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Discussions

Interactive comment on "Impacts of future climate change on urban flood risks: benefits of climate mitigation and adaptations" *by* Qianqian Zhou et al.

Anonymous Referee #1

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The article by Zhou at al tackles a very topical issue in the field of flood risk assessment, which deals with climate change, mitigation and adaptation measures. The research questions that the authors investigate is sound and meaningful, and it is particularly interesting as the benefits of adaptation and mitigation measures are evaluated numerically through a modelling framework (though their associate cost is not assessed). Now the bad news: the structure of the article is sometimes not so clear, due to missing links, lack of details in the methods, questionable assumptions and unclear interpretation of results. Also, the use of English, although sufficient, is sometimes sub-optimal, and could do with a revision by a native speaker. Please pay careful attention to the use of prepositions and of the "s" for plurals. I found a number of mistakes and inappro-

priate use. Nonetheless, I think that the article had good potential for being published, provided that the following comments are adequately addressed. Please pay special attention to the general comments, where substantial work is needed to improve parts of the description of methods, assumptions and evaluation of results.

General comments

L 131-146: I would like to see some comments by the authors on the suitability of CMIP5 data for studies on urban flooding. Given the coarse resolution of CMIP5 (as they are global models), I'm sure that the entire study region is considerably smaller than 1 model grid cell. This poses some questions on how well extreme precipitation for modeling urban flooding is adequately represented by such datasets, given that such models are not able to represent local and short-lived storms commonly inducing flooding in small catchments. Intuitively one would say that downscaled projections with high resolution would be more suitable for this work, though that clearly depends on the data availability. Perhaps the authors can comment on that.

L 169-182: I suggest expanding this section as I think there are some unclear points which prevents the reader from understanding some modeling steps, underlying assumptions, as well as from making the approach reproducible. For example, is q in eq. 1 the peak intensity? Which is the temporal resolution considered? Most climate datasets have 1 day as highest temporal resolution, but that would probably be rather coarse for urban flooding applications. How are then the hyetographs calculated from the q? Is it a simple rescaling based on their peak, keeping the same shape? Also, I see a lack of information on how climatic data is handled statistically to estimate storms/volumes with selected return period between 1 and 1000 years. For example, I see that the considered period for assessing future scenarios is 2020-2040, hence 21 years of data. Does it mean that return periods in the order of 1000 years are estimated from 21 years of data? Could the authors clarify on this? Can they provide ranges of uncertainty due to the undersampling of the climate variability in such long periods? Also, this should be mentioned in Sect. 4 as a further uncertainty source.

Final comment is about eq. 1: could you briefly comment on how the parameters A, b, c, D are valid under a non-stationary climate? 4 parameters and just 2 variables sounds a lot for an empirical formula.

L235-250: Despite the authors' efforts to link the flood volume with flood risk and damage, I find inappropriate to call results in Figure 4 as "risk" and "damage". There is clearly a missing step in linking flood volume with some socio-economic indicator on the impact of floods. This also results in a biased evaluation of what is called "flood risk", which suggests in Figure 4 that the largest contribution is given by floods with 1-2 year return period. In reality, it may well be that a single 100-year flood induces a damage which is larger than 100 1-year floods. For this reason, I do not agree with the statement in lines 239-242. The authors should definitely clarify this part and spend some words on what are the consequences of their assumptions, if that is retained at all. In addition, the authors should clarify the relations between Fig 4a and 4b. I have the feeling that values in 4b are simply obtained by dividing numbers in 4a by their theoretical expected annual frequency indicated below each column. This would be incorrect as in this way you would be double counting all probabilities smaller than each considered class. You should instead apply the formula for piece-wise integral of flood damage versus the expected frequency of each class, hence considering the width of each bar (e.g., for the second column is 1/2-1/3, for the third one is 1/3 -1/10 and so forth).

L 265-286: I find this part rather difficult to understand and suggest the authors to clarify some points and describe more thoroughly Figure 6 and its usefulness. First, the way changes (CTFV) are defined is not intuitive, as it is now defined as a multiplicative factor. Changes should be CTFV=(TFVc-TFVnc)/TFVnc. Also, why the current system is less sensitive to climate change than the adapted system (l 268-269)? I'm a bit puzzled by seeing that small changes in the 10-year precipitation intensity lead up to a 7-fold increase in TFV under the case of adaptation. Does it mean 7 times worse conditions or simply that the adapted system can hold more water, also because the

catchment area is larger? Then I get confused on the definition of TFV: is it the total volume or simply the excess volume after filling completely the pipes system? I thought it's the second option, but now I'm confused. Please clarify in sect. 2c. In both cases it's difficult to assess how worse the conditions (i.e., the damage) would be under larger TFV in the adapted system, though I think a graph with such information is currently missing and could be added. Finally, please avoid 4 decimals in numbers at lines 270-271; 2 decimal digits are surely enough.

Specific comments

L 31: given the delay between submission and publishing I suggest removing "current" from the text. Same for line 81.

L 32: I suggest removing "existing" in favor of "past", "recent," "literature" or similar

L 40: "Based on the results" –> "Results indicates that"

L45: This is an outcome of your research, hence I would not say it is "obvious" but rather something like "very likely" or "results clearly indicates. . ." or similar.

L 46: "greenhouse gas emissions"

L 62: The sentence is not clear. Please specify units of the change and in relation to what (e.g., flood peak, precipitation intensity?)

L 66-69 is again not clear. E.g., non-stationary changes reads awkward. Also, what do you mean by future hydroclimate?

L71-77: As the article has a strong focus on mitigation and adaptation I suggest adding some relevant references in those areas. See the work by (Alfieri et al., 2016; Arnbjerg-Nielsen et al., 2015; Moore et al., 2016; Poussin et al., 2012) among others. The few ones currently listed in the article are somehow hidden in the conclusions.

L136-137: the sentence is currently hard to read. Please reformulate.

L 140-144: The sentence is rather misleading, first because there is now a wealth of studies using ensembles of several GCMs, and second because “all five GCMs” sounds like if there were only five, while CMIP5 includes way more than that.

L 151: Rainfall is a climatic data. Please clarify.

L 176: there are –> we considered

L 181-182: This sentence should be supported by data, graphs or a reference to publications showing the validation work against historical records.

L 186-191: This part is difficult to read and understand. Please clarify and add some detail on how the TFV – return period relationship was derived. Figure 2 currently doesn’t help a lot as it is too general, with no units nor tick marks. For example, if it the grey area is meant to indicate those events that contribute the most to the annual damage, then it should take at least 50% of the area under the curve in Figure 2, as its integral is proportional to the total flood risk.

L 191- 195: This statement indicates a strong assumption which is not justified at this stage and sounds like a speculation. Perhaps the authors want to introduce what is later on indicated by their findings, but I think at this point this is unjustified, unless the point is supported by stronger evidence and/or some references.

L204-205: What is the extent of the enhancement of pipeline diameters in the adapted scenario? I couldn’t find it anywhere in the text.

L230-231: Is this 52% a simple average of the percent changes shown in Figure 3? Then I suggest to clarify, as it doesn’t necessarily mean the overall projected change in flood risk.

L 254: More correctly “10 magnitudes of rainfall events”.

L 263: 19% should be 49%.

L 332-333: Not just uncertainties but modeling assumptions as well.

L 328-329: That’s true but perhaps out of the scope of this article, as anyways there is no real damage model to evaluate economic flood losses.

L 358-363: Following the discussions above one should be careful in calling these numbers “flood risk”. Please adapt according to the indications in the discussion points above.

L 605-606: I suggest including the period “2020-2040” in the caption for better understanding the graph.

Table 1: Which are the units in the table? Please specify units and the storm duration related to the precipitation intensity values listed (key parameter to understand such values).

Figure 5: Please choose a more visible way of indicating overloaded pipelines, perhaps with a thicker line and/or a different color. Also the POM is currently mistakenly written as “NOM” in the 6 panels.

Figure 6: Add units in the axis labels. E.g.: “[-]” for dimensionless. Also, note the typo in the x-axis label.

Figure 7: Negative values for risk reduction means increasing risk. Please reverse graphs with positive values (plus fix the typo rish -> risk)

References

Alfieri, L., Feyen, L. and Baldassarre, G. D.: Increasing flood risk under climate change: a pan-European assessment of the benefits of four adaptation strategies, Clim. Change, 136(3), 507–521, doi:10.1007/s10584-016-1641-1, 2016.

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