Statistical assessment of chemical and hydraulic trends in groundwater of the Mooki River alluvium

Scott B. Cook[1, 2, 3], Wendy Timms[1, 2], Bryce F.J. Kelly[1, 4], Ross S. Brodie[3]
1. Connected Waters Initiative Research Centre, UNSW Australia
2. School of Mining Engineering, UNSW Australia
3. Geoscience Australia
4. School of Biological Earth and Environmental Sciences, UNSW Australia

The Mooki River is situated in the New South Wales headwaters of the Murray-Darling Basin. Groundwater in the alluvium is essential for agriculture, town water and environmental flows. Irrigation extraction has caused widespread groundwater level decline while proposed coal mines are predicted to cause localised drawdown in the alluvial aquifer. Previous studies have considered the relationship between extraction and changes in groundwater level and salinity in a general sense up to 2011. However, in part due to incomplete chemistry records, a comprehensive, integrated assessment of historic groundwater level and chemistry data has to now been lacking. Further, previous studies relied on bimonthly groundwater level records precluding assessment of higher frequency hydraulic response. We aimed to address these analysis gaps by characterising chemical and hydraulic trends dating back to the 1960's and analysing high frequency hydraulic data. We aimed to relate these trends to hydraulic connectivity and anthropogenic and environmental stresses to improve our understanding of system behaviour. Historic groundwater chemistry records were quality-checked and supplemented with additional sampling. Manual water level readings were historically recorded bimonthly in state monitoring bores. We recorded water levels with dataloggers at 15-minute intervals in representative boreholes for comparison. Time series data were analysed using multivariate statistics and interpreted in the context of lithological setting, groundwater extraction and climatic variability. The 15-minute interval data enabled estimation of loading efficiency to distinguish loading response from recharge and an assessment of how monitoring frequency influences interpretation. Our integrated analysis provided insight into catchment processes and showed how long-term groundwater chemistry trends are related to hydraulic changes in the system. We recommend that to adequately characterise system response, lower frequency hydraulic observations should be supplemented with higher frequency data. Our increased system understanding can inform continuing effective groundwater management and enable improved predictions of future stress effects.