Review of “Identifying flood recharge and inter-aquifer connectivity using multiple isotopes in subtropical Australia” by King et al.

Overall this is an interesting paper that is on a subject that would be of interest to the readers of HESS. As discussed in detail below, my main concerns relate to the rather general / vague descriptions of the data and the degree of justification of the interpretations. The ^{14}C data are not interpreted well and that section needs more work. Additionally, the study’s conclusions are very specific and the authors should think about the broader implications in section 6, which would give the paper a better overall impact.

I hope that the authors find the comments useful in revising the paper.

Abstract.

The abstract covers most of the material covered in the paper and does both cover the aims of the study and the major conclusions. It would be helped by putting a few key values in the text; for example the stable isotope values are important to the interpretation, but it is difficult to fully understand this without a few key values in the text. Similarly there are a fair number of qualitative terms such as “thick”, “rapidly”, “smaller” etc. Without quoting all your data having a few more details will give the reader a better idea of what the key evidence and details are.

Introduction.

In general the introduction is a coherent to the topic and covers an appropriate amount of previous literature. The aims are well set out and also try to place the study in a global context.

The description of the hydrogeology is not very detailed. There is some description of river flows and groundwater levels; however, there really needs to be some information on hydraulic properties, groundwater flow patterns and variation in the river stage. Given that this paper describes floods in a given year, a river hydrograph for that year (rather than an annualised discharge summary) would be useful.

Pg. 3713, line 10. I’m not sure that this is the case. While annual recharge rates are often reported, most researchers would recognise that recharge (like precipitation, which is also often reported as an annual amount) is episodic on inter or multiannual time scales.

Pg. 3713, line 16. Not clear what you mean by “enlarged pathway between surface- and groundwater, due to the increased width of the creek and the saturated zone beneath it”. Also are you talking about disconnected ephemeral streams (which you mention at the end of the paragraph) or are you thinking about all streams.

Pg. 3716, line 7. Are there any estimates of transpiration rates, which I would imagine are significant at least in the forested areas?

Pg, 3716, lines 20-25. Do you have any information about the peak flows from the dam during the high-rainfall period?

The last part of section 2.1 is a little vague. What are the gradients, how much did the water levels recover? A few more specifics would help the reader get a picture of what exactly happened.

Section 2.2. Are there any more hydrogeological details available? For example, hydraulic conductivities would help with the assessment of recharge and the likelihood that there is significant flow from the basement into the alluvium.

Methods

Pg. 3718, line 24. How wide are the bore screens (this is useful information as it defines how "mixed" the samples are).
Sections 3.1 & 3.2. Quote your analytical precisions (major ions / CRDS missing). Section 3.2 is oddly ordered; it would make more sense to group this by analytical type rather than lab or water source.

Section 3.3. This is out of place as it is not really methodology; suggest that you put it into the discussion section where you first use the modelling. Also, are your assumptions about mineral precipitation valid (dolomite commonly does not precipitate even when oversaturated – is there any indication that dolomite has precipitated in your catchment).

Section 4

Section 4.1. This is difficult to follow without referring to the figures or table. Put the ranges of the values in the text and try and avoid qualitative descriptors (brackish, fresh, higher etc – be specific or define the terms if you are going to use them later).

Section 4.2. Again this section seems out of place as it is deals with interpretation not data description. Put this in the discussion section but more importantly you need to explain how the diagrams were plotted (either reference the source of the figures or the program that you used to plot them). There are no Al concentrations in your data, so you also need to explain how you estimated Al activities.

Section 4.3. Again this section would be more readable with a few key values and less qualitative descriptions.

Section 4.4. I think that there are also Sr isotopes of rainfall in Ullman, W.J., Collerson, K.D., 1994. The Sr-isotope record of late Quaternary hydrologic change around Lake Frome, South Australia. Australia Journal of Earth Sciences 41, 37– 45.

Section 4.5. The section on 14C ages is not well written. I don't think that you can easily get $\delta^{13}C$ values of -4 during closed-system calcite dissolution with calcite of ~0‰ and an initial $\delta^{13}C$ of say -19‰ (basically the water becomes oversaturated wrt calcite before you get that high); this is covered in Clark & Fritz (and elsewhere). More importantly, if you were to do it by calcite dissolution, all of your ages would be modern and some of the implied initial $a^{14}C$'s would be far higher than have ever been recorded. There are examples of high $\delta^{13}C$ calcite elsewhere in Australia (Cartwright et al., 2013. Applied Geochemistry, 32, 118-128; Cartwright I, 2010. Journal of Hydrology, 382, 174-187) which might be useful in interpreting the data. Whatever, this section needs much better discussion.

Section 5

Section 5.1 General comment. While I agree with most of the interpretation, the justification is not very good. Try to be more specific as to why the data lead to the conclusions that you make and try to integrate the major ions and isotopic data better.

Section 5.1.1. As elsewhere this is really hard to follow without some values in the text. the correlations seem to have been done largely by inspection and it would be useful to put some stats around this (either a correlation coefficient "tree" or ANOVA). I think that this is important to add some weight to your arguments.

Section 5.1.2.

The statement on page 3725 lines 4-8 regarding a number of processes that may contribute to high HCO_3 concentrations can be tested with major ions also. You should discuss this in a bit more detail before launching into the Sr isotopes.

Page 3752. Following on from the point above, one could easily interpret the Sr as coming from another low 87/86 ratio source such as calcite (even if there isn't much calcite in the system, it does tend to weather readily). This is why it is important that you try to use the major ions (or other data such as the C isotopes) to back up your conclusions.

Section 5.1.3.

Page 3726, lines 5-15. Have you tried to calculate the % evaporation based in the stable isotopes. Looking at Fig. 8, the displacement from the MWL is relatively modest and much less that is commonly seen in high evaporation environments (such as salt lakes). I would say that most of the samples are dominated by transpiration, which is the case in much of Australia.

Page 3726. While I agree with the interpretation of high degrees of ET, you don't justify this very well. You probably should point to some evidence (e.g., consistency of element ratios with increasing salinity). As is generally the case in section 5, the justification is a bit sparse, even if the conclusions are broadly correct.

I got a little confused in this section as to what you think the major geochemical process is (ion exchange or silicate weathering). In waters where ET is dominant it is not always easy to discern other processes, but the section tails off without really stating what you think is happening.

Section 5.2

The same general comments apply to this section, the conclusions may be valid but they are not always well justified. Part of what you need to do in this section is to lead the reader through the logic that you used to make your conclusions.

Section 6

The conclusions are fairly specific to the paper. Try to use this section to say something more broad; for example, you could discuss implications for management or what might happen if conditions change (e.g. dam storages or climate change). This is the opportunity to show why this study is important.