Review response for manuscript entitled "Assessment of coastal inundation triggered by multiple drivers in Ca Mau Peninsula, Vietnam"

We sincerely thank the editorial team and reviewers for their dedicated time and thorough evaluation of our manuscript. We are grateful for the additional feedback provided on this revised version and deeply appreciate the opportunity to revise and improve the manuscript based on the reviewers' insightful comments.

Below, we present a detailed, point-by-point response to the reviewers' remarks (shown in blue text), along with our replies (in black text) and descriptions of the corresponding changes made to the manuscript (in black italicized text).

Report #1 (Referee #2)

I appreciate the authors' efforts in addressing reviewers' comments. However, there are still a couple of grammar issues in the abstract that need to be corrected.

1) Line 23: Please change "analyzing" to "analyze".

We thank the reviewer for pointing this out. We have corrected this grammatical error in the revised version.

2) Line 30: Please change "is" to "are".

We thank the reviewer for pointing this out. We have corrected this grammatical error in the revised version.

We deeply appreciate the reviewer's thoughtful feedback and ongoing support of our manuscript. We greatly appreciate the time and effort invested in reviewing both the manuscript and our responses, and we are pleased that the revisions have been deemed appropriate.

Report #2 (Referee #3)

This study makes a meaningful contribution to understanding the compounding effects of multiple flood drivers in a very localized Mekong Delta region. Authors demonstrate that the main drivers of flooding is not the Mekong River but the combination of other scenarios involving land subsidence and sea level rise. Below are some minor comments for authors to consider in terms of enhancing understanding and clarity for readers.

We sincerely thank the reviewer for their valuable feedback and recognition of the importance of our work in addressing compound flooding under future scenarios in coastal zones. We greatly appreciate the thoughtful comments, which have helped us further refine and improve the clarity and impact of the manuscript.

1. Abstract: Authors may consider explicitly noting that they are assessing the impact of "compounding" hazards in the region. In addition, the main text states that a "key contribution of the study is the updating of datasets" for re-calibration of the model. If this was a major effort that also significantly

improved the performance of the model, this is worth mentioning in the abstract (and show how performance was improved in supplementary).

We sincerely thank the reviewer for their insightful comment. In response, we have revised the abstract (lines 22–27) to explicitly highlight the assessment of *compounding* hazards and the model improvements. The revised text now reads:

"*In this study, we assess the impact of compounding hazards by developing regional inundation maps and analysing flood dynamics in the CMP using a large-scale hydrodynamic model encompassing the entire VMD. The model was enhanced with updated bathymetric data for major river channels, along with synchronized information on the dyke across the VMD from the 2018–2019 period, resulting in a substantial performance improvement. It was then applied across multiple future scenarios based on both individual drivers and their combinations, representing a wide but plausible range of anthropogenic and climate changes*"

2. Figure 3: the skewed tail at the two downstream monitoring stations implies that the model consistently under predicts reductions in the water level and discharge rates during the dry season at these locations. Was this expected?

We thank the reviewer for their insightful feedback. It is correct that the skewed tail observed at the two downstream monitoring stations (My Thuan on the Mekong River and Can Tho on the Bassac River) during periods of low discharge and water levels indicates the model tends to underpredict reductions in water level and discharge during the dry season (Fig.3, manuscript paper). However, our study primarily focuses on flood hazard assessment based on maximum water levels during flooding events to develop inundation maps. Therefore, discrepancies during low-flow periods have limited impact on the key results.

Furthermore, the differences between observed and simulated data during the lowest water levels are minimal, around tens of centimetres at the Can Tho station, which is near our study area (Ca Mau Peninsula), in both calibration and validation steps. (see Fig.3, Can Tho row, water level column, manuscript paper). Additionally, the Nash-Sutcliffe Efficiency (NSE) and coefficient of determination (R^2) values demonstrate strong overall model performance throughout the dry season in both calibration and validation. In response to the reviewer's suggestion, we have revised the text in the 'Model calibration and validation' section. Please refer to our response to Point 3 below for further details

3. Figure 3 and Table 2: data for the Ca Mau station is missing: The Ca Mau station is the only gauge that falls within this study region (based on Fig 1). More details about model performance at this station seems warranted, building on the reference in the main text (line 226). Is the 12% discrepancy between simulation and observed value at this station is due to fluctuating water demand from aquaculture in the region?

We thank the reviewer for this insightful feedback. In response, we have collected additional water level data for the Ca Mau region, now using hourly measurements rather than only daily maximum and minimum values as in the previous version. The calibration and validation section has been revised to better reflect the model's performance across the entire Vietnamese Mekong Delta, with a particular focus on the Ca Mau station.

Regarding the previously reported 12% discrepancy between simulated and observed values at Ca Mau, we have removed this deviation figure due to the absence of a clear benchmark. Instead, we highlight that the difference between maximum simulated and observed water levels is on the order of centimeters for both calibration and validation periods, which suggests that the small difference is acceptable.

We also agree with the reviewer's suggestion that this discrepancy may be influenced by fluctuating water demand from aquaculture and agriculture in the region, which are not explicitly included in the model. However, the dense network of side channels in the study area (see Figure 1) likely limits the overall impact of these demands on water levels.

The revised line 210- 227 now reads:

"Minor overestimations are observed during low-flow periods at My Thuan (Mekong River) and Can Tho (Bassac River), with deviations of approximately 20 cm and 10 cm, respectively (Fig. 3a). However, these discrepancies are relatively small when compared to the daily water level fluctuation of about 2.5 m at these stations during dry season. Given that the primary objective of this study is to generate maximum inundation maps for flood hazard assessment, slight inaccuracies during low-water conditions have minimal influence on the overall outcomes.

Across the study area, the model also demonstrates strong performance at the Ca Mau gauging station. The simulated maximum water level is approximately 0.92 m, slightly overestimating the observed value of 0.84 m by around 0.08 m. This small discrepancy may be attributed to the exclusion of local water extraction for agriculture and aquaculture in the model. However, given the region's dense network of side channels, the influence of such withdrawals on overall water levels is likely minimal. This small difference is negligible compared to the daily water level fluctuation of around 2.5 m in the area. Importantly, both the NSE and R^2 values demonstrate excellent agreement between the simulated and observed water level data, further confirming the model's capability to accurately represent the dynamics of water levels in the system, making it a valuable tool for flood hazard prediction and management, particularity for the study area.

For the validation stage, the results reveal a consistently strong agreement between the simulated outcomes and the corresponding observed data across the VMD gauging stations (Fig. 3b and Table 2). There is a persistent pattern of high agreement in water level values and an overall strong agreement in terms of water discharge. At the Ca Mau gauging station, the simulated maximum water level was 0.86 m, compared to the observed value of 0.77 m, an overestimation of only about 0.09 m indicating good model performance."

4. Does it make sense that the Manning roughness coefficients are calibrated for a wet year (2018) and validated on a dry year (2016)?

We thank the reviewer for this feedback. To the best of our knowledge, this approach is appropriate. The calibration aims to evaluate the robustness of model parameters, specifically, the hydraulic roughness coefficients (Manning's n), under certain hydrological conditions, followed by validation to test the model's performance under different hydrological scenarios. We calibrated the model using data from a high-flow year (2018), which aligns with the primary objective of this study is to assess flood hazards. The resulting optimal roughness values were then validated using data from a low-water flux year (2016) to evaluate the model's performance under low-flow conditions. This strategy ensures the model's reliability across a broad range of hydraulic condition and supports its overall effectiveness.

5. Deviation values: It would be worth showing the deviation values in a Table. Can authors provide a sense of how good the deviation values of 10-12% are based on literature? Authors state that this is a 'satisfactory level of agreement'; readers would benefit from knowing a benchmark value.

We thank the reviewer for this feedback. Kindly refer to the response to Point 3 above for detailed information.

6. Sea Level Rise vs Land Subsidence: Authors note they avoid potential double-counting by ensuring land subsidence is a separate factor (line 305), but it's unclear what are the implications for interpreting this scenario: should readers understand Scenario 5 then as the combined influence of subsidence and sea level rise?

We thank the reviewer for this insightful comment. We acknowledge that there is a complex relationship between sea level rise (SLR) and land subsidence in coastal regions. Land subsidence can result from both natural processes, such as sediment compaction and tectonic activity, and anthropogenic drivers, especially groundwater extraction.(Minderhoud et al., 2017; Karlsrud et al., 2020).

However, it is important to highlight that the sea level rise projections used in this study for the coastal Vietnamese Mekong Delta—sourced from NASA's SLR Projection Tool—already account for Vertical Land Motion, meaning that they partially include the effects of land subsidence. Therefore, it is crucial to clearly distinguish the components included in each scenario to avoid any potential double-counting.

In our study, we isolate the land subsidence scenarios (lines 276–280, manuscript), which state that "Delta Subsidence (S4_a, S4_b): These scenarios evaluate the changes in inundation associated with land subsidence in the projected future. It is important to note that, we only assess the impact of groundwater extraction-induce land subsidence and does not include other contributing factors such as natural subsidence, tectonic movements, or other human activities (Minderhoud et al., 2017; Zoccarato et al., 2018); Karlsrud et al., 2020). This focus is due to the fact that land subsidence in the CMP is primarily driven by groundwater extraction (Minderhoud et al., 2017; Karlsrud et al., 2020)".

That mean the land subsidence scenarios used here focus only on groundwater extraction-induced subsidence, as the fact that land subsidence in the CMP is primarily driven by groundwater extraction. We explicitly exclude other sources of vertical land movement (e.g., natural subsidence, tectonics) in these scenarios to ensure that our assessment does not overlap with what is already embedded in the SLR projections.

In contrast, the sea level rise scenarios (line 298 and onward) consider only the rise in mean sea level as projected by climate models, including natural vertical land movement components, but excluding localized human-induced subsidence. This distinction is critical to ensure the effects of groundwater extraction are assessed independently in our land subsidence scenario.

To further reduce ambiguity, we have emphasized this clarification again in the Discussion section, where we now explicitly state:

"Regarding land subsidence scenarios, this study focuses solely on the impact of groundwater extraction, excluding other factors contributing to land subsidence, such as natural subsidence, tectonic movements, or other human activities."

In response to the reviewer's comment and to prevent potential misinterpretation, we have revised the text at line 301, revised manuscript. It now reads: "*To prevent potential double-counting, we have treated land subsidence as a separate factor in our analysis, considering only subsidence driven by groundwater extraction (see Delta Subsidence Scenarios: S4_a, S4_b). In contrast, the SLR scenarios already incorporate land subsidence associated with Vertical Land Motion. Following this, the values representing sea-level rise scenarios are incorporated into the time series of tidal levels from the year 2018, functioning as downstream boundaries for the model scenarios.*"

Karlsrud, K., Tunbridge, L., Khanh, N. Q., & Dinh, N. Q. (2020). Preliminary results of land subsidence monitoring in the Ca Mau Province. Proceedings of the International Association of Hydrological Sciences, 382, 111–115. https://doi.org/10.5194/piahs-382-111-2020

Minderhoud, P. S. J., Erkens, G., Pham, V. H., Bui, V. T., Erban, L., Kooi, H., & Stouthamer, E. (2017). Impacts of 25 years of groundwater extraction on subsidence in the Mekong delta, Vietnam. Environmental Research Letters, 12. https://doi.org/10.1088/1748-9326/aa7146

Zoccarato, C., Minderhoud, P. S. J., & Teatini, P. (2018). The role of sedimentation and natural compaction in a prograding delta: insights from the mega Mekong delta, Vietnam. Scientific Reports, 8(1), 1–12. https://doi.org/10.1038/s41598-018-29734-7

7. Figures 4-6: It would be helpful to have short scenario names as the titles for each panel or provide a legend for readers.

We thank the reviewer for this insightful comment. In response, we have revised Figures 4–6 to include a legend that presents the scenario names in a shortened format, as suggested.