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 the 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 water table at the same rate. Therefore, the reason that the 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 S_y*".*

We agree with the point raised in this comment and it is what we tried to explain in Section 1.1.2. Many applications of the WTF method have assumed a value for S_y that is close to the effective porosity. As the reviewer correctly points out, the value of S_y needs to take into account the moisture content of the unsaturated zone and will be less than the effective porosity. This was discussed in detail by Crosbie et al. (2005, 2019) as noted in the text. The consequence of assuming that S_y is equivalent to the effective porosity is to overestimate recharge using the WTF method (as discussed in Section 5). Nevertheless, many studies using the WTF method make this assumption, and this is something that we wanted to draw attention to. This section will be clarified to emphasise that what we were discussing a common assumption made around S_y when using this method.

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 the comparison of S_y *values from pumping tests and* n_e *values from Darcy's Law (*$n_e = Ki/v$*). In this study, values of* S_y*, n and* n_e *are used interchangeably, and the authors need to correct this or at least explain why they used these values. Previous studies found* S_y *values of 0.03 to 0.1 and mean porosity of 0.1-0.15; in this paper values of* S_y *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 is likely to be too low and will make the TRR numbers calculated also too low.*

Again we agree with the reviewer and will clarify this in the paper. As discussed above, the assumption that S_y is similar to the effective porosity is one that is commonly made for the WTF calculations but one that is probably incorrect (as we discussed in the paper). The values of porosity used in this study are those from Adelana et al. (2014) and are similar to typical values for these aquifer materials. We can discuss the uncertainties in the TRR recharge estimates arising from these values in Section 5; however, given the nature of the aquifer materials, they are unlikely to be significantly higher and the uncertainties arising from having to estimate b and the input function of ^3H are probably greater. Overall, the TRR recharge rates are still considerably higher than those from the CMB method but lower than the WTF estimates.

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 water table drops, so S_y does not become "close to 0".

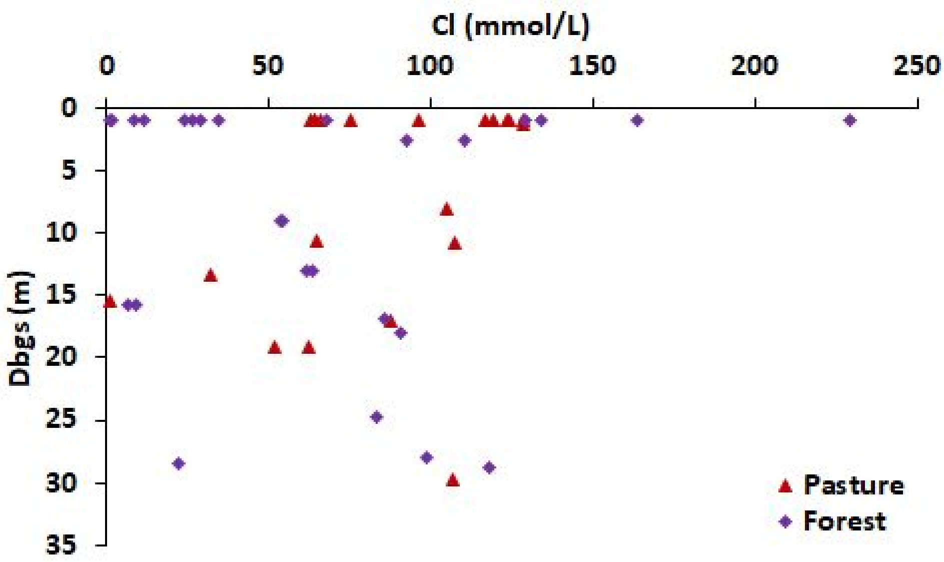
This discussion was taken from Gillham (1984). The water levels that are measured in the bores correspond to the water table and not the top of the capillary fringe, which is not under positive pressure. As small amounts of water are added at the top of the capillary fringe, part of that water becomes pressurised and the head increases. As noted above, we probably over-complicated this discussion and the main point (which is that many applications of the WTF method misassign the S_y value) got lost. We will omit this detail as it distracts from that point.

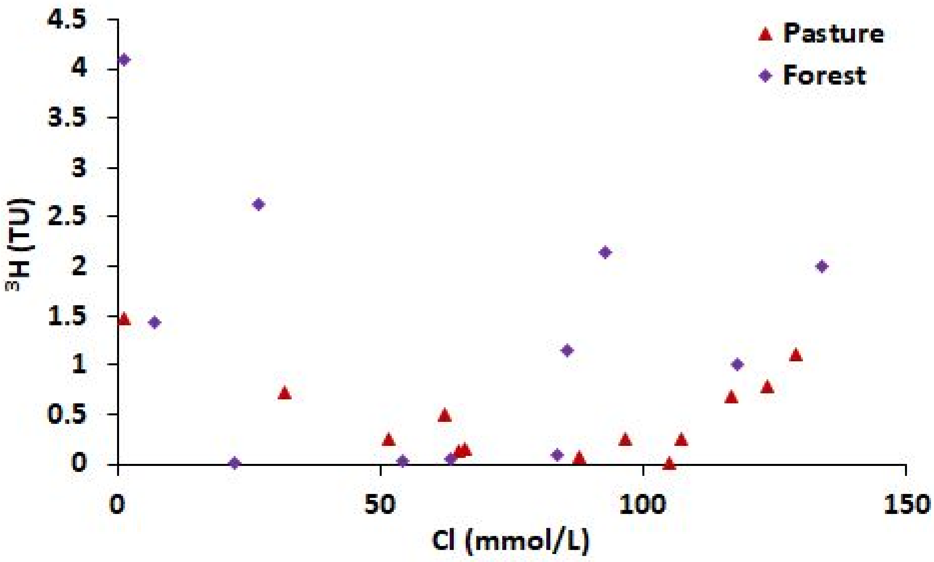
4. Another puzzling aspect is the definition of b for calculating TRR; b is "the thickness of the upper part of the aquifer system that receives annual recharge". Is this the part of the aquifer that is subject to water table fluctuations, i.e. is b equal to the maximum fluctuation? If this is the case, 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 the clearing of native vegetation in the area. In either case, the 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.

We defined b in section 1.1.3 and 4.5.3 using observations of chemical stratification. The value of 1 to 5 m is the distance at the top of the aquifer over which the groundwater chemistry is relatively uniform. These values of b are similar to those proposed elsewhere (Le Gal La Salle et al., 2001; Cartwright et al., 2007). We discuss the uncertainties in the b values in section 4.5.3; increasing the depth of the zone of active mixing at the top of the aquifer to 10 m (which is unlikely given the observations of the depths over which the geochemistry varies) would increase the recharge rates but the differences between CMB, WTF and TRR recharge rates remain significant. Using the WTF to estimate b at the top of the aquifer is not generally done; however, it would yield a similar estimate of b, and we can discuss this.

There is no evidence of two separate aquifers; the bore logs do not indicate any major low K layers and the groundwater generally contains measurable ^3H at depths of up to 29 m (Table S1). This precludes the presence of a deeper groundwater system that is isolated from the shallower part of the aquifers. The joint use of ^3H and ^{14}C activities allows macroscopic mixing of old and recently recharged groundwater in the aquifers to be tested (Fig. 4), which also implies a single flow system and adds confidence to the TRR calculations.

In terms of the CMB technique, if recent recharge rates have changed due to land clearing, the Cl concentrations in the upper part of the aquifer may be lower (this might be expected mainly in the pasture catchment). However, the Cl concentrations of the shallow and deeper groundwater overlap and there is no correlation between Cl and ^3H (see below). This probably reflects the timescale of Cl delivery. Because Cl in saline groundwater may take several thousand years to accumulate, recent changes in evapotranspiration (which reduce the Cl concentrations) are not yet visible in the groundwater. Thus, the CMB recharge rates represent the average of those over the last several hundred to thousands of years. This has also been noted elsewhere in SE Australia (Cartwright et al., 2007; Dean et al., 2015). It is an interesting point that we can discuss in the revised manuscript.





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.

In the Forest, the annual variations of the head in bores 3656, 3657 & 3669 are up to 3 m, which is similar to many of those in the Pasture catchment (Fig. 2). These are the bores that yield high WTF recharge rates. As we discussed in section 5.1, the trees cover ~62% of the forest catchment, and many of the bores are in cleared areas between the stands of trees (Fig. 1a). So, the recharge rates may not be representative of the forest as a whole and are similar to the cleared areas in the pasture. This is discussed in Section 5.1, but we will make sure that this is clear in the revised paper.

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 water table beneath the forest shows that this is not the case.

This is what we concluded in the paper (Section 5). As we discussed above, the WTF method commonly uses an estimate of S_y that is based on the effective porosity. As noted by this reviewer and as we noted in the Introduction, this is one of the failings of the method. The consequence of doing this is to overestimate S_y and to thus overestimate the recharge rates using the WTF method. Other studies have demonstrated that the WTF method yields higher recharge rates (Cartwright et al., 2007; Crosbie et al., 2010) and Crosbie et al. (2019) discussed this topic more generally. Nevertheless, the WTF method with this assumption of S_y remains widely used as we also discussed. We also explored other reasons why the WTF method yields high recharge rates (e.g., focussed recharge and the subsequent evaporation of water from the water table - Section 5). While these are also issues, the incorrect assumptions around the S_y are probably more serious.

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 the comparison with other areas in SE Australia.

The Gatum area is one of many in SE Australia that was identified as being impacted by dryland salinity due to land clearing and rising water tables (Clark and Harvey, 2008: Dryland salinity in Victoria in 2007, Department of Primary Industries Report). The area has common saline discharge to streams and local salt scalds. The bore monitoring and streamflow network were set up in the pasture catchment in this area on that basis. During the Millennium Drought in the first decade of the century, the water table levels dropped considerably and the emphasis on soil salinity diminished. The focus of water management in the area switched from salinity to water availability and the effect of land use on the water balance of these catchments. Accordingly, monitoring in the forest was set up to assess the subsequent impact of the tree plantation on the groundwater and surface water. We can add these details to the study area and emphasis that it is typical of many of these 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).

A one-year aggregated rainwater sample was collected in a narrow-mouthed container with an open funnel. We periodically removed the sample from the container and stored it in the lab (adding the subsequent rainfall to that sample). The value in Table S1 is the aggregate value, not an average. We will clarify this in the revised manuscript.

9. The aquifer is described as "silty clay to coarse-grained sediments" and as comprising "inter-layered clays and silts". Silts are not coarse-grained and the porosity values (0.1-0.15) suggest sandy sediments. The authors need to resolve this.

The aquifer materials are mainly silts to coarse-grained weathered ignimbrites with minor discontinuous clay layers. These are described by Brouwer & Fitzpatrick

(2002) and Adelena et al. (2014) who also report aquifer properties such as porosity. We will be consistent in the revised paper.

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

We will correct grammatical/spelling errors in these lines.

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

Because we use Fig 2 to discuss heads in the catchment and this figure links to the head values in Fig. 1b, we prefer to leave this as it is. The individual bore hydrographs are also more easily seen on this version of the Figure. We will add rainfall to Fig. 2 as requested by the other reviewers.