

Comment on hess-2022-26

Anonymous Referee #3

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-RC3>, 2022

This study compares storm runoff processes between two catchments with similar size based on the analysis of transfer time distributions (TTDs). The authors present a seasonality in TTDs, which had a different trend between the two catchments. Quick runoff transfers occurred under dry condition in a catchment. The authors attribute the rapid flows to marly plateaus, hydrophobic forest litter, and the absence of a riparian zone in the catchment.

This paper deals with an important topic. I think their analysis of TTDs using a unit hydrograph model is effective for comparing the storm runoff characteristics between the neighboring catchments. Seasonality in TTDs (Figure 8) is especially interesting. However, data for discussing the causes of the seasonality and inter-catchment differences in TTDs are insufficient. More information about groundwater dynamics and topographic analysis is needed to discuss the causes of rapid flows. My major concerns are listed below, followed a list of specific comments and technical corrections.

General comments

- Which is the novelty of this study, analytical methodology or the estimated causes of rapid runoff? If the TTD-based comparison of storm runoff characteristics is a novel approach, the authors should emphasize this content in Introduction and Discussion. If they think the causes of rapid runoff are the main findings, they should increase reliability of estimating the causes. In this manuscript, relationships between runoff mechanisms and TTDs are unclear and the factors causing rapid flows in their study

- sites are only speculated from the results in TTDs.
- Although the authors focus on bedrock geology, groundwater dynamics in each geology are unclear. The rapid flow due to hydrophobic forest litter was also not observed in their study sites. Moreover, differences in riparian topography between the catchments were not presented despite mentioning riparian buffering. Due to lack of these data, they only speculate the causes of rapid flow. If they want to discuss the causes based on the data in these two catchments, more detailed presentation of groundwater flows and topographic characteristics in the catchments is needed.
 - I can't understand why the authors compared only two catchments despite the observations in six nested catchments (Figure 1). How different were TTDs between the six catchments? I think examination of relationships between TTDs and catchment characteristics (including geology, topography, catchment size, and vegetation) using the data of six catchments can provide more valuable implications. Even though groundwater flows were not observed, the causes of rapid flow may be estimated with reliability if the comparison of six catchments is conducted.

Specific comments

Title: If the main theme of this paper is causes of flashy runoff, the causes should be examined more deeply based on other groundwater and topographic data or the comparison of TTDs between more catchments.

L14-17: Although the geology of the catchments is well described, there is little information about their topographic characteristics. I want the authors to clearly present the difference in topography between the catchments.

L27-29: These causes are only the speculation and remains hypotheses. As these hypotheses were not verified, this is inappropriate as the conclusion. It may also be possible that the quick runoff under dry condition was caused by direct precipitation on stream channel and/or rapid runoff from riparian zone. As the catchment got wetter, hillslope runoff with long transfer time may contribute to stream water, which can be a possible mechanism of longer TTDs in wet conditions.

L58-60: Whereas the authors wrote "The numerous faults and cracks support quick water transfer through the weathered bedrock and explain fast hydrological responses" in this sentence, they also wrote "Less permeable bedrock will lead to ... smaller catchment mean transit times." in L80-81. Whether the weathered bedrock can contribute to fast responses (smaller transit times) or not?

L89: If the main problem of previous research is the lack of observations in extreme

events, this should be clearly presented in Background section. The event magnitude should also be emphasized in the Results and Discussions.

L98-99: I could not understand the difference in flash flood type between Central Europe and MA regions. Please describe the difference more clearly in Background.

L116-162: I could not understand which catchments had more permeable bedrock and larger storage capacity. According to Table 1, geology seems similar between the catchments: Both had the main geology of sandstone and second geology of marls. If the authors focus on the geological features, geological difference between the catchments should be explained more clearly. Information about vegetation is also required because the effects of litter are discussed.

Figure 1: Please add contour lines in the figure. Addition of the map of slope angle or topographic index is also helpful to understand the topographic features of study sites. As soil moisture was observed at the points of raingauges, "Raingauges" should be changed to a phrase such as "Raingauges and soil moisture observations".

Table 1: What is the difference in river width and riparian area between the catchment sections? Similar area, elevation range, and slope range does not necessarily mean that the two catchments have similar topography.

L139: Does "deeply cut" mean that valley was deeper in HM section than KOE catchment? If so, this topographic characteristic should be quantitatively presented.

L212 "net rainfall amount after infiltration": How did you determine the amount of loss (i.e., total rainfall – net rainfall)?

Figure 7: Hydrographs in Heffingen catchment were very clearly different from those in Koedange and Medernech catchments. Why was the runoff delayed in Heffingen? I think the comparison between various catchments may provide clearer insights into runoff mechanism than the comparison between only the two catchments.

Figure 8: Please add the results in runoff coefficients of each event. I also recommend the authors to conduct statistical in order to examine whether the difference in the TTD values between the two catchments was significant in each event.

L418: I want the authors to show the location of "large flat terrain" in Figure 1 based on

topographic map with the spatial distribution of slope angle or topographic index. It would also be helpful if the area of this flat terrain can be shown in Table 1.

L421-422: Why does the limited permeability of underlying bedrock lead to large storage capacity? I think permeable bedrock has larger storage capacity because groundwater is stored within weathered layer or fractures in bedrock.

L490-510: Although only the effect of litter layer is discussed, discussion about evapotranspiration is also necessary for the impact of the vegetation because LAI directly affects it.

L513-514: Differences in geological substrates and landscape features between the catchments should be more clearly presented throughout the manuscript.

L516-517: There is no evidence that main runoff source in the KOE catchment was groundwater and deep soil water.

L521-523, L529-530: It seems that the authors attribute the difference in runoff characteristics to topography in slope and riparian zone rather than geology. If so, stories focusing on the topographic features may be better.

L531-532: Runoff coefficients were one of magnitude smaller in summer than in winter (L439). I think this result indicates that runoff during dry summer season had small risk of flooding even if the rapid flows occurred. Both results of runoff coefficients and TTDs should be considered to provide conclusion for flood risk management.

Technical corrections

L24: "Another catchment" would be better than "The HM section" because I could not understand this is the name of catchment when I firstly read Abstract.

L100: Does "mean summer and winter runoff" mean baseflow runoff in summer and winter?

L111-114: I think these sentences are unnecessary.

L154-156: The order of Figures 2 and 3 is reversed.

L177: Although it was written that "the rainfall amount had to exceed 10 mm", there is an event with the rainfall amount of 9.8 mm (Table 2).

Figures 6 and 7: Please check if the date of (c) is true. Were they really different between the two figures?

L308-310: Were these values the ranges in both catchments?

Figure 10: The color of SWC20 and RC may be wrong.