Climactic of Wetlands and Landscape Condition in southern South Australia
November 2013
Climactic Discussion relating to the Wetland and Landscape Condition in southern South Australia, December 2013.

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significant rainfall events promote wetland vigour and expand waterfowl habitat, but most importantly, they stimulate breeding. the eastern aerial waterbird survey (eaws) has shown over a succession of years that there is a strong positive correlation between waterfowl abundance, wetland condition and rainfall. waterfowl have the ability to anticipate climatic changes before their effects are felt, often migrating under the cover of darkness to areas where water is expected. this behaviour is triggered by the need to find productive feeding habitat but also by their instinctive will to breed if water levels and habitat condition permit.

waterfowl lead a tenuous existence; their distribution and abundance is controlled by the availability of shallow wetland habitats, often in the interior, which are spatially and temporally highly variable. they must also compete with humankind for water resources that are becoming increasingly regulated and less commonly allocated as environmental flows.

climatic conditions regulate waterfowl population sizes in an unforgiving and often ruthless manner. functionally, ‘boom and bust’ changes in waterfowl abundance correlate with climatic extremes. were it not for their opportunistic ability to breed, in some cases instantaneously, waterfowl populations would not be able to benefit from the short duration but high productivity of many of australia’s ephemeral wetland systems.

to appreciate changes to waterfowl population dynamics we must be aware of the likely effects of climate on their activity cycle. this paper examines recent rainfall statistics, discusses similarities between rainfall and wetland condition and compares it with ndvi satellite images and landscape models which show the density and vigour of green vegetation growth across the australian continent and more closely within regional sa.

quail lead a nomadic existence; their movements are thought to be dictated by the availability of food resources and ground cover. anthropogenic activities such as cropping play some role in co-determining the suitability of habitat for quail. however, true abundance is thought to be regulated by climatic influences and landscape condition.

quail are difficult subjects to monitor and their behavioural response to dry climatic conditions is not completely understood - other than the vague notion that population densities decrease. this paper uses the aussie grass pasture model (csiro) and wheat yield data to explain the condition of natural and anthropogenic landscapes in south australia.
Slightly lower than average rainfall was received across the Australian continent during the past 12 months. South Australia and most of the Murray-Darling Basin received less than average rainfall (Figure 1). With some exceptions, the eastern two thirds of the continent, including all of the Murray Darling Basin has experienced average or below average rainfall during the past 12 months.

Figure 1. Australian Rainfall Deciles (November 2012-October 2013).

The interannual rainfall anomaly for 2011/12 compared with 2010/11 shows areas of lower rainfall, particularly along the Great Dividing Range and the northern Murray-Darling Basin (Figure 2). The Murray-Darling Basin is a region supporting many aquatic ecosystems and is an important region for waterfowl recruitment.
The rainfall history in the Murray-Darling Basin over the past 12 months shows below average rainfall across the basin (Figure 3, 4).
3. **SOUTH AUSTRALIA - Rainfall 12 months to October 2013.**

South Australia has experienced a below average rainfall for the 12 months to November 2012 (with the exception of Kangaroo Island, Figure 6). For the year as a whole, South Australia had a deficit of 50mm below average annual rainfall (Figure 8).

The inter-annual difference between 2012/13 and 2011/12 (Figure 7) reveals a decline in total rainfall in the northeast of the state.
3.1. RAINFALL WITHIN THE FOUR SOUTHERN DISTRICTS OF SOUTH AUSTRALIA

Table 1. Rainfall summary of the four southern districts used in the annual South Australian waterfowl survey (from November 2012 to October 2013).

<table>
<thead>
<tr>
<th>District</th>
<th>Rainfall total (mm)</th>
<th>Rainfall anomaly (mm above average)</th>
<th>Rainfall % (% of mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleurieu</td>
<td>600 to 900</td>
<td>0 to 100</td>
<td>90 to 120</td>
</tr>
<tr>
<td>Murraylands</td>
<td>200 to 400</td>
<td>-100 to 0</td>
<td>75 to 100</td>
</tr>
<tr>
<td>Coorong</td>
<td>400 to 600</td>
<td>0 to 100</td>
<td>100 to 125</td>
</tr>
<tr>
<td>Southeast</td>
<td>400 to 900</td>
<td>0 to 100</td>
<td>100 to 125</td>
</tr>
</tbody>
</table>

FLEURIEU
The Fleurieu Peninsula supports a mosaic of small water storages, farm dams and spring fed wetlands across a highly fragmented landscape. Some storages are artificially maintained at high capacity and others are surcharged from the River Murray. Overall, the district was considered stable for the 12 months to November 2013 relative to the long-term average for the region (Table 1; see Figure 6).

MURRAYLANDS
Below average rainfall over the past 12 months was been received in sections of the region (Table 1; see Figure 6). Wetland status has improved with local inflows contributing to improved cross-border River Murray inflows over the past two years.

COORONG
The Coorong region contains a significant number of large and small mostly shallow wetlands and watercourses that become seasonally inundated each winter. Some of the wetlands are dependent on discharges associated with the drainage scheme.
Rainfall during 2013 is close to the long term mean. (Table 1; see Figure 6).

**SOUTH EAST**
The South-East experienced average rainfall conditions during 2013.

**4. VICTORIA**

In 2013 Victoria has had lower than average rainfall across most of the State (0-200mm below mean). Some coastal areas received above average rainfall conditions (100-200mm above mean) (Figure 9, 10).

**Figure 9. Victoria Rainfall Anomalies**
Rainfall Anomalies (mm) 1 November 2012 to 31 October 2013
Product of the National Climate Centre

**Figure 10.** Interannual Rainfall Difference Nov/Oct 2013/2014 - Nov/Oct 2011/2012
Product of the National Climate Centre
5. DROUGHT INDEX

The size and distribution of areas in the Murray-Darling basin subject to severe and serious rainfall deficiencies has increased between 2012 and 2013. Most of this has occurred across SE Queensland (Figure 10). Figure 11 shows the for the three year period 2010-2013 the Murray-Darling Basin remains unaffected by drought.

Figure 10. Drought Index November 2012 to October 2013.
Murray-Darling Rainfall Deficiencies  1 November 2012 to 31 October 2013
Distribution Based on Gidded Data
Product of the National Climate Centre

Figure 11. Drought Index November 2010 to October 2013.
Murray-Darling Rainfall Deficiencies  1 November 2010 to 31 October 2013
Distribution Based on Gidded Data
Product of the National Climate Centre
6. BUREAU OF METEOROLOGY 2013 SUMMARIES

6.1. South Australia in winter 2013: A warm and wet winter for most

Rainfall

Winter 2013 rainfall was generally well above average across much of the state, apart from the far north. Winter rainfall started with above average rainfall across most of the state in June, this continued across the agricultural districts into July, with rainfall becoming largely restricted to agricultural districts in August. Much of the rainfall was observed in events early in June, and in the second and last weeks of July. Many locations observed highest on record winter daily rainfall totals on the 1st June 2013.

Some sites had their highest total winter rainfall on record. Some sites had their highest total winter rainfall for at least 20 years. Some sites had their highest winter daily rainfall on record.

Pastoral Districts

Rainfall totals for winter as a whole were generally well above average, though extremely variable at a time of year when rainfall can be low in northern parts South Australia. Rainfall totals ranged from below 10mm in some locations up to in excess of 100mm at several locations. Yardea in the far south of the northwest pastoral had the highest winter rainfall total with 160.2mm.

Agricultural Districts

Rainfall totals in the agricultural districts were widely above average, with rainfall totals ranging from around 60mm in the Riverland, 100 to 200 mm in the Western Agricultural and Upper North districts and increasing to 200 to 300 mm further south and ranging up to 500 mm in the Mount Lofty ranges. The wettest location overall in the agricultural districts was at Uraidla in the Mount Lofty ranges with a winter rainfall total of 688.4 mm, the wettest winter at that location since 1996.

6.2. 2012 – LATEST ENSO SUMMARY (Bureau of Meteorology)

Tropical Pacific remains ENSO-neutral

All atmospheric and oceanic indicators of the El Niño-Southern Oscillation (ENSO) remain within neutral bounds. While the tropical Pacific has gradually warmed over the past three to four months, it remains close to the long-term average. International climate models surveyed by the Bureau of Meteorology indicate that the tropical Pacific will warm slightly over the coming months, but remain ENSO-neutral for at least the coming southern summer.

While ENSO is the dominant natural driver of Australia’s climate, a neutral period does not guarantee a benign or normal season. A neutral ENSO period indicates
that the equatorial Pacific Ocean is not shifting the odds towards a significantly wet or dry period for Australia. However, more localised weather extremes can and do occur during neutral ENSO phases as secondary or local factors come into play. For instance, warmer-than-average sea surface temperatures around parts of the Australian coastline may currently be influencing regional climate.

The Indian Ocean Dipole is currently neutral. It typically has little influence on Australian climate during the months from December to April.

7. **BUREAU OF METEOROLOGY 2013**

7.1. **SOUTH AUSTRALIAN SEASONAL CLIMATE SUMMARIES FOR 2013**

**South Australia in summer 2012-13: Dry and hot!**
issued on 1 March 2013 (Bureau of Meteorology, 2012)
- Rainfall only 41% of the summer average for much of the State, and the driest summer in 27 years.
- Second hottest summer days on record for South Australia (after 2000-01).

**Autumn 2013: Near record autumn heat for South Australia**
issued 3 June 2013 (Bureau of Meteorology, 2013)
- Several warm spells result in temperatures 1 to 3 °C warmer than average.
- Warmest autumn for the State in 8 years, and third warmest autumn on record.
- Above average rainfall in the north and west, but drier than average in eastern agricultural areas.
- Record hottest autumn day and night time temperatures for several locations including Adelaide.

**Winter 2013: A warm and wet winter for most**
issued September 2013 (Bureau of Meteorology, 2013)
- Wetter than average across much of the State, tending drier than average in the across the north.
- Record highest winter rainfall in some locations across the centre of the State, and on Kangaroo Island.
- Warmer than average winter temperatures, with record warmest winter nights at some locations.
- Second warmest winter for the State as whole.

**South Australia in spring 2013: A hot and dry season with a cool finish**
issued 1 December 2013 (Bureau of Meteorology, 2013)
- An exceptionally warm start to the season results third warmest spring
- Day and night temperatures above average across most of the state
- Dry across most of the state, with locations in the north having their driest spring on record.

7.2. **NATIONAL SEASONAL RAINFALL OUTLOOK PROBABILITIES FOR NOVEMBER 2013 TO JANUARY 2014: Drier season more likely for northeastern Australia**
issued 23 October 2013 (Bureau of Meteorology, 2013)
- A drier than normal season is more likely for most of northeastern Australia
- The chances of a wetter or drier than normal season are roughly equal over the remainder of the country
Climate influences include locally warm sea surface temperatures around most of Australia, and a neutral tropical Pacific.

Outlook accuracy is moderate over most of the eastern States, and northern and western WA. Elsewhere, outlook accuracy is weak.

The chances of exceeding the median rainfall during November to January are 30 to 40% over most of Queensland, most of the NT, northeast SA and northern NSW. In other words, the chances of below average rainfall are 60 to 70% over these areas. So, for every ten November to January outlooks with similar odds to these, about three or four of them would result in above-average rainfall over these areas, while about six or seven would be below average.

The chance of receiving a wetter or drier than normal November to January period is roughly equal (i.e., close to 50%) over the remainder of the country.

Climate influences

The tropical Pacific has remained ENSO-neutral since mid-2012. Dynamical models surveyed by the Bureau suggest ENSO-neutral conditions are likely to persist at least for the remainder of spring and summer. This means there is no strong shift in the odds from the tropical Pacific in this outlook.

The Indian Ocean Dipole (IOD) is neutral, and is expected to remain so for the next month. Beyond that time, the effect of the IOD on Australian climate from December through to April is limited, and is therefore not an influence in the outlooks during this period.

With the main climate influences likely to remain neutral (and hence have lesser impact upon Australia), secondary influences, such as warmer-than-normal sea surface temperatures around Australia are tending to drive the Australian climate patterns.
8. THE SOUTHERN OSCILLATION INDEX (SOI)

The Southern Oscillation Index (SOI; Figure 13) is calculated from the monthly or seasonal fluctuations in the air pressure difference between Tahiti and Darwin.

Sustained positive values of the SOI (above +8) may indicate a La Niña event, while sustained negative values (below −8) may indicate an El Niño event. Positive values are associated with stronger pacific trade winds and warmer sea temperatures to the north of Australia and above normal rainfall across large parts of Australia, most notably eastern and northern regions. Negative values are usually accompanied by sustained warming of the central and eastern tropical Pacific Ocean, a decrease in the strength of the Pacific Trade Winds, and a reduction in rainfall over eastern and northern Australia. Values of between about +8 and −8 generally indicate neutral conditions.

Table 2. Comparison SOI values between 2012 and 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>9.4</td>
<td>2.5</td>
<td>2.9</td>
<td>-7.1</td>
<td>-2.7</td>
<td>-10.4</td>
<td>-1.7</td>
<td>-5.0</td>
<td>2.7</td>
<td>2.4</td>
<td>3.9</td>
<td>-6.0</td>
</tr>
<tr>
<td>2013</td>
<td>-1.1</td>
<td>-3.6</td>
<td>11.1</td>
<td>0.3</td>
<td>8.4</td>
<td>13.9</td>
<td>8.1</td>
<td>-0.5</td>
<td>3.9</td>
<td>-1.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 13. Southern Oscillation Index (January 2007 to October 2013).
Normalised Difference Vegetation Index (NDVI) products are produced by the Bureau of Meteorology for the Australian region using measurements from the Advanced Very High Resolution Radiometer (AVHRR) on board the USA’s NOAA polar orbiting meteorological satellites. The reflectance measured from Channel 1 (visible: 0.58 - 0.68 microns) and Channel 2 (near infrared: 0.725 - 1.0 microns) are used to calculate the index: $\text{NDVI} = \frac{\text{Ch2} - \text{Ch1}}{\text{Ch2} + \text{Ch1}}$

The differential reflectances in these bands provide a means of monitoring density and vigour of green vegetation growth using the spectral reflectivity of solar radiation. Green leaves commonly have larger reflectances in the near infrared than in the visible range. As the leaves come under water stress, become diseased or die back, they become more yellow and reflect significantly less in the near infrared range. Clouds, water, and snow have larger reflectance’s in the visible than in the near infrared while the difference is almost zero for rock and bare soil. Vegetation NDVI typically ranges from 0.1 up to 0.6, with higher values associated with greater density and greenness of the plant canopy. Surrounding soil and rock values are close to zero while the differential for water bodies such as rivers and dams have the opposite trend to vegetation and the index is negative.

Figure 14 illustrates a decrease in the abundance of vegetation over much of Australia with a slight increase in parts of the Murray-Darling Basin in 2013, when compared with 2012 and 2011 (Figures 15-16).

**Figure 14. Normalised Difference Vegetation Index (NDVI) at a continental scale in 2013**
Figure 15. Normalised Difference Vegetation Index (NDVI) at a continental scale in 2012

10. LANDSCAPE MODELLING

The Australian Government operate a National Agricultural Monitoring Service (NAMS) that contains a range of climatic and production information, initially for dry-land/broad-acre industries, for over 600 regions throughout Australia. Landscape models are widely used to infer condition based on a range of data sources. Importantly, the interpretation
of these models requires an understanding that the values are relative not absolute. They are indicative spatial interpretations.

10.1. **AussieGRASS – SPATIAL**

This model shows relative growth percentiles across South Australia, averaged over 12 months. The data is sourced from the AussieGRASS pasture model; it considers the effects of pasture communities, climate, tree density, soil attributes, stock and other herbivore numbers on growth. The legend defines relative growth percentiles. The spatial distribution of the actual growth percentiles is compared to the historical median, based on 115 years of modelled data. Some model inputs, such as plant available water capacity, are estimated from other data.

Figures 17 shows average to below average pasture growth in 2013, associated with lower than average rainfall, particularly in the northeast of the State. Figure 18 shows the continued abundance of biomass attributed to the high rainfall between November 2010 and October 2011. When comparing current biomass (Figure 18) with that of recent years (Figures 19–21) there is decreasing amounts of pasture biomass throughout agricultural regions of South Australia since the high levels of 2011.

**Figure 17. SA Pasture Growth Relative to Historical Records from 1957, October 2013**

![Pasture Growth Relative to Historical Records from 1957, October 2013](image-url)
Figure 18. SA Pasture Biomass Relative to Historical Records from 1957, October 2013

TSDM Relative to Historical Records from 1957
October 2013

www.LongPaddock.dld.gov.au
Figure 19. SA Pasture Biomass Relative to Historical Records from 1957, October 2012

Figure 20. SA Pasture Biomass Relative to Historical Records from 1957, October 2011.
10.2. PASTURE GROWTH RATE

The Pastures from Space program is a joint venture between the Department of Agriculture of Western Australia, Department of Land Information Western Australia, and the CSIRO. The program combines pasture biomass and feed on offer estimates obtained from satellite data, with climate and soil information to produce an estimate of Pasture Growth Rate (PGR) that can be used for regional agricultural monitoring. The satellite imagery is converted into a normalised difference vegetation index (NDVI), a measure of greenness of the pastures. This is then combined with climate information and soil data to give estimates of PGR. PGR is calculated and provided weekly and is provided as kg/ha/day rather than as a relative index of greenness and is of immediate value for on-farm decision making. By following the line in the graph, it is possible to determine the amount of pasture growth rate for that particular period compared to the median. The median is represented by the grey line.

Figures 22-25 show an estimate of PGR for three areas in southern South Australia (Adelaide Hills, Mid Murray and Orroroo/Carrieton) based upon satellite data from 2009 to 2013.

It should be noted that PGR outputs are not absolute values of pasture production. Some model inputs, such as plant available water capacity, are estimated from other data, and therefore the model output should be viewed only as an indication of pasture production. PGR has been extensively validated for Western Australia; however, there has been little validation work completed for the eastern states.
Figure 22. Pasture Growth Rates, calculated monthly for the Adelaide Hills, Mid Murray and Orroroo districts in 2013

Figure 23. Pasture Growth Rates, calculated monthly for the Adelaide Hills, Mid Murray and Orroroo districts in 2012

Figure 24. Pasture Growth Rates, calculated monthly for the Adelaide Hills, Mid Murray and Orroroo districts in 2011
Rainfall for September was average to below average across the State. October rainfall varied from below average in most of the cropping districts to average on Lower Eyre Peninsula and well above average in the Lower South East. Strong to gale force winds were recorded across large areas of the State during September and October. There were several significant frost events in parts of inland districts from early to late October. Thunderstorms in late September and early October brought heavy rain and hail to isolated areas.

Crop yields are likely to vary from average to well above average but are now significantly lower than earlier estimates due to a range of extreme weather events during spring. Strong to gale force winds in early to mid-October caused significant flattening of plants and head loss in ripe barley crops in several areas of the State with losses of 30 to 50% reported in some paddocks. Grain loss from wind damage was also reported in ripe wheat crops on Upper Eyre Peninsula. Wind also knocked canola crops down and caused significant grain shattering in crops planned to be direct headed. Bean crops in the Mid and Lower North were damaged by the strong winds, with stems being kinked half way down the stem reducing grain fill of the upper pods. Frost in early October damaged some early sown pea crops. A relatively widespread frost in mid-October caused severe damage to wheat, barley, pulse and canola crops. The worst affected areas were the Upper and Mid North, and Southern Mallee. Some frosted wheat crops in the Upper and Mid North were cut for hay, but crops in other districts were generally too far advanced to cut.

Pastures have adequate to good levels of feed in most areas, although the dry finish in the Mallee and cold wet conditions in the Lower South East have reduced pasture growth. There has been an increased area of pasture hay cut in many districts to replenish on-farm fodder reserves with reports of high yields of good quality hay in most areas.
11.1. CROP AND PASTURE CONDITIONS AND PERFORMANCE WITHIN THE FOUR SOUTHERN DISTRICTS OF SOUTH AUSTRALIA.

FLEURIEU AND CENTRAL HILLS

Rainfall has been average to below (especially in October) for the region. Temperatures have been average.

Cereal crops on average are past the milky dough stage and starting to ripen. Canola has been windrowed and harvesting will commence in early to mid-November depending on weather conditions. Harvesting of barley crops should commence in mid-November and wheat in late November. Disease levels in all crops have been moderate given the wet winter, below average rainfall and windy weather in spring slowing disease development. The quantity of hay made will be above average to replenish stores depleted over last summer and autumn. Pasture quality is average at present with further growth highly dependent on late spring rains.

MURRAYLANDS

Rainfall was average to below average during September and below average in October. Maximum temperatures were well above average (3 to 4°C) during September and average to slightly above in October. This region has experienced many days of extreme winds and there have been a few reports of severe frosts.

Some barley is yielding very well, while other areas are below average. Earlier-sown crops are clearly superior to later-sown crops. Warm dry conditions leading into September caused some moisture stress and yield losses. Overall, farmers are expecting an average
to slightly-above average season. Hay yields have generally been good with excellent quality. Pasture feed is generally diminishing fairly quickly and farmers will be looking to put livestock on to stubble paddocks as soon as possible.

**COORONG/UPPER SOUTH EAST**

Rainfall was below average across the district during September but varied from below average (inland) to well above average along the coast during October. Maximum temperatures were above average during September and average during October. Strong to gale force winds have been recorded on numerous days throughout the period.

Strong winds knocked down some crops, although the impact on yield is likely to be minor. Pasture and other small seed production are likely to be above average. Hay quality for export is lower due to rain damage and high fibre (lower digestibility) content. Pasture growth has been above average, resulting in high amounts of feed.

**LOWER SOUTH EAST**

Rainfall was below average in September and well above average in October. Maximum temperatures during September were above average with average to slightly below average temperatures in October. Strong to gale force winds were recorded on numerous occasions throughout the period.

Heavy rain and strong winds have flattened plants and damaged flowers in both canola and bean crops. The impact on crop yield is not clear at this stage. Canola crops suffered significant waterlogging in parts of paddocks early in the season consequently reducing yield potential. Only small amounts of hay have been cut at this stage with the above average October rainfall increasing crop and pasture growth. High hay yields are anticipated. Cool cloudy conditions have slowed growth but warmer conditions should result in rapid growth. Pastures are of good quality but growth has been slow due to climatic conditions.

12. **LANDSCAPE CONDITION AND QUAIL**

Quail are difficult to monitor and their responses to climatic conditions are inferred from an analysis of their preferred habitat. Pasture growth models, greenness index and wheat yield data indicate that though landscape condition did not consistently improve during 2013, previous well above average conditions are still visible over large areas of agricultural and pastoral South Australia. These above average conditions indicate favourable habitat conditions for quail. Quail are expected to be well distributed and in high abundance in 2014, with above average levels of breeding activity likely to continue into late summer. Birds are understood to actively breed during a phase of optimal habitat quality and food resources.

13. **REFERENCES**

