RMCG

JULY 2020

Water Update – Southern Connected Basin

Prepared by RMCG consultants – Rob Rendell, George Warne, Charles Thompson and Daryl Poole

Note – a summary paper has also been separately produced covering the above topics and is available from RMCG

Level 1 East, 1100-1102 Toorak Road, Camberwell Victoria 3124
rmcg.com.au — ABN 73 613 135 247 — RM Consulting Group Pty Ltd
Victoria — Tasmania — ACT — NSW

Table of Contents

Introduction 1

1 Fundamentals 2

1.1 THREE PHASES AND FIVE CONNECTED REGIONS 2
1.2 AVAILABLE WATER 4
1.3 WATER PRICES 7
1.4 UNDERLYING PRODUCTION TRENDS 9
1.5 REGIONAL IMPACTS OF CHANGED WATER USE VARY 12

2 19/20 season – drought 13

2.1 STORAGE INFLOWS 13
2.2 AVAILABLE WATER 14
2.3 WATER USE BY INDUSTRY AND BY REGION 16
2.4 WATER PRICES 16
2.5 WATER TRADE 18
2.6 KEY LEARNINGS FROM 19/20 SEASON 19

3 Last 5 seasons are instructive and give a taste of the future 20

3.1 WATER AVAILABILITY, USE AND TRADE 20
3.2 PRODUCTION BY MAIN INDUSTRIES 24
3.3 LAND/WATER USE WITHIN REGIONS 24
3.4 WATER PRICES 27
3.5 ALLOCATIONS AND YIELD 30

4 Season 20/21 32

4.1 A GOOD START 32
4.2 SEASONAL FORECASTS – WHAT THEY MIGHT MEAN FOR ALLOCATIONS AND PRICE 33

5 Future trends 34

5.1 IF THE MILLENIUM DROUGHT WAS REPEATED 34
5.2 WATER PRICING 34
5.3 FARM WATER USE EFFICIENCIES ARE ALWAYS IMPROVING 35
5.4 THE KEY AGRICULTURAL CHALLENGES 36
5.5 BASIN CHALLENGES 36
5.6 CLIMATE CHANGE 37

Introduction

This paper provides a report on the state of play regarding water availability in the Southern Connected Basin – as at July 2020. The paper is based on the recognition that a new equilibrium has become established between the diverse mix of irrigated sectors that have varying requirements regarding the security of their water supply- and the three water security products that are now available. The paper therefore covers:

- Some water fundamentals covering history, water use by region and industries, water prices, underlying production trends and how regions have been impacted by water changes
- An analysis of the 2019/20 season which was a severe drought
- An analysis of the last five seasons that give a taste of the future scenarios
- The implications for water markets and outlook for 2020/21 season
- The relationship between the level of water allocations and prices
- An assessment of likely future trends and the major challenges facing the Basin.

1 Fundamentals

1.1 THREE PHASES AND FIVE CONNECTED REGIONS

1.1.1 FIVE REGIONS

Within the southern connected basin (sMDB) there are five general regions or communities that interact i.e.

Riverland in SA – comprises predominantly horticulture supplied by direct pumping from the Murray mostly from pressurised pipelines operated by Central Irrigation Trust, Renmark Irrigation Trust or by individual farmers. The region typically uses 400GL.

Sunraysia in Victoria and (to a much lesser extent) NSW – comprises predominantly horticulture supplied by direct pumping from the Murray mostly from pressurised pipelines operated by Lower Murray Water (Vic), Western Murray Irrigation NSW, but largely by individual farmers on both sides of the river. The region typically uses up to 700GL.

GMID (Goulburn Murray Irrigation District 640,000Ha) – comprises predominantly dairy pastures, or crops that can be utilised on nearby dairy farms, but has significant horticulture and some annual cropping. The water is supplied via an automated gravity channel system operated by GMW (Goulburn Murray Water). The region typically uses 900-1,300GL within the GMID district and another 100GL outside.

Murray Irrigation Area – (c700,000Ha) comprises primarily rice and annual cropping where the water is supplied via gravity channel systems operated by Murray Irrigation Ltd. The region typically uses 300 – 800GL plus another 100GL outside.

Murrumbidgee Irrigation Area – (c600,000Ha) comprises a mix of rice, annual cropping, cotton, and horticulture. Water is supplied via a mix of gravity canal systems operated by Murrumbidgee Irrigation and Coleambally Irrigation, some pipeline supplies for horticulture and private river pumping. The region typically uses a total 700-1,500GL.

Figure 1-1: Map showing the irrigation regions in the Southern Basin

1.1.2 THAT HAVE SEEN THREE PHASES

The region has been through three broad phases:

1. **50 years post World War II** – unbridled growth – each region operated in a world of our their own and was their our own unique area
2. **A turbulent twenty years** from the year 2000 – each region had to adjust to joining as part of a single whole southern catchment of the Murray Darling Basin
3. **Establishing a new equilibrium** – individual regions have to plan differently as they are now part of the connected Southern Basin.

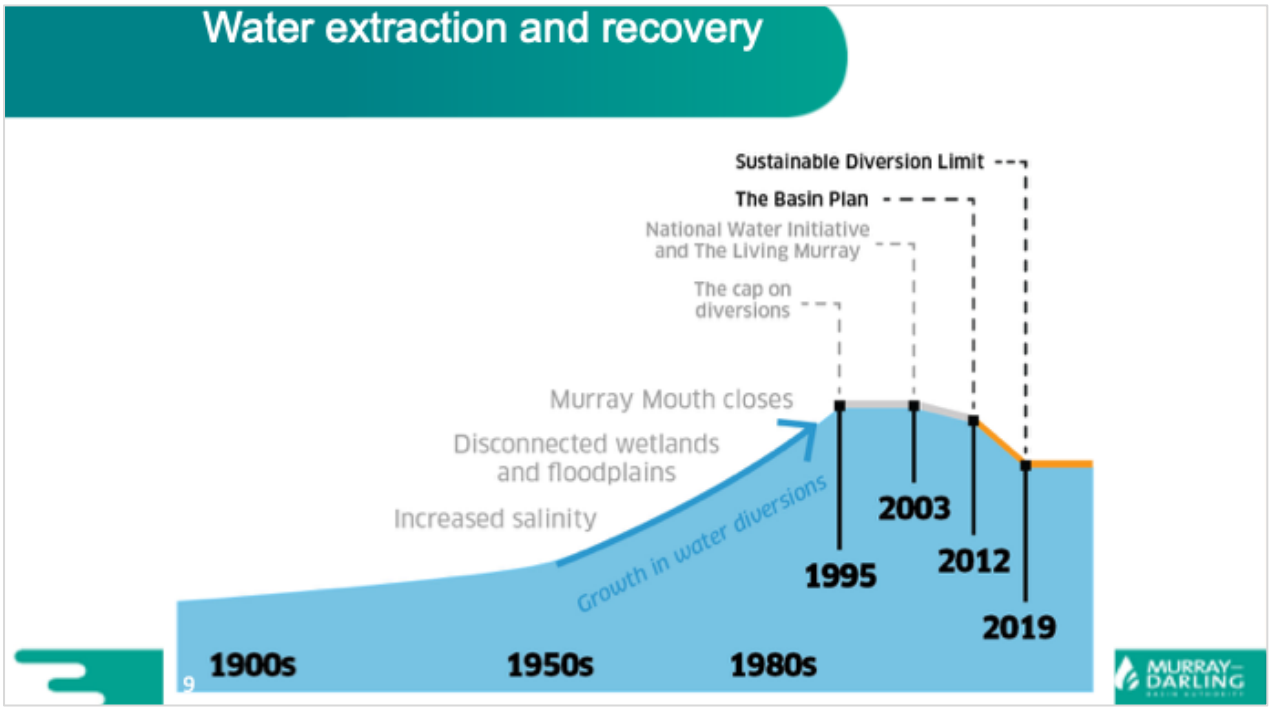

Figure 1-2: MDBA timeline showing the water extraction and recovery in the Southern Basin

1.1.3 CONNECTED SYSTEMS

While it is true that the southern basin generally acts as one coordinated supply-system and water market, there are some trade limitations that effectively break the southern MDB into two parts i.e.:

- The “Connected Murray” consists of SA, Sunraysia, MIL, and GMID which act almost as one although the physical flow limits in the Barmah choke and the lower Goulburn river can at times reduce the “connectivity” during periods when transfers of water are suspended. Transfers of environmental flows to SA from upstream of the choke, or the upper Goulburn R are exacerbating this problem
- The Murrumbidgee system is often poorly connected to the Murray and Murray water markets and is less connected.

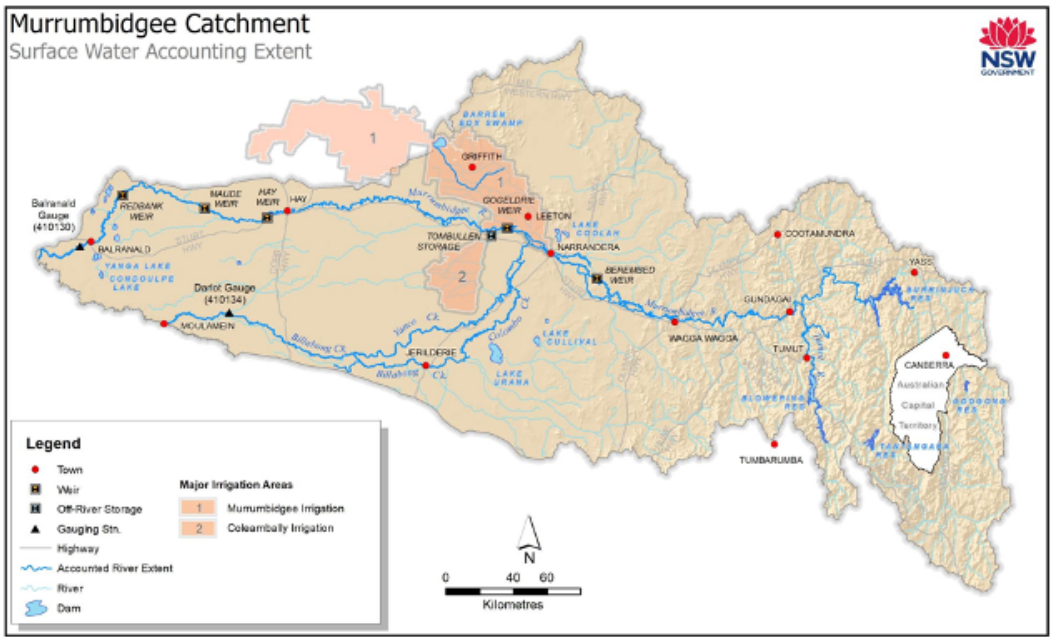

Figure 1-3: Map showing the Murrumbidgee catchment in the Southern Basin

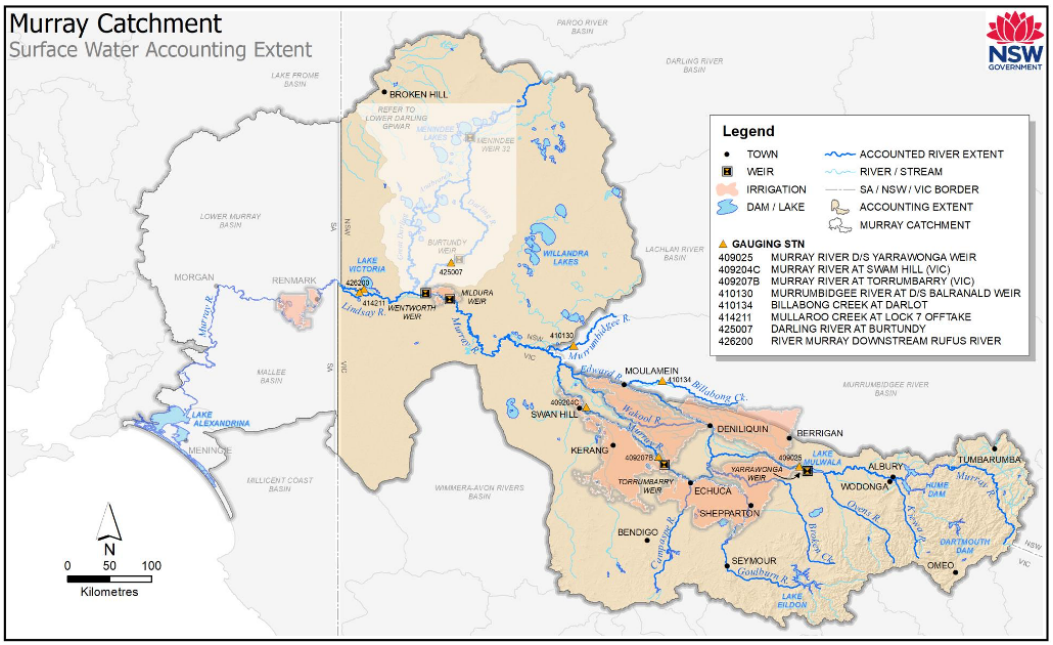

Figure 1-4: Map showing the Murray catchment in the Southern Basin

1.2 AVAILABLE WATER

1.2.1 LESS WATER AVAILABLE

The introduction of the Murray Darling Basin Cap in 1997 (based on 1993/4 levels of development) placed a limit on the total water available and was an important step in limiting total diversions. However, over the past two decades there has been a step change in water availability and price which is combination of:

- Reduction of the volume of water in the consumptive pool through the implementation of the Murray Darling Basin Plan (MDBP) and associated water recovery from irrigators
- Policy changes by NSW and Vic governments including Carryover and changes to worst inflow assumptions that is impacting on allocations against NSW General Security (NSW GS) water entitlements and Victorian Low Reliability Water Shares (LRWS) in particular

- Irrigator behaviour around carryover leading to more water being held in store has meant increased spills, increased volumes of 'dead storage' in the dams and less water being used
- A shift in climatic conditions resulting in lower average inflows in the last 20 years compared longer term averages
- Change in industry demand profiles, in particular the increased demand from permanent horticulture (almonds) in the lower Murray region.

This paper will attempt to bring some clarity to the current water position within the southern connected Murray Darling Basin.

1.2.2 FIVE RECENT PERIODS

The last 25 years can be viewed as five lots of five years, where the average annual available water and *average available allocation prices ($ 2020)* in each period is shown i.e.:

i. 1995 – 2000: Historical wet 90's – extreme wetting period – 6,662GL
ii. 2000 – 2005: "Normal period after a long wet period" but still had a mix of wet and dry years – 5,463GL
iii. 2005 – 2010: "Millennium drought" – the most extreme drought series – 3,099GL
iv. 2010 – 2015: "Wet period" with almost maximum allocations every year but some basin recovery – 5,563GL
v. 2015 – 2020: "Dry period" but with mix of wet and dry years after Basin recovery – 3,342GL, $277/ML.

The average available water, over the last five years, has therefore declined by a total of 3,320GL or halved since the historical wet period, pre 2000, **whilst at the same time, the price of water in real terms has increased by a factor of eight.**

Of this reduction in **available water**, 1,146GL is due to the Basin Plan recovery, up to 500GL from Policy changes and irrigator behaviour resulting in "underuse"[1] and therefore 1,674GL or more is due to drier conditions. In summary, of the reduction in water and increase in water prices over the last 20 years, 1/3rd is due to the Basin Plan, 1/6th to underuse, 1/2 to drier conditions.

Many commentators and analysis of water use associated with the Basin Plan have failed to grasp the underlying differences between these five periods.

1.2.3 UNDERSTANDING WATER RELIABILITY

There is a misconception that all water allocated is the same and ultimately will trade to the highest value user, i.e. horticulture. What is not understood is that the sMDB system generally has three levels of surface water security i.e.:

i. **Super Secure water** – Including 50 % High Reliability (HRWS) allocation, approximately 1,500GL/year. This is usually available every year, including for most of the Millennium Drought. In simple terms, this is when there is only about 50 % allocation for Murray and Goulburn High Reliability Water Shares in Victoria. This is estimated to occur up to one year in every 20 years or having a 5 % probability
ii. **Secure water** – 100 % HRWS allocation, adds another approximately 1,500GL/year. This volume (or more) is estimated to be available in 95 % of years, although in some years the maximum level of allocation will occur later in the irrigation season
iii. **Variable water** – NSW Murray GS allocations in the Murray and Murrumbidgee ranging from 0 to 100 %, which adds between 0 and 2,600GL/year. On average 65 % i.e. an extra 1,790GL/year is theoretically available and utilised.

[1] MDBA "Trends in water use relative to the Sustainable Diversion Limit in the Southern Murray Darling Basin" draft 11 June 2020.

In practical terms this means that for surface water supplies there is:

i. **Super Secure water** (1,500GL), which is used by Horticulture to irrigate permanent plantings without risk

ii. **Secure Water** (1,500GL) which is used by the next most high value industries i.e. cotton, dairy and maize, available in almost all years, but being able to 'opt out' if conditions are very dry

iii. **Variable water** (2,200GL) which is used predominantly for rice, pasture for livestock grazing and finishing winter cereals. These industries must cope with an interruptible allocation and have low overheads.

In order to change the "variable" water into a more "secure" water product, farmers use "carryover" which increases the available water in dry years but comes at a yield cost i.e. making variable water secure means that there are more spills and less water used by irrigators in *all* industries on average over a period of time (say ten years).

There is also approx. 500GL of Groundwater (deep lead) available throughout the southern connected basin. This water is extremely secure and with the relative price of energy falling, as water market values for surface water increase, farmers are able to maximise its use in all years, but particularly the dry years. The water is available mostly in the Murrumbidgee area (350GL), but there is 80GL in Murray Irrigation and 70GL in GMID plus another 50GL scattered throughout the upper reaches of the Murray Goulburn catchments. However the sustainable yield for groundwater is closer to 400GL but there is the ability to carryover water and use up to 200 % in any year. There is also some local shallow groundwater systems in the Murray Irrigation and GMID which can add up to 150GL but most of it is recycling.

1.2.4 INEVITABLE EQUILIBRIUM

Prior to the introduction of the cap there was effectively unlimited water in all but the worst droughts (1967, 1972, 1982 and 1994) and industries expanded as markets permitted. However since the introduction of the cap and water trade in the 1990's, some industries have expanded, and others have declined. The size of the industries has also been influenced by water availability and the capacity to increase yields per ML applied. This has significantly reduced due to climate change, water recovery and water policy changes, such as carry over. Supply and demand determine water price and competing industries buy or sell water in the southern connected Murray Darling Basin (sMDB) at different price points.

Because the water available varies from year to year, there will always be three broad groups of industries. These industries will eventually develop an equilibrium based upon perceptions of water reliability, influenced by relative commodity prices.

The equilibrium has taken a long time to evolve with:

- Rice and Dairy replacing mixed grazing in the 80's and 90's
- Wine grapes in Sunraysia through trade replaced mixed grazing in the Kerang/Pyramid region in the 90's
- Cotton (and some maize) replacing rice since the Millennium Drought
- Almonds have taken water from dairy pasture irrigation since the Millennium Drought, and have sourced water for expansion largely from within the GMID
- Table grapes have expanded in Sunraysia
- Other Horticulture has continued to slowly expand throughout the whole southern basin.

The equilibrium of different enterprises relates to gross income per ML as shown in the table below. The volume available of 'super secure' water provides a limit to how much almonds and other perennial horticulture can expand. Any expansion above this volume must be dried off in the next drought.

Table 1-1: Water used by different industries and their relative gross income

WATER SECURITY	SECTOR	GROSS INCOME $/ML
High value – limited to Super Secure water volume.	Fresh stone and pome fruit / table grapes	$5,000 - $10,000
	Canning fruit	$3,000
	Dried fruit / wine / almonds / citrus	$1,600 - $2,000
Medium value – uses the Secure Water above that used by high value.	Dairy – Traditional grazing	$1,200 - $1,400 $1,800 - $2,400
	Maize	$800 - $1,000
	Cotton	$500 - $900
Low value – uses the Variable Water above the Secure Water.	Rice	$300 - $600
	Winter Cereals	$200 - $400
	Livestock Grazing	$150 - $400

1.2.5 EST. WATER USE BY DIFFERENT INDUSTRIES WITHIN THE CURRENT EQUILIBRIUM

Table 1-2: Water used by different industries

INDUSTRY	WATER USE RANGE (GL)
Horticulture (excluding almonds) slowly increased by 50 % over 50 years	800 - 900
Almonds have increased from almost zero demand in mid 1990's soon to be	500 - 600
Cotton has replaced rice in "Bidgee" since starting in 2010 – rise to	450 - 700
Dairy peaked in 2000 but is now about half	800 - 900
Irrigated crop (winter and summer)	200 - 600
Rice has drastically reduced and varies from year to year	50 - 1,000
Mixed grazing declined drastically from peak in the 1980's of 2,500 GL to now	250 - 500
Carryover is used to store water in wet years for dry years	+600 - 300
Total water available (includes 500GL of ground water)	Typical 3,000 - 5,600
	Averages around 4,500 but in a drought could be 2,200

1.3 WATER PRICES

1.3.1 SUPPLY DRIVEN TEMPORARY MARKET

The sale of water both permanently as entitlements, and temporarily as allocations, has enabled water to move both long term and short term to find the most economic use and thus maximise total southern basin economic output. This was most evident during the Millennium Drought but is also evident through the evolution of the "equilibrium" of industries that has evolved.

RMCG has plotted the average annual temporary price of water versus annual allocations and found a strong correlation, as is shown in Figure 1-5 below.

This demonstrates the enormous range of possible allocations between years and so the large range in likely water prices. It also demonstrates that the NSW General Security allocations are key to the available water in all but the drought years. This is the market at work. The temporary market reflects the marginal value of the water to the industry that is accessing the water. In simple terms the relative prices for different climatic seasons are as follows:

Wet	$75/ML – value to a rice farmer to set-aside for next year	– 16/17 (100 % GS)
Average	$180/ML – max value to a rice farmer	– 17/18 (50 % GS)
Very dry	$425/ML – max to a dairy/cotton/maize	– 18/19 (0 % GS – 100 % HRWS)
Drought	$900/ML – max to a horticulture enterprise	– (0 % GS – 50 % HRWS).

This suggests that the price of water is driven by the level of available supply. Therefore, any change in supply will directly affect the price of water.

This is demonstrated by comparing (refer to Section 1.2.2) the recent five year period (2015-2020) with the late nineties (1995-2000) where the available water has halved and the average allocation prices in real terms have increased by a factor of eight.

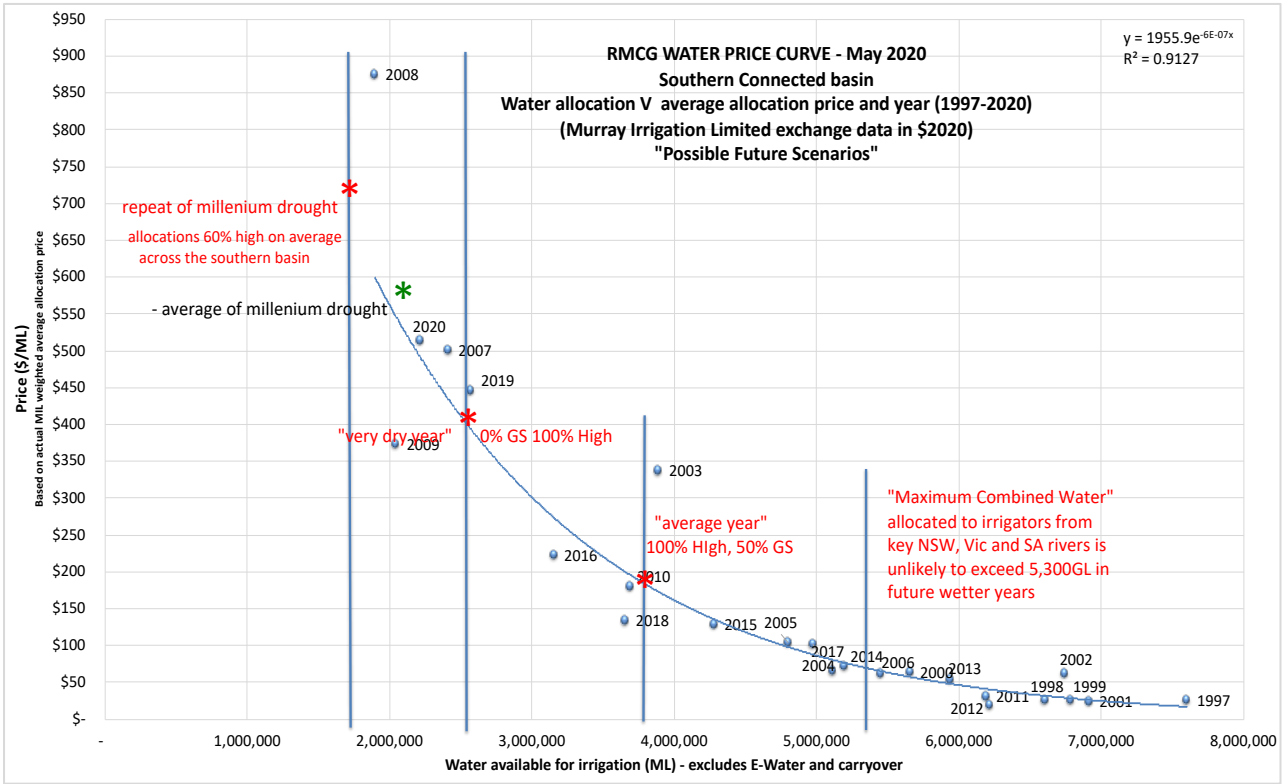

Figure 1-5: Water allocation vs average allocation price and year (1997-2020) (Murray Irrigation Limited exchange data in $2020) – Historical Scenarios

1.3.2 ENTITLEMENT PRICES OVER LONG TERM

The price of entitlements has increased over time as shown in the Figure 1-6 below.

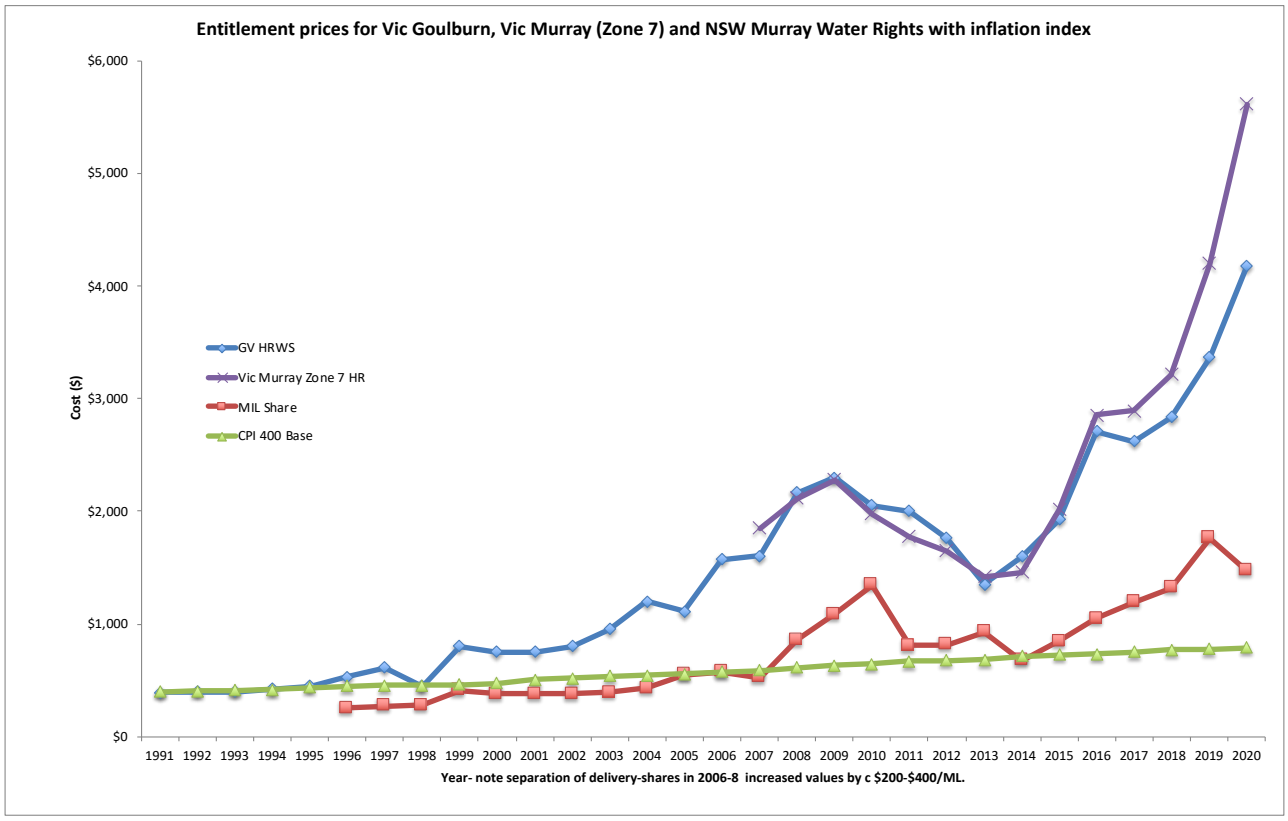

Figure 1-6: Longer term entitlement price trends

The graph is based on data on long term annual weighted average annual entitlement prices paid ($/ML) for NSW Murray GS (Murray Irrigation Ltd trades 1996-2019), Victorian Murray HRWS, Goulburn HRWS (1991-2019) all presented in the current price base using Australian CPI (1991-2019).

The graph also indicates that the price of entitlements appears to reflect dry/wet seasons.

Since the millennium drought, the price of high security entitlements has increased by 45 to 96 % in Victoria in real $, whereas General Security entitlements in the same time have not increased in real terms since the millennium drought.

For sellers or holders of entitlements there has been a windfall gain of substantial amounts for high security holders but not as much for General Security holders, particularly recently. By contrast, those wishing to develop new enterprises or expand existing enterprises have been disadvantaged.

The increase in the entitlement price has occurred despite the previous price/allocation graph indicating that the real price of water relative to volumes allocated has not changed over time. Therefore, it is proposed that what has changed is the probability of different allocated volumes.

Thus the price of water has increased due to less water being available not because the price/supply relationship has changed.

1.4 UNDERLYING PRODUCTION TRENDS

The following data illustrate the changes in production in various industries, showing a pattern over time of a period of growth, the impact of the cap and the drought, and then the impact of recovery leading to a new equilibrium position.

1.4.1 RICE INDUSTRY

Rice experienced a period of considerable growth in the 90's but the level of production is now highly variable depending on GS allocations.

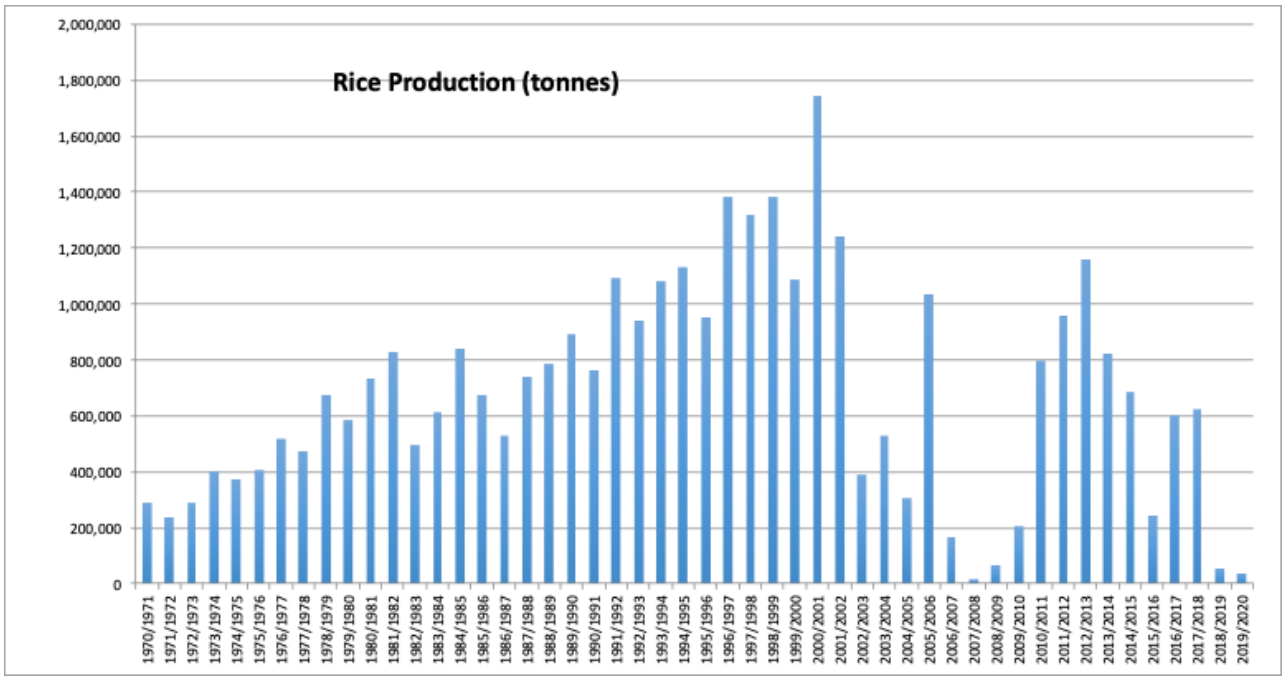

Figure 1-7: Rice production

1.4.2 DAIRY INDUSTRY (IRRIGATED, NORTHERN VICTORIA)

Like rice, dairy experienced high growth in the 90's and is now stabilising at about half of its previous peak.

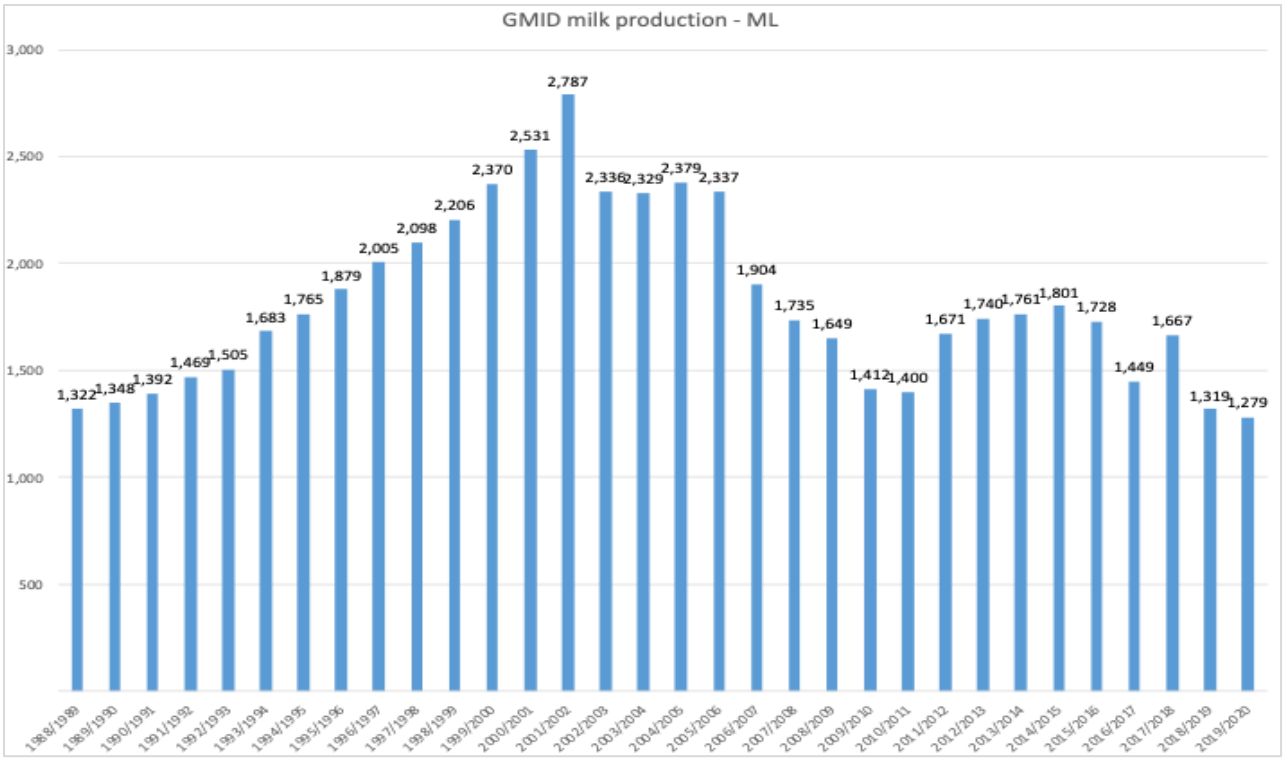

Figure 1-8: Dairy industry trends

1.4.3 HORTICULTURE

The growth in Horticulture development is shown by the change in area for the Lower Murray (including Riverland, Sunraysia etc), Lower Darling, Lower Wakool and lower Bidgee area. Horticulture has progressively grown by 30 % over the past 20 years.

Table 1-3: Horticultural Growth[2] total and crop type

YEAR	2003	2009	2012	2015	2018
Total Ha (excl Field crops)	103,335	113,540	114,485	115,855	128,290

Crop type		2003	2009	2012	2015	2018	% of 2018 total	Change 2003-2018
Permanent plantings	Grape Dried	6,360	3,750	3,780	3,750	3,845	2%	-2,515
	Grape Table	7,715	7,400	8,275	9,205	11,080	5%	+3,365
	Grape Wine	45,745	45,000	42,150	39,735	36,910	15%	-8,835
	Citrus	13,975	12,885	12,975	12,230	13,065	5%	-910
	Fruit Olive	1,585	4,920	4,525	4,430	4,600	2%	+3,015
	Fruit Stonefruit	4,250	3,920	4,210	4,175	4,050	2%	-200
	Fruit Other	1,060	930	1,210	1,485	1,850	1%	+790
	Nut Almond	7,200	24,360	24,935	25,750	35,895	15%	+28,695
	Nut Other	450	560	595	655	1,095	<1%	+645
	Miscellaneous	1,410	1,265	1,235	1,145	1,230	1%	-180
Seasonal	Field Crop	64,130	10,945	37,890	38,160	46,370	19%	-17,760
	Vegetable	13,585	8,550	10,595	13,295	17,670	7%	+4,085

The above table does not include the horticultural plantings in the Murrumbidgee (approx.40,000ha), within Murray Irrigation Area (2,000ha), the GMID (18,000ha) or the upper Murray/Goulburn (2,000ha). It is understood that the growth in horticultural plantings within Murrumbidgee's MIA and along the river is similar proportionally. There is only a small amount of horticulture within the Murray Irrigation area. Within the Goulburn Valley, horticulture was predominantly driven by the fruit canning industry in the 70's and is now predominantly a fresh fruit industry with similar areas of plantings and water use but with considerably greater income.

The water used by horticulture across the Southern basin has reached a total of up to 1,430 GL/year, comprising up to 400GL in Riverland, 600GL in Vic. Sunraysia and 100GL in NSW Lower Murray/Darling, 200GL in Murrumbidgee, 110GL in GMID, 20GL in other areas. It is likely that increased use based on the final stages of the current expansion phase (mainly in Murrumbidgee) will see up to a total of 1,500GL being used.

1.4.4 COTTON

Cotton has expanded from almost nothing ten years ago to recently peak at more than 64,000 ha and an estimated 640 GL of water-use in 2017/18. However, cotton production is not immune to low allocations and high prices with production dropping back to 40,000 ha in 2018/19 and a further drop to 15,000 to 20,000 ha in 2019/20 (estimated 200 GL of water use). The cotton production is mainly in the Murrumbidgee irrigation area but there are significant areas being planted in the northern sections of Murray Irrigation's area of operations.

[2] SunRISE Mapping and Research – "Irrigated crop area data for the Lower Murray-Darling 2003 to 2018." – MDBA 2019.

1.5 REGIONAL IMPACTS OF CHANGED WATER USE VARY

Some industries continued to expand, and others decline as markets change, crops adapt and the water availability has reduced through a combination of climate change, changing allocation policies, the Basin Plan focus on water-recovery, and changed irrigator behaviour. Similarly, some regions have expanded, and others have declined. In general terms since 1999/00 when water use across the basin was at its peak, it is observed that:

- SA Riverland region has maintained its overall level of water use through two mechanisms. It has increased its utilisation of SA water entitlements held and its irrigators are actively buying water entitlements and water allocations from interstate, particularly from Victoria. (This does not include the Lower Swamps, where there have been large changes to the previously flood irrigated pastures - loss of dairying etc.)
- The Victorian/NSW Mallee region (Sunraysia) has expanded its water use significantly – almost doubled, primarily due to increased almond plantings
- NSW Murrumbidgee has maintained its High Security water use (less affected in droughts) but decreased its GS and Low Bidgee floodplain water use. Horticulture is largely unaffected by the dry seasons and is still expanding. Although Murrumbidgee irrigators have lost 25 % of GS but cotton with higher returns replaced rice and this was assisted through Commonwealth funded farm efficiency scheme.. Rice production is now very variable in both the Murrumbidgee and NSW Murray Valleys
- NSW Murray (MIL) – lost 25 % GS and affected by down-stream trade and dry conditions. Water use halved and now is extremely variable. The region traditionally depends on mixed farming with a cornerstone being rice production systems, and has been drastically affected
- VIC GMID – Lost HS to water recovery, down-stream trade and dry conditions. Halved its water use, horticulture mostly unaffected and moved from canning varieties to higher value fresh fruit, but dairy production has halved. Some offset and improvements in delivery efficiency with the 2 billion investment in irrigation modernisation.

In simple terms three regions have prospered and two regions have substantially reduced production, income and regional prosperity.

2 19/20 season – drought

2.1 STORAGE INFLOWS

Inflows in the 2019/20 season were poor and directly influenced water allocations and price which is illustrated in Figure 2-1.

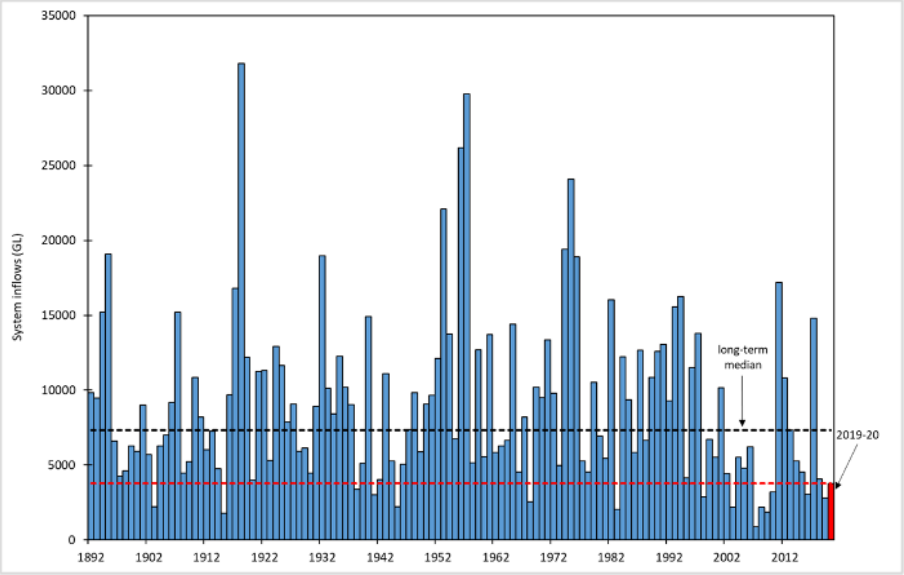

Figure 2-1: River Murray system inflows – water year totals (to end May) since 1892. Inflows exclude Snowy Hydro inflows, IVT delivery, managed environmental inflows and inflows to the Menindee Lakes[3]

This has reflected in a decline in MDBA active storages and while storage volumes have not declined to the level experienced in the Millennium drought they are still at low level.

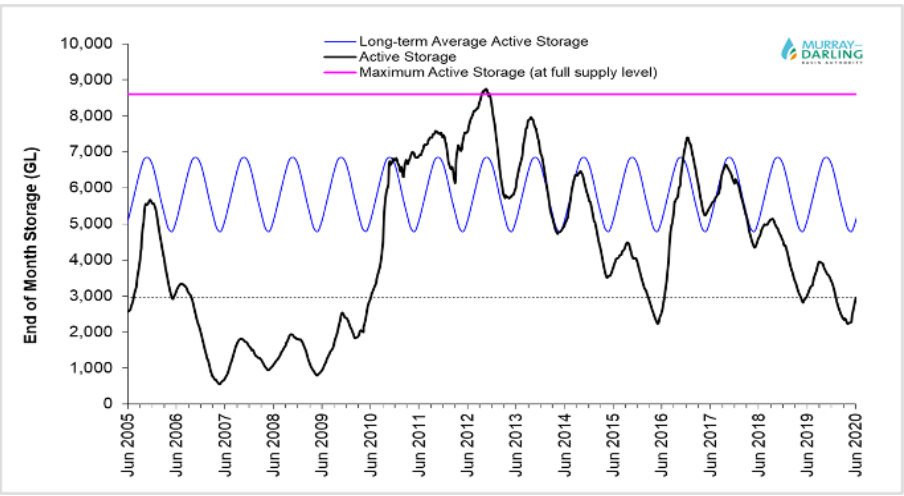

Figure 2-2: MDBA active storage, June 2005 to present. This graph shows the sum of active storage in Dartmouth and Hume Reservoirs, Lake Victoria and the Menindee Lakes. Menindee Lakes only contributes to MDBA active storage when the storage volume is available as a shared resource

[3] Source: River Murray Weekly Report – for the week ending Wednesday 3rd June 2020 – Murray Darling Basing Authority.

2.2 AVAILABLE WATER

2.2.1 ALLOCATIONS

The 19/20 season was one of very low allocations throughout the southern connected Murray-Darling Basin (sMDB). The table below provides the LTDE[4] factor for each entitlement type and this is the theoretical long-term average allocation and yield (or use) for each of the main entitlement types.

Table 2-1: Allocations for season 19/20

VALLEY	ENTITLEMENT TYPE	ENTITLEMENTS GL HELD BY IRRIGATORS	ALLOCATION %	LTDLE FACTOR*
Murrumbidgee	High Security	348	95 %	.977
	General Security	1,417	Initial 6 %, plus late season 5 %	.591
NSW Murray	High Security	165	97 %	0.873
	General Security	1,189	Initially 0 % Late season 3 %	.699
Vic Murray	High Security	879	66 %	.974
	Low Security	275	0	.543
Vic Goulburn	High Security	718	80 %	.967
	Low Security	371	0	.583
SA Murray	High Security	382	100 %	.882

No supplementary water allocations were announced in season 2019/20.

There are also a number of small catchments in Victoria i.e. Campaspe, Broken, Loddon, Ovens and Kiewa systems that have approx. 65GL of entitlements in total where allocations varied from 2 % to 80 %. Contributions to available water from the NSW Lower Darling were available late in the 2019/20 water-year and were very limited.

The NSW Irrigation supply companies also provide addition efficiency allocations or distributions of various types of around 5 % to their customers from improving delivery efficiency and providing dividends to users from their water conveyance allowances (Murray Irrigation, Coleambally Irrigation and Murrumbidgee Irrigation).

The water for Fodder program added another 40GL to the Southern Basin in water-year 2019/20 (this was achieved by reducing Adelaide's Murray demands by using the Adelaide de-salination plant) and the Victorian urbans also sold unused allocations (including Melbourne Water who traded its NVIRP dividend), of around 50GL, into the market.

2.2.2 THE TOTAL VOLUMES ALLOCATED – COMPARISON WITH MILLENIUM DROUGHT

The following table reports the total volume allocated in 19/20 for the major valleys (Murrumbidgee, Murray and Goulburn) where this was about 40 % of the maximum possible allocations.

[4] LTDE Long Term Diversion Limit equivalence, previously known at LTAAY Long Term average annual yield.

The table provides a comparison of the volumes allocated in the 19/20 season with the volume allocated on average during the three years of the millennium drought. Overall, the southern connected system volumes were very similar to the millennium drought volumes available to irrigators.

However, the table indicates that the Murrumbidgee systems volumes were much less (70 %) than the average in the millennium drought but that the connected Murray system (Murray and Goulburn) was 23 % better than the millennium drought average.

Since the millennium drought there has been considerable water recovery under the Basin Plan and if the millennium drought was repeated (i.e. similar allocations) the available water would be significantly less (c600GL less) in the connected Murray although there would be not much difference in the Murrumbidgee.

This indicates that in future planning scenarios, the 19/20 season is about as bad as it gets in the Murrumbidgee Valley (unless the drying trend in the Snowy scheme continues), but it is possible that the connected Murray could have a third less water in a repeat of a millennium drought.

Table 2-2: Allocated volumes in season 19/20

SYSTEM	19/20 IRRIGATOR VOLUMES ALLOCATED GL	MILLENIUM DROUGHT VOLS GL ALLOCATED	REPEAT OF MILLENIUM DROUGHT ALLOCATION –GL (WITH TODAYS ENTITLEMENT)
Murrumbidgee	473	687	629
Connected Murray	1,714	1,394	1,094
Total sMDB	2,187	2,081	1,724

Note: the above volumes do not include the very late 2019/20 allocations in NSW, which increased the carry over by approx 108 GL in May 2020.

2.2.3 GROUNDWATER

A similar volume of groundwater was used in season 19/20 and it is estimated to be 323GL in Murrumbidgee, 120GL in NSW Murray and 70GL in Vic Murray (not including some shallow system use in Murray Irrigation and GMID).

2.2.4 CARRYOVER

The Carryover volumes in the various valleys are shown for the start and finish of the season. This shows that despite the extreme low allocation volumes (comparable in volumes to the millennium droughts) there was a net increase of approx. 451GL in water carried into 2020/21 compared with the year before.

Table 2-3: Carryover volumes in season 19/20

SEASON 19/20	VICTORIA	NSW MURRAY	MURRUMBIDGEE	TOTAL
Start	360	264	112	734
End	609	319	268	1196
Change	+249	+55	+156	+451

The change in carryover is a reflection of two things i.e.:

- A conscious effort by horticulturalists to have sufficient water in case a millennium drought reoccurs in 2020/21, and
- April rains and a late-season allocation in NSW which meant some planned water-use was not required.

The June 2020 total carryover has increased from an equivalent of 20 % to about 33 % of the average annual use in the southern connected basin.

2.3 WATER USE BY INDUSTRY AND BY REGION

The crop water demand varies by +/- 10 % around the mean each year depending upon evaporation and effective rainfall for the season (apart from extremely wet years (such as 2010/11)). Season 19/20 was similar crop demand to 18/19 up until early April when crop water demand declined due to rainfall and cooler weather. Thus the actual water use would be expected to be approx. 5 % less for permanent plantings (i.e. horticulture).

It was predicted (Aither reports) that in Sunraysia and the Riverland that the water use would increase due to increased plantings. However this was not found to be the case in 2020 and it is suggested that lack of allocations and associated high temporary water prices led to a greater focus on water use efficiency and to some grape vines being “dried off”.

As expected, the water use within the GMID was greatly reduced as the dairy industry used 350GL or about half of its normal water use. Good milk prices and plenty of available fodder from adjacent Victorian dryland areas enabled the industry to maintain production as a one-off seasonal measure.

The Murray Irrigation district used only 87GL or about 10 % of its recent maximum usage, as the rice industry was unable to compete in the market for water and any water that was available was mostly sold to the horticulture sectors.

Murrumbidgee Valley total surface-water use at ~400GL was about 30 % of its recent maximum surface water usage. The rice industry used a very small amount and cotton used using about 200GL or about 1/3rd of the previous year’s water use. However Murrumbidgee irrigated production was underpinned by use of significant volumes of groundwater (340GL).

Table 2-4: Water use by region in season 19/20

RIVERLAND (SA)	SUNRAYSIA (VIC)	GMID (VICTORIA)	MURRAY IRRIGATION AREA (NSW)	MURRUMBIDGEE (NSW)
Normal same as 18/19?	510GL (normal)	500GL (under half normal) plus about 70GL groundwater	87GL (10 % of maximum)	400GL (30 % of its maximum) is supplemented by 340GL of g/water

2.4 WATER PRICES

2.4.1 WATER PRICES ALLOCATION

AVERAGE PRICE

RMCG’s experience is that the best long-term reliable predictor of water allocation prices is the NSW Murray Irrigation Water Exchange. The prices have also been found to reflect typical prices throughout the Southern Murray Basin. Using the average weighted price within the NSW Murray Irrigation District we find that:

- During the millennium drought the three year average was $600/ML (CPI adj) or $447/ML (actual $)
- This equates to a 2019/20 price of $515/ML.

This suggests that season 19/20 had a similar price as the millennium drought year. This is not surprising seeing that the volumes available to irrigators were broadly the same – it indicates that the development since the drought (less dairy, more almonds, more table grapes, more cotton, less rice) has had little if any net impact on the price relative to the volumes available in a drought i.e. same volumes = same price.

REGIONAL PRICE VARIATIONS

However in season 19/20 we saw the largest regional difference in price at some time during the season, due to trade and water transfer restrictions.

Table 2-5: Weighted average allocation water price from July 1 2019 to 30 April 2020

TRADING ZONE	WEIGHTED AVERAGE PRICE ($/ML) 2019/20
MIL	$515
Goulburn 1A	$466
Zone 6 Murray – Dart to Barmah	$451
Zone 7 Murray – Barmah to SA	$598
Murrumbidgee	$527
SA River Murray	$485

PRICE VARIATION DURING THE SEASON

The price of water varied over the 19/20 season as shown in the graph below. It can be seen that as the season developed and got drier, the price increased then as we got nearer to 20/21 season and the above average April rainfall , the price reduced.

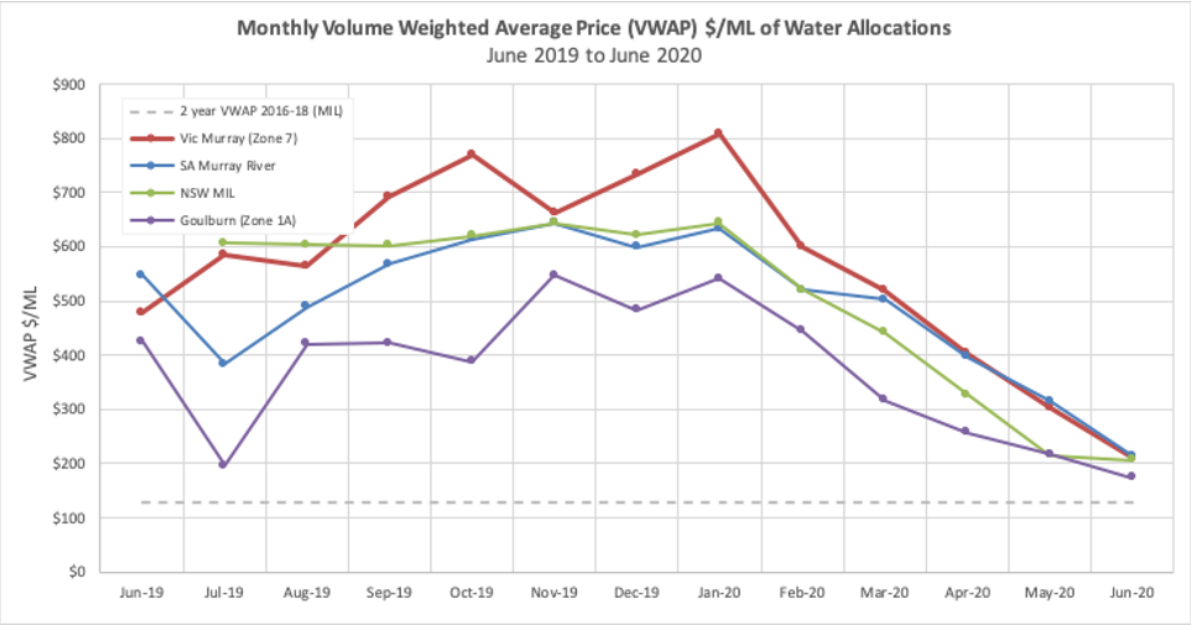

Figure 2-3: Reported allocation traded/transferred (Murray River, excluding NSW State registry) May 2105 to May 2020[5] (excludes $0 trades)

[5] Victorian Water Register: http://waterregister.vic.gov.au, NSW Murray Irrigation Limited: http://www.murrayirrigation.com.au/water/water-trade/, and South Australia WaterConnect: https://www.waterconnect.sa.gov.au/Systems/WTR/Pages/Default.aspx.

2.4.2 ENTITLEMENT PRICES

The entitlements prices over the 19/20 season are shown below for HS and lower security products.

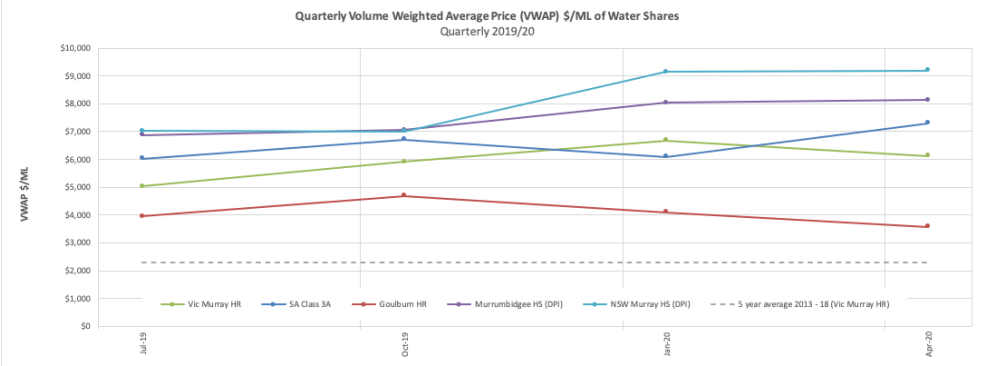

Figure 2-4: Values for high security water products

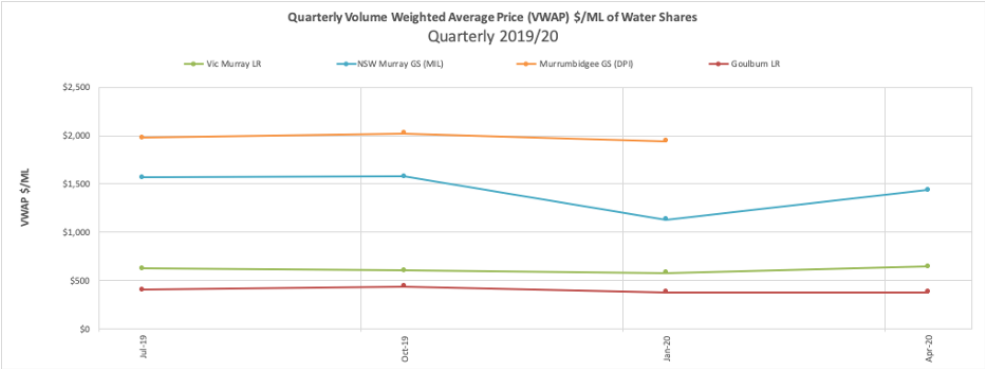

Figure 2-5: Values for low security products

Season 19/20 has seen the continued increase in prices for high security entitlements, except for the Goulburn system, where perceptions that future out-of-valley trade may be restricted seem to have had an impact.

In contrast season 19/20 has seen a holding or softening of the lower security entitlements.

2.5 WATER TRADE

2.5.1 WATER TRADE BETWEEN CATCHMENTS

The data surrounding net trade volumes between catchments is usually not available until October or later when individual state authorities compile their annual reports. However it is suggested that in season 19/20 the net movement was as follows:

- Movement to Sunraysia districts from mainly the Victorian Murray and Goulburn, although trade restrictions limited the volumes
- Some movement south to the NSW Murray from the Murrumbidgee
- Movement from SA to the Vic Murray.

Murray Irrigation Ltd recorded a net outflow of traded water reaching a small peak of 17GL in January and then gradually reversing and finishing the season with a net inflow of about 12GL.

There was a net trade into the Vic Murray of 204GL and a net trade out of the Goulburn of 72GL, with 12GL out of the other minor Victorian river systems.

2.5.2 TRADE RESTRICTIONS

During 2020 a number of trade restrictions were applied, including:

- Extended periods of no trade from the Murrumbidgee to the Murray, due to reaching prescribed annual limits
- Extended periods of restrictions of trade from above to below the Barmah Choke, impacting transfers for NSW and Victorian Murray water entitlement holders
- The introduction of more restrictive limits on volumes traded out of the Goulburn Valley
- Limits on trade from the Lower Darling, when flows recommenced in late summer 2020.

2.5.3 VOLUMES TRADED

The volumes of, and prices nominated for, allocation trades recorded are difficult to accurately understand because many trades are:

- Internal business trades from one entity to another with 'zero' prices recorded
- Trades within a business from water not attached to land
- On-sold or parcels are divided and resold
- Transfers occurring as a result of a long term lease commitment
- A transfer of environmental water, which was once assigned to a user in a different reach of the river, or even a different upstream valley
- An aversion by some traders to quote prices, recognising the penalties of non-reporting, or falsely reporting prices are not applied.

It is hoped that better transparency will evolve and better data will become available to inform the water industry. The recent ACCC report on water markets and trading should also help promote this outcome.

2.6 KEY LEARNINGS FROM 19/20 SEASON

The key lessons from 19/20 season are that:

- After allowing for the large increase in E-water holding, the available water for irrigators for the sMDB was very similar to that of the millennium drought years and the overall water prices were very similar
- It was an extreme drought event for the Murrumbidgee area, i.e. worse than the millennium drought, though this was able to be partly offset by access to groundwater
- The connected Murray, whilst receiving drought allocations, was not as bad as it was in the millennium drought. If the millennium drought was repeated it would now have 1/3rd less water
- Horticulture development in the Murrumbidgee is still occurring and can continue based on the volume of High Security entitlements and high levels of groundwater access, at the likely expense of the cotton industry
- The horticultural area planted in the connected Murray appears to have reached its limit
- A large volume of water (204GL) was traded into the Vic Murray system to supply the Sunraysia horticulture expansion. This is likely to occur every drought - when the dairy industry and the rice industry trade water to Vic Lower Murray area
- Irrigators are adopting unexpectedly high carryover levels – of around 20-33 % of average catchment water use
- The cotton industry has drastically reduced its water use and production relative to the record year for the Murrumbidgee Valley of 2017/18
- The dairy industry with good prices, useful rainfall and good fodder supplies, maintained production, despite using about half its normal volume of irrigation water
- As expected in years of very low allocations, the rice production was extremely small
- There was a significant difference for some periods of time between regions in water prices due to trade restrictions
- Entitlement water prices continued to increase for high security products (except for the Goulburn).

3 Last 5 seasons are instructive and give a taste of the future

The last five seasons represent the full range of scenarios that are likely to occur into the foreseeable future. While we do not know what the future mix of scenarios will be – the last five years provide examples of what individual years could look like. Possible exceptions include a repeat of an extremely wet summer (2010/11) when irrigation demand is very low, or extreme droughts (Millennium drought) when available water is at a minimum.

3.1 WATER AVAILABILITY, USE AND TRADE

3.1.1 WATER AVAILABILITY AND PRICE

Table 3-1: Water availability in the Southern Basin

SEASON & CLIMATE SCENARIO		ALLOCATIONS %			AVAILABLE WATER IN SOUTHERN BASIN (GL)[6]	PRICE OF WATER ($/ML) [7]
		NSW GS (MURRAY)	VIC HS MURRAY (GOULBURN)	BIDGEE GS		
2015/16	Dry	23	100	34	3,232	208
2016/17	Wet	100	100	100	5,204	63
2017/18	Average	51	100	41	3,738	129
2018/19	Very Dry	0	100	7	2,644	438
2019/20	Drought	0 (late 3 %)	66 (80)	6 (extra 5 % late)	2,187 (late + 108GL)	515
Repeat of millennium drought – worst on record		0	50 %(50)	10	1724	$800 - 900
Repeat of a wet summer e.g. 10/11		100 %plus suppl.,	100 %	100 % plus suppl.	5,600	55

3.1.2 WATER USE BY DISTRICTS

Table 3-2: Surface Water use (GL) in the different districts (irrigator use only)

SEASON & CLIMATE SCENARIO		SA	NSW		VIC		TOTAL
		SA	MURRAY	BIDGEE	GMW	LOWER MURRAY	
2015/16	Dry	391	404	1,102	1,234	503	3,634
2016/17	Wet	344	855	1,311	994	424	3,928
2017/18	Average	410	1,060	1,347	1,433	537	4,787
2018/19	Very Dry	Est 434	536	707	1,137	570	3,384
2019/20	Drought	Est 400	233 (less enviro' 30?)	404 (less enviro'50?)	550 est	510 est	2,097

[6] Water available to irrigators in main surface systems and excludes environmental water and groundwater. Also some additional water from conveyance dividends (NSW& Vic totals 150GL), plus NSW Suppl. Water (237GL in 2016/17, 140GL in 15/16), plus upstream Vic rivers 65GL.

[7] Weighted average price – MIL.

The Murray volumes includes about 90 to 100GL of water use by horticulture in NSW Sunraysia area.

The above water use excludes conveyance water in NSW and Vic systems, but it includes supplementary and conveyance 'efficiency dividends' redistributed and used by irrigators (approx. 70GL in 'Bidgee, 40GL in the Murray systems) and 50GL water traded from Vic Urban authorities.

It is expected that the water use in a repeat of the Millennium drought would be very similar to 2019/20 season as it is expected that extensive use of carryover would be used to maintain production.

In an extreme wet summer such as 2010/11 the total water use would be very similar to 2019/20 season but there would be less use in the horticulture regions (SA and Lower Murray) and higher use in NSW rice and broad acre areas.

3.1.3 WATER USE BY OPERATING SYSTEMS

Table 3-3: Surface Water use (GL) in the different districts (irrigator use only)

SEASON & CLIMATE SCENARIO		NSW MURRAY		NSW MURRUMBIDGEE			VIC		
		OTHER	MIL	MI	COLLEAMBALLY	OTHER	OTHER	LOWER MURRAY	GMID
2015/16	Dry	187	317	526	183	393	87	503	1,147
2016/17	Wet	49?	806	621	323	367	79	424	915
2017/18	Average	268	792	800	263	284	115	537	1,318
2018/19	Very Dry	240	296	484	104	119	Est 100	570	1,067
2019/20	Drought	146 (less enviro' 30?)	87 est	est300	est50	est54	Est 50	510 est	500 est

The NSW Murray other includes about 100GL of horticulture in the Sunraysia region.

3.1.4 CARRYOVER

Irrigators use of carryover has also evolved over time partly due to changes in water policy (i.e. carryover was introduced in Victoria for the first time during the 2007/08 millennium drought when previously it did not exist) as well as changes in irrigator crop choices and risk management behaviour.

Table 3-4: Carryover trends (GL)

SEASON START	ALLOCATIONS MIL % (DIVIDEND %)	MIL PRIVATE CARRYOVER START OF SEASON	TOTAL MURRAY CARRYOVER INCL MIL CONVEYANCE	BDGEE TOTAL C / OVER INCL MIA / CIA CONVEYANCE	VIC BOTH GOULBURN AND MURRAY	TOTAL ALL VALLEY CARRYOVER	CHANGE IN CARRYOVER	ALLOCATIONS MIL % (DIVIDEND %)
2015/16	23 (2 %)	216	342	355	400	1,097	-9	2015/16
2016/17	100 (3 %)	169	301	281	505	1,088	+922	2016/17
2017/18	51 (8 %)	297	670	484	856	2,010	-754	2017/18
2018/19	0 (10 %)	146	431	368	457	1,256	-530	2018/19
2019/20	Late 3 % (2 %)	60	264	112	360	734	+451	2019/20
2020/21	30 (? %)	91	319	268	609	1,196		2020/21

1. SA Carryover is complicated but is a maximum of 70 GL and not included in the Table
2. Forecast allocation for .2020 is shown
3. MIL carryover is shown for comparison with the total carryover held in NSW Murray
4. The NSW ca.

The total combined carryover has ranged from 736GL to 2010GL but seems to stabilise around 1200GL.

When looking at just the connected Murray, carryover has ranged from 600 GL to 1500 GL but is typically around 900 GL.

3.1.5 SPILLS(VIC) AND WATER FOREFEITED(NSW)

When the storages are full and water spills, the spills cannot be collected and used for allocations. If the spills are caused by storages holding "carryover" water then both Vic and NSW have accounting mechanism that deducts the spills against carryover water and credits the allocation water.

In Victoria this results in so called "spills" and in NSW in water "forfeited". The accounting methods very between states but the outcome is very similar. The spills and forfeits are shown in the table below.

Table 3-5: Spills and forfeits (GL) trends[8]

	GOULBURN		VIC MURRAY		NSW MURRAY		MURRUMBIDGEE	
	Carryover	spills	Carryover	spills	Carryover	Forfeit	Carryover	Forfeit
2020/21	306		305		319		268	
2019/20	173	0	190	0	262	0	111	0
2018/19	285	0	172	0	449	6	359	2
2017/18	538	29	318	58	654	12	484	7
2016/17	220	0	286	163	301	54	281	181
2015/16	204	0	196	0	342	9	355	7
2014/15	357	0	267	22	352	18	470	23
2013/14	298	0	663	472	170	33	309	30
2012/13	867	288	1,240	33	668	37	544	77
2011/12	930	113	1,228	0		151	564	335
2010/11	325	0	446	0			493	678

The spills from the NSW Murray system are shown pictorially on the following diagram.

This illustrates the order and frequency of spills given the various levels of carryover.

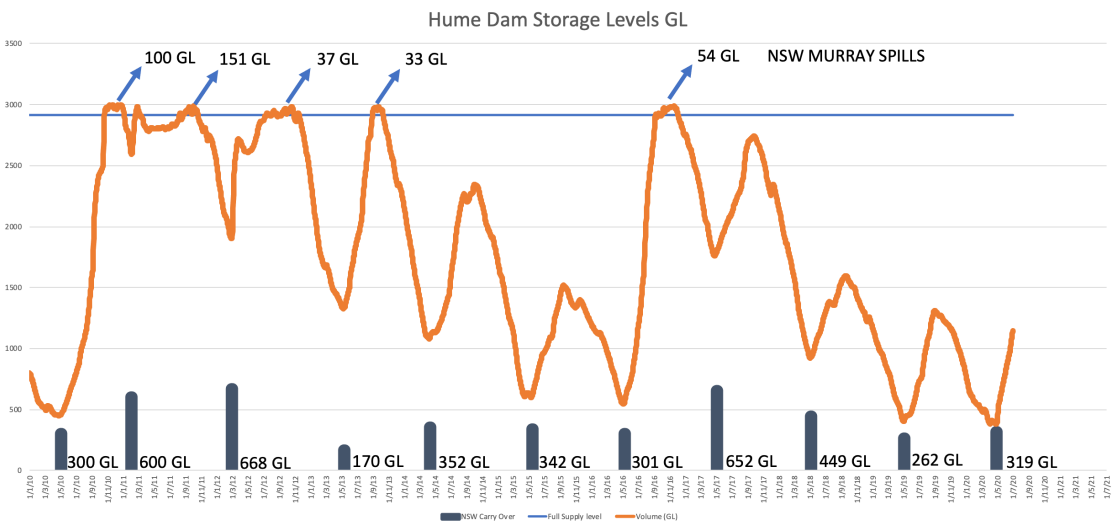

Figure 3-1: NSW Murray Spills from Hume Dam

[8] The Vic Murray spill rule changed in June 2013 from Dartmouth spill to Hume spill which increased the spills accounted and inc reasedas a one off the spills in 2013/14.

3.1.6 WATER TRADE

The following tables provide irrigators allocation water trade data between valleys, states and within Victoria systems. (Not all data is yet available.)

Table 3-6: Water trade (allocation GL) between valleys[9]

FROM TO	VIC SA	VIC NSW MURRAY	VIC NSW BIDGEE	BIDGEE NSW MURRAY	BIDGEE SA	NSW MURRAY SA
2015/16	-52	-140	-30	+240	0	+70
2016/17	-125	-80	+10	+50	0	+30
2017/18	+7	+90	+55	0	0	0
2018/19	?	+80	-10	+25	0	0
2019/20	?	?	?	?	0?	0?

Table 3-7: Net water (allocation GL) trade by state

NET TRADE +VE INTO	SA	VIC	NSW MURRAY	NSW BIDGEE
2015/16	+18	+223	+30	-261
2016/17	-95	+208	-200 (incl 140 to lower darling)	-34
2017/18	+7	-154	+ 76	+76 (incl 20 from Lower Darling)
2018/19	+14?	-60 est?	+83	-37
2019/20	?	120 est?	?	?

Table 3-8: Net water (allocation GL) Trade within Victoria

NET TRADE +VE INTO	GOULBURN	MURRAY	OTHER VIC	TOTAL
2015/16	52	187	5	245
2016/17	99	152	-24	227
2017/18	-98	-9	-34	-142
2018/19	-124	81	-17	-60
2019/20	-72	204	-12	120

The only consistent finding from the above analysis of water trade is that the Victorian Murray system is a net importer of water, except when there is a large volume of carryover. This is in response to the increased horticulture demand in Sunraysia. The Goulburn system has become a net exporter in recent years and this has put pressure on the Goulburn river from increased summer flows that result from this inter valley transfer.

[9] the source of trade data is a combination of DEWLP water ownership tables, Vic Tim Cummins report, NSW General Purpose Water Accounting reports and there is minor inbalance between the numbers.

3.1.7 GROUNDWATER USE

The groundwater use across the southern connected system is fairly uniform (except for wet years when it reduces) despite the seasonal conditions and is concentrated mainly in the Murrumbidgee region.

Table 3-9: Groundwater use within the southern basin

SEASON & CLIMATE SCENARIO		MIL	BIDGEE	GMID	TOTAL EXCL SHALLOW SYSTEMS
2015/16	Dry	84	267	119 (80shallow)	470
2016/17	Wet	35	150	74 (56shallow)	259
2017/18	Average	78	327	69 (78shallow)	474
2018/19	Very Dry	109	377	91 (93shallow)	577
2019/20	Drought	86	323	Est 120 (100 shallow)	529

The groundwater use in the shallow systems in the MIL and GMID are mostly recycling of local surface accessions.

There is about another 50GL of annual use of groundwater for irrigation scattered throughout the upper reaches of the Victorian Goulburn/Murray/Loddon rivers.

3.2 PRODUCTION BY MAIN INDUSTRIES

Table 3-10: Production by main enterprises over the last five years

SEASON	RICE (TONNES)	COTTON (BALES)	DAIRY GMID (ML MILK)	ALMOND (TONNES)	WINE GRAPE CRUSH (KT)
2015/16	244,184	100,000	1,728	82,333	1,075
2016/17	600,000	409,000	1,449	79,462	1,128
2017/18	625,000	63,500	1,667	76.000	1,075
2018/19	54,000	409,000	1,319	92,000	1,110
2019/20	40,000	100,000	1,279	97,000	1,081

Note: that the wine grape crush is for the three regions, SA Riverland, Murray-Darling to Swan Hill (Vic & NSW) and NSW Riverina.

The production by various industries shows that horticulture production is fairly stable despite the season, dairy has continued to decline and appears to have just reached its baseline, and cotton was increasing but due to recent drier conditions has declined, whereas rice fluctuates according to available water.

3.3 LAND/WATER USE WITHIN REGIONS

The data for land-use throughout the sMDB is very detailed across most of the region for three to four of the last five seasons. The data comes from a variety of sources and is reproduced below. There is also some catchment wide land-use data from the ABS though it is collected once every five years and 15/16 is the last detailed survey. The land use on the areas not covered by the detailed data can be estimated from deduction of ABS and extrapolation of the detailed information.

3.3.1 LOWER MURRAY/DARLING (NSW,VIC, SA)

The area of different horticulture crops and permanent plantings in this region is shown in Table 1-3 (Section 1.4.3). The land use data is some of the most complete in the sMDB. This area is predominantly planted to horticulture and thus it is reasonably easy to apportion the water used by different types of horticulture in the region based on land use area and the total recorded water use.

In general the water used in horticulture in this region totals up to 1,100GL with up to 400 in SA, 600GL in Vic Sunraysia and 100GL in NSW Lower Murray/Darling.

Over the last five years the water use has increased by a total of approx. 20 % (mostly due to almond crop growth), It is expected that any further increase will be very modest given that 19/20 season gave strong market signals on the impact of limited water under drought conditions.

3.3.2 MURRUMBIDGEE WATER USE BY ENTERPRISE

The water used by each enterprise is provided in the tables below for the large Murrumbidgee Valley irrigation districts: Murrumbidgee Irrigation (MI) and Coleambally Irrigation (CICL) . The water used outside of these districts (direct pumping from the river) or from groundwater is not provided below. Generally the two districts account for between a ½ and 2/3rds of the total water use (including groundwater) in the MIA. The ABS provides data for 15/16 year only for the whole area and is provided in the ABS grouped by NRM regions or SLA.

Table 3-11: Murrumbidgee Irrigation - Water use by main enterprises over the last five years

YEAR - ML	RICE	PASTURE	CEREAL AND OIL SEEDS	VEGETABLE	CITRUS, VINES, FRUITS	COTTON	UNKNOWN	TOTAL
15/16	158,720	12,649	136,158	8,625	141,144	112,535	71,488	641,328
16/17	304,200	26,030	57,479	10,129	109,257	82,004	71,376	660,475
17/18	220,423	37,952	123,439	10,940	134,716	174,778	76,864	779,112
18/19	37,171	12,753	88,968	10,518	130,716	113,443	71,460	465,029
19/20								

Table 3-12: Coleambally Irrigation - Water use(GL) by main enterprises over the last five years

YEAR - GL	RICE	WHEAT	COTTON	CORN	PASTURE	SOYABEAN	OTHER	TOTAL
2015/16	63	27	38	25	13	5	12	183
2016/17	173	15	58	44	13	6	14	323
2017/18	92	21	55	37	13	3	42	263
2018/19	3	14	41	25	9	-	11	104
2019/20	-	-	-	-	-	-	-	-

3.3.3 MURRAY IRRIGATION AREA

The water used by different main enterprises is shown in the table below. Murray Irrigation accounts for about 3/4qtrs of the total water (including 80GL of groundwater) used in the NSW Murray upstream of Sunraysia region. ABS data is available for 2015/16 census for the whole Murray Irrigation Area broken into the NRM areas and SLA's, but is not reproduced here.

Table 3-13: Murray Irrigation - Water use by main enterprises over the last five years

YEAR - ML	RICE	PASTURE	CEREAL AND OIL SEEDS	VEGETABLE	CITRUS, VINES, FRUITS	COTTON	UNKNOWN	TOTAL
15/16	158,729	12,649	136,158	8,625	141,144	112,535	71,488	641,328
16/17	304,200	26,030	57,479	10,129	109,257	82,004	71,376	660,475
17/18	220,423	37,952	123,439	10,940	134,716	174,778	76,864	779,112
18/19	37,171	12,753	88,968	10,518	130,716	113,443	71,460	465,029
19/20								

3.3.4 GMW IRRIGATION AREA

The water used by different main enterprises is shown below for the GMID for the five-year period analysed. This is based on industry production data, numbers of farms, calibration with ABS data 2015/16 and local knowledge. The GMID accounts for 90 % of the water used in the GMW irrigation area. ABS data is available for 2015/16 census for the whole area broken into the Broken Goulburn catchment and North central catchments.

Table 3-14: Water use in the GMID by sector (GL) (incl 70-120GL of groundwater)[10]

SECTOR	HISTORICAL		CURRENT	
	2000	DROUGHT	AVERAGE	DROUGHT
Mixed grazing	283	75	120	40
Crops	160	42	108	33
Dairy	1,468	615	838	327
Horticulture	90	100	110	119
Total	2,000	832	1,175	510

The horticulture land use area was extensively surveyed in 2017 and has currently been repeated but the information is not yet available.

[10] RMCG (JAN 2020), *The New Face of Regional Northern Victoria GMID water update – in response to the Basin Plan, drought, climate change and water trade,* Prepared for Greater Shepparton City Council.

Table 3-15: Horticulture Irrigated land cover/usage in the GMID[11]

USAGE	COVER
Stone fruit	4,309ha
Pome fruit	3,841ha
Other permanent orchard (berries nuts, kiwi fruit)	3,447ha
Grapevines	2,380ha
Tomatoes	2,239ha
Other vegetables	742'ha
Citrus	226ha
Total horticulture	17,184ha

Assuming an average application of 6.5ML/ha gives 111,000ML/annum in 2017.

3.4 WATER PRICES

3.4.1 HOW TEMPORARY PRICES VARY MONTHLY

The market also varies throughout the season depending upon the perception of the likely allocations. This is shown below in the figure below for the last five years.

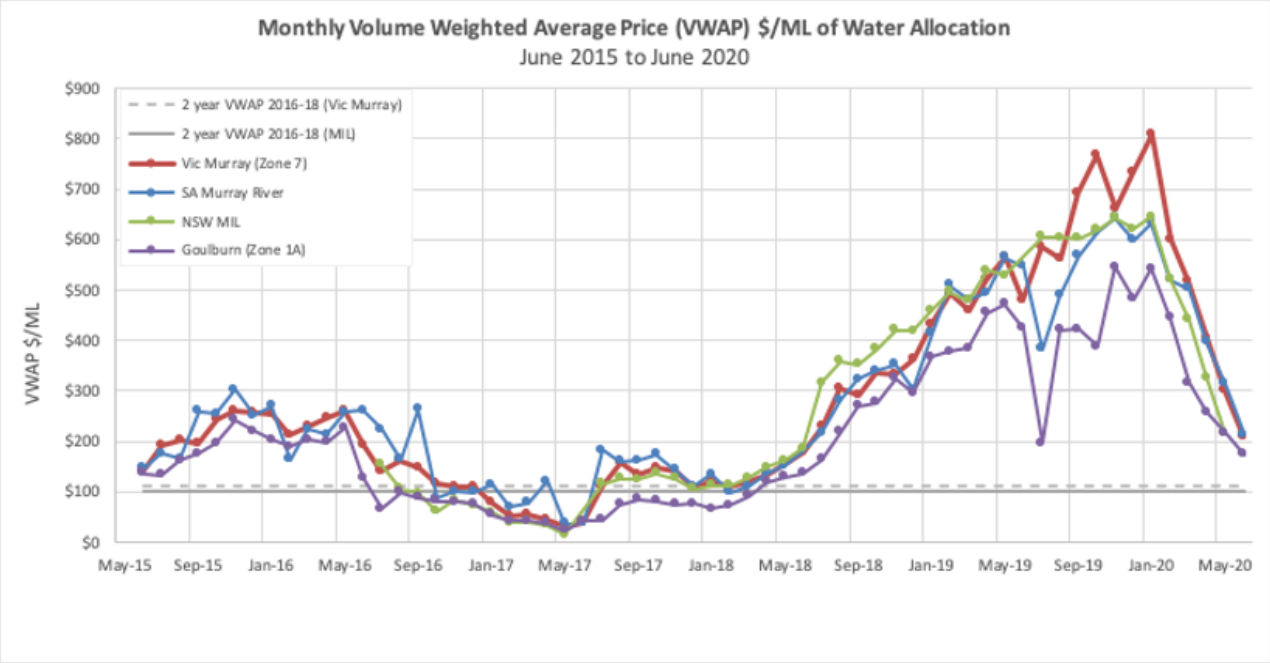

Figure 3-2: Reported allocation traded/transferred (Murray River, excluding NSW State registry) May 2105 to May 2020[12] (excludes $0 trades)

3.4.2 ENTITLEMENT PRICES

The entitlements prices over the last five years are shown below for HS and lower security products.

[11] Goulburn Broken CMA (2017), *Regional Irrigated Land and Water Use Mapping in the Goulburn Murray Irrigation District*, Technical Report.

[12] Victorian Water Register: http://waterregister.vic.gov.au, NSW Murray Irrigation Limited: http://www.murrayirrigation.com.au/water/water-trade/, and South Australia WaterConnect: https://www.waterconnect.sa.gov.au/Systems/WTR/Pages/Default.aspx.

All of the high security products have increased significantly over the last five years, some doubling and some trebling in price. In contrast the general security products have increased by around 50 % in the last five years.

The Victorian low security products (LRWS) have doubled in value in the case of the Murray system but remained static for the Goulburn system, probably reflecting the value placed on carryover for horticulturists in the lower Murray, and the problems of transferring water from the Goulburn in some seasons.

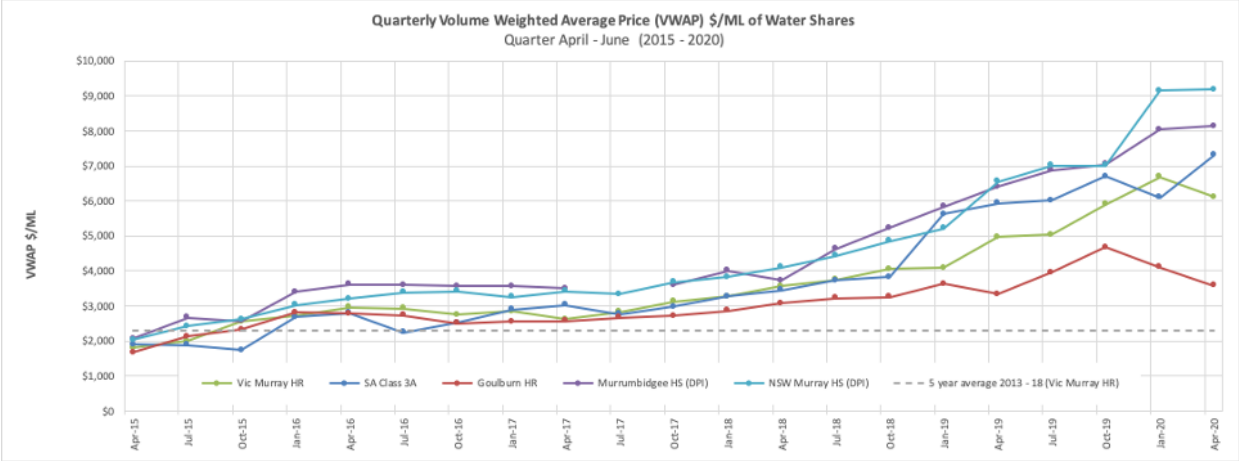

Figure 3-3: Values for high security water products

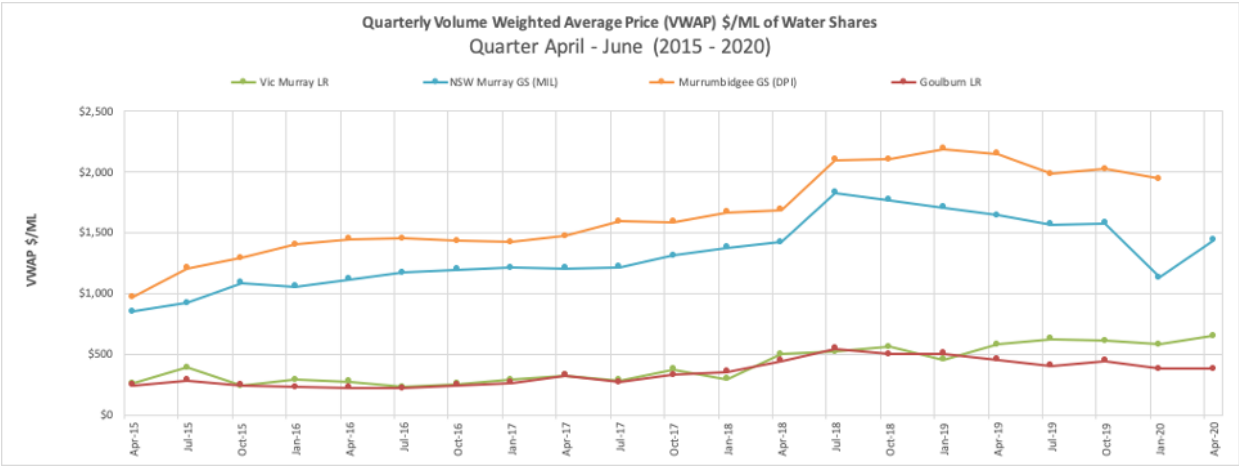

Figure 3-4: Values for low security products

However it is noted earlier (refer to Figure 1-6) that the entitlement prices reflect the general seasonal trends i.e. in drier times they increase but in wetter periods they decline.

3.4.3 COMPARING ALLOCATION PRICES WITH ENTITLEMENT PRICES

RMCG has also compared the value of entitlements to annual yield (or allocation) and the average annual temporary market price paid, by using weighted probabilities of annual income dividends (i.e. allocation prices times allocation) and found that the temporary value reflects about an annual 3-4 % return on the entitlement price (regardless of which of the multiple mainstream Southern MDB entitlement or water-share products are purchased). This is illustrated in the following table.

Table 3-16: Income per ML of entitlement owned – NSW General Security

	GENERAL SECURITY	HIGH SECURITY
The average "income dividend" over the last five years	$53/ML	$278/ML
Today's entitlement value Return on entitlement	$1500/ML 3.5 %	$9,000/ML 3.0 %
Entitlement value five years ago Return on entitlement	$800/ML 6.6 %	$2,500/ML 10.9 %
Capital gain last five years	10 %/year	70 % per annum
Fixed charges applied per ML	$18/ML	$5-20/ML

The relationship between entitlement prices and allocation prices (expressed as rolling five year income dividends as % of entitlement value) is shown over time in the following figures for Victorian High Security products. It is noted that the dividend return from entitlements has declined in recent years and this is consistent with interest declines over the same period.

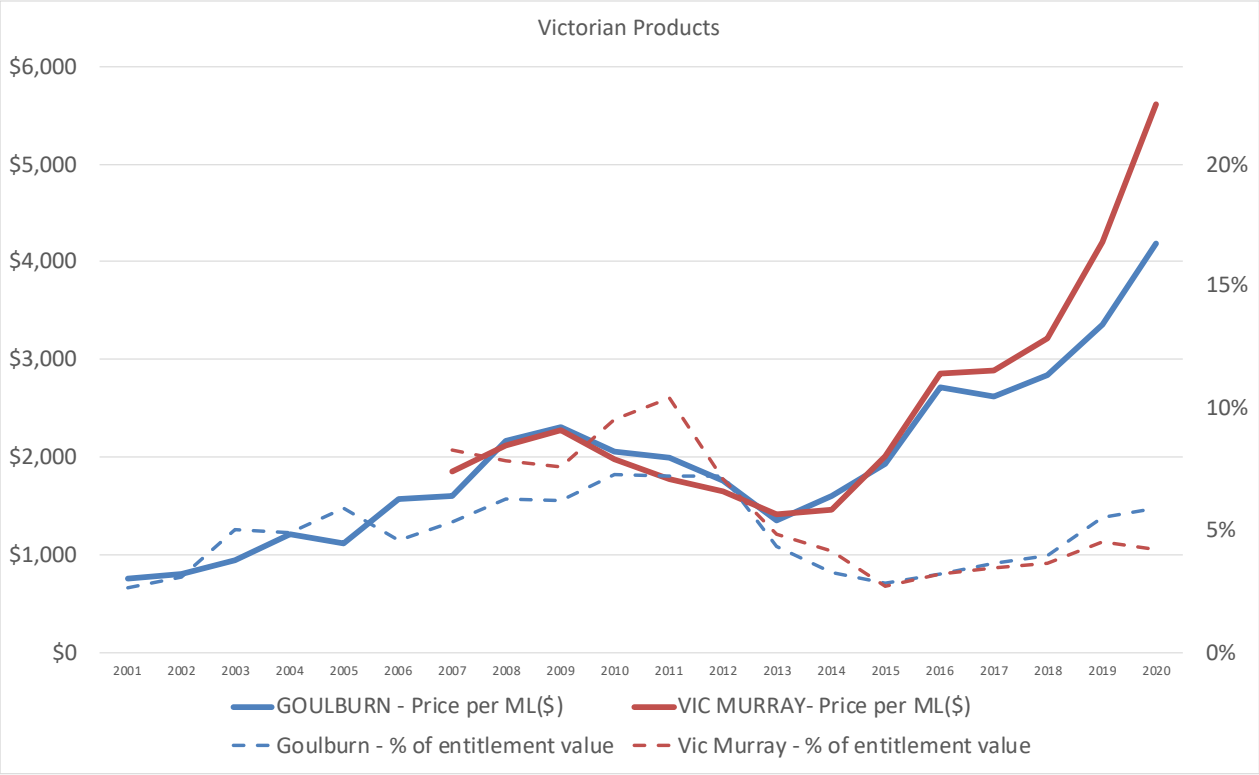

Figure 3-5: Income dividends % versus entitlement prices $ for Victorian High security

The same relationship is shown below for Murray General Security entitlements and there appears to be an anomaly in 2010 where entitlement prices appear to have escalated due to Basin Plan water recovery.

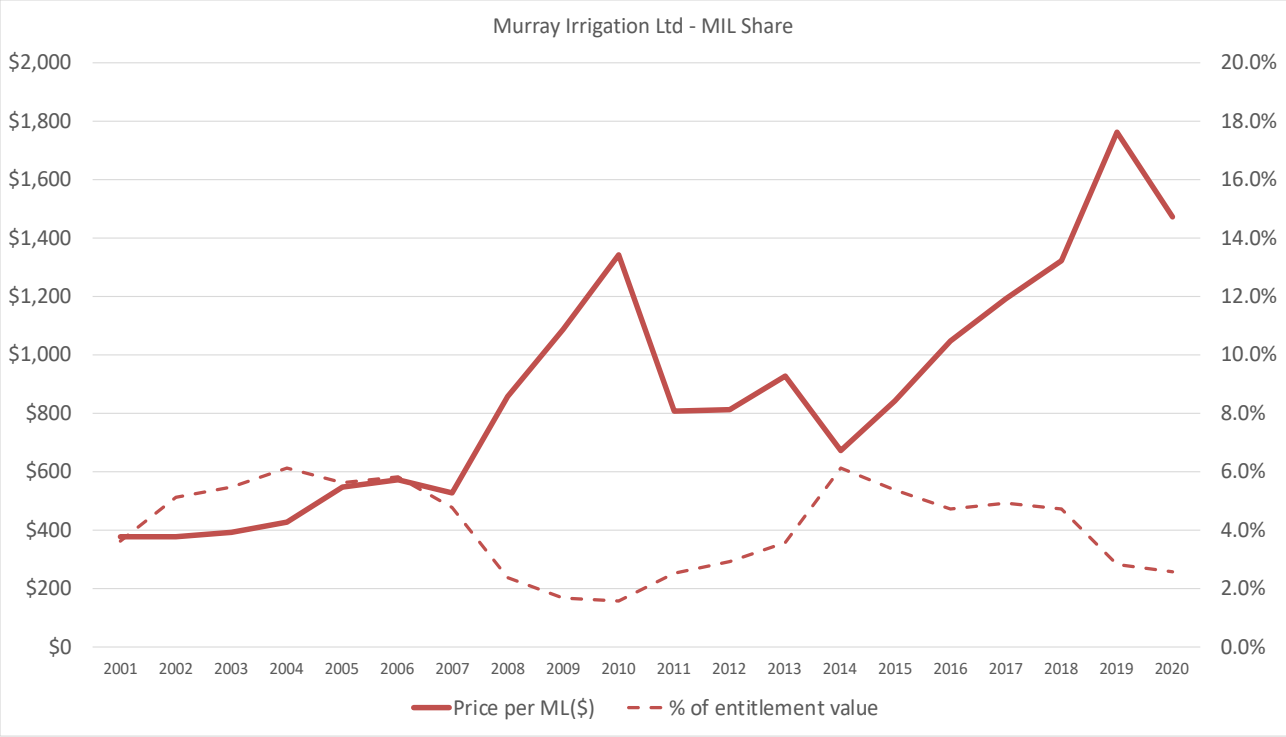

Figure 3-6: Income dividends % versus entitlement prices $ for NSW Murray General security

RMCG suggest that the relationship between entitlement value and allocation prices is within commercial return on capital expectations. The sustained increase in entitlement value reflects the increased income dividends over the last five years, the steady fall in commercial interest rates for finance, and a perception that there is likely to be less water allocated to the lower security entitlement products in future.

No-one knows what the future will provide in terms of seasonal scenarios (i.e. wet, average, dry, drought). However, it appears that when entering a wetter period (lower allocation prices) the income dividend from owning entitlements reduces and thus the value of the entitlements also appears to reduce.

3.5 ALLOCATIONS AND YIELD

It is interesting to look back at allocations over the past five years, ten years and 20 years to see how things have moved and changed over that time. The allocation trends are illustrated in Table 3-18.

Table 3-17: Allocation trends over the past 20 years

ENTITLEMENT		ALLOCATION % & TIMELINE				MARKET PRICE
		LAST FIVE YEARS	LAST TEN YEARS	LAST 20 YEARS	THEORETICAL LTDLE[13] LAST 120 YEARS	$ / ENTITLEMENT
High security	SA	100 %	96.7 %	86.4 %	88.2 %	7,500
	NSW Murrumbidgee	96.0 %	97.0 %	96.25 %	97.7 %	8,000
	NSW Murray	97.6 %	98.5 %	94.5 %	87.3 %	9,000
	Vic Murray	93 %	96.6 %	91.9 %	97.4 %	6,000
	Vic Goulburn	94.0 %	97.0	85.8 %	96.7 %	4,000
General Security	NSW Murrumbidgee	37 % (+5 % dividend)	62 %	52 %	59 %	2,000
	NSW Murray	35 % (+5 % MIL divid.)	64 %	53 %	69.9 %	1,500
Low security	Vic Murray	1 %	0.5 %	13.9	54.3 %	600
	Vic Goulburn	0 %	0 %	0 %	58.3 %	400

The above table highlights some inconsistencies with actual allocations and the theoretical yield developed by State Authorities, and endorsed by the MDBA. For example:

- The variance in the Murray High Security products between states where Victoria is supposedly the most secure at 97.4 % compared with NSW Murray and SA at 88 %. In practice this last season Victoria's allocation was only 66 % compared with a full allocation (or 97 %) for NSW and 100 % for SA
- The yield of the Victorian low security product is nowhere near the 54 % - 58 % of the theoretical yield.

It would appear that the market prices being paid more closely resembles the recent historical performance.

[13] Long Term Diversion Limit Equivalent Factors for entitlements.

4 Season 20/21

4.1 A GOOD START

The main irrigation storages are now into the fill phase and time will tell how well they recover before the next irrigation season. However, there has been a good start and rainfall outlooks are positive. Autumn rainfall across the Murray Darling Basin has been excellent and the catchments are wet.

The level of Autumn rain is generally a key indicator for the likelihood of for next season's inflows.

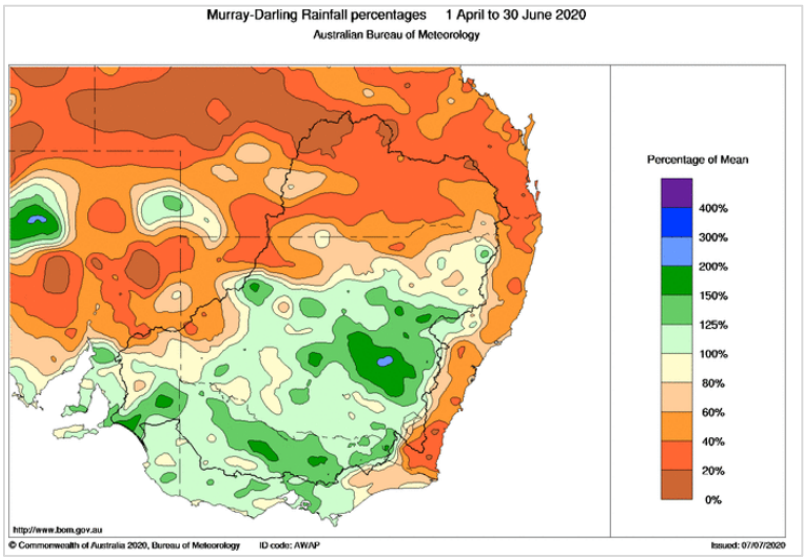

Figure 4-1: Bureau of Meteorology rainfall – April to June 2020

Catchments are responsive and inflows have improved and have recently moved above the long-term average inflows.

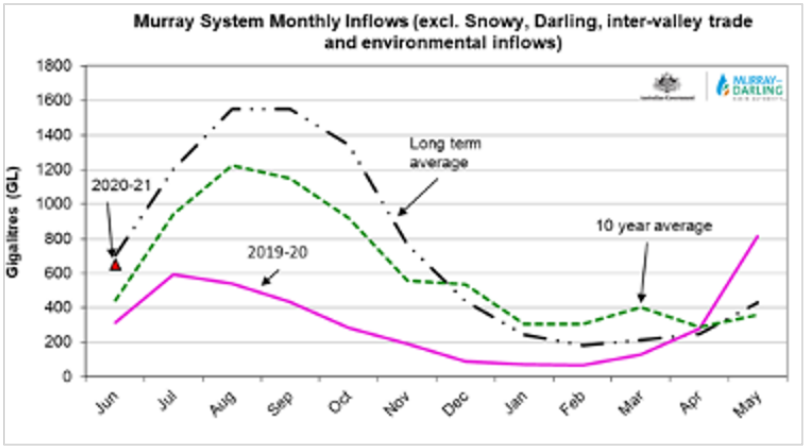

Figure 4-2: Murray System Inflows

While there has been a good start it does not guarantee it will continue this way. The most important months are July through to October and monitoring inflows during this period will provide some insight into likely water allocations for 2020/21.

Long range weather forecasts are indicating slightly wetter to neutral rainfall outlooks for winter and spring, which is positive.

4.2 SEASONAL FORECASTS – WHAT THEY MIGHT MEAN FOR ALLOCATIONS AND PRICE

The water authorities released seasonal outlooks for all of the major river systems in May. The outlooks are summarised in Table 4-1 below.

Table 4-1: Seasonal Outlooks for season 2020/21 and final (as of 15th July 2020)

ENTITLEMENT	WET: 1 IN 10	AVERAGE	DRY: 1 IN 10
NSW Murray High	97 %	97 %	97 %
NSW Murray General	Not published	30 %	7 %
NSW Murrumbidgee High	95 %	95 %	95 %
NSW Murrumbidgee General	Not published	45 %	22 %
Victorian Murray High	100 %	100 %	48 %
Victorian Goulburn High	100 %	100 %	68 %

The above table seasonal scenarios are defined as:

- Wet – inflow volumes to major storages that are greater in ten years out of 100
- Average – Inflow volumes to major storages that are greater 50 years out of 100
- Dry – Inflow volumes to major storages that are greater in 90 years out of 100.

So, what do the scenarios mean in terms of the water available and indicative water allocation prices?

The different scenarios are plotted on RMCG's price curve to provide an indication of likely price ranges.

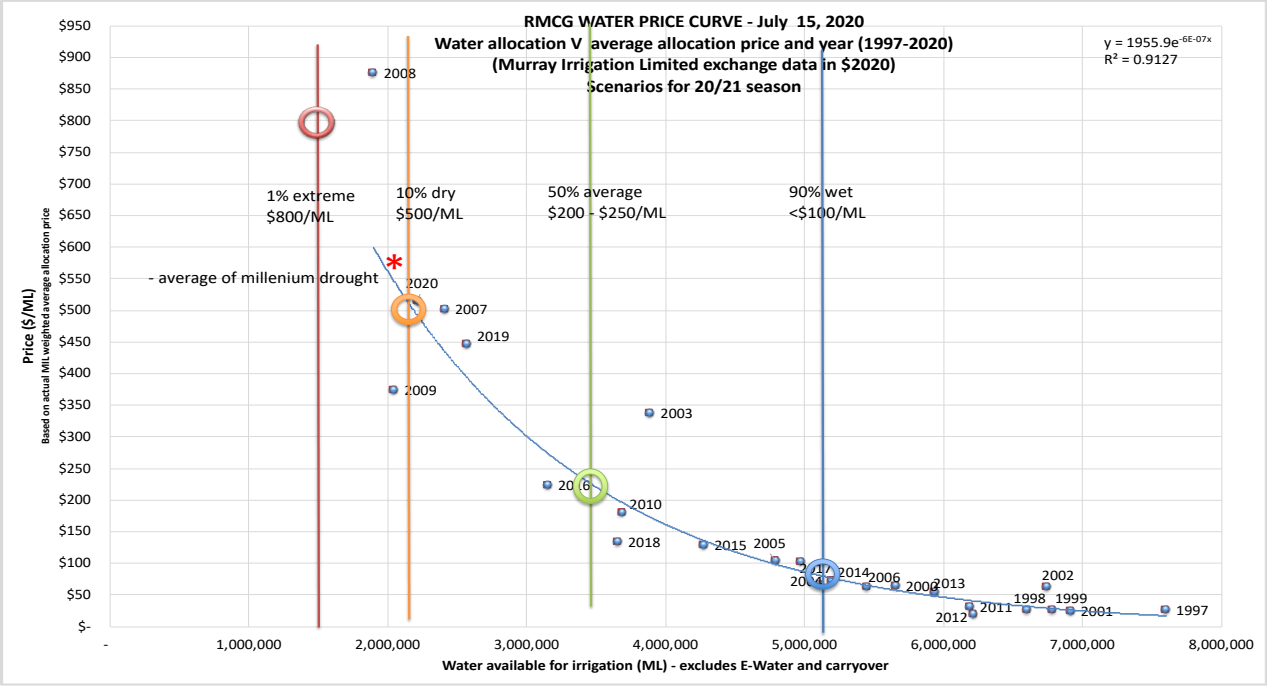

Figure 4-3: Indicative water allocation prices based on seasonal scenarios for season 2020/21

Based on the outlooks from now on provided on 15 July based on the historical price curve we would get:

- Extreme dry scenario – price approx. $800/ML
- Dry scenario – price approx $500
- Average scenario – price range $200 to $250
- Wet scenario – price range <$100.

5 Future trends

There are a number of trends that are considered likely to occur and these are discussed in the following.

5.1 IF THE MILLENIUM DROUGHT WAS REPEATED

5.1.1 REPEAT OF THE MILLENNIUM DROUGHT IN THE CONNECTED MURRAY SYSTEM

The connected Murray system has almost reached an equilibrium with little further horticulture development being anticipated. A repeat of the millennium drought would result in 620GL less water being allocated, compared to the 19/20 season. In practice, this would result in a 720GL deficit compared to the 19/20 season because of the small estimated increase in horticulture water demand. This reduction could be accommodated in a drought scenario by a combination of:

- not increasing carryover (160GL),
- “mining” 1/3rd carryover/year (300GL),
- a slight reduction in horticulture demand (100GL - opportunity for rationalisation/ drying off in preparation for replanting those perennial plantings (trees/vines) that are reaching the end of their economic life would be taken as per millennium drought),
- further reduction (160GL) in dairying/mixed farm water use in GMID and MIL,
- any contribution of net trade to the Murray (as per the last drought) from Murrumbidgee would be a bonus and further ensure that horticulture demand would be met.

It is considered that a one-year repeat of any of the millennium drought years could be managed without overly impacting horticulture in the connected Murray system. However, it is considered that if there were three years of this drought scenario, as happened in the millennium drought (2007/8, 2008/9, 2009/10), there probably would be a considerable “shake out” in the dairy industry again but there would also be a “shake out” in the horticulture industry.

5.1.2 EQUILIBRIUM YET TO BE REACHED IN MURRUMBIDGEE

Allocations in the Murrumbidgee in 2019/20 was similar to the worst year of the millennium drought (2006/07) and we saw:

- Some water still used for cotton, with 15,000 to 20,000 bales, and an estimated water use of 200 GL
- Horticulture is still developing, and this indicates that it could increase substantially over the next five to ten years by up to 50 % - mainly at the expense of the cotton industry
- Significant use of groundwater (324GL) which underpinned supply
- Therefore it is concluded that a repeat of the millennium drought would be little different to 20019/20 for the Murrumbidgee area except that:
  - there would be more pressure on ‘Bidgee to trade south to the connected system
  - the water price would increase because capacity restrictions may not apply, and allocation prices paid in the connected Murray are likely to be $200/ML or more higher.

5.2 WATER PRICING

5.2.1 ALLOCATION PRICES

The supply demand curve (refer fig 4.3) has remained very similar over the last 25 years (CPI adjusted) where the price of allocation water in any one year is related to the volume of water allocated in that same year.

There have been numerous changes that could affect the relationship of allocation prices such as:

- Volatile market prices for different enterprises, and the capacity of some irrigators within industries to drive greater returns from each ML
- Different production levels and different demands for water
- Changes in water availability (drought-frequency, ongoing basin plan water recovery)
- Ongoing changes in water efficiency in particular industries
- Technological changes e.g. cotton genetics, adoption of maize fodder system in dairy etc.

Despite these changes, the supply price curve has not materially changed. Looking to the future there is no essential reason that the relationship will hold but based on its resilience to-date there is no apparent reason either for it to change.

5.2.2 ENTITLEMENT PRICES

There has been enormous variation in the pricing of entitlements over the last 25 years, although the general trend has been:

- Constantly increasing – reflecting the reduced supply of water, lower interest rates for finance
- Reaching peaks during droughts and decreasing during extended wetter periods.

The entitlement prices are unlikely to continue to rise at the same rapid rate assuming:

- There will be no further reduction in available water
- Commercial banking finance rates for water purchases cannot fall any further
- The supply price curve doesn't change.

5.3 FARM WATER USE EFFICIENCIES ARE ALWAYS IMPROVING

Water-use efficiencies within delivery systems, and on-farm have been continually improving for the last 100 years or so of irrigation. RMCG's analysis of different industries production versus water-use would suggest that:

- The rice industry for example has gone from 0.3t/ML applied to almost 1.0t/ML applied over the last 50 years. It is already possible to achieve up to 1.2t/ML with the 2019 crop-award won by a MIA Reiziq crop of 14.0t/ha using less than 12ML/ha. This increase in yield has come about through a combination of factors including the less efficient growers leaving the industry, better varieties, improved irrigation technology (laser grading) and, most importantly, better site selection for soil types to grow a ponded crop such as rice
- Similarly, the dairy industry has increased its production from 1,500litres of milk per ML of irrigation water applied to 2,000l/ML during the last 35 years. It is possible to achieve up to 4,000l/ML if different farming systems (such as barns and maize feeding) are utilised. The change has come about in similar ways to rice but also includes the introduction of more purchased grain feeding to supplement irrigated crops, meaning less irrigation water is required
- Other industries including horticulture have made similar changes to improve water use efficiency over the long-term, although this has often been driven by factors related to better crop and better fruit production, rather than simply introducing new technologies and practices to save water.

These technological and system improvements have been and will continue to remain key ways (along with the constant challenge of labour efficiency improvements) of enabling irrigated agriculture to remain viable.

5.4 THE KEY AGRICULTURAL CHALLENGES

Different challenges face the different agricultural commodities within the basin as summarised below:

Horticulture:

- Aiming for maximum areas permitted by limits of almost all-season secure water (knowing that limit and avoiding industry restructure following or during a future drought sequence.)
- How to encourage the appropriate development in MIA, MIL, GMID but no more growth in Riverland/ Sunraysia due to declining Murray peak supply capacity and limits to annual water availability being reached.

Fruit Processing:

- Viability of the next generation of processed fruit following the demise of the canning sector in Goulburn Valley with high water prices.

Dairy Production:

- Aiming for more milk litres per ML
- Universal conversion to cut and carry fodder systems is not yet a certain outcome with a question mark on barns
- The Cohuna dairy farming region is under considerable water trade pressure from horticulture expansion downstream. Because of the Barmah choke and Goulburn weir trade limits, this area is a preferred area for downstream horticulture to access water.

Dairy Processing:

- Lower production levels needs less stainless steel and risk of rationalisation of milk factories.

Rice Industry:

- Can farmers maintain the highly efficient rice farming systems, and survive and manage increased water variability in areas planted?
- Can Sunrice manage to support its capital-intensive brands and skilled labour force economically in the face of highly variable Australian production?

Water Trade:

- Will this continue downstream and can we be sure IVT recognises environmental impacts and real delivery constraints.

Water Delivery Costs:

- Can the recent surge in system modernisation be funded in a sustainable ongoing manner in the face of lower water availability, large areas being dried-off, and investment outside traditional irrigation areas?

5.5 BASIN CHALLENGES

Some of the key basin challenges are summarised below:

450 GL Upwater:

- Would see an further ~18 % decline in rice and dairy industries
- 8 % decline in horticulture.

Sustainable diversion limit adjustment mechanism:

- What are the implications if the offset projects are not completed successfully? Will the threat of further water recovery through buy back materialise?

Socio-economic study report:

- Has the study and research picked up the impacts within the MIL area of operations and the GMID properly?

Keelty report:

- Acknowledges the issue of 375 - 600 GL annual year-on-year underuse - irrigators not getting their share. How is this acted-upon?

Lower Lakes report:

- Ongoing issue, is there a long term solution, or is more water going to be recovered?

Deliverability:

- Horticulture has reached a limit based on drought-year availability in the combined SA/VIC and NSW Lower Murray
- Downstream of the choke, annual and even peak irrigation use is largely unchanged (increased use in lower Murray offset by reduced used in Torrumbarry)
- But GMID and MIL water transferred to the environment is now being used downstream and managing the choke and Goulburn flows is an ongoing challenge
- The Choke capacity continues to decrease and may be now as low as 8,500ML/day
- Can river operators improve delivery efficiency the same way irrigation canal operators in the big scheme areas have?

Ongoing Inquiries:

- Creating even more uncertainty
- Every New Minister has a new idea on the solutions!

5.6 CLIMATE CHANGE

The Victorian Climate Projections 2019[14] indicate that, when compared to the 1986-2005 sequence, by the 2050s, the climate of Mildura could be more like the current climate of Menindee, NSW, and Swan Hill more like Balranald, NSW and the climate of Shepparton could be more like the current climate of Griffith, NSW.

The rainfall decline has serious consequences. Winter rainfall generates storage inflows for irrigation and could fall by around 20 %. This would mean that stream flow and water availability (irrigation allocations) will be reduced by an even higher percentage, perhaps by 50 %[15].

Converting these predictions into possible scenarios around the current equilibrium is almost impossible as in 30 years time there will be considerable policy changes and agricultural industry changes that will evolve the outcomes to something quite different to what is happening now. If we reflect back 30 years ago i.e. pre Basin cap, the changes since then have been enormous and the changes in the next 30 years could be equally significant.

[14] Clarke JM, Grose M. et al., (2019 updated Feb 2020) http://www.climatechange.vic.gov.au/adapting-to-climate-change-impacts/victorian-climate-projections-2019.

[15] Water for Victoria – Water Plan, DELWP 2016 projected 10-20 % reductions in streamflow from current levels in the Goulburn catchment by 2065 under medium climate change.

However, what can be indicated is that in the foreseeable future the possible scenarios will be a mix of the last five seasons plus the possibility of a wet summer and an extreme drought. It is likely that there could be more of the drier year scenarios than the wet ones in the future.

What is becoming evident is that it is the “variable water” or the allocations attached to the “General Security” entitlements that will decline first in the event of climate change.

Because of reduced inflows there will effectively be more storage relative to inflows in future. This will mean that there is more capacity to “carryover” water and make the supply more reliable year in year out. This will advantage and support the higher value industries like horticulture and will mean less water for annual crops like rice.

In making these suggestions it is important to recognise that any impact from climate change will still interact with long term wetting and drying patterns as is shown in the Hume dam graph below. This graph stops at 15/16 and if it was updated then the graph would drop much further showing a continuation of the drying phase.

Currently it would appear that the Hume catchment is a drying phase but whether it will stay that way is unknown.

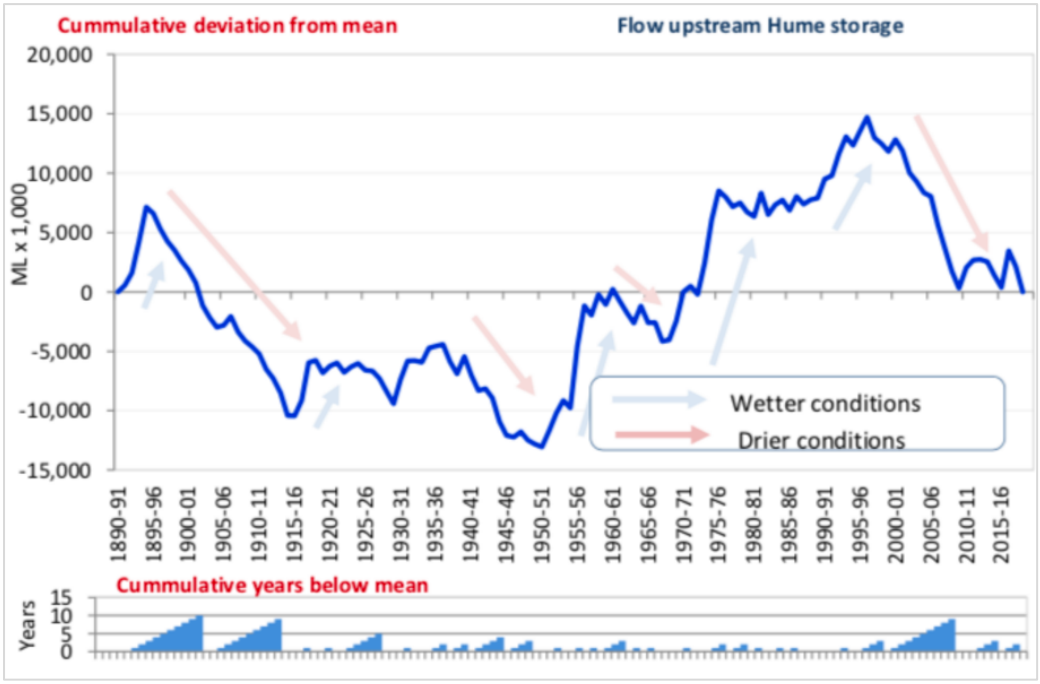

Figure 5-1: Long-term annual flow upstream of Hume Dam and cumulative deviation from mean

This report has been prepared by:

RM Consulting Group Pty Ltd trading as RMCG

Level 1 East, 1100-1102 Toorak Road, Camberwell Victoria 3124

(03) 9882 2670 — rmcg.com.au — ABN 73 613 135 247

Offices in Victoria, Tasmania, ACT and NSW

Key RMCG contact

Rob Rendell

0428 510 642 — robr@rmcg.com.au

Document review and authorisation

Project Number: #0695

Doc Version	Final/Draft	Date	Author	Project Director review	BST QA review	Release approved by	Issued to
1.0	Draft	13/07/2020	R. Rendell G. Warne C. Thompson D. Poole	R. Rendell	-	R. Rendell	G. Warne
2.0	Draft	27/07/2020	J. Belz – format into new document only	-	-	-	R. Rendell
3.0	Final	03/08/2020	R. Rendell G. Warne C. Thompson D. Poole	R. Rendell	J. Belz	R. Rendell	General public