Response to Anonymous Referee #2

The authors developed a method for integrating wetlands and reservoirs into a semi-spatially explicit modeling framework (PHYSITEL/HYDROTEL) to project the magnitude, duration, and frequency of future floods and droughts in a northeast China river basin.

This is a straightforward paper that will be a great contribution toward our scientific understanding of how wetlands and reservoirs mediate droughts and floods, as part of the push for nature-based solutions. It also emphasizes the importance of integrating wetland and reservoir hydrological processes into watershed-scale models for large river basins.

Response: We are grateful for Referee #2's thoughtful evaluation and support of our work. Our responses to all the comments are listed below in the order they appear.

Two main points for the authors to consider:

- The authors need to recheck the results text and compare that to their figures. The statements in the text often do not correspond to the figures – particularly those discussion future flood risks. Please see my specific comments below. Also, some figures (e.g., Figure 6) are not labeled, which makes it difficult to following along with some of the results.

  Response: Thank you for your valuable comments and suggestions. We have carefully checked the full text and revised it in light of your specific comments below to ensure: (i) a consistency between the statements of the text and the figures; (2) All figures are clearly marked.

- The paper is generally well-written, but please re-review it for grammatical errors. I made a few specific suggestions below, but there are several others throughout.

  Response: We thank your comment here. We regret that there were grammatical errors. The paper has been carefully revised by all authors to improve the grammar and readability.

I also have some general suggestions, including:

Line 43 – Delete "In the future" to make verb tenses correct.

Response: Changed as suggested.

Line 46 – Move "disaster-related" to before the word "loss".

Response: Changed as suggested.

Line 107 – Change to "included", not "including".

Response: Changed as suggested.

Lines 107-112 – Not 100% following this statement: As I read it, it states that integrating wetland and reservoir hydrological processes in the calibration process increases model error and uncertainties but that integrating wetlands and reservoirs (without processes?) minimizes uncertainties and improved model performance? The studies cited *do* integrate some hydrological processes of wetlands and reservoirs, and overall these statements do not seem to align. Could you please clarify this statement?

Response: We are sorry for unclear state here. What we want to state in the text is that: disregarding of the wetlands or reservoir operation would add significant error and larger uncertainties to simulate hydrologic processes; while integrating the wetlands or reservoir operation alone into watershed-scale hydrologic models may largely minimize uncertainties and improve model performance. We have rephase the sentences as follows (Lines 112-121):

Recent studies have suggested that disregarding of the wetlands or reservoir operation would add significant error and larger uncertainties to simulate hydrologic processes (Ward et al., 2020; Brunner et al., 2021). Because wetlands are often abundant across many landscapes, making their water storage and cycling fundamental to estimating a watershed's water balance (Rains et al., 2016; Lee et al., 2018). Therefore, missing this component of water balances could potentially lead to disproportionately large model errors (Rajib et al., 2020). Consequently, integrating the wetlands (Rajib et al., 2020; Golden et al., 2021; Fossey et al., 2015a) or reservoir operation (Zhao et al., 2016; Dang et al., 2020; Yassin et al., 2019) alone into watershed-scale hydrologic models may largely minimize uncertainties and improve model performance.

Figure 1. The caption says the figure shows elevation, isolated wetlands, riparian wetlands, their drainage areas, and land-use types. Out of these listed, I only see lumped "wetlands" and nothing else in the figure legend indicating the other listed characteristics of the watershed. Please amend the figure or the caption.

Response: We apologize for the inconsistencies in the representation here. We have changed the caption as follows:

Figure 1. Location of the Nenjiang River Basin and the distribution of wetlands, river networks, Nierji Reservoir, and hydrological and meteorological stations within the basin.

Lines 240-241: Are only the pixels adjacent to the hydrographic network considered riparian and all others are isolated? Please include that information here. Also, in the subsequent lines, you may want to define for the reader what the HEW concept is and to specifically mention the "lumped" nature of HEWs. Just a few extra words are needed here for clarity.

Response: We thank the reviewer for pointing this out. We have rephase this sentences and added additional statement to clear this as follows (Lines 241-245):

In addition, the PHYSITEL platform distinguishes wetlands from other land-use types, and then classifies both isolated and riparian wetlands based on an adjacency threshold (i.e., percentage of pixels in contact) between the wetlands and the river network (Fossey et al., 2015). Specifically, if more than the adjacency threshold (e.g., 1%) of wetland pixels are connected to the river network, they are considered as pixels of a riparian wetlands; otherwise, they are referred to as isolated wetlands.

Lines 256-261: Within the RHHU, isolated wetlands cannot hydrologically connect to RWs, correct, because of spatial lumping? May be worth mentioning here.

Response: Thanks for your comments. Indeed, isolated wetlands cannot hydrologically connect to RWs within a RHHU. This is because we integrated RWs and IWs based on the concept of hydrologic equivalent wetland (HEW) developed by Wang et al. (2008). We have added additional statement to clear this point as follows (Lines 2674-278):

It should be mentioned that the HEW concept developed by Wang et al (2008) served as the foundation for the integration of RWs and IWs into the modeling framework. This concept contends that the features of one HEW (also known as an isolated wetland or riparian wetland) are equivalent to the sum of the characteristics of each wetland inside a RHHU (which could either be hill slopes or elementary sub-watersheds related to one river segment). The following premises apply to this concept: (i) only one isolated and/or riparian HEW per RHHU; (ii) one HEW can be fully integrated within a RHHU; (iii) isolated HEW parameters must be numerically integrated; and (iv) riparian HEW parameters must be numerically integrated and spatially integrated (i.e., located in a specific location on the river segment). Therefore, IWs and RWs do not appear to have direct hydrological connection within a RHHU. However, IWs also have hydrological interactions with RWs through vertical water balance processes and fill-spill processes (Fossey et al., 2015).

Lines 301-302: What did you do with the data once overlaid? Did the 2015 wetland distribution maps trump the land-use/land-cover data (meaning did you use that instead)? Please mention here how the wetlands were represented once the overlay with the lu-lc data happened.

Response: We thank your kind reminder here. We apologize for the unclear presentation here. The land-use/land cover types data we collected contains wetland types and can be directly used as input data for PHYSITEL without additional overlay. We have deleted the sentence and revisited another sentence as follows (Lines 166-169):

The land-use/land-cover types for 2015 (including wetland types), soil texture, digital elevation models, digital elevation models and drainage network were obtained from Resource and Environment Science and Data Center (https://www.resdc.cn/).

Lines 320-322: So to be clear, you have two calibrated models: one with wetlands and one without? I read later (lines 367-369) that the wetland- and reservoir-integrated model is used for future flow projections. I would mention that here, too, since it's not clear here why there were two model calibrations.

Response: We thank your valuable comments here. This is not a simulation with and without wetland scenarios, but with and without wetland-reservoir scenarios. We apologize for the unclear presentation here. We have revised the sentence as follows (Lines 219-221):

For the downstream reservoir, we calibrated the hydrologic-wetlands-reservoir model against observed streamflow of Tongmeng, Fulaerji and Dalai Stations.

Line 340: Had you considered using a behavioral parameter set so that output uncertainty bounds could be produced?

Response: We thank your comments here. We considered behavioral parameter set when conducting model calibration. Because a discussion on this point is beyond the scope of this paper, we recommend you to read the work of Foulon and Rousseau, (2018). However, we thank your kind reminder here and added relative reference to detail this point.

Then, the best set of parameter values out the 10 trials were selected following Foulon et al. (2018).

Line 349: Why use the NSE here when in lines 340-342 you argued against it? Please add the rational here.

Response: We thank the reviewer for pointing this out. Firstly, compared with NSE, using KGE as the objective function can improve the calibration efficiency of hydrological model. Specifically, KGE combines the three components of Nash-Sutcliffe efficiency (NSE) of model errors (i.e., correlation, bias, ratio of variances or coefficients of variation) in a more balanced way, has been widely used for calibration and evaluation hydrological models in recent years (Liu, 2020). Therefore, we against NSE in lines 340-342. Second, we used multiple performance criteria (including NSE, CC, RMSE and Pbias) because it may unreliable to rely on a single objective function to determine whether the model performs well (Pool et al., 2018; Fowler et al., 2018; Seibert et al., 2018). Here, the NSE is mainly used to evaluate the simulation efficiency of the calibrated model. Based on these, we have changed “objective function” to “performance criteria”, to distinguish the utility of NSE in the text. Then, we have added a sentence to state the rational here as follows (Lines 359-361): It should be noted that although NSE as an objective function has limitation in model calibration, it can still provide an important reference for the evaluation of simulation results as a performance criterion as suggested by Moriasi et al. (2007, 2015).

Line 351: Add “be” in front of unreliable.

Response: Changed as suggested.

Line 498: Replace “Specially” with “In fact”.

Response: Changed as suggested.

Line 565: Add “and” in front of “increase”

Response: Changed as suggested.

Paragraph starting on 559 – It would be helpful to point to the exact figure (e.g., Figure 4b or Figure 5d) when describing results so that the reader can follow along closely with the text. It will also help to correct some of the errors listed below.

Response: We agree with your constructive suggestion and have detailed all figures referenced in the text.

Lines 566-568: The near-future flood volumes appear to remain the same for the near future SP126 and SP370 pathways in Figure 4g and do not decrease in Figure 5c = the statement and figures do not seem to correspond. Also, what does varying contrarily mean? Check these statements and please clarify. Similarly...

Response: We apologize for unclear statement here. We have rewritten this part as follows (Lines 534-539):

Flood volume shows divergent change trend under the three SSPs. For the SSP126 scenario, flood volume will grow in the near-future and diminish in the mid- and end-century. Flood volume will decrease in the near-future, increase in the mid-century, and increase slightly in the end-century under the SSP370 scenario. However, following an apparent reduction in the near-future, flood volume is anticipated to have no discernible change trend in the mid-century and a clear increasing trend in the end-century for the SSP585 scenarios.

Lines 568-569: Flashiness does *not* appear to follow the trends stated in the text, compared to Figure 5d. Flashiness also doesn't increase substantially for SSP370, as stated in the text, in the near future. It decreases in Figure 5d. Also, near-century needs to be changed to near future on Line 569.

Response: We are sorry that the representation does not correspond to the Figures. Here, lines 568-569 correspond to Figure 5h rather than Figure 5d. For your convenience in reading and understanding, we have specified all the figures in the text in this paragraph.

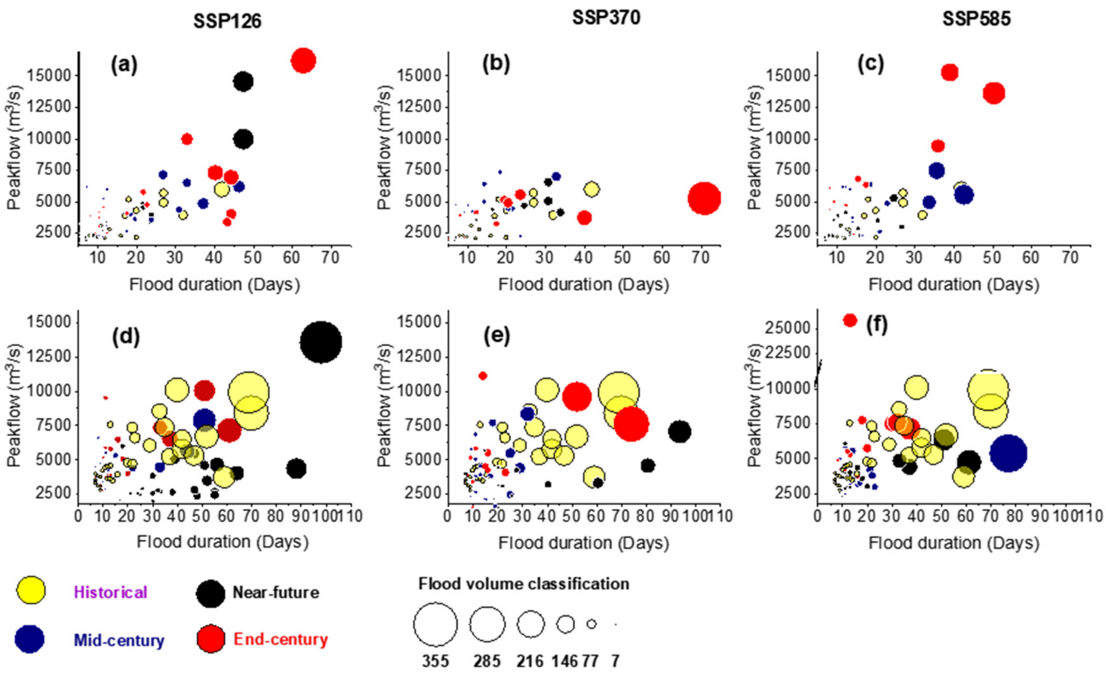
Check sentence on line 571-572 – "...flashiness will experience a considerable increase of flashiness..."???

Response: We apologize for the typographical error here. We have deleted "of flashiness" in this sentence.

Figure 6: The SSPs are not labeled (I *think* the columns represent SSPs?), so it's difficult to interpret Figure 6. Please re-do the figure with labels and check/re-write, if necessary, the paragraph from 584-596 and the one from 603-612 to correspond with Figure 6.

Response: We thank your valuable comments here. The SSPs has been labeled in Figure 6. Further, we have carefully checked the text and revised few sentences to keep correspondence.

The labeled Fig.6 is as follows:



Lined 615: Add "d" to increase.

Response: Changed as suggested.

Line 619: Delete "y" from clearly and add "be" in front of equivalent.

Response: Changed as suggested.

Line 625: Change “shorting” to “shortening”.

Response: Changed as suggested.

Line 627: capitalize SSP in ssp126.

Response: Changed as suggested.

Figure 9: SSPs need to be labeled on the figure itself.

Response: Changed as suggested.

Lines 627-629: Definitely true, though that is unclear in the violin plots (Figure 7). I would suggest considering moving Figure 7 and Figure 4 to the supplemental. They don’t really add much and can partially confuse the story because the results are visually clear at that resolution.

Response: We fully agree with your suggestion and have moved Figures 4 and 7 to the supplemental.

Lines 847-878: It seems the study explored how the integration of wetlands and reservoirs affect the streamflow test statistics for a river basin modeling framework and how climate-change induced floods and droughts can be projected using this wetland- and reservoir- integrated model. That’s slightly more nuanced than what is currently stated and seems a bit more correct?

Response: We apologize for the logical error in the statement here. This study explored “How will estimated future flood and drought risks be changed by considering the combined effects of wetlands and reservoirs?”. To achieve this objective, we first developed a framework of hydrological modeling coupled with wetland modules and reservoir operation scenarios, and then applied it to the Nenjiang River Basin. We have rewritten the first two sentences in Conclusion, as follows (Lines 772-775):

This study projected future flood and drought risks by considering the combined impacts of wetlands and reservoirs. To achieve this, we developed a hydrological modeling framework coupled wetlands and reservoir operations and then applied it in a case study involving a 297,000-km2 large river basin in northeast China.

References:

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