

Interactive comment on “Land use alters dominant water sources and flow paths in tropical montane catchments in East Africa” by Suzanne R. Jacobs et al.

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We would like to respond in detail to point 1 (Data presentation and analysis) provided by the reviewer. With regards to point 2 (Manuscript structuring), we are grateful for the suggestions provided by the reviewer and will incorporate the feedback (improved structuring and content of introduction and discussion, as well as presentation of the raw data collected) into the revised version of the manuscript.

1) There is some concern with taking these isotopic data into the convolution modeling. Specifically, the length of observation record is not overly long which limits the ability to map out some realistic travel times here. The uncertainty gets very high in this regard.

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So, at best one could argue that the MTT estimations are just first-order assessments for comparing between the catchments. Further, taking on a classic time invariant MTT estimation is a bit troublesome with regard to the potential for comparisons. Namely, the travel times for each catchment likely shift with wetness (storage) condition and this dynamic shifting (mixing) likely represents itself differently throughout the one and a half year been considered here. As such, it is difficult to separate the impact of the land use on MTT from the variability of the flow on the MTT – more likely these aspects compound (and confound) the issue (see van der Velde et al., 2015, Consequences of mixing assumptions for time-variable travel time distributions, Hydrological Processes).

Reply: We acknowledge that the application of the convolution method to estimate MTTs, generally applied for time-invariant conditions, does not allow a precise estimation of the effect of land use on MTT. The main reason is that the high damping of the stream water signal compared to the amplitude of the isotope signal of rainfall, indicates high MTTs of water. In this case, where the MTT is of an order of magnitude of years, it could be difficult to identify subtle differences in the order of days, weeks or a few months caused by differences in land use. Furthermore, as it has been stated by Velde et al. (2015), it is also possible that changes in MTT occur on an inter-annual basis, depending on the soil's previous moisture conditions. We argue, however, that the three sub-catchments are subject to similar rainfall patterns, as can be seen in the weekly precipitation time series presented in Figure 4 of the manuscript. Furthermore, differences in storage and flow and resulting differences in MTT can from our view be attributed to a land use effect as geological differences between the three sub-catchments are minimal. We do, however, agree with Reviewer #2 that the MTTs presented here are unlikely to be the 'true' MTTs of the catchments. Due to the limited information on transit times of tropical montane catchments of Africa, compared to the amount of information available for mountainous catchments of high latitudes, we consider that it is necessary to include the present stable isotope data and their respective MTT estimations in the manuscript. In this regard, preliminary but relevant information, as expressed by Reviewer #2, is the knowledge of at least the order of

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magnitude of MTTs, which, for stationary conditions, can be obtained by the convolution method. Although the present outcomes are preliminary findings, they could serve as the baseline for future studies in which a greater number of samples could be used or a longer sampling period, which will allow the use of more sophisticated methods (e.g. time-variant approaches) and thereby more subtle differences in the movement of soil water could be accounted. In a revised version of our manuscript, we will emphasize that the present isotope data and the respective estimates derived from them, serve a preliminary characterization of the water MTTs in the analysed catchments, for stationary conditions. Based on the magnitude of the estimated MTTs of stream water (of the order of years), for stationary conditions, we will also emphasize that with the current available data it is not possible to discern whether these small differences (among catchments MTTs) are actually caused by differences in land use. In addition, regarding the assumption of stationary conditions for the present work, the criteria for which this assumption was adopted will be explained in detail, and, due to the limited sampling period, the scope of the present MTT estimates will be emphasized accordingly. On the other hand, a more detailed analysis of the observed data will also be performed: the amplitude of the observed input and output isotope signals will be contrasted, including the estimation of the young water fraction (YWF) (Kirchner, 2017) (see reply to Reviewer #1). With respect to the uncertainty associated to MTT of stream water, we will include, in a supplementary material, plots of the best fitting efficiencies and the associated GLUE uncertainties. In the same way, we will focus on a more detailed discussion of these aspects.

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