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Comment on nhess-2021-65

Anonymous Referee #2

Referee 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-RC2, 2021

General comments

The manuscript presents the detailed study of changes in hydrology and in flood areas in the Cambodian part of the lower Mekong basin. 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. While no new concept or method is introduced here, the results could be of interest and use to a vast range of disciplines, including in hydrology, water management, natural hazards, climate impacts, ecology and socio-economic modeling. I nevertheless recommend major revisions to the manuscript, and potentially to the analysis, to address too many shortcomings of the study and of its presentation.

The main shortcomings, to my judgement, are:

- 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.
- 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.

- 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.
- 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.
- 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.

Detailed comments

Abstract

I suggest that the first three sentences could be condensed so that the abstract can soon reach the core of the paper at hand.

When in the fourth sentence you mention impacts, it is not clear what these impacts refer to: which is the impacting phenomenon? I suggest you take the occasion to explain that you are scientifically assessing the implications of planned interventions in a context of changing climate (or some similar formulation).

In the following sentence you mention modeling, but you have not explained what type of modeling: please use some words to lay out the methods of the paper.

Following sentence: isn't there overlap between 'monthly' and 'sub-seasonal'?

How come a ‘scenario’, i.e., a formulation of the future (as implied also by the use of the future tense), refers to year 2020, which is in the past?

What concretely is altered, in the ‘hydrological regimes’: is it discharge?

What is ‘hydropower mitigation investment’?

I think the last sentence of the abstract is vague and not connect to the results of the study.

Introduction

The part on the benefits of annual (seasonal?) flooding is very important, and it’s essential that it be well explained since the notion and key concept don’t receive much focus in the literature. I suggest adding a sentence to explain how annual flooding improves water availability in the dry season, as this is not obvious.

Please, make reference to Fig. 1 when pointing to locations in the study area, so the reader can better follow the explanation.

Line 33: substitute comma for semicolon.

L 39: please rephrase sentence starting with ‘moreover’ (add a verb). Also, explain what you mean by ‘energy’ here.

L 41: ‘Hydropower’ doesn’t seem a phenomenon of concept that can impact the water cycle: I think you should rather talk of ‘hydropower dams/reservoirs/infrastructure’ here.

L 41: you mention future projections here, but don’t add any detail about e.g. which climate scenario and which future time horizon these refer to: please explain better. Also,

which study do these come from? I suspect they don't come from both of the studies mentioned. In the following sentences these aspects are treated more systematically, but please try to be more specific also there, e.g. in terms of scenarios and time horizons.

L 55: you mention 'in opposition to climate change', but the reader should know what is the expected effect of climate change on the metrics treated here.

L 59 on: is 'peak inundation area' the same as 'flood extent'? if so, please use the same term to avoid confusing the reader. Also, you express change in terms of percentage and also in terms of surface area, which prevents understanding the difference between such changes.

Please check that it is clear to the reader how this study goes beyond the one of Try et al. 2020a. I understand that that study's limitation is that infrastructure development was not considered?

L 80: I'd leave 'important' out from this sentence, as it is a subjective judgement. Also, in the following lines, I'd avoid mentioning 'global sustainable development goals' as it seems to only serve to aggrandize the study. But this is only my opinion, please judge for yourself.

Please keep abbreviations to the minimum necessary. E.g. UMB and MRB are almost never used.

Is it warranted to dedicate virtually all attention in the introduction to the problem of flooding, and not e.g. to the problem of scarcity of water for agriculture?

Materials and methods

Explain MRC. Don't use abbreviations HR, TR and NE.

It is a bit disappointing that the elevation model used is the SRTM 90 m resolution one, whose vertical inaccuracies are known. Was it not possible to access lidar data for this relatively small area, or datasets that improve on SRTM, e.g. MERIT (Yamazaki et al.

2917) which you do use in the remote sensing part of this work. Please mention this in the methods. Also, the land-use map is quite dated (is it from 2003): can you justify the (necessary?) choice?

L 109 on: Please explain more clearly how each model stands in relation to the other, and what each model uses as input and what output is analysed and further used. There is mention of hydrological model IWRM-VMod, floodplain (hydrodynamic?) model IWRM-Sub, SWAT, IQQM and ISIS. Unlike stated, Table 1 doesn't describe models. Fig. S1 does a far better job at this, but the key points of the methodology should be clear without opening the supplementary material.

Table 1: what is 'climate change' here?

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.

L 132: 'For the range adopted for performance rating see ASABE (2017).' Please provide further explanation for this. E.g., what 'range'?

L 138: please explain better what NE is.

L 149 on: I cannot understand the explanation of the satellite-based images. See following points:

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.

L 165: Please re-think the explanation of the scenarios to see if you can make it more straightforward. Also, please explain the overall thinking behind the formulation of the scenarios: what overall questions are you trying to address with such study setup? You explain some of this in the Results, e.g., at lines 248 on, but it would seem necessary to explain this in the Methods. Some more specific points follow. What do you mean by

‘definite’? It is highly confusing to the reader that you define year 2020 as a future scenario. I cannot see the reasons behind this choice: please either provide clear reasons or modify the definitions. Why didn’t you add the effect of climate change to all scenarios of future infrastructure? Or, even better, why didn’t you plan to simulate all future infrastructure scenarios both with and without climate change? I understand this would multiply work and results and complicate their presentation, but please discuss whether this is a warranted simplification. Are dams of the central panel in fig. S3 already realized, or are these ‘plans’?

L 173: there is no Pla2020 scenario in table 2.

L 174: are LMB 2020 dams only two, in addition to those of 2007 in scenario BASE? If so, don’t mention ‘Xayaburi and Don Sahong only’, or it will seem like an arbitrary choice to include only two. Further, when describing e.g. scenario Pla2020 just outline the differences from the BASE scenario, without mentioning everything that is included again. Also, clarify how factors like agriculture, land use irrigation change across years 2007, 2020, 2040: what are the sources of these datasets and what drivers and socio-economic scenarios do they presuppose? How are these factors included in the modeling, how are they parametrized?

L 179: ‘IPSL-CM5A-MR under RCP4.5’ this requires explanation. Define (and cite?) IPCC, GCM and RCP4.5. I don’t think that one model can ‘represents the range of uncertainty inherent in the GCM climate change projections’. Do you mean that its results are representative of the IPCC ensemble of GCMs because they fall around the mean/median of the ensemble ones? What do you mean by ‘covers monsoon seasonality’: does the model successfully capture the seasonal variations in precipitation that characterize the local summer monsoon? Did you only use the results of the GCM for the scenario(s) of year 2040, or did you use them to simulate the situation at year 2007 and 2020, to assess biases and differences with the same simulations forced with observed temperature and rainfall? Was the output of the model bias corrected? What is the reference for this GCM’s setup?

L 184: what does ‘mitigation’ here refer to? What do these plans try to mitigate?

Some questions I believe where not addressed: How long were the simulations of scenarios? What are the past meteorological data based on? What spatial resolution? How where the precipitation data from the GCM downscaled? How is the effect of dams/reservoirs/hydropower stations included in the simulations? What dam operation decisions and principles have been included, what is the level of confidence about these?

Results

Table 3: please explain abbreviations.

L 200: stations cannot overestimate: the model either over- or underestimates.

L 206: what floods are presented and discussed here? Because this was not explained in the methods, the reader is not sure that this is the maximum flood extent in the 1985-2008 period, or a specific return period, or something else.

L 208: please remind the reader that the SWMT data represent the (proxy for) flood observations. Also in the figure, please from which models and datasets the images come from.

L 209: it is indeed interesting that the overestimation could be (partly) an artifact in the strong difference in the resolution of the two datasets. Is there a way to test this, potentially by aggregating the higher-resolution data to a coarser resolution (in different ways) and looking at how the comparison then looks? The degree of agreement between observed and modeled floods is in any case remarkable.

L 210: what do you mean by 'scattering in the flood extent', and how would this affect the comparison with the modeled extent?

L 2020: I am not sure 'flow duration curves' are what is displayed in fig. S6, where the discharge is plotted versus exceedance probability. These are indeed often called 'exceedance probability' curves.

L 222: fig 3 is an effective way to summarize differences. But are these percentage changes with respect to the BASE scenario? Please explain.

L 235: this is not 'independent of climate variability'. It shows the impacts of planned developments if anthropogenic climate change were not to occur. Climate variability is a different concept. On another note, with respect to the GCM results: could you briefly specify somewhere how temperature and precipitation change in the simulated future climate with respect to the 1985-2008 reference period?

L 237: ‘severely impact the hydrological functioning of the Mekong main channel’ seems unwarranted wording. You should explain what ‘function’ the main channel has, and why the modeled homogenization of the seasonal flows should be seen as a ‘severe impact’. Maybe these sort of reasoning (also present in other parts of the Results) should be moved to the Discussion, where additional explanations and concepts can be added?

L 251: I suggest to leave judgement of what is the most sustainable course of action for decision making to the Discussion or other section. Results are not the place to add these. Why would it be preferable to minimize hydrological alterations? This requires arguing that doesn’t fit here.

L 255: sentence staring with ‘The comparisons’ is unclear, please rephrase.

L 257: what does this range refer to , annual maximum flood values across the period?

L 260: readers will be familiar with flood being a peril and a problem that needs mitigating and reducing, so wording flood reduction as ‘exacerbated’ will at minimum read odd to many. I understand that in this context floods have both advantages and disadvantages, so I suggest a solution would be to exclude wording that expresses a value judgment and use more neutral and descriptive terms.

L 425: why is the ‘water-energy-food nexus’ mentioned here, with no motivation: what would be the merit of addressing that concept and how would that be possible?

In general, similar to my recommendation for Section 4.2, I suggest for Section 4.3 to stay closer to the core topics of this study, and avoid embarking in the longest possible list of things interesting about the Cambodian Mekong.

Discussion

I suggest to re-think the opening paragraphs to start-off the Discussion less as a listing of ways in which the present study is superior to previous comparable efforts.

L 319: I do not think here much can be said about confidence on future projections,

especially not mentioning the 'error inherent within the GCM predations of future climate change', as only one climate scenario was simulated by only one model.

L 323: how have you compared the performance of your setup for a single event to the performance of Fujii et al, 2003?

L 326: 'confidence in our future projections of the Cambodian Mekong floodplain's response to changes in the flood hydrograph.' Please rephrase at it's not clear what response to what you are treating here.

For the discussion of the implications of the changes in hydrological conditions and flood occurrence and extent, I suggest to stay relatively close to the results of this study. It is interesting to mention the cascading effects of more or less floods on different sectors and aspects of the socio-economy and the environment, but these seem to receive disproportionate space when considering that none of these consequences have been modeled in this study. Section 4.2 is largely a review of the literature of the ramified impacts of hydrological and flood changes, with limited connection to the study at hand.

L 411: 'land use change was considered unchanged in the future': this contrast with the Table above that specifies that different land use is used to simulate years 2020 and 2040.

Conclusions

There is in general a large degree of overlap between concepts included here and in the Discussion and also in the Results. Please review each of these sections and try to reduce repetition to the minimum, repeating only the main concepts that you consider essential for the reasoning in each section.

Fig. 1

Why in the small map some areas are dark and soma are light green?

Since country boundaries are important in defining the study area, I suggest making more clear from the map where each country lies.

The Tonle Sap lake is mentioned many times in the paper but the name doesn’t feature in the map, please specify. Also, other names are mentioned in the text that are not reported in the figure, like the tributaries. I suggest to only mention names of places that are functional to understand the key aspects of the study, and to report those in the map for the many readers that will be unfamiliar with the area.