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Review and rebuttal of the paper

The Potential for Various Riverine Flood DRR Measures at the Global Scale

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Editor handling the paper: Miguel Esteban & Maria Pregnolato

Manuscript title: the potential for various riverine flood DRR measures at the Global scale

The paper examines three distinct disaster risk reduction measures (DRR) on a global scale, aiming to mitigate the effects of riverine flooding. It assesses their performance using traditional Benefit-to-Cost Ratio analysis and efficacy analysis. The efficacy analysis seeks to identify the optimal solution for achieving a targeted reduction in relative risk levels.

This paper is undoubtedly interesting, providing insightful albeit very abbreviated analyses on the subject. I have several questions and points for clarifications that, if addressed, could strengthen the paper.

My primary concern is that riverine floods (generally floods) are often localized, specific to certain regions. Accurately quantifying their impacts necessitates highly detailed data encompassing both the physical conditions conductive to flooding and the assets/people susceptible to it. It remains unclear how these granularities are lost within the process of aggregation. Moreover, flood repercussions are also localized, and in many sizeable countries, their effects on national accounts (e.g., impacts relative on a county's total GDP) might be negligible. This prompts the question of what we gain in studying this problem on global scale, considering the imperative to account for multiple local variables. In sum, the broader perspective of the study appears absent from the motivation. I suggest the authors to think more creatively on why conducting analyses at this scale merits consideration.

Secondly, it seems that the authors use all countries to study the impacts riverine floods and DRR solutions, utilizing various performance metrices. However, not all countries are prone to riverine flooding. It would be informative to include a baseline map that ranks countries on their propensity of riverine flooding risk.

Additionally, the authors make reference to sub-national regions. Could you clarify the nature of these regions? Do they correspond to jurisdictional boundaries within a country, or are they defined by watershed boundaries?

When considering dykes and levees and generally structural measures to mitigate flood impacts, it is reasonable to assume that central governments typically take charge in implementing these measures. This is true even in federal systems, such as U.S., where most of the large dykes and levees are federally funded, supported, and maintained. The other two discussed DRR measures (namely, dry proofing and zoning) are primarily local adaptation strategies. Enforcing these measures from central governments would prove challenging, unless there are nationwide building codes stipulating dry proofing for all newly constructed homes in floodplains.

Uniform implementation of zoning across the country is not feasible due to factors such as the case in the USA where zoning decisions are typically made by local governments. These decisions regarding stringent zoning regulations are often influenced by factors like the officials' perception of flood risk, their tenure in office, and the potential impact of zoning on the local tax base. (Local governments often rely on revenue from property taxes, and zoning restrictions that hinder development could impact fiscal matters related to local services, potentially facing opposition from constituents.) How has this global analysis taken into consideration these aspects?

Is there a specific rationale behind the authors' choice to examine a 60-year timeframe in the future as opposed to, for instance, 50 years or even a shorter time psan? The majority of economic literature commonly centers on a 50-year horizon when modeling human behavior due to its inherent uncertainty and consideration of numerous factors. Furthermore, this study appears to overlook the fact that private agents (individuals, households, businesses) may also adapt autonomously when confronted with recurrent floods, potentially relocating to higher grounds without government intervention. How has your model taken these autonomous responses into account, and what are the implications of ignoring them for the efficacy and Benefit-Cost Analysis (BCA) comparisons?

It is hardly the case that a country would consider only one solution to address riverine flooding. This is even true for the country such as the Netherlands that is highly fortified with dykes and levees. Have the authors considered what would be the optimal combination of the DRR that would achieve the same relative risk in the future, for example? Maybe for some countries it is 100% dykes and levees, and in others it is split across the three DRR.

Does this paper take into account future flooding conditions? Are future flood impacts quantified based on the future development/population growth or current?

More description of benefits and costs calculations and how they spread over 80 years is important. For example, how do dyke/levee costs spread over time? For dry proofing it seems that large chunk of the cost is accrued at the initial period. What are the costs of zoning? Forgone development value? How do the authors determine how much zoning is done annually?

I suggest that the authors provide a clearer discussion on how how the efficacy metric improves over the BCA and under what circumstances it is advisable to use one vs. the other. We know that BCA can at times be challenging to quantify (due to time constraint, the funds that they require). In contrast, cost-effectiveness measure is relatively straightforward. Is the rationale for employing the efficacy metric based on a similar line of reasoning?

The authors argue that the efficacy measure might offer a better guidance comparted to BCA. However, it is imperative to note that the efficacy measure hinges on the accurate establishment of the risk reduction target. but efficacy measure is conditions on setting the target correctly (target for risk reduction). In numerous countries, the prevailing risk metrics fail to effectively capture the extent of flooding risk. For example, the United States predominantly relies on outdated maps and 100-year floodplains to gauge risk, but recent flood events have revealed a broader and non-stationary risk landscape. If the countries are off the target to start with than the metric you suggest could inadvertently lead to misleading guidance. Addressing these facets within the paper holds significant importance

All figures and tables should include better and accurate descriptions on what they depict. This is true throughout the paper and not only limited to figures. For example, title of the paper has DRR as abbreviation, abstract gives disaster risk reduction without linking it to DRR.

accurate and comprehensive descriptions of their content. This issue extends across the entire paper and is not limited solely to the figures. For instance, the title of the paper employs the abbreviation "DRR," while the abstract spells out "disaster risk reduction" without linking it to "DRR."

To illustrate, in Figure 1, the representation of "no actions required" through the gray shading appears counterintuitive. Many states along the Gulf of Mexico coast (e.g., Florida, Louisiana, Texas) are shaded in gray. Does this mean they don't necessitate any actions? Are they adequately protected? The current labeling doesn't precisely convey the authors' intended meaning. The same issue arises in Figure 2. In Table 1, there are numbers and percentages enclosed in parentheses, but there should be corresponding notes for each figure and table to provide proper explanations.

Additionally, in figure 3, the label “DR→other” is unclear. What does the other refer to? Why there is an arrow? Clarifications and explanations should be provided for each figure and table to enhance understanding

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This paper analyzes which DRR measure (dykes and levees, dry-proofing, zoning restrictions) is effective in each sub-national region at the global scale. The structure of the paper is clear, and the results of the analysis give some insights on the effectiveness of each DRR measure in different parts of the world. But I think some additional discussion and explanation are needed. Please find the following specific comments:

1) In the section 2.1.1, how to evaluate each risk component (hazard, exposure, vulnerability) is described. It is mentioned that hazard is based on hazard maps, which have the resolution of 30" x 30". The datasets of exposure and vulnerability also have the same resolution?

2) In the 3rd paragraph of the section 2.1.1, it is mentioned that to evaluate vulnerability flood depth-damage functions for each occupancy type are used. Here, what the "occupancy type" means is not clear for me. How did you classify the types of each area?

3) The effects of climate change is included as the change of hazard in this study. I think the results of this point may give better understanding of the overall results. Could you show us which area has larger change?

4) How did you determine the heights of dykes and levees in each area (the protection standard)? Please describe this in a little bit more detail. And if possible, please provide the global distribution of the protection standards.

5) In page 5 line 34, it is mentioned that some results are shown in the appendix, but I can't find this appendix. Please provide.

6) The sizes of sub-national regions used in this study are very large in some countries (e.g. North America, China, Australia) and very small in other countries (e.g. Europe, East and Southeast Asia). In Table 1, the results are summarized based on the number of sub-national regions, but the sizes of these regions are too different, so is it better to give results with total areas instead?

7) I feel in some cases it is important to consider DRR measures against riverine flood not with administrative divisions but with the catchment area of each river. In this study why you chose the administrative divisions for evaluation?