

Interactive comment on “Where to locate a tree plantation within a low rainfall catchment to minimise impacts on groundwater resources” by J. F. Dean et al.

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This is an interesting study that would be a welcome contribution to the understanding of landscape change and recharge. Having said this, the main part of the paper (Section 4) needs a fair bit of attention. This section is poorly set out and presents interpretations ahead of data being presented. More importantly, the level of justification of the conclusions is not always convincing and there is a fair amount of data (the 3H & 14C) that are underutilised.

As it stands I don't think that the paper does itself justice and in its present form would

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not have the impact that it deserves. This would be a pity as it is clear that there are a lot of carefully collected data here and the overall conclusions are probably correct. I have made several suggestions below, but the main one is that the authors be more clear and rigorous as to how they deal with their data. I hope that the comments are useful in revising the paper.

Abstract

The abstract is a clear indication as to what the paper will discuss but it could use a few more details (e.g. some key values such as the recharge rates, the timescale of land clearing etc). Also be clear as what you mean by terms such as “low rainfall” as they are rather subjective – to be clear put the definition in here. Try to make sure that the abstract gives the reader a clear understanding of the key results as it will improve the impact of the paper.

Page 10002 Lines 14-20. The conclusion that recharge occurs mainly in the lower regions of the catchment may not be common (it certainly is not the “textbook” situation). I presume that it is due to some local effects (geology etc). However, here it is conveyed as a general conclusion, which I'm not sure will be the case.

Introduction

The first paragraph presents a good general introduction to the rationale behind the study and places it in the appropriate broader context. I am not certain that I fully agree with the first statement in all cases. For example, in Australia where this study is set, land clearing which removed the very water-efficient native vegetation caused a major increase in recharge (and the attendant dryland salinity problem). Plantations may get the landscape back to their pre-clearing high E-T state. Are there any estimates as to whether plantations decrease recharge over and above what they were pre-land clearing?

Page 10003, Lines 8-11. This statement wouldn't mean much to anyone not familiar

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with SE Australia. This is essentially the dryland salinity problem that is being addressed. You need to be more specific as what the impacts and problems are.

Page 10003, Lines 13-25. While the historical context is interesting, I don't think that you need it. It is well understood that groundwater recharge in semi-arid areas can occur from ephemeral stream channels etc. Just say that with reference to the reviews by Scanlon et al.

Page 10003-10004. While the choice of references is somewhat subjective, I was surprised that Cartwright et al. 2006 (Constraining modern and historical recharge from bore hydrographs, 3H, 14C, and chloride concentrations: Applications to dual-porosity aquifers in dryland salinity areas, Murray Basin, Australia: J Hydrol, 332, 69-92) is not cited. This paper provided recharge estimates in cleared landscapes in SE Australia, discussed that recharge occurred away from the hills, and looked at the implications for tree planting as a mitigation mechanism; it also used some of the similar techniques.

Background

This is well described and gives a clear indication of the main elements of the study site.

Page 10006, Lines 4-9. I presume that the rainfall is a long-term average, but the stream hydrographs may not be. Can you specify the timeframe that these data are collected over and give a more context? The reason for this is that given your reported variability in rainfall, if the hydrographs on the stream only represent a dry or wet period then they are likely not to record the overall situation. Also are the lengths of the hydrographs similar (for the same reason).

Page 10006, paragraph starting Line 24. The material in this paragraph is oddly ordered – discuss when and how the bores were constructed first and then the monitoring. Methods

Section 3.1. I am surprised that rainfall (or more particularly throughfall) was not mea-

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sured onsite. Given that one of the impacts of trees is that they intercept rainfall, this would have been valuable. Are there throughfall data from this or adjacent sites.

Section 3.1. You mention that groundwater inflows are low, which they may be; however, are the streams ephemeral (if not they have a long-term water store somewhere in their catchment, e.g. in the regolith). This would be worth mentioning in Section 2.

Sections 3.3-3.4. While the methodology for these techniques is discussed elsewhere, you need to add a few more details here (analytical techniques for 14C & 3H and the detection limits and precision of the various techniques as a minimum). The reader needs to understand this without having to trawl through other references.

Section 3.5. Similar with the Rn, what is the precision of the analyses?

Section 3.6.1, Page 10011, Lines, 7-19. This paragraph is confusing. It commences with a discussion of the steep recession limbs which aren't well explained (all you say is that these steep limbs have been noted elsewhere, what is more important is why and whether there are implications for the WTF technique). The latter part of the paragraph discusses discharge and it is not clear how it relates to recharge estimates.

Section 3.6.1, Page 10011, Lines, 25-30. The barometric pressure correction is a worry! I cannot think of why there would not be the usual inverse correlation. I presume that your loggers are unvented and that you used the barometric pressure from onsite or from the nearby weather station which should be close enough. However, the fact that you see a positive correlation needs more thought / explanation (as with the point above it is why it exists that is important).

Section 3.6.2. The assumed Cl concentration in rainfall of 4.3 mg/L seems very high by global standards and is also much higher than in Blackburn & McLeod, 1983 (Salinity of atmospheric precipitation in the Murray Darling Drainage Division, Australia. Austr J Soil Res 21, 400-434) which is a more comprehensive survey than Hutton & Leslie.

Results and Discussion

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There is a lot in this section, but the order that it is discussed in is difficult to follow. For example in the first section (4.1) there are interpretations that are based on the grain size data and groundwater ages; however those are not yet presented. While I don't necessarily consider that papers cannot mix results and discussion in the same section, the results need to be presented first. Sections 4.1 and 4.2 should go much later as they are mainly interpretations based on your data. While this is the exciting part of the study, the reader needs to be led through the logic a bit more.

Section 4.3. It would be much better to start off with some of this material as here are the data that you base the interpretations on

***Having read through Section 4 two or three times, I think that you need to reorder it and attend to several rather superficial conclusions and interpretations. This is not being over pedantic, but it is difficult to follow and it detracts from what is really a solid study. As it stands you have the potential to confuse or not to convince the reader which will mean that the study does not have the impact that it deserves.

Firstly, present the data early on. There are observations mixed up with the interpretation and although it does necessarily not make for exciting reading, presenting your data first will at least mean that you ensure that you have presented it all.

Secondly, justify your interpretations better. For example at the end of section 4.3, you make interpretations based on the Rn and EC data from the stream. However, you leave the reader to surmise as to how you made these interpretations. I think I agree with the interpretations but they need to be justified. In some ways it does not help that data appear in Section 3 (for example the specific yield data are there); data would be much better presented where you use them.

There are data that are not well used.

For example the 14C and 3H data can be used to test whether some of the assumptions in the understanding of recharge are correct (e.g. whether there is piston flow from the

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surface or mixing between older and younger water in the aquifers- See Cartwright et al., 2006).

Additionally, rather than just using the 3H in a qualitative manner, it can be used to place quantify groundwater recharge. If you do do this I would probably use a Lumped Parameter Model (e.g. Cartwright & Morgenstern, 2012. J Hydrol, 137-149 and other references cited there) rather than the renewal rate method. This will give an extra dimension to your study and make use of data that are currently mentioned but not really interpreted.

The Radiocarbon dates (Table 1) are presented without discussion. Firstly, you need to explain how you corrected the ages (corrections for calcite dissolution etc); while I wouldn't image that this was significant, you still need to go through the process. Secondly, and more importantly, what do the ages mean for the hydrogeology – are they telling you about historic recharge, mixing of old and young waters or what?

Another way to view the CMB data is to estimate how long the CI in a given volume of aquifer takes to be delivered (since you know the rainfall amounts and CI concentrations, this should be straightforward). If it is several hundreds to thousands of years, then you can comment on what timescales the different recharge techniques are estimating recharge.

It would also be interesting to mention whether and how the different techniques compare between the forested and cleared catchments. You do this for the WTF; however, if say the CMB or 14C is reflecting older recharge rates there should be little or no difference between the two catchment types. This is important as it gives you confidence that the two areas behaved similarly prior to the landscape modification.

Conclusions

I guess that where to plant the trees depends on your overall objective. Other studies have advocated planting trees on the lower parts of the catchment precisely because it

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was desirable to reduce the water table more and that was the issue being addressed.

Figures.

Fig. 1 is well enough known that it need not be included.

Fig. 3 seems to show little more detail than is in Fig. 2, could these be combined.

Fig. 9. This is in different units (Bq/L) than you quote in the text (Bq/cm³); be consistent.

Fig. 10. The numbers are hard to read (there is a lot of space to make them bigger).

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