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Discussions

# *Interactive comment on* "Where does streamwater come from in low relief forested watersheds? A dual isotope approach" *by* J. Klaus et al.

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The authors take a novel approach to estimate sources of water to stream flow in low relief sub-humid (P<ET) catchments using established dual isotope methods. This study makes a significant contribution both in terms of the techniques to interpret and the conceptual understanding of runoff (or lack there of) from low gradient catchment in drier regions, which are, arguably, under represented in the published literature. I believe this paper should be published in HESSD. I propose some changes, mostly to provide more information on physiographic setting and some suggestions in aid of interpretation of the conceptual model.

The paper is well written. The main assumptions of the techniques are addressed,



and with respect to the conceptual model the distinction between speculation and actual data is reasonably clear. However, in using isotopic techniques equifinality (Buttle 1994) can make it difficult to make inferences about sources and especially flow path of water in complex systems, were complementary sources and process may contribute water. The paper also compares isotopes of N, and in conjunction with the dual isotopes provides a convincing argument. However, the interpretation and conceptual model also relies heavily on hydrometric data that was largely not presented and currently not accessible to the reader (Du et al in review). I echo the editor's comments about needing a little more quantification. At times, I am left asking how much water and when does it move.

1) There are potentially several conceptual models that could be applied to direct field sampling, interpret isotopic data and water cycling and sources to stream flow. Conceptualizing the x-section slope to the stream is often applied to steep systems with a confining layer where the contribution from hill slopes is contiguous along the stream reach. The x-section provided in Fig7 for the conceptual model seems reasonable, given the location of the depth of the argilic horizon presented in Figure 7. However, fig 7 is the only place in the paper were the reader receives information or can conceptualize the potential layering and depth of soils in the catchments. Only physical properties, not depth, are provided in study sites description. Providing general information on distribution of the thickness of the surface sandy layer (and depth to argillic horizon) in the hillslopes and draws, and a relative scale on the conceptual diagram would help the reader conceive and infer how much storage there is between the hilslope and the stream, and how often this storage is potential filled and thus makes it to the stream? Also, providing the timing of flow from the plot study relative to the streams would provide some information on the time lags or threshold in storage.

2) The authors present two alternative models for flow in the catchment: the conceptual model in fig7 and that of saturation excess flow from the valleys. It appears that contributions from saturation excess surface flow are not a major mechanism, at least

during the study period. In drier system where the hillslope is disconnected, there may be other alternate conceptualizations of water flow to exclude. The interpretation of the stream isotope data seems to be focused on the x-section right behind the weir. In fact it appears that the weir appears to be illustrated in the conceptual model (Fig 7). Understanding the distribution of the riparian zone and the stream-riparian-hillslope interaction is integral to conceptualizing the water cycling and interpreting the data. In low gradient systems with wide valleys, the riparian areas are not often narrow strips near a stream channel. Currently no information on the riparian zone, i.e the distribution or soil characteristics, has bee provided. Providing these may allow the reader to better visualize the potential catchment scale process presented and would address many of the questions presented above. A formal definition of what constitutes a riparian zone would help in extrapolating the conceptual model. Is the riparian zone defined to be adjacent to a well-developed stream channel eroded into the forest floor and mineral soils, or does it extend up into the ephemeral streams with no stream channel? Do the ephemeral streams have a defined channel? Do the riparian zones include the extensive valley wetlands, or are they defined as between the valley wetlands and the hillslope?

Clearly define the wetlands (over and above CB) and what the riparian zone is in fig 1. In the study site description there appears to be distinct forest wetland vegetation that could be used to map out or infer the riparian area. Is there major changes in soil organic depth or other characteristics (ie holding capacity) or is it mostly slope that defines the riparian zone?

3) Study Site info. Please provide the latitude and longitude for the catchments (allows to reader to use google earth and view the site).

4)page 6, ln 20-25. The term “deep ground” has been used through out the MS. The reader needs to know what deep means? To interpret the chemistry from the wells, the depth of well completion, depth of top and bottom screen and whether the well was sealed (bentonite) is required. Clearly present whether the groundwater wells collect



water from the layer above the argillic layer or is it in the confined aquifer below the surface soils in the catchment.

5) A glance at the hydro-geology literature indicates that the long-term vertical recharge through the argillic horizon could be provided for this site. This helps in visualizing the water balance. Also, in these low relief systems, there can be interactions of different scales of groundwater flow. From the “deeper well” data (locations on fig 1) presumably the general location and gradient of the water table relative to the three catchments can be presented (at least in the text). Do the valley bottoms of any of the catchments intersect the WT of the larger groundwater systems, and are the hill slopes perched when delivering flow? One or two lines can be inserted so the reader can make some assessment of the potential interactions and exclude a number of potential conceptual models of catchment-stream interaction.

6) The wells are located on figure 1. The location of the riparian piezometers (relative to the distribution of the wetland/riparian area) should be indicated on the map (Fig 1). Also, the completion depth, length of screen, ad the soil layer they sample from should be presented.

7) page 9, ln 19. The EWLs for groundwater include 14 wells. It is not clear if these include riparian or stream areas, or they are all exclusively from the confined aquifer. Listing completion depths would clarify this.

8) page 10, ln20-25. The authors indicate that hillslopes can generate considerably more peak flow than the catchment outlet. It is implied that the water is evaporated/transpired. Could this go into deeper storage, and eventually recharged to groundwater?

11) p11, ln 14-16. Could the valley wetlands above the weir also provide a mixed source of water?

12) Citations not in the reference list: Page 3 ln 3: Sidle et al. 2000 – is not in the

references, p3 ln5: Jensco et al. 2009 –is not in the references

13) Figure 1; Note. Map out the riparian areas, location of piezometers. It could be my printer, but it seems that the contours and the intervals would not reproduce very well. Also, I have trouble distinguishing between the perennial and ephemeral streams.

14) Figure 3. There are periods of zero flow and periods with no data. It is difficult to tell which is which. If not already done, could zero flows be denoted with a symbol, and blank for no flow (some manipulation because of the log scale). Presenting the flow from the trench data and comparing with stream flow would provide information on the timing of potential storage and connectivity.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 2613, 2014.