

An isotopic approach to hydrological mass balance in the Nattai River catchment, NSW 1. rainfall – runoff and $\delta^{18}\text{O}$, $\delta^2\text{H}$

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Isotopic hydrograph separation techniques can be used in conjunction with standard hydrological measurements to study catchment runoff processes and pathways (e.g. Gibson et al, 2000). In the Sydney region, where water supplies are impacted due to changes in climatic conditions, the contribution and impact of groundwater and subsurface flow paths to streamflow and water quality are of increasing interest. In this study, high frequency rainfall and stream flow samples were collected during a major rainfall event in the Nattai River catchment near Mittagong and analysed for $\delta^2\text{H}$ and $\delta^{18}\text{O}$. In addition streamflow, rainfall and discharge to the river data for the catchment were obtained from the Sydney Catchment Authority (SCA) database.

The 441 km² Nattai River catchment comprises open grazing land and the township of Mittagong in the upper part of the catchment with predominantly native bush cover in the lower two thirds. Rain averages 1000 mm/yr at Mittagong, to <800 mm/yr for the lower reaches and is highly variable in space and time. Tributary creeks and urban discharges from the Mittagong area supply additional inputs, which flow down the Nattai River into Warragamba Dam. Meteorological and stream flow data is presented from three locations along the Nattai after a large 91 mm rain event on 30/6/2005 (Figure 1).

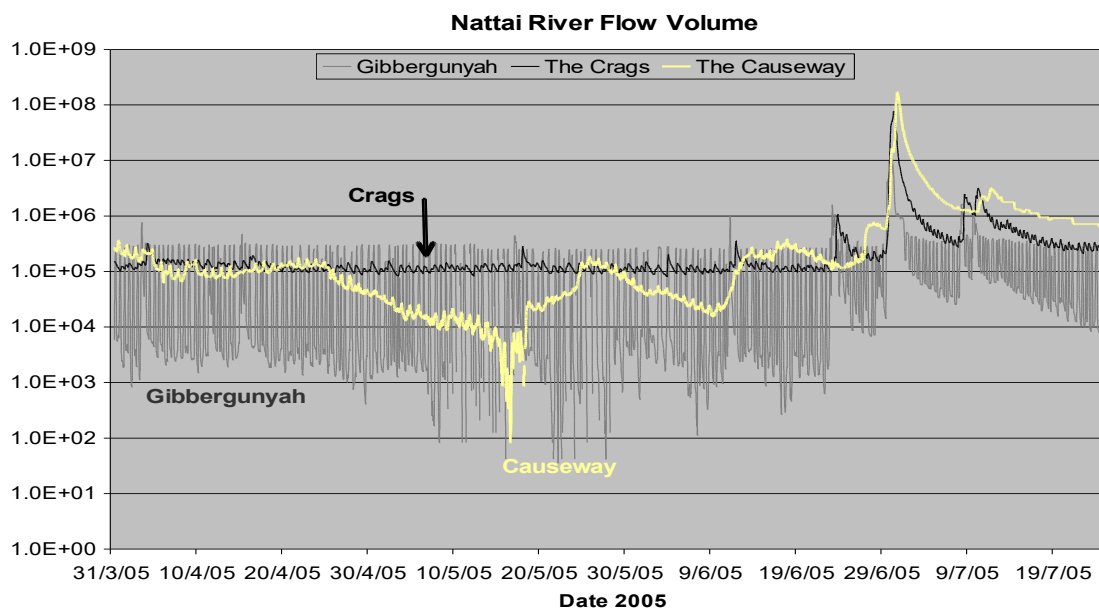


Figure 1 Nattai River flow at three SCA gauging stations from Gibbergunyah at the very top to the Causeway close to Warragamba Dam. Logarithmic scale for discharge volume. Oscillation due to effluent discharge (raw data obtained from SCA).

The 30/6/05 rainfall event represents the most significant flow in the Nattai River since October 1999 when Warragamba Dam was last filled. Data analysis shows:

- Only 16% of a large 91 mm, 24 hr rain event drains to the Nattai after a week; after a further 13.6 mm rain and 3 additional weeks the cumulative 4 week streamflow/rainfall ratio is 14.7%
- Urban discharges from the Mittagong area form 99% of flow volume at Gibbergunyah Ck (headwaters), 52% at the Craggs (mid catchment) and 73% of flow at the Causeway (lower catchment) between significant rain events

- Average Nattai dry weather discharge during 31/3/05-29/6/05 was comprised of an equivalent groundwater baseflow rate of 536 ML/yr and urban discharge rate of 572 ML/yr, with an apparent 324 ML/yr of gauged water losses from The Craggs to the Causeway in lower reaches possibly due to evaporation or sub-surface flow.
- Discharge for the month after high volume rain (29/6/05 – 26/7/05) was 3,726 ML.

Deuterium ($\delta^2\text{H}$) measured in high frequency rainfall and stream water samples is shown in Figure 2. Progressive depletion of $\delta^2\text{H}$ in rainfall occurs during the event ranging from 0.8‰ at the beginning of the event to -111.3‰ at the end with a volume weighted average of -61.1‰. The streamflow $\delta^2\text{H}$ minima is observed 6 hrs after rain ceased and coincides with the average rainfall $\delta^2\text{H}$ for this event (-61‰). Pre-event streamflow (-32.7‰) is slightly more enriched than the average of four local groundwater discharge bores sampled before and after the rain event with a $\delta^2\text{H}$ of -37.8‰.

Streamflow shows a clear isotopic response to this rain event. Mixing of event rainfall with pre-event waters is evident as the streamflow returns gradually towards the baseflow composition. This dataset will be used to estimate the varying contributions of pre-event waters or baseflow and event water through the event, and the dependence of infiltration and subsurface flow on rainfall intensity.

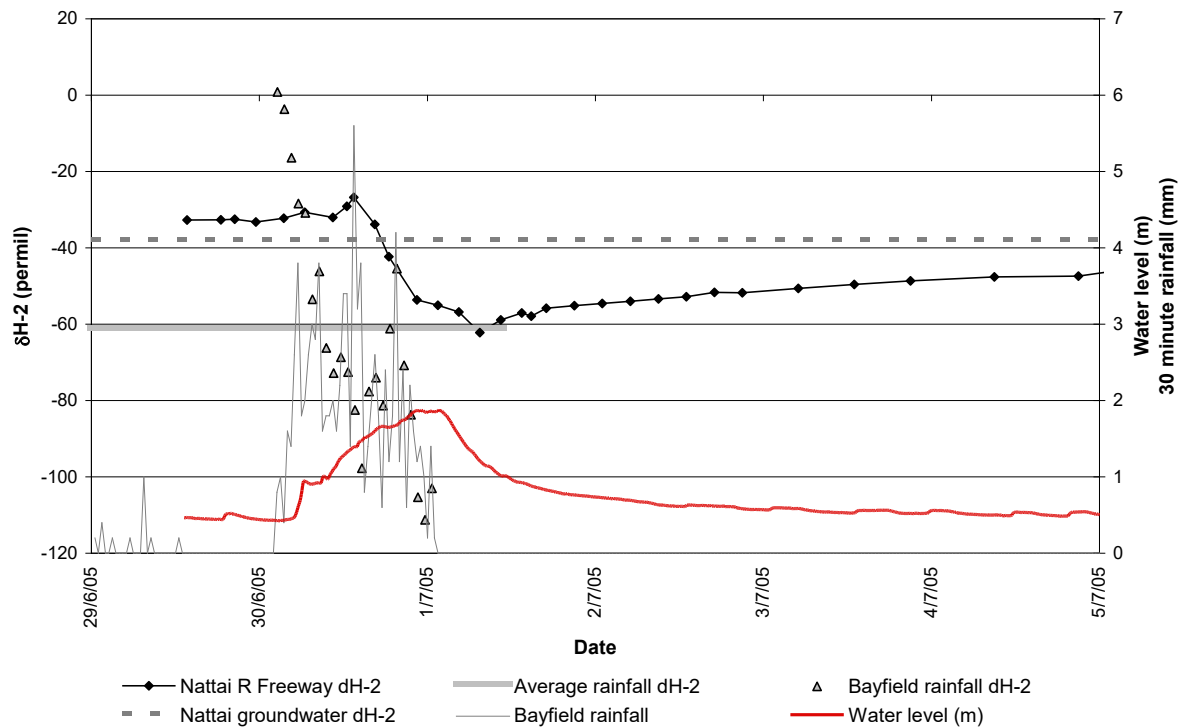


Figure 2 Hydrograph showing $\delta^2\text{H}$ in rainfall, streamflow and groundwater in relation to water level and rainfall in the Nattai River above Gibbergunyah Ck.

Acknowledgments

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References

Gibson et al (2000) Hydrological Processes 14. 2711-2730