

Waiting for recharge at Wellington: what have we learnt from fifteen years of cave drip water monitoring?

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Abstract

It is fifteen years since the 13th Cave and Karst Presenters conference at Wellington, where the concept of monitoring cave drip water to understand groundwater recharge processes was introduced (Henderson, 2010; Baker et al, 2010). What has happened since then and what have we learnt?

Groundwater recharge is the process by which groundwater is replenished, and we can use caves as ‘observatories’ of this recharge happening. In 2010, we placed drip counters in Cathedral Cave, Wellington, just above the groundwater, and waited for recharge events to occur. The network was described in Jex et al. 2012. It turns out that they occur so infrequently that we haven’t had enough data yet to publish it. Results so far will be presented.

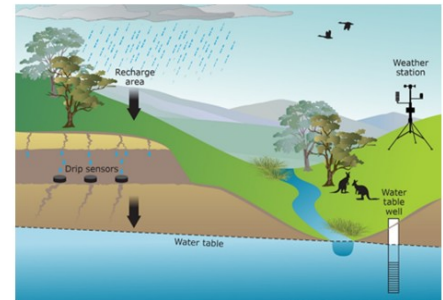
While waiting for enough recharge events at Wellington, with Monika Markowska (ANSTO) and Katie Coleborn (UNSW) we installed drip counters at Yarrangobilly. The Kempsey Speleological Society designed a monitoring program for the Macleay karst, and the Kempsey Cave Studies Team was born. It turns out that there were many more recharge events in the Macleay and the Snowy Mountains, and results were published (Markowska et al 2015; Coleborn et al 2016; Baker et al 2020; 2021).

Still waiting for enough recharge events at Wellington, a group of us were funded in 2022 to set up the National Groundwater Recharge Observing System. This was a network of drip loggers in caves, and also mines and tunnels. Margaret Shanafield (Flinders University) led collaborations in South Australia, Wendy Timms (Deakin University) led collaborations in Victoria and Tasmania, and Andy Baker led in New South Wales, Queensland and Western Australia. The network is described in Baker et al (2024) and the latest results will be shared in this presentation, thanks to our many partners, including cave sites at Mole Creek, Capricorn Caves, Yarrangobilly Caves, Wellington Caves, Yanchep, Caldargup, Naracoorte, Tantanoola and Byaduk Lava Cave.

What have we learnt while waiting for recharge events to occur at Wellington? We recently published a summary of the first year of results (Priestley et al., 2025), where we show that groundwater recharge is uncommon, and at all our sites, you need rainfall events in the top ten percent of all rainfall for recharge to be possible. In numbers, around 20 mm of rain is needed within 48 hours, more than you would get in a typical rainfall event. And even with that amount of rain, groundwater recharge it is not guaranteed in summer and autumn, when the soils are dry and the trees are thirsty.

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Design credit: Anna Blacka, UNSW Water Research Laboratory

Outline

Groundwater recharge – why is it important?

Underground observatories of groundwater recharge

Across Australia, only the wettest 10% of all rainfall events might replenish groundwater

Which is why we have been waiting for recharge at Wellington

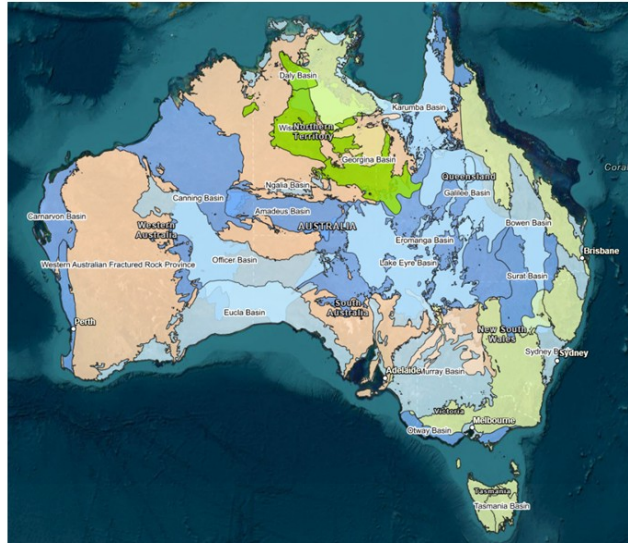


Groundwater and its replenishment

Knowing how groundwater is replenished (recharged) is essential to manage the resource sustainably.

Why? Groundwater has a significant value to Australia's economy. For example:

- Groundwater is worth AU\$6.8 billion GDP equivalent to the Australian economy (2013 figures from the National Centre for Groundwater Research and Training).
- In the last drought, the NSW Government provided AU\$1 billion of loans for drought infrastructure (<https://www.raa.nsw.gov.au/>)



<https://portal.ga.gov.au/restore/002a2e20-0fdc-49cc-bbfd-4e524232f9e3>

Caves (and other underground spaces) as observatories of groundwater recharge

Why caves (and tunnels and mines)?

You can directly observe the water percolating from surface to groundwater table.

You know where the water has come from (i.e., through the soil as focused recharge).

Technically, it is *potential* recharge.

Data at the scale of rainfall events - enabling calculation of the amount of rainfall required for recharge to occur.

Thanks to Australian Research Council funding, we have national data on the timing of recharge events since 2022.



Prof Andy Baker (left) demonstrates his drip water data loggers to attendees at the recent 13th Cave and Karst Presenters' Conference at Wellington Caves.



2010 – here at Wellington



2014 – Kempsey Speleo Soc
Macleay karst, NSW



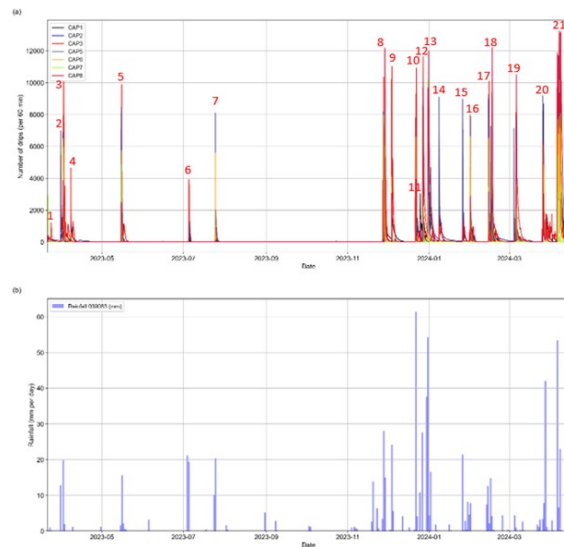
2023 – everywhere!

Capricorn Caves, QLD

18 recharge events per year
(the most of all our sites).

On average, 25 mm of rainfall in 48 hours
needed, some events occur after 5-10 mm.

(Priestley et al., 2025)



Mole Creek, TAS

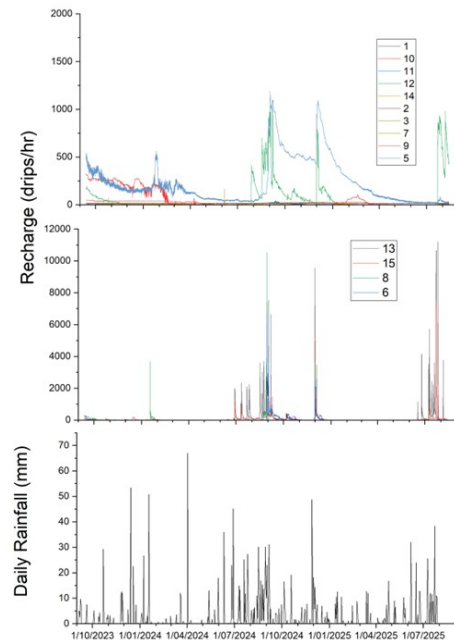
15 recharge events per year.

On average, 26 mm of rainfall in 48 hours needed.

No recharge events in February to May.

22 out of 30 events occur in June-August

(unpublished data)



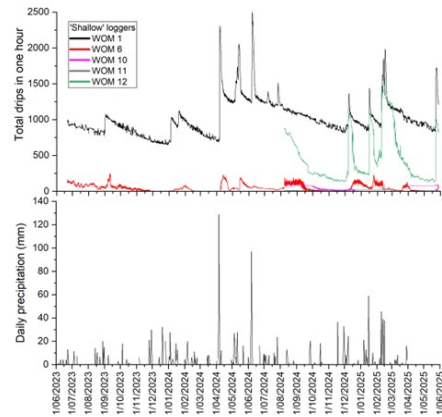
Wombeyan Caves, NSW

6 events per year.

On average, 37 mm of rainfall in 48 hours needed.

Recharge can occur in any time of year.

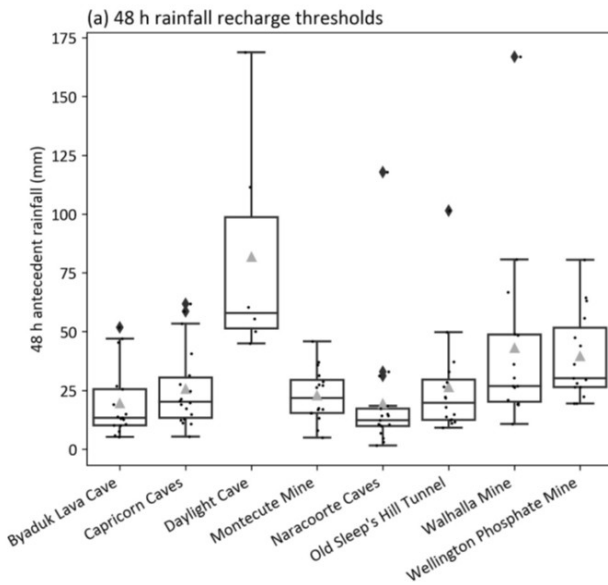
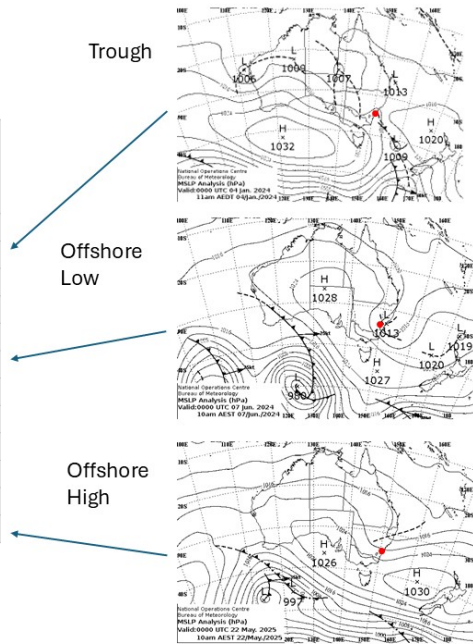
(unpublished data)



Wombeyan Caves, NSW



Event number	Date of recharge increase	48hr precipitation (mm)	Rain station
1	01/09/2023	17.0	063093
2	04/01/2024	30.2	063093
3	18/01/2024	18.4	063093
4	06/04/2024	166.0	063093
5	06/05/2024	43.2	063093
6	06/06/2024	135.0	063093
7	04/07/2024	14.4	063093
8	26/07/2024	23.6	063093
9	08/12/2024	24.6	063093
10	15/01/2025	60.8	063093
11	08/02/2025	45.6	063093
12	22/05/2025	76.4	070144



For groundwater recharge to potentially occur, you need > ~10 mm of rain over 48 hours in winter months and cooler climates, and > ~20 mm of rain in summer months and warmer climates.

Recharge events are infrequent. The maximum number was at Capricorn Caves (QLD) with 18 recharge events in one year. Minimum was 3.

Rainfall needed is in the upper decile of 48 hr rainfall totals for all sites.

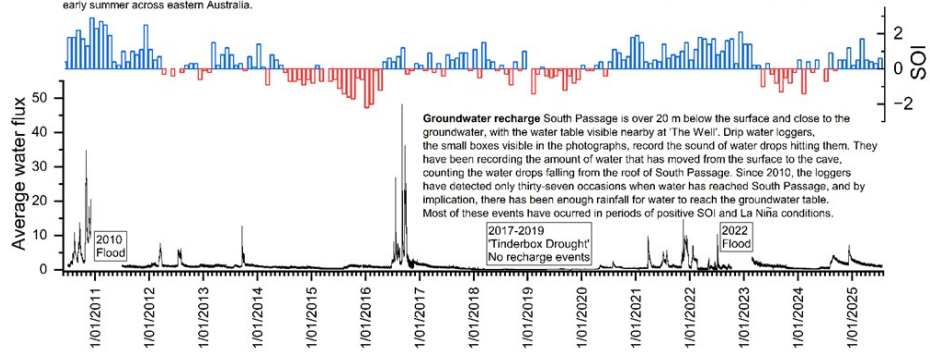
(Priestley et al., 2025)



Caves as Observatories of Groundwater Recharge Cathedral Cave Wellington



SOI The Southern Oscillation Index (SOI) is based on the observed sea level pressure differences between Tahiti and Darwin. A negative SOI (red) represents above-normal air pressure at Darwin, a positive SOI (blue) represents below-normal air pressure at Darwin. Prolonged periods of positive SOI values coincide with cooler than average ocean surface temperatures across the central and eastern tropical Pacific typical of La Niña. La Niña conditions generally lead to above average rainfall in winter, spring and early summer across eastern Australia.



Lidar mapping, Woolondilly Cave, Wombeyan

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(links provided where 'Open Access')

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