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Hydrology and Earth System Sciences Discussions

Interactive comment on "Identification of runoff generation processes using hydrometric and tracer methods in a meso-scale catchment in Rwanda" *by* O. Munyaneza et al.

Anonymous Referee #1

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The authors sample several solutes, deuterium and oxygen-18 during two flood events in a semi-arid meso scale catchment. They used a two component and a three component hydrograph separation to identify runoff sources and flow paths. They identified that 80% of the discharge was generated by subsurface flow. They link the runoff generation to the high water tables and the runoff coefficient of the two events. Further they conclude that spatial and temporal variability in the tracer signal of precipitation is important at meso-scale.

The manuscript needs several improvements before it can be accepted for publication. Burns (2002) stated: "As the science matured further in the 1990s, a point

was reached at which isotope based hydrograph separations alone were insufficient to guarantee publication of study results in the leading water resources journals. Many studies seemed only to reconfirm that stormflow in small forested catchments is dominated by 'pre-event' or 'old' water, and hydrologists did not need to be told so over and over again. Thus, isotope-based hydrograph separation had become simply another toolâĂŤone that could not lead to a more profound understanding of catchment runoff processes unless combined with many other tools." Since then, the application of hydrograph separation together with hydrometric observation became state of the art. Hydrograph separation was applied to semi-arid or better sub-humid catchments with the support of well data (Cras et al., 2007; Marc et al., 2001). The role of spatial and temporal variability in the input signal is known.

Nevertheless, as pointed out by the authors, there is still a need to improve understanding of hydrograph separation methods and runoff generation in semi-arid catchment. Thus the study can contribute to the understanding of hydrological processes in semi-arid catchments. But the authors have to improve the introduction section, give clear objectives, show the novelty and/or necessity of this study and explain what differentiate this study from a simple case study. Further the discussion needs a clear link to the study objectives. Further a better linked to studies dealing with runoff generation in semi-arid catchments and studies combining hydrometric observations and hydrograph separation has to be made. There are several studies that can show suggestions and ideas how the content of this manuscript can be improved (They include several ideas and methods how the content of this manuscript can be improved (e.g. James and Roulet, 2009). The study of James and Roulet (2009) give an excellent example of the combination of hydrograph separation combined with hydrometric observations.

Some points that can be considered when iterating the introduction: What do the authors now before the study? What are the objectives/the working hypothesis? Why we need this in process hydrology? What is new? Consider: 1. Please formulate clear objectives 2. Why do we need this in hydrology? 3. The introduction needs a red line,

with the objectives at the end. Now there is no clear structure that leads the reader to the objectives. 4. Why another case study? Is there something that moves this work beyond a simple case study? There is a significant amount of work done that linked hydrometric observations with hydrograph separation. Considering that the authors already highlight the used of hydrometric observations in the title, they should use some of the work in their introduction.

Detailed comments

Abstract: Line 21, "...(16.7%-44.5%)..." change to "(16.7% and 44.5%)" because "-" suggest that you observed a range of events between these values. Is a runoff coefficient of 44.5% low? When you call this low, please give numbers from other catchments. Maybe later in the manuscript? Are subsurface contributions always linked to low runoff coefficients (RC) and high RCs always to surface runoff? Line 21: "Groundwater...". The last sentence is not really linked to the rest of the abstract, please reformulate. Introduction: 672, 26: "Gain further insights", what insights do you have at this point? 673, 27 ff. How can this help improving crop production etc.? Vague statement. 674, L5: "they found..." Reformulate, e.g.: "Based on a baseflow recession curve they showed decreasing baseflow contributions..." Baseflow contributions to what? So the discharge at low flow is deacresing, or what exactly do you mean here?

Study area: 675, L7ff.: Can you give the coverage in percent? 675L12-19. This section has to be rewritten. Suggestions: If you don't sample a subcatchment, there is no need to mention them, it just confuses. 675,L28: "The itumba...". Language: The investigated invents occurred during the...

Methods 676, L17ff., Please supply the information about the device for field and lab measurements. Further section 3.3.needs improvement. The assumption that the concentration of subsurface water can be represented by pre-event water at the sampling point is often considered to be critical (e.g. Buttle et al., 1995). How will this influence the results of this study, especially since data about shallow wells and springs area

available? Especially considering the differences between stream water and groundwater in table 3 and 4. Please give more details about the 3-component separation, i.e. what are the end members and how were they determined? How is the runoff coefficient calculated?

Results: Parts of the results are already discussion. Chapter 4.2 needs to be shortened. Page 681, l2: "close" is a very vague term. E.g. surface water EC at the Kansai is less than half than GW, and 30% less than Spring water. Sio2 shows variation by a factor of 3! Chloride is nearly a factor 4-6 between surface and GW. Potassium a factor 3. Ca up too factor 4. High variations of other solutes are also summarized in table 3. Thus I cannot follow the argument that in Line4-5. Additional, are the surface water samples only flood samples? Otherwise it would indicate that streamflow is not representative for subsurface water. Is 30% really a low contribution of surface runoff? And is it surface runoff, or can it be subsurface runoff of new water? At least if chloride is used? Page 682L3-5: Can this also be a relic from the method based on inappropriate description of end members? 680, L4-5. "...when the surface runoff contributed to stop" Do you have observations of surface runoff? Otherwise that would be speculative, especially considering that 80% is subsurface flow. 680,l13-14. Some numbers would be helpful. Also maybe move to discussion? 680,l15-16: Describe this thought better, how to you link that exactly? Move to discussion? 680,l20ff: If a high percentage of rainfall becomes subsurface runoff, it would be still runoff and thus contribute to stormflow. So this argument that low runoff coefficient can be explained by that does not make sense, in my opinion. Maybe it is filling up storage? Please comment on that or improve it. Did I miss something? P684,l5ff. It can also be evaporation from the shallow water tables! P684,l11ff. Why did you change the tracers? P684,L20. New water must not be direct runoff, e.g. there might be transport of new water by subsurface stromflow. P684,L16ff. I cannot complete follow this description. The authors describe a three-component separation. In the text they talk about two end member: Old and new. Is shallow and deep GW one or two end member, make clear! This has to be improved and better explained. Maybe in the method section, where the authors

can clearly state what end members they used in the separation. The same for figure 9 and the description.

Discussion The discussion has to be better linked to the objectives of the study, some sub-headers would help too. Nearly no comparison to other studies about runoff generation in semi arid catchment is made. What is the uncertainty in the work. Applying hydrograph separation methods to larger catchments >40km2 often leads to only qualitative results (Uhlenbrook and Hoeg, 2003). How far does a hydrograph separation on such a relatively large scale helps in process understanding? P686L6. Units in mm/h would help, Please compare it to the rainfall intensity.

Conclusions Page688,L1-3. Why testing something that we already know? The discussion is clearly missing a link to other studies using hydrometric observations and hydrograph separation. They include several ideas and methods how the content of this manuscript can be improved.

Figures Figure 1: Maybe location within Africa?

Figure 3: Caption of a: 1-2May, figure 29April to 6May! Font size of axis might be too small in the published paper.

Figure 4: Plot precipitation in the figure.

Figure 5: Plot precipitation, improve visibility of captions.

Figure 6: Font size too small, Abbreviations of data points are not in the figure captions. AVE_P_Weight has to be explained.

Figure 7: Why four components? Brown line the sum of blue and yellow? It was not clear in the text in the result section. Plot Precipitation.

Figure 8: small font size.

Figure 9: See figure 7.

References Burns (2002): Stormflow-hydrograph separation based on isotopes: the thrill is gone-what's next? Hydrol. Process. 16, 1515–1517 (2002)

Buttle, J. M., A. M. Vonk, et al. (1995). "APPLICABILITY OF ISOTOPIC HYDROGRAPH SEPARATION IN A SUBURBAN BASIN DURING SNOWMELT." HYDROLOGICAL PROCESSES 9(2): 197-211.

Cras, A., V. Marc, et al. (2007). "Hydrological behaviour of sub-Mediterranean alpine headwater streams in a badlands environment." Journal of Hydrology 339(3-4): 130-144

James, A. L. and N. T. Roulet (2009). "Antecedent moisture conditions and catchment morphology as controls on spatial patterns of runoff generation in small forest catchments." Journal of Hydrology 377(3-4): 351-366

Marc, V., J. F. Didon-Lescot, et al. (2001). "Investigation of the hydrological processes using chemical and isotopic tracers in a small Mediterranean forested catchment during autumn recharge." Journal of Hydrology 247(3-4): 215-229.

Uhlenbrook, S. and S. Hoeg (2003). "Quantifying uncertainties in tracer-based hydrograph separations: a case study for two-, three- and five-component hydrograph separations in a mountainous catchment." HYDROLOGICAL PROCESSES 17(2): 431-453

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 671, 2012.