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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Flood type classification and assessment of their past changes across Europe" *by* Yeshewatesfa Hundecha et al.

Anonymous Referee #1

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Review of "Flood type classification and assessment of their past changes across Europe"

This paper presents a broad assessment of floods in Europe by:

(i) gathering GRDC streamflow data from several hundred catchments in Europe. (ii) identifying floods events using base-flow separation techniques (iii) collecting hydrological and hydrometeorological state variables from existing data sets and models (iv) classifying floods into 4 different event types (short rainfall, multi day rainfall, rain on snow, snowmelt) (v) assessing changes in flood mechanisms and occurrences over time (vi) quantifying the spatial extend of flood. (vii) and presenting the links between iii-vii

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From this analysis, the authors report extensively on all these aspects. While the presented results (iii-vii) are potentially a useful contribution to HESS, I cannot recommend publication of this work in HESS in its current format. Before I can recommend publication a large number of aspects need to be revised and clarified (which potentially will lead to a completely different paper). My main concerns are:

1) The paper is not explicit about the knowledge gap it fills. This needs to be emphasized much better. I provide specific comments on this in the detailed comments. But main concerns are:

- When reading the abstract I read a long list of results, but it is unclear what the novel take home message is. - When I read the introduction, I read many studies that have done partly overlapping work before, but when you state your aim (lines 1-2, page 4) it remains unclear what is really novel compared to earlier work. - When I read the methods section I have no idea what I should pay attention too, since I am not sure what the “new thing” is the paper will show me. - The results give a wide overview of “findings” but all of these are presented in a somewhat superficial manner (because you present so many different things) - The discussion section discusses some links with previous studies, but fails to reflect on what we really learn compared to earlier work. - The conclusions are just an overview of findings, not a conclusion about what we learned in this paper.

Better emphasizing the novel aspects of the paper is critical to understanding the contribution of your work.

2) The rationale of how flood events are defined is unclear and seems inappropriate to me; why is a flow where direct runoff (according to base flow separation as explained in section 2.2) that exceeds base flow and the mean flow, considered a flood? According to this definition a flow peak that just exceeds the mean annual flow, (and is mostly direct runoff) will be classified as a flood. However, in such a case flow conditions have nothing to do with flood conditions in my understanding. Of course, your method will

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also likely identify real floods as flood events (since they exceed the mean annual flow, and are likely to have a lot of direct runoff) but these events will (probably) be much rarer than the events that I listed before. Therefor it seems that your study mostly characterizes events that should not be considered floods?

Without better justifying/clarifying this definition of floods the rest of the analysis has no value to me, since I have no idea if the presented statistics really characterize floods (or I am looking at some other flow characteristic)

3) The classification analysis is unclear, and seems inappropriate. Concerns are: - How can you define a classification scheme, and afterwards manually change for particular catchments to which class they belong? This approach is not repeatable and does not sound very scientific? Was your initial approach wrong anyway if you have to manually adjust afterwards? - All catchments are allocated to a particular class, but there are (potentially) important flood generating mechanisms that are not included in your four predefined flood types. For example, are soil moisture dynamics controlled by seasonal evaporation not important for floods in Europe? Are there any catchments where none of the posed mechanisms seem a reasonable explanation of the floods that you describe? - The description of the used cluster analysis is unclear (to me) (I cannot repeat the analysis presented at page 9 given on the provided information). In addition, the physical rationale why this clustering approach will actually lead to a reliable classification of flood mechanisms is unclear to me. Defining four mechanisms, and providing some clustering algorithm does not seem sufficient without explaining the physical rationale behind this approach (and emphasizing its limitations).

4) the method used to quantify the spatial extend of floods seems unreliable; first the chosen requirements are highly subjective (e.g. what would change in your analysis if you used different threshold conditions?). Second, these chosen conditions appear not to have to do anything with the definitions of flood outlined in section 2.2.? Third, the method seems highly sensitive to whether there is actually data available from nearby gauges available?

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5) The presentation of all results needs to be improved. Currently a lot of vague terms are used to refer to results, without explicitly stating where (in e.g. the figure) the reader can see what result is referred to. An example would be “Distribution of the event duration of events displays a connection with whether snowmelt is involved in the process of event generation” (page 15, first lines) where unclear terminology is used (e.g. what do you mean by “shows a connection”?) and it is unclear where the reader can find these results (i.e. what figure do I need to look at, and what specific aspect within that figure?).

6) The writing of the paper needs to be improved a lot. While I provide a long list of suggestions in the detailed comments, this list is not exhaustive for the number of improvements that need to be made.

Considering these outlined concerns, I think the paper needs to be (extensively) revised before I can (consider) recommending this paper for publication in HESS.

Detailed comments

Page 1: Title: when I read the title, it remains unclear if “their” refers to “floods” or to the “flood classification”. Consider rephrasing the title such that this is clear.

The abstract is a good overview of what is done in the paper, but it does not specify what is really new about the work, or what the specific hypothesis/niche is that this paper addresses. Explicitly including this in the abstract, will make it much easier for the reader to understand the novel contribution.

Line 10: “leading up to” or “causing”?

Line 10: later in the manuscript you state you use 614 catchments in the study (since you omitted the ones with too few data). 614 seems more appropriate to mention in the abstract than 745.

Line 11: “peak flows”? Can you be more specific since this is a poorly defined term.

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Line 12: “form the same flood event” is unclear to me. Do you mean something like “are caused by the same driver”?

Line 13: “delineating” or something like “"providing a proxy for" (since it seems unlikely that you have enough data to really derive the spatial extend of flood events.

Line 14: what do you really mean by “are relevant in the flood generating process”?

Line 15: “for each of the identified spatially delineated flood events” Does this mean you first delineate the spatial extend of a flood, and after that for that “lumped” event search for the cause?

Line 13-15: “A pan-European . . . flood events”. I have difficulty to really grasp what you try to say here. Maybe this is resolved by addressing the two previous comments

Line 16: “each flood event” does this refer to a single gauge or a group of catchments that together are part of the same bigger flood event?

Line 17: “were identified” is confusing. Make clear that these are 4 mechanisms originate from your modelling choices, and not from what data has taught you. Thus “tested” may be more appropriate than “identified”.

Line 17: “long” and “short” are unclear. Is it not better to refer to as “(sub-)daily” and “multi-day”?

Line 17-18: “A trend . . . investigation period” is this trend analysis performed per mechanism (this giving a lumped picture of Europe) or per location (giving trends at individual catchments?)

Line 21: “did not” instead of “didn’t”

Line 21: “total number of flood events” thus far it is unclear how you defined a flood. Consequently, I do not learn anything from this statement currently. The same problem applies to any of statements on flood changes in Lines 21-27.

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Line 27: OK now I have read the entire abstract, but what is really the take home message? And what was the initial problem/niche that this paper addresses? Please clarify this to the reader (which is in line with my earlier comment that “The abstract is a good overview of what is done in the paper, but it does not specify what is really new about the work, or what the specific hypothesis/niche is that this paper addresses. Explicitly including this in the abstract, will make it much easier for the reader to understand the novel contribution”)

Page 2: Line 3: “recent past”? Why not being more specific? For example, something like “past decade”?

Line 4: “The studies” or “These studies”?

Lines 4-5: “led to the events” or “caused these flood”?

Line 7: “there is a likelihood of their increase” is a meaningless statement; there is always some likelihood (it can just be bigger or smaller).

Lines 6-7: would it be useful to state WHY there is an increase in interest so this statement doesn’t come out of the blue?

Line 8-10: It seems that all these studies characterize past changes, while you end the sentence before that talking about future flood changes; this may confuse the reader a bit.

Line 12: I am not sure if “proper” adds anything to this sentence? (or if it is even appropriate?)

Line 11-12: “Understanding the . . . local conditions”. This argumentation is not complete; the argument needs to include a statement on how understanding of flood mechanisms helps flood management (which should be straightforward to include, and in general will help the reader to better understand the value of part of the work you present in the paper).

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Line 15: do you mean “spatial” or “temporal” scales? Or both?

Line 16-20: this list of studies selected seems rather arbitrary. There are many more studies that characterize flood mechanisms? What is the value in listing these examples? More importantly, I am not interested in what “people have done before”, I am interested in reading “what knowledge gap you are going to fill”. In context of the latter statement, I suggest to reformulate such an overview to something like “while many studies characterized BLA BLA [references], it remains unclear STATE KNOWLEDGE GAP”.

Lines 22-28: the same problem seems to apply here (but now for flood changes, rather than flood mechanisms classification)

Page 3 Lines 29 (page 2) – 16: the same problem seems to apply here (but now for flood change attribution)

Lines 17-33: the same problem seems to apply here

Page 4: “The aim . . . across Europe”. This is an unclear goal to me, especially since there are other studies that do very related stuff already. Be more specific to make your goal clear.

Line 16: what screening criteria did apply that led to eliminating >100 catchments?

Line 17: which model did you use? (OK you will explain this later I see, but at a first read this confused me)

Line 18: Do you try to say you applied Hundecha’s model results? (OK you will explain this later I see, but at a first read this confused me)

Line 20: How did you derive the HRU’s? (OK you will explain this later I see, but at a first read this confused me)

Lines 27-28: Are these datasets somewhat consistent with another (or is combining them inappropriate for trend analysis?)

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Section 2.1 What size catchments are we looking at?

Page 5:

Figure 1: Since you are inconsistent in the number of catchment that you use in this study (>745 in the abstract vs 614 in the methods) I do not know if this figure includes 747 or 614 catchments.

Figure 1: Where did you retrieve info that helped to delineate these different hydro-climatological regions? What is the rationale behind this classification? Why is that classification useful for your paper? It seems rather useful to include this information, since you use this classification later in the paper.

Line 4: “extreme flow” or “flood” (it may be useful to be consistent on wording throughout the manuscript)

Page 6:

Line 5 (page 4) – Line 20: I expressed my concern about the use of your “flood” definition in the main comments at the start of this review. In case you can make a decent rebuttal for this argument, please ensure that you much more clearly explain the rationale behind this definition? Are there other studies that use a similar definition of floods? What was their rationale behind choosing this definition?

Line 26: isn’t every routine for land surface and subsurface processes “conceptual” at the scales we apply our models?

Page 7:

Line 3: “PET is achieved”? Don’t you mean evaporation itself?

Most information on this page up to line 22 seems to come directly from Hundecha? Is it really worth repeating these details? Or can you make this section much shorter (and not confuse the reader since they are unsure whether you did this work, or just describe the data you borrowed from others?

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Page 8:

Section 2.4: I do not see how these definitions (partly based on return periods) link to the definitions of flood peaks presented in section 2.2.

Page 9:

Line 17: what do you mean by “little”? This seems especially relevant since (i) this study should be repeatable and (ii) how much rain is needed to go from a snowmelt flood to a rain on snow flood?

Lines 30: Ok great you put effort in checking your results, but now that you “manually correct” some it seems like you just choose a wrong method to start with? Also, how can someone else repeat your analysis and results when you start changing results manually afterwards without specifying what the requirements are for you to change a catchment from one class to another?

Page 10: Ok, but what did you do with catchment where you manually changed the classification?

Page 11: Lines 9: Maybe it is worth to repeat the time periods you use to define “winter” and “summer”? (since people tend to skip to results).

Line 9: “more” can you be quantitative?

Figure 3: are there catchments where you identified no floods?

Figure 3: “Annual events” can be interpreted as “annual flood peaks” which are often used in flood studies. Maybe therefor change the label to avoid confusion?

Figure 3: Is there any solution to having so many catchments markers stacked on top of another in all the maps? It makes it difficult to see what is really going on in this region (same for the UK)

Figure 3: is it useful to add a frequency distribution of the number of recorded floods

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over the stations?

Page 12: Figure 4: is it not much more useful to display the occurrence of flood types as percentages (or fractions) rather than total numbers? Now it is very difficult to see which processes are dominant in which region and how that varies between regions.

Line 6: “Annually, this is”? Please rephrase this.

Lines 9-10: “Regionally, short . . . in winter” I do not fully understand this sentence.

Line 16: “are little represented” or something like “rarely occur”?

Entire section 3.2: this description is too qualitative and vague to be useful to me. All these statements can be supported by for example including percentages or some other quantitative measure. For example, write things down like “short rain floods account for XX% of all recorded floods, and are thereby the dominant mechanism at the continental”.

Page 14: “into different” or “according to”

Figures 5-7: How can you calculate these percentages when many of the catchment seem to have only a few floods recorded per catchment? Especially when you look at it per season (Figures 6 and 7)?

Section 3.3: Are these calculated areas not highly sensitive to the regional coverage of flow stations?

Line 7: variability in what?

Line 8: “less range of” or “smaller”

Page 15:

“displays a connection with whether snowmelt” such a formulation is really unclear to a reader. What connection do you see, which figure do we need to look at?

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Reconsider "flood genesis" since it may be unclear what you mean (and will might confuse readers with a biblical reference).

Mangini et al. (under review): if this paper is not published by the time you revised your manuscript, I suggest removing this.

"didn't" or "did not"

I recommend rewriting this discussion section, in line with the main comment I provided at the start of this review.

Conclusions:

I recommend rewriting this conclusion, in line with the main comment I provided at the start of this review.

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