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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Hazard maps with differentiated exceedance probability for flood impact assessment" *by* P. K. Bhola et al.

Anonymous Referee #1

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The main objective of the paper is to develop a new methodology to generate flood hazard maps. Compared to other studies, the new methodology considers the exceedance probability of multi-model combinations based on forecasted peak discharges derived by a set of hydrological models. In addition, the type of building (purpose & structure) is considered to define the hazard at an object. This is important in terms of prioritization for e.g. early warning and emergency planning.

General comments:

The paper is very interesting and the main objective to create hazard maps or doing impact assessment with a transparent declaration and consideration of uncertainties is desirable. Especially the presented approach using confidence intervals of a hydrological forecast ensemble is interesting and has potential. However, there are doubts

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Discussion paper

about some major points in this study.

It is questionable whether the approach presented in this study “inherently communicates the underlying uncertainties”, as stated in the conclusion. Looking at the final map presented in figure 9a), the meaning of Scenario I, II and III is not directly derivable and the coherence of all classifications and the different combinations of hydrograph scenarios with building types is not easily comprehensible. Even if the names of scenarios in the map would be changed to “high exceedance probability” (=S I), “average exceedance probability” (=S II) and “low exceedance probability” (=S III) – what would already improve the understanding - it’s still questionable whether the multi-model combination presented is the right way to deal with uncertainties in hydrological forecasting for flood impact assessment. To combine the exposure for different confidence interval hydrographs in a new scenario defined by the same exceedance probability is not very elegant. According to the output of the ensemble members, the M50% confidence interval hydrograph as used in the paper (= best-model = median) is the hydrograph that is forecasted as the most likely one and therefore, to define scenarios with low, average or high exceedance probabilities based on multi-model combinations referring to different confidence intervals is misleading. I try to exemplify this issue on table 3: The way the M%-hydrographs from the ensemble forecast are used would imply that the higher the confidence interval, the lower the exceedance probability of an event. But this is not the correct way to implement the confidence intervals here. At the time of the forecast and according to the model ensemble, it is as likely that a M25% or a M75% (= 50% confidence interval) event appears (when I understood it right that for example the lower 80% confidence interval figure 2 corresponds to the M10% hydrograph -> 80% confidence interval means that 80% of the forecasted cases will also be in this range and 20% not -> 10% at the lower and another 10% at the upper end of the scale). In general, the terminology used in this study is also misleading, as for example the 50% confidence interval discharge is used as the median (= M50% = best model), whereas the 50% confidence interval would correspond to the M25% discharge and M75% discharge -> 25th and 75th discharge percentile or 0.25 / 0.75 quantile.

I think that two (hydro-)statistical approaches were unconsciously mixed – the one of confidence intervals of a model ensemble forecast and the general probability of discharge to exceed a certain value (extreme value statistics are not any more relevant at the time of the forecast). When applying the method with the confidence intervals correctly, it appears that scenario I (defined as high exceedance probability) is the most unlikely scenario according to the model forecast. Therefore, the multi-model combination is not working as supposed.

In addition, I don't see the a fundamental novelty of this approach compared to the cited study by Zarzar et al. (2018), who already presents the use of a multi-model ensemble framework based on hydrological ensemble members for visualizing flood inundation uncertainty. I agree with the authors that the use of confidence intervals in the case of a high number of hydrological forecast members can support a transparent declaration of forecast uncertainties.

Besides all of this, to my point of view the display of the inundation pathways and extend is necessary for a use in early warning systems, emergency planning or flood impact assessment. The approach of a building hazard map doesn't provide enough details to intervene (where does the water come in contact with the building, where are the "weak spots" in the river- and floodplain-system).

In addition to these major points, there are some further remarks in the specific comments.

Specific comments

Section 2.1, 2.2 + supplement tables: It is mentioned that the particular focus of this study is on the development of the post-processing part (classification and multi-model combination, mapping). Therefore, the two parts of the framework that are already developed and explained similarly in Beg et al. (2018) and Bhola et al. (2018a, 2018b) should be shortened, as for example a detailed explanation of the model LARSIM, FloodEvac and HEC-RAS is not needed to understand the context of this study. Nevertheless, Figure 3 helps to understand the setup of the multi-model approach. It should be better explained, where for example the M10% hydrograph can be found in such a graphic (consistent use of confidence intervals). It would be helpful if you could add the forecast ensemble for the virtual station that was used as upper boundary condition and maybe mark the used hydrographs.

Section 2.3: The main literature cited (Krieger et al., 2017) is specific to Germany and is not peer-reviewed. In which way are the classification methods for buildings and hazard types comparable with international, peer-reviewed literature? E. g. Jonkman et al. (2008), Dutta et al. (2003), as well as Thieken et al. (2008) and Kreibich et al. (2010) on german scale, differentiate loss estimations of residential/industrial/commercial etc. buildings due to different vulnerability, whereas here these types are represented in the same class here (III).

p. 8, lines 17 + 18; figure 4; p. 14, line 12: Check the numbers given on p. 8 – they do obviously not match the numbers per class in figure 4 and also not with the statement on p. 14, that the most buildings were classified in the classes II and III. I'm also doubting the usefulness of building class I, as there are parks included (which are not buildings) and there is only one member. Furthermore, it's questionable if the applied classification method in the context of the study makes sense, as relative to total number of 2695 buildings, creating separate classes with 1 and 20 (based on figure 4, I would assume that this is class IV) buildings respectively, lead to underrepresentation of these classes. Based to that, it's not surprising that for example the low exceedance scenario is similar to the M50% and M75%, as the buildings are mostly distributed in the classes combined with these hydrograph scenarios.

Figure 8 + 9, p. 15 line 1 - 3: In this context, you should maybe explain somewhere, how you assign the hazard for the same building (finally in figure 9) that is in a moderate hazard zone for scenario I but then rise to a very high hazard in scenario III (is the potential in the forecasted event to have very high hazard at a particular building somehow considered?).

p. 16, lines 4 – 11: In this part, the time issue in real-time assessment of the framework is discussed. As well in the introduction it is mentioned, that flood forecasts might be restricted to computational time of the models. Please provide information about the lead- and run-time of the hydrological forecast model, the computational time for the HD model with each hydrograph and, therefore, how much time would be left for authorities to intervene. This is evident for early warning and emergency planning. It would of course also be interesting how the offline maps from Bhola et al. (2018a) would perform compared to the modelled confidence hydrographs.

Technical corrections

In general: As already mentioned, the use of the term confidence interval discharge in combination with the M% HD outputs seems not to be correct. Please replace confidence interval with "percentile" when referring to M%-levels – or change these levels accordingly.

p. 1, line 21: It would maybe help if you would explain a bit more in detail, what in this study is meant as multi-model combination. Based on this first explanation, one would assume that the building classification is not part of the multi-model combination and this consists only of the HD and hydrological model (which, according to figure 1, is not the case). The term is also used in various ways: multi-model, multi-model combination, multi-model ensemble combination, multi-model combination scenarios. E.g. in the first sentence of the discussion section, the context is given only to hydrology. If this is the case, then figure 1 should be adapted. This can be a bit confusing.

p. 8, line 17 + 18: As mentioned, check the numbers for each class and compare with figure and other statements.

p. 11, line 11/12: As mentioned in special comments, to my point of view the confidence intervals cannot be used to describe exceedance probabilities in the way it was done here.

p. 11, line 22: You refer to post-event information that “no serious damage was reported” -> p. 14 line 4: “figure 7c is in agreement with the post-event information” -> 7c = M50% discharge scenario. According to figure 6, in this scenario 126 buildings are exposed, 67 classified with high hazard -> How does that fit to “no serious damage was reported”?

Figure 7, 8 and 9 b-d: Legends (and building numbers in 9b) are not readable. Also the maps themselves are at the edge of readability. The red circles in figure 9 are not in the legend and are never mentioned in the text (see comments below)? Is figure 9d really necessary? p. 13, line 12 – 15: This error should be eliminated by either using water depth derived from water surface elevation [m a. s. l.] minus ground level of building [m a. s. l.] or by removing the river channel elements from the dataset you used to assign to the buildings. Check out Bermúdez and Zischg (2018).

p. 14, line 17 – 22: Please add the information that you in this specific case compare the red circles from M50% and the multi-model map. ID 1393 is not recognizable in figure 9d. p. 16. Line 3 + 4: What is the computational time of the whole framework? What’s the lead-time used here?

Publication bibliography

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