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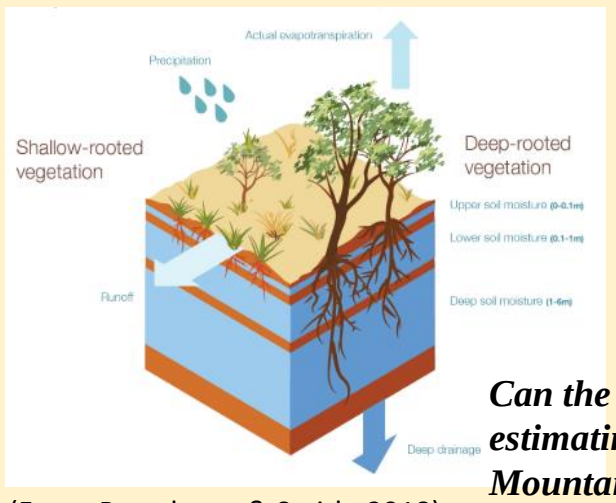
Improving the understanding of recharge in a basalt aquifer based on a soil moisture model, water levels and climatic data



(Frost, Ramchurn, & Smith, 2018)

Groundwater levels

Can the AWRA-L model be used for estimating recharge at Tamborine Mountain?

Purpose

Knowledge of recharge processes in groundwater resource areas is of great importance for developing sustainable water management plans. In an effort to enhance the understanding of recharge in a basalt aquifer, a national water balance soil moisture model was compared with the response in water tables in multiple private pumping bores across the Tamborine Mountain plateau located in South East Queensland, Australia.

Data

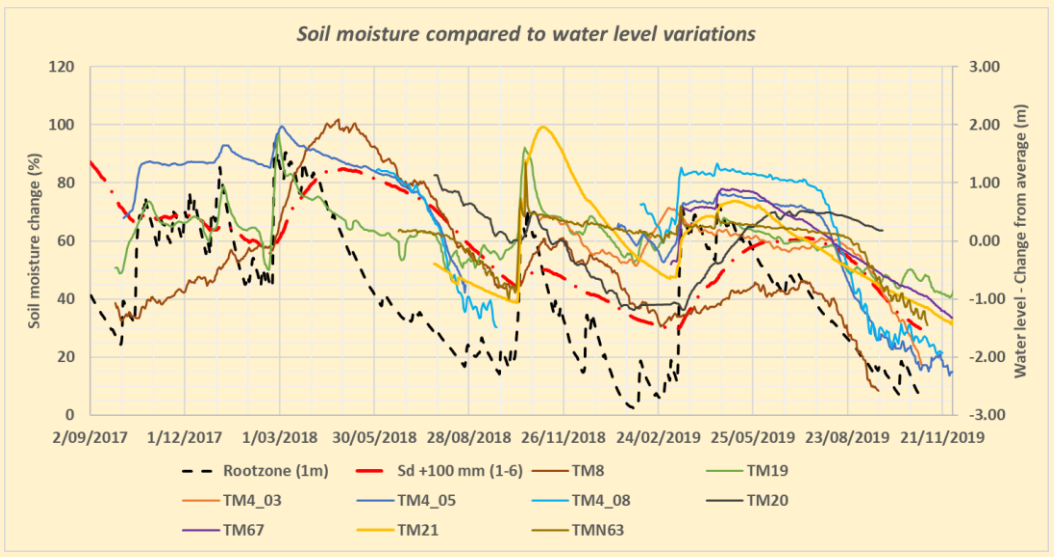
The water levels in the pumping bores were influenced by the everyday use of the bores, which are utilised for household supply, stock watering, garden watering and irrigation. In each bore, the pumping response was identified and filtered out before being compared to the soil moisture model results.

AWRA-L model results include soil moisture in % and mm for rootzone (0-1 m), upper soil (0-10cm), lower soil (10-100cm) and deep soil (6m). It also include rainfall, deep drainage (mm), runoff (mm), actual evapotranspiration (mm). This data for Tamborine Mountain was supplied by AWRA-CMS (BOM, 2020) for 01/01/2017-31/10/2019 (BOM, 2020).

Bore ID	Bore Depth (Screen) m	Daily highest used	Daily highest average (Days)	Exclusion (Exclusion)
TM4_03	92 (55-70 82-88)	Yes	Yes (4)	No
TM20	55 (40-52)	Yes	Yes (6)	Yes (Dh > 0.2)
TM8	50 (32-50)	Yes	No	No
TM4_05	30 (15-28)	Yes	Yes (6)	Yes (Dh > 1m and WL>10)
TM63	20 (N.A)	Yes	No	No
TM19	20 (N.A)	Yes	Yes (5)	Yes (WL > 10 m)
TM21	18.3 (12-17)	Yes	No	No
TM67	18.3 (7.5-15.4)	Yes	No	No

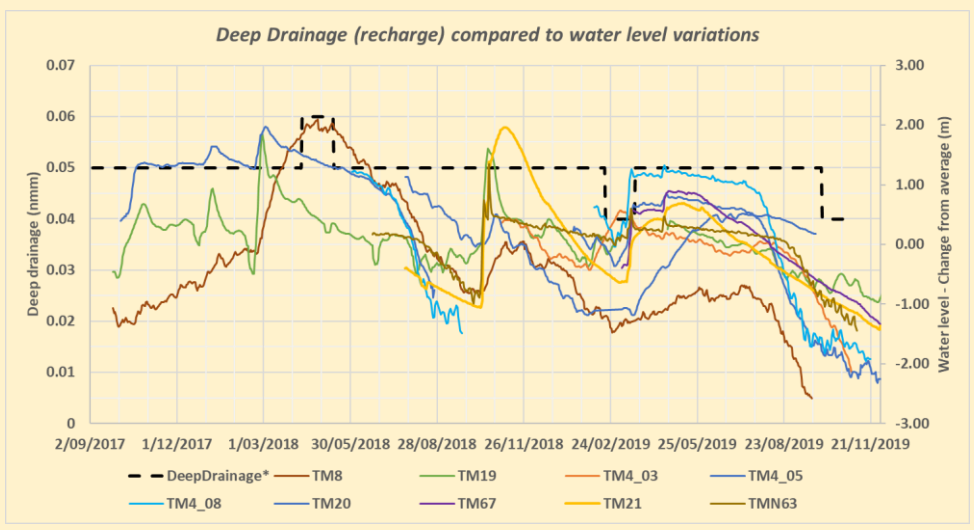
Corrections applied to water levels to adjust for pumping events. Dh is daily change in water table ((D-1) – (D)). WL is water level. Daily highest is highest water level recorded in a day.

Comparison



The simulated soil moisture levels in the rootzone (rootzone defined as depth between 0 - 1 m), showed a similar hydrographic response following rain events to that observed in water levels in the aquifer. The response in the aquifer compared to the soil moisture showed some of the deeper bores had a lag effect and furthermore, the response also showed dependency on the soil moisture level (%) and on the size/duration of the rain event. The simulated deeper soil (1-6 m) moisture showed a greater resemblance to the aquifer water levels, however did not capture the quick response to rainfall in the several of the bores.

It was observed that the simulated deep drainage (recharge) did not correlate to the observed changes in water tables. The soil moisture model simulated a nearly constant deep drainage (recharge) of 0.05±0.01mm a day, whereas the bores showed large increases in water table in response to rainfall events.



Findings

Year	Rain (mm)	Runoff (mm)	Actual Evapotranspiration (mm)	Deep Drainage (mm)	Deep Drainage/ Rainfall
2017	1614.9	428.7	1060.6	18.8	1.2%
2018	1102.2	245.0	1005.9	18.6	1.7%
2019	680.4	19.16	678.28	14.3	2.1%

Previous studies in the area based on the chloride mass balance approach have estimated the annual deep drainage/recharge is on average approximately 30% of annual rainfall, while the soil moisture model approach has simulated an annual deep drainage volume of 1.2 – 2.1% of the total annual rainfall. While these results show that there are shortcomings related to applying the soil moisture model to estimate aquifer recharge, these results are an important initial finding regarding the estimation of recharge in the study area and can be used in water balance calculations for water management purposes.

Future

The observed variations in modelled deep soil moisture showed correlation in trends with water level variations. With further research into the observed relationships and parameterisation of these relationships, the soil moisture model together with water levels can be used to represent recharge within this, and similar, study areas.

References:
Frost, A. J., Ramchurn, A., and Smith, A. (2018). Technical Description of the Australian Water Resources Assessment Landscape (AWRA-L) model version 6. Bureau of Meteorology Technical Report.
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