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Interpretation of Time Series Groundwater Monitoring Data Using Analytical Impulse Response Function Method to Understand Groundwater Processes Along the Murray River Floodplain at Gunbower Forest, Victoria, Australia

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Abstract : There is concern about the potential impact environmental flooding may have on groundwater levels and salinity processes in the Murray-Darling Basin. A study was undertaken to determine if environmental flooding of the Gunbower Forest has an impact on groundwater level and salinity which is in Victoria, Australia. To assess the impact, Impulse Response Functions (IRFs) are applied to time series groundwater monitoring well data in the area surrounding Gunbower Forest. It is found that rainfall is the primary driver of seasonal water table fluctuation, and the Murray River water level is a secondary contributor to the water table fluctuations. The dominant process that influenced the long-term water table level and salinity conditions is associated with pressure changes in the deep regional aquifer. The study demonstrates that groundwater level fluctuations in the vicinity of Gunbower Forest do not correlate with flooding (natural or managed). Groundwater recharge is calculated by applying the bore hydrograph method to the rainfall-attributed forcing function fluctuations. Data collected from thirty-three bores between 1990 to 2020 is processed to determine a 30-year average groundwater recharge rate. A 5% specific yield of the unconfined aquifer is assumed based on previously published data. It is found that the rainfall-attributed mean annual groundwater recharge varied between 2 mm/year and 189 mm/year with a median of 33.6 mm/year. Surface water recharge is also calculated by analysing the surface water attributed forcing function fluctuations and found to be as high as 37 mm/year, with most of the high values in the vicinity of rivers or agricultural land. There is a long-term regional aquifer declining trend where most water table bores have an average falling trend of 20 cm/year independent of rainfall over the past 30 years. It is found that the groundwater level beneath the Gunbower Forest is dominated by groundwater evapotranspiration. Evapotranspiration lowers the water table by as much as 0.5 m within the forest, thereby causing a relative groundwater level depression under the Gunbower Forest. Historical data shows that groundwater salinity in the area varies and has an electrical conductivity of up to 45 000 µS/cm (comparable to seawater). High groundwater salinity occurs both within and outside the Gunbower Forest as well as adjacent to the Murray River. Available groundwater salinity data suggests trends are generally stable; however, data quality and collection frequency could be improved. This study shows that at the majority of locations analyzed, the groundwater recharge occurred due to both rainfall and water loss from the Murray River. It is found that Deep groundwater pressures determined the base groundwater level, and the fluctuation of the deeper aquifer pressures determined the environmental interaction at the water surface. Local groundwater processes, such as high evapotranspiration rates in Gunbower Forest, have the capacity to lower the water table locally. The rise or fall of the regional aquifer water level has the greatest influence on the groundwater salinity in and around Gunbower Forest.

Keywords : groundwater data interpretation, groundwater monitoring, hydrogeology, impulse response function
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