greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Climate briefing

Wellington region, December 2015

Alex Pezza and Mike Thompson
Environmental Science Department

For more information, contact the Greater Wellington Regional Council:

Wellington
PO Box 11646

T 04 560 4746
F 04 385 6960
www.gw.govt.nz

Masterton
PO Box 41

T 04 560 4746
F 06 378 2146
www.gw.govt.nz

December 2015

www.gw.govt.nz
info@gw.govt.nz

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1. Highlights

Rainfall has been persistently below average in parts of the Wellington region, especially the south and east coast, since the end of 2014. Figures vary, but according to one indicator produced by NIWA, the "Potential Evapotranspiration Deficit", which tells you how much additional irrigation may be needed for optimum crops growth, the calendar year 2015 in the Wairarapa is comparable to the driest years on record (measured since 1940). This is largely because the previous summer and autumn were very dry.

A strong El Niño has been present since April 2015, helping create dry and cool conditions. In addition to this, there is also a longer-term drying tendency with persistent dry years over the last decade, with 2013 being the worst year. This longer-term dryness is not related to the El Niño, but instead may be a symptom of climate change. Future climate change projections for our region indicate a significant increase in "drought-like" conditions in the Wairarapa.

Cool temperatures during winter and spring have helped reduce evaporation, preventing a more widespread drying of the landscape up to now. However, as we progress into summer, things may worsen, if rainfall remains below average. NIWA is monitoring several indicators at a national level, using the term "hotspots" to refer to areas where rainfall has been deficient, and soils have been significantly dry. According to their latest release, the south Wairarapa and Wellington area are current hotspots. The 'Hotspot Watch' from NIWA is updated weekly, advising the New Zealand media about areas that may be in for extremely dry conditions in summer: http://www.niwa.co.nz/news/niwas-hotspot-watch

NIWA is predicting a 45% probability of a dry summer in the Wairarapa. In the absence of any forecast guidance there would be an equal likelihood (33% chance) of either dry, normal or wet conditions. This agrees well with statistical rainfall data collected by the Environmental Science Department, that shows that there is an increased probability of the occurrence of up to one in a 50-year dry summer in parts of the Wairarapa, particularly within the Ruamahanga and Wairarapa Coast Whaitua, during very strong El Niño years. Because of the "internal variability in the atmosphere" it is not possible to accurately predict the total seasonal rainfall in advance other than by a probabilistic approach.

Water conservation strategies for summer: In light of current El Niño conditions and the climate predictions, Wellington Water has already highlighted the need to enhance water conservation strategies this summer. For more information please refer to their website: http://wellingtonwater.co.nz/media-releases/get-set-for-a-dry-summer/

Seasonal Climate and Water Resources: The extended seasonal climate reports for the Wellington region produced by the Environmental Science Department can be found here: http://www.gw.govt.nz/seasonal-climate-and-water-resource-summaries-2/

2. El Niño – Southern Oscillation (ENSO)

2.1 Current status

The latest development of the current El Niño is seen in Figure 2.1, with fairly warm waters in the Equatorial Pacific Ocean extending all the way to South America as of 28 November. The waters are cool on the eastern coast of New Zealand, which is a normal response of the oceanic circulation to El Niño events.

The cool waters around New Zealand help reduce the amount of moisture in the atmosphere over summer, favouring drought conditions on the east coast. To the west of Australia, the warm waters south of the equator work to create more storms that may eventually reach New Zealand, as occurred in Hawkes Bay with sporadic heavy rainfall events which ended up bringing the spring totals to above average rainfall.

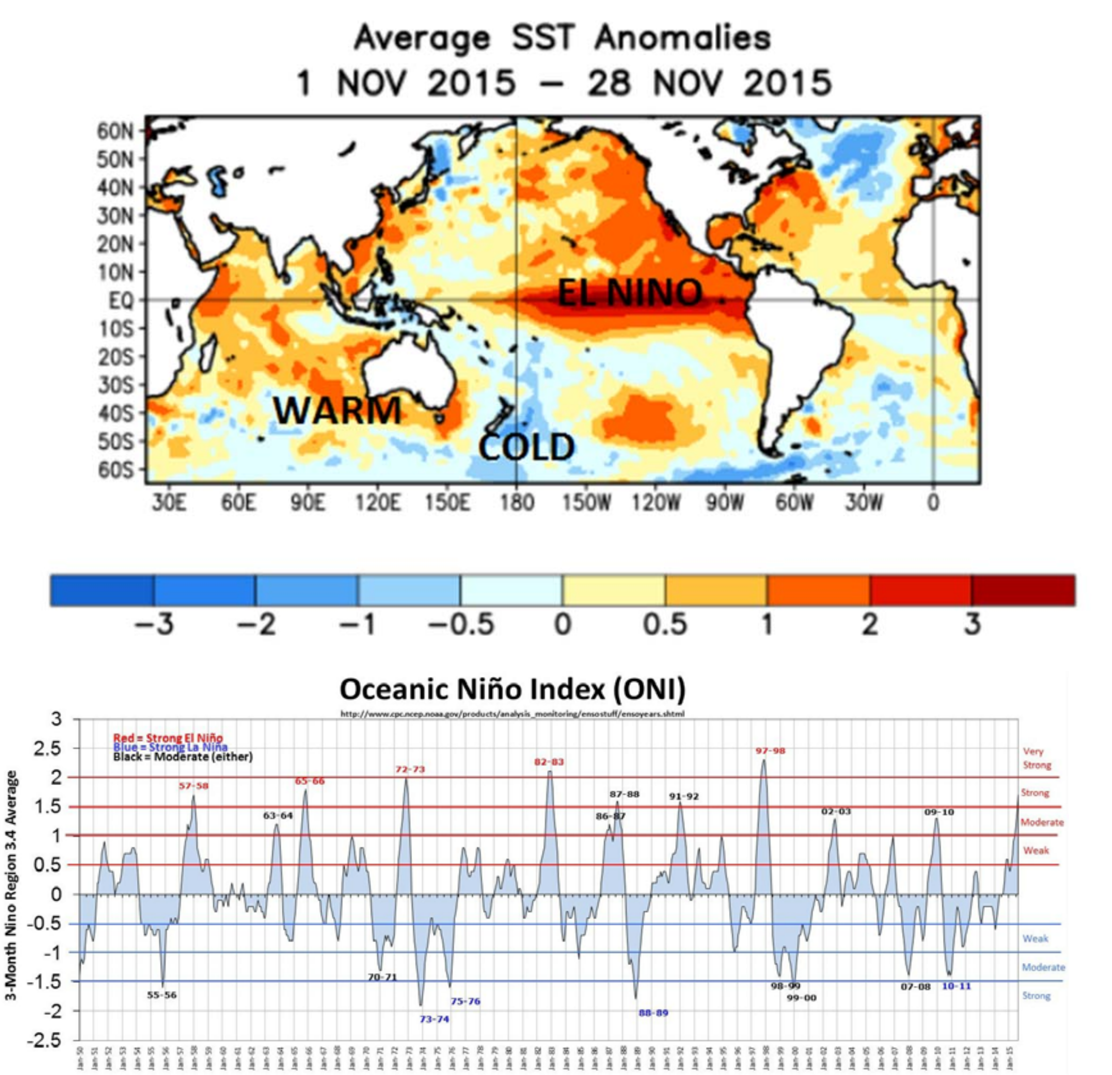


Figure 2.1: Latest water temperature anomalies (upper panel) and how the current El Niño sits in historical perspective. Source: NOAA/USA

The actual observed climate results from the equilibrium of these opposing forces. At the bottom panel we can see that the current El Niño is “very strong”, comparable to the 1997-1998 event which was one of the strongest ever measured.

Since our last briefing in November 2015, there has been very little change in the sea surface temperature anomalies around the globe, except for the Indonesian region where the colder than normal waters are now closer to normal, implying a weakening of the Indian Ocean Dipole. This could imply a slight weakening tendency of the current ENSO, as reflected by the less extreme Southern Oscillation Index (SOI) measured in November.

2.2 Large scale effects

The next sequence of figures shows what has happened during past historical El Niño summers (nine events since the record 1983 El Niño). Figure 2.2 shows that a high pressure anomaly sits to the south of New Caledonia (northwest of New Zealand, in red) and a low pressure anomaly forms to the south-east of New Zealand during typical El Niño summers. This pressure differential is quite strong, changing the wind patterns and contributing towards droughts on the eastern part of New Zealand.

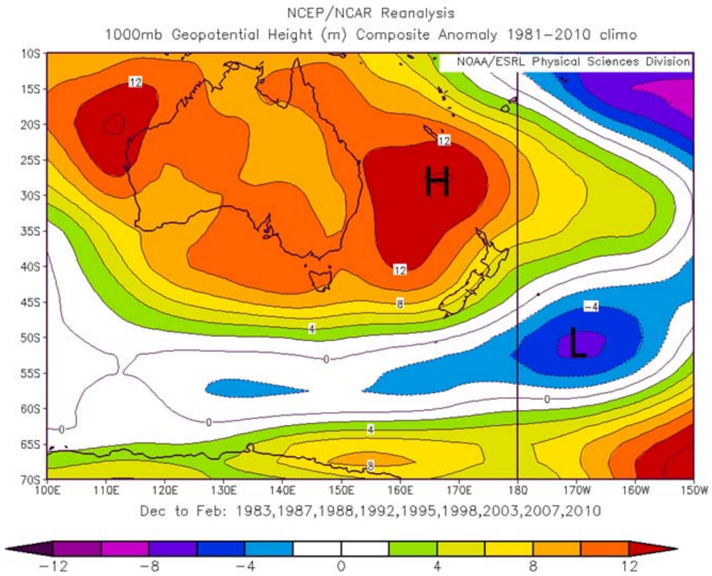


Figure 2.2: Pressure anomalies during typical El Niño summers. New Zealand is seen under the influence of high pressures (in red), which helps reduce the normal rainfall pattern. Source: NCEP Reanalysis/USA

2.3 New Zealand wide effects

As a result of the pressure changes, the westerly winds tend to increase all over New Zealand during El Niño summers (Figure 2.3, in red). We can see that this pattern is stronger in the northern part of the North Island and in the southern part of the South Island. Over the Greater Wellington Region this increase is not as pronounced (yellow tones), reflecting the fact that we sit in a transition area with variable effects.

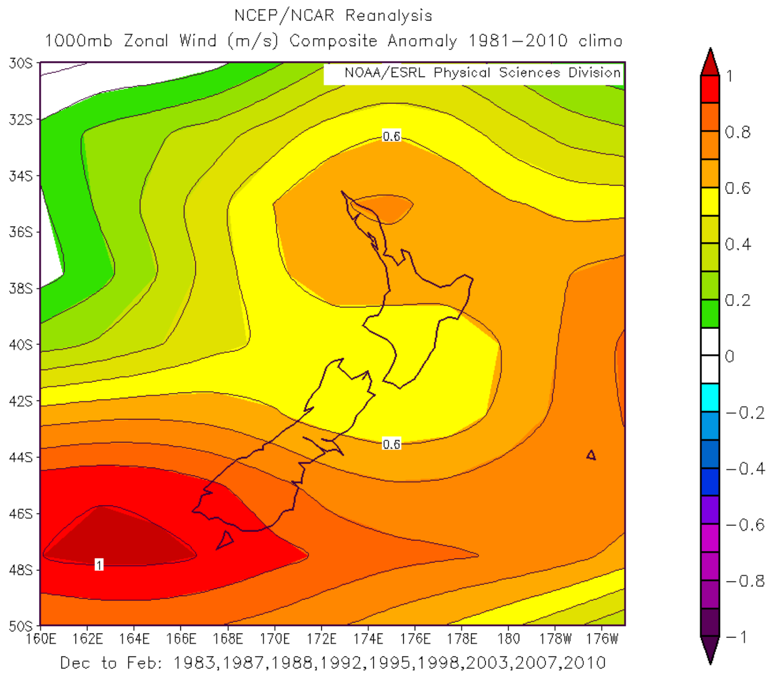


Figure 2.3: Change in the zonal wind (westerlies) observed during typical El Niño summers. A strengthening of the westerlies is seen all over New Zealand (in red). Source: NCEP Reanalysis/USA.

Figure 2.4 shows that the drying effect of summer El Niño events tends to concentrate on the northern part of the North Island and the southern part of the South Island (in red), following the proportionally greater increase of westerly winds in those areas, due to the drying effect of the winds. In the Greater Wellington Region there is a modest reduction of the relative humidity particularly on the northern Wairarapa coast.

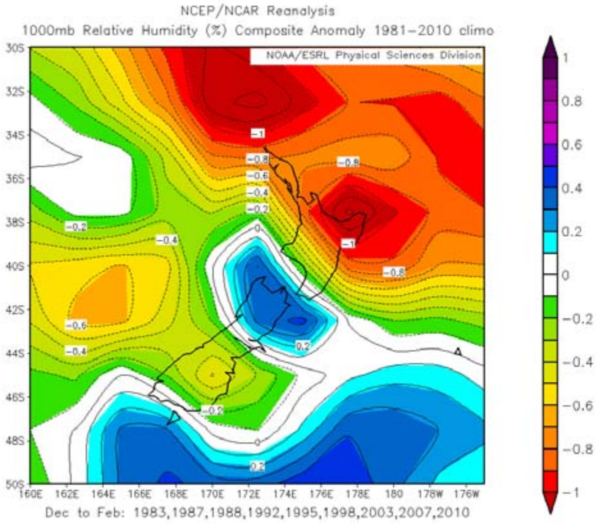


Figure 2.4: Change in the relative humidity observed during typical El Niño summers. Source: NCEP Reanalysis/USA.

During very strong El Niño events, the typical summer pattern is of drought on the whole eastern part of New Zealand, as shown in Figure 2.5. In the Greater Wellington Region the driest area tends to be the northern Wairarapa Coast, where it can rain less than half of the normally expected rainfall over summer.

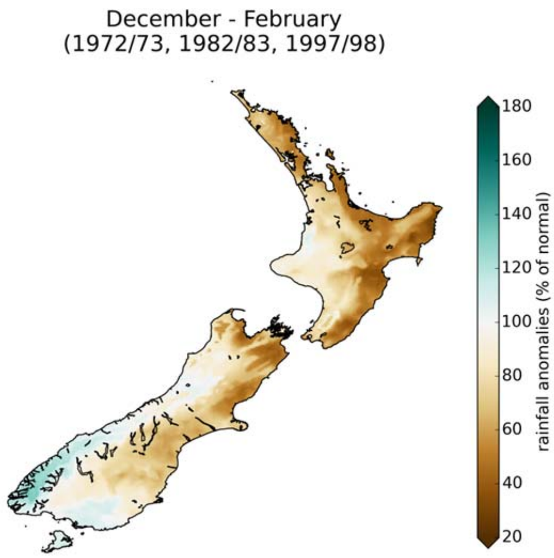


Figure 2.5: Rainfall anomalies during the three previous strongest El Niño on record. Source: NIWA.

2.4 Regional effects

Figure 2.6 shows that there is an increased probability of up to one in a 50-year dry summer, immediately after El Niño springs, for most of the Wairarapa (orange shading, left panel). This is not observed for neutral or La Niña years (middle and right panels).

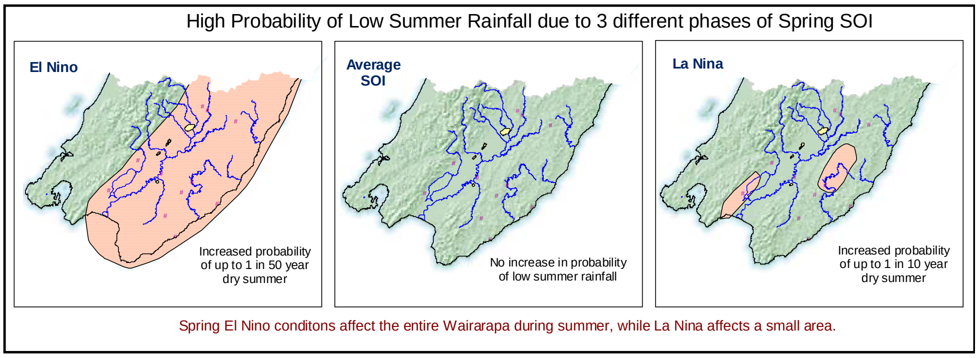


Figure 2.6: Probability of drought in summer associated with the ENSO phase during the preceding season. Source: Greater Wellington Regional Council.

3. Broad scale drought indicators

The latest results from the NIWA Drought Monitor show that most of the Wellington region is now very dry. There is a severe soil moisture deficit in most of the Wairarapa, comparable with parts of the eastern South Island (Figure 3.1 – top and bottom left). The Standardised Precipitation Index (SPI) for the last 60 days indicates a gradient from 'moderately dry' in the north of the region to 'extremely dry' across the south (Figure 3.1 – bottom right).

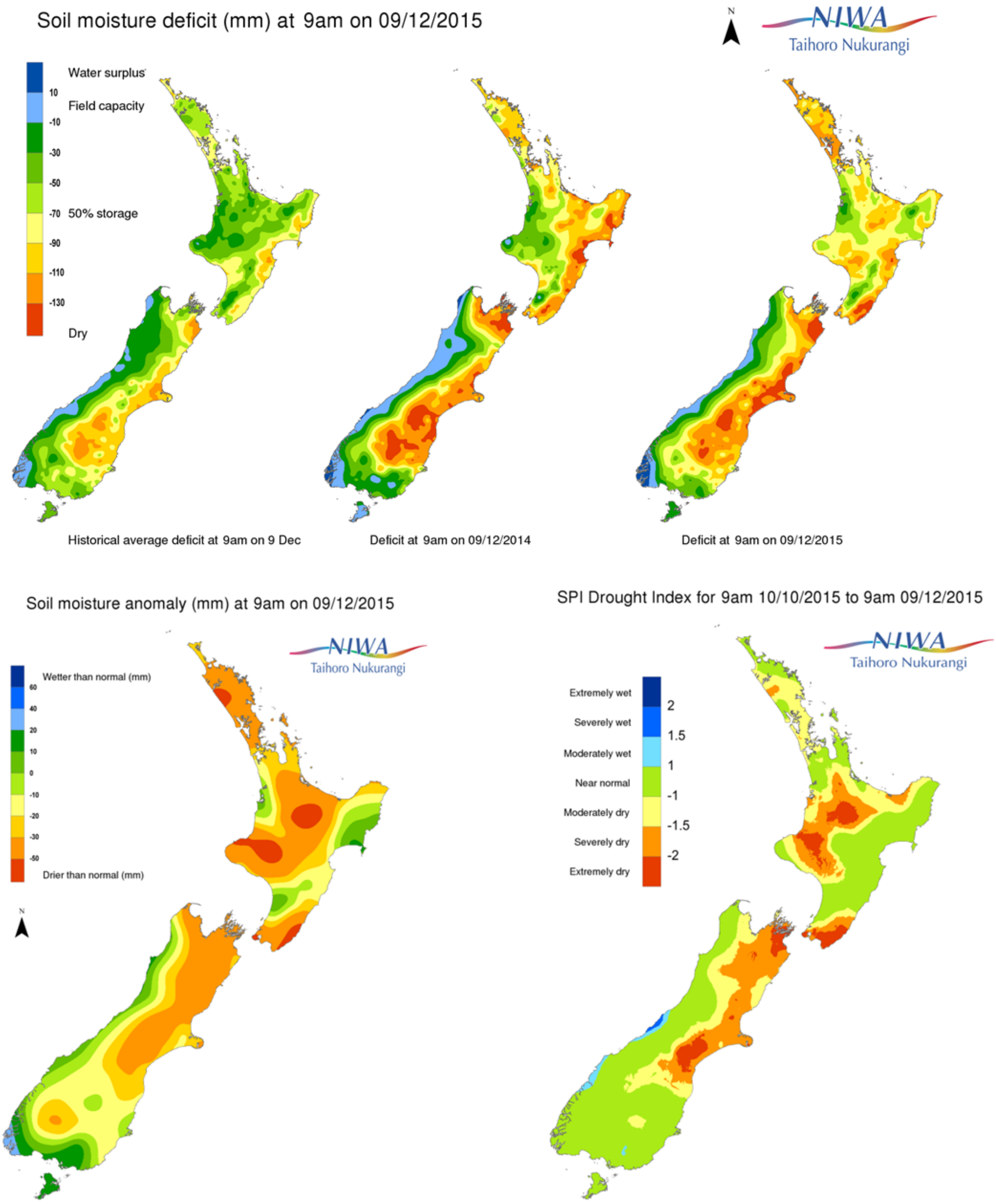


Figure 3.1: Soil moisture deficit (compared to historical average and same time last year) and soil moisture anomalies as of 9th Dec 2015 (upper panels and bottom left), and Standardised Precipitation Index for the last 60 days (bottom right). Source: NIWA Drought Monitor.

4. Observed rainfall and soil moisture conditions

4.1 Regional rainfall pattern

Data from GWRC rain gauges (Figure 4.1) shows that the southern part of the region had only about half of the normal rainfall in spring (September to November), while parts of the northern Wairarapa had slightly above average rainfall mostly as a result of an isolated heavy rainfall event in September.

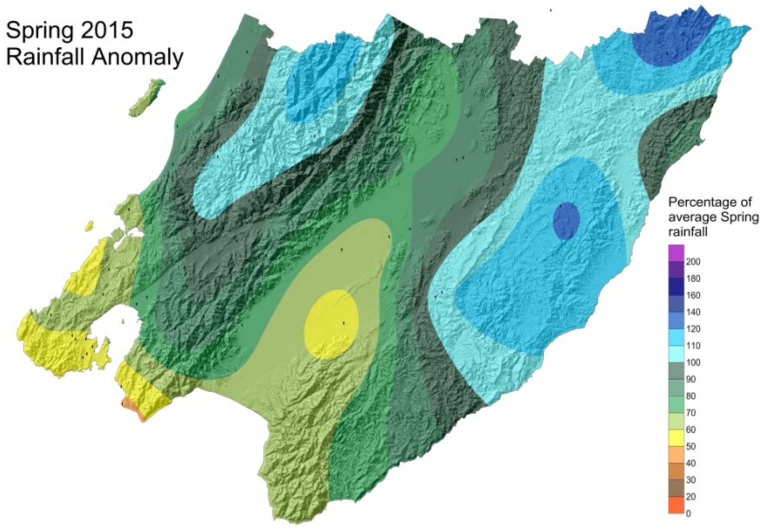


Figure 4.1: Rainfall for spring 2015 as a percentage of normal spring rainfall.

4.2 Accumulated rainfall and soil moisture at selected sites

Figure 4.2 shows the location of a selection of representative GWRC rainfall and soil moisture monitoring sites. Plots of accumulated rainfall and soil moisture trends are provided in the following pages.

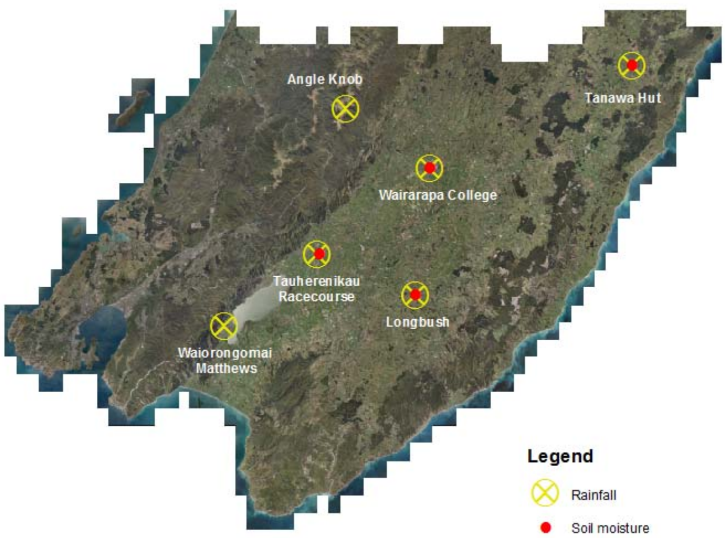


Figure 4.2: Map of rainfall and soil moisture monitoring locations

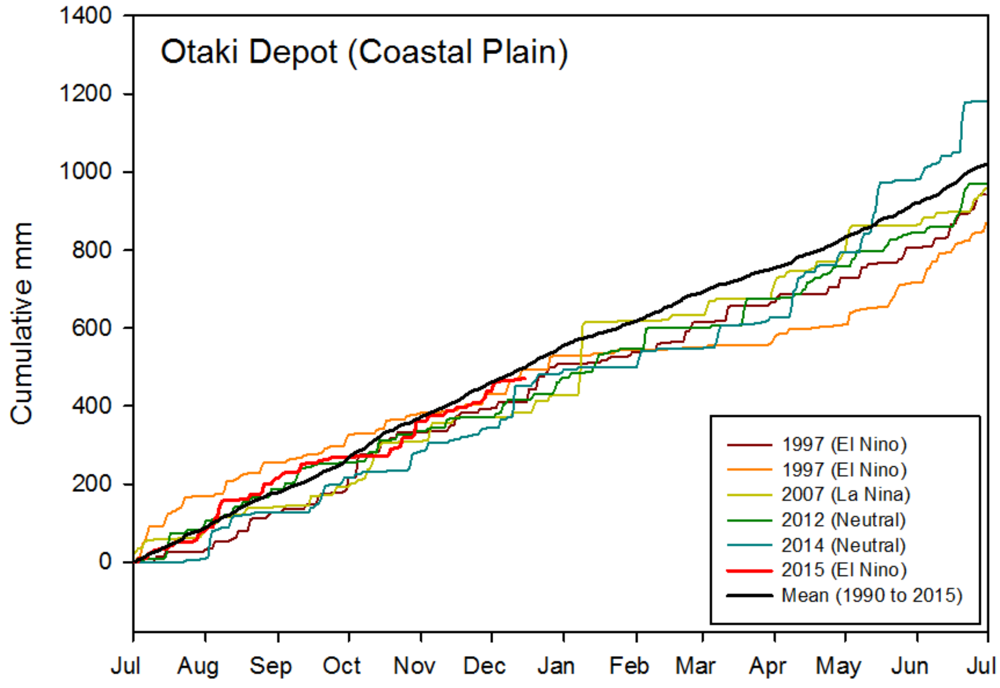
4.2.1 Rainfall – year to date since 01 July 2015

The following rainfall plots show total rainfall accumulation (mm) for the year to date (since 01 July 2015). For comparative purposes, cumulative plots for selected historic years with notably dry summers in the Wairarapa have been included, as well as the site mean. Many of the GWRC telemetered rain gauge sites in the lower lying parts of the Wairarapa (ie, 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.

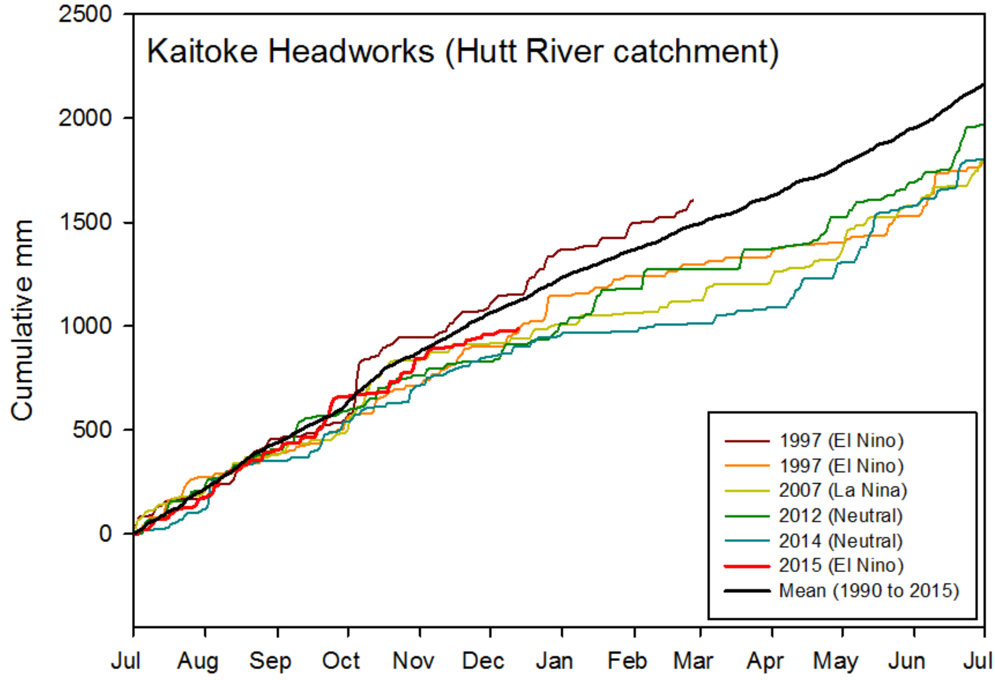
Generally speaking, rainfall accumulation since July has been below average across the region and significantly so in some areas (eg, the mid to southern Wairarapa Valley), even compared with years in which notably dry summers occurred. Furthermore, a large proportion of the total rainfall in the Wairarapa this year fell in two short events several months ago (August and September). While the rainfall from these two individual events has helped bring the total accumulation to near average levels in the eastern hills (represented by the Waikoukou and Whareama rain gauges), the soil moisture recharge has been limited (compared with a situation where the same total rainfall is more evenly distributed through the season).

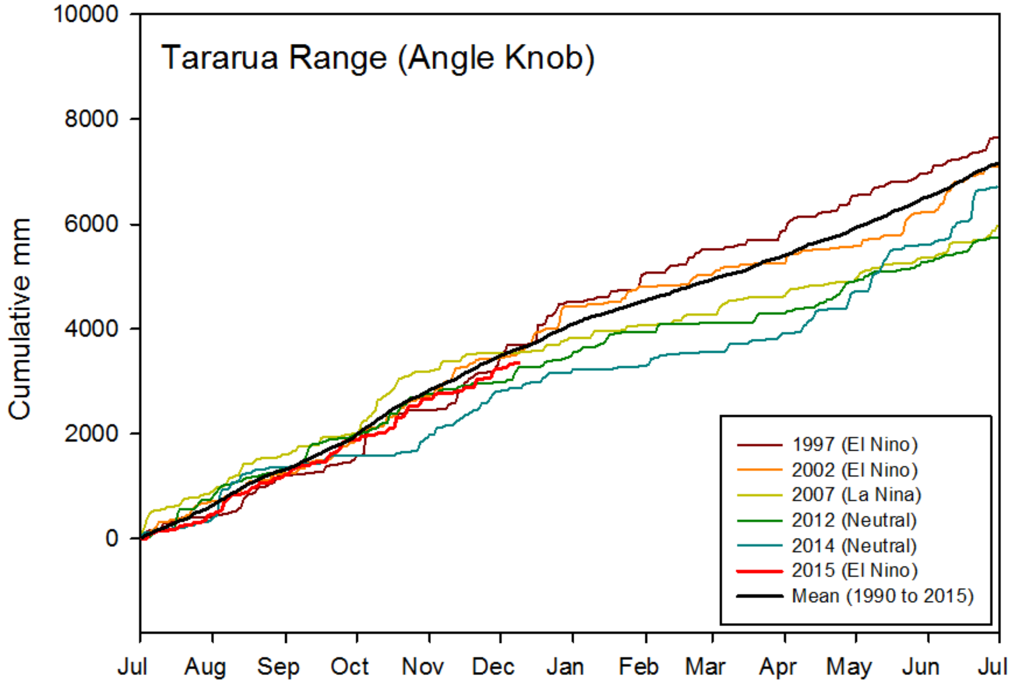
It is also important to note that GWRC do not operate a rain gauge in the southern Wairarapa that is suitable for presenting data here. This means that the severity of the rainfall deficit being indicated by the NIWA modelling for this part of the region (Figure 3.1) may not be fully reflected in the following plots.

(a) Kapiti Coast

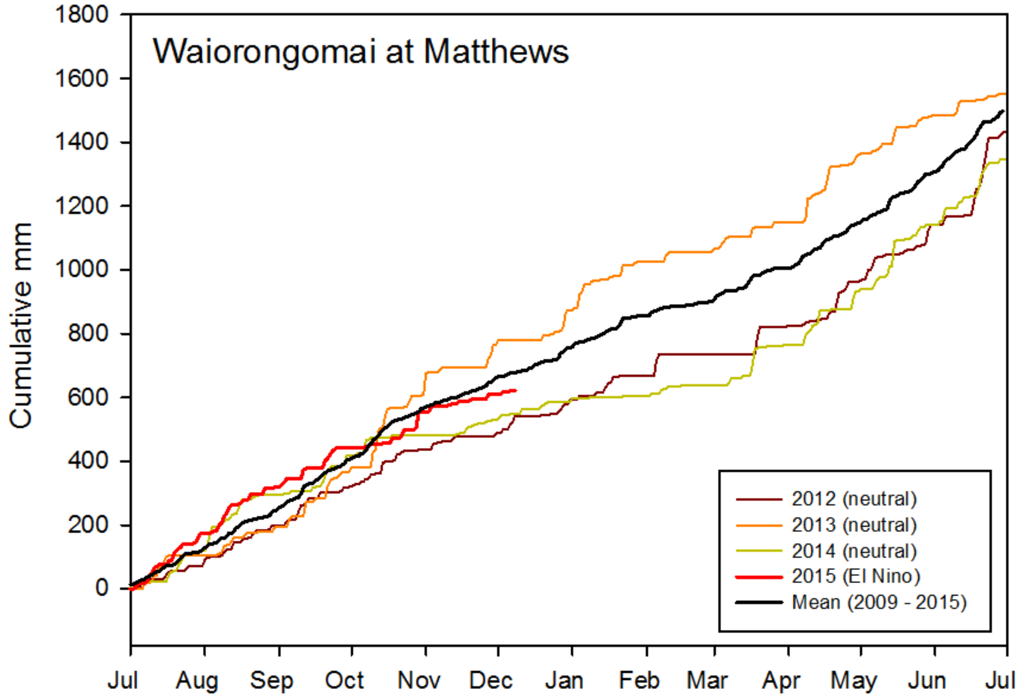


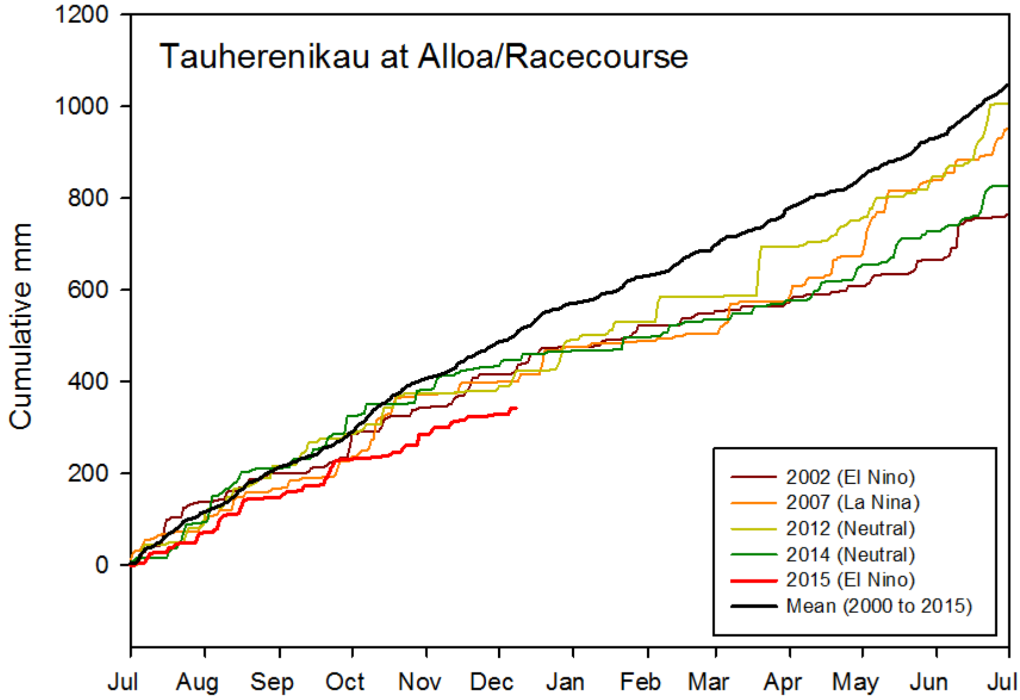
(b) Hutt and Tararua Range

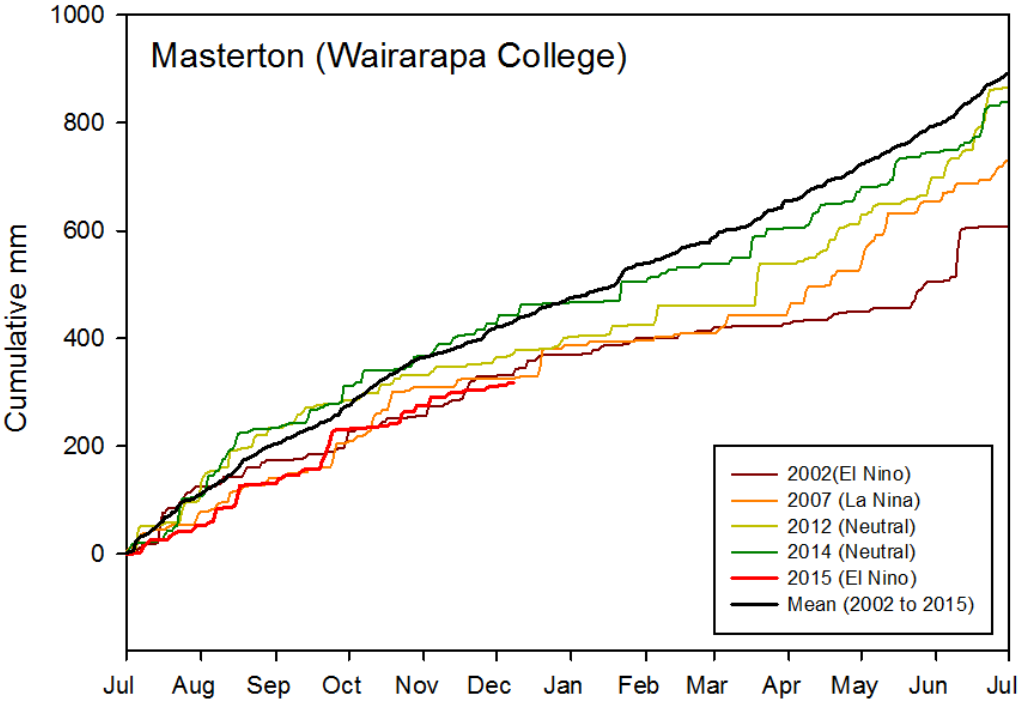


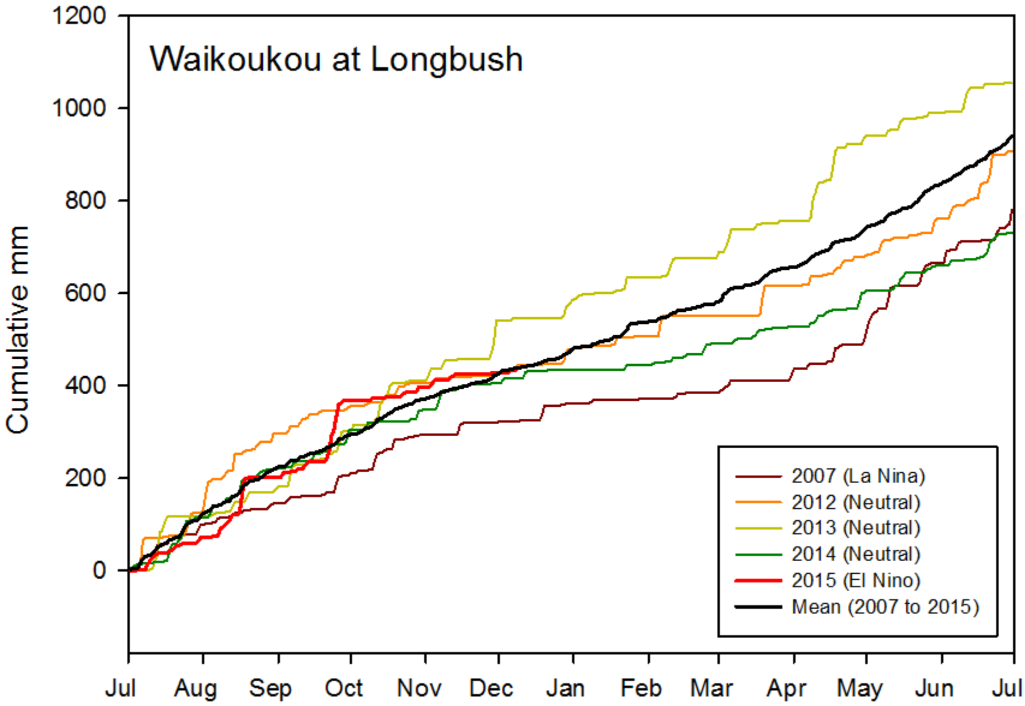


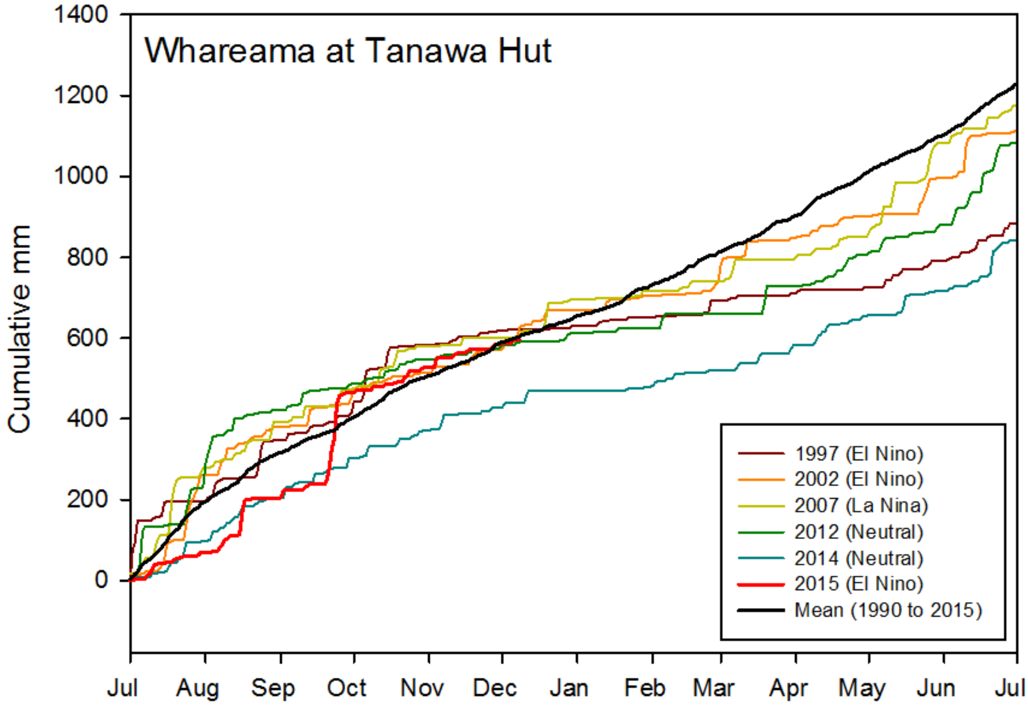
(c) Wairarapa


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


Tauherenikau at Alloa/Racecourse
Cumulative mm
1200
1000
800
600
400
200
0
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2002 (El Nino)
2007 (La Nina)
2012 (Neutral)
2014 (Neutral)
2015 (El Nino)
Mean (2000 to 2015)


Masterton (Wairarapa College)
Cumulative mm
1000
800
600
400
200
0
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2002(El Nino)
2007 (La Nina)
2012 (Neutral)
2014 (Neutral)
2015 (El Nino)
Mean (2002 to 2015)


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

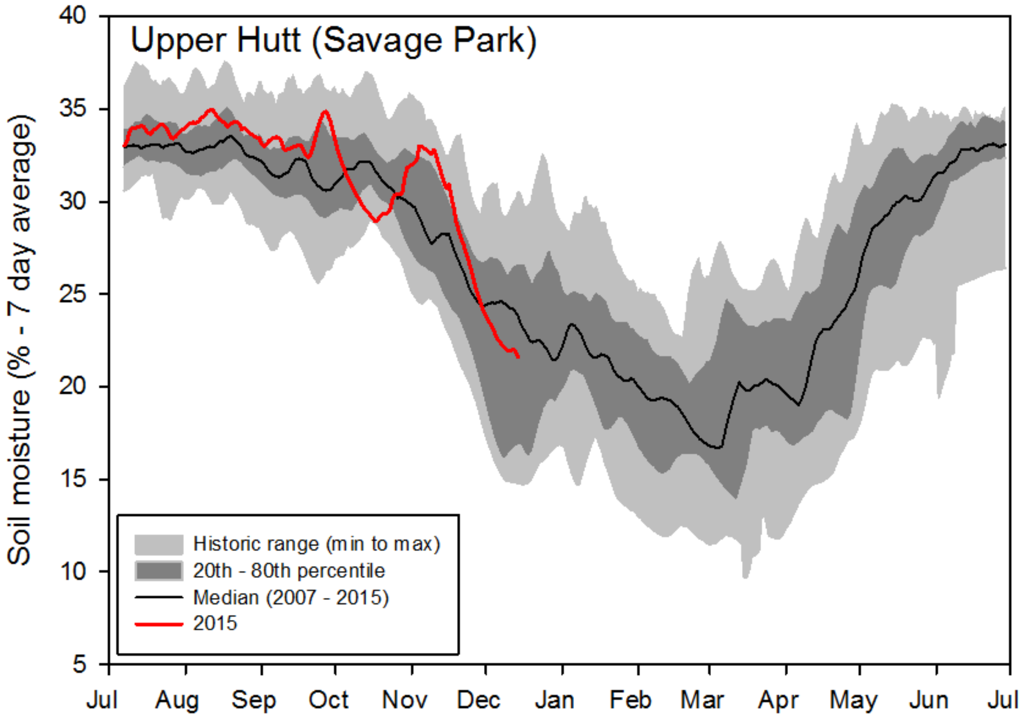

Whareama at Tanawa Hut
Cumulative mm
1400
1200
1000
800
600
400
200
0
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
1997 (El Nino)
2002 (El Nino)
2007 (La Nina)
2012 (Neutral)
2014 (Neutral)
2015 (El Nino)
Mean (1990 to 2015)

4.2.2 Soil moisture content – year to date since 01 July 2015

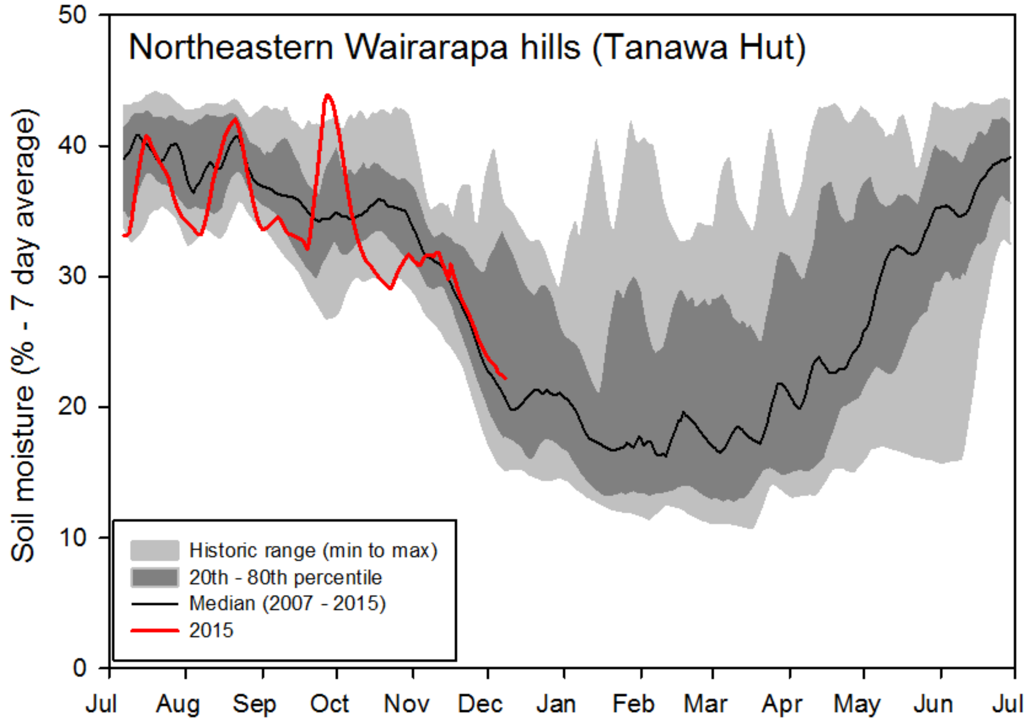
The soil moisture plots show seven day rolling average soil moisture (%) for the year to date (since 01 July 2015). An envelope plot of the historic range of data (and site mean) is also provided to give an indication of how the current soil moisture compares with that for a similar time of the season in past years. While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, 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.

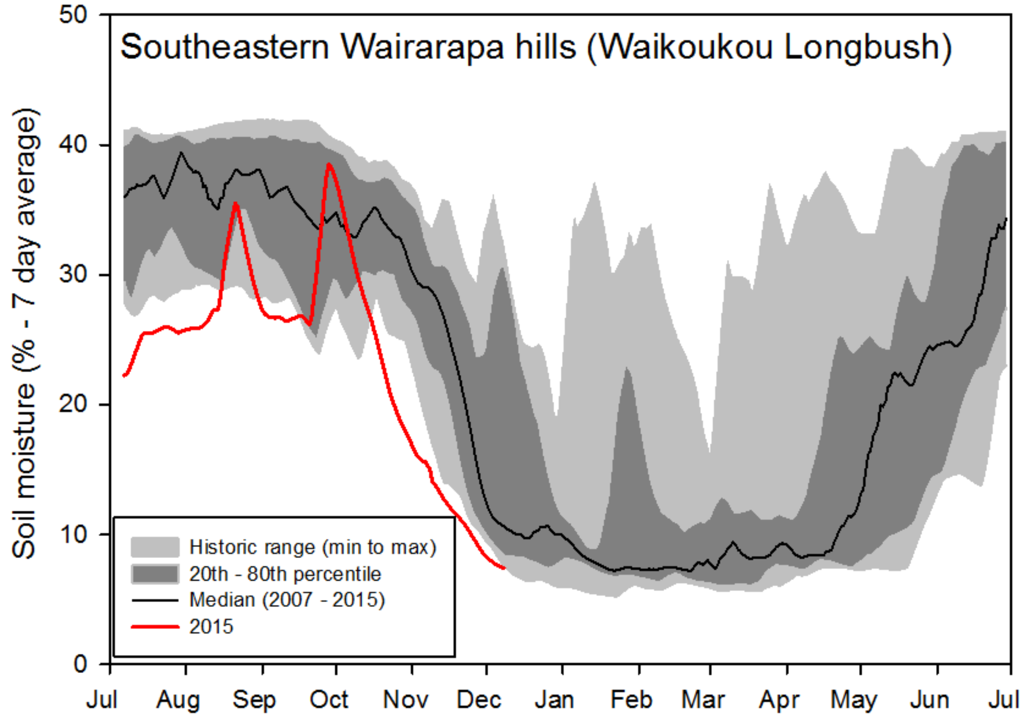
The soil moisture trends generally reflect the picture being generated by broad scale indicators (eg, Figure 3.1) of drier than normal conditions, becoming especially severe in the southern parts of the region.

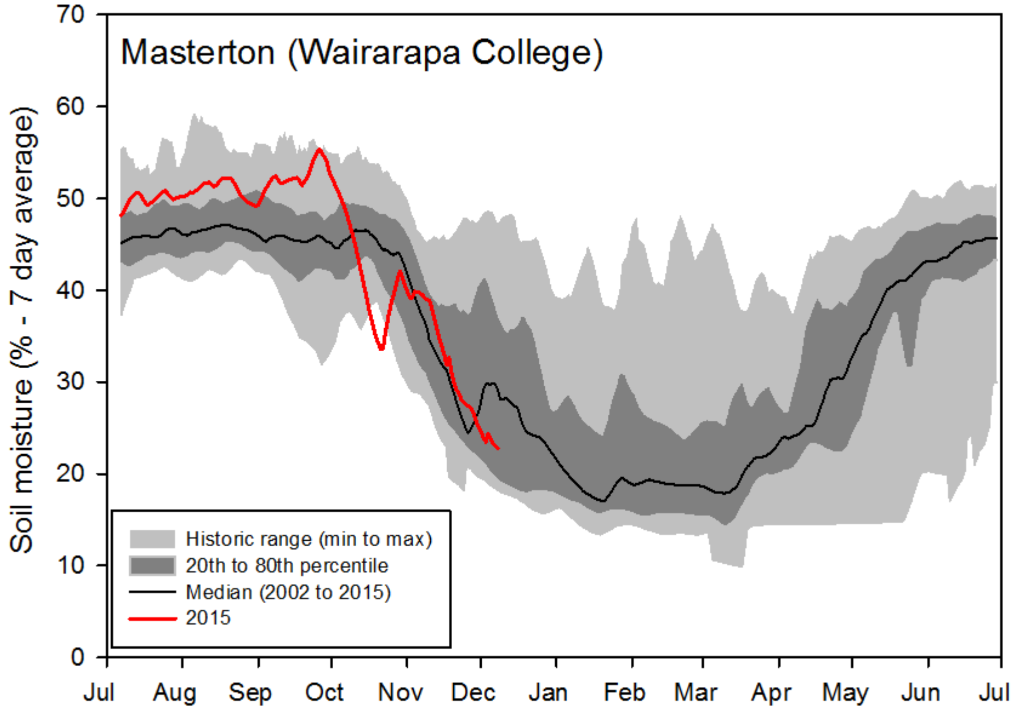
(a) Hutt Valley

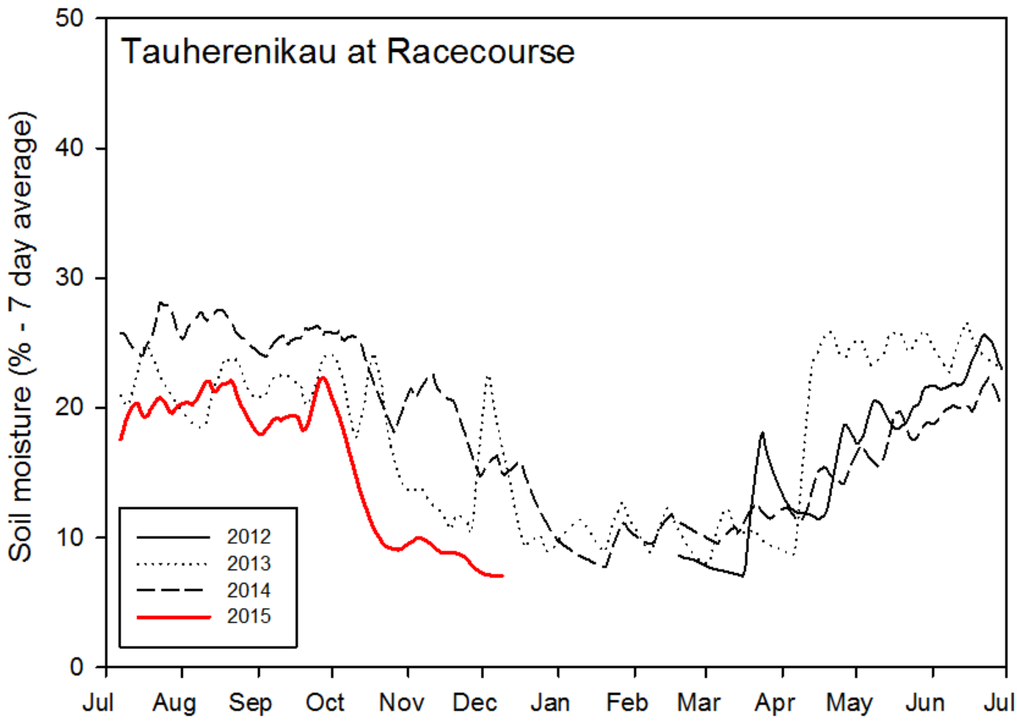


(b) Wairarapa


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


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


Masterton (Wairarapa College)
Soil moisture (% - 7 day average)
70
60
50
40
30
20
10
0
Historic range (min to max)
20th to 80th percentile
Median (2002 to 2015)
2015
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul


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

5. Climate predictions

5.1 El Niño strength and decay

As shown by Figure 5.1, the current El Niño is expected to remain strong throughout summer, before steadily declining until reaching normal conditions in June 2016. As mentioned earlier, the latest data suggests that the ENSO may already have reached maturity with preliminary signs of slowing down. Due to the inertia of the climate system, we expect the atmospheric effects of the strong phase of the El Niño to last at least until the middle of next winter, although progressively less severe. As each El Niño is different, and there are many opposing forces interacting to determine the final observed climate (e.g., more storms coming from the Indian Ocean), it is not possible to confidently predict how much it will rain in summer. For instance, Hawkes Bay had a wet spring contrary to the drought forecasts in that area, which traditionally is more affected by ENSO than the Wellington Region.

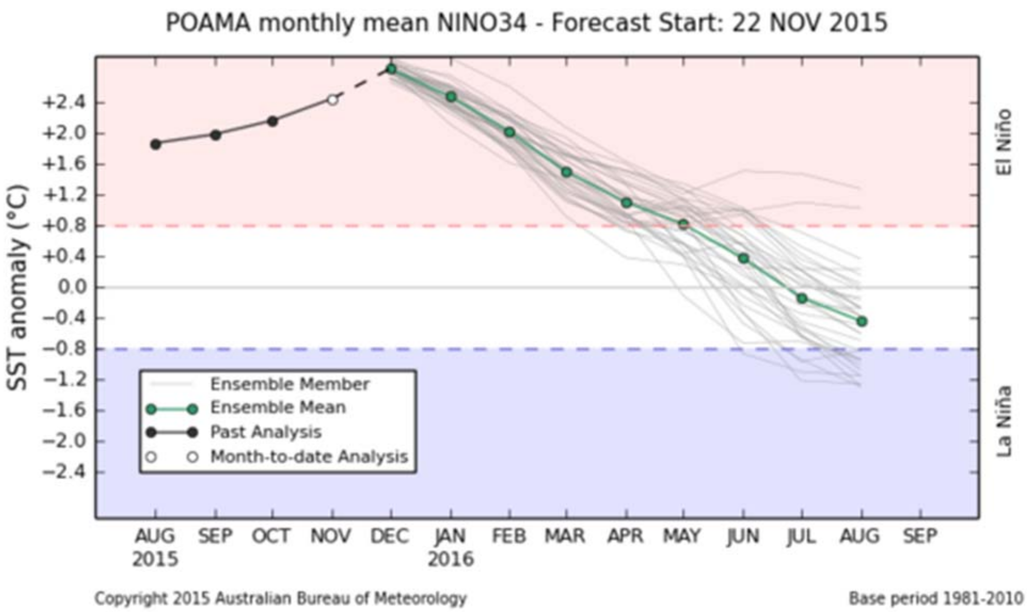


Figure 5.1: Climate projections for the evolution of the current El Niño. The projections show a progressive return to near normal conditions by winter 2016. Source: Bureau of Meteorology, Australia.

Figure 5.2 shows the rainfall anomalies observed in the Wellington Region during the two historical El Niño events with the most resemblance to the current episode. The latest guidance suggests that the ENSO is already showing signs of early decay, with further disruption from a very warm Indian Ocean which was not seen in the previous El Niño episodes. Hence, the effects on rainfall this coming summer, although still strong, would unlikely be much worse compared to the drought measured in previous El Niños.

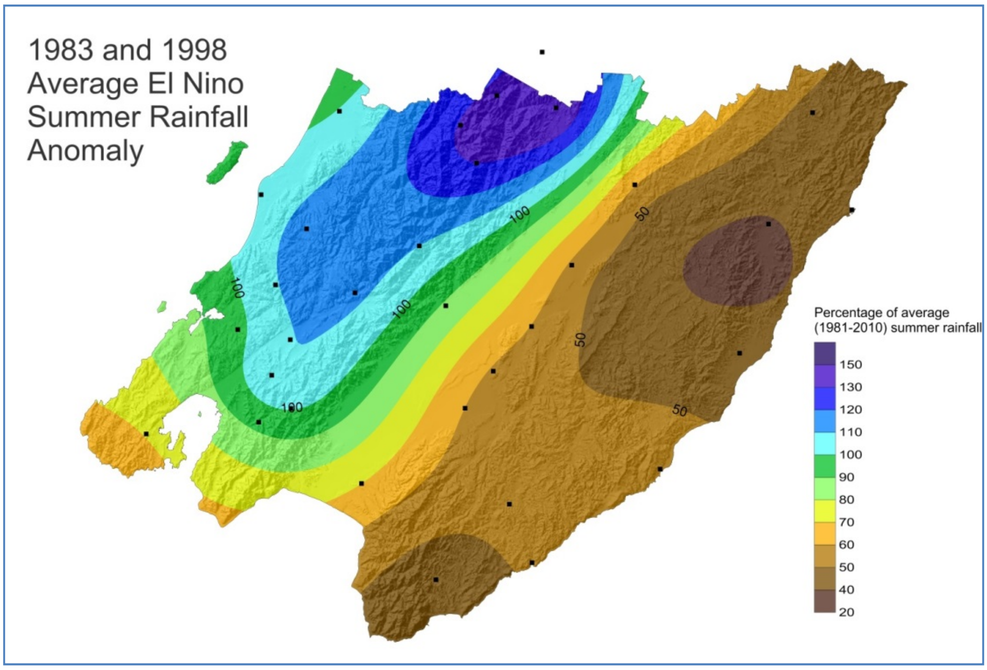


Figure 5.2: Rainfall anomalies observed over the Wellington Region during the pevious two strong historical El Niño events (1983 and 1998) with strong resemblance to the current El Niño. As the current ENSO is already showing preliminary signs of decaying (coupled with a very warm Indian Ocean), it would be unlikely that the rainfall deficit for the coming summer will be much worse than the anomalies shown in the figure.

5.2 Summary outlook for summer 2016

Whaitua	Climate outlook for summer 2016
Wellington Harbour & Hutt Valley	Temperature: Normal to below normal, higher variability of cool and warm. Rainfall: Normal to below normal.
Te Awarua o Porirua	Temperature: Normal to below normal, higher variability of cool and warm. Rainfall: Normal to below normal
Kapiti Coast	Temperature: Normal to below normal, higher variability of cool and warm Rainfall: Normal
Ruamahanga	Temperature: Higher variability of cool and hot, greater diurnal amplitude Rainfall: Below normal, possibly sitting at one in a 50-year dry summer
Wairarapa Coast	Temperature: Higher variability of cool and hot, greater diurnal amplitude Rainfall: Below normal, possibly sitting at one in a 50-year dry summer

This climate outlook was prepared by the Air and Climate Team of GWRC based on our own expertise, and information provided by NIWA, MetService and international centres such as the International Research Institute for Climate and Society of Columbia university (http://iri.columbia.edu/our-expertise/climate/forecasts/seasonal-climate-forecasts/). This guidance is qualitative only, and GWRC takes no responsibility for the use or accuracy of this information. For more details on long-term climate forecasts at a national level the reader should refer to NIWA in the first instance (https://www.niwa.co.nz/climate/sco)