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Discussions

Interactive comment on "Using ^{14}C and ^{3}H to understand groundwater flow and recharge in an aquifer window" *by* A. P. Atkinson et al.

Anonymous Referee #2

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This is a review of the manuscript "Using 14C and 3H to understand groundwater flow and recharge in an aquifer window" submitted to Hydrology and Earth System Sciences by A. P. Atkinson et al.

General comments:

This paper describes the hydrogeological study of the "aquifer window" (indeed, the discharge zone) of the Eastern View formation, a confined aquifer located in southeast Australia, with a major focus on groundwater/surface water interactions. The tools used are long-term river water levels and water table levels, major ion geochemistry, stable isotopes of water and carbon, and radiogenic 14C and 3H.

The paper is well written and the figures are clear, despite some modifications proposed thereafter. Still, in my opinion, the discussion could be notably enhanced, as the potential of the geochemical tools is not really exploited. Indeed, most considerations on the hydrogeological flow pattern that compose the conclusion could have been attained mainly based on the available water level data, i.e. without requiring costly 3H and 14C analysis. Nonetheless, I believe there is a very interesting potential for reaching an upper level of knowledge of the hydrogeological context by optimizing the available material. Therefore, if the paper pretends using environmental tracers to understand groundwater flow and recharge in the study area, the manuscript should go deeper into geochemical and isotopic interpretation and try to provide quantitative results on the water balance in the valley. I therefore recommend “major” revisions.

According to the authors, “major ion chemistry of groundwater is similar across the catchment, and the groundwater is Na-Cl type”. Then, a written description of the proportion of several species is provided as well as some indicators (Figure 3). Nonetheless, the contribution of these considerations, conducted at a general scale, is not clear regarding the aim of the paper. Why are all dots graphically undifferentiated? Is there really no geochemical distribution of water types, no different mineralization processes? I believe improved graphical representations of geochemistry could help the authors to go deeper into the interpretation, and provide more efficient and convincing elements to the reader. Rather than simply describing mineralization processes, the interest of such approach would be to define specific geochemical features of groups of samples and to attend to identify and quantify mixing processes between water masses.

Similarly, stable isotopes of water might provide additional information. But, why was such scale chosen in Fig. 4? What is it supposed to show? To my mind, it impeaches visualizing any process that could take place, any potential differentiation between groups of samples based on fractionation processes. Ideally, a dual “Barongarook High” and “Gellibrand River Valley” signature might be found inside the Eastern View formation, with the corresponding altitudinal gradient of precipitation. As well, a slight differentiation might be found between groundwater recharged from infiltration of Gellibrand river and from local precipitation in the valley, as boreholes k and l, located where the Eastern View formation outcrops in the valley, do feature evaporated signature (when plotted on a more representative scale).

The interpretation of geochemistry seems to consider that the river is the only possible source of recharge to the aquifer in the valley. What about groundwater recharged from rainfall infiltration on the unconfined surface of the Eastern View formation inside the valley? Its role is cited when describing potentiometric data, but seems to have been forgotten for geochemical interpretation. Indeed, potentiometric data does indicate that such recharge happens at important levels, as shown in Fig. 2 for piezometer “j”, located in the Southern part of the valley. By the way, why isn’t water table data for piezometers k and l, also located southwards, displayed here? If available, it could provide a confirmation of such process.

The role of recharge from rainfall infiltration on the unconfined surface of the Eastern View formation inside the valley is also absent of the conceptual flow model from the Gellibrand River Valley (Fig. 8), although its impact on groundwater recharge is probably the main driver of water table variations measured in the aquifer, later transmitted to the river by groundwater discharge as supposed by the regional configuration of the aquifer and confirmed by the upward vertical head gradient in the valley (Fig. 2a). The contribution of infiltrated river water to the recharge of the Eastern View formation, if it exists, will be limited to periods where the upward vertical gradient is downward. As aforementioned, these conceptual considerations do not necessarily require geochemical or isotopic analysis of groundwater.

Regarding the interpretation of 14C and 3H, I would propose some clues to reach a more integrated interpretation. As described in several textbooks (e.g. Cook and Böhlke, 2000), the spatial distribution of groundwater ages differs according to the aquifer geometry and to the flow configuration. In addition, depending on the length of the screen inside the aquifer, groundwater pumped from a well or tubewell might result from a distribution of ages, as it is representative of several flow lines. To take into account these features in the interpretation of the tracers, some tools exist, like the physical modeling of groundwater flow or Lumped Parameter Models (LPM, e.g. Zuber and Maloszewski 2001; Jurgens et al. 2012; Suckow 2012). I would suggest trying to reproduce the conceptual model of groundwater flow pattern through one of those tools in order to deduce the respective contribution of groundwater recharged inside the valley and originated from the Barongarook High. To my understanding, this would be one of the most interesting way to fit to the title of the paper by "using 14C and 3H to understand groundwater flow and recharge in an aquifer window".

Some specific observations

- Figure 8 indicates groundwater levels lower than river levels, i.e. supposing losing conditions. Are water levels in this figure really to scale? - Regional potentiometric data: it would be interesting to know where were measured the potentiometric heads used for this map. - Number/name of the groundwater bores: why not use the same names everywhere? I would recommend generalizing the use of letters a, b, c. . ., as Table 1 provides the "official" name.

References:

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