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Discussions

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Comment on hess-2022-26: Flood patterns in a catchment with mixed bedrock geology: causes for flashy runoff contributions during storm events

David Dunkerley (Referee)

Referee comment on "Flood patterns in a catchment with mixed bedrock geology and a hilly landscape: identification of flashy runoff contributions during storm events" by Audrey Douinot et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-26-RC1, 2022

This paper presents an analysis of some high-quality rainfall and streamflow data collected in two adjacent catchments in Luxembourg (the Ernz Blanche basin). The objective, as reflected in the title of the manuscript, was to understand better the hydrological mechanisms resulting in flash flooding in this catchment. The paper is generally clear and straightforward to read, though I think that the main focus should have been more strongly on large rainfall events than on hydrologic response under more usual events.

Oddly, though the authors mention the occurrence of several historical flash floods, including one in 2016 and another in 2018, they do not describe those events in any detail. They provide no discharge data, no runoff coefficients, and no rainfall event data. In order to find something of these events, I consulted an EGU Abstract (Iffly et al. 2018) by some of the same authors. There, I was able to learn that the 2016 event had much more intense rainfall than anything that the authors investigate in the present ms., recording 20 mm in 10 minutes (=120 mm/h), 50 mm in 1 hour, and up to 70 mm in 6 hours (=almost 12 mm/h). In contrast, in the present paper the most intense event reported had a maximum rainfall rate of ~ 27 mm/h. All but one of the remaining events listed in Table 2 had maximum intensities of < 10 mm/h. These seem unlikely to be responsible for flash floods. I was not able to locate information on the 2018 flash flood event for additional comparison. I think that it would help readers place the results of the current ms. in context, if some information on the historical flash floods could be provided, at least in summary.

I think that the focus on 'ordinary' events needed some comment. How can a study of much more ordinary rainfall events shed light on what occurs during the seemingly far more intense rainfalls that seemingly accounted for the historical flash floods? Did these, for instance, occur when the soil had been thoroughly wetted by antecedent rainfalls? Does surface runoff overtop ground surface roughness elements when the rain is sufficiently intense (above some threshold?), allowing a smoother and more direct path downslope? What was the nature of the precipitation? I assume that the flash floods were the result of shorter, more intense, convective events, and therefore were likely to have occurred in summer (this information is missing from the current ms.). I imagine that these were late afternoon events, but this would also be relevant information. Were there very local runoff sources located close to the stream channels, perhaps? Iffly et al. refer to lag times to runoff peak of just 90 minutes, whilst in the present study these lags extend to many hours. Could the movement of convective cells parallel to the long, narrow catchment be significant? Did that occur (perhaps Doppler radar might shed some light on this)? Catchment response to intense convective cells might be quite different from that in stratiform rain, for instance, and different parts of the catchment might show altered hydrologic responses under those different rainfall inputs.

The study is weakened by the assumption of a constant runoff coefficient through the duration of rainfall (mentioned in line 200 and elsewhere). This seems particularly inappropriate for long events of several days duration, such as were examined in this ms., and even for events of a few hours duration, when breaks in rainfall (e.g. shown in Figure 6 and Figure 7) allow soil drainage and the re-invigoration of soil infiltrability. It would have been interesting and informative to have seen at least some preliminary sensitivity testing to see how important an effect a changing runoff coefficient might have been to the hydrologic modelling. Perhaps the authors have done such tests and could comment?

It would also strengthen the argument of the paper if the authors could present some data on hydrophobicity in the forested areas, that they appeal to as a mechanism to account for more runoff there. Was hydrophobicity actually present, or was this not investigated? If present, does it dissipate in longer events, so that perhaps it differentially affects runoff behaviour in short convective events in summer?

The authors identify LAI as an important factor in the hydrologic response (TTD) (lines 491-492). Though without comment, the authors appear to use LAI data from 2002-2006, many years prior to their field data collection. This warrants some comment. Further, the LAI seems to be very small, to judge from Figure 9 (left panel), seemingly the only data presented on this variable. The authors only appear to link LAI to the speculation about litter layers and wettability, evidence for which is not provided. Could the authors offer a fuller comment on why LAI might relate to TTD? Do they consider this to be a real, physical effect, or merely a chance statistical correlation (for instance, via some other seasonally-varying parameter)? Their comments and thoughts would be helpful. They could also perhaps consider presenting LAI data for their catchments (as a map) if they have it available. It would appear to be very variable among fields, forests, etc.

Finally, I wondered whether there is a role for roofs, roads, drains, culverts, etc., in the catchment response. I do not know this area, but Figure 2 suggests that, at least locally, the villages may have impervious areas that are efficiently drained. The main stream channels also warrant at least some description. Have they been modified, perhaps to flow between artificial banks or walls? How significant is the channel travel time from the upper to the lower catchment? In the same way, landuse could helpfully be described, especially whether fields are tilled seasonally.

Overall, this is a solid study, containing some interesting results. However, I am not sure to what extent these actually bear on the factors accounting for flash flooding.

Minor errors:

line 13: should be 30 km^2 (space is required between numerals and symbol for unit of measurement)
line 46 and throughout the paper: 'et al' should be 'et al.' (as a contraction of et alia)
line 93: should end sentence with a question mark
line 120: omit the parentheses
line 145: Captions are reversed (left to right)
line 162: should say 'Figure 2 left', not right
line 180: it would be preferable to refer to time-aggregated data as rainfall rates (they are equivalent mean rainfall rates, not true intensities)
line 253: again, space required following numerical quantity
Figure 9: there are two dashed lines, only one is listed in the legend
line 500: Hortonian (capital H after the family name of Robert Horton)

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