Anonymous Referee #2

General Comments

Dear authors, thanks for the well designed and inspirational paper. I was asked in October 2018 to review the paper, when another colleague already did a detailed review and gave very valuable comments to the paper. I agree with his comments and underline his implicit proposals for revision. Consequently I will concentrate on additional comments, which might have partial minor importance.

Authors:

We sincerely appreciate the constructive feedback from the reviewer in improving the quality of the manuscript. We have addressed all the review comments in the revised manuscript.

After revision of reviews 1, we have changed the term “confidence interval” to percentile and “exceedance probability” to risk perception.

The followings are our point-by-point responses to the reviewer’s quotes

Detailed Comments

Reviewer: Title The title is short (which I prefer) and defines the general topic of the paper. As the core of the paper deals with the flood impact to buildings classified by the building use, I propose to add this to the title e.g. by a more specific definition of "flood impact assessment" in the title.

Authors: We have updated the title

> “Buildings hazard maps with differentiated risk perception for flood impact assessment”

Reviewer: Page 3 line 12 It is written "The framework to generate building hazard maps in REAL TIME ..." In the paper I did not find any information about this real time feature of the framework. I assume real time did not mean on-time. Can you specify the meaning of real time or simply skip the term ? e.g.: Is real time related to the calculation time of the frame work tools (24 h real time -> 24 calculation time (or less) ?

Authors: We have omitted the term from methodology. The real-time refers to producing the maps as the discharge are forecasted. We have provided more provided information on the run-time of the entire map production. In Discussion Page 20: Line 12

> “In this study, a 50-member ensemble forecast was used from Beg et al. (2018) where the entire process took 25 minutes in a 3-core desktop in parallel mode to generate a forecast of 12 hours. Various percentile discharges were then run simultaneously in the HD model, which required 30 min to simulate a 12-hour event on an 8-core, 2.4 GHz (Intel E5-2665), including the initial start (Bhola et al. 2018a). Post-processing of the model results would consume an additional 15 min. Therefore, real-time hazard maps are delivered to decision makers in 70 min.”

Reviewer: Application Domain The paper is using as case study a smaller German city with a specific topographic situation and type of river size. Such situations might exist in other parts in Germany, Europe as well as the whole world, but there might be also buildings in other environments (e.g. urban area with "plain" topography, "big" cities/metropolises, large rivers

with different flow characteristic). The paper is focusing on the method and not on the case study it might be useful for the reader to have a paragraph about the type of case studies suitable for the application of the proposed method (maybe including the limits of the methods for other types of case studies). It might be also helpful to specify the required data to apply the method for other case studies. In the paper the used data is partial described in different chapters, but esp. the type/quality/level of details of the requested building data for this model should be describes. Are the four classes in this case study specific for the case study or a general approach ?

Authors: We added references to other classification in literature.

In methodology, Page 8: Line 6-10

> "There are various classifications of land use features available in literature. Dutta et al. (2003) have used direct and indirect damages as the basis of their classification and classified their study area in residential and non-residential categories. Jonkman et al. (2008) have classified urban features in residential, businesses, commercial and public property and agricultural to estimate flood loss. Furthermore, vulnerability was the basis of classification in residential (Thieken et al., 2008) and Industrial & commercial sectors (Kreibich et al., 2010) in order to estimate flood losses. "

And we justify the one we used based on: Page 8: Line 10-13

> "We have used damage potential of a building as a basis for classification in order to focus on the flood impact assessment. Building damage potential is required for a variety of flood mitigation planning activities including flood damage assessment, multi-hazard analyses and emergency measures (Shultz, 2017)."

And we added also in Page 8: Line 16-18

> "In the authors opinion by keeping our classification simple will likely fit a vast majority of cities regardless of their size. In any case we acknowledge that the number of classes/ criteria can be changed/adapted depending on the aim of the forecast."

For applicability in other study areas, In discussion, Page 20:Line 10-11

> "Overall, the methodology is independent of the choice of models, i.e. hydrological and HD, and is transferable to other study areas."

And In conclusion, Page Page 21: Line 25-28

> "Further research investigating multi-model combinations and validation in other study areas may be beneficial. A more extensive study on the validation of the multi-model combination may be required, possibly by using measuring gauges, post-event survey (as conducted in Thieken et al., 2005), satellite images (as in Triglav-Čekada and Radovan, 2013), and/or crowd-sourced data (Bhola et al., 2018b)."

Reviewer: Chapter 2.2 shortly describes the basics of the 2D hydrodynamic modeling. I'm missing the description about the handling of the buildings in this model. Are they included explicitly by their shape in the grid and excluded from the flow calculation (no flow through the building) ? Is the urban area including buildings "only" considered by a different (but global) roughness value (Table 2 suppl.)? These two approaches might lead to different water levels at the buildings.

Authors: We have added the information on handling the buildings and assigning hazard. In 2.2 Hydrodynamic modelling Page 7: Line21-23

> "The buildings are explicitly included using their shape in the mesh and are excluded from the flow calculation by assigning a high roughness value. To assign hazard to a building, the maximum water depth of all the neighboring cells was used."

Reviewer: Figure 4 I propose to change the color for Class I, as it is very difficult to distinguish between the light gray of Class I and the lighter gray of the background image. Maybe Class I and II should be not gray but yellow and lighter yellow ocher coming from Red and orange for class IV and III.

Authors: Thank you for pointing it out, we have changed the color so they are visible.

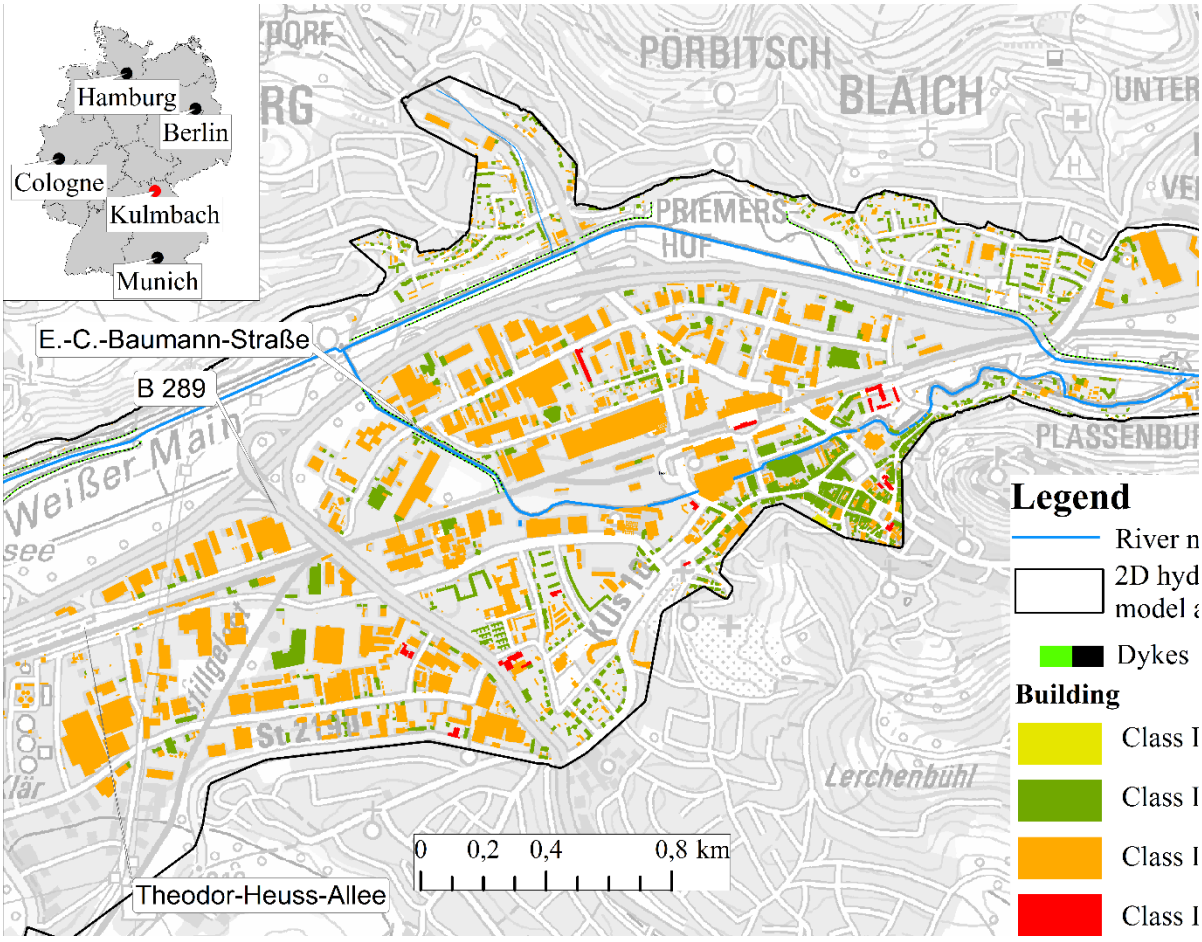

Figure 1. City of Kulmbach and building use classification. (Data source: Bavarian Ministry of the Interior, for Building and Transport and Water Management Authority Hof).

Reviewer: (Page 10 line 14) not so important: the comment about the underground metro access is in general correct, but is there a metro in this "small" city ?

Authors: The classification is general and can be applied in any other city. In this study area there is no metro but there are class IV buildings.

Reviewer: Figure 5 The idea of the figure is well chosen, but it took me some time to understand this. Assuming my interpretation is correct, I think this is not a summing up of components (+ operator) which is equal (= operator) to the part on the right side of this equation. It should be not a sum, maybe a selection I propose to replace the = by a ->

Authors: We have replaces = by ->

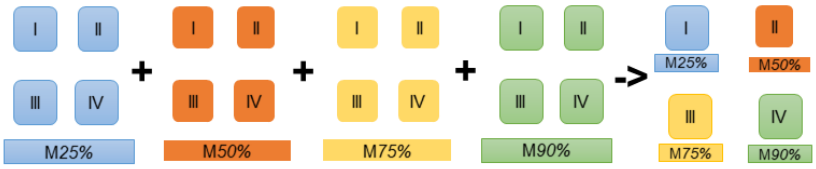

Figure 2. An example of a multi-model combination in which the four building classes I, II, III and IV are assigned to the 2D HD model results of 25%, 50%, 75% and 90% respectively.

Reviewer: The discussion and conclusion is touching in some parts the application aspects for the target users (e.g. page 15). It would be useful to have an explicit discussion about the "progress" of the proposed methods to produce hazard maps for the target users (advantage and disadvantages). With other words: to evaluate the method from the target users point of view and not "only" from the hazard map producer point of view. As the focus of the paper is on the method the application oriented view might be considered at least by some sentences/a paragraph in the conclusions (outlook part).

Authors: Thank you for the comment. The following paragraph was added/changed in the discussion, Page 21: Line 5-10.

> "Therefore, our methodology would allow the target users to benefit from hazard maps enabling them to better prioritise and coordinate evacuation planning based on the highest forecasted impacts. The maps could further serve as a tool for flood risk assessment. The methodology can be used for flood mitigation and flood forecast planning in the form of emergency management training, where forecasted hazard scenarios can be presented to the training groups. By visualising inundation scenarios, potential damage at the building's level which have been prioritized based on a desired classification, can be estimated with this methodology and made available together with each forecasted scenario."

And in outlook, Page 21: Line 29-Page 22 Line 5

> "In future, damage potential classification can further be improved by including additional criteria, such as population density or water quality, and with it extend the applicability of this method. For example, the assessment of the damage potential of commercial enterprises, substances or machinery containing elements that which could be a source of water pollution could be included (Krieger et al., 2017). In addition, other classification methods for buildings and hazard types should be evaluated, especially to further dissect the impact of class III in commercial and industrial. Finally, the output of the framework could be extended to hazard maps uploaded in a web-based GIS system to improve visualization, along with providing layers of additional information, such as inundation pathways and hot spot to aid in planning. The latter would enhance the usefulness to different target users, such as planners, decision makers and flood forecasting agencies."