

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.

G. Bertrand (Referee)

guillaume.bertrand@email.com

Received and published: 30 September 2014

Dear authors and editor,

Please find my comments on the paper entitled "Where to locate a tree plantation within a low rainfall catchment to minimise impacts on groundwater resources" by J.F. Dean et al.

General comments: In my opinion, this paper can be a valuable contribution to better understand hydro(geo)logical processes and forestry/pasture interactions. The paper is generally well written and easy to follow. The pictures are of good quality. I have

C4126

two main concerns that should be, in my opinion, addressed in a revised version. At first, I have some reserves about the CMB method and especially on the chloride concentration calculation in precipitation. Using arithmetic median is not adapted to my knowledge. A better estimation could be done through to Volume weighed mean as I mention several times in my comments. Same remark for the estimation from weirs. Weighing the data is important given the natural variability of chloride caused by the amount effect (= dilution effect), when precipitation events are great. Secondly, I suggest the authors to strengthen their discussion about the management option concerning tree plantation. They address "trees" in a very general way on the basis of their results from eucalyptus plantations. But there is an abundant bibliography about forestry management and gw (including eucalyptus, see suggested references), that I advise to include/discuss, to give more perspective on the interesting results which were provided.

On the basis on these general comments, I think that major revisions would give the opportunity to authors to propose an improved contribution to HESS.

Best regards,

Guillaume Bertrand

Specific remarks:

P10002 "Tree plantations are known to have the potential to negatively impact groundwater and surface water resources (e.g. Bell et al., 1990; Benyon, 2002; Bosch and Hewlett, 1982; Jobbagy and Jackson, 2004; Scanlon et al., 2007; van Dijk et al., 2007), particularly in dry regions (low rainfall and high evapotranspiration), where the high transpiration demands of the trees make them a significant user in the water balance (e.g. Benyon et al., 2006; Fekeima et al., 2010; Jackson et al., 2005; Schofield, 1992)." I suggest to moderate a little bit, and may be remove "negatively"...Actually a forest may reduce the availability of groundwater for public water supply or industrial purpose, that's true, and it is perceived negatively by these users. But for people involved

C4127

in agroforestry and its depending economy, it is not necessarily seen as "negative" but just as a consequence. As you say in P 10004: "what areas should be planted to maintain or intercept groundwater recharge, depending on the management application" what is consistent with the fact that the impact can be viewed as positive or negative, depending on the areas and depending on the users.

P100004 "Altering land cover can therefore affect recharge patterns; for example, the replacement of native forest vegetation by pasture and crops, which use less water, has led to increased recharge, rising water tables and ultimately water and land salinisation in southeast Australia (Allison et al., 1990; Bennetts et al., 2007)." How increase of recharge can lead to a rise of salinization of water and of land surface?? If you want to evoke the consequences geochemical variability, you should at least evoke the associated process to help the reader.

P10009: "Seasonal variability in groundwater composition is considered negligible due to the age of the groundwater at the study site, and repeat sampling produced virtually identical field parameters (Dean et al., 2014)" What is the age of the groundwater? Actually negligible chemical variability seems somehow contradictory with the fact that you studied a local groundwater system, generally much less buffered from a geochemical point of view than a regional system.

P10009/ Paragraph 3.4. " The dating results showed that the groundwater in both catchments was almost all recharged before the July 2008 establishment of the eucalypt plantation, so the groundwater composition is unrelated to the recent change in land use (Dean et al., 2014)" At first this sentence should not be in a methodological paragraph. Secondly when speaking about already known relevant information for your study, Please inform a bit more the reader. It is OK to me if you refer to a previous work, but you should be a bit more informative this paper. I would like to have an idea about the age estimation without needing to see in other papers. May be you could summarize all what you already know in the context part! If I summarize your paragraph, you say that the methodology could be read in another paper and you do not inform about

C4128

ages, so in my opinion this paragraph is useless for the reader, in its current form, at least.

P10011 " The fluctuations in the water level and the barometric pressure are normally inversely correlated (Butler et al., 2011), and can be readily corrected (Rasmussen and Crawford, 1997; Toll and Rasmussen, 2007). At the study site these fluctuations are clearly correlated with barometric fluctuations (Fig. 4a), but are positively correlated, and as a result normal barometric compensation techniques could not be applied" Is there any known explanation for this inconsistency? I have to admit that I am not a specialist about barometric effect in gw. But perhaps you could consider this hypothesis: May be it is because you are focusing in a recharge zone and not a discharge zone. in a discharge zone there is schematically 2 strengths which are opposed, a gw arriving from upland with its own pressure and the atmosphere pushing over (the few example I know about barometric effect analysis were done in discharge zone. In the recharge zone, the gw is not so much arriving but rather going away, deeper in the system and the two strength are not opposed...If so, would it not be a new (or no?) method to identify recharge zone from discharge zones?

P10012 "The estimation of specific yield is a potential source of considerable error in recharge calculations, as it can vary spatially and temporally (Healy and Cook, 2002)" In Healy and Cook's paper, I did not read that exactly: yes indeed specific yield is spatially variable but "Specific yield is treated as a storage term, independent of time [...]". Actually in this paper, the time issue is much more adressed because of the estimation of specific yield may require a lot of time (sometimes several years) and therefore the obtained results are changing if you do not wait the same duration. So I suggest you to reformulate to avoid any misunderstanding.

P10013: "and rainfall Cl- content was the median value from three different sampling periods at nearby sites (Fig. 2): 1954–1955 at Cavendish (Hutton and Leslie, 1958), 2003–2004 at Hamilton (Bormann, 2004), and 2007–2010 at Horsham (Nation, 2009)" Why did you use the median? How can you be

C4129

sure it is representative? To my knowledge, the unique way to have a representative concentration in the precipitation reaching an hydrosystem is to calculate the volume-weighted mean concentration (e.g. Appelo and Postma, 1994; Celle-Jeanton et al., 2009; Bertrand et al., 2008) $[Cl]_{precip} = \frac{(\sum ([Cl]_{event} * H_{event}))}{(\sum H_{event})}$ where H_{event} is the precipitation height corresponding of the sample (pr

Appelo C.A.J., Postma D. (1994) : Geochemistry, groundwater and pollution. A.A.Balkema Ed., Rotterdam, 536 p Celle-Jeanton H., Travi Y., Loye-Pilot M-D., Huneau F., Bertrand G. (2009). Rainwater chemistry at a Mediterranean inland station (Avignon, France): local contribution versus long range supply. Atmospheric Research 91: 118-126. DOI:10.1016/j.atmosres.2008.06.003. Bertrand G., Celle- Jeanton H., Laj P., Rangognio J., Chazot G. (2008). Rainfall chemistry: long range transport versus below cloud scavenging. A two-year study at an inland station (Opme, France). Journal of Atmospheric Chemistry 60 (3): 253-271. DOI: 10.1007/s10874-009-9120-y.

P 10016: " The 222Rn data (Fig. 9) show that there is minor groundwater discharging to the surface water, particularly in the eucalypt catchment, and this is verified by the salinity of the streamflow ($7700 \pm 2300 \mu\text{Scm}^{-1}$ in the eucalypt catchment and $5500 \pm 700 \mu\text{Scm}^{-1}$ in the pasture catchment)."

Why the E.C is informative about gw discharge?? If you want to use this tracer you have to provide in the text the gw conductivity and the rainfall (or better, the recharge as you can calculate this by taking into account evapotranspiration) conductivity as well. In many system, such a conductivity would be interpreted as a first insight as a recharge by groundwater! So if your case is different, you have to prove it with the data.

In addition, you say that the gw recharge is less important in the eucalypt catchment but you mention higher conductivity ($7700 \pm 2300 \mu\text{Scm}^{-1}$)...what could appear contradictory with the common statement that higher the gw participates, higher is the E.C. Please clarify.

P 10018: "To account for this difference the CMB values were recalculated using the

C4130

volume and Cl- content of runoff in place of rainfall volume and Cl- 5 concentration in Eq. (2). What is better than an arithmetic median in rain, for sure. I strongly suggest you to propose to use the Volume-weighted mean since the beginning of the paper, or at least the surface water estimation. It would shorten your paper and would avoid to read results people would have difficulties to agree with since the beginning. (Once again, consider to have a look to at least in Appelo and Postma, 1994 but also to many other papers aiming at characterize the input signal in hydrosystems from a geochemical perspective.) Nevertheless, still, you seem using only arithmetic calculations: "Cro is calculated from the average EC measured at each weir (averaged over the available data at the weirs from May 2010 to February 2013), converted to Cl- using the EC: Cl- ratio for the study site dataset (0.39 and 0.37 for the pasture and eucalypt catchments respectively)" OK but what kind of average? arithmetic? Volume weighed? (with the discharge at the weir?)? The second option should be used as for precipitation (replace H_{precip} by discharge in the equation mentioned above). I would also suggest to select only entire hydrologic year data, e.g. between March 2011 and February 2013 in your case (=2*12 months).

P10018: "Because of the highly variable nature of the streamflow Cl-, the potential variation in recharge values calculated from Eq. (3) is large, and this is in the error values (1_ - Table 3)"So may be you can try with the volume-weighted mean and the corresponding std deviation.

P10018: " The recalculated recharge values generated from Eq. (3) are much closer to the WTF recharge values, but are still generally a factor of five to 15 lower. This may reflect the fact that the groundwater across the study site is mostly thousands of years old, indicating that the CMB values are mostly representative of recharge rates under native vegetation prior to land clearance during European settlement in the late 1800s" Please could you explain how the native vegetation would impact the CMB calculation?? More evapotranspiration with the native vegetation? if yes, say so, but please clarify to help the reader.

C4131

P10021: " the aim is to reduce the impact of plantations on groundwater recharge, tree planting should be avoided in the dominant zone of recharge, i.e. the topographically low areas and along the drainage lines. Instead trees should be planted on the upper slopes where the water tables are deeper and the trees are less likely to access the groundwater and transpire it directly. This is supported by the smaller water table decline seen in the upland areas of the eucalypt catchment at the study site. At present, tree plantations in Victoria cannot extend within 20m of drainage lines, due to the erosion that can occur when the crop is removed (Dept. of Environment and Primary Industries, Victoria); the suggested management change would expand the currently restricted area along the drainage lines based on the topography of the site." This paragraph is interesting. However, it gives the impression that all this statement is based only on your results. Eucalyptus are known to be strong consumers of (ground)waters, but are they representative of the whole range of tree specie options the managers, farmers have? Is there any other type of plantations that would be possible? As you mentioned, tree plantation somehow facilitates infiltration through to roots pathways, but they can have negative feedback if consumption of (ground)water increases. However, if we imagine that one can set low water consumer species, would it not be a valuable way of management? (And knowing the local hydrologic specificities, is it reasonable to set eucalyptus in the upland part? Will they be able to adapt in a drier environment??). For example, some studies have shown that water uses may change during the hydrologic year but that some biological (e.g. growing, flowering) or ecological (competition) processes may impact water uses, processes which are supposed to depend on species, or at least to genus (cf. e.g. Bertrand et al., 2014, and references review therein). Other studies have shown that through to an establishment with wider spacing, one can regulate water uses by trees (see references below). Therefore, I suggest you to document a bit more about eucalyptus ecology and adaptative and/or management possibilities, and also to discuss the opportunity to set other type of vegetation, presenting variable added values/impact from an economic perspective and from a water consumption perspective. In my opinion, addressing these two points

C4132

in your discussion would strengthen much more the outputs of your paper and would provide a valuable information for the community. In addition it would discuss more what you promised in the paper title: " Where to locate a tree plantation within a low rainfall catchment to minimise impacts on groundwater resources" (You do not mention only eucalyptus) A rapid search in internet led me to discover the following references which can be useful to you to discuss these points:

Albaugh J., Dye P.J., King J.S. (2013). Eucalyptus and Water Use in South Africa. International Journal of Forestry Research Volume 2013, Article ID 852540, 11 pages DOI: <http://dx.doi.org/10.1155/2013/852540> Oballa et al. (2010) FACTS ON GROWING AND USE OF EUCALYPTUS IN KENYA. Available on <https://www.fornis.net/system/files/new%20eucalyptus%20final.pdf> (accessed the 30th of September 2014) MORRIS J., NINGNAN Z., ZENGJIANG Y., COLLOPY J., DAPING X.(2004) Water use by fast-growing Eucalyptus urophylla plantations in southern China. Tree Physiology 24: 1035-1044. Bertrand G., Masini J., Goldscheider N., Meeks J., Lavastre V., Celle-Jeanton H., Gobat J.M., Hunkeler D. (2014). Determination of spatio-temporal variability of tree water uptake using stable isotopes ($\delta^{18}O$; δ^2H) in an alluvial system supplied by a high-altitude watershed, Pfy Forest, Switzerland. Ecohydrology 7(2): 319-333. DOI: 10.1002/eco.1347

Figures Figure 4: 4a: I am not used to read barometric pressure in cm. Is it not supposed to be expressed as hPa?

Please also note the supplement to this comment:

<http://www.hydrol-earth-syst-sci-discuss.net/11/C4126/2014/hessd-11-C4126-2014-supplement.pdf>

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 10001, 2014.

C4133