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title: **Characterising groundwater dynamics in Western Victoria using Menyanthes software**

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Water table across much of the western Victoria, Australia have been declining for at least the last 10–15 years, and this is attributed to the consistently low rainfall for these years, but over the same period of time there has been substantial change in land use, with grazing land replaced by cropping and tree plantations appearing in some areas. Hence, it is important to determine the relative effect the climate and land use factors on the water table changes. Monitoring changes in groundwater levels to climate variables and/or land use change is helpful in indicating the degree of threat faced to agricultural and public assets. The dynamics of the groundwater system in the western Victoria, mainly on the basalt plain, have been modelled to determine the climatic influence in water table fluctuations. Previously, linear regression analysis was used to estimate trends in individual bores in the study area and thereby predict areas most at risk from shallow or rapidly rising groundwater (Pillai, 2003).

In this study, a standardized computer package *Menyanthes* (Von Asmuth et al., 2002) was used for quantifying the influence of climatic variables on the groundwater level, statistically estimating trends in groundwater levels and identify the properties that determine the dynamics of groundwater system. This method is optimized for use on hydrological problems and is based on the use of continuous time transfer function noise model, which estimates the Impulse response function of the system from the temporal correlation between time series of groundwater level and precipitation surplus.

In this approach, the spatial differences in the groundwater system are determined by the system properties, while temporal variation is driven by the dynamics of the input into the system. Results of 80 time series models are summarized in Table 1, with the model output parameter values characterized by their moments. The zero-order moment Mo of a distribution function is its area and M1 is related to the mean of the impulse response function. The relation is M1/Mo. It is a measure of the system's memory. It takes approximately 3 times the mean time (M1/Mo) for the effect of a shower to disappear completely from the system.

Overall, the model fitted the data well, explaining 89% (median value of R^2) of variation in groundwater level using the climatic variables (rainfall and evaporation) left without significant trend (-0.046 m/yr, on average), which is within the range of variable input standard error.

The average estimated system response (memory to disappear) is 5.2 years which is less than by 1/10th of the previously estimated time using Ground Water Flow System approach (Coram et al., 2000). The average Mo is 1.45 m, which means that a precipitation of 365 mm/yr will eventually lead to a ground water level rise of 1.45 m on the location.

The Menyanthes result is compared with HARTT (Hydrograph Analysis and Time Trends) method (Ferdowsian et al., 2001). The trend and Mo estimate using Menyanthes and HARTT show comparable result. From a time series analysis there is no indication that the groundwater table was rising/falling due to changes in landuse, at least not during the observation period.

Table 1. Statistical analysis results and model parameter estimates (median value).

Aquifer	Trend (m/yr)	Mo (m)	3×Mo/M1 (yrs)
Basalt	–0.046	1.45	3.4
Deep lead	–0.047	1.4	6.5
All bores	–0.046	1.45	5.2

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