



The impact of rainfall & flooding on watertable levels at Wakool

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Adapted from a research report by Shahbaz Khan, Butian Wang & Natalie O'Connell, CSIRO Land & Water

in a nutshell

- The Wakool Irrigation District has experienced a history of watertable rise, including likely contributions from widespread rainfall and flooding
- CSIRO was commissioned to quantify the contributions of rainfall and flooding on shallow groundwater, compared to on-farm management, to help develop targeted management actions to control watertable rise and salinity in the area
- In analysing rainfall-recharge relationships it was found that recharge occurred once rainfall in Wakool increased above 350 mm per annum
- A review of flooding across the region showed that areas which have previously been inundated are the first to be affected by watertable rise in subsequent flood events

Two studies conducted by CSIRO Land & Water clearly identified links between rainfall/flooding and rising watertables in the Wakool Irrigation District. Recharge from these events overshadows any management actions that can be implemented to manage shallow groundwater.

Watertables in the area have been declining in the last 10 years and a component of this is likely to be the result of management actions implemented as part of the Land and Water Management Plans. However, there has also been several below average rainfall years. We should remain aware that the effectiveness of the program will not be tested until we experience higher rainfall years, or possibly floods.

Wakool Irrigation District

The Wakool Irrigation District is one of four irrigation districts that make up Murray Irrigation Limited's area of operations (Figure 1). The Wakool Irrigation District covers approximately 210,000 ha. The climate is arid to semi-arid with average annual rainfall of 350–400 mm. The topography is very flat with the average ground slope being 1:5000 from the south east towards the north west.

Formal irrigation began in the region in 1935. The success of early irrigated enterprises led to the expansion of the irrigation area for a number of decades until water use stabilised in the 1980s. While this expansion of irrigation has brought benefits to the local economy, it has also seen

shallow saline watertables in the region rising to levels that threaten the sustainability of agricultural production.

The Wakool area sees the convergence of several rivers and creeks – Murray River, Edward River, Wakool River, Billabong Creek and Neimur River. The denseness of these waterways and the flat nature of the landscape make the area prone to flooding. This was displayed in 1956 when over 50% of the Wakool region was inundated. The regulation of Murray-Darling Basin rivers has however reduced the chance of this occurring in the future.

The Wakool community was interested in quantifying the impact of rainfall and flooding on their groundwater systems. On behalf of the Wakool community, the Murray Land and Water Management Plan Research Committee commissioned CSIRO Land and Water to carry out Geographic Information System (GIS) based investigations into the relationships between rainfall/flooding and watertable rise.

Impact of rainfall

Rainfall plays an important role in regional hydrology, including groundwater recharge. The researchers collated rainfall data from 84 stations around the Murray Irrigation area and utilised a GIS to create maps of rainfall distribution for both winter and summer periods for each year during the period 1965 to 2000. This allowed for detailed analysis of rainfall patterns over a series of years.



To help with quantifying the impact of rainfall on shallow groundwater levels, GIS was also used to analyse the spatial and temporal variations in piezometric levels. Piezometers are generally read biannually, at the start and end of the irrigation seasons. This allowed for the calculation of change in watertable depth as a result of rainfall and irrigation management for two periods – summer (irrigation season) and winter.

Years and seasons where the change was deemed to be the result of rainfall were isolated from all years/seasons, mapped to show these changes spatially, and volumes of recharge, discharge and available groundwater storage capacity were calculated. Correlation coefficients (r^2), comparing change in watertable level and volume of rainfall, were between 0.7 and 0.9 for all time periods studied, indicating that rainfall does have a significant impact on watertable changes in the Wakool Irrigation District.

The analyses revealed some interesting findings.

If the annual rainfall in Wakool is 350 mm or less, then the climate will have little impact on groundwater levels. In other words, the watertable change will be mainly caused by management actions.

The same relationship happens if the total summer season rainfall is 200 mm or less, or the total winter season rainfall is 170 mm or less. However, if these ‘threshold’ figures are exceeded, then recharge will occur as a result of climate.

In most instances the watertable changes in summer were compensated by watertable changes in winter. The analyses showed that the impact of rainfall on watertable rise is much more significant than management actions in winter.

Impact of flooding

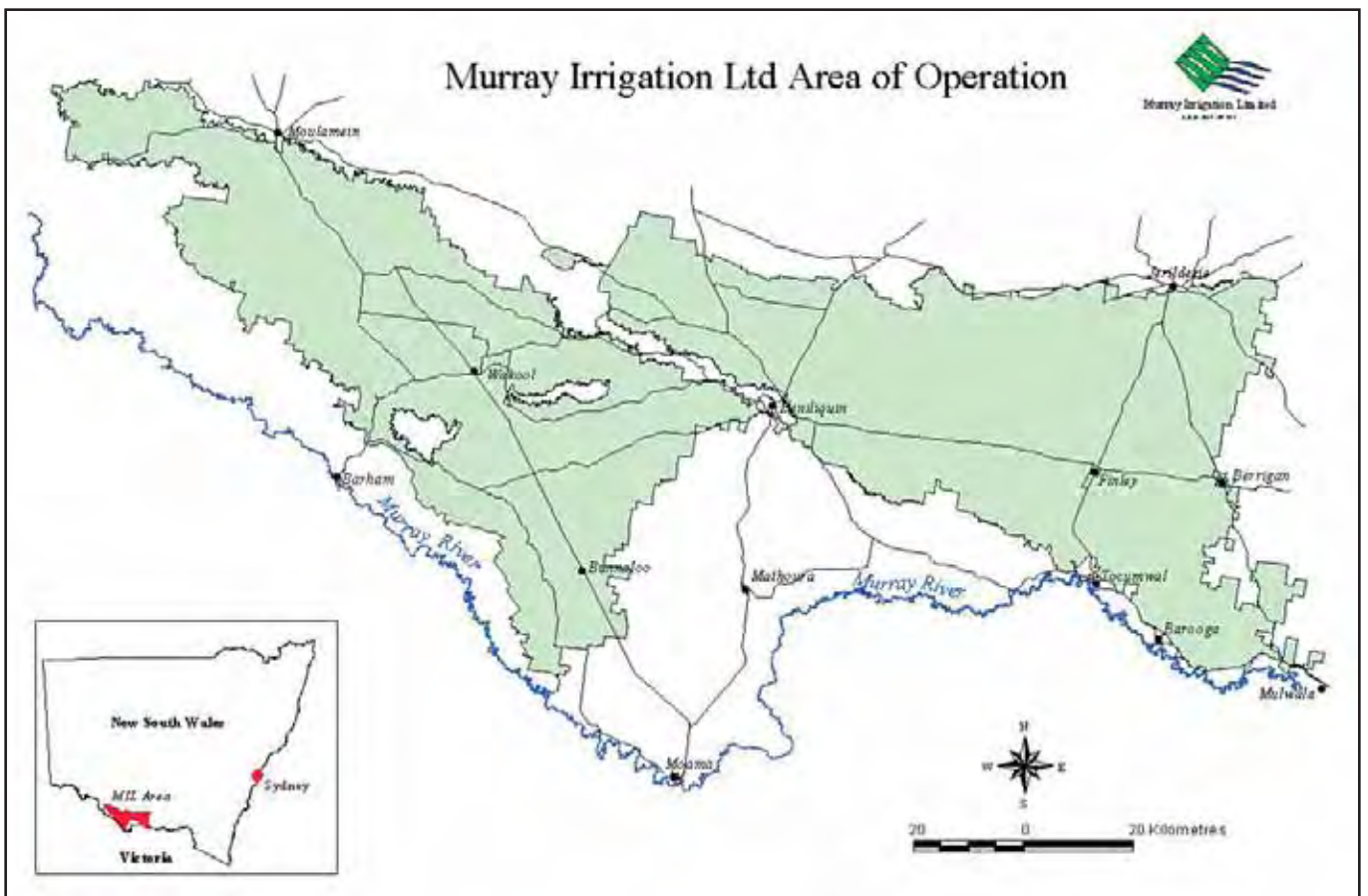
Following on from the rainfall investigations, this study again used GIS-based analyses to quantify the response of the shallow groundwater to major flood events in the Wakool area. The same piezometric and rainfall data was analysed to determine the spatial and temporal impacts of flooding as reflected by changes in watertable levels, and to quantify this impact by calculating volumes of net recharge following flood events.

Floods can be classified based on their cause:

- local rainfall
- rainfall in the upstream catchment areas
- water released from upstream storages
- a combination of the above.

Historical flood records were analysed and the wettest time within the study period was identified as the years 1973–75. There were 10 flood peaks that occurred in the Murray Irrigation districts during that time. The floodwater was generated both from local heavy rainfall and upstream discharges.

In order to observe the impact of the events on the shallow groundwater during this time period, all watertable levels post flooding were compared with the March 1973 levels. It was chosen as a reference date as no significant changes in watertable levels were observed prior to and significant changes were observed after this date. The comparisons showed that there was a significant change in the extent of the shallow groundwater in each of the three years (1973–75) with the watertable mound spread over the greatest





area in December each year. The most significant increase in watertable levels occurred between March and June 1973 where levels rose by up to three metres over 82% of the Wakool area.

The area of shallow groundwater continued to increase as flood waters continued recharging. Low lying areas filled and rates of groundwater recharge were highest in these zones. By December 1974, 96% of the Wakool region had experienced watertable rise of greater than half a metre and 75% of the area rose by more than one metre compared with March 1973 levels.

A comparison of the extent of both the 1956 and 1973–75 floods was made and showed that those areas inundated in both events experienced the largest rise in watertable levels.

At the peak of the 1973–75 floods, between September and December 1974, watertables had risen on average by 1.58 m from March 1973 levels, to an average depth of 3.28 m. By the end of the flood event in 1975, the average depth to watertable had risen to 3.13 m (Figure 3).

Apart from flood magnitude, the amount of flood water recharged to the groundwater is also related to the available groundwater storage capacity. The higher the watertable, the less storage capacity is available. In the early stages of the wet period of 1973–75, watertable levels were relatively low and as a result the rate of recharge was high (70,100 ML). When the next event occurred in 1974, as the watertables were already high, the recharge was reduced to 55,200 ML. And by the last event in 1975, recharge was further reduced to 44,200 ML. It is interesting to note that the combined net recharge in Wakool during the three years 1973–75 was around 12 times greater than the recent volumes of annual pumping from the Wakool-Tullakool Sub-Surface Drainage Scheme (WTSSDS) (approximately 14,000 ML/y).

As watertables began to recede another pattern emerged; the highest watertables were discharging (going down) at a faster rate. It appeared that the higher watertable was creating a hydraulic gradient to the deeper groundwater and allowing for increased evaporation due to its proximity to the soil surface. As such, groundwater recession gradually slowed

with time subject to weather conditions and management actions following the flooding.

In analysing rainfall for the full data period it can be seen that prior to the 1973 flood, the watertable fluctuated up and down, not far away from the March 1973 level. However, after the 1973–75 wet period, watertables rose considerably and have not shown any signs of returning to pre-flood levels. Even by March 2001, the average depth to watertable was still 0.82 m above the March 1973 level. This is except for within the area of influence of the Wakool-Tullakool Sub-Surface Drainage Scheme (WTSSDS) which maintains watertable levels at pre-flood conditions to ensure the sustainability of agricultural production in the region.

Summary

In summary, the two studies clearly identified links between rainfall/flooding and rising watertables. Recharge from these events overshadows any management actions that can be implemented to manage shallow groundwater.

The Murray Land and Water Management Plans are implementing targeted management actions to manage watertable levels in the region including:

- development of farm plans and irrigation recycling systems to increase the efficiency of water use on farm
- increasing the areas of native vegetation to utilise excess water in the soil profile
- operation/expansion of the Wakool-Tullakool Sub-Surface Drainage Scheme to maintain watertable levels at an acceptable depth in the Wakool region.

These actions are aimed at managing specific problems, reducing watertable recharge and to increasing the overall groundwater storage capacity across the region.

Although we have experienced declining watertables in the last 10 years and a component of this is likely to be the result of the LWMPs, we have also experienced some below average rainfall years. We should remain aware that the effectiveness of the program will not be tested until we experience higher rainfall years or floods. ☁



Figure 2: The links between rainfall/flooding and rising watertables in the Wakool Irrigation District have been clearly identified, and recharge from these events overshadows any management actions to manage shallow groundwater.

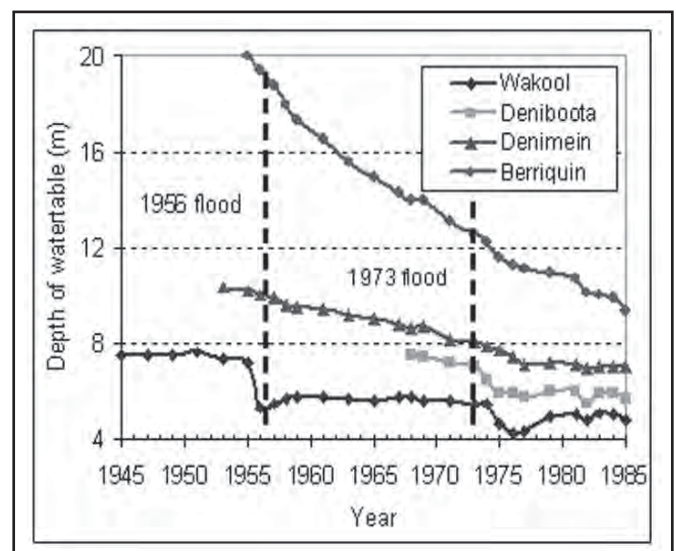


Figure 3: Depth of watertable in the Murray Valley irrigation districts, 1945–1985



Further information

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Further reading

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