

Darling River flow contributions to the River Murray

History and calculation of different contribution statistics using modelled and observed data

Summary

Stakeholders have raised concerns about the effects of floodplain harvesting in northern NSW valleys on water availability to NSW River Murray water users during implementation of the NSW Floodplain Harvesting Policy. This technical paper presents information about the contribution of the Darling River to River Murray inflows and NSW River Murray allocations.

Analysis completed by NSW Department of Planning, Industry and Environment (the department) and the Murray–Darling Basin Authority (MDBA) shows that inflows from the Lower Darling River represent, on average, 14% of the total inflows to the River Murray. This means that major changes to inflows from the northern Basin have only minor impacts on total River Murray inflows.

Some stakeholders have quoted that the Darling River provides 39% of entitlement flows to South Australia. Therefore, it could be expected that growth in floodplain harvesting in northern NSW valleys could contribute to the loss of inflows to the River Murray. This would place an additional burden on NSW River Murray storages to meet the higher priority South Australian entitlement flow requirements, resulting in lower allocations for NSW River Murray water users.

The department and the MDBA investigated the 39% River Murray inflow contribution statistic, concluding that it is being used incorrectly to describe the extent to which Darling River inflows contribute to the South Australian entitlement flow in a typical year. The reasons for this include:

- The statistic assumes that Lower Darling inflows are always used first to meet the South Australian entitlement flows, but this is not the way the NSW Murray system is managed in practice. In practice, the River Murray above Wentworth contributes to the South Australian entitlement flow targets and flows from the Lower Darling are used as a supplementary water source to provide greater flexibility over peak ordering times.
- The statistic does not account for water that may have been delivered from the Darling River to:
 - cover losses and diversions in the Wentworth weir pool and to the South Australian border
 - meet the target storage volumes under the Lake Victorian Operating Strategy
 - meet other commitments at the South Australian border above the South Australia entitlement, such as trade commitments and additional dilution flow (ADF)
- The calculation of the statistic at an annual scale overstates the contribution of the Darling River in flood years.

Sources for the 39% contribution

The following references have been sourced regarding the origins of the 39% figure:

1. Thoms et al 2000, Report of the River Murray Scientific Panel on Environmental Flows: River Murray – Dartmouth to Wellington and the Lower Darling River, Murray–Darling Basin Commission, p.123
www.researchgate.net/publication/274007430_Thoms_et_al_2000_River_Murray_Scientific_Panel_Report_on_Environmental_Flows
2. Murray–Darling Basin Authority 2012, Assessment of environmental water requirements for the proposed Basin Plan: Lower Darling River System, p.8
www.mdba.gov.au/sites/default/files/archived/proposed/EWR-Lower-Darling-River-System.pdf

It is noted that the second reference cites the first reference.

Investigation of the origins of 39% contribution

The statement that the Menindee Lakes supplies 39% of entitlement flows to South Australia appears to originate from page 123 of the Murray–Darling Basin Commission’s (MDBC) 2000, *Report of the River Murray Scientific Panel on Environmental Flows: River Murray – Dartmouth to Wellington and the Lower Darling River*.

The report states, “The Menindee Lakes supply part (approximately 39%) of annual entitlement flows to South Australia. (Thoms et al, 2000),” as part of a general description of the Lower Darling and Great Darling Anabranch systems before moving on to the reports focus of making seven recommendations for environmental flow reforms in these systems.

Since that time, the figure has been referenced in multiple reports without additional analysis or consideration on whether that statistic is useful in the new context.

The MDBA contacted the report author, but Thoms was unable to recall twenty years later why the statistic was included or exactly how it was calculated. The best guess was that the number is determined as the annual flow at the Burtundy gauge¹, limited to annual South Australian entitlement and expressed as a percentage of 1850 GL. This means that a time series of annual contributing Burtundy flow was calculated by truncating the observed annual flows to the South Australian entitlement volume of 1850 GL where the annual flow is higher, and that the average of this time series was 720 GL which, expressed as a percentage of 1850 GL, is 39%.

The modelling data which informed the original 2000 report, was not found and the person most likely to have worked on it is no longer available. Based on other work at the time, it is likely that the 2000 report used a modelled climate sequence of 1891 to 1999.

Reproduction of the 14% and 39% contribution

NSW DPIE and the MDBA calculated² a number of statistics using both observed monthly data (July 1968 – June 2020) and monthly timestep modelling output from the Basin Plan BDL - Legislative Instrument run (No. 871) to inform the discussion on how the 39% value was calculated (Table 1).

The statistics below refer to data at:

- Darling River @ Burtundy flow

¹ The Burtundy gauge is the last gauge above the influence of the Wentworth weir pool on the Lower Darling River.

² Unpublished spreadsheet ‘Menindee Contributions.xlsx’

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History and calculation of contribution statistics

- Murray River @ Wentworth flow
- South Australian entitlement.

Table 1. Flow metric

	Modelled BDL (1895-2009)	Observed (1968-2020)	Modelled BDL (1895-2009)	Observed (1968-2020)
	Average %	Average %	Median %	Median %
Annual Burtundy flow expressed as a percentage of 1850 GL	49%	63%	25%	27%
Annual Burtundy flow limited to annual SA entitlement and expressed as a percentage of 1850 GL	36%	45%	25%	27%
Annual Burtundy flow expressed as a percentage of annual Wentworth flow	11%	15%	8%	11%
Monthly Burtundy flow expressed as a percentage of monthly SA entitlement	50%	67%	6%	10%
Monthly Burtundy flow limited to monthly SA entitlement and expressed as a percentage of monthly SA entitlement	27%	32%	6%	10%
Monthly Burtundy flow expressed as a percentage of monthly Wentworth flow	14%	18%	4%	6%
Annual Wentworth flow (minus Burtundy flow) limited to annual SA entitlement and expressed as a percentage of 1850 GL	99%	98%	100%	100%

It should be noted that:

- The annual Burtundy flow limited to annual South Australia entitlement and expressed as a percentage of 1850 GL for the BDL gives 36%. This is similar to the 39% quoted in the 2000 report. The differences are likely due to:
 - Modelling completed in the 2000 report were likely undertaken on a modelled climate sequence of 1891-1999 as opposed to 1895-2009 for the BDL.
 - There were different levels of development and policies represented in the models.
- A median statistic is supplied for comparison to the averages. We know that the Darling River is highly variable, and averages can be distorted by extreme drought or flood years. Since a median is the middle value in a sorted list of numbers, it is generally a better indication of the 'normal' contribution of the Darling River than using an average figure.

History and calculation of contribution statistics

- The statistics are provided for both modelled and observed data. Although the periods of the data are different, the general results are similar, and this gives confidence that the relative contribution of the Darling River is not a distortion or error caused by using modelled figures.
- The department used table 23 of the published MDBA report “*Water resource assessments for without- development and baseline conditions*” www.mdba.gov.au/sites/default/files/pubs/1111-BPKId-water-resource-assessments-development-baseline.pdf to prepare its 14% figure.

Issues with the 39% contribution

The department and MDBA believe that the 39% figure is being used incorrectly to describe the extent to which Darling River inflows contribute to the South Australian entitlement flow in a typical year. For example:

- The calculation assumes that all water supplied down the Darling River to the River Murray is used and accounted first in delivering the South Australian entitlement volume. However, this is not how flows are accounted for or managed by River Murray Water. In reality, minimum flow requirements above Wentworth mean that the River Murray above Wentworth always contributes to the South Australian entitlement flow targets and Burtundy inflows act more as a supplement that can reduce additional calls on River Murray storages. If we reverse the assumption being applied in calculating 39% and instead assume that Wentworth flows are the first contribution to South Australian entitlement flow targets, we get a result that 99% of South Australian entitlement flow is supplied by the upper River Murray and this is not consistent with experience on how the Darling River contributes to water availability in the River Murray.
- The calculation does not account for water that may have been delivered from the Darling River to:
 - a) cover losses and diversions in the Wentworth weir pool and to the South Australian border,
 - b) meet the target storage volumes under the Lake Victorian Operating Strategy, and
 - c) meet other commitments at the South Australian border above the South Australia entitlement, such as trade commitments and additional dilution flow (ADF).
- The calculation of this statistic at an annual scale overstates the contribution of the Darling River in flood years. For example, a flood late in the water year can be accounted as supplying entitlement flow in earlier months.
- The calculation ignores the operation of Lake Victoria as a re-regulating structure.

Recommendation and future work

In the context of the ongoing public discussions on the potential effects of northern Basin floodplain harvesting on water availability to NSW River Murray water users, the department and MDBA believe that the most meaningful simple statistic to describe the long-term average Darling River contribution to meeting downstream demands is taking the Burtundy flow as a percentage of the total Wentworth flow and assuming that the meeting of operational priorities downstream is that same ratio. Using a monthly calculation for this suggests that on average the Darling River contributes 14% of the total flow below Wentworth.

The 39% figure being quoted has flaws that make it unsuitable for use in this way.

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History and calculation of contribution statistics

MDBA is currently preparing a more detailed analysis and information publication to describe how Darling River flows contribute the River Murray resources. This will go beyond simple volume ratios and consider operational aspects.

The department is preparing environmental outcomes modelling and reports that will propagate the effects of reduced floodplain harvesting take in each northern Basin valley down through the Barwon–Darling system to be used as a modified Menindee Lakes inflow sequence in the eWater Source Murray model. This collaborative modelling program with MDBA is expected to accurately estimate how northern Basin floodplain harvesting affects NSW River Murray water availability in a broad range of climatic conditions.

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