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.

The TTD-based comparison is not a novel approach as it is already used either in old studies comparing the shapes of the hydrograph to classify a set of catchments or more recently to study the impact of catchment management (before and after restoration management, as example see Memberu et al, 2018, figure 6). From our point of view, the novelty presented here is a clear demonstration of the distinct impact of dry conditions on runoff transfer processes. It is thus shown that beyond the precipitation characteristics, the configuration of the catchment will be a key factor in the generation of a flash flood following a summer storm. In order to emphasize this idea, we reworded the paragraph summarizing the results:

*"We observed a seasonality of the TTDs for both catchments, with dry conditions having an opposite impact on them. The KOE catchment reacts less quickly and more spread out under dry conditions. On HM catchment on the contrary, response times are significantly shorter and concentrated (-59% ± 33%) and (+33% ± 87%). **This opposite seasonality** leads us to consider/hypothesize different control factors of the runoff transfer processes in relation with the topographic and geological layout of the catchment areas."*

(REF:Menberu, M. W., Haghighi, A. T., Ronkanen, A.-K., Marttila, H., & Kløve, B. (2018). Effects of Drainage and Subsequent Restoration on Peatland Hydrological Processes at Catchment Scale. Water Resources Research, 54(7), 4479–4497. doi.org/10.1029/2017WR022362)

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.

Unfortunately we do not have groundwater flows data, nor hydrophobic forest litter measurements. The main idea of the paper was to highlight the distinct behavior along the Ernz Blanche catchment on dry conditions. We orientating the discussion toward the causes because it seemed to us coherent to enumerate the possible factors - even though we cannot justify otherwise than by the literature. The idea here is to propose several avenues for further investigation.

Concerning the topography, it is true that we have reduced its presentation while it occupies a major part of our conclusion/discussion. We have therefore added some elements in the presentation section of the watersheds, in particular the iso-contours on figure 1 and a map superimposing slopes and Heights Above Nearest Drainage (HAND) highlighting the riparian zone on KOE and the steep slopes on the perimeter of the hydrographic network on HM.

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.
We carried out the analyses on only two catchment areas and not on all six embedded catchment areas, because on the one hand the flow series at two stations (Reisdorf, Hessemillen) are uncertain due to the backflow of a confluence and a dam respectively, and on the other hand the comparison of transfer time distributions of catchments of different size seemed less convincing to us. We have nevertheless mentioned them because the shape of the hydrographs clearly indicates a break in behavior between what happens upstream of Heffingen and what happens downstream (Larochette, Médernach, Hessemillen, Reisdorf). This is particularly showed/visible on Figure S1 in the supplementary materials.

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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.
We changed the title for: **„Flood patterns in a catchment with mixed bedrock geology and topography: highlighting the delimited flashy runoff contributions during storm events“**
The initial objective was to find the causes of flashy contributions. Although we believe that we have identified and highlighted when and where rapid contributions occur on the White Ernz, we recognize that we do not have enough evidence to clearly identify the causes.

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.
As suggested, We gave more details about the topographic characteristics:
The upper catchment (KOE) is dominated by **a low land area (38% of the catchment is located less than 30 m above the river network) consisting in variagated** marly bedrock (Midle Keuper Km3) and moderately steep Luxembourg sandstone outcrops (Lower Liassic Li2). The lower catchment (HM) has its drainage network deeply cut into the Luxembourg sandstone, with half of it being covered by marly plateaus (Lower Liassic Li3, **located between 80 m and 100 m above the river network)** featuring heavy clay soil.

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.
It seems to us that we are defending the same hypothesis: dry conditions imply direct and rapid runoff to the river. The real question is why this has more impact on HM than on KOE. We thus clarify our hypothesis by assuming that: I) the impact of dry conditions is stronger on marly

plateaus; ii) the dry litter of sloping forests favors runoff rather than water retention and infiltration, and iii) the riparian zone when sufficiently wide allows a buffer effect on this direct runoff. We agree that those hypotheses not actually proven by experimental results, but they are suggested as such: line 30: "stand as **our main hypotheses** in this respect".

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?
...both : depending at which time scale we look at. At event scale, we observed fast flows, but at seasonal scale the baseflow release is low. „catchment mean transit times" in Pfister et al. 2017 actually refers to „baseflow mean transit times". I replaced it to clearly make the distinction.

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.
You're true. Our study is based on moderate events and the event's magnitudes do not make the our study specific. The specificity of our study is to focus on what impacts the speed and amplitude of runoff processes beyond rainfall properties. The last studies in Luxembourg does not enables to answer this question. We changed the lines 90-95 to clarify this idea.
*"To date, all investigations focusing on rainfall-runoff transformation processes in the Luxembourg context have been limited to small experimental watersheds (< 5 km$^2$) or dedicated to storage and catchment release. While these studies have substantially improved our understanding of physiographic controls on runoff generation, we still have poor knowledge of the processes leading to quick runoff on catchments with a genuine river network as in flash flood events."*

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.
The lines 74-78 explain the different context between Central Europe and MA region which makes impossible to transfer knowledge of the flash flood processes in MA to the Central Europe. We thought it is clear enough but we give more details here:
*"While most flash flood related literature published to date refers to the Mediterranean area (MA), the processes underlying flash floods in Central Europe remain poorly understood. This mainly relates to the fact that :*

- *in these catchments (i) the climate forcing is not primarily controlled by topography (as opposed to MA),* → in MA, the Alps, the Pyrenees, the Cévennes foothills consists in elevated mountains which can block and induce convective and stable (in space) storms. In Central Europe, there is no such topographical barrier. Although the 2018 and the 2016 flash flood event were induced by relatively high rainfall amount, this is not the same order of magnitude than in MA (~50 mm compared to ~200 mm)
- *(ii) catchment storage filling states are very different between early summer (storage levels being still high when flash floods occur in Central European catchments) and autumn (storage levels being low when flash floods occur in MA catchments)* → the catchment conditions are not the same as the season of occurrence is different so the conclusion found in MA could not be transfer to Central Europe.
- *and (iii) the underlying bedrock geology is very different between Central European and MA catchments."* → *As well, some studies on MA relate the flash flood processes to specific bedrock geology. Here in Central Europe, the bedrock is linked to other mountains formations, so the impact could not be deduced again.*

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.
At a first glance the catchment seems to get the same geology; half part being marls and the other part Luxembourg sandstones. However there are two big differences:

- First, the marls layers consists in two different geological substrates with different properties. On Koe catchment the marls is a middle Keuper stratum (km3, Trias superior) and on HM the marls date from the Sinemurian period (Li3, mars of Strassen). The middle Keuper marls actually includes conglomerates and thin beds of dolomite, which can in turns include aquifers that are significant enough to be mentioned (Bouezmarni et Debbaut, 2006). Conversely, the Strassen marl is revealed in the landscape by the appearance of numerous springs at its upper limit. These features tend to reveal a relative permeability of km3 in comparison to Li3.
- Second, the arrangement of the sandstones and the marls layers is reversed. On HM, the marls of Strassen consist in the plateau, i.e the top of the relief, while the midlle Keuper marls on KOE consists in the riparian zone. Because of it respective location, the marls layer on HM will be more sensitive to dry condition.

We make several changes in section 2.1 and table 1 to be more accurate on that point. When speaking of km3 marls, we said “variagated marls”. On table 1, instead of speaking of the first and second geology in terms of size area, we speak about “lower geology” and “overhanging geology”.

(REF: Bouezmani, Debbaut. Carte géologique de Wallonie, Tintigny, Etalle, Notice explicative. Université de Liège, 2006.)

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”.
The suggestions have been applied to improve the catchment’s presentation: the topographic contour lines have been added to the figure and the legend has been modified. Furthermore a map which integrates the slope display and the heights above nearest drainage map. The latter information highlights the buffering area on KOE catchment and the closeness of the slopes to the main river network on HM catchment.

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.
We added a statistic about the height above nearest drainage that characterizes the difference in surface area of the riparian zone between both catchments.

L139: Does “deeply cut” mean that valley was deeper in HM section than KOE catchment? If so, this topographic characteristic should be quantitatively presented.
The surface area close to the river network in terms of elevation is 3 times smaller on HM catchment in comparison to the KOE one. This figure presented now in table 1 supports the qualification of “deeply cut” apply to the river network in HM catchment. In an illustrative way, the slope display in figure 1 now illustrates this characterization.

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

This is based on the observation of the average runoff coefficient: the net rainfall volume is equal to the discharge volume observed. Assuming a constant RC along each event the net rainfall at each time $t_i$ is : $R_{net}(t_i) = RC* R_{total}(t_i)$ (this is already described in equation 7)

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.
See figure S1 in supplementary materials. The hydrographs in Heffingen catchments are different from the Medernach catchments but not from the Koedange catchment. With the latter there is only a delay and a spread, which is an expected behavior when looking at a downstream measurement. This has been already described lines 187-189 (first submission): *"The headwaters (as expressed through the Koedange and Heffingen stream gauges) consistently triggered rather attenuated hydrological responses. Further downstream, the stream gauges located downstream of Larochette exhibited a much more responsive behavioural pattern."*

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.
We are not sure to understand your suggestion. The runoff coefficient is part of the observation and not calculated using the model. That's why it does not appear in the figure. Or do you mean to range event according to the runoff coefficients?

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.
This is now visible through the heights above nearest drainage statistics (table 1 and map (figure 1 right).

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.
It is rather a misunderstanding of the connection between the two parts of the sentence. We reworded the sentence: *"This almost 100% marly (km3) catchment has a rather large storage capacity,* ***despite of*** *~~considering~~ the limited permeability of its underlying 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.
As focusing on the time transfer distribution variability and not on the runoff coefficient ones, we do not discuss on evapotranspiration.

L513-514: Differences in geological substrates and landscape features between the catchments should be more clearly presented throughout the manuscript.
Thanks to your suggestion, we added several description that - we hope – will help the catchment's characterization.

L516-517: There is no evidence that main runoff source in the KOE catchment was groundwater and deep soil water.
We reworded this part of the conclusion*: " In the KOE catchment, the water transfer get a seasonal variation disconnected from precipitation characteristics (except for one summer event)."*

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.
As said before, changes have been made in line with this suggestion.

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.
Our conclusion deals with the specific context of **flash** floods. In this context, the short timing and the peak magnitude rather – than the runoff coefficient – are of first importance. As a prove, the 2016 and 2018 **flash** flood events get not so high runoff coefficients (14% and 20%), while their flood peaks are among the three highest recorded.

→ ...

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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.
The HM acronym presentation has been added line 18.

L100: Does "mean summer and winter runoff" mean baseflow runoff in summer and winter?
It means "runoff coefficient". This has been specified.

L111-114: I think these sentences are unnecessary. ok.

L154-156: The order of Figures 2 and 3 is reversed. The caption has been corrected.

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).
The threshold of 10 mm was actually applied on the raingauge observation average that make a slight difference with the rainfall amount on Medernach catchment (obtained with weights on raingauge according to the Thiessen polygons).
We changed the description: "*[…] according to the following criteria: i) the rainfall amount average on the 4 raingauges had to exceed 10 mm, [...]*"

Figures 6 and 7: Please check if the date of (c) is true. Were they really different between the two figures?
The dates of (6c, 7c) are right. The figure 6 shows the result of the KOE catchment simulation, and the figure 7 shows the same but for Medernach. On panel, We choose two different events, because it seems to us more illustrative of the model "weaknesses" on each catchment respectively.

L308-310: Were these values the ranges in both catchments?
Sorry but we do not understand the question.

Figure 10: The color of SWC20 and RC may be wrong.
This has been changed.