Climate and water resources Seasonal update

Autumn 2017 summary
Winter 2017 outlook

June 2017

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Overview

Autumn 2017

Following from a highly unsettled summer, the wet weather continued throughout autumn in the Wellington region. The temperatures were much closer to normal compared to the markedly cold summer pattern, but still leaning towards the cool side. Rainfall in the Wairarapa was below average in March and May, which was the predicted pattern according to the climate analogues. However, the influence of two ex-tropical cyclones in a row in April brought the overall seasonal rainfall total to about one and a half the long-term average in some areas. Unfortunately the influence of ex-tropical cyclones cannot be predicted by climate models, due to the smaller scale of these systems. More information about the impacts of ex-tropical cyclones on the regional rainfall is presented in the warm season report:

http://www.gw.govt.nz/assets/Our-Environment/Environmental-monitoring/Environmental-Reporting/Climate-and-Water-Resource-Summary-Warm-Season-2017.pdf

Climate drivers

As discussed above, overall the weather patterns were more settled in autumn, but the influence of ex-tropical cyclones dramatically increased the overall rainfall totals that would otherwise have happened. One of the key climate drivers that affect New Zealand, the Southern Annular Mode (SAM), remained between about neutral and slightly positive during the season, contributing to the relative increase in the number of settled days in between the heavy rainfall bursts. The ENSO (El Niño – Southern Oscillation) has been neutral and will likely remain so, apart for a slightly increased chance of a weak El Niño by the end of the year according to some international models. New Zealand is highly influenced by the nearby oceanic temperatures, and the Sea Surface Temperature (SST) around the country was slightly above average. The best model guidance suggests that this pattern will persist during winter, moderating the influence of occasional cold outbreaks. The sea ice extent (SIE) around Antarctica has been near lowest on record for this time of the year, further suggesting that cold waves would be moderated by this factor.

Climate outlook for winter 2017

Based on the neutrality of the climate drivers, both temperature and rainfall should be around normal this winter. Odds favour weaker frosts due to the elevated soil moisture content at the start of the season and the warm oceanic temperatures around New Zealand. Heavy rainfall events are possible, with the climate analogues suggesting a wetter than normal winter in parts of the Wairarapa.

Contents

1. Climate drivers

1.1 El Niño – Southern Oscillation (ENSO)

The ENSO phenomenon remains neutral, even though the equatorial Pacific Ocean has been somewhat on the warm side. There is a 50% chance of a weak El Niño developing by the end of the year when considering a range of international climate models, but the Australian model from the Bureau of Meteorology continues to suggest neutral conditions (Figure 1.1).

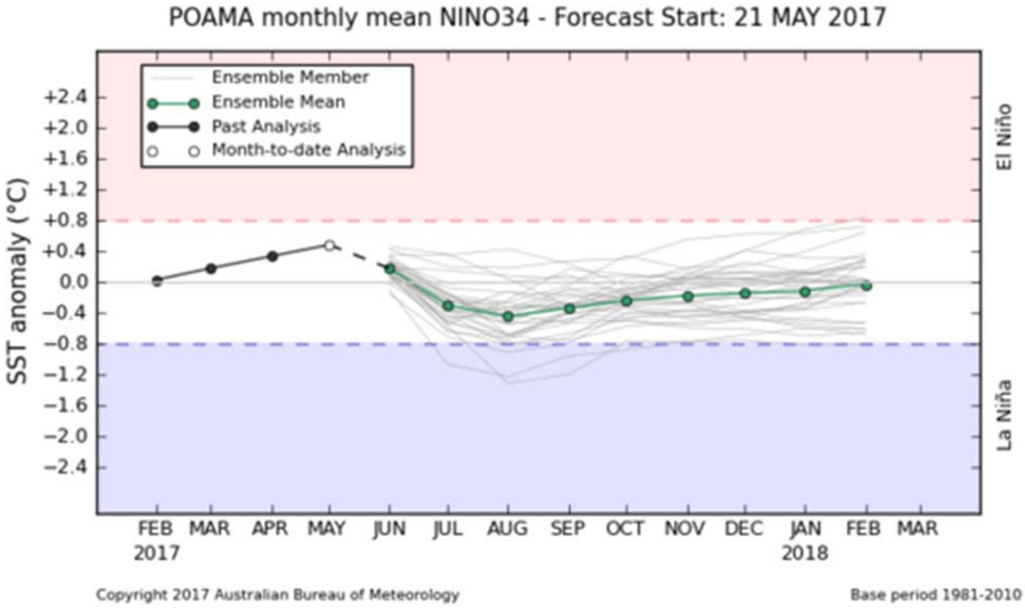


Figure 1.1: ENSO projections until February 2018 show conditions are tracking around neutral based on the Australian model. The Australian Bureau of Meteorology is however keeping the possibility of an El Niño forming by the end of the year at 50%, due to the fact that around half of the available international models are predicting warming conditions by the end of 2017. 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 29 May 2017. The Antarctic sea ice extent continues to track well below average for this time of the year, with the May value being the second lowest on record, for data starting in 1979. The SSTs remained just slightly above average around New Zealand during the last season, although with some oscillating patches of colder than average water influencing the east coast. This easterly cold tongue may have contributed to the persistence of air temperatures still on the cooler side for most of the Wellington region during autumn, but climate models continue to indicate that warmer than average waters are expected to prevail over the next few months.

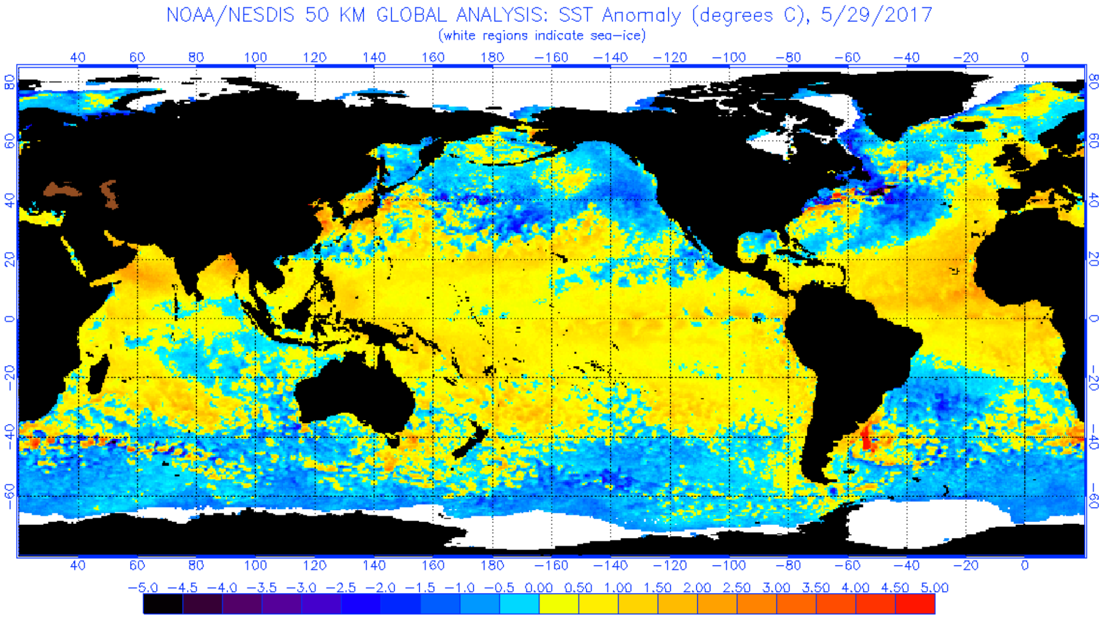


Figure 1.2: Sea surface temperature (SST) anomalies for 29 May 2017. Sea ice coverage is shown in white. Colder than average waters are seen in the high latitude belt around Antarctica (just north of the sea ice), while warmer than average values are seen north of New Zealand. Source: NOAA.

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 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 more on the positive side in autumn, with a high pressure dominating southwest of New Zealand (indicated by ‘H’) and low pressures around Antarctica. This area of high pressure ‘blocked’ the flow, causing more north-easterly winds in the North Island and easterlies in the South Island.

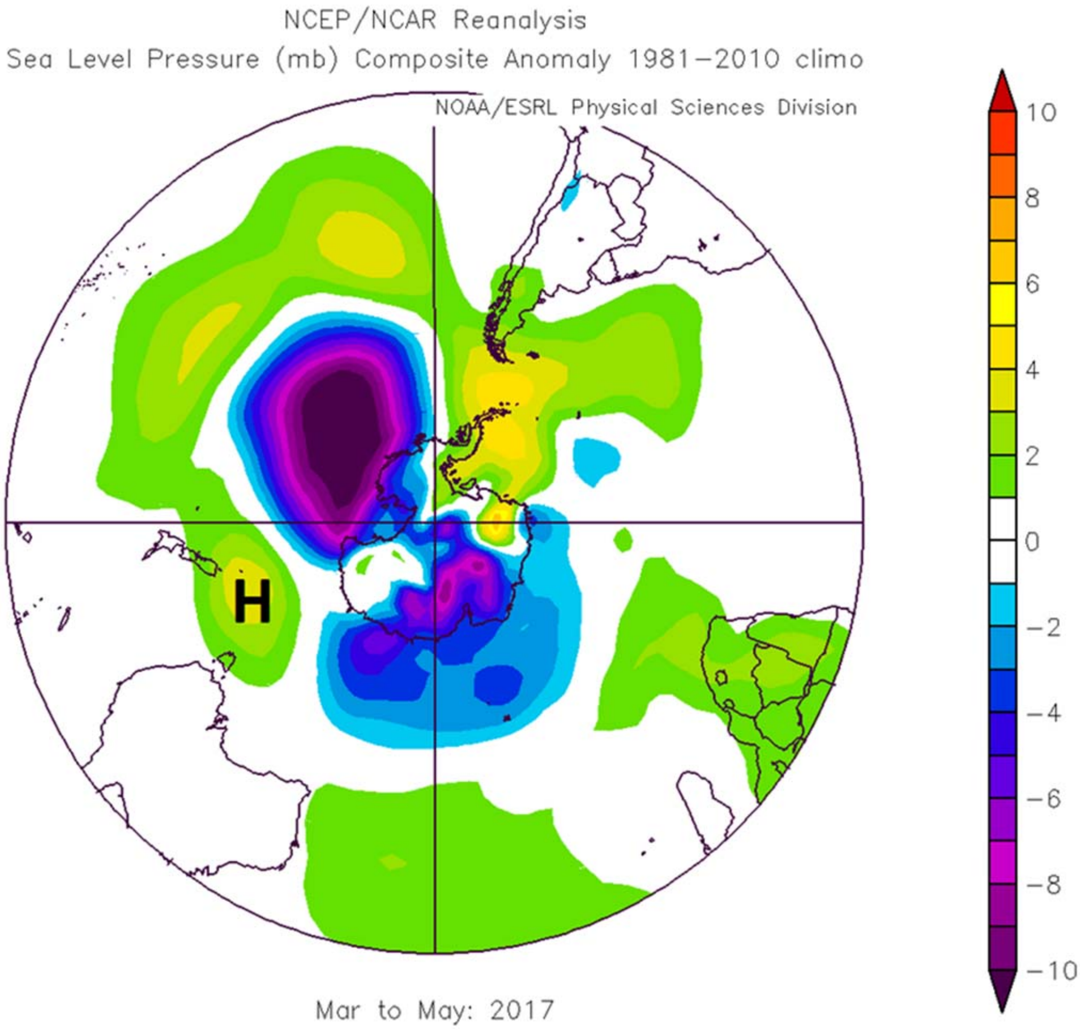


Figure 1.3: Sea level pressure anomalies for MAM 2017. The H indicates the area of high pressure southwest of New Zealand that helped bringing more north-easterly winds over the North Island. Source: NCEP Reanalysis.

2. What is the data showing?

2.1 Regional temperature

Figure 2.1 shows the maximum and minimum temperature anomalies for the region based on all monitoring sites available from GWRC, NIWA and Metservice (indicated by dots). We can see an interesting pattern with cooler than average maximum (daytime) temperatures and warmer than average minimum (nighttime) temperatures for most of the region, reflecting increased cloud cover with lower than normal sunshine hours. The coldest spot was on the Wairarapa coast, and the warmest anomalies were around the Kapiti coast. This pattern is related to the SSTs discussed earlier, which are warmer in the Tasman Sea and cooler to the southeast of New Zealand.

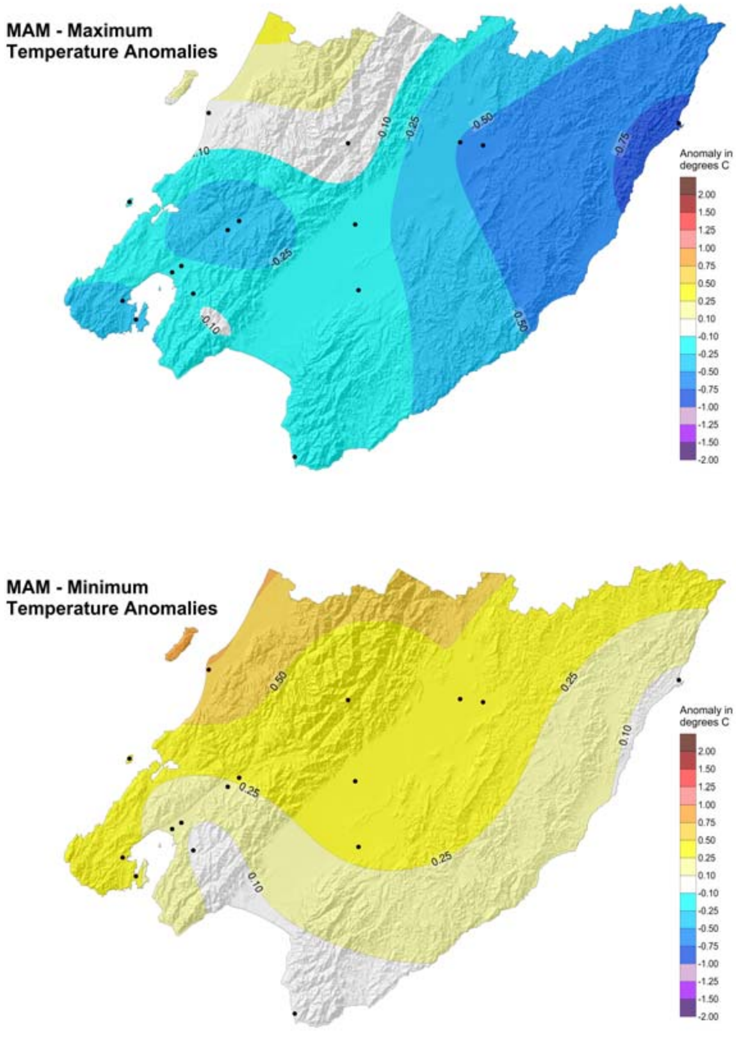


Figure 2.1: Daily Average Max and Min temperature anomalies for MAM. Source: GWRC, using station data from the GWRC, NIWA and MetService networks.

2.2 Regional soil moisture assessment

Figure 2.2 shows the latest soil moisture anomaly for the region, as of 5 June 2017. Most of the southern part of the region shows above average soil moisture. There is no area of soil water deficit observed anywhere in the region at present, as a result of the above average rainfall during the last two seasons.

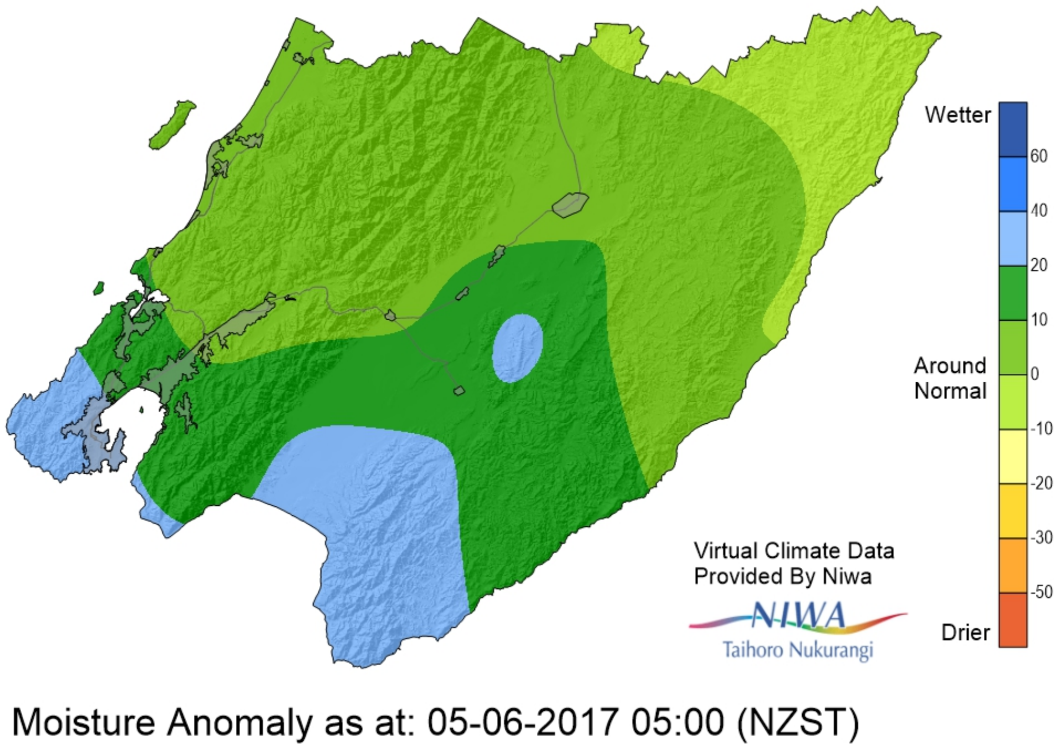


Figure 2.2: Soil moisture anomaly for 5 June 2017. Moisture levels show above normal conditions for most of the region, especially in the south. Source: GWRC, using selected Virtual Climate Station Network (VCSN) data kindly provided by NIWA. Note that this data is indirectly calculated by modelling and interpolation techniques, and does not necessarily reflect the results obtained by direct measurements (compare with Section 2.3). This map should only be used for a general indication of the spatial variability.

2.3 Regional rainfall

Figure 2.3 shows the regional autumn rainfall expressed as a percentage of the long-term average. Most of the region shows greater than average rainfall totals with only the Wairarapa coast showing totals slightly below average. The area around Masterton had almost double the expected autumn rainfall based on the long-term averages.

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 141% of the 1980-2010 rainfall average over the autumn period. As discussed earlier, this figure was significantly influenced by concentrated heavy falls in April under the influence of two ex-tropical cyclones with a short time interval between the two cyclones.

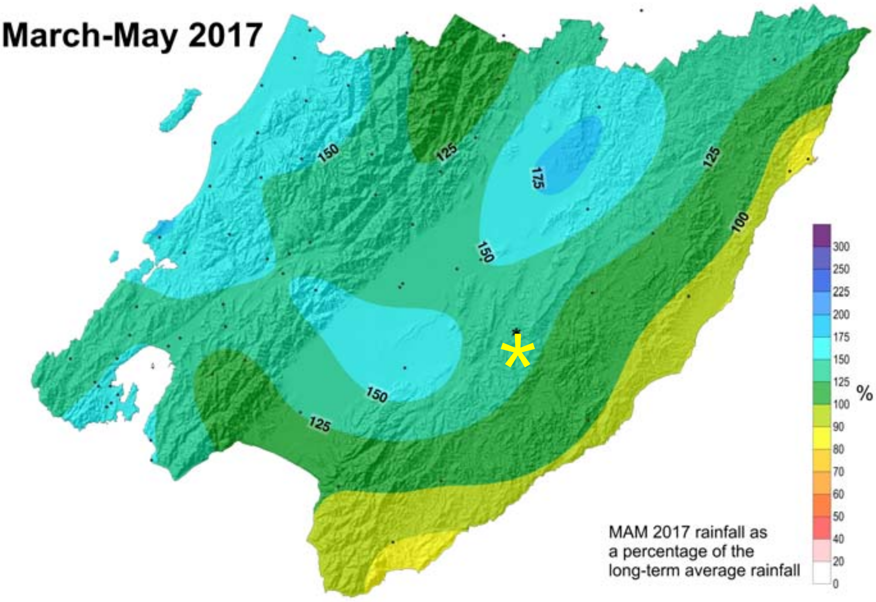


Figure 2.3: Rainfall for autumn 2017 as a percentage of the long-term average. Above average rainfall is seen for most of the region, except the Wairarapa coast. The asterisk shows the location of the rainfall time series at Waikoukou, Longbush, used for the climate analogues rainfall projection (see 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.

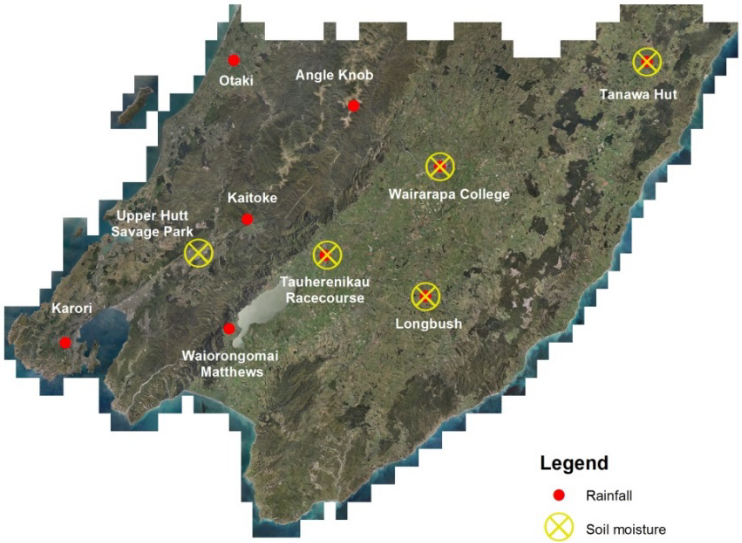


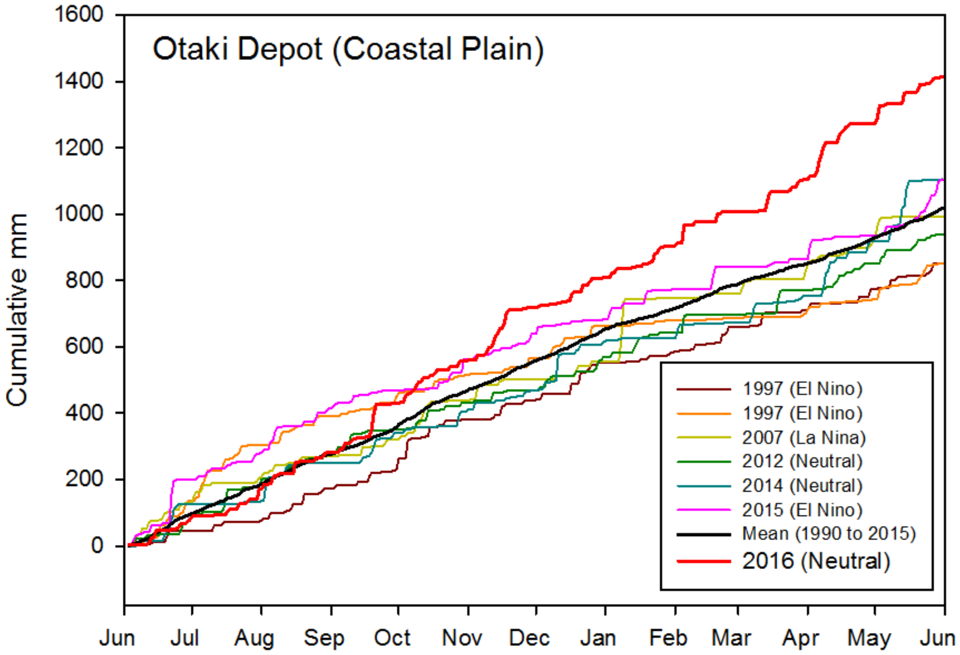
Figure 2.4: Map of GWRC rainfall and soil moisture monitoring locations

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

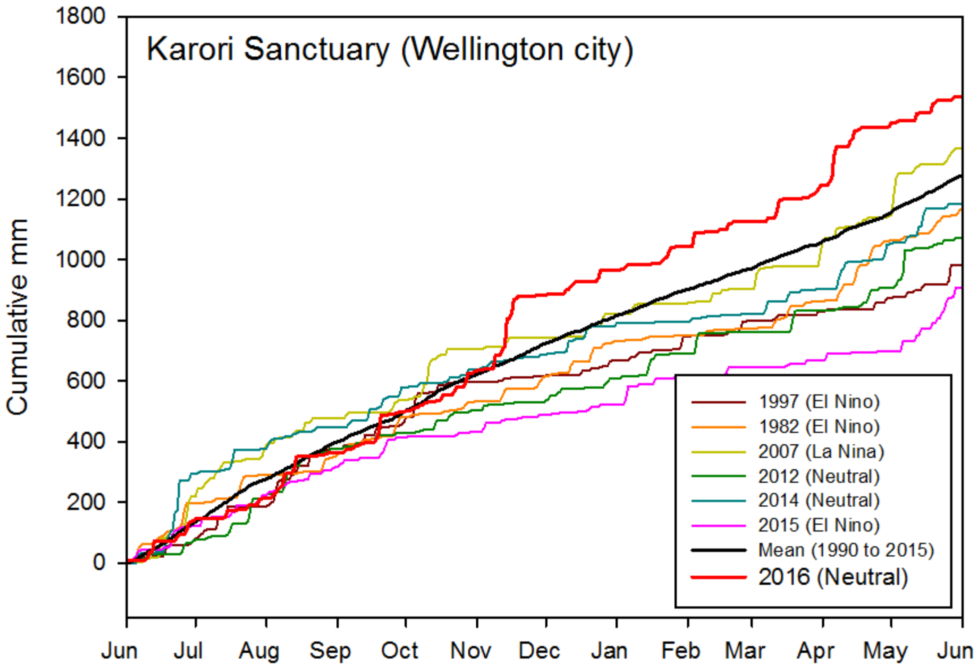
The following rainfall plots show total rainfall accumulation (mm) for the hydrological year for several years. For comparative purposes, cumulative plots for selected historic years with notably dry summers in the Wairarapa have been included, as well as the site average. Many of the GWRC telemetered 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 for the year July 2016 to June 2017 (labelled 2016 on the plots) have been above normal across the region and well above normal in the west and the Tararua Range. In the Wairarapa, about half of the autumn rain fell in one event towards the beginning of April. Without this event, rainfall totals for the year in the central to eastern parts of the Wairarapa would have been about average.

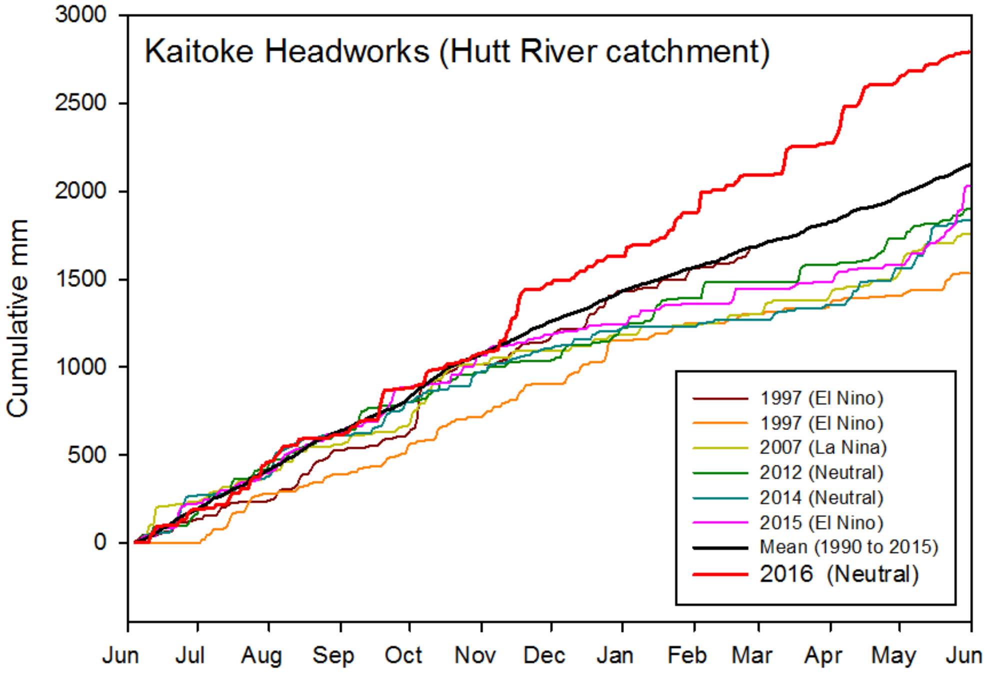
Kapiti Coast

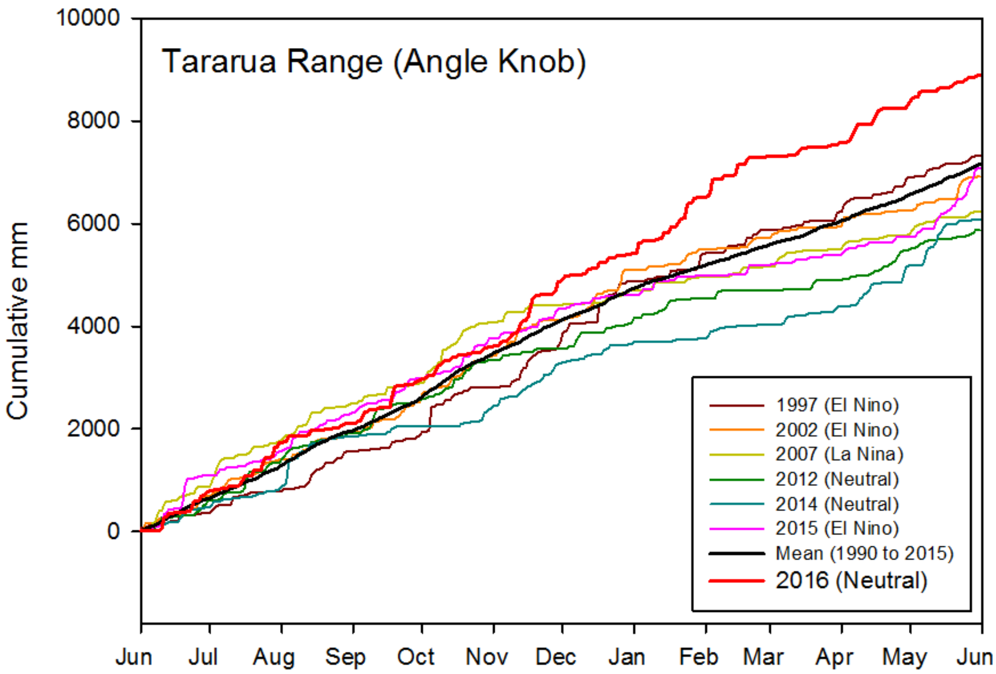


Southwest (Wellington city)

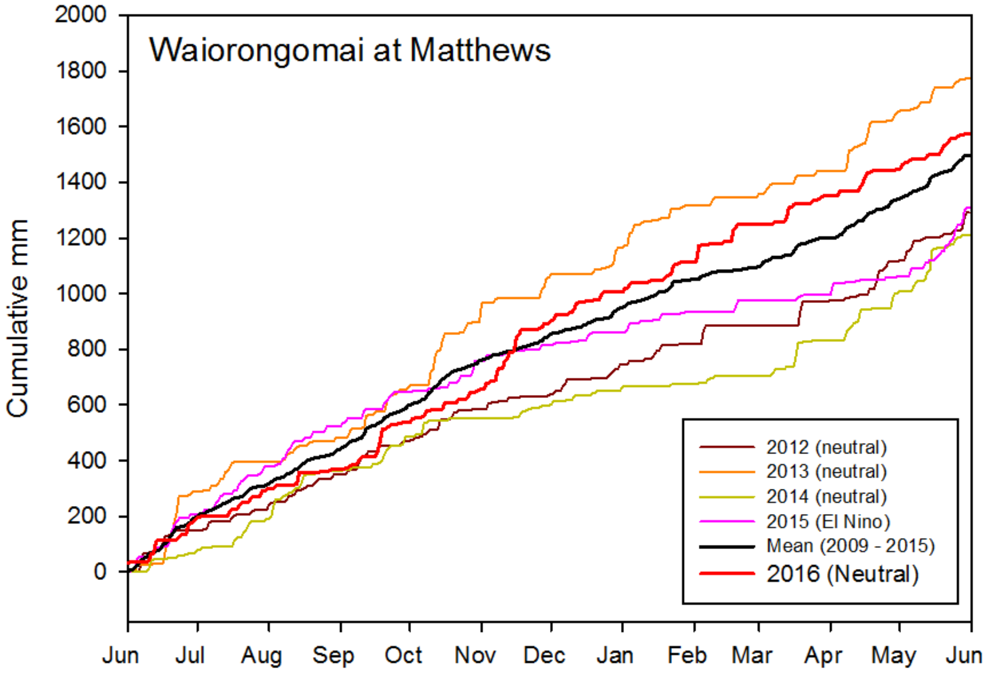


Hutt Valley and Tararua Range

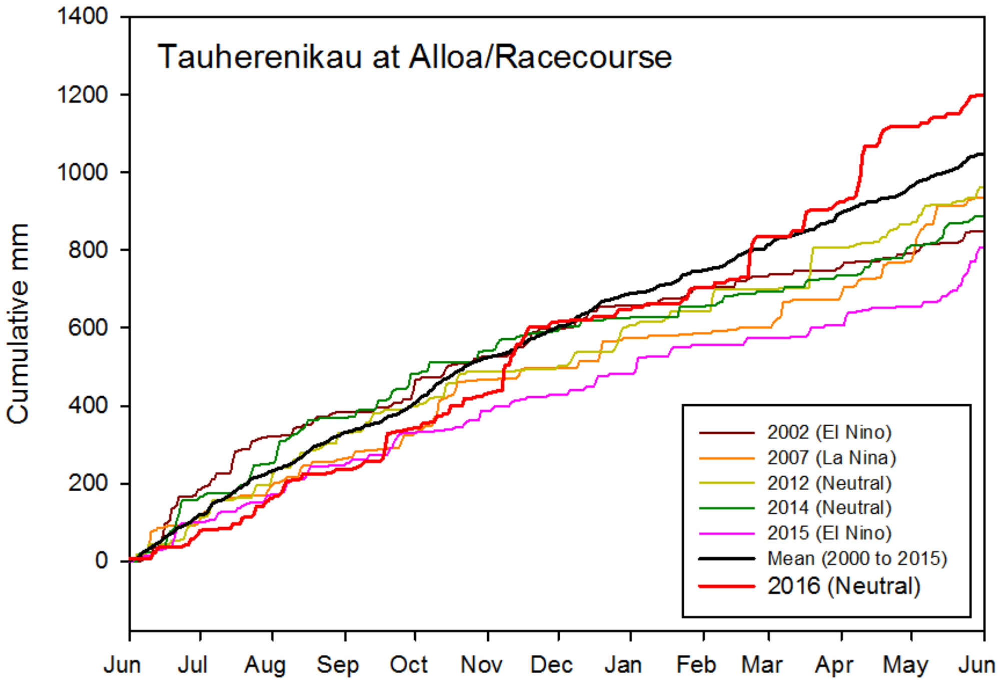




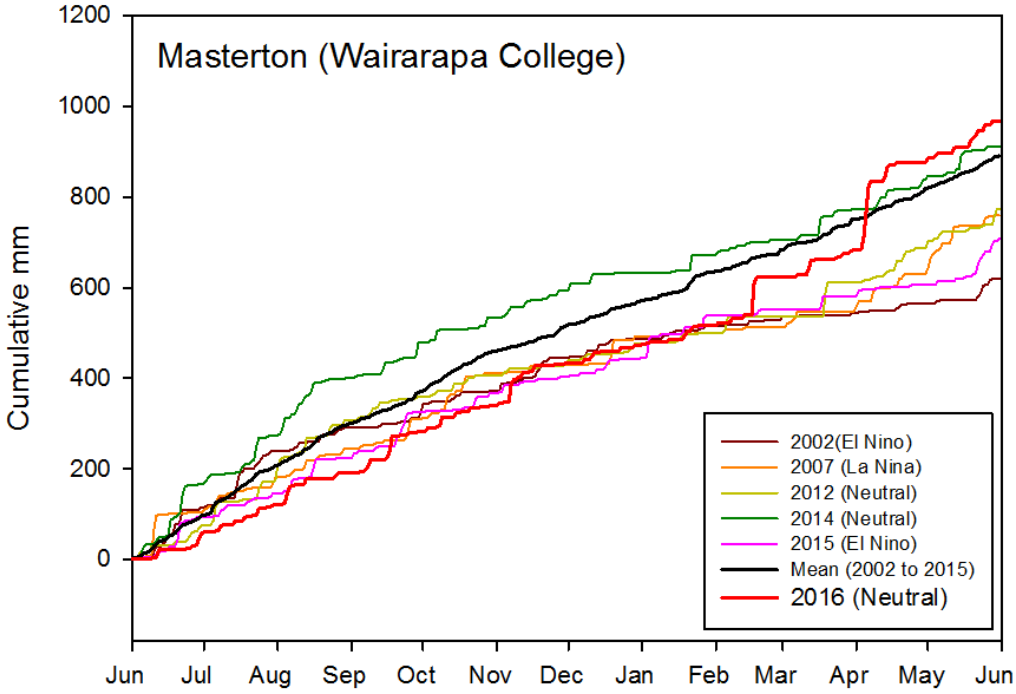
Wairarapa

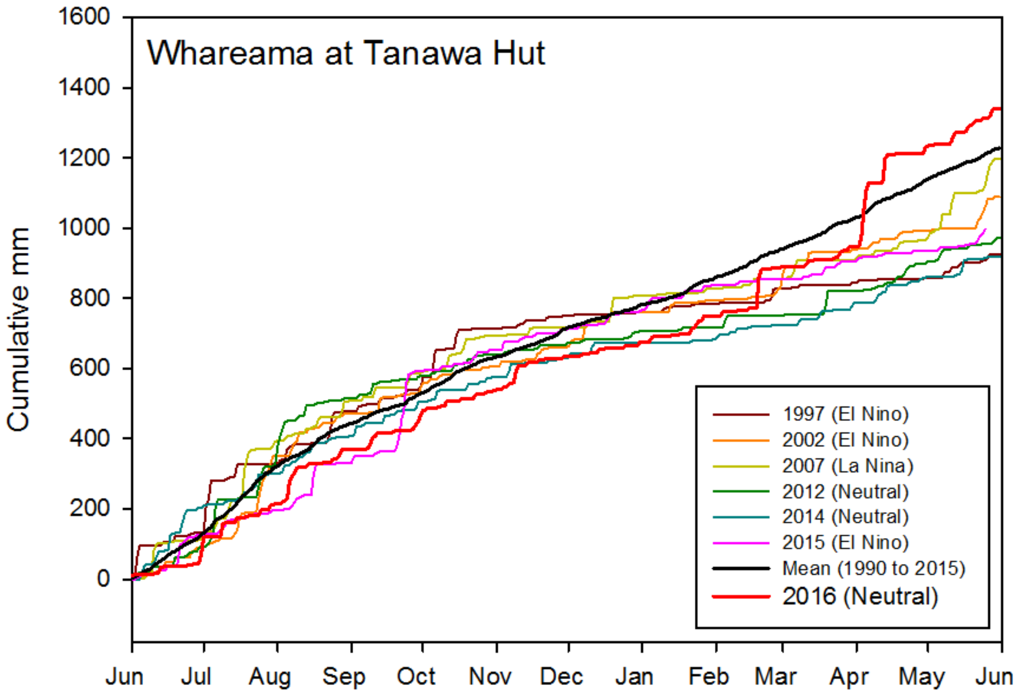


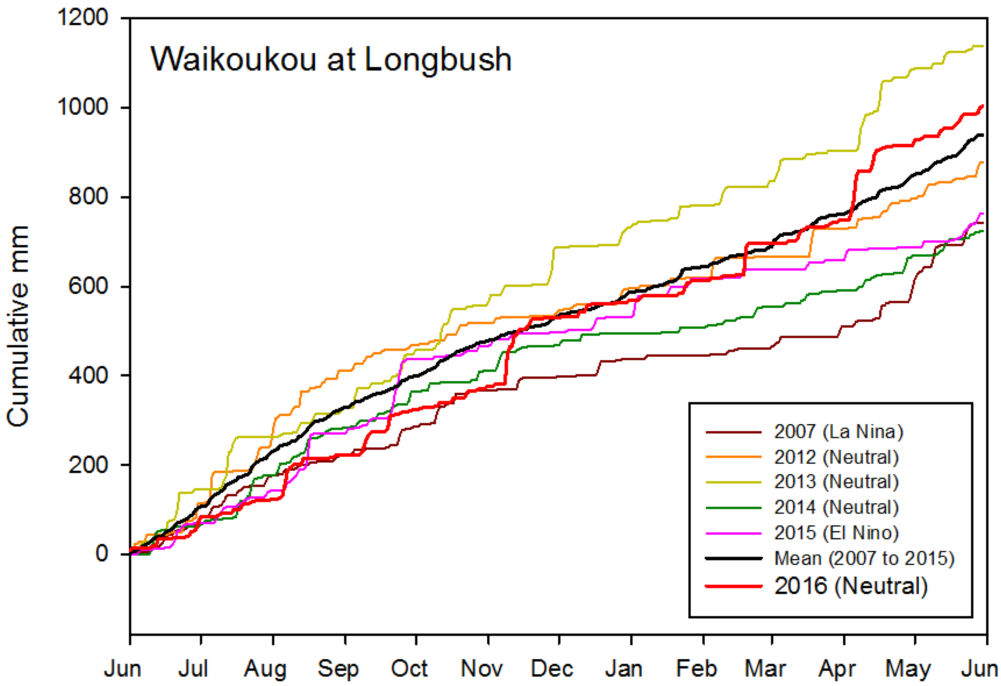
Waiorongomai at Matthews
Cumulative mm
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
2012 (neutral)
2013 (neutral)
2014 (neutral)
2015 (El Nino)
Mean (2009 - 2015)
2016 (Neutral)



Tauherenikau at Alloa/Racecourse
Cumulative mm
1400
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
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 (2002 to 2015)
2016 (Neutral)


Whareama at Tanawa Hut
Cumulative mm
1600
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)

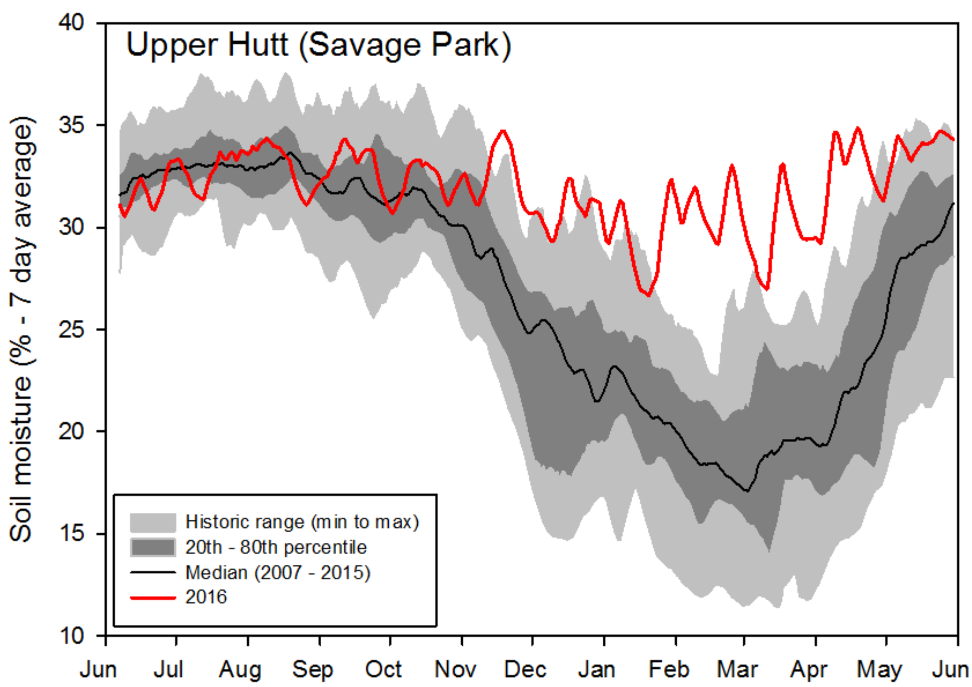

Waikoukou at Longbush
Cumulative mm
1200
1000
800
600
400
200
0
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
2007 (La Nina)
2012 (Neutral)
2013 (Neutral)
2014 (Neutral)
2015 (El Nino)
Mean (2007 to 2015)
2016 (Neutral)

2.4.2 Soil moisture content (1 June to 31 May)

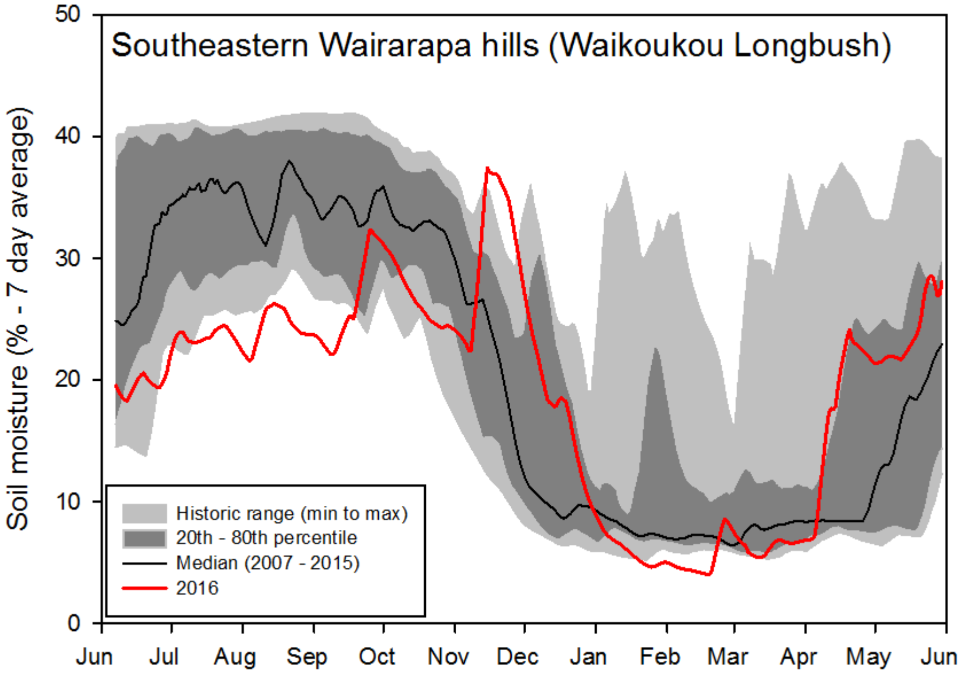
The soil moisture plots show seven day rolling average soil moisture (%) for the hydrological year (current year labelled 2016). An envelope plot of the historic range of data (and site mean) is also provided to give an indication of how the current soil moisture compares with that for a similar time 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.

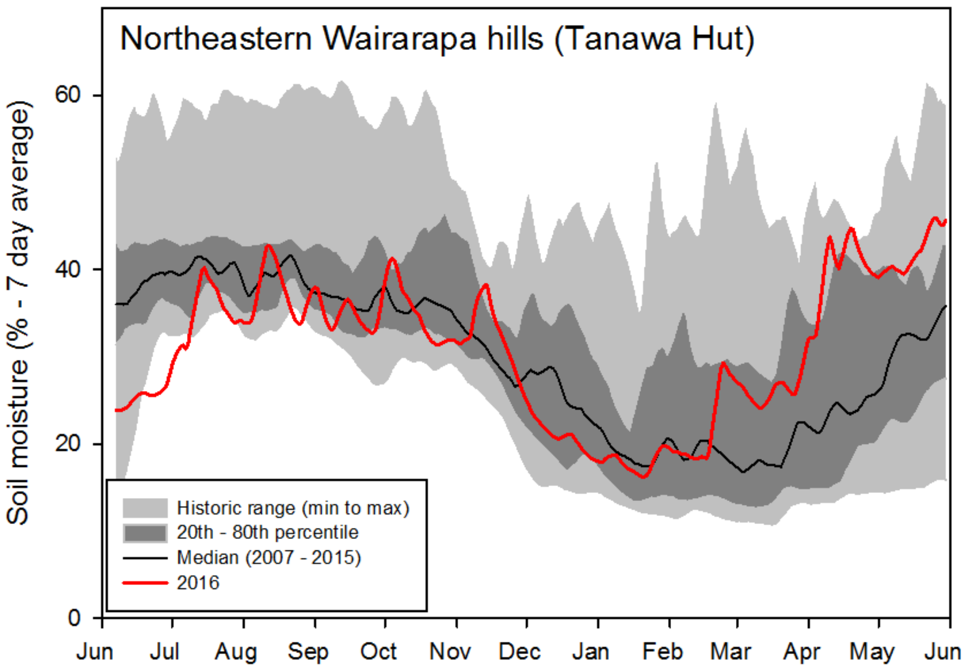
Soil moisture levels by the end of May were above normal across the region and as high as they have been observed since records began in 2002 at the GWRC Masterton site. This general pattern from the GWRC measurement sites is consistent with the picture revealed by the soil moisture anomaly map in Figure 2.2 (based on modelled and interpolated data).

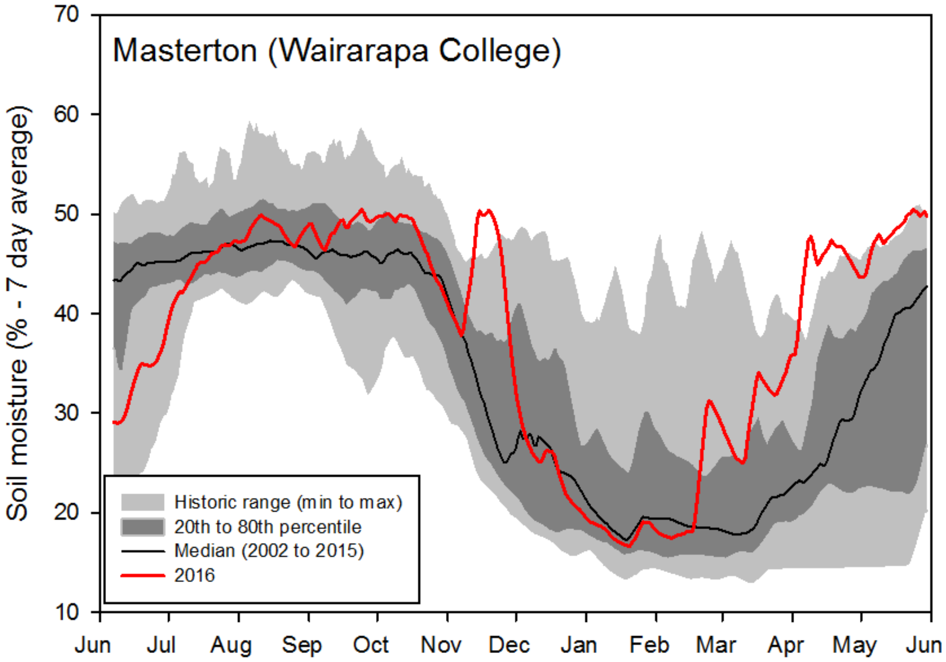
Hutt Valley

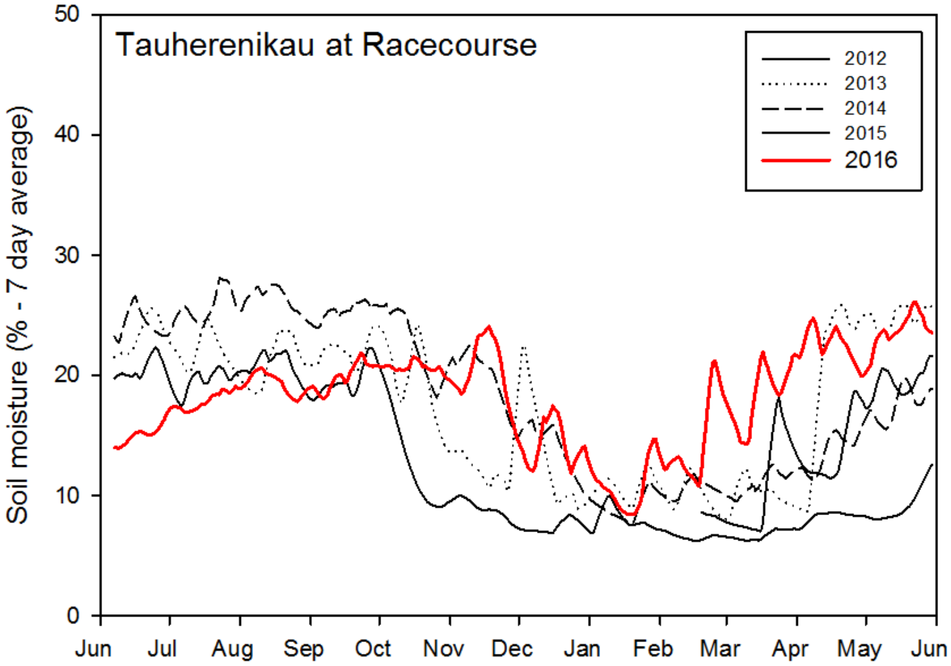


Wairarapa


Southeastern Wairarapa hills (Waikoukou Longbush)
Soil moisture (% - 7 day average)
50
40
30
20
10
0
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)
60
40
20
0
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
Historic range (min to max)
20th to 80th percentile
Median (2002 to 2015)
2016
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun


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

3. Outlook for winter 2017

- ENSO likely to remain neutral, but about half of climate models still leaning towards a weak El Niño by the end of the year;
- Sea surface temperatures with a mixed signal, mostly warmer than average around New Zealand but cold tongue on the southeast. Climate models suggest SSTs will remain slightly above average in winter, with little influence on air temperatures;
- Weaker frosts due to elevated soil moisture;
- Progressive return to more normal westerly winds in between high pressure cells, after 'blocked' pattern that prevailed during autumn;
- Around average rainfall, with increased chance of above average in the Wairarapa according to climate analogues;

Whaitua*	Variables	Climate outlook for winter 2017
Wellington Harbour & Hutt Valley	Temperature:	Around average, weaker frosts due to elevated soil moisture.
	Rainfall:	Around average, dry periods alternated by heavy rainfall events.
Te Awarua-o-Porirua	Temperature:	Around average.
	Rainfall:	Around average, dry periods alternated by heavy rainfall events.
Kāpiti Coast	Temperature:	Around average, weaker frosts due to elevated soil moisture.
	Rainfall:	Around average, dry periods alternated by heavy rainfall events.
Ruamāhanga	Temperature:	Around average, weaker frosts due to elevated soil moisture.
	Rainfall:	Around average. Dry periods alternated by heavy rainfall events. Chance of above average according to climate analogues for the central-eastern area (Longbush): 126 to 141% of the 1981-2010 average, with 134% most likely – see graph below
Wairarapa Coast	Temperature:	Around average.
	Rainfall:	Around average, dry periods alternated by heavy rainfall events.

*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 JJA rainfall range: 126% to 141% (134% 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: 1980, 1996, 2004. The current analogue years were adjusted based on sea ice extent and ENSO behaviour combined.

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: MAM predicted: 67% to 88% (78% most likely), using different analogue years; MAM actual observation: 141% of the 1981-2010 average. Hence, the observed conditions for MAM **fell outside** 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.

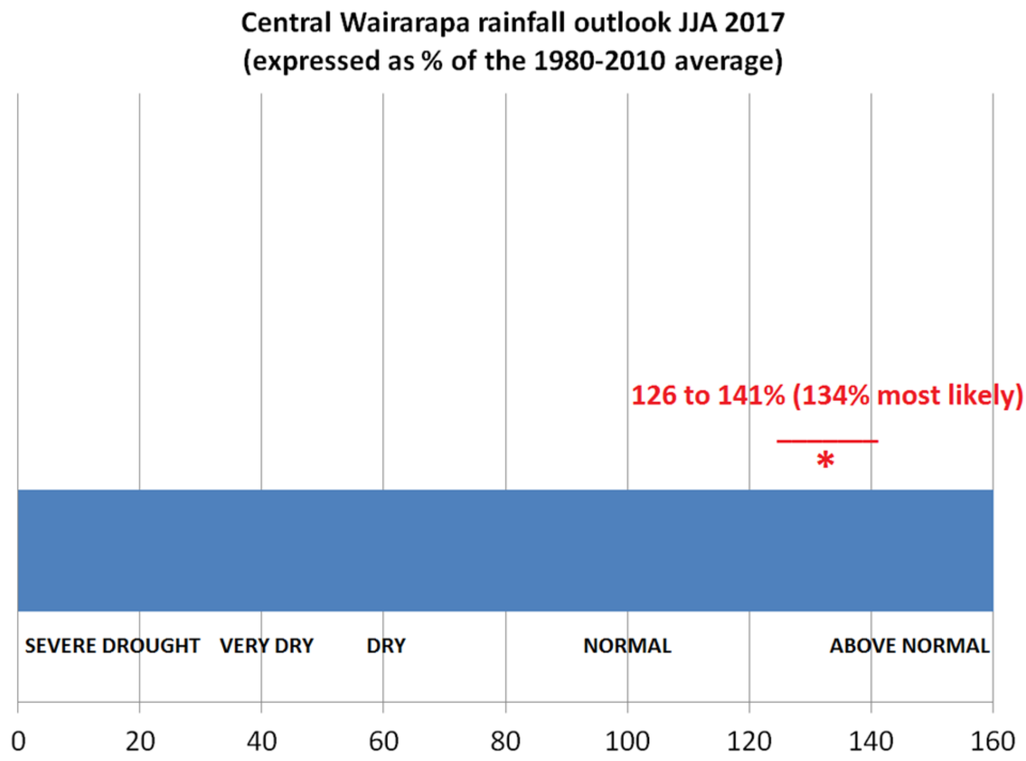


Figure 3.1: Climate analogue statistical rainfall projection using data for Waikoukou, Longbush (see Figure 2.3 for exact location), expressed as percentage range of likely autumn rainfall compared to the 1980-2010 average. Due to the unusual behaviour of the climate drivers as well as the impacts of 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 above average rainfall for the Wairarapa (https://www.niwa.co.nz/climate/seasonal-climate-outlook/seasonal-climate-outlook-june-2017-august-2017)

Acknowledgments

We would like to thank NIWA for providing selected VCSN data points for the calculation of the regional soil moisture map.