Response to Referee #1

We thank Referee #1 for the profound and detailed evaluation of the paper and the helpful comments, which will further improve this paper. We are confident that we can adequately address each of these comments and understand that we need to work especially on the presentation of our results. Please find below our responses describing our planned revisions (highlighted in blue and italic type).

Hello Ms. Töpfer.

Thank you for the opportunity to provide an internal review of the paper Hydrological threats for riparian wetlands of international importance – a global quantitative and qualitative analysis. The authors have created an innovative and useful screening tool to flag particularly vulnerable wetlands. I am particularly impressed by the integration of quantitative and qualitative methods to achieve their goals. This will be a strong contribution to the literature and useful to organizations seeking to target wetland conservation funds. In addition, the same schematic approach can be applied far beyond wetlands, further enhancing the potential impact of this work. Below, I discuss the major suggestions I have for the manuscript. Finally, I have added comments well over 100 comments directly to the PDF version of the paper and figures, included below within this same document. To read my embedded comments, please hover your cursor over the many red and orange colored icons, shaped like keys, stars, and text bubbles.

1) I feel the authors need to very clearly acknowledge the essence of their study. The way I read the paper, the authors created a diagnostic tool, or procedure, to flag wetlands likely to be most vulnerable in the future. It bridges quantitative and qualitative research, applied in a high profile setting. Most importantly, it helps solve the problem of scale in global assessments. This product satisfies the stated goals (p. 4, line 29 through p. 5, line 7). This is a product worthy of praise and significant to both the science and management communities.

   Unfortunately, the study is not presented in this light. This sets the stage for the real problem with the paper, that the authors do not consistently or explicitly discuss the limitations of the study, resulting in chronic problems with overstating conclusions - addressed in my second major comment.

   To remedy the situation, I recommend:

   1. Reframe the study as the development of a screening tool
   2. In the Discussion/Conclusions section, refrain from restating what the results are, and instead focus on what the results mean. Specifically that they guide future research and/or allocation of resources for wetland protection
   3. In the Discussion/Conclusions section, add a very clear explanation of the study limitations.
   4. Avoid making conclusions about the wetlands themselves - other than to say they are likely to be vulnerable or not. Or that they are vulnerable under future simulated conditions. Perhaps discuss why hotspots exist. There absolutely is no basis to prescribe specific management action other than where to direct conservation resources and future investigation.

Currently the focus of the paper is on the wetland analysis. We understand that the approach (i.e. the development of a screening tool) need to be more highlighted and in the focus of the paper. In accordance with the comments from the other reviewers, the discussion and conclusions section will be revised as follows: (i) The aims and main results of the study will not be repeated but limitations of the quantitative-qualitative approach will be more explicitly discussed. (ii) We will describe what the results mean for water management, river ecosystems and future research. (iii) We also agree that from the global perspective no specific management actions can be provided for single wetlands. (iv) To avoid overstating conclusions, we will make more generic statements on hotspots (not specific wetlands) and potential management options depending upon the nature of the threat as suggested by Reviewer #1.

2) I feel the authors overstate their conclusions. However, this appears to be a symptom of a structural problem with the paper. With regard to the Methods section, the authors made many decisions on how to go about their study. This is inherent in any study and particularly messy when trying to scale up to a global assessment. Unfortunately, very little is said about the rationale for their decisions. I'm not saying I think the authors made poor decisions; I'm merely saying they should share their rationale. For example, they chose WaterGAP3 as a model. But they never state why they chose that model. I would like to see that they actually thought about other options and felt WaterGAP3 was the best for some actual reason. Also, the authors chose one particular climate change projection to use in their 50-year forecast. I'm happy they discuss this scenario as one of many. But there is no rationale provided for why they chose this one. They could add sentence and I would be happy. I flag several instances of this in my embedded comments.
More importantly, I would like to see the Discussion section evaluate the consequence of these decisions, if relevant. For example, I wonder how sensitive the results are to using that one specific climate projection. Or not considering present allocations of eFlows. This helps delineate the limitations of the study and helps guide where future study should focus. Once the authors have thought through and delineated the limitations of the study in the Discussion section, they will be far less likely to overstate the conclusions.

Thank you for pointing this out. In the revised version of the manuscript we will include the missing explanations:

- *Why we chose WaterGAP3? WaterGAP3 is an integrated global modelling framework to assess impacts of global change on renewable freshwater resources. The model has been developed at the Center for Environmental Systems Research and further improved during my PhD to conduct studies for identifying river ecosystems at risk. WaterGAP3 is a state of the art global water model which performs well compared to other global models (Beck et al. 2016). Of particular interest for this study is the high spatial resolution of 5 by 5 arc minutes, the temporal resolution of daily time steps used in the analysis, the global coverage, the operation of >6000 dams with optimisation schemes for different dam types, and water withdrawals and consumption of 5 sectors (domestic, manufacturing, thermal electricity production, irrigation and livestock).*
- *Why we chose the RCP6.0 emission scenario? Current CO_2 emissions are close to the upper end of the scenario range. RCP6.0 is a medium-high emission scenario with a*

global mean temperature increase of 2.2°C until the end of the century (compared to 1986-2005). The differences between the emission scenarios (as represented by the radiative forcing) are smaller than between scenarios based on different GCMs until 2050. Therefore, we considered climate forcing of 5 Global Circulation Models (GCMs) in order to address the uncertainty of projected impacts.

- *Why current eFlow provisions are not included? Today, no global database exists that describes dam management strategies, operation rules or applied eFlow provisions of large dams. Our study benefits from the qualitative assessment where we collected legal eFlow provisions which we combined with our quantitative model outcomes. However, this data collection does not guarantee that eFlows are actually enforced and established in practice.*

Overall, we agree that it is important to provide the rationale for our decisions more clearly. The consequences will be discussed under consideration of the limitations (model, approach) in the Discussion and Conclusions section.

3) I feel the manuscript could better "funnel out" in the Conclusion section. This is a chance for the authors to wave their flag and tell me why their work is important. Scientifically, I'm impressed that they combined qualitative and quantitative methods to navigate issues of scale in a global assessment. They should feel free to state this as an academic contribution. The implications of this study could be far reaching. Guiding resources to protect Ramsar wetlands is a big deal. And sure, this study has its limitations. But the authors created a template that could have more broad applications. This study focused on Ramsar wetlands. But maybe the next one could be a true global wetland assessment. Maybe this template could be tweaked and applied to settings such as coral reefs, forest production, or water supply. I wish the authors would express a vision for how this study advances us in the big picture.

In the revised manuscript we will make clear that the Ramsar sites have been chosen as an example for our screening tool and point out that many other applications of our quantitative-qualitative approach are possible. For example, the bankfull flow approach enables the assessment of all larger riparian wetlands worldwide, flood risk, and flood related processes such as temporary storage of river discharge in adjacent riparian wetlands. Other possible applications based on our study can be mentioned, e.g. the quantification of specific ecosystem services provided by intact riparian wetlands (e.g. forest production, water purification, fish production, flood control, etc.) and how this is likely to change in the future under climate change and further dam construction. It could also support the allocation of water resources to different water use sectors and the respective consequences. We will focus on providing the big picture which embeds our analysis. Thanks for this valuable remark!

4) My one objection to their methods is the throwing out of results that suggested more overbank flooding will occur in 2050 than occurs now. This might be justified, but it sounds fishy to me. Of course climate change will cause flooding to increase in some places and decrease in others. Why wouldn't they include that in their assessment? At the very least, I recommend this decision be discussed and a rationale provided. Not providing other studies that have done similarly makes me suspicious this isn't a valid assumption. The Discussion section should provide some assessment of how this decision affected the results.

Floods are one of the most damaging natural disasters to human lives and property. We wanted to be cautious in our paper by not labelling increasing floods as a "positive event" because many people are affected and even lose their belongings. As the focus is on riparian wetlands, we argue in the paper that "only reductions have been documented, because it cannot be distinguished whether an increase in flood volume benefits the wetland or generates flood damages, which, in turn, would be an incentive to build more dams for flood control". Nevertheless, for quantifying the increase in flood volume we could include thresholds (0-20%, 20-40%, and >40%) in the map and discuss the changes by describing the potential consequences.

5) I sense the paper was drafted by a non-native English speaker. I am supportive of this and welcome different perspectives in the literature. Unfortunately, I had a difficult time understanding the content. If left unaddressed, I feel this will reduce the impact of the paper. I have some specific recommendations to move forward.
    1. Adding subsections would greatly help keep the text organized.
    2. Please keep paragraphs short and focused on the topic sentences. For example, the first paragraph of the introduction is almost a page long and drifts away from the topic sentence. That is too much.
    3. Adding a flow chart to the methods section that schematically illustrates your 3 modeling exercises would be very effective at communicating what you did. I visualize your methods as having 3 'cuts' of modeling: "natural" conditions, "natural + modeled water management," and "climate change 2050 without water management." Even if/when readers become confused by the text, a nice flow chart will communicate your general approach well. See my embedded comments.
    4. I feel adding a table to the Results section is essential and will allow you to delete at least half the text in the current Results section. I visualize one row per wetland in the study and one column each for wetland number, wetland name, vulnerability for the three conditions tested, and perhaps a comment column. The Results section text could be reserved to identify trends and hotspots rather than telling the reader verbally what wetlands were vulnerable. To be clear, any text that simply tells the reader "wetland X was vulnerable" could be deleted and replaced with more substantive information.
    5. The Discussion section is largely dedicated to re-presenting results. In my own writing, I typically find this to be my #1 problem. Deleting any presentation of results in the Discussion section will free up vast amounts of text to focus instead on what the results mean to your study goals and the limitations of your results.
    6. Similarly, conclusions are also presented in the Results section and this text should also be removed. I flag these instances in my notes on the manuscript PDF, included below within this same document.
    7. Other issues exist, notably sentence structure. My sense is putting the paper through an editorial review would be the most expedient solution. There is a lot that a good editorial reviewer can add that I simply cannot.

The methodology section contains a lot of information and the entire (modelling) approach is quite complex. We totally agree that subsections will help to better structure and improve the

understanding and readability of the paper. A flow chart at the beginning of the methodology is another great idea that we will adopt.

In line with comments of other reviewers, the discussion and conclusions section will be revised. In the new discussion section the aims of the study will not be repeated and limitations of the model and the approach applied for the assessment will be explicitly discussed. In this context we will put emphasize on interpreting our results.

A table with results for each wetland and condition will be implemented in the supplementary material.

Next to the edits made by Reviewer #1 we will take care of correct spelling.

To conclude my thoughts on the manuscript, I feel it is publishable with major corrections. The corrections, however, are largely limited to the presentation of the paper, not a fundamental problem with the methods, per se. Again, I have added ~130 comments to the manuscript PDF, included below, to further guide revision of the manuscript. Thanks again for the opportunity to review this paper.

We are very thankful for the specific comments in the supplementary, which were summarised in the major points above. We will address each comment appropriately in the revised manuscript.