greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

Climate briefing:
Wairarapa dry conditions

Wellington region, April 2016

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

April 2016

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

Executive summary

Overview: Rainfall has been persistently below average in most of the Wellington region since the end of 2014, coinciding with a climate pattern where several dry years have occurred within the last decade or so. Some partial recovery occurred in early January 2016, but rainfall subsequent to this and to date has been well below average. The latest satellite information suggests that the level of dryness experienced this season may have already peaked (as of 31st March), and that vegetation health and soil moisture are now slowly improving in response to cooler temperatures and decreased solar radiation. Additionally, the current El Niño is dissipating more quickly than expected and will possibly revert to a La Niña mode from early winter. Statistically speaking, under neutral or La Niña conditions we would expect closer to average rainfall this winter and next spring and summer (2017), compared to this year. This means that, in the absence of other climate drivers (ie, mechanisms that influence the global climate such as oceanic temperatures, the strength of westerly winds, etc.) rainfall in the Wairarapa should return to normal levels by late autumn this year.

Wairarapa dry conditions compared to past years: The Vegetation Health Index (VHI) and Drought Stress Index (D) derived by satellite (NOAA/US) show that most of the Wairarapa is under considerable drought stress, and certainly worse than last year for this late in the season. Virtual Climate Station data (VCN) supplied by NIWA also present a picture of severe climatological drought-stress and corroborate the satellite-derived indices. The southern Wairarapa Valley in particular is currently experiencing conditions that are drier than any previous event in recent decades, including the 1997/1998 El Niño which was amongst the driest on record over most of the Wairarapa. For the north-eastern Wairarapa valley, the rainfall deficit has been worse this year compared to previous El Niño events. However other water stress indicators more closely associated with drought effects show conditions to the north are not quite as severe as in southern Wairarapa (relative to other years). This could be due to reduced winds this summer, which prevented even further drying.

Drought indicators: Both satellite and VCN data unequivocally show that 'drought-stress' (or dryness) this year in the Wairarapa is quite severe and has extended further south than the 1997/1998 event. The level of severity varies depending on the variables, period and area analysed. A key feature of the current situation is how late in the season the dryness is persisting, as well as the extension of the stressed area further south compared to previous years. There are many additional indicators that need to be considered in order to assess drought more formally. In this briefing only rainfall, potential evapotranspiration, soil moisture and satellite-derived drought indices based on vegetation health are assessed. While GWRC is not able to make explicit statements or recommendations about formal drought declaration, we note that in the short-term conditions are unlikely to become drier due to the sharply decreasing solar radiation levels at this time of the year and rapid dissipation of the El Niño (ENSO) phenomenon. Further climate briefings will be prepared by GWRC as the season unfolds.

Summary of key findings:

1. Satellite, VCN and station data all confirm that most of the Wairarapa is currently under severe drought stress.

2. For most of the Wairarapa, the indicators of drought stress (rainfall, potential evapotranspiration (PET), and vegetation condition) appear similar to, although not quite as severe, as the 1997/1998 El Niño event. The exception is the southern Wairarapa Valley, where the current drought stress is worse than in 1998 and possibly the worst in recent decades.

3. Drought stress has become more frequent in recent years, primarily due to increased evapotranspiration as a result of higher air temperatures. This is largely consistent with climate change predictions.

4. It is very unlikely that the current dryness will further worsen before and into winter even if rainfall remains below average, due to rapidly decreasing solar radiation and evaporation over the next four months.

5. Long-term seasonal climate forecasts are favourable to a return of normal rainfall pattern in the Wairarapa into winter, as the current El Niño event is dissipating faster than originally predicted.

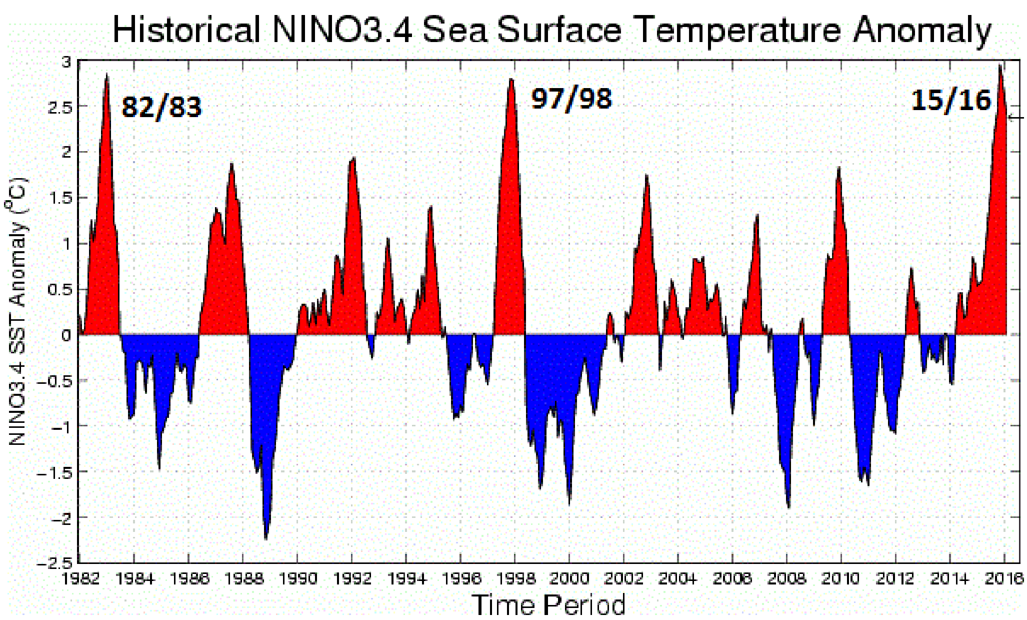
Contents

Executive summary		**i**
1.	**Climate drivers**	**1**
1.1	El Niño – Southern Oscillation (ENSO)	1
1.2	Southern Annular Mode (SAM)	3
1.3	Atmospheric blocking	4
1.4	Sea ice extent	5
1.5	Sea surface temperatures	5
2.	**Wairarapa dry conditions compared to past years**	**6**
2.1	Satellite-derived vegetation health and drought stress indices	6
2.2	Soil moisture assessment from the NIWA-Drought Monitor	8
2.3	Virtual Climate Station (VCN) analysis	9
2.4	Observed rainfall and soil moisture conditions for selected sites	14
2.4.1	Rainfall accumulation – since 1 July 2015	14
2.4.2	Soil moisture content – since 1 July 2015	19
2.4.3	Overall assessment of rainfall accumulation and soil moisture	21
3.	**Updated climate outlook for the remaining of autumn**	**23**
Acknowledgments		**24**

1. Climate drivers

1.1 El Niño – Southern Oscillation (ENSO)

The 2015/2016 El Niño was very strong, comparable in intensity to the record-breaking El Niño events of 1982/1983 and 1997/998 as shown in Figure 1.1 (upper panel). The current El Niño peak has now passed and is losing intensity. Although some uncertainty remains, the best guidance from international predictions is that the event will rapidly dissipate and possibly switch to La Niña conditions by early winter (Figure 1.1 lower panel). This means that the drying effects of the El Niño should decrease in the next few months, returning to a more normal rainfall pattern depending on the behaviour of the other climate drivers (see sections 1.2 to 1.5). Established statistical relationships between seasonal low rainfall and ENSO phase in our region suggest that if La Niña conditions eventuate, this will not increase the probability of low winter rainfall, placing the Wellington region under much more favourable conditions compared to the present El Niño regime.



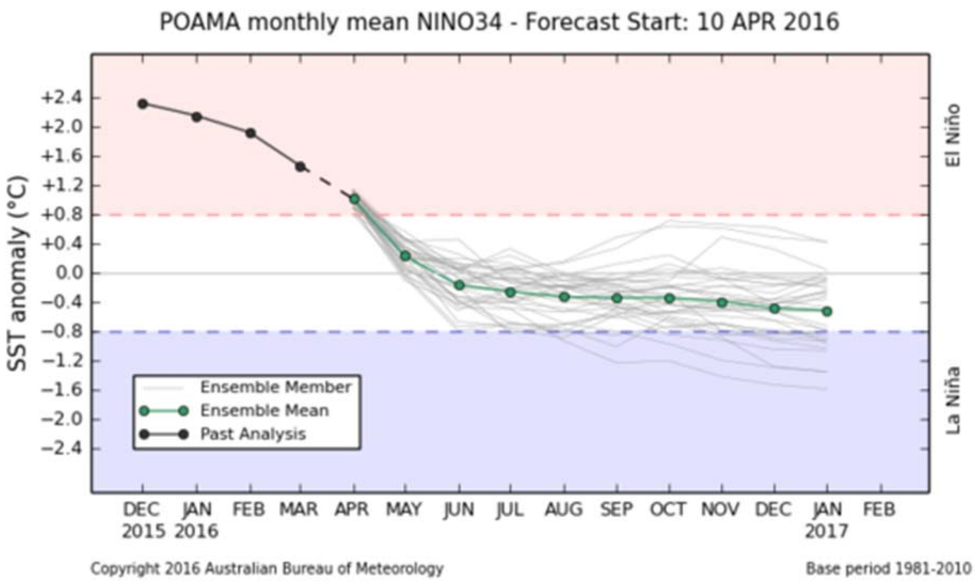


Figure 1.1: Latest ENSO Sea Surface Temperature anomalies in historical context (upper panel) and projections for the remaining of the year (lower panel). Source: NOAA/US and BOM. The figure shows that the 2015/2016 El Niño event was of very similar magnitude to the record events of 1982/1983 and 1997/1998, and that either neutral or weak La Niña conditions are predicted from mid-winter.

1.2 Southern Annular Mode (SAM)

The Southern Annular Mode (SAM) describes the movement of the westerly wind belt that encircles Antarctica in the Southern Ocean. Although the SAM is normally negative during El Niño years, Figure 1.2 shows that this climate driver has been mostly positive since the beginning of summer. A positive SAM is associated with more anticyclones over New Zealand causing more settled weather, less wind and hotter temperatures during summer. It is not possible to predict the behaviour of this climate driver over the next season other than the predicted short term tendency (shown in red on the right corner). The latest guidance from the US National Oceanic Atmospheric Administration (NOAA) suggests that the SAM will briefly shift to negative in the second half of April 2016 before returning to positive, possibly indicating that rainfall will remain below average at least until May 2016. The GWRC autumn climate outlook (section 3) reflects these predicted changes in SAM.

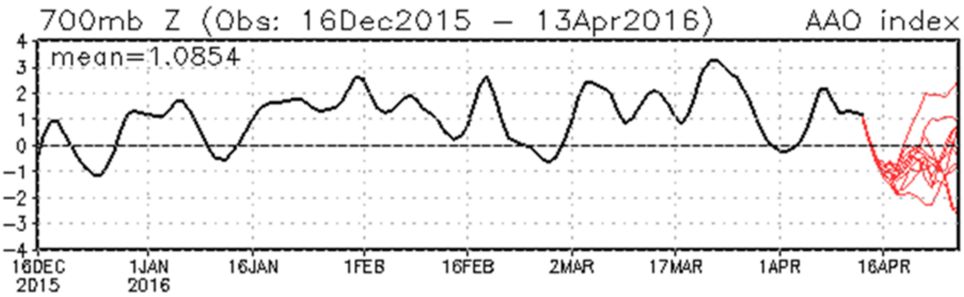


Figure 1.2: Evolution of the Southern Annular Mode, as measured by the Antarctic Oscillation Index (AAO). A persistence of positive values is seen for much of 2016, with forecasts for the remaining of April (in red) indicating a brief shift to negative values. The persistence of the positive phase of this index tends to be associated with blocking anticyclones to the east of New Zealand and a reduction of the westerly winds, causing warmer than normal temperatures and lack of rainfall in the warm season. Source: NOAA/US

1.3 Atmospheric blocking

Atmospheric blocking is associated with SAM and the other drivers. It is measured by the persistency of anticyclones around New Zealand, which 'block' the normal westerly flow and tend to produce low winds, higher temperatures and low rainfall during the warm season. Figure 1.3 shows that the blocking has been very active over the entire period from 1 January to present, helping explain the anomalous conditions observed, that is, less fronts, less wind, hotter temperatures and much less rainfall than normal in some areas. Rainfall can only return to more normal levels after this pattern is completely dissipated. There is a good chance that this pattern will break down once the more vigorous winter fronts become established and the SAM reverts to negative, but present guidance suggests, as discussed above, that this is unlikely to happen until later in May 2016.

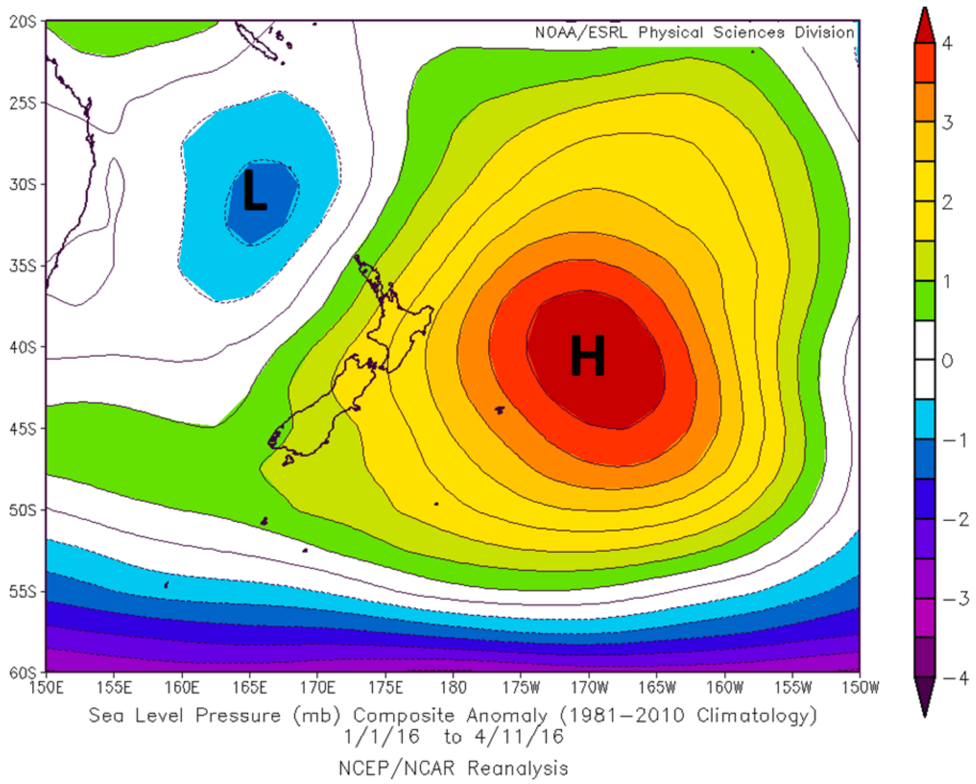


Figure 1.3: Mean Sea Level Pressure anomalies (hPa) over the New Zealand sector for the period 1 Jan 2016 to 11 April 2016. A very vigorous blocking high is seen to the east of New Zealand, with a small low pressure area to the north-west of the country. As a result of this pattern New Zealand has seen less fronts, less wind, higher temperatures and much less rainfall than normal in some areas, of which the Wellington region and Wairarapa in particular have been one of the most affected. Source: NCEP reanalysis/US.

1.4 Sea ice extent

The sea ice extent is very important to New Zealand because of our relative proximity to Antarctica. The ice strengthens the cold fronts that affect New Zealand during winter. It also interacts with the Southern Annular Mode potentially affecting the rainfall anomalies, as discussed in section 1.2. The Antarctic sea ice extent is currently close to average (not shown), different from last year when the ice extent was significantly greater than average.

1.5 Sea surface temperatures

The latest sea surface temperature for March 2016 shows that the oceanic waters to the west of New Zealand have been the warmest on record, while the waters to the south of New Zealand have been the coldest on record. The warm waters help explain the unusually warm and settled weather that has persisted since the beginning of the year. However, as the fronts strengthen towards the winter they shift cold water towards New Zealand, as well as becoming more vigorous (ie, colder) while sitting on top of cooler than normal water around Antarctica. This means that once the blocking pattern (section 1.3) finally breaks down the region will likely experience a quite vigorous climate reversal towards very cold and wet conditions.

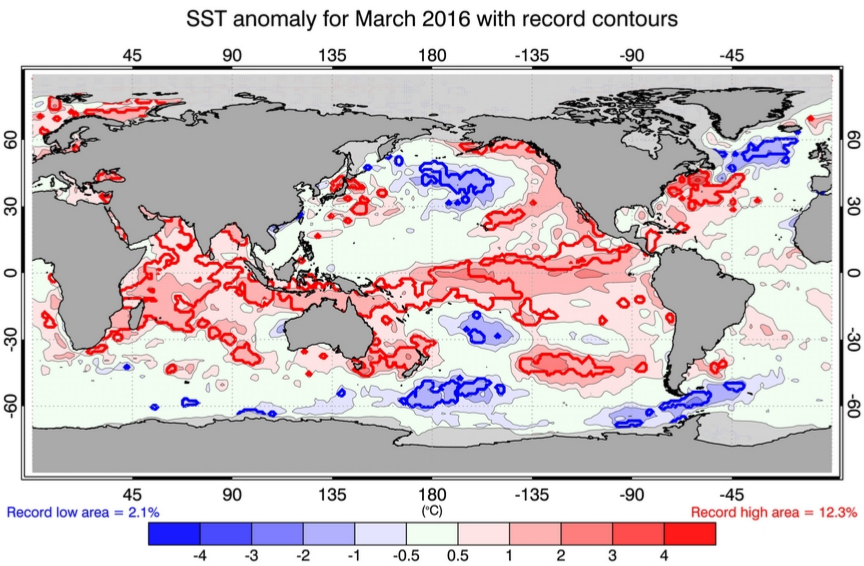


Figure 1.4: Sea Surface Temperature Anomalies for March 2016. Areas of record warm or record cold are marked by the contour lines. Warmest on record waters to the west of New Zealand help explain the very warm and stable weather observed since the beginning of this year, but as we progress into the colder season the cold fronts will be amplified by the record cold waters to the south of New Zealand, as well as possibly bringing this colder water mass towards New Zealand. This configuration has the potential to generate an abrupt shift into cold and wet conditions by the end of autumn. Source: Australian Bureau of Meteorology.

2. Wairarapa dry conditions compared to past years

2.1 Satellite-derived vegetation health and drought stress indices

Figure 2.1 shows the satellite-derived Vegetation Heath Index (VHI) for week 13 (ending 31 March) for the years 1983 (El Niño), 1998 (El Niño), 2013 (drought-declared year in the North Island) and 2016. Indices below 40 (yellow and red tones) indicate vegetation stress with likely losses of crop and pasture production; while an index above 60 (dark green and blue) would imply plentiful production[1]. Figure 2.1 shows that although the drought-declared year of 2013 was overall much worse in the North Island, for the Wairarapa the worst years were 1997 and 2016. A closer inspection of the Wellington region shows that the present dryness (2016) is much worse than in 1997 for the western part of the region. For the Wairarapa, the area south and south-east of Lake Wairarapa, which appears as light green (ie, relatively healthy) in 1997, is significantly worse in 2016 (see enlarged comparison in Figure 2.2)

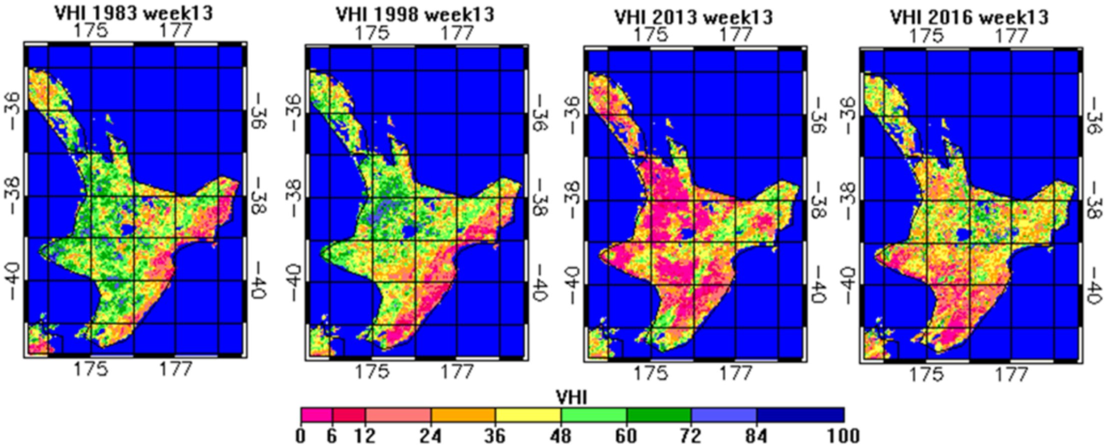


Figure 2.1: Vegetation Health Index (anomaly based on a 25 year climatology) comparing week 13 (31 March) for the years 1983 (strong El Niño), 1998 (strong El Niño), 2013 (declared drought in the North Island) and 2016. Yellow and red show drought-stress with likely losses of crop and pasture production; dark greens and blues show healthier vegetation compared to normal. The images show that, although the North Island as a whole had its worst year in 2013, in the Wairarapa the current condition is comparable to the 1997 El Niño event, but actually worse than 1997 to the south of Lake Wairarapa. Source: Images produced by NOAA/US. Resolution: 4km resolution pixels used.

[1] Koga, F. and Guo,W. 2015: 2006-2015 mega-drought in the western USA and its monitoring from space data. Geomatics, Natural Hazards and Risk, published online, DOI:10.1080/19475705.2015.1079265.

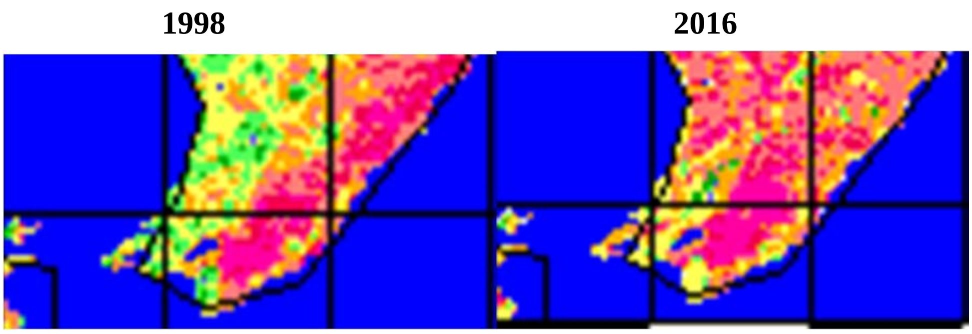


Figure 2.2: VHI as per Figure 2.1, but zoomed in comparing 1998 (left) with 2016 (right). The area south of Lake Wairarapa, which appears relatively green in 1998, is considerably worse in 2016.

Importantly, the VHI and D-index convey the actual anomaly calculated based on robust (25 year) climatology, taking into account the vegetation health as well as temperature related stress compared to the long-term average. Hence, an indication of 'stressed conditions' means that the stress is higher than what would normally be expected for the time of the year. Although not specifically calibrated for New Zealand conditions, the satellite vegetation and drought-stress indices offer a good sense of relative change from year to year. These satellite products are used by the US-drought monitor (http://droughtmonitor.unl.edu/).

Figure 2.3 shows the week ending 31 March 2016 zoomed in for the Wellington region, albeit using the same 4km resolution as in Figure 2.1. The left panel shows the VHI as in Figure 2.1, while the right panel shows the Drought-stress index (D) derived from VHI, which basically highlights the areas that are drought-stressed on a progressive scale from low to high. We can see that the vegetation is highly stressed for most of inland Wairarapa, less so in the hill country. These maps are not intended to be used at a scale of less than 4km so very localised features will not be accurately shown.

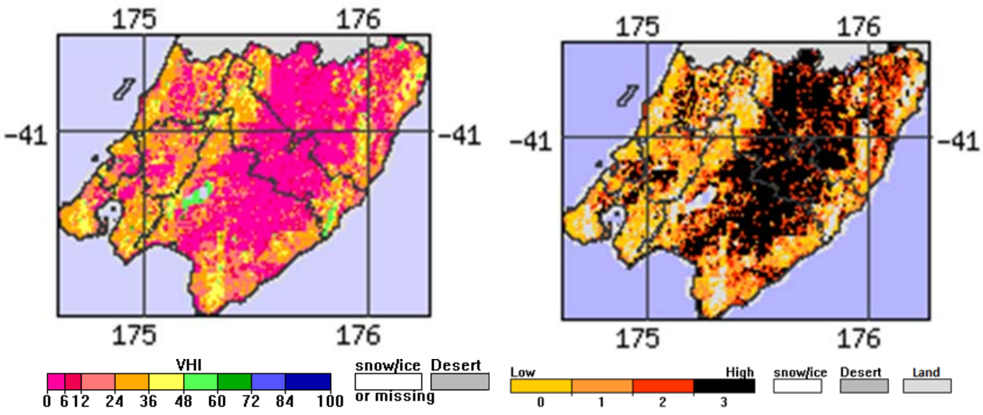


Figure 2.3: Satellite-derived images of Vegetation Health Index (left) and Drought-stress Index (right) for the week ending 31 March 2016. VHI scale (left) as per Figure 2.1. Drought index scale (right) as per follows: 0 (moderate or no stress), 1 (severe stress), 2 (extreme stress), 3 (exceptional stress). All metrics are in relation to a 25 year period base climatology. Source: NOAA/US, resolution 4km.

2.2 Soil moisture assessment from the NIWA-Drought Monitor

Figure 2.4 below shows the soil moisture deficit from the NIWA national drought monitor zoomed in for the Wellington region for 7th April 2016. As very little rain fell between 31 March and 7 April, this map should be comparable to the satellite previously shown. We can see that the driest area according to the NIWA soil moisture deficit indicator more or less matches the area indicated as severe by the satellite–generated indices, with the difference that the NIWA map doesn't reflect the severity of the dryness south of Lake Wairarapa, possibly because the data coverage is very sparse for the area.

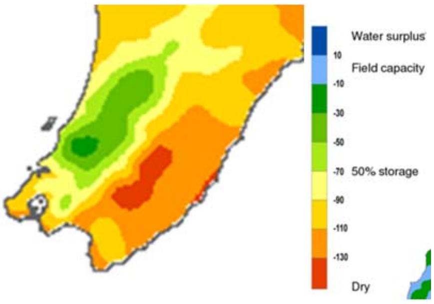


Figure 2.4: Soil moisture deficit for 7 April 2016. Source: NIWA drought monitor. https://www.niwa.co.nz/climate/nz-drought-monitor/droughtindicatormaps/Soil%20Moisture%20Deficit%20%28SMD%29

2.3 Virtual Climate Station (VCN) analysis

Modelled daily climate data from the NIWA Virtual Climate Network (VCN) have been used to compare the current summer with those over the past 35 years. Three sites were selected to generally represent the major geographical and climate sub-zones of the Wairarapa (Figure 2.5):

- Southern Wairarapa Valley (VCN site 30242)
- Northern Wairarapa Valley (VCN site 27781)
- Eastern Wairarapa (VCN site 28831)

Three indicators of water stress have been chosen to characterise the relative severity of the current summer. These are:

- Accumulated summer rainfall (mm)
- Accumulated summer potential evapotranspiration, PET (mm), defined as the total evapotranspiration that would occur if sufficient moisture is available
- Number of days of ‘severe’ soil moisture deficit. A severe deficit is defined as 130 mm or more and is consistent with the threshold commonly used in New Zealand. A deficit of 130 mm means that this amount of effective rainfall (ie, penetrating the soil) is needed in order to bring the soil back to saturation.

For the purposes of this exercise, ‘summer’ was defined as the six month period October to March inclusive, to generally coincide with the time of year that water stress begins to emerge. Different definitions of what constitutes ‘summer’ may lead to slightly different results.

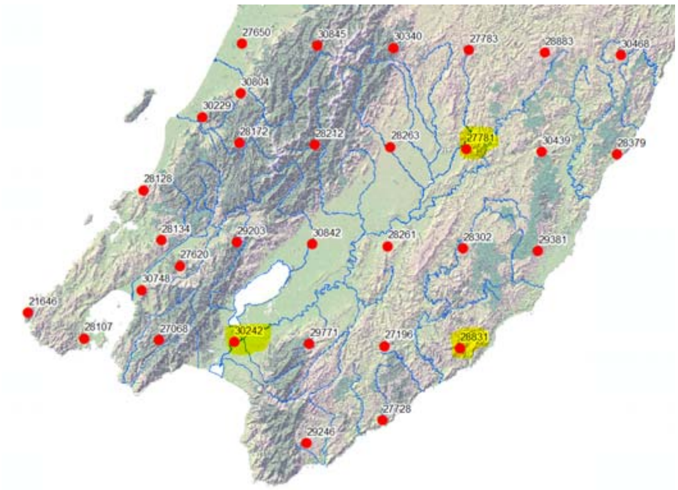


Figure 2.5: Map of available VCN sites with subset of three sites selected for analysis highlighted in yellow

Summary data for each indicator is ranked by year (Figures 2.6, 2.7 and 2.8) for each of the three VCN sites. In each plot, the current year is highlighted (red) and the summers of 1997/98 and 1982/83 in orange. These summers correspond to the previous strongest on record recorded El Niño events. The horizontal black line is the average for the 35 year period (which broadly meets the criteria of a standard climatological period).

Key observations:

- This summer has been extremely dry across most of the Wairarapa, confirming the findings of both satellite data and soil moisture deficit from the NIWA drought monitor previously shown. All indicators at all sites suggest a higher water stress than normal.

- In south Wairarapa Valley (VCN site 30342), summer rainfall this year is about as low as last summer which was the lowest since 1980. Summer PET was much higher than normal and on a par with the highest on record (which have all been recorded in the last several years). Days of severe deficit were much higher than normal, similar to last summer. Only 2000/01 has been more extreme.

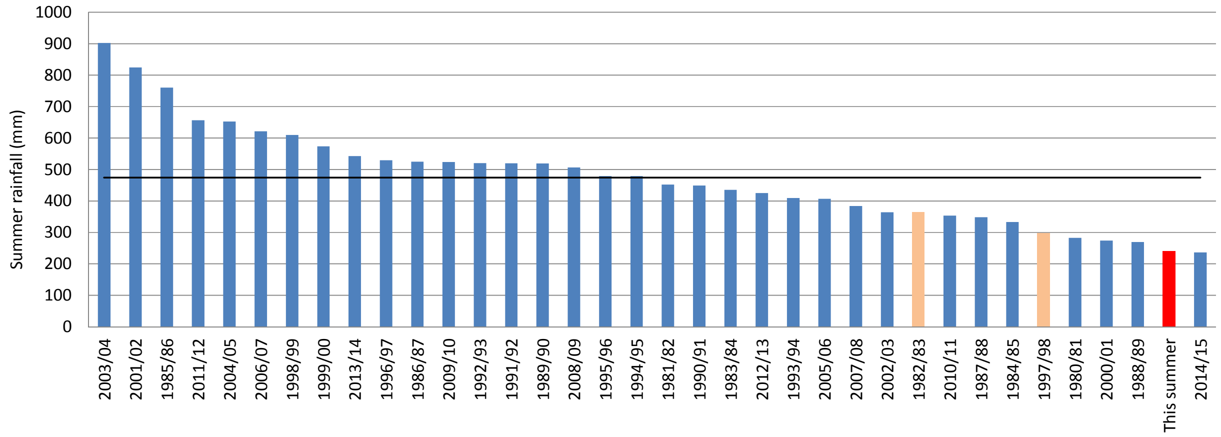
- Across all three indicators, water stress in the southern Wairarapa Valley has been higher this year than in either the 1997/98 or 1982/83 El Niño years.

- Rainfall has been the lowest since 1980 in the northern Wairarapa Valley (VCN site 27781) but, compared with the southern Valley, PET and days of severe deficit do not present such an extreme overall picture of water stress. The 1997/98 El Niño year appears to have been more significant in the northern Valley. Parts of the climatic reason for this could be due to the fact that this summer had very little wind compared to previous years, due to the effects of atmospheric blocking mentioned in section 1.3.

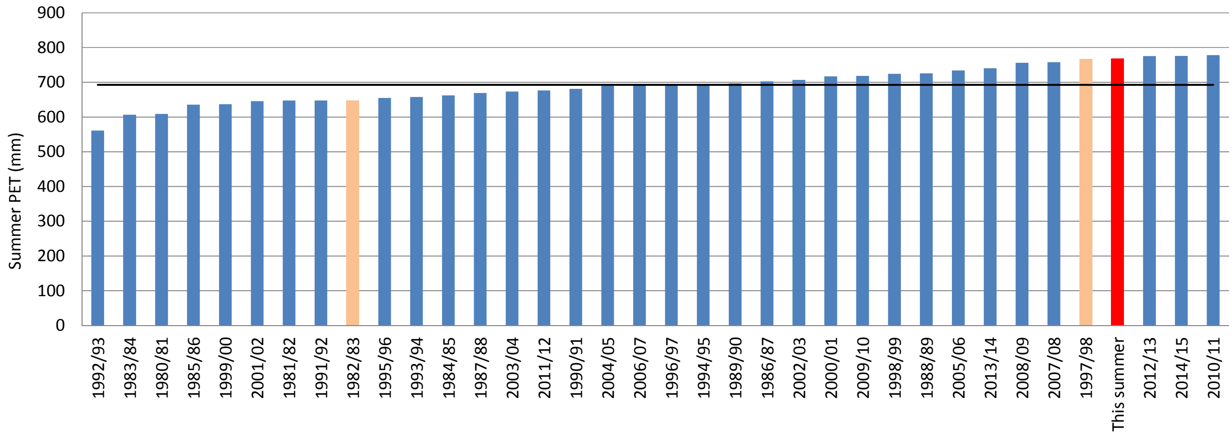
- The picture to the east (VCN site 28831) is also one of extreme dryness, although not quite as severe as 1997/98.

- The finding of drought effects at all three sites doesn't seem to be a random pattern. Seven out of the ten highest ranked PET years occurred in the last 10 years for the south and north-eastern Wairarapa, with nine out of ten in the eastern Wairarapa. For rainfall, the figure for all sites is only three out of ten dry years occurring over the last decade. Hence, we can conclude that environmental conditions leading to drought stress have become dramatically more pronounced over the last decade irrespective of rainfall not following a similar proportional decrease. This tendency for increasing dryness over the last 10 years matches the increase in global temperatures associated with increasing levels of atmospheric CO_2. Warmer temperatures increase the potential for evaporation and hence more water loss from both the soil and plants.

Accumulated rainfall (Oct to March)



Accumulated PET (Oct to March)



Total days in 'severe' soil moisture deficit (>130 mm)

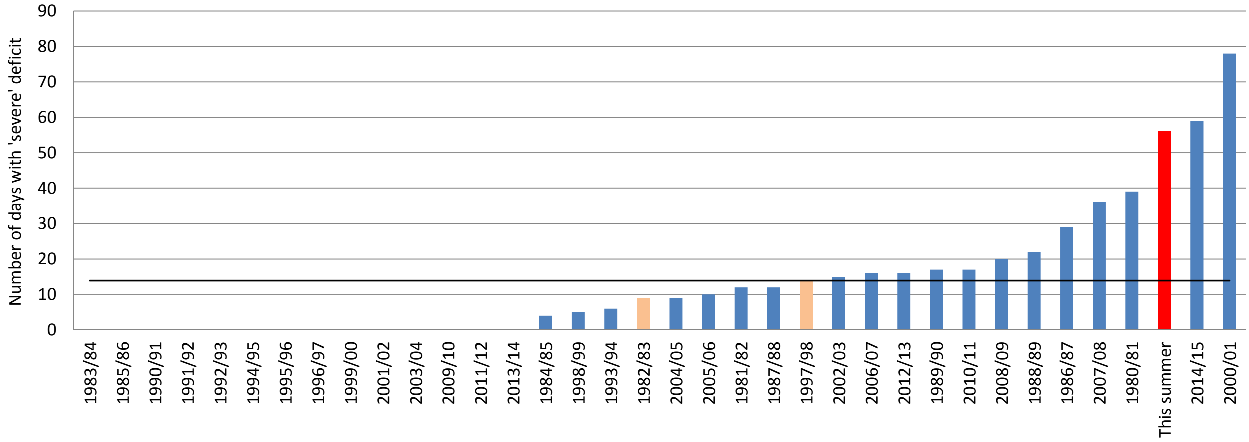
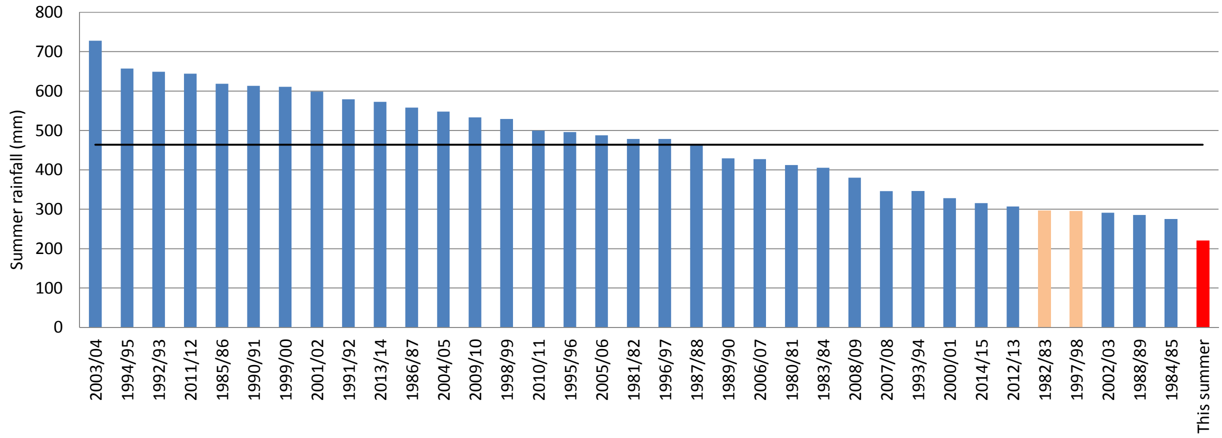
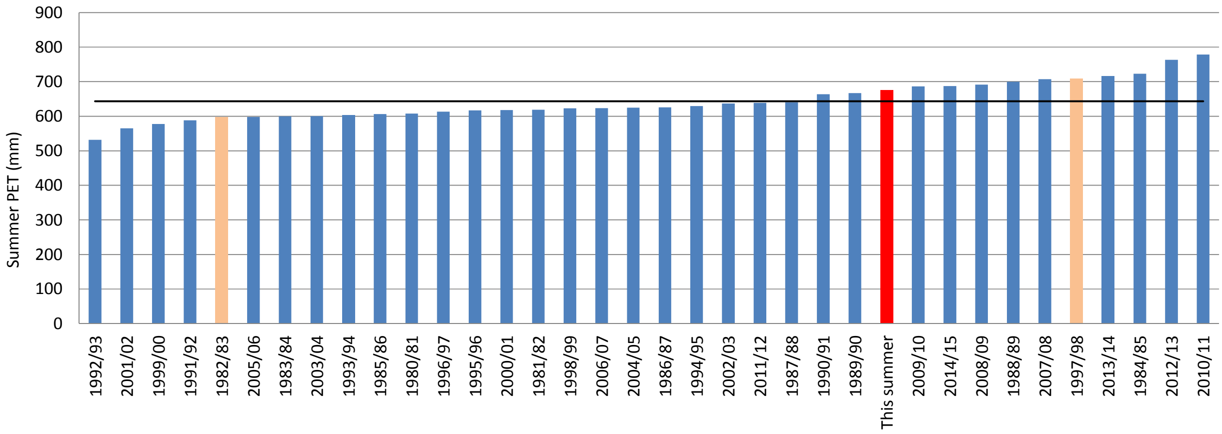


Figure 2.6: South Wairarapa Valley (VCN site 30242). Rankings of years by climate indicators with summer 2015/16 (shown in red) and summers 1997/98 and 1982/83 (shown in orange).

Accumulated rainfall (Oct to March)



Accumulated PET (Oct to March)



Total days in ‘severe’ soil moisture deficit (>130 mm)

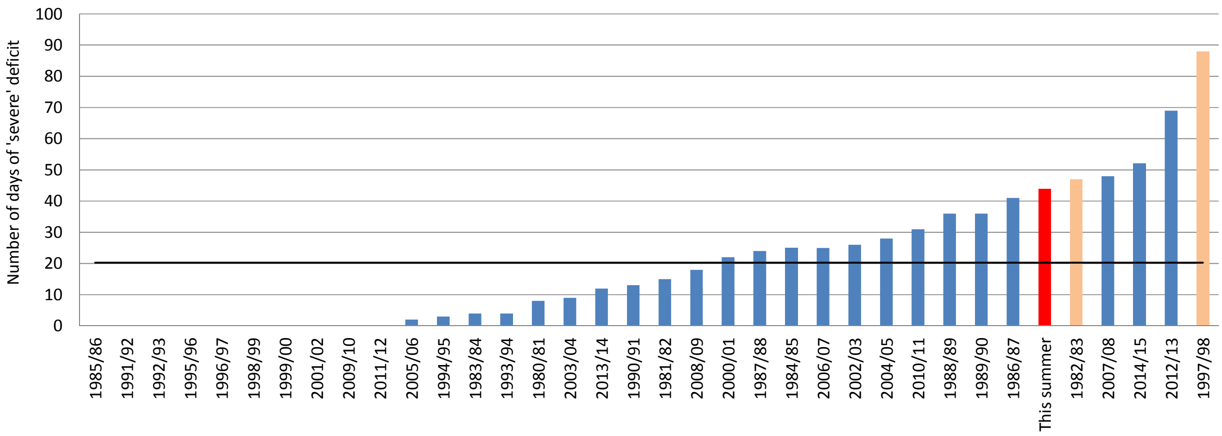
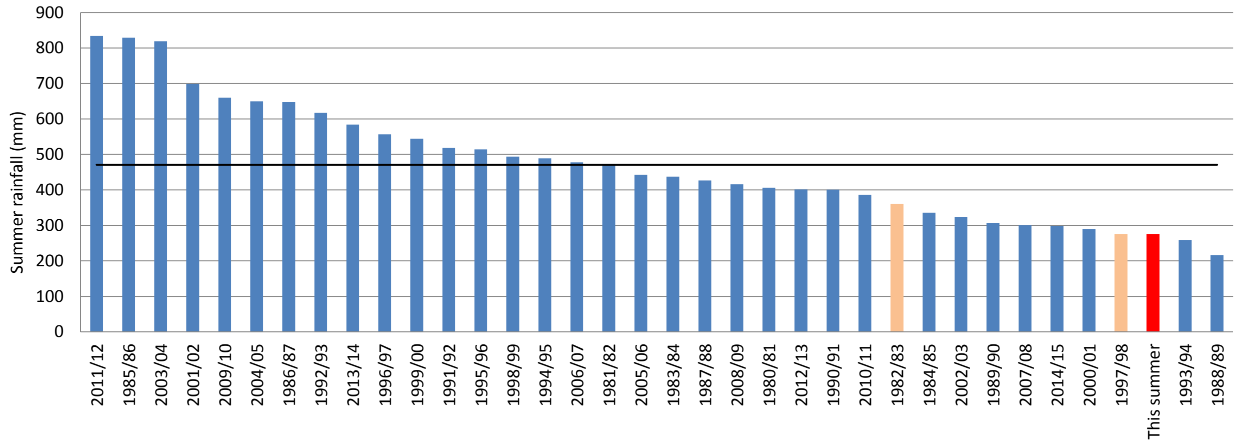
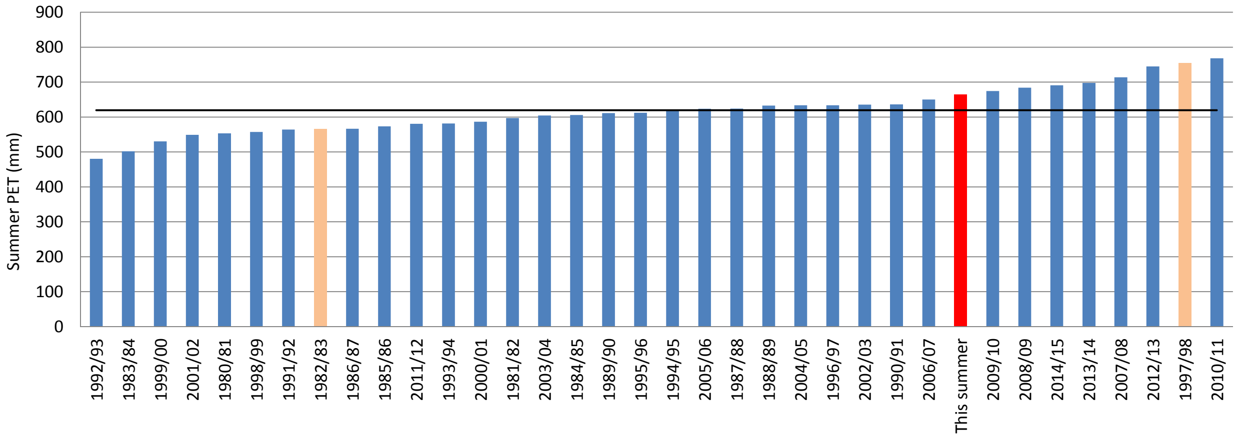


Figure 2.7: Northeastern Wairarapa Valley (VCN site 27781). Rankings of years by climate indicators with summer 2015/16 (shown in red) and summers 1997/98 and 1982/83 (shown in orange).

Accumulated rainfall (Oct to March)



Accumulated PET (Oct to March)



Total days in ‘severe’ soil moisture deficit (>130 mm)

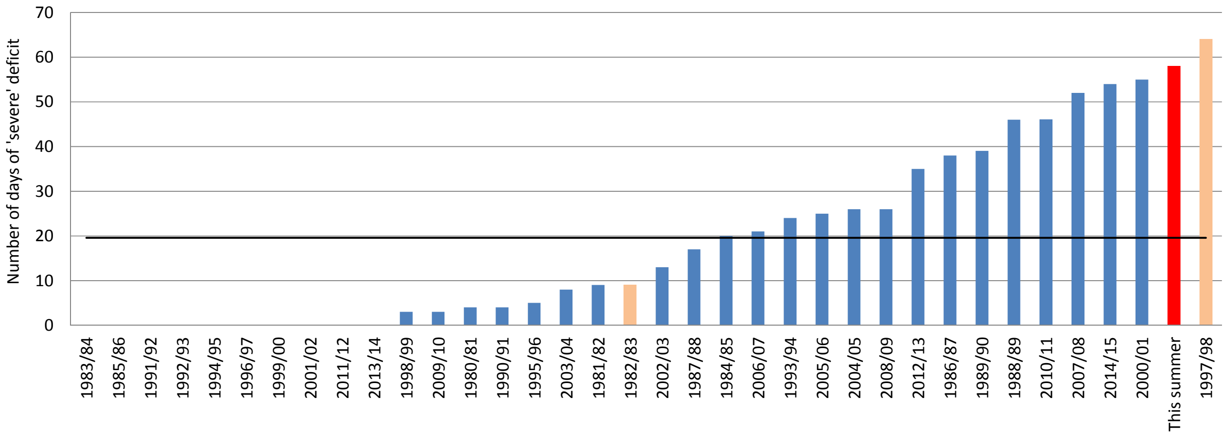


Figure 2.8: Eastern Wairarapa coast (VCN site 28831). Rankings of years by climate indicators with summer 2015/16 (shown in red) and summers 1997/98 and 1982/83 (shown in orange).

2.4 Observed rainfall and soil moisture conditions for selected sites

Figure 2.9 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.

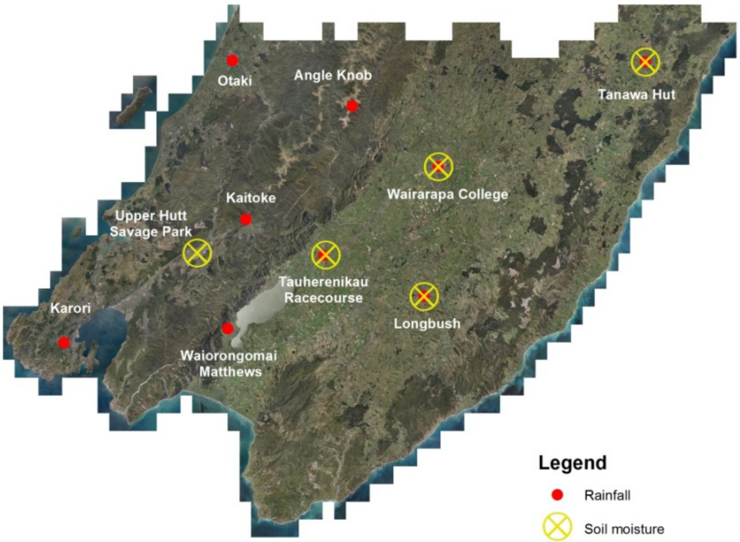
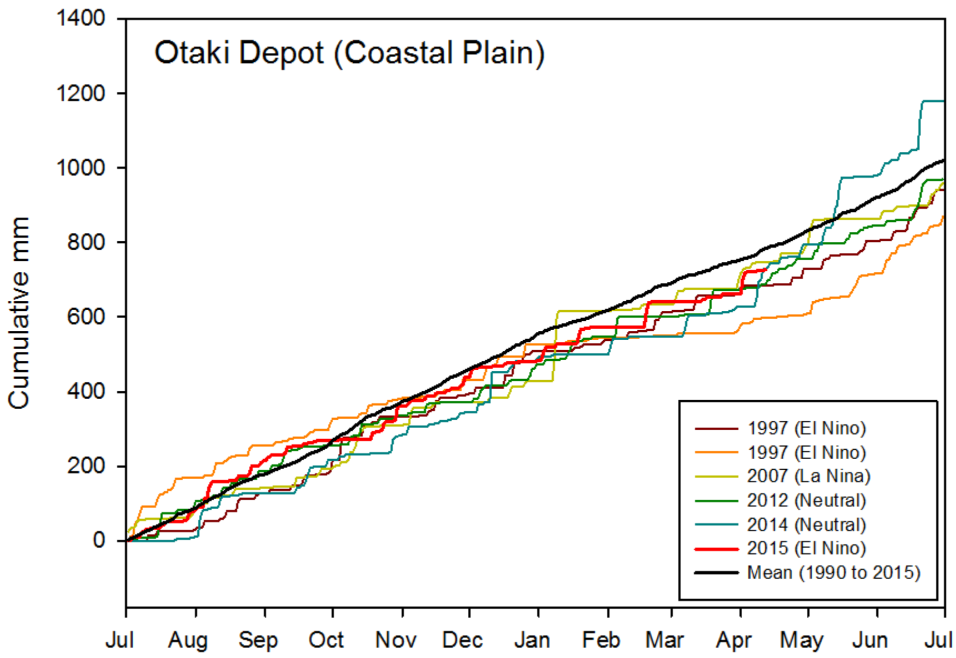


Figure 2.9: Map of rainfall and soil moisture monitoring locations

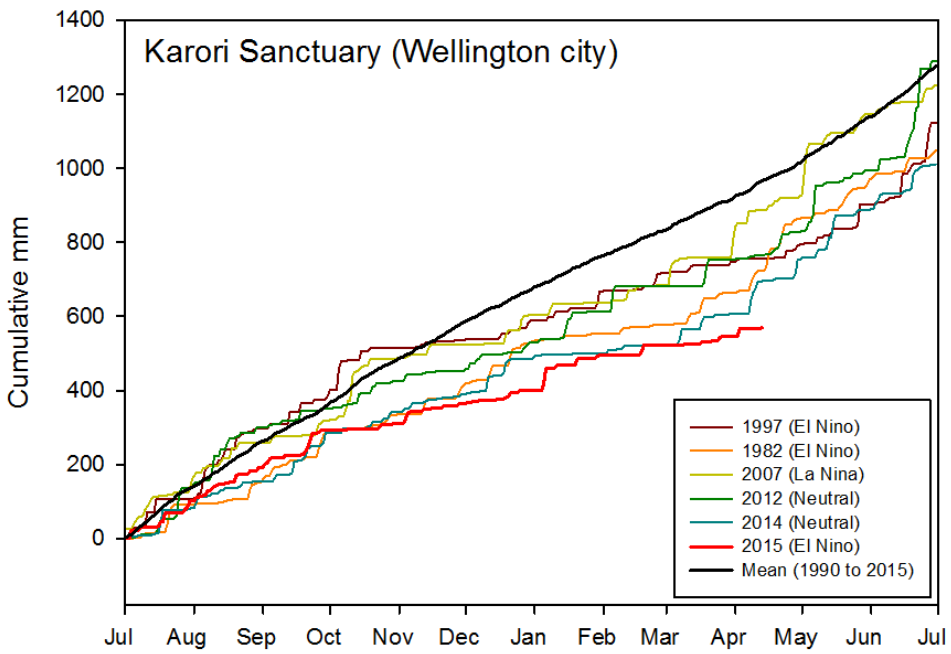
2.4.1 Rainfall accumulation – since 1 July 2015

The following rainfall plots show total rainfall accumulation (mm) since 1 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. 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.

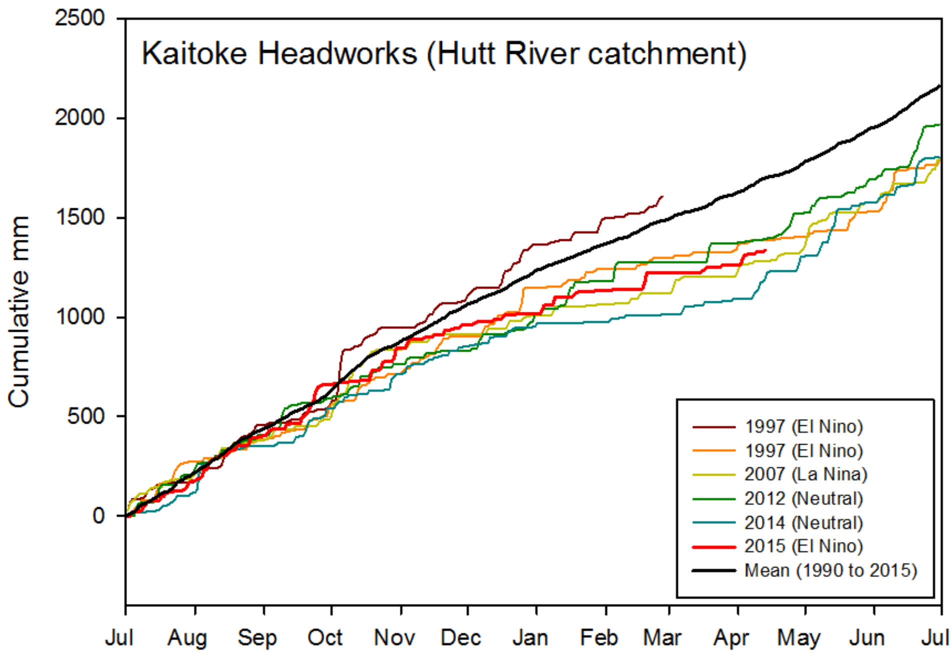
Kapiti Coast

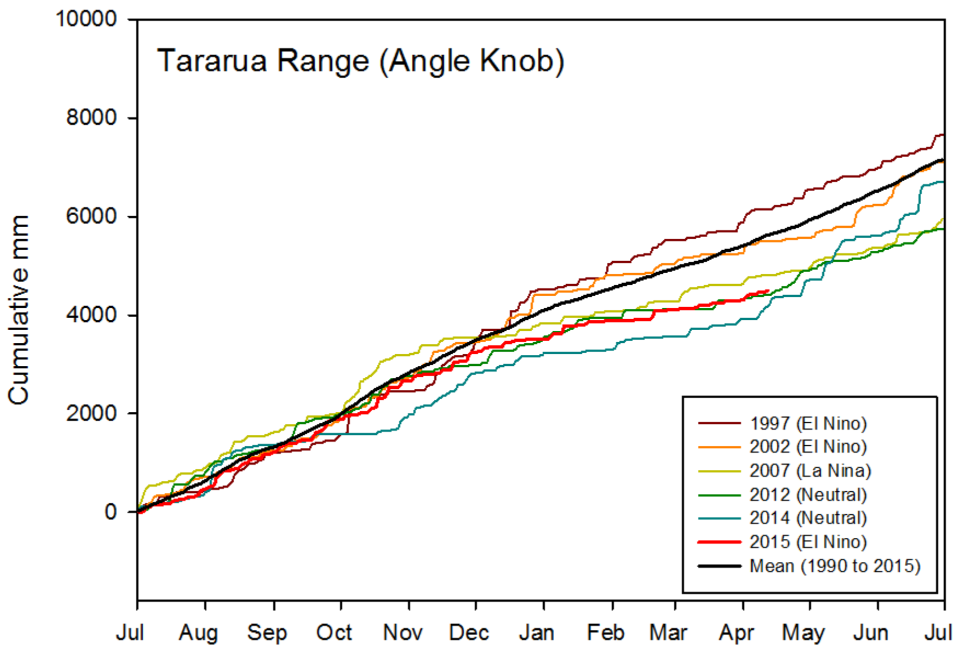


Southwest (Wellington city)

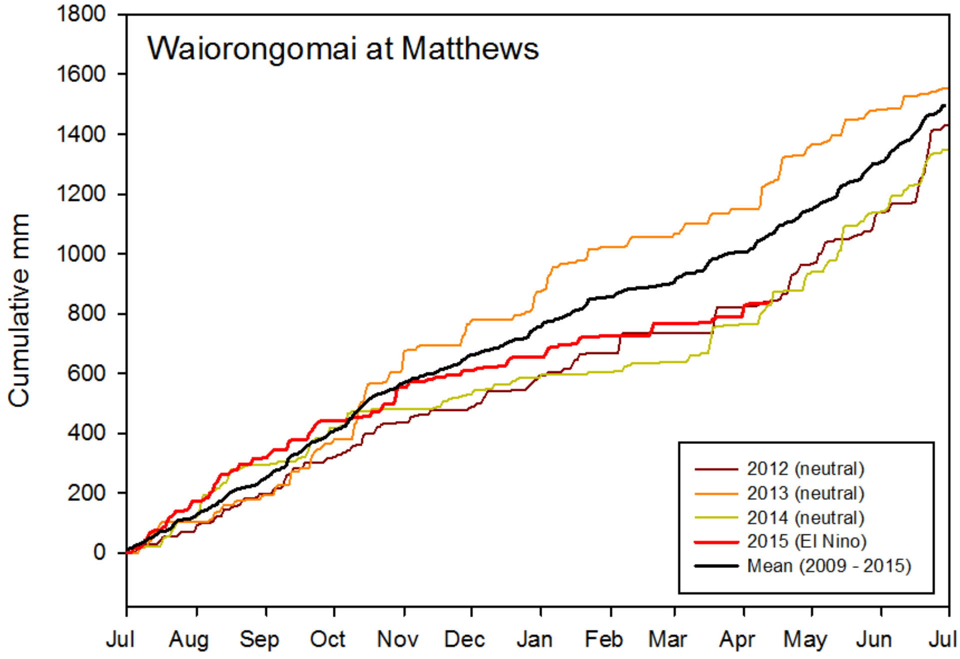


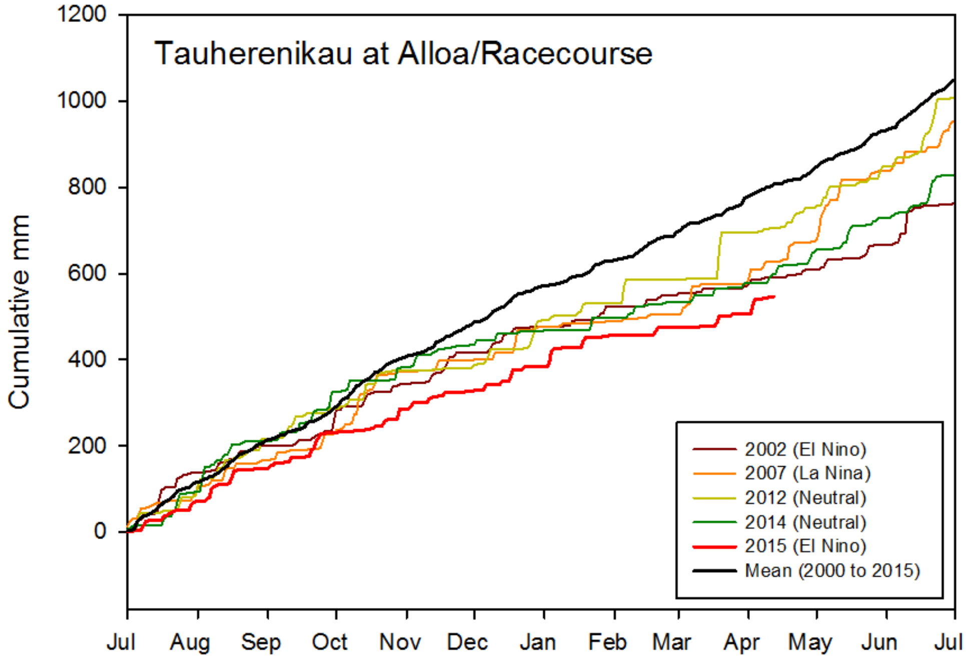
Hutt and Tararua Range

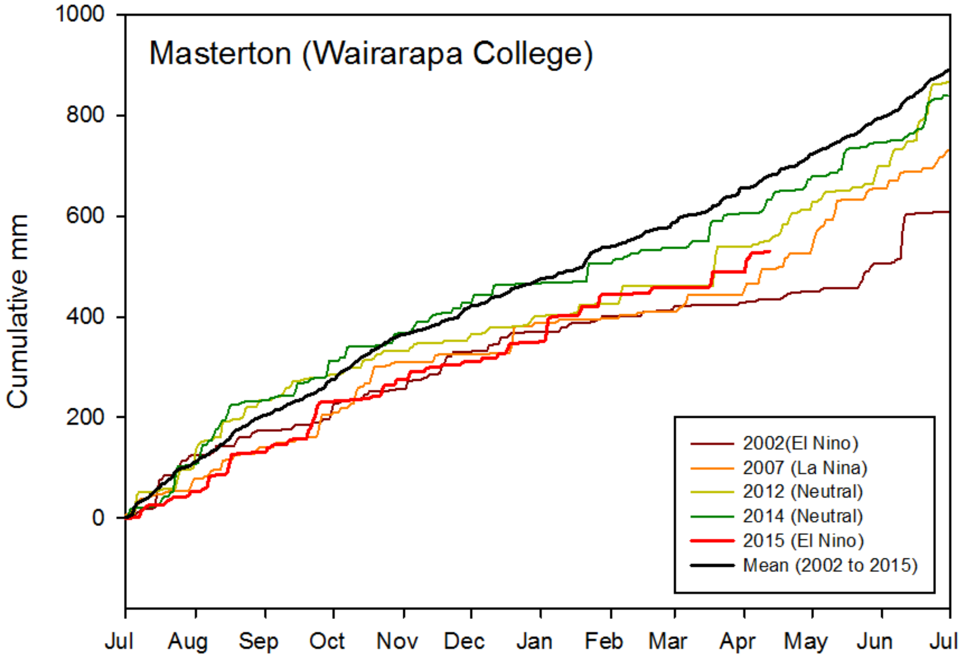


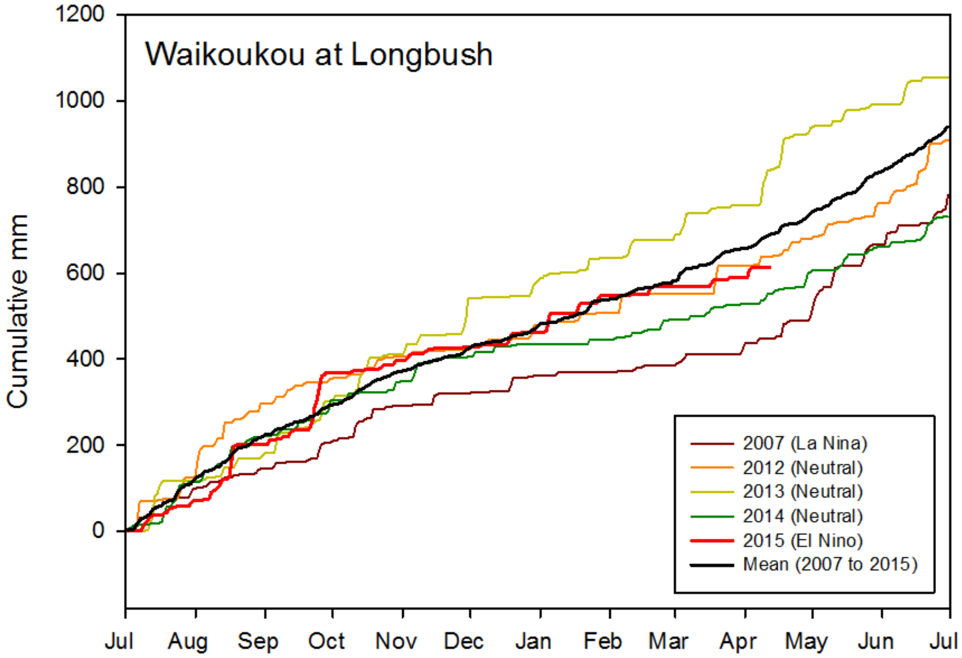


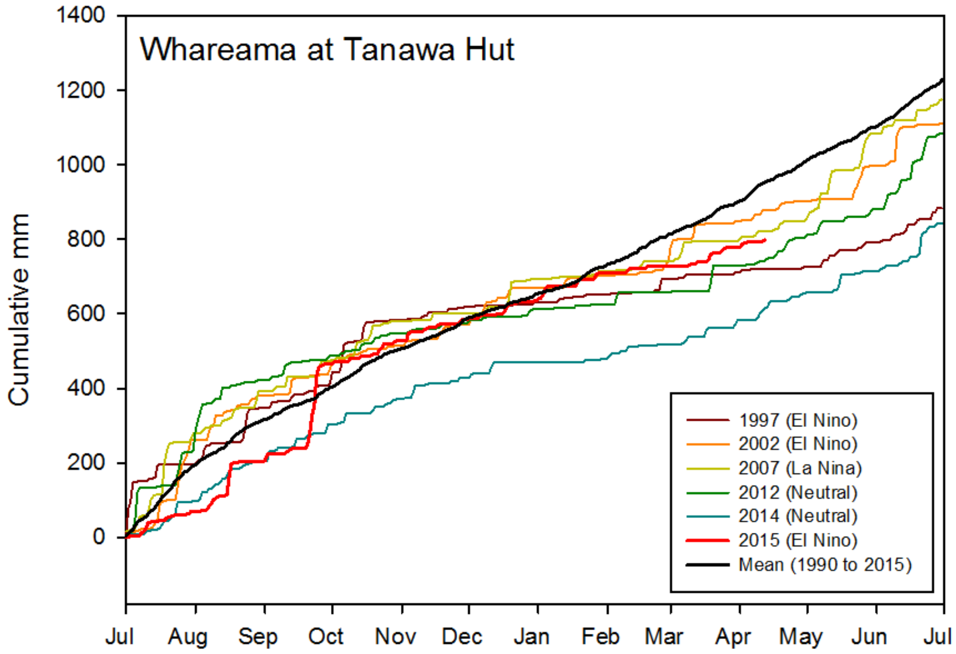
Wairarapa


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)

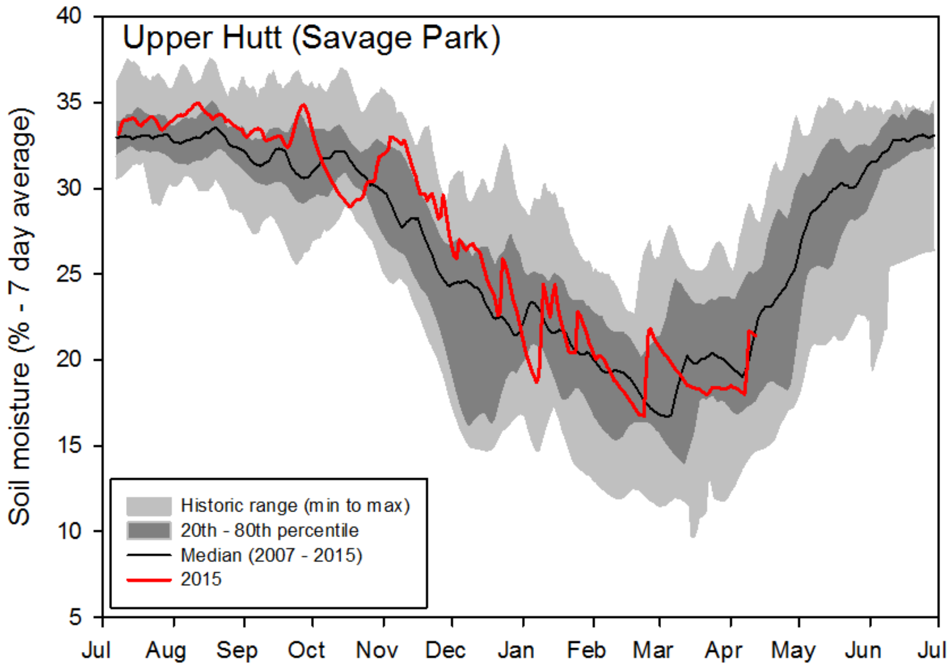

Waikoukou at Longbush
Cumulative mm
1200
1000
800
600
400
200
0
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2007 (La Nina)
2012 (Neutral)
2013 (Neutral)
2014 (Neutral)
2015 (El Nino)
Mean (2007 to 2015)



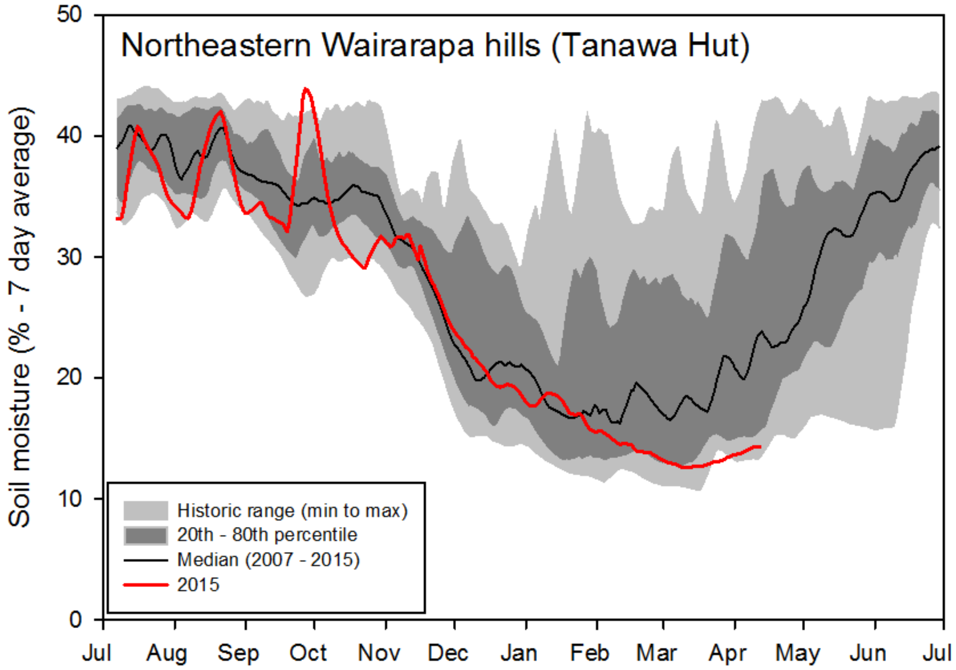
2.4.2 Soil moisture content – since 1 July 2015

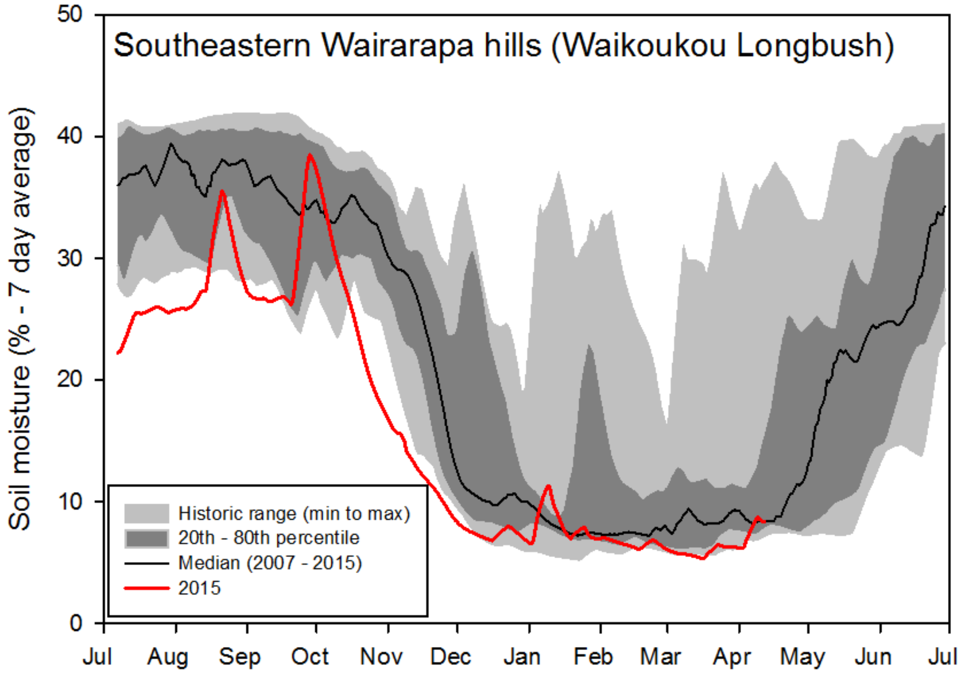
The soil moisture plots show seven day rolling average soil moisture (%) since 1 July 2015. An envelope plot of the historic range of data (and site mean) is also provided to give an indication of how the current soil moisture compares with that for a similar time of the season in past years. While the soil moisture plots are useful for tracking change within the current season and comparing relative differences between years, they do not provide the absolute moisture content (%) as many of the GWRC soil moisture sites have not yet been fully calibrated.

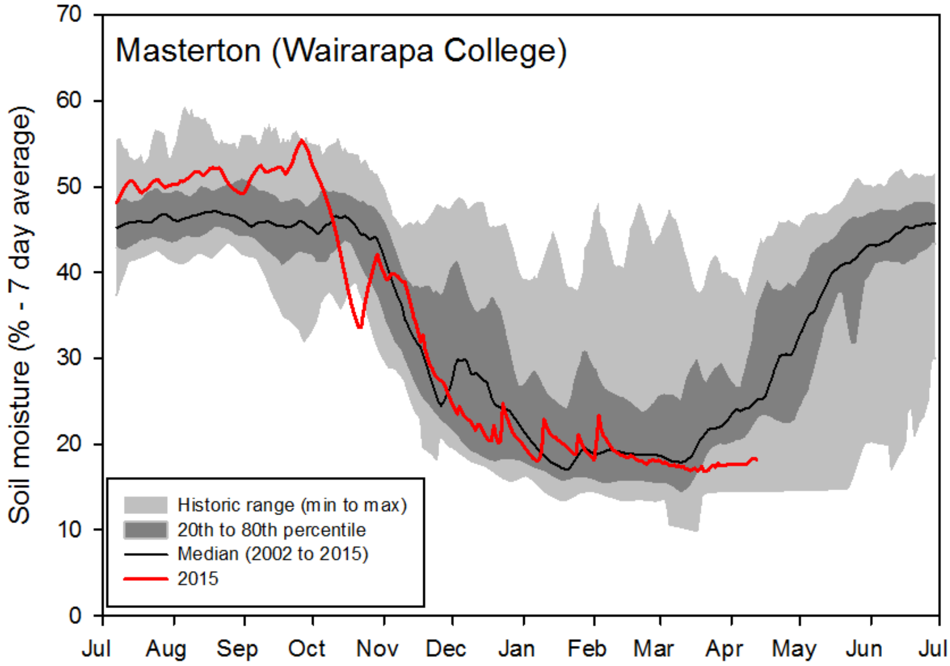
Hutt Valley

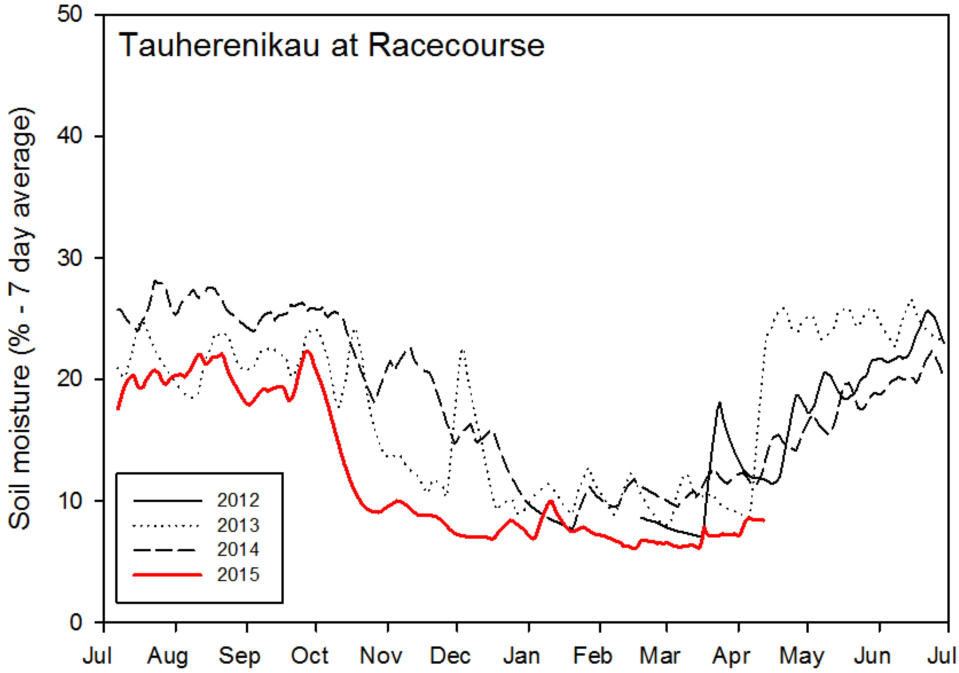


Wairarapa


Northeastern Wairarapa hills (Tanawa Hut)
Soil moisture (% - 7 day average)
0
10
20
30
40
50
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)
0
10
20
30
40
50
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





2.4.3 Overall assessment of rainfall accumulation and soil moisture

Cumulative rainfall as of April 2016 is well below normal for all sites analysed, with the exception of Kapiti coast where accumulated rainfall is closer to average. A few sites are currently sitting at the lowest on record for the cumulative period, including the Karori Sanctuary and the Tauherenikau site near Featherston. The accumulation over the ranges (Angle Knob) has also been quite low. The Karori site is very important as it has a very long data series, and observations from this site are consistent with the satellite appraisal that this year has been much worse than any previous El Niño years in the west part of the region. In the Wairarapa the sites have been installed much more recently, and places like Tanawa Hutt may be subject to localized topographic rainfall which is not representative of the overall low lying dry areas depicted by satellite. Overall, the station data was highly influenced by a very heavy and short duration rainfall event that occurred in September. This event wasn't included in the VCN analysis provided in section 2.3 because summer was defined as starting in October, which is when water stress normally starts to affect the agricultural sector. Hence, the satellite and VCN analysis are probably more representative of the actual water stress rather than the full year hydrological plots provided above.

Unlike rainfall, soil moisture measurements are only available for recent years. Hence, a direct comparison with previous El Niño years is not possible. Also, because the last decade has been exceptionally dry (as discussed in section 2.3), the deviation from average will be proportionally smaller as the average is already relatively dry. Nonetheless, the measured soil moisture shows near lowest on record for the north-eastern Wairarapa with a very slight recent recovery, and near driest on record for the south-eastern Wairarapa for most of summer with some recovery early in April. The sites around Masterton and Featherston show persistent low moisture levels with no signs of recovery so far, while the average moisture for this time of the year should already be strongly increasing. In short, the locally measured soil moisture is consistent with the satellite information showing overall dry conditions in the Wairarapa and particularly so for this late in the season, although signs of a slight recovery have already started in the south-eastern hills. As mentioned earlier in the report, it is extremely unlikely that the current dryness (as measured by the specific parameters discussed in this report) will worsen as we head into winter, due to the sharp decline in solar radiation experienced this time of the year.

3. Updated climate outlook for the remaining of autumn

An update of the climate outlook for autumn previously included in in the Climate and Water Resources Summary for the Wellington Region, Summer 2015/16 is presented in Table 3.1. This outlook was prepared by GWRC based on in-house expertise, and information provided by NIWA, Metservice and international centres. This information is qualitative only. The extended seasonal climate reports for the Wellington region can be found here: http://www.gw.govt.nz/seasonal-climate-and-water-resource-summaries-2/

As the current El Niño is already declining, and showing an unusual atmospheric pattern with very warm waters around New Zealand, it is unlikely that the traditional statistical relationship will hold too strongly, and short duration heavy rainfall episodes are possible. Even then, the probability of above average rainfall on a seasonal basis is very small (estimated at only 20% by NIWA).

Table 3.1: Climate outlook for autumn (updated from the Climate and Water Resources Summary for the Wellington Region, Summer 2015/16)[2]

Whaitua	Climate Outlook for autumn 2016	
Wellington Harbour & Hutt Valley	**Temperature:** **Rainfall:**	Above average, greater variability of hot and cold. Below average, long dry periods alternated by possibly heavy rainfall events later in the season.
Te Awarua-o- Porirua	**Temperature:** **Rainfall:**	Above average, greater variability of hot and cold. Below average, long dry periods alternated by possibly heavy rainfall events later in the season.
Kāpiti Coast	**Temperature:** **Rainfall:**	Above average, greater variability of hot and cold. Below average, long dry periods alternated by possibly heavy rainfall events later in the season.
Ruamāhanga	**Temperature:** **Rainfall:**	Above average, greater variability of hot and cold. Below average, long dry periods alternated by possibly heavy rainfall events later in the season.
Wairarapa Coast	**Temperature:** **Rainfall:**	Above average, greater variability of hot and cold. Below average, long dry periods alternated by possibly heavy rainfall events later in the season.

[2] This climate outlook was prepared by 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)

Acknowledgments

We would like to thank the National Oceanic and Atmospheric Administration (NOAA/US) for kindly providing us with satellite-derived drought indices.

We would also like to acknowledge NIWA for granting access to selected VCN sites.