Analysis to support connectivity discussions

August 2021

Approach

There is no agreed definition of connectivity or what we need to achieve, or the trade-offs that need to be made.

The focus of these discussions is on low and no flows

<u>Approach to these meetings:</u>

Meeting 1 (today):
Present data about low and no flows in the Barwon-Darling so we have a shared understanding of the evidence

Meeting 2:
Discuss the focus of connectivity – we cannot address or achieve everything at once

Meeting 3:
Discuss options and solutions – before they are more widely consulted on

What is out of scope of this discussion:

- Changing the Basin Plan and the Sustainable Diversion Limits.
- Actions outside of NSW control
- Addressing connectivity for needs that are not considered to be critical needs and the full range of flow types, including higher flows

Context

- Extended dry periods have a significant impact on humans, the environment, communities and industries
- The debate around connectivity has focussed on water in rivers during dry periods and the equity between upstream and downstream take during these periods
- The focus of this data is to unpack this issue – to understand what is driving changes in low and no flow periods and inform an evidenced based conversation about what we need to do to support critical needs during dry periods
- It is not about assigning blame.
- We have not modelled other flows for this connectivity work at this stage e.g. freshes, overbank. It is impossible to have reliable models on this without metering and licencing floodplain harvesting and collecting data for an extended period of time.

Questions we get asked

1. Did the Barwon-Darling river flow constantly before upstream development?

2. Has upstream irrigation development extended low and no flow periods downstream?

3. Have our recent changes to the Barwon-Darling Water Sharing Plan improved connectivity?

4. How will climate change impact on extended droughts?

Questions we get asked but will be discussed in a future meeting:

1. Will restricting supplementary access and floodplain harvesting make a real difference in reducing low and no flow periods in the Barwon-Darling?

2. How does floodplain harvesting in the north affect the flows and allocations in the south?

This pack presents background information and data to help answer these questions.

Not all questions can be answered definitely.

There are things:

- we know,
- we don't know,
- we have enough information to make expert assessments

Question 1

Did the Barwon-Darling river flow constantly before upstream development?

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What do we know about the climate based on the last ~130 years?

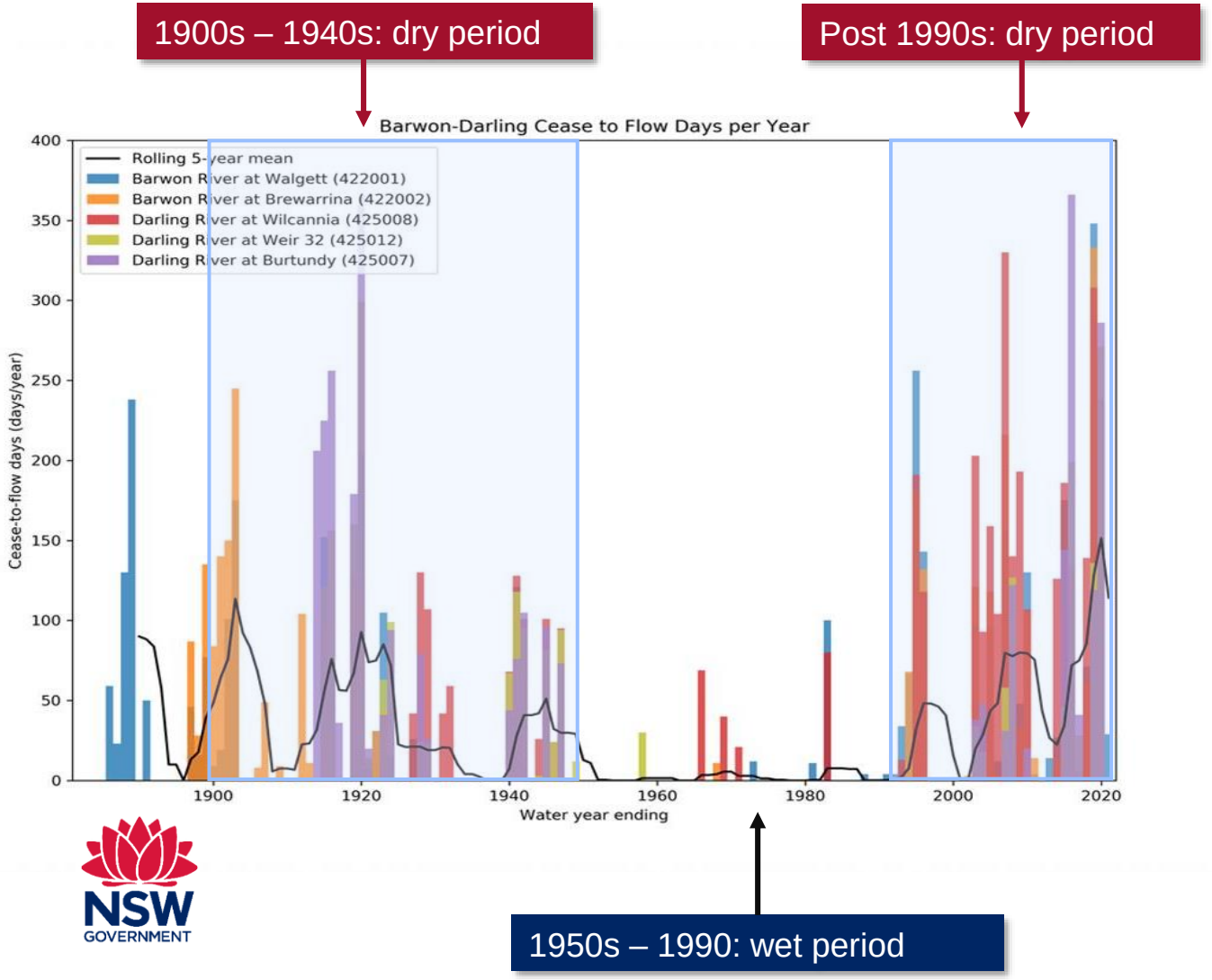
The northern valleys cycle between wet and dry periods

- 1900s – 1940s: comparatively dry
- 1950s – 1990s: comparatively wet
- Since the start of the millennium drought: returning to drier conditions

The driest recorded decadal (10-year droughts) happened during these periods for ALL northern and western valleys

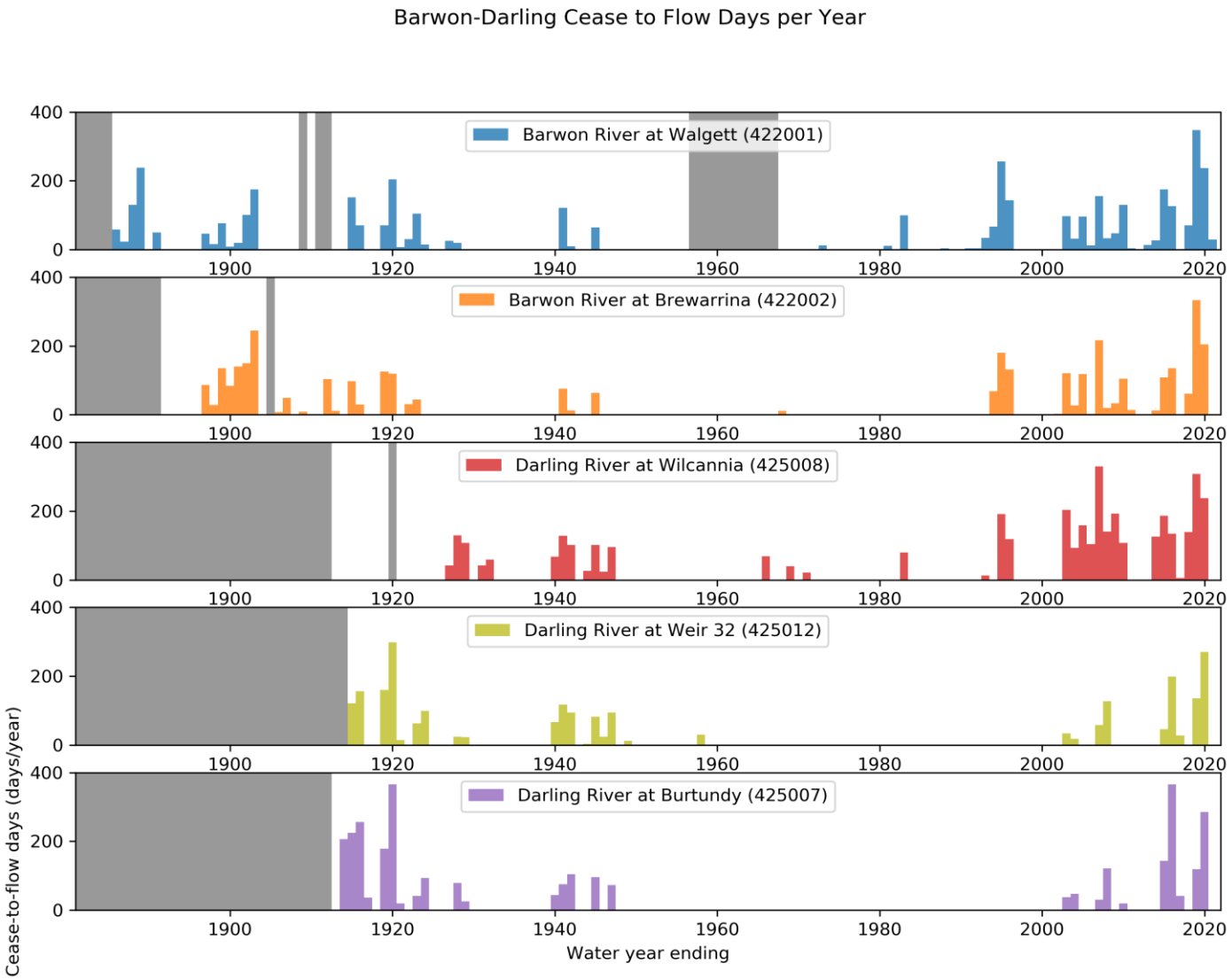
These dry periods influence the amount of water flowing into the Barwon-Darling

Question 1: Did the river flow constantly before development?



- The river has stopped frequently during dry periods in our climate.
- The observed cease-to-flow conditions since the 1990s have been severe, but not unusual when compared to the early 1900s
- We can't guarantee a constantly flowing river – it is not natural

Question 1: Did the river flow constantly before development?



Question 1: Did the river flow constantly before development?

What we know

- The river stopped flowing for extended periods of time before development
- There are wet and dry cycles that last for decades
- We think that long periods of cease to flow are mostly because of climate while short cease to flow periods are affected by climate and development

What we don't know

- We don't know the relative contribution of the climate and development have had on increased cease to flow periods

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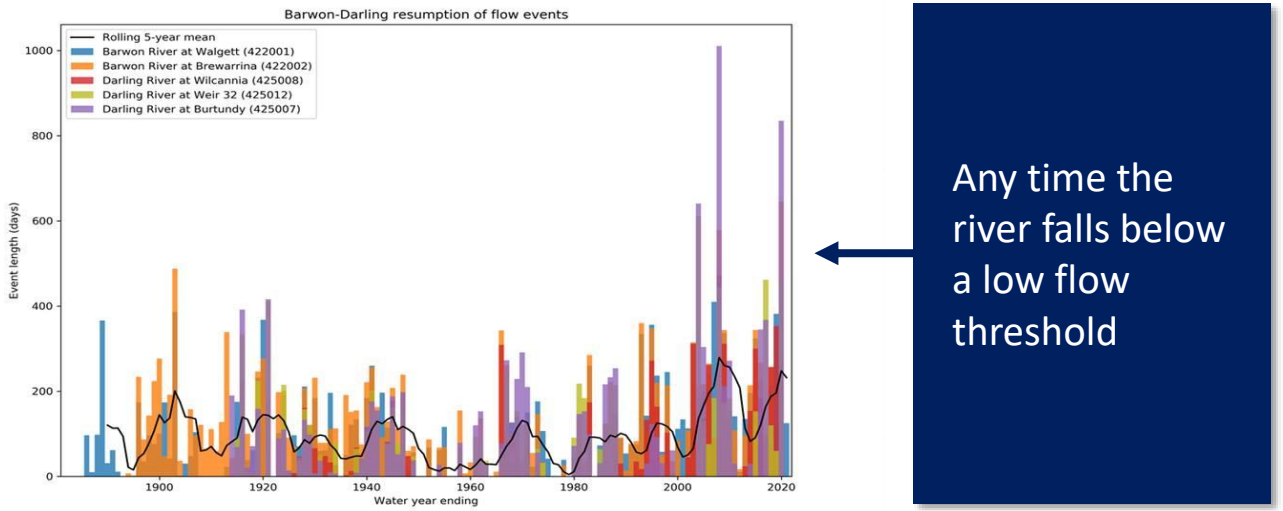
Question 2

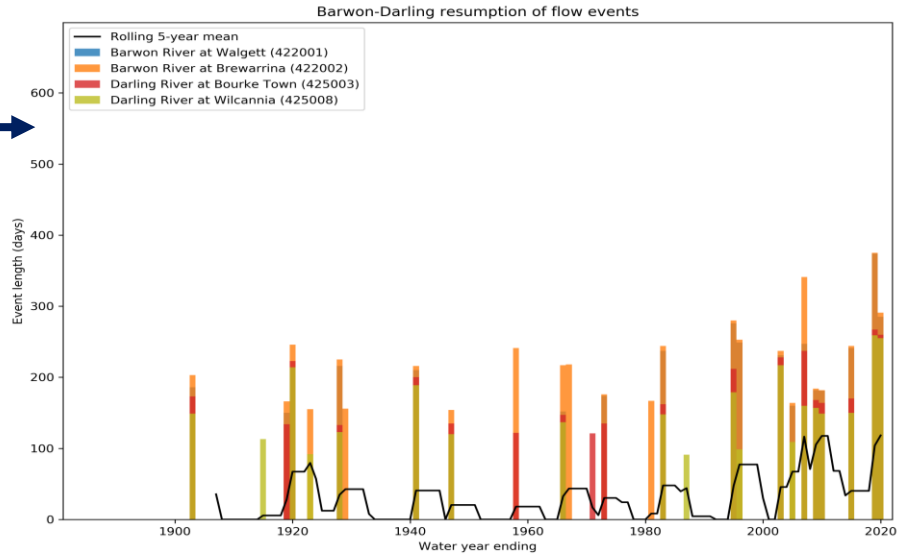
Has upstream irrigation development extended low and no flow periods downstream?

Low flow periods are increasing (Observed data)



Any time the river falls below a low flow threshold

Extended low flows – when the river is below a threshold for longer than 3 or 5 months

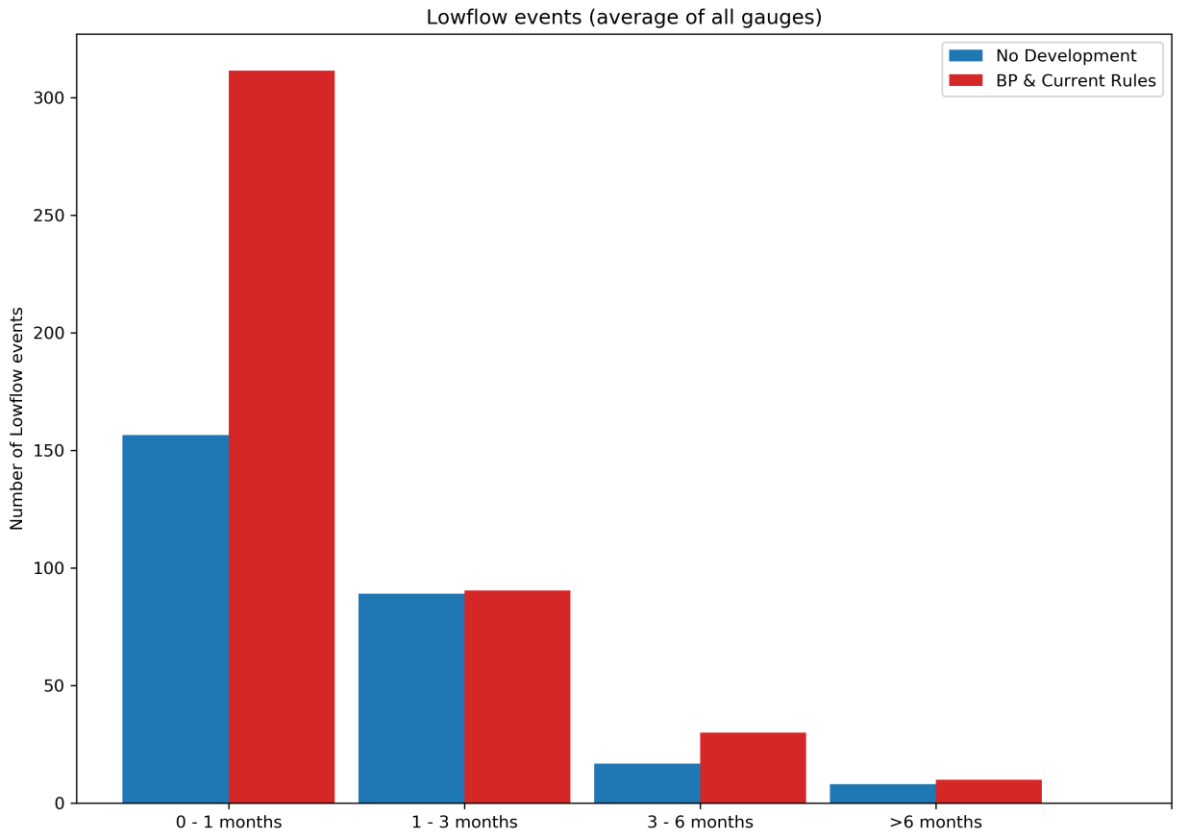


Low flow periods in the Barwon-Darling are common, but are increasing:

- The river experiences low flow periods from time to time with increased frequency of low flows during dry periods
- The frequency of low flow periods is increasing. There appears to be a step change in the frequency of low flows around 1991-93
- Water sharing plan rules have been amended in the Barwon-Darling WSP to restrict water being taken after an extended dry period.

Development has increased low flow periods

The total number of low flow periods before and after development (modelled data)



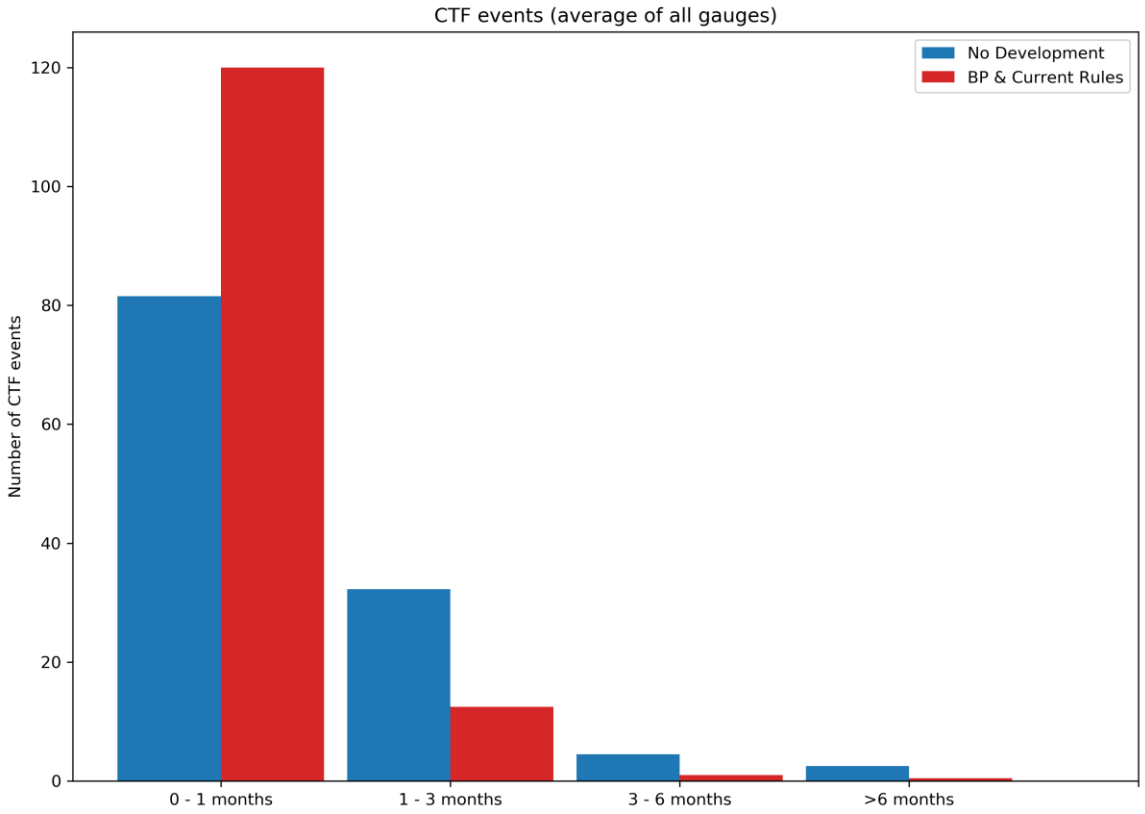
Development has increased the number of low flow periods:

- significant impact on short periods of low flow – approximately doubled on average
- measurable impact on the number of low flow events:
  - longer than 3 months – increased by approx. 50% on average
  - longer than 6 months – increased by approx. 20% on average
- Possible reasons: higher flows are extracted, and dams are operated to reduce no flows. This may mean that we now have more low flows, but fewer high flows and fewer cease to flows

Note: development refers to the current public and private infrastructure like dams, pipelines and weirs, water extractions and water management rules. No development is a model run where this infrastructure and extraction is removed.

The climate may be driving extended cease to flow periods

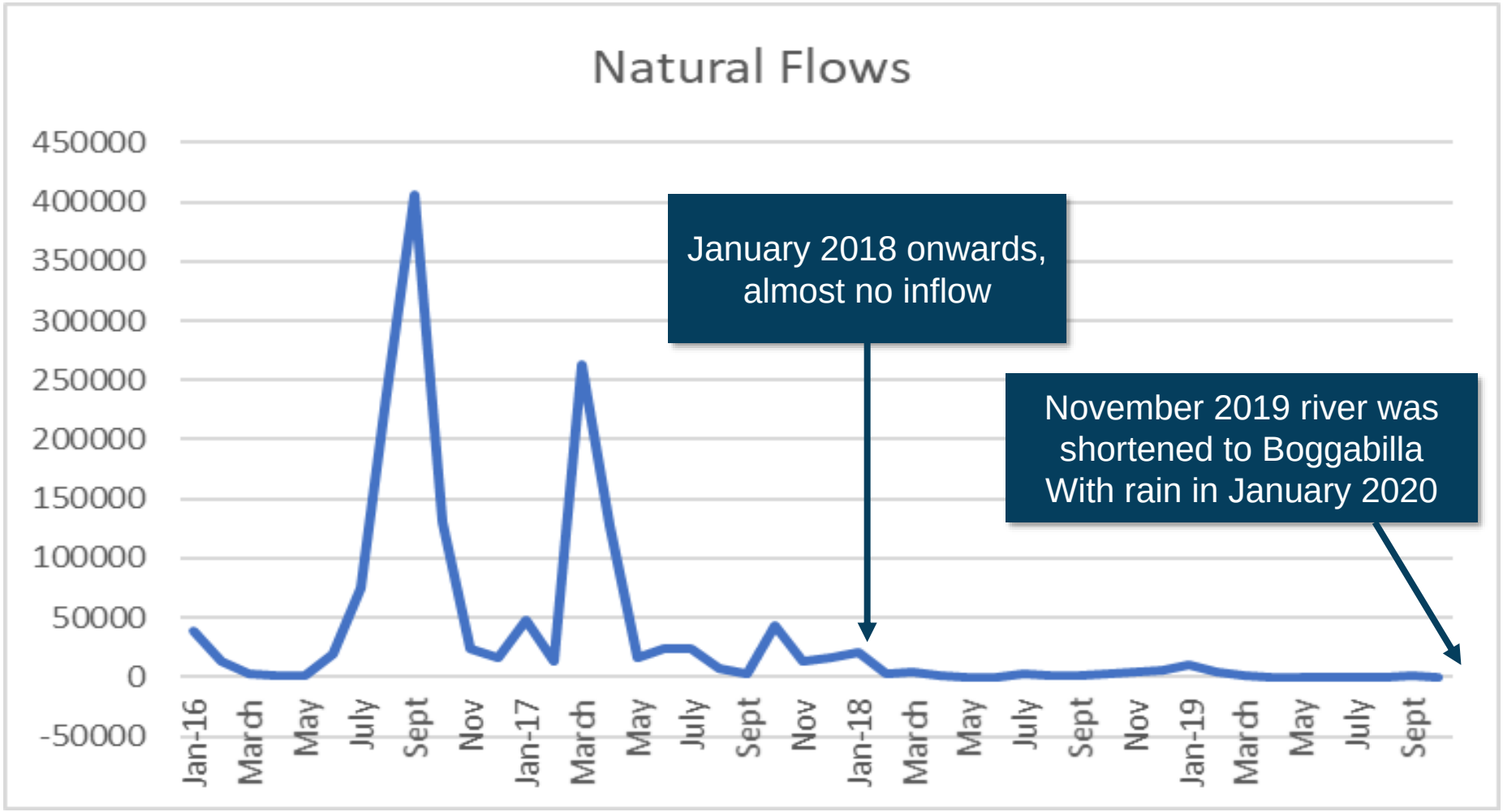
The total number of cease to flow periods before and after development (modelled data)



Dams, water management rules and extractions have increased shorter cease to flow periods but reduced extended no flow periods

- Possible reasons:
  - Dams have been operated in recent years to avoid cease to flow periods for as long as possible, prolonging low flows and reducing no flows
  - The peaks of higher flows are taken by water users, resulting in lower flows
  - End of system flow targets mean there are some flows into the Barwon-Darling
- **Note:** development is public and private infrastructure like dams, pipelines and weirs, water extractions and water management rules.
  No development is a model run where this infrastructure and extraction is removed

Flows in the Border Rivers during the last drought



Question 2: Has upstream irrigation development extended low and no flow periods downstream?

What we know

- Both the climate and development have contributed to low and no flows
- The climate may be the main driver behind extended cease to flow events
- Low flow periods in the Barwon-Darling are increasing in frequency and duration. Development in the northern basin may be the main driver behind more frequent short-term low flow events
- Dams and irrigation development can cause additional low and cease to flow periods however they can also contribute to mitigating climactically driven cease to flow periods within valleys.
- There are fewer higher flows than there used to be and this is primarily driven by development. We think that the freshes are being turned into low flow events

What we don’t know

- The models aren't set up to determine exactly how much of the low flows and cease to flows are driven by climate versus development
- We have not analysed the extent to which Queensland development has impacted on Barwon-Darling cease to flow and low flows

How have cease to flow and no flow been defined?

Town	Cease-to-flow (pre 1980)	Cease-to-flow * (post 1980) ML/d	Low Flow ML/d **	Extended Low Flow Resumption of flows target ML/d
Walgett	Practical cease to flow estimated	25	326	326 (for more than 150 consecutive days)
Brewarrina		20	468	468 (for more than 150 consecutive days)
Bourke		0	450	450 (for 120 consecutive days)
Wilcannia		20	200	200 (for 90 consecutive days)
Weir 32		5	Monthly pattern between 350 and 200	N/A
Burtundy		0		N/A

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Question 3

Have our recent changes to the Barwon-Darling Water Sharing Plan reduced low and no flow periods?

Number of low and no flow events pre and post BD WSP changes

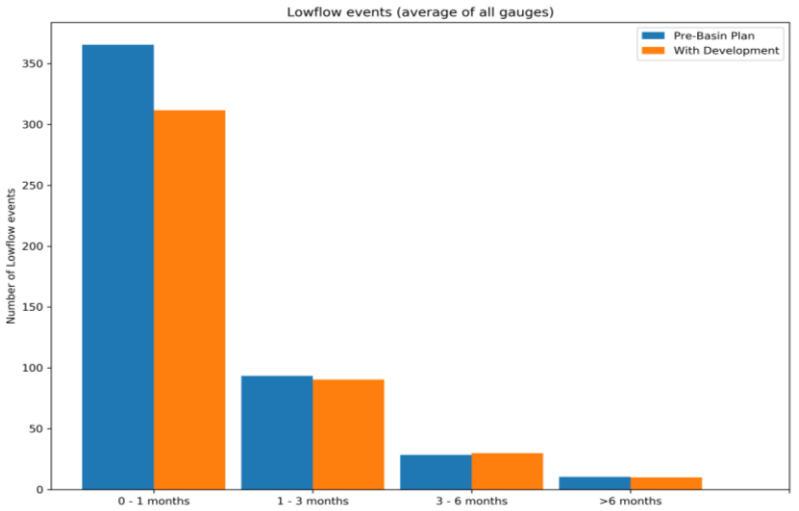
The 2020 changes to the Barwon-Darling water sharing plan have reduced low and no flow periods

The main difference between the Pre Basin Plan and the Annual Permitted Take model runs are the following changes to the B-D WSP:

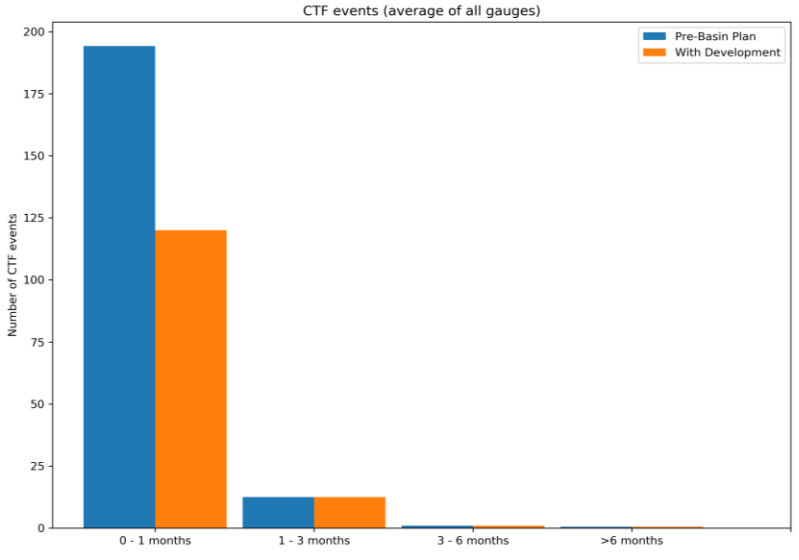
- revised A-class access thresholds
- Resumption of flow rules
- limiting daily extraction volumes

	Total Number of low flow events	Total Number of no flow events
Pre-Basin Plan – before rule change	**498**	**208**
With development - After rule change	**442**	**134**
% change	**11%**	**36%**

Total low flow events averaged across gauges



Total cease to flow events averaged across gauges



Question 3: Have our recent changes to the Barwon-Darling Water Sharing Plan reduced low and no flow periods?

What we know

- The recent changes to the Barwon-Darling Water Sharing Plan have reduced the number of low and no flow periods.
- The greatest benefits are likely to be around Bourke where larger volumes of water are taken than elsewhere in the Barwon-Darling
- The resumption of flow rules in the Barwon-Darling WSP were intended to provide connectivity down to Wilcannia
- The rules are unlikely to have a significant impact on the Lower-Darling River as low or cease to flows in the Lower-Darling are more influenced by long periods of no flows and climate.

What we don't know

- While we think that the main drivers to this reduction are the BD WSP changes, the extent to which other water management issues in the tributaries are contributing to this result is not fully understood.

  e.g. extent to which environmental water use in the tributaries is being used to achieve connectivity outcomes

- The information presented is modelled data and it will take 20 to 30 years for the effects of the WSP changes to be observed.

Question 4

How will climate change impact on extended droughts?

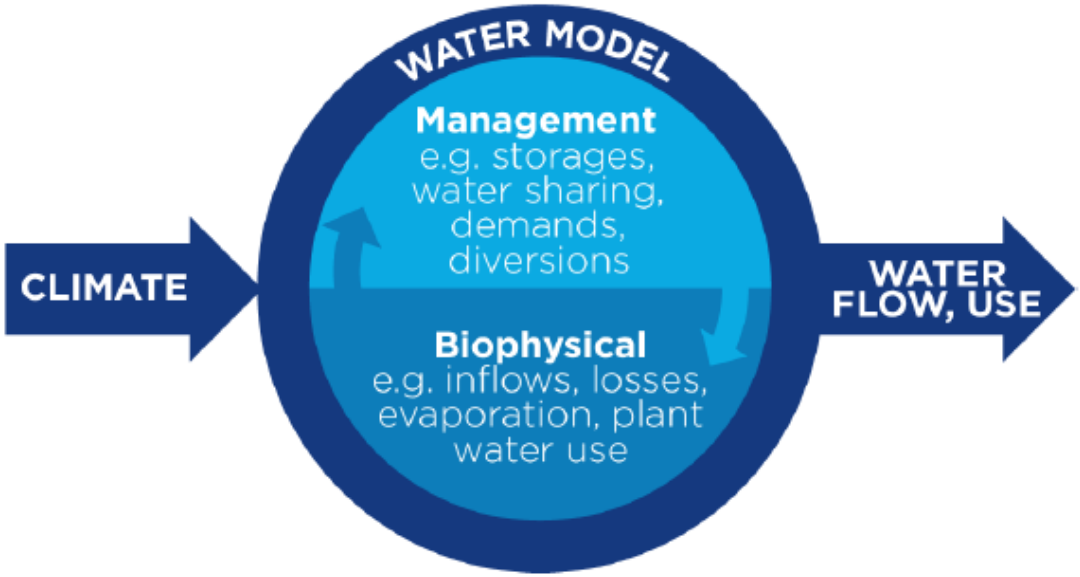
Climate modelling method and steps

Observed historical climate data + Paleoclimate data = 500+ years of climate data

Climate drivers

Stochastic modelling = 10,000 years of climate variability risk data

Climate change projections = Plausible future climate variability with climate change impacts and risks



Inflows into the Barwon-Darling

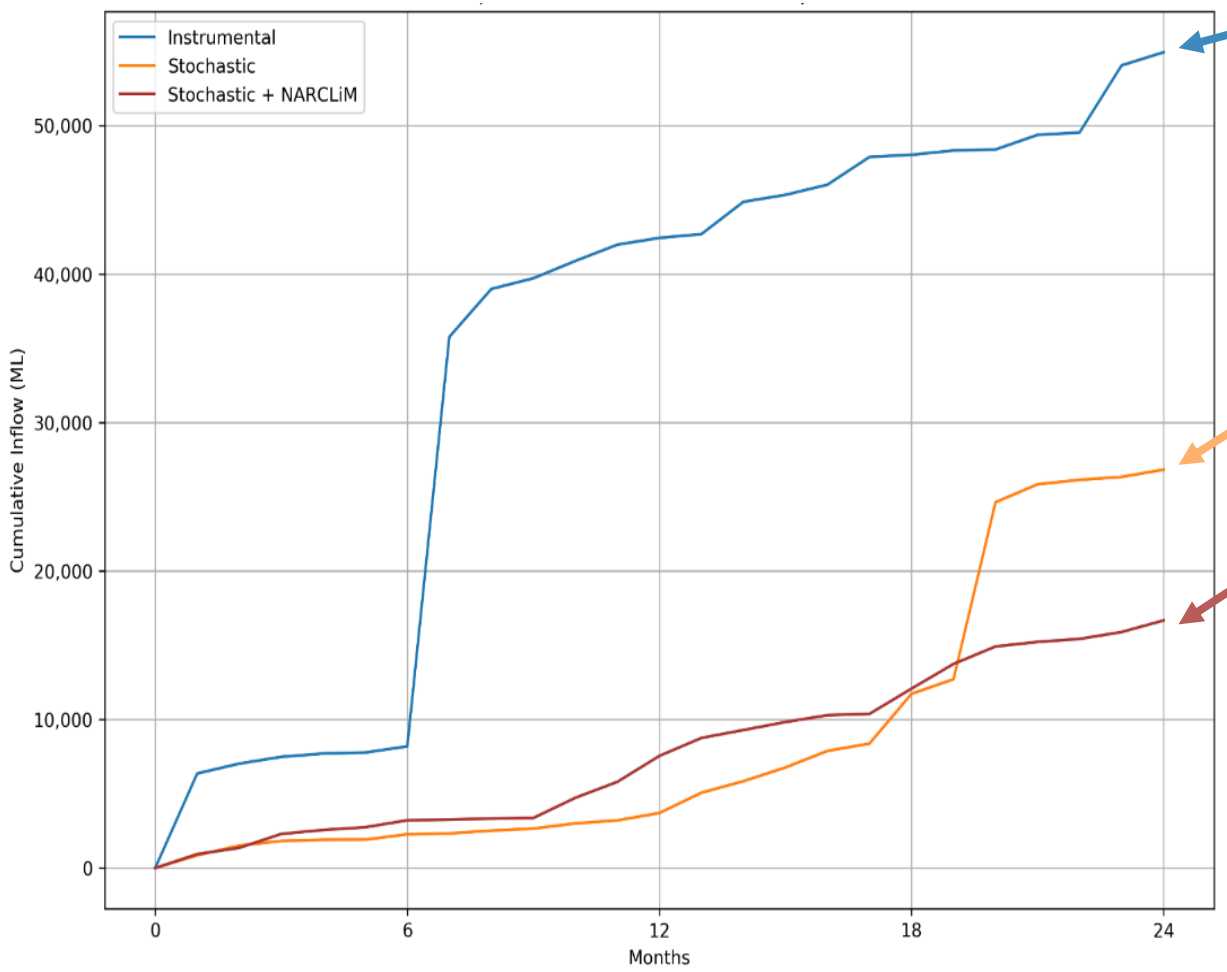
	Barwon-Darling
Catchment	% of flow contribution *(modelled)**
Border Rivers	22
Castlereagh, Macquarie and Bogan Rivers	15
Namoi River	15
Gwydir River	9
Warrego + Paroo	20
Moonie	12
Condamine-Balonne	8

*these are average flows. In some catchment such as Warrego, Paroo, Moonie, Condamine-Balonne, the large contributions are influenced by wet years

- **Inflows:** 99% of the flows come from upstream catchments.
- **River system:**
  - 1900km long and unregulated until Menindee Lakes
  - Menindee Lakes connects the northern and southern parts of the Murray Darling Basin and is the link for water management between the two.
- **Population:** 36,600 people - 0.5% of the state's population.

There could be lower flows into upstream catchments

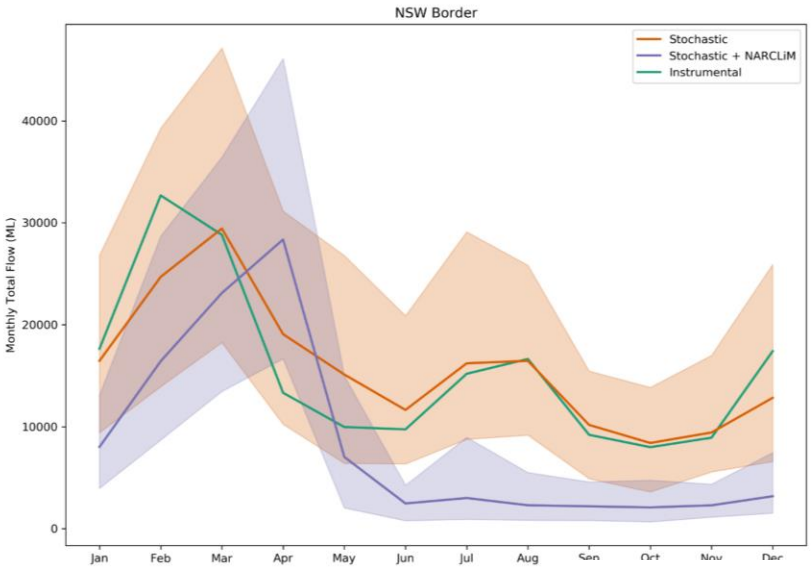
Worst case inflows (prior to the most recent drought) into Copeton Dam modelled under different climate scenarios

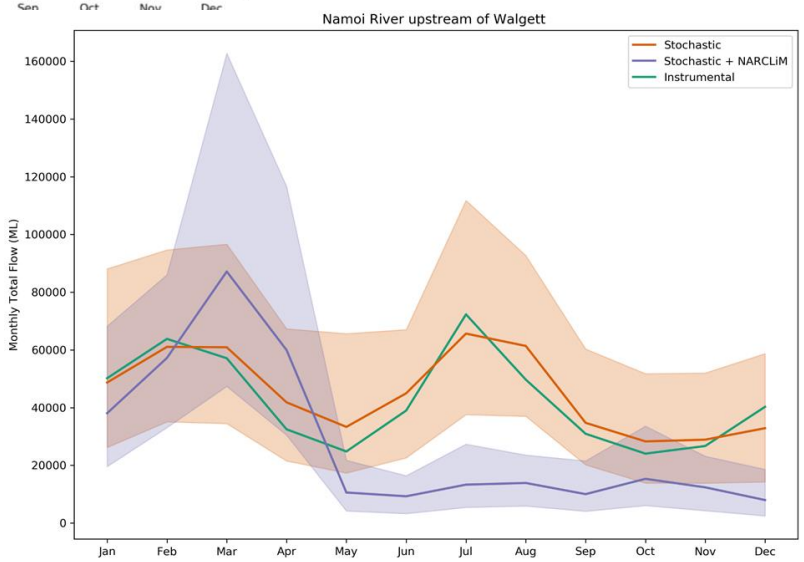


- The lowest inflow into Copeton Dam approx. 50 GL
- Under a worst-case scenario:
  - inflows could be half that volume (27 GL over 24 months)
  - a dry climate change scenario reduces this to 17 GL.
- These volumes are not able to run the Gwydir River
- The probability of this is very small but these results are consistent across the Northern Valleys.

Note that we have deliberately used the driest, most conservative climate change scenario. These might not eventuate, and if they do, we don't expect to see the impacts for another 40 years

What could this mean for the Barwon-Darling?





- There will still be wet and dry periods
- Overall long-term decline in tributary inflows.
- More frequent events when the northern tributaries do not connect with the Barwon-Darling.
- Longer cease to flow events under a worst case scenarios
- Seasonal changes to tributary flows:
  - reduction in winter and spring flows
  - delay in peak flows from summer to autumn.

What does this mean and what next?

Given these results, how and when do we focus on critical needs?

Should we be focussing on the shorter cease to flow / low flow periods which are more impacted by development? Or the longer dry periods which are driven by the climate but have greater impacts on critical needs

How do we address critical needs in extended dry periods, particularly in the face of a drier future climate?

Thank you