The Murray Darling Basin Plan

The Lower Murray River and Coorong Lower Lakes Murray Mouth Dilemma – We need more than a freshwater solution that can't be delivered

Background to Plan

The Murray-Darling Basin Plan was developed to improve the health of rivers and floodplains by acquiring water for the environment, at an estimated cost of $13 billion to the Australian taxpayer. The Basin Plan was signed into law in November 2012 under the Commonwealth Water Act 2007. The Basin Plan sets limits on how much water can be taken from the Basin for irrigation, drinking water, industry or for other purposes in the future. These limits are called Sustainable Diversion Limits or SDLs. The SDLs came into effect in 2019.

Water for the environment

The Basin States and the Federal Government agreed that 2,750 gigalitres (GL) of water from across the Basin will be recovered and returned to the environment. Another 450 GL (sometimes called 'upwater') can be recovered above 2,750 GL to enhance environmental outcomes, provided further water recovery results in neutral or positive socio-economic impacts. A project's potential impacts are assessed by the State where the project is located.

Water recovered from consumptive use is used for environmental flows to try to improve the health of the Basin's rivers, wetlands, floodplains, plant and animal habitats.

The lower Murray history, present day and possible future

When discussing the 'end of system' it is important to note that from a geographical sense, 'The Coorong, and the Lower Lakes (Lake Alexandrina and Lake Albert) in South Australia are ***major interconnected coastal water bodies*** between the Murray River and the Southern Ocean.' **(AusGeo a**)

River Murray Channel

The Lower Murray river channel in this context begins downstream of Lock 11 close to the town of Mildura, and is now a highly modified environment (Figure 1). The river channel and the Lower Lakes have undergone considerable development over the last 100 years with the installation of 11 lock systems turning a once highly variable flowing river system into a series of weir pools which experience very little height variation for most of the year (**Mallen-Cooper and Zampatti 2018**). The series of locks were originally established for navigation for steamboats, but are now maintained to provide drinking, irrigation, and recreational opportunities. Although there are many social benefits of maintaining weir pools, the ecology of the system is highly degraded due to a flowing environment being turned into a pooled environment. For example, fishing for Murray Cod in South Australia is now catch-and-release only as the iconic species can no longer breed in the series of lock weir pools as it requires river type environments to successfully spawn. In addition, the weir pool environment and the freshwater Lower Lakes provides the perfect conditions for carp, and it is estimated there are millions of carp in this section (**Koehn et al 2016**). Fringing wetlands to the main channel have also been drowned out and no longer function as wetlands due to their wetting and drying phases being removed.

Lower Lakes

The Lower Murray River enters the Lower Lakes which are situated at the end of the Murray River in South Australia. The Coorong then extends between the lakes and the Southern Ocean (Figure 1). As Adelaide's population increased in the early 1900's and flows from upstream decreased as irrigation in upstream reaches increased, they were faced with needing to secure a more reliable freshwater supply, given the city is located in the driest state in the most arid inhabited country on the planet (**SA Water**). Construction of the barrages began in 1935 and these were completed in 1940, preventing sea water from entering Lake Alexandrina to keep the Lower Lakes as a completely freshwater system. Prior to the construction of the barrages tidal influences periodically pushed seawater back up the Murray as far as 250km upstream during low flow periods (**MDBAa**).

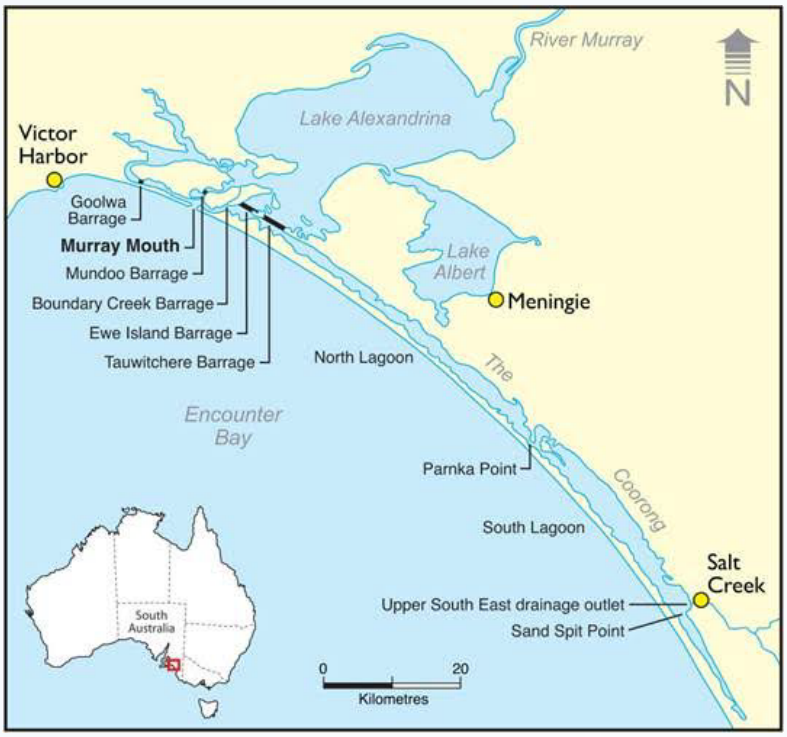
Figure 1 – Murray River Lock, Weirs, Dams and Barrages. The Lower Murray begins just downstream of the town of Mildura (**Source: About the Murray**)

The construction of the barrages blocking tidal influence on the Lower Lakes resulted in sediment build up outside of the barrages, and a complete loss of the estuary environment that existed before the barrages. In addition, the system is now maintained at a relatively stable water level. Both loss of flows from upstream, the exclusion of the southern ocean and the constant water levels have now resulted in a significant change in the flora and fauna of the Lower Lakes system. Fish that used to enter the lower lakes from the sea such as Mulloway and Black Bream to breed are now blocked from doing so, and populations have crashed. Fish passage has been supplied at a few barrages, but the natural ecological cues and the salinity difference between a totally marine environment and freshwater environment discourage fish to move through the fishways (**Baumgartner et al 2012**). The lower lakes are now completely freshwater and maintained at a stable water level and are now home to an estimated million carp, which are able to swim upstream for many 100s of kms and spawn in wetlands as high as the Barmah/Millewa forest.

Coorong and Murray Mouth

The Coorong is a shallow stretch of water, stretching approximately 140km along the south east coast of South Australia. It comprises a north and south lagoon and varies in width between 2 – 3 km's. The Coorong is 'separated from the Southern Ocean by a narrow sand dune peninsula' (**DWAE.**) Freshwater historically entered the southern Coorong (South Lagoon), before a series of extensive drains were built to divert surface water directly out to sea (**MDBA b**).

The unique landforms of the South East region of South Australia have a long, complex geological history, including volcanic activity in the Lower South East. One of the unique characteristics of the region is the slight gradient declining east to west and south to north, caused by volcanic activity. The high rainfall of the region, mostly from May to October results in inundation of the plains over winter, 'the region also hosts an extensive network of limestone sinkholes and caves' (**Govt. SAa**). The natural gradient indicates historically water from these inundation periods fed into the South Lagoon.



Map 1 – The Coorong stretches to the south east from the Lower Lakes

Construction of an extensive network of drains in the South East of South Australia first began in the 1800's. Large pastoral properties were established in the upper and lower South East in the 1840's, and as the population grew so did the need for infrastructure such as roads and increased diversity of agricultural use. Public pressure from residents in the lower South East led to a complete inspection of the South East region in 1863 by 'W Hanson (Engineer-In-Chief and architect), W Milne (Commissioner of Public Works) and George Goyder (Surveyor General). This was a significant trip, as it set the vision for the region. Hanson's primary interest was in draining wetlands to improve access across them during the wet months. Goyder, however, had a wider vision and recognised the interests of the South East community.'
He stated:
The subject is of great importance to the residents in the South-East, and to the colony at large – as a successful prosecution of the work would not only double the area at present available to the stockholder, and place at the disposal of the Crown a large extent of rich agricultural land, but it will also materially aid the general traffic of the country, and enable good roads to be formed at much less cost than must necessarily be expended if the country continues to be liable to inundations from inefficient means to carry off the ordinary winter's rain (**GOVT. SA b**).

Construction of the Millicent Drainage System began in 1864, redirecting surface water which inundated the lower South East regions during winter out to sea, water which once naturally found its way either over land or through the unconfined aquifer to the south of the Coorong. This is further supported in (**Aus Geo**).

The construction of drainage in the lower South East continued until 1972, resulting in 1875 km of drains and floodways. In the 1990's construction of the upper South East Drainage System began resulting in an additional 714km of drains and floodways. According to the South Australian Government website the Upper South East Drains were constructed to address 'a combination of persistent and prolonged flooding of low lying lands during rainfall events, and the presence of dryland salinity placed at risk the agricultural productivity of the region. This was as a result of a combination of factors including:

- Land development and vegetation clearance during the 1950s and 1960s.
- Loss of lucerne pastures – as a result of aphid attacks during the 1970s and an inability to replace lucerne with aphid resistant crop varieties.
- Surface flooding and saline groundwater – the regional hydrology is generally slow flowing with flooding of low lying areas, and loss of pasture from such an extensive area contributed significantly to the local recharge of groundwater.' (**Govt SA a**).

Although some work has begun to redivert water from the upper South East drains back into the Coorong, water entering the southern Coorong is extremely nutrient rich due to agricultural practices from where the water is collected.

RAMSAR Listing and what it means for management

In 1985 both the Lower Lakes and the Coorong were listed under the RAMSAR Convention, an international convention aimed at the designation of sites containing representative, rare or unique wetlands, or wetlands that are important for conserving biological diversity (Ramsar Convention 1996). As a contracting party to the Ramsar Convention, Australia is required to promote the conservation of the Ramsar wetlands, and to manage sites to maintain their ecological character. The Lower Lakes were categorized as fresh at the time of listing and is the main reason why the government insists that they need to be maintained in this freshwater state to meet the requirements under the RAMSAR convention. This is incorrect. In Finlayson et al 2020; they cite Davidson (2016) who notes, the Convention "...makes it very clear that the description can be adjusted as new information becomes available or if the site has changed as a consequence of management interventions or 'natural' change". In addition Finlayson et al 2020 notes "The Convention acknowledges that a country may re-establish an ecological character that existed prior to the date of designation and also for including natural variability and known past and current trends (**Ramsar Convention 1996, 2012a**)".

Therefore the insistence of governments and other groups that the Lower Lakes must be maintained in a freshwater state to meet the requirements under the RAMSAR Convention are simply incorrect and water level variation and trialling of brackish water conditions in the lake to improve the opportunities for wading birds would actually benefit the species the original RAMSAR designation was intended for.

More than just Freshwater Solutions to environmental challenges – Saving water through other restoration measures.

Freshwater will not solve the ecological challenges of the Lower Murray, and unless a multiple measures approach integrating local solutions is implemented, the health of the system will continue to degrade. A series of pragmatic approaches that could be trialled in collaboration with the affected third parties are described below. In combination with a realistic flow regime and appropriate land management, the health of the Lower Murray can be improved if a more that 'just add water' approach is taken.

Weir Pool Manipulation

Flow and river height variation is a key consideration when proposing to improve the ecological state of the Lower Murray River channel. It is well established in the middle Murray sections to lower weir pools in off-irrigation season, and to raise the gates on water control infrastructure to allow for bank drying and to allow weir pool areas to become flowing again. For example, Murray Crayfish are active in the winter and the flowing environment helps to remove sediments and facilitates breeding and feeding for crayfish.

Lower Lakes Barrage Estuary Trials

Allowing for seawater intrusion back through the barrages and into the Lower Lakes will help encourage fish such as Mulloway and Black Bream back into the system by improving both passage and ecological conditions for them to return. This will also disadvantage carp populations who currently proliferate due to the complete freshwater nature of the Lower Lakes.

Lower Lakes Water Level Manipulation

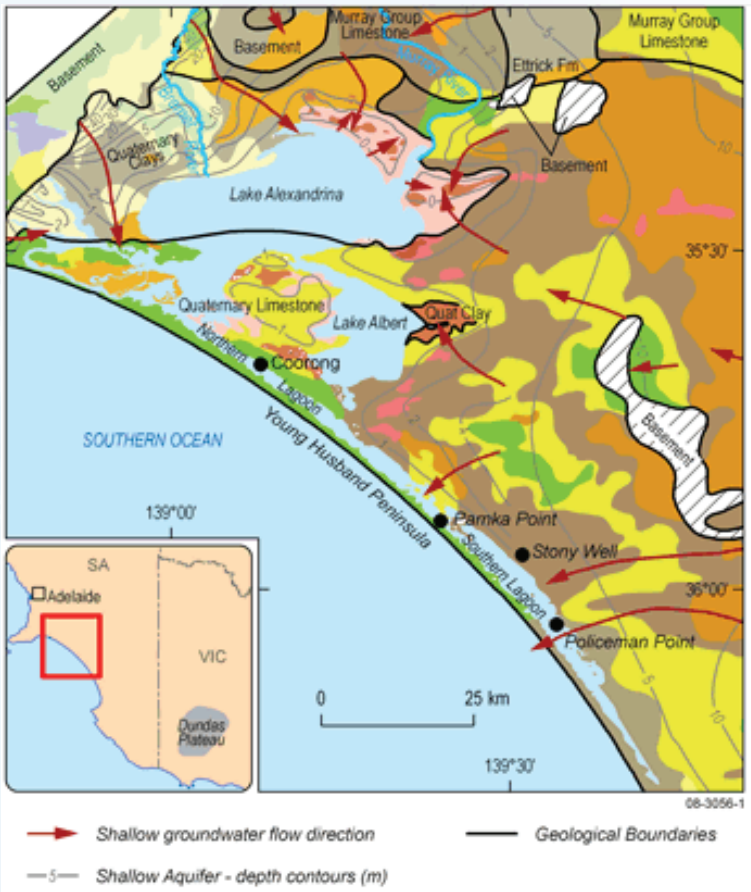
The Lower Lakes water levels would have naturally varied due to both water entering from the Murray and tidal surges from the Southern Ocean. This variation in water levels is needed to allow for biota that is adapted to differing water levels such as wading birds. Manipulating water levels in both the Lower Murray River channel and the Lower Lakes would provide valuable habitat for wading birds and improve the RAMSAR significance of the system as a whole.

The 2011 technical report 'Specifying an environmental water requirement for the Coorong and Lakes Alexandrina and Albert: A first iteration' published in June 2011 states -
'In addition to the flow related objectives, the flora and fauna of Lake Alexandrina require a variable flow regime. A recommended water level regime varied seasonally between 0.35 and 0.75 m AHD. Every three years, lake levels were recommended to remain higher to induce flooding of surrounding riparian zones, such that they varied seasonally between 0.5 and 0.83 m AHD.' (**Rebecca E. Lester 2011**)

Data from the MDBA Live River Data shows that Lake Albert has not dropped below 0.427m and Lake Alexandrina 0.405m since the MDB Plan was implemented. A more variable water level should be re-instated to the Lower Lakes to benefit wading birds. This may be facilitated through tidal process through the barrages which would also save considerable amounts of water, and allow for greater variation.

Coorong South Drainage Scheme and wetland rehabilitation
While some small projects to return flows to the southern Coorong from the Upper South East Drains are underway, in relevance to the potential volumes which once flowed into the southern Coorong they are quite small. Conclusions drawn from field observations and the discovery of carbonate deposits or 'tufa' (concentric carbonate cylindrical tubes) found eastern shore of the Coorong's South Lagoon during the Millennium Drought are indicative of the significant contribution groundwater discharge (**Aus Geo**) played in maintaining the health of the entire 'end of system'.

Figure 2 highlights the groundwater influence of the entire 'end of system



Salinity/Yield Matrix

Salinity (mg/L TDS) \ Bore yeild (L/s)	<0.5	0.5-5	5-50	>50
<500	1,1	1,2	1,3	1,4
500-1000	2,1	2,2	2,3	2,4
1000-1500	3,1	3,2	3,3	3,4
1500-3000	4,1	4,2	4,3	4,4
3000-7000	5,1	5,2	5,3	5,4
7000-14000	6,1	6,2	6,3	6,4
14000-35000	7,1	7,2	7,3	7,4
35000-100000	8,1	8,2	8,3	8,4
>100000	9,1	9,2	9,3	9,4

Investing in localised projects in both the Upper and Lower South East of South Australia, to return flows to the Southern Coorong will play a life saving role not only on the ecological health of the end of system, it will also provide social and economic benefits for the entire length of the Murray.

Addressing the concerns about the impacts on additives from agricultural and other industrial practices to the ground and surface water in the South East will need to be addressed. However, this can be achieved, as proven by communities in the Mid-Murray region who worked collaboratively with all levels of government to develop land and water management plans to address salinity and waste water issues.

Lock Zero

The construction of an additional lock (Lock Zero) at Blanchetown, 245km upstream of the Murray Mouth between Wellington and Tailem Bend, has the potential to provide a much more cost effective way for managing water security during drought periods in South Australia. This can be done by modernising the barrages, which are still hand operated, the removal (or part removal) of an unwanted island (Bird Island) which grew from being a sandbar and is blocking approx. 70% of direct out-flow from Mundoo channel, towards the river mouth. Removing Bird Island will be critical to ensure high volume tidal out-flows from Lake Alexandrina to keep the Murray Mouth scour.

Managing the lower lakes system to return the system to an effective marine/fresh estuary, retains the social and tourist benefits of the areas surrounding the lakes, and achieves the desired outcome of keeping the Murray mouth open. It can be achieved with some new infrastructure that can be funded with remaining Basin Plan funds, and with 40% less water from upstream than is mandated in the MDB Plan. For a full overview of the potential of Loch Zero please read 'A Better Way' by SA Ken Jury, Senior Investigative Journalist, Marine & Aquatic Ecology.

Way forward and future

The word integrated is integral in relation to meeting the targets we want for our river and wetland systems. Single measure approaches fail to address multi-faceted challenges and the MDB Plan 'Just Add Water' approach will continue to fail until it embraces a fully resourced multiple measures approach. We have the knowledge, tools, and programs to proceed with a multiple measures approach to the MDB Plan, it only takes political will and appropriate investment.

Recommendations

1. Employ a multiple measures approach within the MDB Plan including a suite of measures that are not just aimed at water recovery but ecosystem health recovery in unison with a triple bottom-line approach to stimulate rural economies
2. Fund recommendation 1 by stopping further acquisition of water entitlements for the environment, and re-invest money into multiple measures approach to achieve greater triple-bottom line outcomes.
3. Invest the remaining SDLAM funds into an evidence-based, multiple measures approach to achieve the desired environmental outcomes in the Lower Murray, including localised restoration projects to return greater volumes of water to the southern Coorong from the south east of South Australia.
4. Investigate the different ecological character options available under the RAMSAR Convention guidance.

REFERENCES

Davidson, N.C. (2016). Editorial: Understanding change in the ecological character of internationally important wetlands. Marine and Freshwater Research 67, 685-686

Ramsar Convention (1996). Resolution VI.1: working definitions of ecological character, guidelines for describing and maintaining the ecological character of listed sites, and guidelines for operation of the Montreux record. Ramsar Convention (2012a). Resolution XI.8 Streamlining procedures for describing Ramsar Sites at the time of designation and subsequent updates. 11th Meeting of the Conference of the Parties to the Convention on Wetlands (Ramsar, Iran, 1971) "Wetlands: home and destination" Bucharest, Romania, 6-13 July 2012

C Max FinlaysonA, Peter GellC and John ConallinA (2020). Continuing the discussion about ecological futures for the lower Murray River (Australia) in the Anthropocene. Marine and Freshwater Research (Under Review).

Mallen-Cooper, M. and Zampatti, B. P. (2018). History, hydrology and hydraulics: rethinking the ecological management of large rivers. Ecohydrology 11, e 1965

Koehn, J., Todd, C., Thwaites, L., Stuart, I., Zampatti, B., Ye, Q., Conallin, A., Dodd, L. and Stamation, K. (2016). Managing flows and Carp. Arthur Rylah Institute for Environmental Research Technical Report Series No. 255. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

Baumgartner, L., Zampatti, B., Jones, M., Stuart, I., and Mallen-Cooper, M. (2014) Fish passage in the Murray-Darling Basin, Australia: Not just an upstream battle. Ecological Management & Restoration 15(s1), 28-39.

SA Water - https://www.sawater.com.au/about-us/our-vision-and-strategy/our-160-year-journey

MDBA a - https://www.mdba.gov.au/water-management/infrastructure/lower-lakes-barrages

MDBA b – Lower Lakes, Coorong and Murray Mouth Environmental Water Management Plan, Murray Darling Basin Authority, May 2014 pg 17

DWAE - http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=25#

Govt. SA a Discussion 2 - SA GOVT History

Govt. SA b (appendix 3) - SA GOVT History

Aus Geo - Australian Geographic - Identifying groundwater discharge in the Coorong

About the Murray - About the Murray

Rebecca E. Lester 2011 - Rebecca E. Lester1,2, Peter G. Fairweather2, Theresa M. Heneker3, Jason S. Higham4 and Kerri L. Muller5. Specifying an environmental water requirement for the Coorong and Lakes Alexandrina and Albert: A first iteration. Technical Report 2011, June 2011