

Interactive comment on “Multiple runoff processes and multiple thresholds control agricultural runoff generation” by S. Saffarpour et al.

Anonymous Referee #1

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General comment

This is a very interesting work that focuses on the analysis of runoff processes and the controls exerted by different thresholds on the hydrological mechanisms related to runoff generation in an agricultural Australian catchment. The research aims to understand how subsurface connectivity, saturation excess and rainfall intensity play a role in rainfall-runoff response at the seasonal and event time scale. The manuscript is well written, logically organized and with overall clear graphical presentations. Results are generally well supported by data and interpretation are overall sound. I particularly like the conceptual summary of hydrological processes and thresholds reported in Fig 1, and how this figure was referred to in the Introduction and in the discussion. However, I think that there are some confused points that deserve to be clarified and better explained. I have some comments and suggestions that can hopefully help this paper to

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have a greater impact on the hydrological community.

Specific comments

5, 24-26. As far as I understand, two different isotope laser analysers have been employed for the analysis of stable isotopes of water. This is a methodologically critical point: based on my experience, two different laser machines, even of the same model and calibrated using the same set of reference standards, could return quite different values of isotopic composition. Using a different sets of standards in different laboratories, as it seems that was the case here, could lead to differences that have the potentials to impact the resulting analysis of hydrograph separation. I think it is important for the paper to run some tests and report some comparison metrics between the measurements performed by the two machines in order to assess, and in case correct, potential deviations.

6, 10-12. It is not clear how the soil water storage has been computed starting from ASI. A specification, perhaps including equations, would be really useful here. This is important because the soil water storage is addressed several times in the rest of the manuscript. Moreover, it's not clear how manual measurements of the saturated are have been carried out. Please explain.

8, 2. The statement that 'any rainfall depth could produce a response' seems to contradict what reported elsewhere in the manuscript (eg, 7, 4-5; 8, 14; 8, 26) about some rainfalls that did not produce runoff. This is confusing and should be clarified.

8, 6-16. Fig. 5b seems to be dense and informative. However, I think that is not straightforward to understand it. The different symbols are hard to distinguish and the scale of runoff coefficients is not very useful to understand their values. I suggest considering to replace it by another graphical way (eg, cumulative distribution + bar plot or multiple panel boxplot). Moreover, I don't understand why ASI and ASI+rain have been plotted against rainfall intensity: the relation is obviously scattered (and so the sentence at 8, 12 is obvious too since rainfall is a stochastic process) because no

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relation is expected between these two variables and intensity of rainfall events. But if the authors used this representation to show how the different events plot in reference to these variable this should be clearly stated.

10, 25-26. Here a two-component mixing model is mentioned but no details are given in the Materials and Method section. I'm not suggesting to report the well-known equations (a simple citation to the suggested references 5 and 6 below is enough) but some methodological/conceptual information are needed, eg: which sample(s) has been considered as pre-event for the application of the hydrograph separation technique? Why only deuterium data have been used since both 18-oxygen and deuterium data have been measured? How many samples for isotopes have been collected and which ones were used? How many events have been sampled? More importantly: why has the separation been carried out only for the 12 August event showed in Fig. 9? Or was it also performed for other events? In this case, what are the results? Are they similar so that they corroborate the proposed conceptualization? Or did they provide much different estimates? Can the author report the results of all sampled events in a Table? This would be useful. All this information should be reported and these points well addressed in the revised version of the manuscript.

Another major point related to this is the lack of uncertainty analysis of the estimated fractions of pre-event water and event water (I prefer these terms instead of old and new water) in streamflow. This is particularly critical since these estimates have been used to build some conceptualization (eg, 17% of event water corresponding to 5% of rainfall amount..but what is the uncertainty of that 17%?). And is the result about 5% of rainfall based only on the 12 August event? In that case this is not robust. The traditional method of uncertainty estimation proposed in reference 2 below is suggested.

11, 1-11. It is mentioned that the concentration of major ions is available for the 8 November event but only chloride has been selected and showed (Fig. 10). What is the reason behind this choice? Moreover, where does the estimate of 5% of the rainfall come from, that agrees surprisingly well with the estimate of the 12 August event (10,

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26)? From a two-component hydrograph separation based on chloride? On isotopes? Please, explain in detail.

11, 19. The saturation amount at the 5% of the catchment area is not shown and clearly presented, yet it is one of the most interesting results in terms of process interpretation. Please, provide a sound explanation.

12, 29. I do not see such a clear threshold at 250 mm of ASI + rain. . .please, explain better, also in the results, where it derives from.

Some relevant studies that I'm aware of and that are strictly linked to this research have not been cited. I think they should be incorporated in the paper, particularly in the Discussion section (except the ones referring to methods, such as 2, 5 and 6):

1. Fu C, Cheng J, Jiang H, Dong L. 2013. Threshold behavior in a fissured granitic catchment in southern China: (1) analysis of field monitoring results. *Water Resources Research* 49: 1–17. DOI: 10.1002/wrcr.20191

2. Genereux D. 1998. Quantifying uncertainty in tracer-based hydrograph separations. *Water Resources Research* 34(4): 915–919. DOI: 10.1029/98WR00010

3. Penna, D., van Meerveld, H.J., Oliviero, O., Zuecco, G., Assendelft, R.S., Dalla Fontana, G., Borga, M., 2015. Seasonal changes in runoff generation in a small forested mountain catchment. *Hydrological Processes* 29, 2027–2042. doi:10.1002/hyp.10347

4. Penna, D., van Meerveld, H.J., Zuecco, G., Dalla Fontana, G., Borga, M., 2016. Hydrological response of an Alpine catchment to rainfall and snowmelt events. *Journal of Hydrology* 537, 382–397. doi:10.1016/j.jhydrol.2016.03.040

5. Pinder, G.F., Jones, J.F., 1969. Determination of ground-water component of peak discharge from chemistry of total runoff. *Water Resour. Res.* 5 (2), 438–445. <http://dx.doi.org/10.1029/WR005i002p00438>.

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6. Sklash MG, Farvolden RN. 1979. Role of groundwater in storm runoff. *Journal of Hydrology* 43(1–4): 45–65. DOI: 10.1016/0022-1694(79)90164-1

Minor comments and technical corrections

1, 10. The reference to individual research catchments makes the reader think that this paper focuses on the analysis of several catchments but this is not the case. I suggest to remove or reformulate.

2, 12. Here the suggested references 1 and 3 could be added.

3, 3-4. This sentence is not totally clear. Please, explain.

3, 22. Typo.

3, 27. 'certain processes': too vague. Reformulate.

3, 30. Here the suggested references 1 and 4 could be added.

4, 9. It is a bit surprising to know that the study area is a hillslope after reading the Introduction that focuses almost exclusively on processes at the catchment scale!

4, 17. 'reasonably' is too vague. Specify.

5, 26. This can be misunderstood as the uncertainty in the presented results of hydrograph separation. I think it's clearer to use the term 'instrumental precision'.

6, 15. Do the authors mean 'conceptually separate' here, ie they are considering these processes, and not physically computing the fractions of return flow and SOF in stream-flow? Please, reformulate for clarity.

7, 6. Better to use 'stream' or 'streamflow' here instead of 'runoff'.

7, 23. For the sake of clarity, indicate which events/panels.

8, 9. How was the quick flow runoff coefficient computed? In section 2.4 it was not defined... unless it's, as I think, the same than 'event runoff coefficient'. In the latter

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case, please be terminologically consistent.

8, 28-9, 4. This part could be condensed by pointing out at the Tables.

10, 10. Although known and intuitive, the symbols of this equation should be explained. Moreover, it should be stated that the events falling into this period are 10 (as inferred from Fig. 8).

10, 17. 'Clearly'. I think it would be more cautious to start this sentence stating the results and/or the figures that point at this.

10, 24. 'different signature': ok, but the trend is similar and should be remarked.

10, 25. Here the suggested references 5 and 6 could be added.

11, 20. Please, explain what the 'field observations' are.

11, 24. Here the suggested reference 4 could be added.

13, 7-13. This part is not very relevant to the observed results and could be skipped, in my opinion.

Tables and Figures Table 1. Remove the first column, it's not useful. Don't use abbreviations in the column name.

Fig. 1. The first 'Yes' on the top horizontal arrows should be moved more to the right close to the dashed arrow, in my opinion. And perhaps the second 'Yes' can be removed.

Fig. 2. I suggest the terms lower, mid and upper hillslope (or slope) instead. Remove the notation and the arrow pointing to the wells and put them in a legend. Why has the DEM been cut before the stream... cannot be extended to it?

Fig. 4. Replace 'overview' with 'example'. I also suggest to include a no-flow event.

Fig. 5. Please, see my comment above. Moreover, the difference between 'Soil Moisture Index' of panel b) and 'ASI' of panel c) is not clear and should be explained (or

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fixed if they are the same thing).

Fig. 6. Why are there values above zero? Explain or fix.

Fig. 7. Why have only these sites been shown and not also water table at the other locations? This should be explained in the text. Additionally, 'high intensity' is too vague and should be quantified, possibly using thresholds presented in Fig. 5.

Fig. 8. Add a mention to the period when these events have been selected. It would be interesting to see these results also for other events.

Fig. 9. The symbol $\%$ should be put in parenthesis.

Fig. 10. Please be consistent with the use of terms such as 'discharge' (as here) or 'flow' (as in Fig. 9).

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