as the Kapiti coast, which had the lowest recorded sunshine hours since 1953 when measurements began.

Reason for the heavy rainfall

As New Zealand is highly influenced by the oceanic temperatures, the relatively warm waters around the country helped bringing more moisture into the atmosphere through evaporation, thus allowing for heavier rainfall rates. This is a pattern that is also expected to get worse with climate change. The ENSO phenomenon in the Pacific Ocean remains neutral, and the risk of La Niña has now considerably lessened. Most climate projections consistently show continuing neutral ENSO conditions for the next two seasons. This pattern, combined with background global warming with warmer than normal waters to the north and south of New Zealand, should add an interesting mix to the climate behaviour.

Climate outlook for summer 2017

Normal to above average temperatures, and around average rainfall. Greater likelihood of extreme weather events, including heavy rainfall alternated by prolonged dry and hot spells. Less reliability of ‘average’ patterns is expected to worsen due to climate change, effectively reducing the predictability based on ‘climate analogues’ of the past.

Contents

1. Climate drivers

1.1 El Niño – Southern Oscillation (ENSO)

The ENSO phenomenon is now completely neutral. Figure 1.1 shows the latest predictions suggest a continuing of the neutral phase at least until the end of winter 2017.

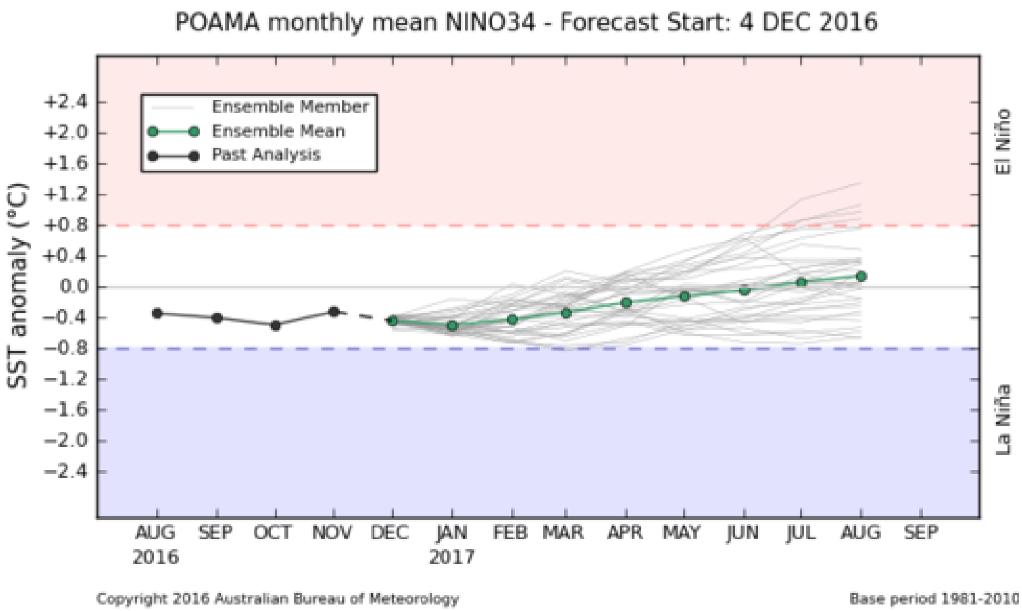


Figure 1.1: ENSO projections until August 2017 show conditions are predicted to be progressively neutral. There are no El Niño or La Niña alerts in place. Source: Australian Bureau of Meteorology.

1.2 Sea ice extent and oceanic temperatures

The oceanic temperature anomalies and the total sea ice extent (in white) are shown in Figure 1.2 for 12th December 2016. Sea ice extent is very important to New Zealand because we are relatively close to Antarctica. The ice strengthens the cold fronts that affect New Zealand during the cold season, delaying the effects of global warming. The Antarctic sea ice extent in November was the lowest on record for the entire satellite era starting in 1979. This represents a drastic reversal from the increased sea ice extent that had been observed in the Southern Hemisphere so far. For the New Zealand summer, the implication is that the waters in the Southern Ocean near Antarctica are warmer than average for the first time in a long time, possibly suggesting more humid cold fronts from the south.

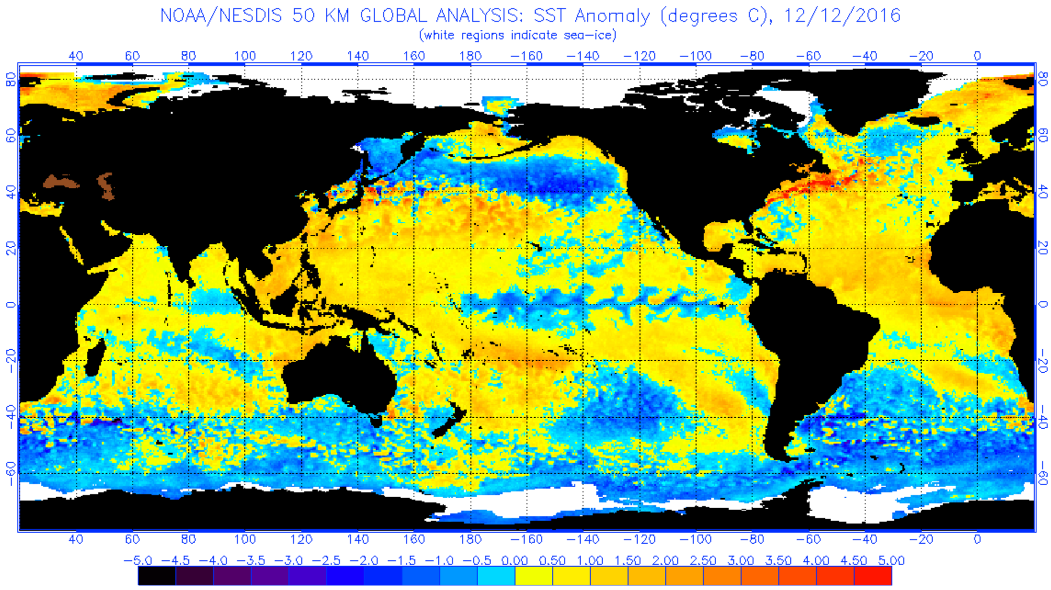


Figure 1.2: Sea surface temperature anomalies for 12th December 2016. Source: NOAA.

1.3 Southern Annular Mode (SAM)

The SAM is the normal 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 November (corridor of low pressure areas indicated by ‘L’), helping explain the abnormal cloud cover and excessive rainfall affecting our region. It is not 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.

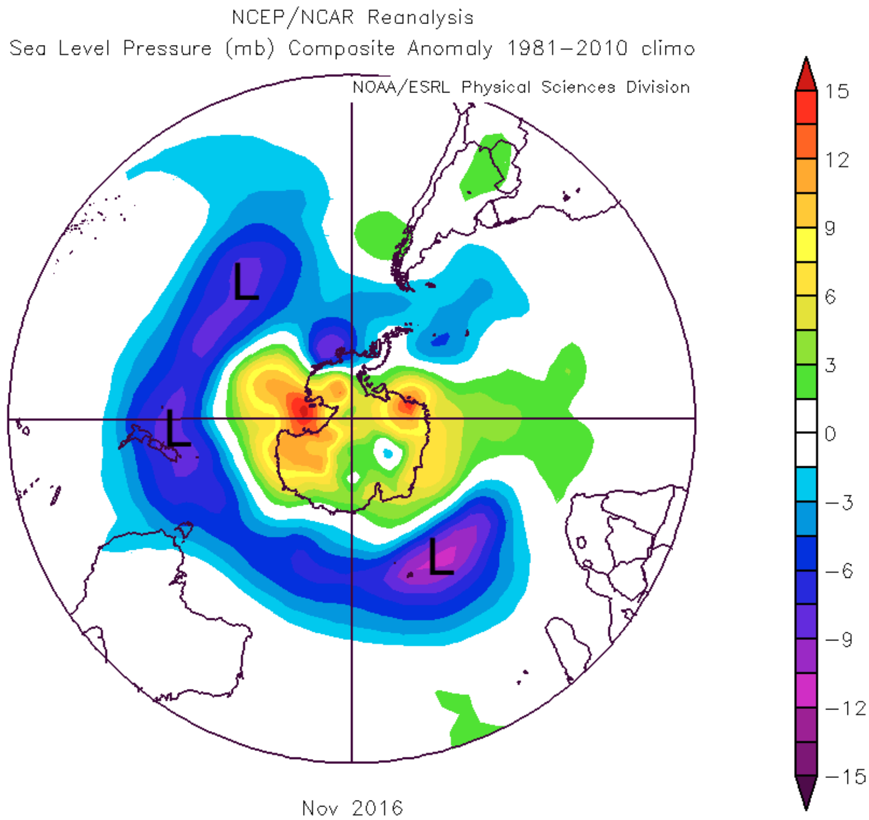


Figure 1.3: Sea level pressure anomalies for November 2016. The negative SAM affecting New Zealand with unstable weather and above average rainfall is shown by the series of troughs depicted by 'L'. Source: NCEP Reanalysis.

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 8th December 2016. As a result of the rainfall recharge in spring most of the region is now "stress-free", showing a great improvement compared to the same time last year. It is important to note that the satellite index gives an overview of "dryness" as felt by the vegetation, compared to normal. As such, this index is not a formal drought assessment as it does not take into account how dry the soil is underneath the surface.

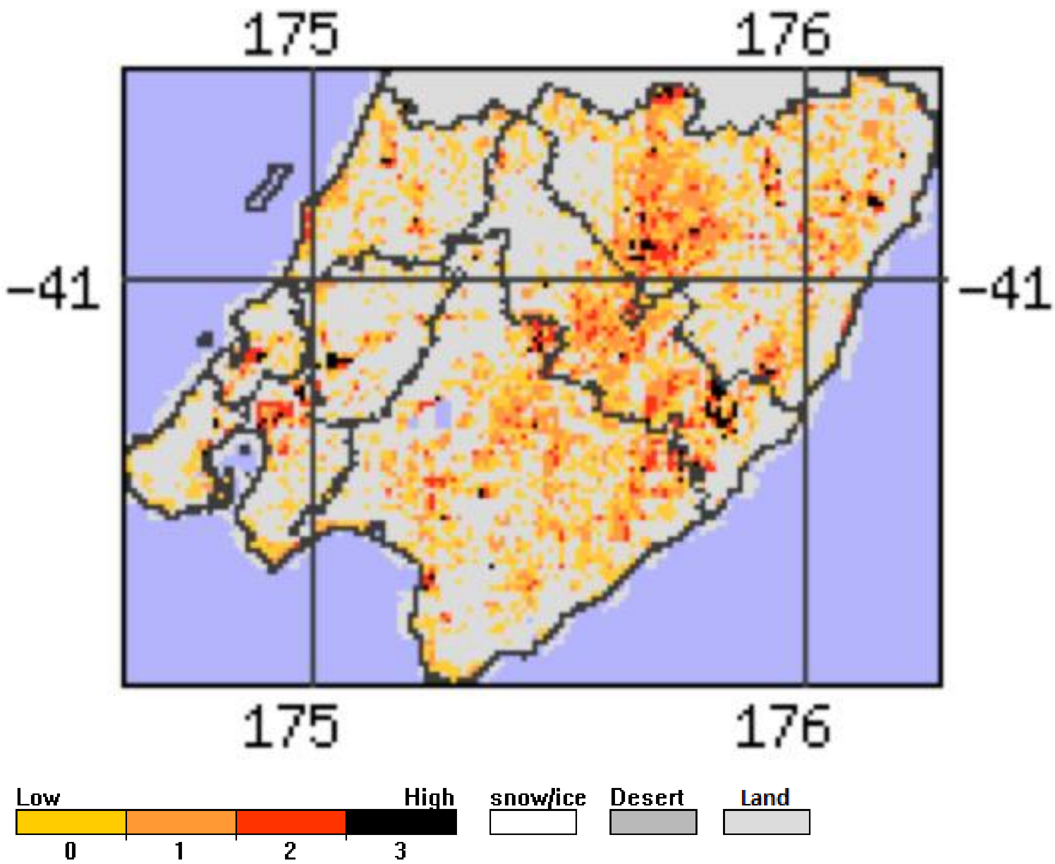


Figure 2.1: Satellite-derived "Vegetation drought-stress" index for the week ending 8th Dec 2016. Drought index scale shows the potential drought risk: 0 (moderate or no stress), 1 (severe stress), 2 (extreme stress), 3 (exceptional stress). The index is relative to a 25 year period base climatology 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 6th December 2016. Most of the region's soil moisture is estimated to be around average (i.e., anomalies between -10 and +10 mm). Only small areas along the Wairarapa coast, especially in the far north east, are showing below average soil moisture. Even then, the satellite-derived vegetation drought stress index shown on Figure 2.1 does not suggest an appreciable risk of immediate dryness in those areas as far as the vegetation health is concerned.

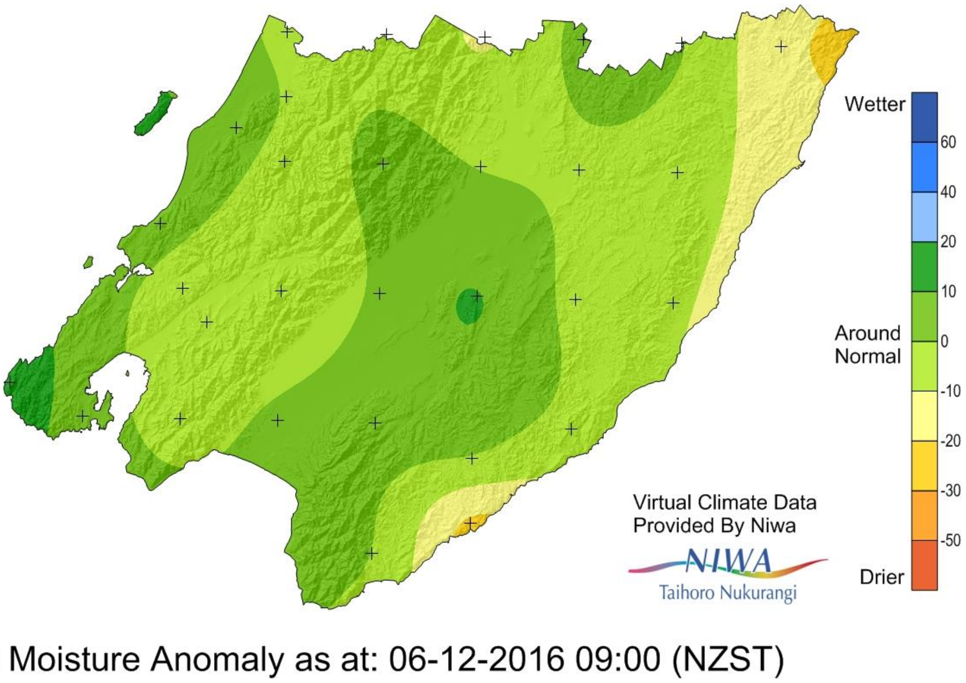


Figure 2.2: Soil moisture anomaly for 6th December 2016. Moisture levels show a great improvement compared to the same time last year. Below average moisture areas are seen only in small patches along the eastern Wairarapa coast. Source: GWRC, using selected Virtual Climate Station Network (VCSN) data 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 spring rainfall expressed as a percentage of the long-term average. Most of the region shows much greater than average rainfall totals, especially in the west, south and in central Wairarapa south of Masterton. A small section of the far north eastern coast was the only area that remained with below average rainfall. 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 about 150% of the 1980-2010 rainfall average.

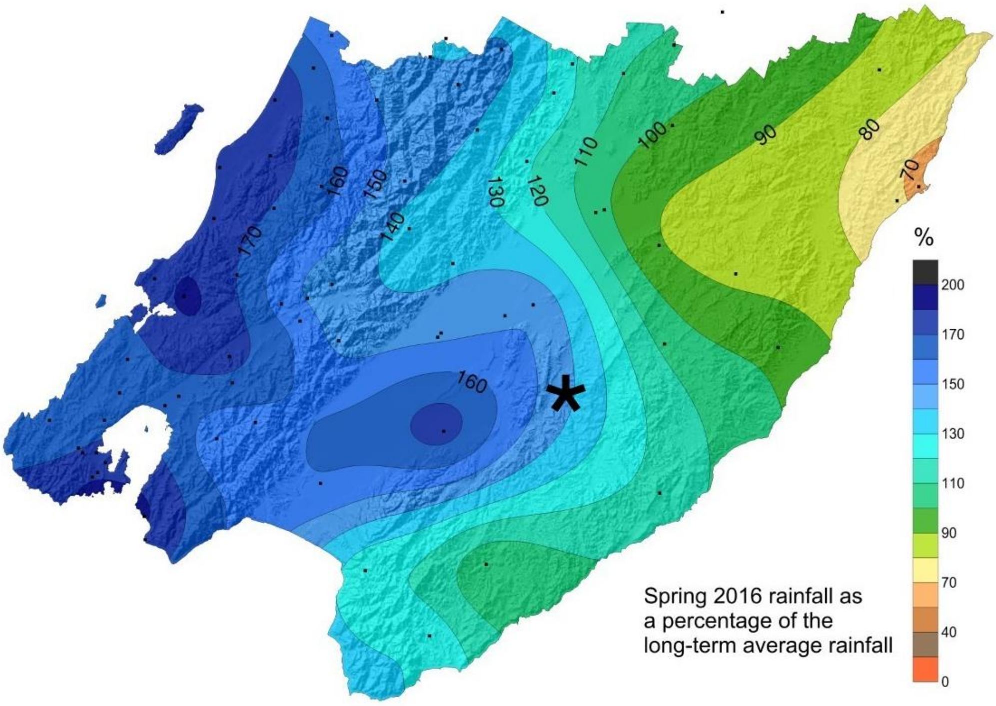


Figure 2.3: Rainfall for spring 2016 as a percentage of the long-term average. A large contrast is seen between above average conditions for most of the region and dry conditions in a fairly small sector of the north eastern Wairarapa coast. The asterisk shows the location of the rainfall time series 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.

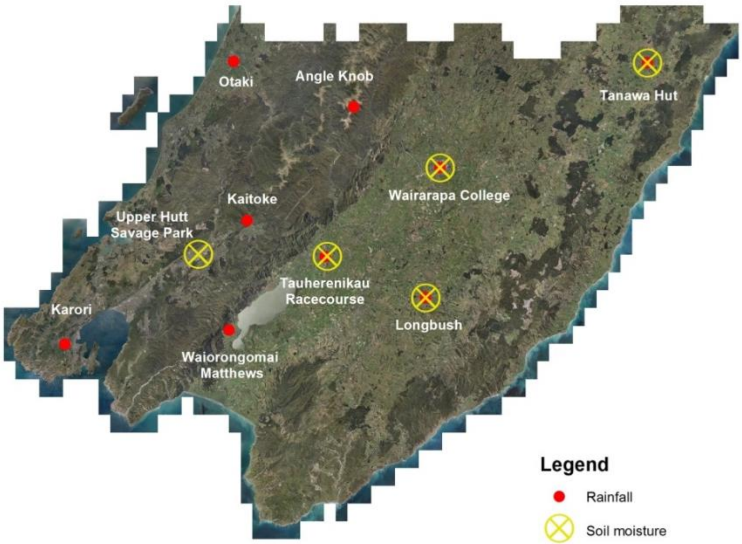


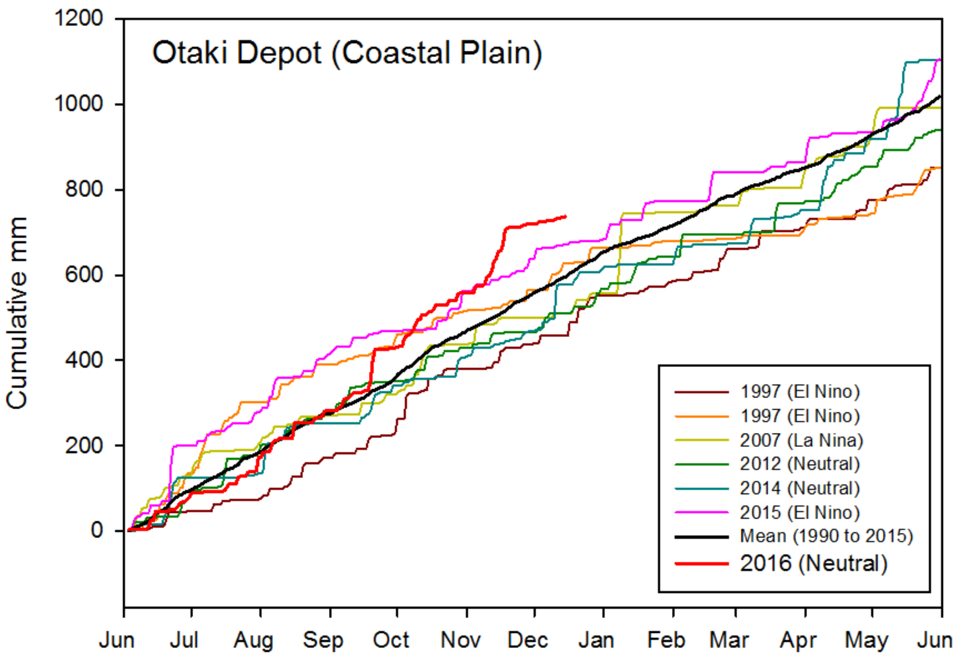
Figure 2.4: Map of GWRC rainfall and soil moisture monitoring locations

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

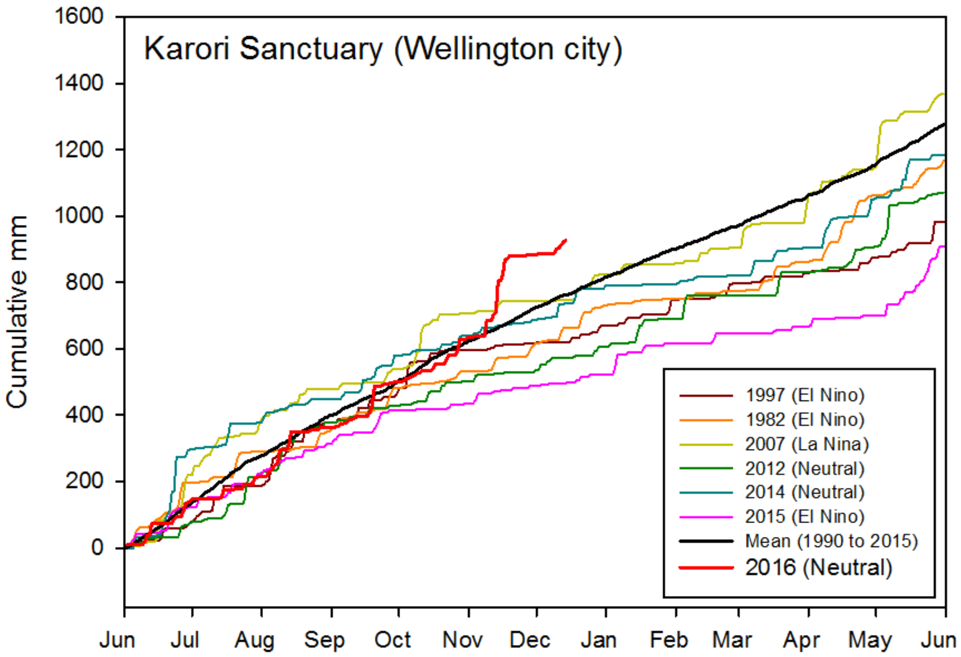
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year for several years. For comparative purposes, cumulative plots for selected historic years with notably dry summers in the Wairarapa have been included, as well as the site average. Many of the GWRC telemetered 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 have been well above normal in the western part of the region and the Tararua Range, primarily due to the exceptionally high November rainfall. The benefit of the November rain is also seen in the west and south of the Wairarapa where there has been a recovery to relatively normal accumulations for this time of year after a very dry winter and early spring. Accumulations remain lower than average in northern Wairarapa and especially low farther east (e.g. Tanawa Hut) where the November rain was not exceptional.

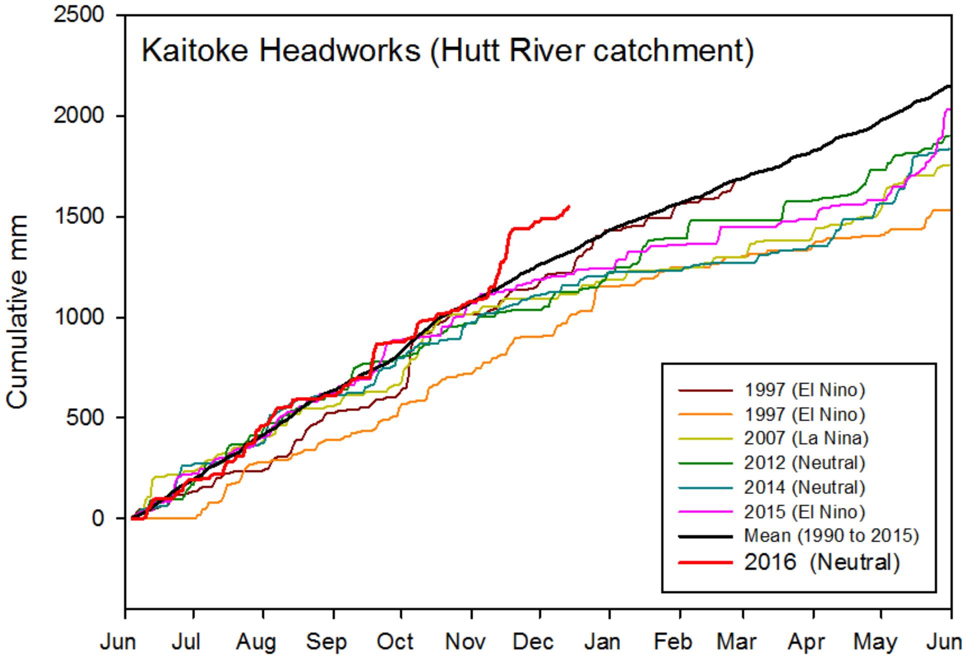
Kapiti Coast

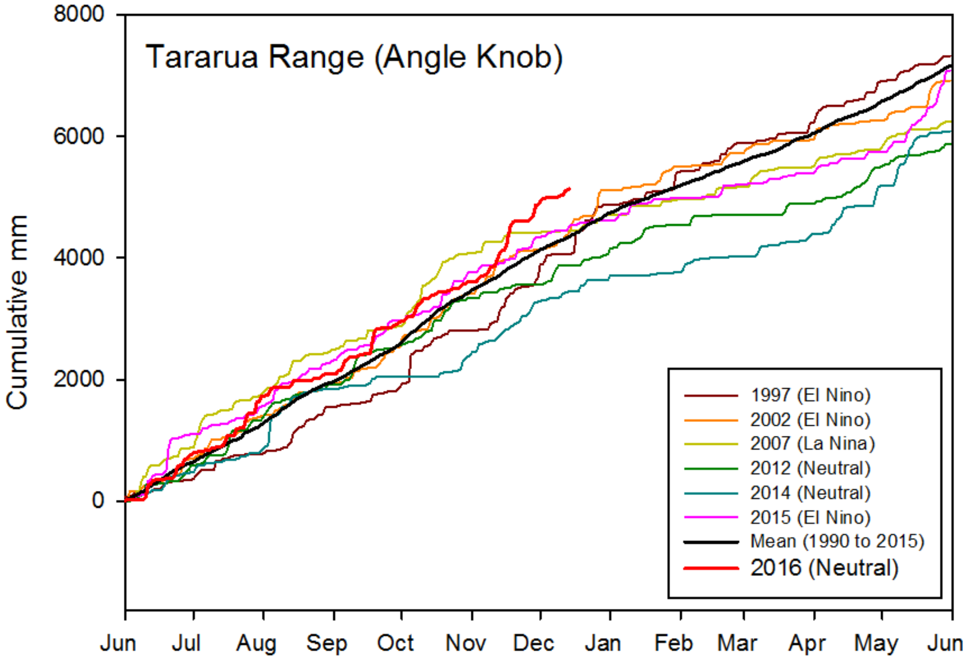


Southwest (Wellington city)

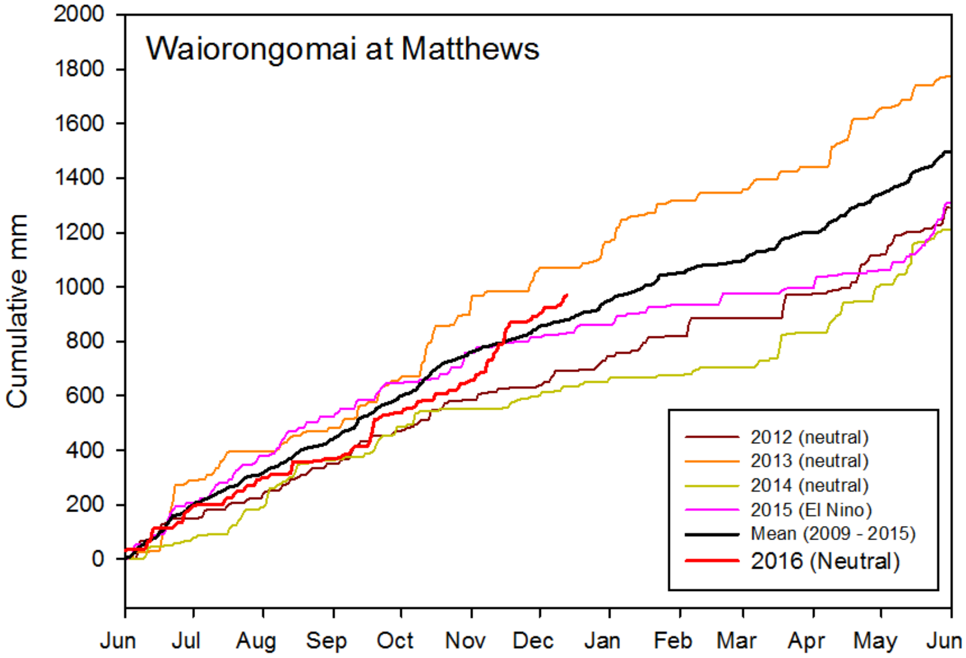


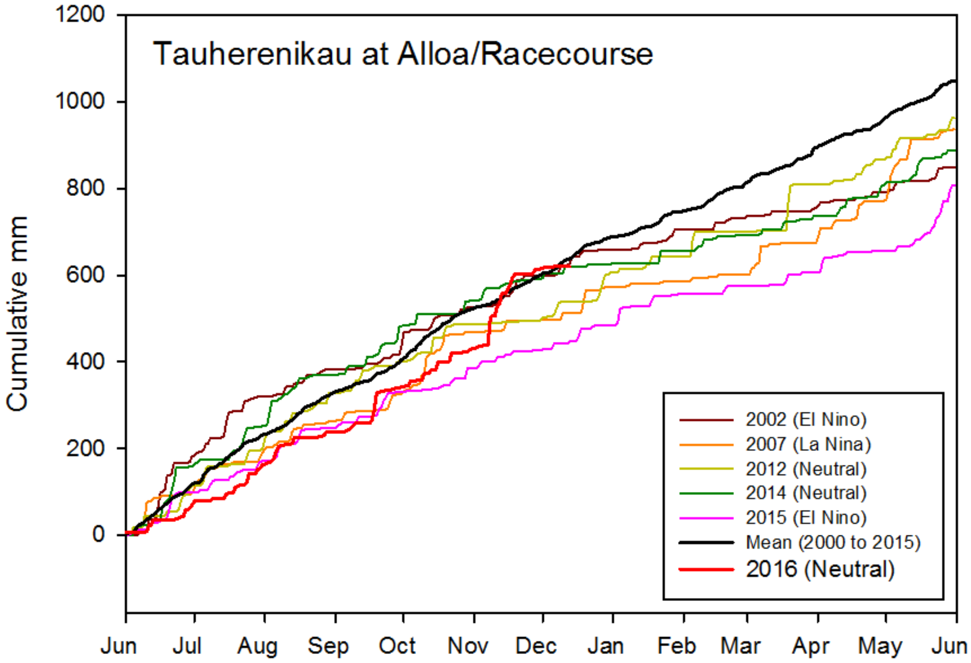
Hutt Valley and Tararua Range

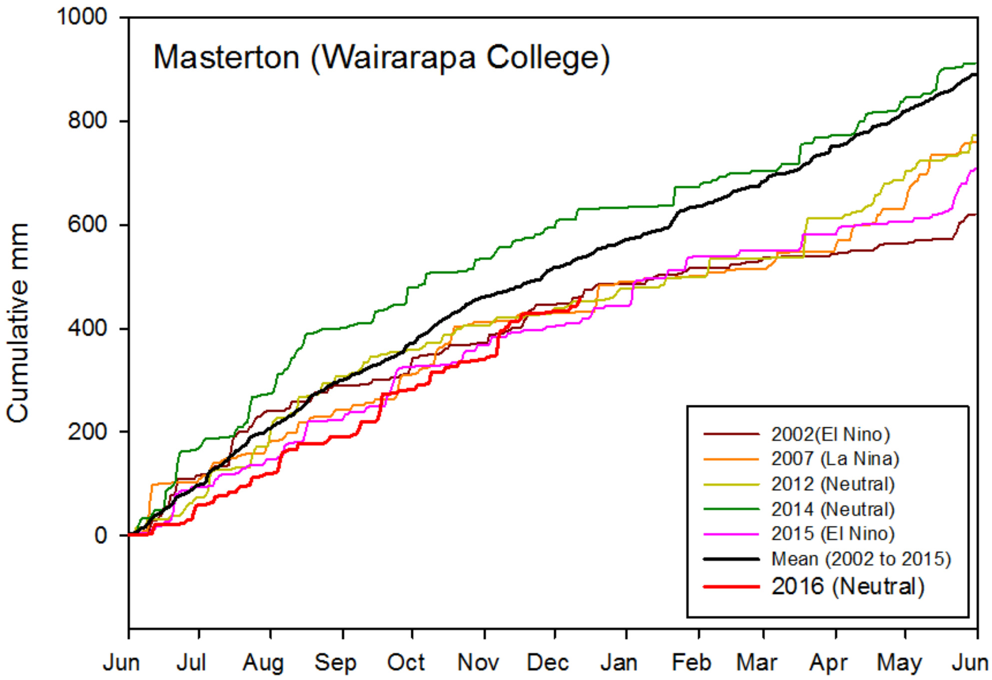


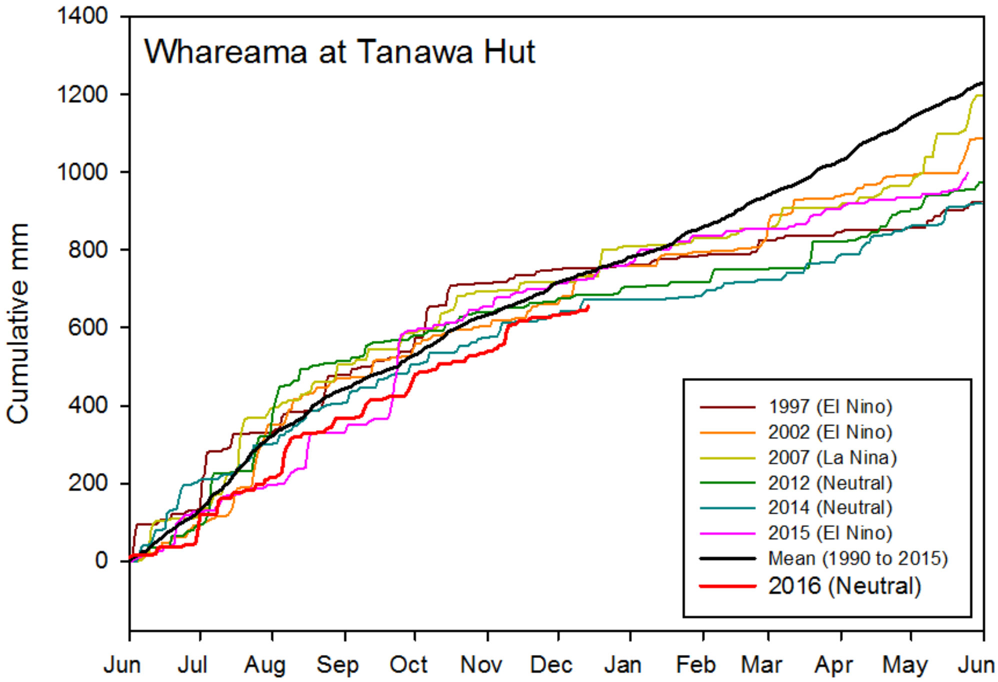


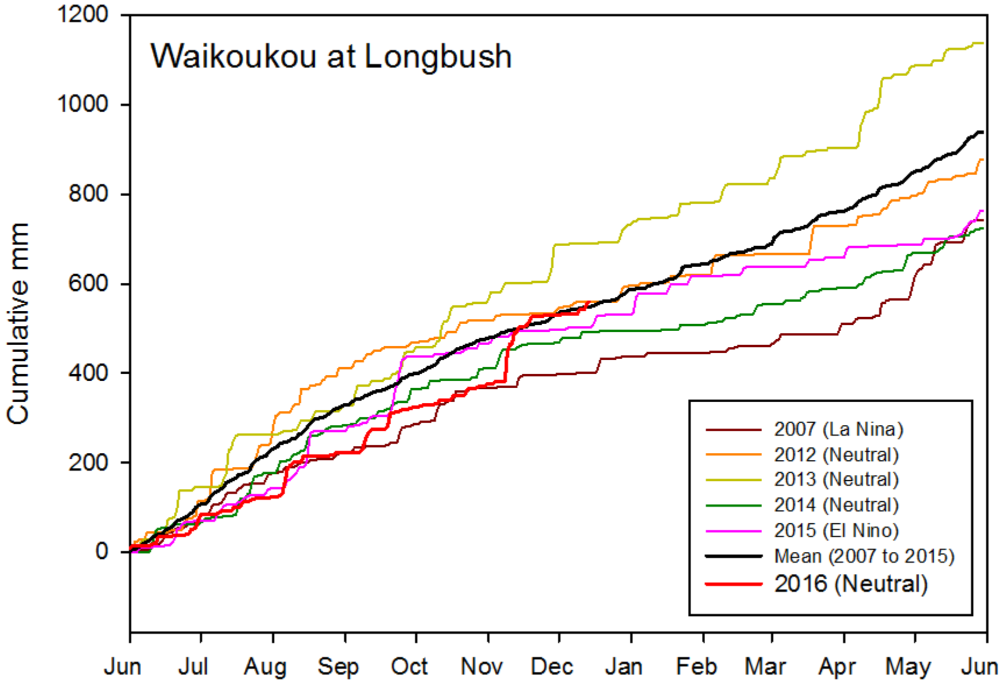
Wairarapa


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)



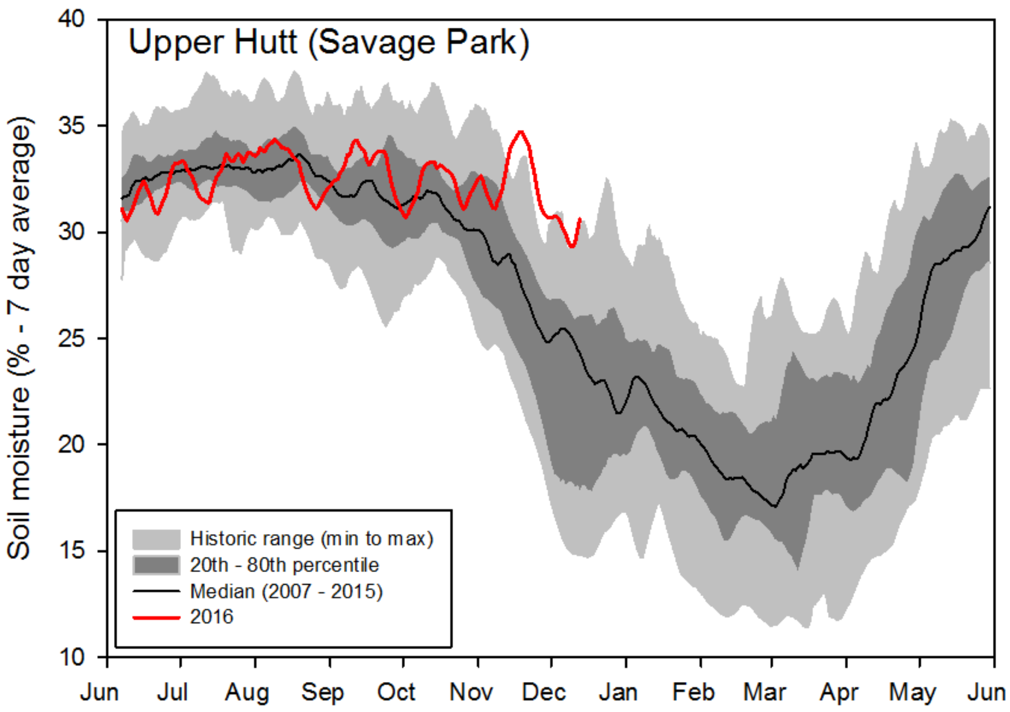
Waikoukou at Longbush
Cumulative mm
1200
1000
800
600
400
200
0
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
2007 (La Nina)
2012 (Neutral)
2013 (Neutral)
2014 (Neutral)
2015 (El Nino)
Mean (2007 to 2015)
2016 (Neutral)

2.4.2 Soil moisture content (1 June to 31 May)

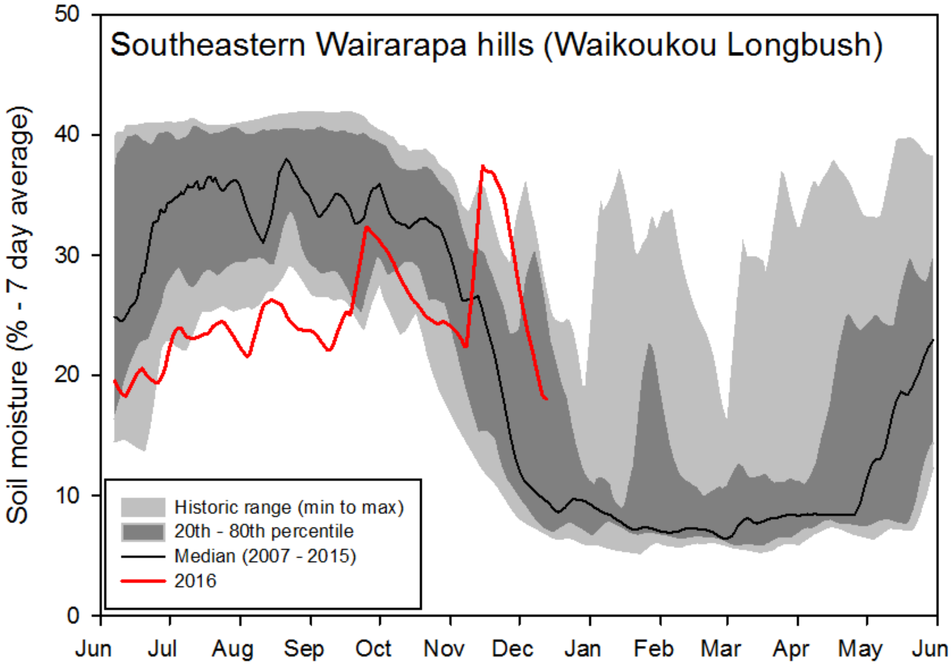
The soil moisture plots show seven day rolling average soil moisture (%) for the hydrological year. An envelope plot of the historic range of data (and site mean) is also provided to give an indication of how the current soil moisture compares with that for a similar time of the season in past years. 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.

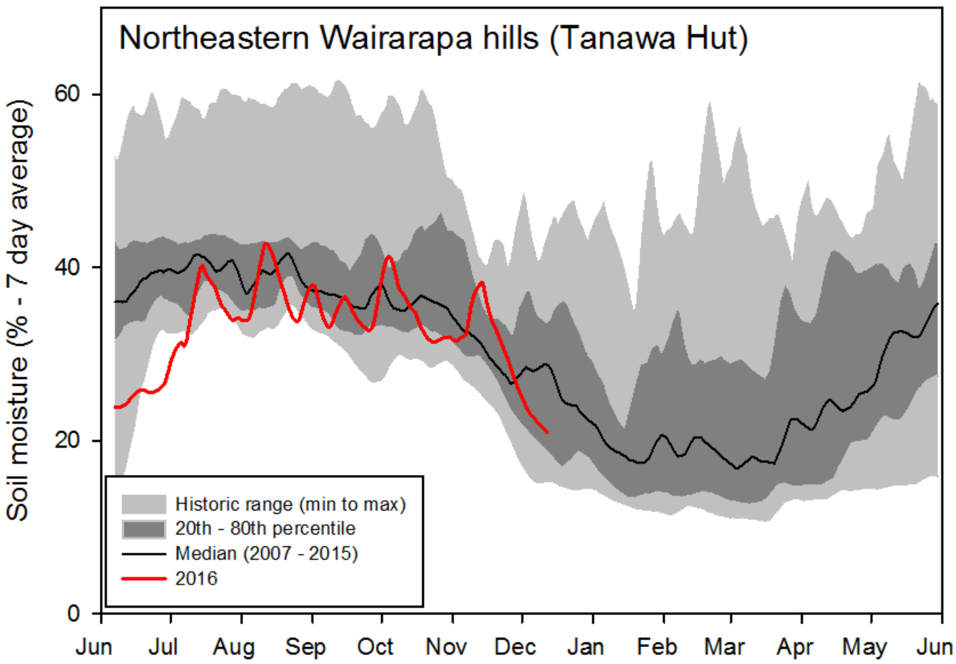
Soil moisture levels in the western part of the region are much higher than normal for this time of year. In fact, data from the Upper Hutt site indicates moisture levels have declined very little since mid-winter and are now at a near-record high for this time of year (based on monitoring since 2003). Soils are drier in the Wairarapa, but not outside normal range for this time of year. The benefit of the high November rainfall is evident, especially in southern Wairarapa where late winter soil moisture levels were at a record low and a significant recovery has now occurred.

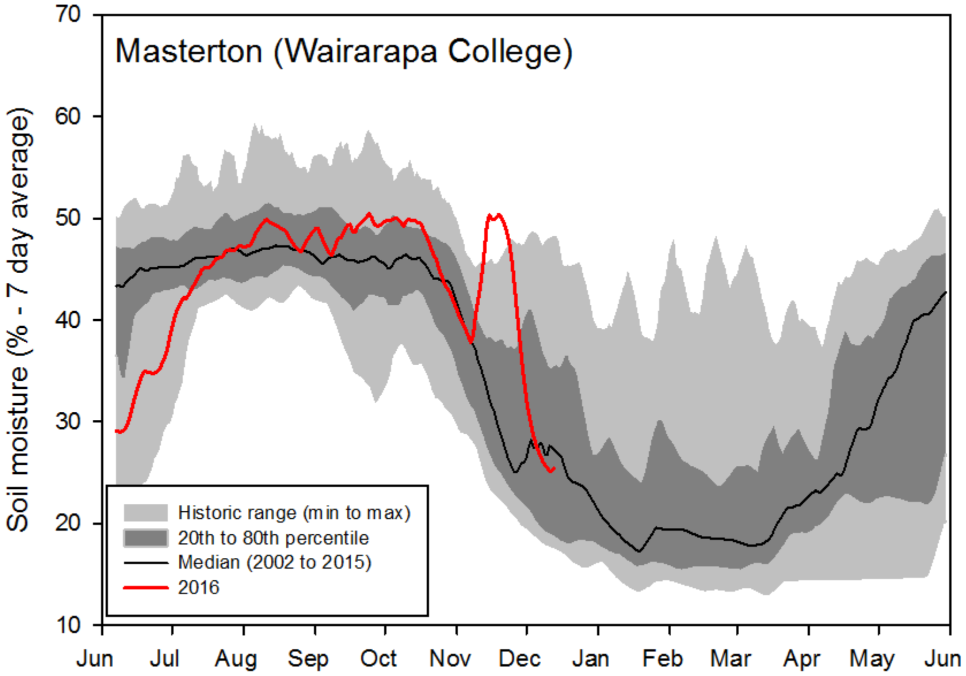
Hutt Valley

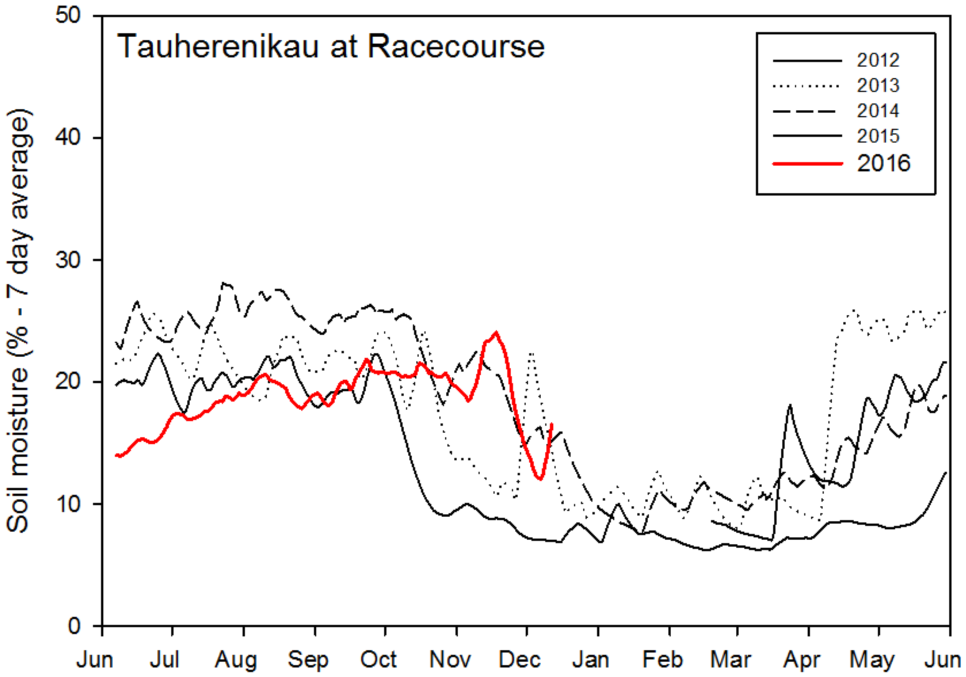


Wairarapa


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


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


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 summer 2017

- ENSO to remain neutral;
- Warm sea surface temperatures to the north and south of New Zealand increasing the chances of warmer than average, and more atmospheric moisture with heavy rainfall episodes;
- Variable rainfall, at or above average for some areas but irregular spatial and temporal distribution;
- Statistical rainfall projection for central Wairarapa: 61 to 227% of 1980-2010 average, with 144% most likely (see next page for details)

Whaitua*	Variables	Climate outlook for summer 2017
Wellington Harbour & Hutt Valley	**Temperature:**	Average to above, greater variability of hot and cool temperatures.
	Rainfall:	Around average, long dry periods alternated by heavy rainfall events.
Te Awarua-o-Porirua	**Temperature:**	Average to above, greater variability of hot and cool temperatures.
	Rainfall:	Around average, long dry periods alternated by heavy rainfall events.
Kāpiti Coast	**Temperature:**	Average to above, greater variability of hot and cool temperatures.
	Rainfall:	Around average, long dry periods alternated by heavy rainfall events.
Ruamāhanga	**Temperature:**	Average to above, greater variability of hot and cool temperatures. Possibility of significant hot spells.
	Rainfall:	Around average, irregular distribution. Long dry periods alternated by heavy rainfall events. Most likely range for the central-eastern area (Longbush) based on climate analogues: 61 to 227% of the 1981-2010 average, with 144% most likely – see graph below
Wairarapa Coast	**Temperature:**	Average to above, greater variability of hot and cool temperatures. Possibility of significant hot spells.
	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 DJF rainfall range: 61% to 227 % (144% most likely) of the 1980-2010 average (see figure 3.1). NOTE: The very large likely interval is due to the mixed climate signal during neutral ENSO conditions. This means that there is LOW confidence in the most likely value.

Current analogue years: 1967, 1993, 1994, 2004.

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: SON predicted: 57% to 94% (75% most likely), using different analogue years that have now been superseded; SON actual observation: 151% of the 1981-2010 average. Hence, the observed conditions for JJA fell outside the predicted range using climate analogues. The previous score has failed in part because a transition to weak La Niña was expected at that time, but this did not eventuate. 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. If these years had been chosen for the last spring the most likely range would have been 142% of the average, i.e., very close to the observed rainfall.

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 at least four of the seven provided climate analogues, 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.

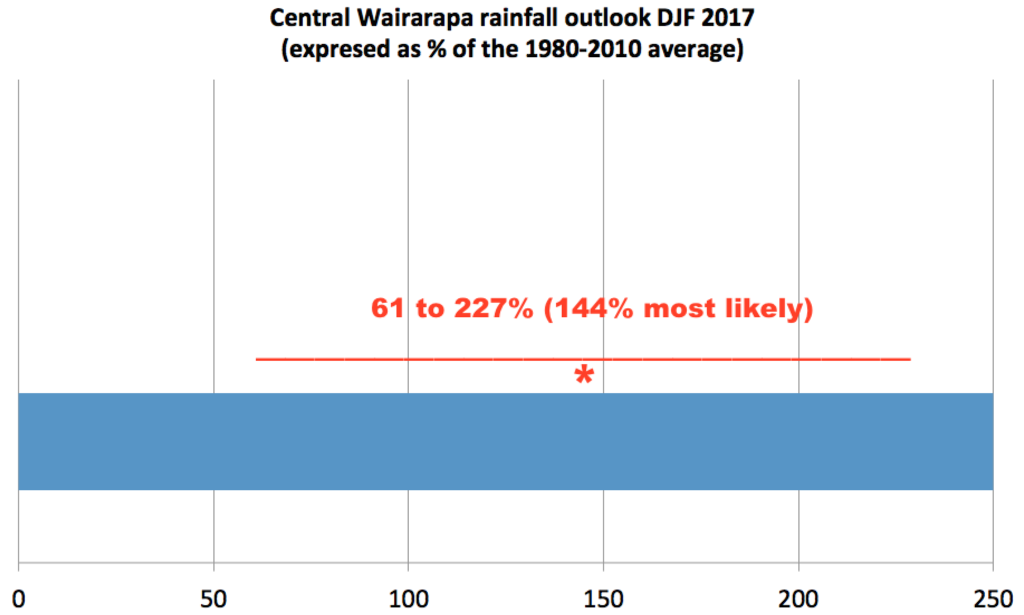


Figure 3.1: Climate analogue statistical rainfall projection using data for Waikoukou, Longbush (see Figure 2.3 for exact location on the map), expressed as percentage range of likely summer rainfall compared to the 1980-2010 average. Due to the large range predicted there is little confidence in the actual most likely value, but the graph shows that there are some reasonable chances of above average rainfall.

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.