Dung Duc Tran et al. Assessing impacts of dike construction on the flood dynamics in the Mekong Delta

Responses to Reviewer#1 comments

By Dung Duc Tran

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General comment: I think the authors have addressed most comments and concerns I made in the last revision. The quality of this paper is significantly improved. I have a few additional minor comments below. And, a copy-editing is still required for some English issues.

We highly appreciate Reviewer#1 for the dedicated reviews and valuable comments on the manuscript. Please find below our detail responses. All the revision is present in red color in the main text of the revised manuscript.

Specific Comments

Comment 1. I don't recommend to put the equations and computational components in the Appendix. They should be introduced in the methodology section. And, I really want to see further and detailed information in the methodology, eg., how does the model determine the exchanges between river and floodplain?

Response: To address this issue we added an additional paragraph to the methodology to explain in more details the exchange between rivers and floodplains. We would like to keep the detailed equations in the annex to limit the length of the paper. Also, the equations have been described in detail in previous papers by Hoa et al, (2008), Soumendra et al., (2010), and Tri et al., (2012).

Comment 2. And also, I think the time-series plots should be move to the result section, too. I don't understand why authors decide to leave them in the appendix.

Response: We moved the time-series plots to the result section as recommended by the reviewer.

Comment 3. It seems the numbers of hours above threshold in Table 2 are observation results but not the simulation results. How is the model result?

Response: Table 2 presents the tidal water levels in numbers of hours above the threshold as the backwater effects at the two coastal stations in the two flood years of 2000 and 2011. We present the observed tidal water levels to better understand phenomenon of the backwater effect; therefore, we did not analyze the model results.

Comment 4. Using 2011 river and infrastructure network for 2000 simulation seems worrisome for me. Is it possible to make any estimation for 2000 dike developments and river network?

Response: We understand the concern of the reviewer about the use of 2011 river and infrastructure network for 2000 simulation, but we did not use it to answer the main objective of this paper. We used it to test the performance of the available hydraulic model in simulating the peak water levels of the 2000 flood for discussion. The main objective of our study is to

present the impact of dike construction scenarios based on the calibration and verification from the 2011 and 2013 floods.

Comment 5. I doubt if the author can claim "tidal backwater effect is minimal" from the 0.08 m increase, considering the 0.28 m change in river and infrastructure network. 0.08 is not minimal to 0.28.

Response: We changed the sentence "tidal backwater effect seems to be limited" instead of "tidal backwater effect is minimal" which makes confusing for readers.

Comment 6. I feel the discussion section is still long and verbose. Try to address the benefits of this model in simulating river discharge in dike-developed scenarios. Eg. how does the model improve? Does it compare with other models?

Response: Compared to the first version of manuscript, we shortened this part significantly as the comments of the reviewer, but kept essential information to present our main findings. As the comment of the reviewer, we added 2 sentences in the first paragraph of the discussion section to present the benefit of the model. We compared the findings on the impacts of dike construction with previous studies. Please find these in the revised manuscript.

Comment 7. In the end of the response to reviewer #2, the authors mentioned the computational demands are one of the major limits for 2D and 3D approach. Could you provide an estimation of computational cost for this simulation?

Response: We cannot estimate the exact computational cost for the simulation of 2D and 3D approach applied for the Mekong Delta but based on simulations for part of the delta we know it is very high. For a large and complex river network as the Mekong Delta, it takes many hours for one simulation with our 1D hydraulic model. In addition, the model is unstable during the simulations if there are errors in the input data. We developed a 2D model network for one of the two floodplains of the Mekong Delta (Long Xuyen Quadrangle), and it took several days for one run using a strong computer.

References

Hoa, L.T.V., Shigeko, H., Nhan, N.H., Cong, T.T., 2008. Infrastructure effects on floods in the Mekong River Delta in Vietnam. Hydrological Processes 22, 1359–1372. https://doi.org/10.1002/hyp.6945

Soumendra, N.K., Dhrubajyoti, S., Paul, D.B., 2010. Coupled 1D-Quasi-2D Flood Inundation Model with Unstructured Grids. Journal of Hydraulic Engineering 136, 493–506. https://doi.org/10.1061/(ASCE)HY.1943-7900.0000211

Tri, V.P.D., Trung, N.H., Tuu, N.T., 2012. Flow dynamics in the Long Xuyen Quadrangle under the impacts of full-dyke systems and sea level rise. VNU J. Sci. Earth Science 28.

Dung Duc Tran et al. Assessing impacts of dike construction on the flood dynamics in the Mekong Delta

Responses to Reviewer#3 comments

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HESS-2017-141 – Review of "Assessing impacts of dike construction on the flood dynamics of the Mekong"

In this paper, the authors assess the hydrologic and hydraulic impacts of levee (dike) expansion on flooding within the Vietnamese portion of the Mekong Delta. The authors employ an existing Mike 11 model which uses a quasi-two-dimensional approach to assess changes in water-surface elevations (WSELs) and the water balance within the delta for four levee configuration scenarios. The result of the modeling showed levees increased WSELs upstream of the levee construction and their water balance analyses suggests a substantial amount of river discharge has been or will be diverted away from the wetlands of the Long Xuyen Quadrangle.

Overall, the paper is reasonably well written, and the manuscript should be considered for publication after a few minor issues are addressed. Please see my comments and suggestions below.

General Comments

1. The most interesting finding in this study are the changes in the delta's water balance. The finding that levees impact WSELs upstream of the levee constriction is less interesting because it is: (1) predicted by hydraulic theory (e.g, Yen, 1995 and Akan, 2006); (2) has been documented in empirical studies (e.g., Hiene and Pinter, 2011); and (3) several modeling studies around the world. Focusing the paper on changes in the water balance and discussing the implications of these changes for river management would make this manuscript stronger.

2. Somewhere in the discussion section the authors should provide a relatively brief caveat about the limitations of their hydraulic model related to changes in the distribution of flow in the delta, the potential associated geometric channel changes, and the possible impact (i.e., uncertainty) on their model predictions of WSELs and water volume estimates.

3. Caveats about the limitations of their model should not be included in the abstract. Dialogue about the limitation of their models are best suited to the discussion section of the paper.

Response: We highly appreciate Reviewer#3 for the dedicated reviews and valuable comments on the manuscript. To address points 2 and 3 we re-moved the limitation from the abstract and added a part to the discussion on the model caveat. The general remark one is well noted but would require a major revision at this point. Replies to the specific comments are shown below and in red color in the main text of the revised manuscript.

Specific Comments

Comment 1. Abstract - Line 8 The term "river levels" is confusing in this context; Please specify you are talking about river discharges and not WSELs here.

Response: We removed the term "higher" in the sentence to avoid the confusion for readers in the context but still use the terms "river levels".

Comment 2. Page 4 - Lines 8-10 The assertion that the change in WSEL for two floods is a "correlation" attributed to levee construction is not appropriate given the natural variability in the stage discharge relationship of a sand-bed and tidally-influenced river. I suggest using the word comparison verse correlation. Statistically speaking, you cannot make a correlation between to observations.

Response: We replaced the term "correlation" by "relationship".

Comment 3. Page 5 – Lines 12-20 Please clarify what the authors mean by "floodwater regimes".

Response: We clarified the term "floodwater regimes" by adding a footnote. Please find our addition in the revised manuscript.

Comment 4. Page 5 – Lines 21-24 The authors should include a sentence or two here why distribution analysis is essential. In addition, the authors should clarify what they mean by "distribution" analyses. Are distribution analyses the same thing as water balance analyses?

Response: We added a sentence in the revised manuscript to indicate why the distribution analysis is essential (Page 5, lines 18-19). This added sentence could also clarify what the distribution analyses are.

Comment 5. Page 6 – Line 10 and 11. The sentence starting with "This paper presents" is superfluous and should be removed.

Response: We rewrote the sentence.

Comment 6. Page 8 Within the modeling setup description more detail is needed about the quasi-two-dimensional cells. Specifically, how were the cell extents defined and what elevation data were used to define the cell volume?

Response: We added and rephrased one paragraph in the revised manuscript (Page 12, lines 7-18) to describe how the cell extents were defined and elevation data were used to define the cell volume in the methodology.

Comment 7. Page 12 Please quantify what the authors mean by "high dikes".

Response: We made it by inserting a footnote as explanation. Please find in the revised manuscript.

Comment 8. Page 19 – Line 1 Please use consistent terminology to describe the modeling scenarios (i.e., S1, S2, and S3)

Response: Thank the reviewer for your comment. We checked the consistency in using these terminologies in the revised manuscript. Therefore, we replaced 2, 3, and 4 to be S2, S3, and S4 (line 1 and line 9, page 19 of the manuscript).

Comment 9. Page 20 – Line 4 A space is needed between "(over) compensated".

Response: A space is added.

Comment 10. Page 21 – Lines 13-15 As worded, these discussion points seem in conflict with bullet point three in the conclusion section. Please specify where future levee expansion or heightening will have little to no impact on WSELs (i.e., downstream of the levee constriction).

In addition, raising the elevation for dikes would likely increase the WSELs for floods which would have a large enough magnitude to overtop the current levees. Unless, the levee constricted flow resulted in substantial channel-bed scour and consequently increase the channel's flood water carrying capacity resulting in no change or possibility a reduction in the WSEL.

Response: We added a sentence in the same paragraph of discussion section (lines 16 and 17, page 21 in red color in the revised manuscript) to clarify these points to avoid the confusion to readers. In the discussion, we stated the small impact on river levels from the expansion of high dikes in case the impact is compared to the existing dike condition of 2011 (S2). In the conclusion, however, the impact is stated as the comparison between the dike expansion from 2011 onwards (S2, S3, and S4) compared with the situation of 2000 (S1-without high-dikes).

The new sentence now reads: "Compared to the dike construction in 2011 (scenario S2), additional expansion of dikes is thus expected to have only small additional impact on river levels".

Comment 11. Page 21 – Line 19 Would cubic kilometers be a more appropriate unit for the estimated flood volumes here?

Response: We appreciate Reviewer#3 for the comment, but we still want to keep it in cubic meter and meter for the whole paper to be consistent

Comment 12. Page 22 – Line 15 A comma is needed - "In part, this"

Response: We add a comma to the revised manuscript.

Comment 13. Page 23 – Line 2 Is the estimated increase of the WSEL at Can Tho based off the modeling performed in this study or the work of Hoa et al., 2007. Please specify the source for this estimate.

Response: We added the reference Hoa et al., 2007 to the last part of the sentence.

Comment 14. Page 23 - Line 7 and 8 The relative stability of discharge in the lower reached of the Hau River may be the likely explanation for stability of WSELs at Can Tho. However, it is not the only explanation unless the authors have bathymetric data showing there was no substantial changes in channel geometry (i.e., scour) between the temporal points of comparison.

Response: We agree with the reviewer's comment. We have no detailed bathymetric data but we do have cross-sections at this point to ensure that there are no substantial changes in channel geometry. In our study, the stable surface water levels at Can Tho shown in both the observed and simulated data, could be affected by the two issues i) water delivering to branches along the main rivers before this point to the West Sea, and ii) two opposite water forces at Can Tho from upstream flow and tide from the sea.

Comment 15. Page 24 – Line 22 I believe the authors mean hydraulic, not hydrologic impact.

Response: The reviewer is correct we changed hydrologic to hydraulic

Comment 16. Page 23 – Lines 18 and 19 I recommend using cubic kilometers instead of cubic meters.

Response: We would like to continue to use cubic meters to ensure a consistent unit throughout the paper.

Comment 17. Page 25 – Lines 1 and 2 Again, this finding is consistent with hydraulic theory and not unexpected.

Response: We agree with the reviewer that this finding is consistent with hydraulic theory but what we try to stress in these sentences the main difference between upstream and downstream rivers in their response to the dike construction scenarios.

Comment 18. Page 25 – Line 3 and 4 It is not clear to the reviewer how continued levee expansion will increase flood risk across the entire LQX. Does the estimated additional 100 cm of WSEL include just levee impacts or the cumulative effects of levees, sedimentation, and sea level rise? Based on the discussion in lines 8 to 16 on page 25, I believe the authors mean continued levee construction will "likely exacerbate flood risk". As this sentence is currently worded, it seems the authors are attributing the entire 100 cm of the anticipated increase in WSELs within the LQX to future levee expansion.

Response: This is additional 100 cm of WSEL due to the dike scenario impact which the authors want to state, but we made a confusion to readers. We added a phrase "over the period from 2000" to conclude from the findings of the study. Please find the added text in red color in the revised manuscript.

Comment 19. Page 25 – lines 6 and 7 It is not clear what the authors are inferring here. Are the authors suggesting levees are increasing river discharges or are the differences in discharge attributable to model uncertainty? While it is possible for levees to increase river discharges by reducing static and transient water storage through the confinement of flood flows to a levee-defined floodway, such an assertion should be laid out in the discussion section stating how this is theoretically possible.

Response: The expansion of dike construction in the Long Xuyen Quadrangle floodplain increases the flood river discharges. Due to the dike construction, the floodplain has reduced its retention volume, which is then stored on the rivers, to increase the discharges. Our conclusion points in lines 6 and 7 of the page 19 results from our model findings which discuss about the excess of the retention volume lost due to dike construction (paragraphs 2 and 3 of the discussion section).

Comment 20. Page 25 – Line 14 – Do the authors mean hydraulic modeling perspective? Hydrological models are not commonly use to assess levee impacts on WSELs.

Response: We mean hydraulic modeling perspective. Please find our change in the revised manuscript.

Comment 21. Figure 5 – Abbreviations such as LQX should be defined in the figure notes or caption.

Response: We defined LXQ in Figure 5.

Comment 22. Figures 6 and 7 The y-axis units are confusing and not consistent with Figure 8. I recommend putting the units in meters or centimeters in all three figures.

Response: We changed the y-axis unit in Figure 8 to be centimeter. The units are now consistent in centimeters in all three figures.

Comment 23. Figure 9 – Reporting the water balance scenario differences in percent change would make these changes appear more substantial and not "radical".

Response: We highly appreciate Reviewer#3 for the valuable comments. However, we prefer to present the increased or decreased numbers in floodwater volume instead of percentage because readers could understand specific numbers as quantitative dynamics of the floodwater volumes under the dike scenarios.