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# Comment on nhess-2021-65

Alexander J. Horton et al.

Author comment on "The Cambodian Mekong floodplain under future development plans and climate change" by Alexander J. Horton et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-65-AC3, 2021

We would like to thank both of the reviewers for supplying such thoughtful insights and comments on our article. In order to address these concerns, we will undertake a major revision of our initial analysis, changing the structure of the scenarios and adding additional climate change components, including more GCMs. To do this, we will apply an improved set of scenarios using data from Hoang et al (2019) and Triet et al (2020). This new set of scenarios will again make the distinction between infrastructural developments (dams) and irrigation schemes, as well as the combination of the two, but this time we will consider each with and without the impact of climate change, as well as climate change in isolation. This new set of climate change scenarios will be derived from a set of 5 GCMs and two RCP levels (4.5 and 8.5) to give a more robust comparison.

This restructuring of our scenarios will take time to implement, so we request time sufficient to carry out the re-analysis. However, the motivation, the framework, the underlying methodology, and much of the discussion will remain the same, therefore we do not foresee these alterations dramatically altering the narrative of the paper that might otherwise necessitate a re-submission.

In addition to these broad alterations to our analysis, we intend to address each of the specific comments that the reviewers have identified, the details of which we have given below.

Thank you again for your time and consideration, and we look forward to your decision.

**Response to reviewer 1 general comments:**

Comment 1.1: The article mixed the impact of Cambodian or Mekong floodplain and Mekong Delta. It does not seem clear which area refer to this or both are the same.

*Reply1.1: We have concentrated our analysis on the Cambodian Mekong floodplain, but we will add a short description that looks at the impacts on the Delta, and ensure that these are clearly defined.*

C1.2: Check the definition of flood season and wet season. Or refer to the same season?

*R1.2: We have used these terms interchangeably, but we will standardise our use of them to a single term.*

C1.3: Check the definition of the wet and dry season – from which month to which month?

*R1.3: We will ensure that a more thorough description and distinction between these seasons is included in the revision.*

C1.4: The research paper seems to miss the discussion of the results and propose solution and mitigation measure to overcome.

*R1.4: Whilst we have included a fairly comprehensive discussion of the results and their implications in the discussion section, we acknowledge that we could expand upon the issue of mitigation or proposed solutions. We will add a paragraph of this to the revised discussion.*

C1.5: The baseline period (1985-2008) is a bit old - consider extending it to more recent years.

*R1.5:For our new set of scenarios, we will actually use a slightly older baseline (1971 – 2001). We have chosen this time period as it represents an era that has relatively little alteration to the flow regime due to large infrastructure (dams) or large irrigation programs. Therefore it serves as a better baseline for comparison than later periods, where the impact of alterations is harder to separate. Further, by choosing this baseline, we can compare our results to existing studies, which have assessed potential changes in the Mekong mainstream discharge (Hoang et al 2019) and Vietnam Delta flooding (Triet et al 2020).*

C1.6: It is not clear how the selection of climate change dataset to apply in this study. This would lead to uncertainty of result analysis and interpretation.

*R1.6:This will be addressed by our inclusion of 5 GCMs and 2 RCP scenarios.*

C1.7: An accurate description of general areas/places is sometimes confusing. This happens in many places throughout the article. Particular attention should be paid when revising the article.

*R1.7: We will look to clarify the site description and the locations of the results.*

*Specific comments of reviewer 1*

We appreciate these specific comments, and will address the specific comments of reviewer 1 in the revised manuscript.

**Response to reviewer 2 general comments:**

Comment 2.1: The study is very ambitious in that it considers a large range of factors, sectors and drivers of change; also, the methodology encompasses a large set of advanced modeling tools.

*Reply 2.1: Whilst we are planning to re-structure our scenarios, we will still encompass the same range of factors, sectors, and drivers of change, as well as the set of modelling tools that make the project ambitious.*

C2.2: The title, abstract and motivation of the paper feature climate change prominently, along only another driver of the changes analysed. Still, the way climate change is treated in the study framework is less than optimal. Regarding the climate model used to simulate future changes in climate: one single model was used, which doesn't allow to address the relative uncertainty; the model chosen is dated (CMIP5 generation); it is not clear that the use of its results is validated through comparison with observations; GCMs are generally considered inadequate for to study hydrological processes at such fine sale over a small domain, where Regional Climate Models are more appropriate and overcome mostly shortcomings that are not negligible when looking at precipitation extremes in a monsoonal climate.

*R2.2: We agree that this is a shortcoming of the used scenarios. For the revised manuscript, we will do a full re-analysis to add clarity to the methodology and to encompass a wider range of climate change simulations. We will use an ensemble of 5 GCMs (ACCESS, CCSM, CSIRO, HadGEM, and MPI). Whilst these are from the CMIP5 collection, they have been used extensively in the area in previous studies (Hasson et al 2016, Hoang et al 2016) and thus will make it possible to compare our results with assessed potential changes in the Mekong mainstream discharge ( Hoang et al 2019) and Vietnam Delta flooding (Triet et al 2020). Further, we will add an analysis to the supplementary of the differences in projected precipitation and temperature between CMIP5 and CMIP6.*

C2.3: It seems that the paper presents the results of an advanced framework that integrates multiple types of models and uses a large variety of datasets. It is not possible to me to judge, however, whether the setup is appropriate, due to a lacking explanation of the experimental setup. In particular, it is hard to understand how each model in the set of those adopted relates to each other.

*R2.3: We apologise that our experimental setup was not sufficiently explained. In the revised manuscript we will be sure to clarify our methodology, and move the explanatory figure (a schematic diagram of our methodology in the supplementary) to the main text.*

C2.4: The setup of scenarios and their explanation are lacking. Mainly: the use of one single future climate scenario, a practice that is strongly discouraged in the field; and the lack of a plan to understand the effects of climate change on each of the scenarios of infrastructure development. Further, scenarios of socio-economic development (their

present IPCC iteration being the Shared-Socioeconomic Pathways, SSPs) seem to matter in the analysis included, for what concerns land use and agriculture, water use, irrigation etc.

*R2.4: We agree with the reviewer and this was in part due to our inability to be in contact with one of our collaborators who set up the initial scenarios. However, after our re-structuring of the scenarios, we will be able to give a much fuller account of the scenarios and their setups.*

*The revised scenarios will be the ones run for the Mekong upstream by Hoang et al (2019):*

- *Baseline (1971 - 2000): including appropriate representations of irrigation and dams currently present in baseline period.*
- *Future climate change impact (2036 - 2065, RCP4.5 and RCP8.5): no additional irrigation or dam representation.*
- *Hydropower development impact (baseline and future climate scenarios): additional dams represented.*
- *Irrigation development impact (baseline and future climate scenarios): additional irrigation represented at both high and low intensity scenarios.*
- *Combined impact of all three drivers: Additional dams and irrigation (high and low) represented with future climate change scenarios.*

C2.5: A notoriously biased and inaccurate elevation dataset is used for the flood modeling, where improved datasets exists that are even included in other parts of the work.

*R2.5: We agree that there is a mismatch between the datasets. The floodmodel we used, is based on older elevation model and combined with detail bathymetry survey data. Due to how the model is constructed, partly because of the combination of SRTM and detail bathymetry data, unfortunately we cannot change the underlying DEM. We will, however, conduct a comparison of the updated elevation dataset (MERIT) with the SRTM dataset used as our model basis. As we use these 90 m resolution datasets at the aggregated 1 km resolution, any differences are unlikely to impact our results. However, we will include our findings as part of the revision and add this to the discussion point too.*

C2.6: Whereas the concept of transboundary water management has gradually gain firm footing in the last years and decades, this study stands in stark contrast with such universally preferred practice in that the situation downstream of the national boundary is neglected. It seems reasonable that focusing on one country, Cambodia, enables a more detailed and focused analysis, allows to neglect the effects of coastal processes and sea level rise, and may be also justified on grounds of dataset availability; but in the context of the lower reaches of the Mekong river it seems arbitrary to cut the modeling and analysis domain at the boundary with Vietnam. I do not ask the authors to repeat their analysis on a larger domain, but I suggest that this aspect should receive (concise) attention, and that the implications of the study, including any policy recommendations the authors may choose to draw, reflect recognition of this limitation. It would indeed be unwise to recommend policy based on knowledge of effects for only one of the countries in the lower Mekong, before quantifying the effects onto other territories downstream.

*R2.6: Thanks for raising this up. Again, apologies for poor communication in the model setup. The flood modelling consists of two models: a simpler flood model that covers the entire Mekong delta (Cambodian floodplains as well as Vietnam delta) and then a more detailed 3D flood model that is able to model the floodplain processes in Cambodia in*

*detail. The simpler model includes the downstream part down to the sea and provides boundary conditions to the 3D flood model.*

*In the updated scenario set-up, the simpler flood model used previously will be changed to MIKE 11, that covers the processes in Vietnam delta very well (see Triet et al 2020). Thus, we do include the sea level changes and flood processes in Vietnam to the simulations through boundary conditions in the Cambodian-Vietnam border. Apologies again for not communicating this clearly.*

*Specific comments of reviewer 2*

In addition to these general comments, the reviewers made many helpful detailed comments concerning each of the sections of the manuscript, all of which we will pay due care and consideration when writing up our revision.

However, there were a couple of points raised in the specific points from reviewer 2 that we thought needed comment at this time, which are detailed below.

C2.S1: L 130: can you please explain the choice of these four stations: are these the only available? It would have seemed reasonable to have selected also a station in the tributary and distributary towards Tonle Sap, due to the complex and seasonal behavior of this river trait.

*R2.S1: This is relevant comment. These four stations were used, as they have good data coverage. We will explore, whether there is enough observed water level data in Prek Kdam station in Tonle Sap River so that we could add that station to the list.*

C2.S2: What are these stacks composed of, daily flood maps? Please clarify the explanation of the percentile maps: what percentiles did you take, what do they represent? 'permanent' and 'temporary' is not clear, do you mean permanent water bodies and flood waters? Why 'default' values? What is the water index? What threshold values? If the explanation is too technical for the non-expert in remote sensing (like me) to follow, please provide a simplified, though understandable, broad explanation in the main, and add technical, though clear, details in the supplementary. Also, please add necessary explanation in the caption of fig. S2, for the abbreviations and each step in the data processing.

*R2.S2: Thanks for raising these issues. We will give a much more detailed description of this part of the analysis and aim to do so in broad terms within the main text, adding technical details to the supplementary if necessary.*

**References**

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