The 2020 growing season: what happened, what about the forecast and what can we learn?

Peter Hayman and Dane Thomas, SARDI Climate Applications

Key messages

The 2020 season on Eyre Peninsula had an excellent start followed by a dry winter, average August and September, wet October and dry November. The winter was cooler than average and the spring warmer than average with an especially hot September. The warm September was associated with heat spikes, but some locations also had frosts from late August to early October.

Forecasts made early in the season were for a wetter than average winter. There are several explanations for the dry winter including an unusual cyclone and an abrupt change to a positive Southern Annular Mode (SAM), these factors were partially captured in later forecasts.

We need to be careful about communicating and using forecasts early in the season and check for regular updates. We need to understand that a forecast of 75% to 80% chance of above average rainfall includes the forecast of 1 in 4 or 1 in 5 years being drier than average.

Growing season rainfall in 2020: Excellent start, very dry winter, average August and September, wet October and dry November.

Few seasons started better than the 2020 cropping season on Eyre Peninsula; a wet summer followed by timely widespread April rainfall. As can be seen in Table 1 all sites had decile 7 to decile 8 rainfall in January and February, the northern sites had good March rain and all sites had decile 8 rain or wetter in April.

*Table 1. Rainfall in mm and decile using a base period from 1900 to 2020 for eight focus paddocks used in the Resilient EP project. Above median deciles (deciles 6 to 10) are shown in **bold.** Data from Silo Data Base as patched point data.*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Apr-Oct	May-Sep
Port Lincoln (Woolga)	**20 D8**	**46 D10**	14 D5	**92 D10**	**75 D7**	67 D3	46 D1	**108 D8**	**86 D8**	**89 D10**	21 D5	17 D5	**564 D8**	383 D5
Port Lincoln (Big swamp)	**18 D8**	**19 D7**	11 D4	**81 D10**	**68 D6**	62 D4	42 D1	**96 D8**	**71 D8**	**67 D9**	20 D5	12 D4	**487 D7**	339 D4
Cummins	**10 D7**	**22 D8**	6 D4	**52 D9**	30 D3	51 D5	25 D1	58 D5	**49 D7**	**68 D10**	8 D3	**15 D6**	333 D5	213 D2
Wharminda	**17 D8**	**20 D8**	3 D3	**40 D8**	17 D3	22 D3	15 D1	36 D5	29 D5	**87 D10**	4 D2	**23 D8**	247 D5	120 D1
Lock (Terre)	**16 D8**	**23 D8**	5 D4	**46 D9**	28 D4	37 D4	28 D2	44 D4	**36 D6**	**79 D10**	3 D2	**20 D7**	**297 D6**	173 D2

Waddikee	**21** **D8**	**28** **D8**	**23** **D8**	**36** **D8**	16 D3	19 D2	24 D3	**44** **D6**	**43** **D7**	**70** **D10**	4 D2	**16** **D6**	**251** **D6**	145 D3
Minnipa	**11** **D7**	**46** **D9**	**19** **D7**	**35** **D9**	16 D3	16 D2	16 D1	36 D5	**33** **D6**	**65** **D10**	1 D1	**22** **D8**	217 D4	117 D2
Buckleboo	**14** **D7**	**28** **D8**	**26** **D8**	**35** **D9**	14 D3	21 D3	24 D3	**47** **D7**	**36** **D7**	**95** **D10**	6 D3	**19** **D7**	**272** **D8**	142 D4

Table 1 shows the contrast of the very dry May, June and July with the preceding months. August was mixed, September was generally wetter than median while October was very wet. The wet October boosted later crops and districts but interfered with harvest for the earliest crops. November was very dry (Minnipa 1mm, Lock 3mm) with December rain above decile 5 at most sites.

Due to the wet April and October, the 2020 growing season rainfall (April to October) will be recorded as Decile 5 or above for all sites except the Decile 4 at Minnipa. The May to September deciles (last column in Table 1) indicate that this part of the growing season was below decile 5. The pattern of a wet start, dry winter and wet October was widespread across the southern grains region. Overall, cropping production from Eyre Peninsula in 2020 was reasonable despite the difficult year. This shows that farming systems on Eyre Peninsula have evolved to be able to use out of season rainfall. Saving rainfall from January, February and March requires summer weed control, saving rainfall from mid-April is due to no-till and efficient seeding.

Growing Season Temperature: Cool winter and hot spring.

Table 2 shows the average temperature (Max+Min)/2)). Winter (June, July and August) at most sites was cooler than average but spring (September, October and November) was warmer. All locations experienced decile 10 average temperature for September. As discussed in the following section there were a series of heat spikes in September, most of which occurred on crops with limited moisture in the profile.

*Table 2. Mean temperature ((Max + Min)/2) (^{o}C) and decile using the base period from 1957 to 2020 for eight focus paddocks used in the Resilient EP project. Above median deciles (deciles 6 to 10) are shown in **bold.** Data from Silo Data Base as patched point data.*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Apr-Oct
Port Lincoln (Woolga)	**20** **D7**	20 D4	**19** **D7**	16 D4	13 D1	11 D3	10 D2	11 D4	**14** **D10**	**15** **D7**	**19** **D10**	18 D3	13 D5
Port Lincoln (Big swamp)	**20** **D7**	20 D4	**19** **D7**	16 D4	13 D1	12 D3	11 D1	11 D4	**14** **D10**	**15** **D7**	**19** **D10**	18 D3	13 D4
Cummins	**22** **D8**	**21** **D6**	**20** **D7**	16 D4	13 D1	11 D2	10 D1	11 D5	**15** **D10**	**16** **D7**	**20** **D10**	19 D4	13 D3
Wharminda	**22** **D6**	21 D3	**20** **D6**	17 D4	14 D1	12 D4	11 D2	12 D4	**16** **D10**	**17** **D7**	**21** **D10**	20 D3	14 D4
Lock (Terre)	23 D5	22 D3	**21** **D6**	17 D5	14 D2	**12** **D7**	11 D5	**12** **D8**	**16** **D10**	**17** **D8**	**22** **D10**	21 D3	**14** **D9**
Waddikee	23 D5	22 D3	20 D4	17 D5	13 D2	**12** **D7**	**11** **D6**	**12** **D7**	**16** **D10**	**17** **D6**	**22** **D10**	21 D3	**14** **D8**
Minnipa	23 D5	23 D3	21 D5	18 D5	14 D1	12 D5	**12** **D7**	**12** **D6**	**16** **D10**	**18** **D8**	**23** **D10**	21 D3	**15** **D7**
Buckleboo	23 D5	23 D4	21 D4	**18** **D7**	13 D3	**11** **D7**	**11** **D8**	**12** **D8**	**16** **D10**	**17** **D7**	**22** **D10**	21 D3	**14** **D9**

Spring heat spikes and frost

At each of the eight sites, Jacob Giles, Research Agronomist EPAG, who is working on the Resilient EP project, installed Tiny Tag temperature loggers supplied by SARDI Climate Applications. Each logger was placed in a plastic shield and installed at 1.2m. Figure 1 shows minimum and maximum temperatures. Not only were there a series of heat spikes through September (7th, 10th and 18th) there were frosts from late August through September.

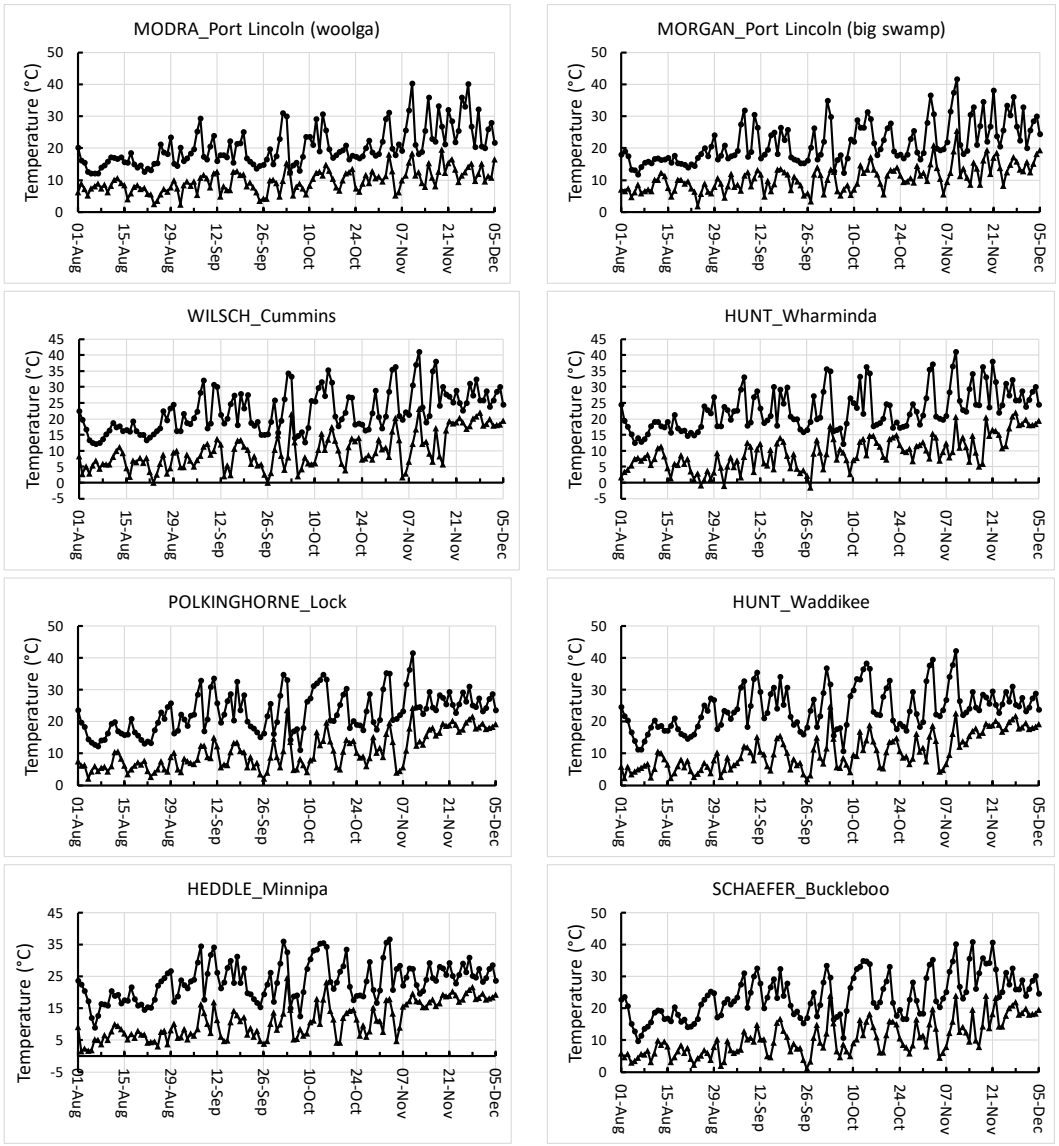

Figure 1. Maximum temperature (circles) and minimum temperature (triangles) for eight reference sites as part of the Resilient EP project.

What happened with the forecast?

At the start of the season, SARDI Climate Applications, along with many agronomists and farmers and most climate scientists expected 2020 to be wet. We were surprised by the dry

winter but relieved that a late developing La Niña brought rain in October which helped most, but not all, regions.

Farmers and agronomists that were following seasonal climate science had invested time to understand that a negative IOD and La Niña was encouraging. They also understood that there were many climate models and sources of information and that when all the models were pointing to the same outcome that this increased confidence. The strong forecast for wet conditions was followed by an extremely dry May to July. Perhaps the month that seemed to be the biggest failure of the forecast was July. This is in part because July is the wettest month and partly because on many paddocks the wet April provided moisture to buffer the early crop growth across May and June.

There has been increasing media discussion and GRDC funded communication on the impact of climate drivers such as ENSO and the Indian Ocean Dipole on winter growing season rainfall in Southern Australia. Sites such as https://forecasts4profit.com.au/ show that these climate drivers swing the odds and are best represented as probabilistic forecasts. For example, a La Niña is best understood as increasing the likelihood of wetter deciles and decreasing the likelihood of dry deciles rather than the easier to follow statement that it will be wet. There is a strong tendency for media to simplify the message to a negative IOD will lead to wet conditions. This simple causal thinking is easier to understand and more natural for most of us. In contrast, probabilistic thinking is harder work. Probabilistic thinking is often presented using mathematical formula, which may be efficient for mathematicians, but is an unnecessary barrier to most of us. The maths involved in probability is very basic addition and multiplication. There is a psychological barrier as dealing with probabilities means we have to accept that when it comes to decisions about the future we have both knowledge and ignorance.

In recent years, climate drivers have performed in a way that supports causal thinking. The very dry spring across southern Australia in 2015 was associated with an El Niño and the following wet year of 2016 was consistent with a negative IOD. The climate drivers of ENSO and IOD were neutral in 2017 and 2018, however as pointed out by Bureau of Meteorology scientist Andrew Marshall, during these winters the subtropical ridge was unusually strong. In 2017 the Southern Annular Mode (SAM) was in a positive phase; in 2018 a higher than normal number of high-pressure systems formed over the Tasman Sea. The very dry spring of 2019 was linked to a positive IOD (Climate Kelpie website 2020). The media coverage of 2020 was framed around a bounce back to a good year after the widespread drought and bushfires that ended 2019.

The positive outlook for the 2020 season started with summer rainfall and widespread April rainfall, but this was bolstered by discussion on climate drivers for the 2020 growing season. This is captured in an ABC article from 18th April titled *"Wet winter likely as speculation over La Niña and a negative IOD mounts"*. The article cites a Bureau of Meteorology spokesperson *"I think it's a little better than rumours now, which feels like a good thing to say," "There are really strong odds, probably the strongest we've seen since 2016." "Looking at other models from around the world, it's amazing they are all saying a very similar thing and I've probably looked at half a dozen or more of the top models now," "They are all suggesting that the odds are increased of having some good rainfall over the next few months for much of Australia."* The ABC article continued *"The outlook suggests there is an above 60 per cent chance of above-median rainfall for most of the country for at least the next three months."*

The emphatically wet outlook for winter was followed by a winter that was emphatically dry. This has an impact on crop growth and level of trust in the forecast.

Blame the dry winter on an unusual cyclone and positive SAM

The oceans were strongly primed for a negative IOD and this was picked up by all six international climate models reviewed by the Bureau of Meteorology. The time series of the IOD index (Figure 2) starts with the negative IOD associated with the wet spring of 2016 and shows how the strongly positive IOD from 2019 dropped to a weakly negative IOD over March to May in 2020. The encouraging signs of a fall of the IOD and warming of waters to the NW of WA surprisingly swung to a positive IOD in June and July.

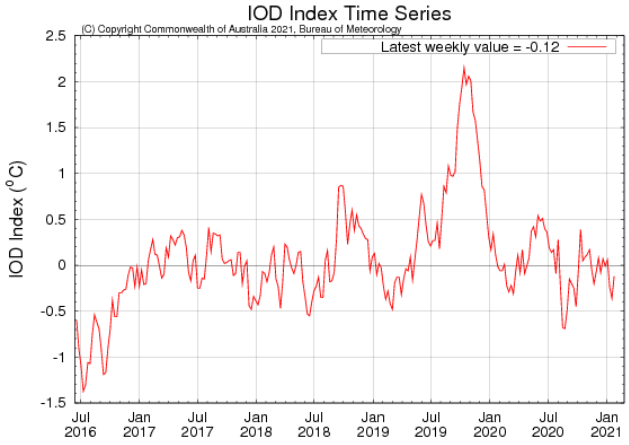

Figure 2. Time series of the Indian Ocean Dipole from Bureau of Meteorology website (http://www.bom.gov.au/climate/enso/indices.shtml?bookmark=iod).

One explanation for the abrupt change in the IOD in July was tropical Cyclone Mangga which was not only unusually late (19th - 23rd May), but followed an unusually southward track. There were wild storms, flooding and power cuts across WA including Perth and a cooling of a section of the SE tropical Indian Ocean to the NW of Australia which reversed the trend in the IOD. A further complicating factor was the rapid development towards a positive Southern Annular Mode (SAM) which contributes to drier conditions in southern Australia in winter.

A general pattern for 2020 was the forecast for the month after next to be wet, and then to see the forecast switch to neutral or dry. For example, the forecast in May was emphatically for a wet July but by June the forecast for July had switched to neutral or dry. This was because the model was picking up the influence of the cooling of the ocean from cyclone Mangga and the development of the positive SAM. SAM events can only be forecast about 2 weeks ahead and cyclones are weather events that can be forecast less than 2 weeks in advance. According to the Bureau of Meteorology, large swings in the seasonal outlook as seen in 2020 are unusual. The key drivers of our climate, which rely on patterns of ocean temperatures such as IOD and ENSO, typically change slowly and users are more used to a shift from neutral to wetter or drier but not a swing from wet to dry. Obviously checking the latest forecast is important, but there are many agricultural decisions that require the longer-term outlook such as the decision to plant a riskier crop such as canola or taking a more optimistic view on top-dressing nitrogen.

The late developing La Niña led to a slowly building confidence of wet conditions. As shown in Table 3, Bureau of Meteorology issued a La Niña watch on 23rd June followed by La Niña

alert on 18th August and declared a La Niña under way on 29th September. The emphatic forecast for a wet October was followed by an actual emphatically wet October.

Table 3 Headlines from Bureau of Meteorology Climate Drivers Update http://www.bom.gov.au/climate/enso/ through 2020.

7 January	Indian Ocean Dipole returns to neutral
21 January	Pacific and Indian ocean patterns neutral
4 February	Tropical Pacific Ocean remains ENSO neutral
18 February	El Niño–Southern Oscillation remains neutral
3 March	El Niño–Southern Oscillation likely to remain neutral to mid-year
17 March	ENSO and IOD likely to remain neutral through southern winter
31 March	Southern Oscillation and Indian Ocean Dipole neutral
14 April	Chance of negative Indian Ocean Dipole increases
28 April	Negative Indian Ocean Dipole possible in 2020
12 May	Negative Indian Ocean Dipole possible in 2020, tropical Pacific likely to cool
26 May	Tropical Pacific cools; negative Indian Ocean Dipole possible in 2020
9 June	Tropical Pacific cooling expected to continue during winter
23 June	La Niña WATCH—likelihood of tropical Pacific reaching La Niña in spring increases
7 July	La Niña WATCH continues—likelihood of La Niña in spring around 50%
21 July	La Niña WATCH continues as Tropical Pacific cools
4 August	El Niño–Southern Oscillation neutral but La Niña indicators continue to develop
18 August	La Niña ALERT—likelihood of La Niña in spring has increased
1 September	La Niña and negative Indian Ocean Dipole likely during spring
15 September	Shift towards La Niña continues
29 September	La Niña underway in the tropical Pacific
13 October	La Niña likely to continue through summer 2020–21
27 October	La Niña likely to continue until at least the end of summer 2020–21

What does this mean for users of climate forecasts?

1. Remember that the skill of the forecast increases from a low base through the winter growing season.

The skill of seasonal climate forecasts comes from the main climate drivers of ENSO and IOD which haven't settled into a neutral, positive or negative phase until later in the growing season. Graeme Anderson (Ag Vic) has the useful analogy of following a football team where there is a lot of pre-season speculation which starts to firm up as the season progresses. The consistency of models in April and May suggesting increased odds of a wetter than average growing season tended to over-shadow the point that all models have low skill at this time of the year and that models can be consistently wrong.

2. Because dynamic seasonal forecasts are influenced by new developments in the ocean and atmosphere during the season, we need to check the latest update.

The reason why the skill of the forecast is low in autumn is because patterns in the ocean and atmosphere evolve over the season. These processes move at different time scales and

2020 is an example where a weather event (cyclone Mangga off the NW coast of WA) and a rapid shift in SAM played a major role. The Bureau of Meteorology are issuing more forecasts (weeks, fortnights, months and seasons) which are updated more often. It is obviously an advantage for forecasts to be updated with the latest information, but this can be a challenge for users. GRDC has funded the monthly Break newsletter from Ag Victoria to comment on South Australian conditions (https://grdc.com.au/news-and-media/newsletters/fast-break/south-australia). This is useful for updates.

3. Appreciating that even 80% chance of above median rainfall includes 20% chance of the opposite happening.

Seasonal climate forecasts from the Bureau of Meteorology are rarely more emphatic than 80% chance of exceeding the median rainfall. As quoted from the ABC article from 18th April 2020, most of Australia had above 60% chance of exceeding median rainfall but some parts of the map had up to 80% chance. Although a high number, 80% leaves a 1 in 5 chance of drier than median rainfall. This chance of the minority outcome is nowhere near the level used in most agricultural experiments (95%) which is 1 in 20 chance of the result being due to chance. Most AgVet chemicals set a much higher level (99% or 1 in 100) of the treatment working and in human health we are used to chances of 1 in 1000 and in aviation safety 1 in 10 Million. The 80% chance is more like a professional golfer missing a five-foot putt (compared to 99.4% for three feet, 91.4% for four feet and 60% for six feet). This is also about the chance of a penalty shoot-out in professional soccer (83%) (Golf website 2020). Watching a professional golfer or penalty shoot-out is interesting because it is uncertain. Even if we know the statistics it remains uncertain and interesting. We don't say *"because there is more than 80% chance the result is guaranteed and I won't bother watching"* rather, if we care about the results, we think about the two possible outcomes even though one is much more likely than the other.

ABC website accessed 28 Jan 2021
https://www.abc.net.au/news/2020-04-18/wet-winter-likely-amid-speculation-of-la-nina-negative-iod/12149510

Climate Kelpie website accessed 28 Jan 2021
http://www.climatekelpie.com.au/index.php/2020/08/24/why-the-late-shift-in-the-winter-2020-rainfall-forecasts/

Golf.com website accessed 28 Jan 2021