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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Using multiple methods to understand groundwater recharge in a semi-arid area" *by* Shovon Barua et al.

Anonymous Referee #3

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This is an interesting study comparing different methods of estimating recharge. It is well written and organised, but needs more thought in the interpretation.

1. There is some confusion in the paper about specific yield. Specific yield is, as the authors quote, "the volume of water that an unconfined aquifer releases from storage per unit surface area of aquifer per unit decline in the water table". This is the water that drains from the aquifer under the influence of gravity as the water table falls. As the water table falls, some water remains in the smaller pore spaces and as rims and menisci around grains. This definition does not "ignore the moisture in the unsaturated zone held in and above the capillary fringe". The moisture in the unsaturated zone does not drain significantly. The capillary fringe is saturated (not unsaturated) and moves downward with the watertable at the same rate. Therefore the reason that the

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Discussion paper

WTF method of estimating recharge gives unrealistically large values in this study is not the result of "the presence of moisture in the unsaturated zone and capillary fringe .. reduc(ing) the effective values of Sy".

2. There is also some confusion about porosity and effective porosity. Effective porosity is the porosity through which fluid can flow and is almost always less than total porosity. Effective porosity is generally similar to, or slightly less than, specific yield, as shown by comparison of Sy values from pumping tests and ne values from Darcy's Law (ne = Ki/v). In this study, values of Sy, n and ne are used interchangeably, and the authors need to correct this or at least explain why they used these values. Previous studies found Sy values of 0.03 to 0.1 and mean porosity of 0.1-0.15; in this paper values of Sy of 0.03 to 0.1 were used for the WTF method, whereas for the mass balance calculation (line 365) and the TRR method, n values of 0.03 to 0.1 were used. The latter are likely to be too low and will make the TRR numbers calculated also too low.

3. Note that "if the soil becomes fully saturated due to the rise of the capillary fringe", the top of the capillary fringe is at the ground surface and therefore no recharge can occur. Small recharge events cannot "produce significant and rapid increases in the head". This has no effect on the amount of water that can drain from the aquifer when the watertable drops, so Sy does not become "close to 0".

4. Another puzzling aspect is the definition of b for calculating TRR; b is "the thickness of the upper part of the aquifer system that receives annual recharge". Is this the part of the aquifer that is subject to water table fluctuations, i.e. is b equal to the maximum fluctuation? If this is the case, why not use this value? In this paper b is estimated from chemical stratification of regional groundwater (p. 18). But if the groundwater is stratified, then this could be because the upper part is not recharging the lower part, i.e. there are two separate aquifers. Alternatively, the chemical stratification could reflect the difference in recharge since clearing of native vegetation in the area. In either case, use of chemical stratification to estimate b is unjustified, and the presence of chemical stratification has implications for the CMB calculations; there should be

separate calculations for the upper and lower groundwater.

5. The forest bores show relatively small seasonal fluctuations compared to pasture bores, and some show no fluctuations at all (Fig 2). Yet the WTF recharge values for the forest are the same as those for the pasture (Fig 6). This seems very unlikely and requires explanation.

6. The WTF values calculated are not just unlikely and higher than expected, they are impossible. Recharge of this magnitude would imply that the vegetation was not extracting significant levels of water, and the consistent drop in the watertable beneath the forest shows that this is not the case.

7. The authors note that "there has been a rise in the water table caused by the increased recharge, and in some cases increased drainage in the streams"; what is the evidence for this in the study area? This topic has been much discussed in the Australian groundwater literature, and needs more discussion and explanation, with comparison with other areas in SE Australia.

8. Rainfall was sampled for tritium content. The sampling method needs to be briefly described and the results given in Table S1 (not a single average value).

9. The aquifer is described as "silty clay to coarse-grained sediments" and as comprising "interlayered clays and silts". Silts are not coarse-grained and the porosity values (o.1-0.15) suggest sandy sediments. The authors need to resolve this.

10. There are a few small grammatical/spelling errors: lines 107, 263, 295-296, 342, 358, 429.

11. Fig 2 would be better plotted as depth bgs.

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