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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 #2

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The authors present an interesting case study in a semi-arid area in Australia. They used three recharge estimation methods for two small catchments subject to landuse change. Based on the Chloride mass balance (CMB), Tritium renewal rate (TRR) and Water table fluctuation (WTF) method recharge rates were estimated. Moreover mixing between older and recently recharged groundwater as well as mean residence time was calculated. Recharge rates are relatively modest but the WTF overestimate recharge rates due to a simplified used of a constant Sy. A stratification was identified where the older groundwater can have a mean residence time of ∼25000a and the thickness of the upper part of the aquifer system that receives recent recharge is less than 5 m.

Overall, the paper is well written and the results are solid. However, the most critical

point I see is that the study do not provides a broader context. How does the results impact water management for the study area and for the region. Regarding the uncertainty in the estimated recharge rates and spatial and temporal variability, it is not obvious for me how sustainable water resource management can set-up. Perhaps the authors have some thoughts about this problem and might provide some suggestions. Moreover, if one of the objectives of this study is to assess and compare uncertainty in the methods, then this has to be more elaborated and systematically compared. In addition, these results should be compared to similar studies. Furthermore, I miss a conceptual model which describe the processes. That can be a schematic figure or a cross-section describing the different flow systems and geochemical signatures.

Some further comments and suggestions are provided below. Introduction: Personally, I believe that the study objectives should be clearly communicated in 1. Introduction. I found it a bit confusing to get information about the different methods before knowing the target of the study. Line 48ff. Not only in semi-arid areas recharge varies in space and time. Also in humid areas recharge can be considerable spatially and temporally different (see for example, Moeck et al., 2020 and Mohan et al., 2018, among many others) Line 50ff: You could add Darcy methods, soil moisture methods, heat tracers, baseflow separation techniques, empirical relationships, etc. for completeness of the provided list (see for instance Healy 2010, Walker et al., 2019). Section 1.1.1. When residence times are around ∼25000 years, how likely is that all Cl is originating from rainfall only and the impact of runoff can be neglected. This is more a questions rather than a critic. You already indicate based Cl/Br ratios that evapotranspiration rather than halite dissolution is the main process in controlling groundwater salinity but would could be the error in estimated recharge rates if a small amount of Cl is not only originating from precipitation? Line 85ff: In the study area with an actual ET of ∼600 mm/a, to what depth can ET impacts be observed. I am asking because I am not sure if the observation wells 3008 (depth 1.3, pasture) and 3657 (depth 2.5 m, forest with deeper root zones) can be reliable used by applying the water table fluctuation method, although I have to note that the estimated rates seems to be in the same range like for

the other observation points. Line 295-297: Maybe I misunderstood something here, but did you not indicate that all Cl is delivered by rainfall (e.g. Line351). Please check the statement and maybe reformulate the second part of the sentence. Line333ff: Not clear. Please explain why it is not possible. Line392ff: Just from Fig.4 it is not possible to identify the samples. Perhaps you can better highlight these samples in Fig. 4 or provide the link to Table 1. Apart from that I am wondering that location 3663 do not show mixing with older groundwater, even though it is one of the deepest location ($\sim$25m) and based on the drawn picture with the stratification I was expecting that older groundwater exist. Moreover, the decline in the groundwater level for 3663 is uniformly over the monitoring period, which is in contrast to the wells 3657 and 3669. But for all these the TRR is applied and no mixing is assumed. Could you please elaborate more on these differences? Line 491ff: Yes, I absolutely agree and this is an important point. The question which arise from the results is how we can set-up sustainable water resource management then when we have such a spatial and temporal variability as well as uncertainty on $\sim$500 ha. Perhaps the authors have some thoughts about this problem and might provide some suggestions. Line 495: Although I agree that physical based models are useful tools, the models will likely not represent in every detail the recharge processes because of the lack of observations although a relatively high density of data exist and information about the subsurface heterogeneity are missing (in both, xy and z direction). Thus, calibration is required which will also lead to uncertainty. For me, this part sounds like we always should use physical based models and then we get the right recharge rates which is obviously not true, even though the models are very powerful. Please reformulate. Figure 1: If available, it would be useful to add the precipitation on top of the graphics (second y-axis). Also why does well 3658 show an increase?

Healy, R.W., 2010. Estimating Groundwater Recharge. Cambridge University Press.

Moeck, C., Grech-Cumbo, N., Podgorski, J., Bretzler, A., Gurdak, J. J., Berg, M., & Schirmer, M. (2020). A global-scale dataset of direct natural groundwater recharge

rates: A review of variables, processes and relationships. Science of The Total Environment, 717, 137042.

Mohan, C., Wei, Y., & Saft, M. (2018). Predicting groundwater recharge for varying land cover and climate conditions–a global meta-study. Hydrology and Earth System Sciences, 22(5), 2689-2703.

Walker, D., Parkin, G., Schmitter, P., Gowing, J., Tilahun, S. A., Haile, A. T., & Yimam, A. Y. (2019). Insights from a multiâĂŘmethod recharge estimation comparison study. Groundwater, 57(2), 245-258.

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