

Interactive comment on “Hydrogeomorphological analysis and modelling for a comprehensive understanding of flash-flood damaging processes: The 9th October 2018 event in North-eastern Mallorca” by Joan Estrany et al.

Anonymous Referee #2

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Summary:

This manuscript analyses a flash flood event in a small catchment in the North-Eastern part of the Spanish Island of Mallorca, that left 13 people dead and caused severe damages to local properties. The analysis looks into four main aspects of the event, namely the meteorological conditions, the hydrological and hydraulic response, the damage assessment and a geomorphological analysis with the aim to improve the understanding of the drivers of this respective event. The authors conducted field measurements on the geomorphology few days after the event and present those findings alongside

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measurements of the rainfall, discharge and a damage assessment of a severely hit village in the catchment based on ground-based records and remote sensing information. The authors use hydraulic and hydrologic models to model the runoff processes in the catchment. The presented data and results are discussed by topic and summarized in the conclusion.

General comments:

The paper is very interesting to read and provides important information on frequently underreported local flash flood events. The four aspects of the event are presented in great detail with very detailed information on the technical background of the data collection and modelling. However, overall the paper appears very fragmented with little connection between the different analysis. From reading the paper I was not able to fully understand how the presented data sets and models relate to each other and what are the main conclusions from the analysis. While the authors claim that their study uses an “[...] integrated approach with meteorological, hydrological, geomorphological, damage and risk data analysis” (L616f), the different analysis are presented largely isolated and independent including the discussion. Here, it would help if the authors would A) provide an overview figure that shows how the data sets and models are linked and B) A joint discussion that highlights how the individual results are linked and how this contributes to a better understanding of what made the event so devastating. It also appears that there is quite a disconnect between the results, discussion and conclusion sections, where topics such as driving factors of the damage in urban areas are for the first time explicitly mentioned in the conclusions, while the previous chapters mainly focus on the methodological aspects of the damage assessments. Similarly, language and grammar vary considerably throughout the paper and rigorous copy editing is necessary prior to accepting the manuscript for publication. Given the otherwise interesting and very relevant contribution the paper makes in the field of flash flood post event studies, I recommend considering the manuscript for publication after major revisions.

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Specific comments

Structure

Introduction

The introduction is very technical and has a very narrow focus on flash flood processes. It also appears to address a lot of specific subjects in no particular order rather than leading to the research questions the authors are aiming to answer. Restructuring the introduction so it clearly leads to the research questions and highlights the importance of the work would therefore really improve the quality of the paper. As this is not the first study of its kind, I would also recommend including a literature review on previous post event studies (both flash flood related and potentially other natural hazards) and their findings. This would give the reader the opportunity to better evaluate the contribution of the paper to the scientific discourse and what knowledge gaps it addresses.

Description of the study area

For the sake of readability, I would recommend separating the meteorological conditions that lead to the event from the actual description of the study area.

Conclusion

The conclusion appears to be quite detached from the rest of the manuscript addressing several points that have not been previously mentioned in the manuscript but are important to fully understand the analysis. For example, how the meteorological, hydrological, geomorphological, damage and risk data analysis are linked. Or what the actual damage driving factor in urban areas are based on the different findings.

Rainfall

This paper focusses on the hydrological response as a main driver of the flash floods and the authors argue in the introduction that “the uncertainty in hydrological modelling can be large and hydrological models often need to be calibrated [...]. Therefore, the

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predictability of such events remain low also adding that predictability is lowered by a high non-linearity in the hydrological response related to threshold effects”. This implies that the uncertainty in the hydrological models are a key barrier in the predictability of flash floods. However, most other studies on flash floods and flash flood early warning systems find the spatio-temporal uncertainties in the rainfall prediction to be the largest obstacle in accurately forecasting and modelling flash floods (see for example Alfieri et al. 2017). This issue is also addressed in the description of the rainfall data, but the authors do not report to what extent the results of the subsequent hydrological and hydraulic models are sensitive to the uncertainties of the rainfall input. Therefore, I would recommend adding a short sensitivity analysis in regard to the rainfall input to the discussion section. It would also be interesting to see to what extent the results vary between the radar and gauge data.

Risk management and early warning

Given the high casualties and damage during this event it would be important to also cover the vulnerability of assets and people in the case study area for a comprehensive analysis of the damaging factors. This aspect however is only very briefly mentioned in the discussion and conclusion. Key questions would include: did people in the village receive some sort of early warning? Are there any risk management strategies in place apart from the mentioned flood zones? Discussing these aspects would also help to conclude with more specific recommendations for the improvement of risk management practises.

Damage classes

In Figure 7(e), the distribution of the damage classes for the three different zones and the total of all zones are shown. It seems that the total does not correspond to the sum of the three zones as the by far largest group in total are houses being “Damaged & Non habitable” with 260 houses, while the sum in this group for all three zones is 37 homes. That might be either an error or it should clearly be stated what is meant by

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“Total”.

Sediment connectivity and geomorphic change

While using the sediment connectivity to support search and rescue missions after flash flood events is a very innovative approach, it is not entirely clear what one can learn from the sediment volume calculation. Discussing this number in the context of the other analysis and its implications for a better understanding of the flash flood processes would help to further improve the manuscript. It would also be interesting to learn what is the accuracy of the mentioned approach given the different spatial resolutions and accuracies between the 2014 and 2018 surface models. Can changes in volume attributed to this specific event or does this number also include other changes to the geomorphology (both human and natural) that happened between 2014 and 2018? I would also recommend to clearly separate the sediment connectivity analysis that was used to support the search and rescue efforts and the geomorphic change detection to make clear that the two analysis had different aims.

Additional comments

As mentioned earlier, the manuscript would benefit from English language copy editing. Instead of giving point-by-point corrections I would like to provide a few examples, which I find difficult to understand:

L 51f: “Characterising the response of a catchment during flash flood events is important because elucidate the hydrological processes from an extreme flood and their dependency on catchment properties and flood severity (Borga et al., 2007)” should probably be: “Characterising the response of a catchment during flash flood events is important because it helps understanding the hydrological processes of extreme floods and their dependency in regard to the properties of the catchment and the severity of the event.”

L 112f: “[. . .] was developed affording the analysis of the rainfall-runoff processes at

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small spatial scale during this extreme event.” I did not understand what “affording” means in this context.

L125: “high-energy environment” I did not understand what “high-energy” means in this context

L156: “under a recurrent affection of wildfires”: does that mean that these areas are regularly affected by wildfires or that these areas are prone to wildfires?

References

Alfieri, L., Berenguer, M., Knechtl, V., Liechti, K., Sempere-Torres, D., & Zappa, M. (2019). Flash flood forecasting based on rainfall thresholds. In *Handbook of Hydrometeorological Ensemble Forecasting* (pp. 1223-1260). Springer-Verlag.

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