Reviewer 2

This study investigated the cause of the large daily flow fluctuations in the Mekong River. After reading the manuscript, I have a strong feeling that the manuscript needs to be carefully revised and reviewed. Precise and clear writing is important and sufficient to report the new findings to our scientific community. Especially for the figures, some irrelevant paragraphs and unclear descriptions would confuse the readers. The authors have done a lot of work to support their findings. But the current version still needs to be improved.

Response: Many thanks for your feedback and valuable comments and suggestions on our manuscript. Below please find our responses to all the comments on a point-to-point basis.

1) I concur with the previous reviewer's assessment that the author's literature review of this paper requires substantial supplementation with recent content, particularly the modelling and simulation of a series of hydrological and hydrodynamic models conducted around the Lancang-Mekong River Basin. Given that 2024 has already commenced, the modelling conducted around the LMRB has been refined to the day or even the hour. In light of the above, it is imperative that the author conducts a comprehensive synthesis and refinement of existing research, elucidating the pivotal contributions of this study. It should be noted that these works should not only be carried out in the discussion, but also require substantial supplementation and modification of the introduction.

Response: Thank you for your suggestion and comment. We agree with the reviewer's assessment and will enhance the introduction by incorporating a thorough discussion on recent hydrodynamic and hydrological modeling studies, particularly those related to flow regime analysis. This will provide a deeper context and relevance to our study. Thank you again for your valuable feedback.

2) The authors hope to estimate the time it takes for large daily changes in upstream rivers to affect downstream rivers, but with the large-scale construction of reservoirs and changes in river dynamics, the results of this study may not provide the expected reference value. Similarly, the authors' claim that "three aspects extend previous research" is difficult to achieve:

Response: Thank you for your comment. We did not state "*to estimate the time it takes for large daily changes in upstream rivers to affect downstream rivers*." Rather, we highlighted the time required for upstream daily river flow to impact the <u>downstream section</u> (lines 241-242). Upstream daily river flow also refers to the mainstream station(s). By "downstream section," we refer to mainstream hydrological stations, as our results were reported at these stations. We did not analyze how upstream river flows influence downstream rivers because there is one river and many tributaries. If the word "rivers" refers to tributaries, we need to clarify that this study has not focused on how downstream tributaries are influenced, which is why we used terms such as "section" and "mainstream station."

We have indeed considered dams in our developed modeling framework. Therefore, all aspects highlighted in the introduction have been addressed. The first author apologizes for the oversight in not providing sufficient information on this aspect initially. Please find our detailed response below.

a) **"Quantitative assessment of the regional contribution to abnormal downstream water level/flow changes". Given that there are about 500 reservoirs in the basin, I doubt the feasibility of this vision;**

Response: Thank you for your comment. We believe that achieving this vision is feasible. To the best of our knowledge and based on our database, the number of constructed dams until 2020 is not 500, as indicated by the sources (https://archive.iwmi.org/wle/thrive/2018/02/13/dams-data-and-decisions/index.html, https://wle-mekong.cgiar.org/maps/). Our database shows that 99 dams were constructed before 2020 with known commercial operation dates (COD). This number increases to 284 if we include dams with unknown COD. Most of these dams are very small tributary dams, with total storage capacities such as 0.2 MCM, 4 MCM, and 0.57 MCM, among others. There are also relatively large tributary dams, as mentioned in Figure 1, with COD before 2010. Out of the 284 dams, around 228 were constructed before 2010 (including those with unknown and known COD). With known COD, this number reduces to 48 for the years before 2010.

We already provided verification results for the years before 2009, and despite the extensive number of dams, the THREW model produced accurate discharge measurements at all mainstream stations focused on in this study (NSE > 0.9). The main reason is that the vast majority of these dams have very small total storage capacities and thus have not significantly impacted the Mekong River's runoff. Many studies have confirmed that the Mekong River remained mostly unaltered by dams before this period (Pokhrel et al., 2018; Morovati et al., 2023; Grumbine and Xu, 2011; Kummu et al., 2014; MRC, 2005, etc.).

From 2010 to 2020, many large dams were built in the Lancang course and lower Mekong mainstream and tributaries. In addition to Chinese dams, two mainstream dams were constructed by Laos, both of which have been in operation since 2019. Except for two large dams constructed in the tributaries of Laos (see Figure 1), most of these are small tributary dams with limited storage capacities.

The new results for the mega-dam period (2010-2020) also confirm that the model has produced good results for the mainstream stations focused on in this study, with NSE values exceeding 0.78. Please kindly refer to Comment 3 for further details.

Grumbine, R. E., & Xu, J. (2011). Mekong hydropower development. Science, 332(6026), 178-179.

Kummu, M., Tes, S., Yin, S., Adamson, P., Józsa, J., Koponen, J., ... & Sarkkula, J. (2014). Water balance analysis for the Tonle Sap Lake–floodplain system. Hydrological Processes, 28(4), 1722-1733.

MRC. (2005). Overview of the hydrology of the Mekong Basin. Mekong River Commission, Vientiane, November 2005;82.

Morovati, K., Tian, F., Kummu, M., Shi, L., Tudaji, M., Nakhaei, P., & Olivares, M. A. (2023). Contributions from climate variation and human activities to flow regime change of Tonle Sap Lake from 2001 to 2020. Journal of Hydrology, 616, 128800.

Pokhrel, Y., Shin, S., Lin, Z., Yamazaki, D., & Qi, J. (2018). Potential disruption of flood dynamics in the Lower Mekong River Basin due to upstream flow regulation. Scientific reports, 8(1), 1-13.

b) **"Quantifying the propagation of upstream river flow changes to downstream sub-basins", as above, the presence of many reservoirs has significantly altered the river propagation process. Although the impact of reservoirs on mainstream flooding during the wet season is small, it should be noted that reservoir operations dominate mainstream water level changes during the dry season in the basin, and large-scale water conservation and diversion projects on tributaries have permanently altered river dynamics in these areas.**

Response: Thank you for your insightful comment. It appears to the authors that the first part of the comment, which states "Quantifying the propagation of upstream river flow changes to downstream sub-basins," stems from a misunderstanding of lines 17 and 81. The term "downstream sub-basin" suggests a relatively large area, whereas our focus is on the mainstream sections. Therefore, we propose replacing the word "sub-basins" with "sections" for clarity. One upstream river flow change may not cause a large fluctuation at a downstream mainstream station, while in other river cross-sections, it may result in significant changes due to river geometry. Therefore, our results specifically focus on the mainstream stations for which we have sufficient daily data for both discharge and water level, as shown in Figure 2. For example, the number of events (large river flow changes exceeding 1 m) shown in Figure 5 has the potential to change in upstream and downstream cross-sections of the mainstream stations because the river cross-section changes. A comparison of Figure 9 (see comment 12 for the updated version), which is based on daily analysis, with Figure 12 confirms this.

Regarding the second part of the reviewer's comment, our analysis based on observed data reported by the MRC shows that large changes have occurred during the wet season, not the dry season (see Figure 5). Such results can be attributed to the compounding impacts of precipitation, dam operation, and other factors. For example, heavy rainfall in an upstream sub-basin can lead to large releases by dams toward downstream areas, and if combined with downstream precipitation, this can cause significant changes in downstream river flow. In Figure 9 (see comment 12), such results are observed in the JH-CS sub-basin where only two small tributary dams were constructed before 2020 (see Figure 1). Therefore, it is difficult to assert that dams have a small impact on the mainstream during the wet season, at least for the Mekong Basin. The authors acknowledge that dams in the basin have increased river runoff during the dry season in recent decades (monthly average, etc.). However, according to our analysis based on the MRC data shown in Figure 5, these impacts have not resulted in many large river flow fluctuations exceeding 1 m, which is the focus of this study.

c) **Due to the lack of consideration of the reservoir impact in the model, this study may only be applicable to the LMRB before 2009, and it is difficult to provide an in-depth understanding of climate impacts. Figures 3 and 4 confirm this view. The author can only show the time series verification results before 2000, and lacks the evaluation of the model effect on the tributaries and mainstream in the middle and upper reaches after the large-scale reservoir development after 2008.**

Response: Thank you for emphasizing the need for additional details to enhance clarity for the community. We acknowledge that the current study incorporates dams in the THREW model based on available databases, as noted in Comment 3.

Regarding the second part of the comment stating that “we only presented verification results prior to 2000. The authors confirm that the verification results were also presented for the years after 2000. While, we acknowledge the limitations of our verification data, Figures 4c, S3, and S5 demonstrate our efforts to provide verification during both the <u>growth and mega-dam periods</u>. Specifically, in Figures 4c, S3, and S5. In Figures 4c and S3, we present velocity data for the years 2018, 2019, and 2020, which correspond to the mega-dam period, i.e., 2010-2020. These results were derived from our hydrodynamic model, incorporating data from tributaries within the developed THREW model. All tributaries were considered in the Delft3D model from JH to KR stations. These tributaries provide more than 80% of the total runoff of the Mekong River. We believe that highly accurate modeling of tributary discharge after 2010 by the THREW model can lead to such accuracy by the Delft3D model.

It should be noted that velocity data is only available for the ST station and for the years 2018, 2019, and 2020, and the entire dataset was utilized for model verification.

Figure S5 further compares discharge data produced by the THREW model with the full observed data available from the MRC website. For instance, in the Siempang River (see Figure S5), we achieved an NSE value of 0.89 for the years 2011 and 2012, representing the mega-dam period. Similarly, for other tributaries such as Pak Mun, Ban Pak Kanhoung, and Chantangoy, verification spans the growth period post-2000. These NSE values (>0.88) demonstrate that the developed THREW model reliably produces tributary discharge within our modeling framework. It should be noted that discharge data is only available for these tributaries, and the entire dataset was utilized for model verification.

3) This study may not be applicable to current LMRB. Given that this manuscript submitted to HESS, I am a little unsure what new insights this paper can give us regarding the LMRB, especially considering that the basin has been undergoing large-scale dam construction for 20 years. Could the authors consider looking at other areas where dam construction has not yet begun, to increase the validity of the study?

Response: Thank you for your comment. With respect to the first part of the reviewer’s feedback, we believe that the three aspects highlighted in the introduction have been addressed. This study is the first to examine significant daily river flow changes in the Mekong and to provide a quantitative assessment of regional contributions. Our findings, such as those presented in Figure 6, offer valuable insights into the time required for upstream river flow changes to impact downstream stations. These insights can inform improved management strategies. Please see our description and new verifications for the mega-dam period below.

Overall, the THREW model schedules reservoirs according to the REW format. Due to the unavailability of detailed dam attributes, the model considers 85 dams within the Basin, a number similar to that reported by Dang et al., 2022. The basin contains 651 REWs and each dam is assigned to its corresponding REW based on location information. For each REW, the annual cumulative reservoir storage is calculated and input as a parameter into the THREW model.

The reservoir module of the THREW model consists of 2 parts: (1) the initial storage phase and (2) the normal operation phase.

(1) Initial storage phase:

Each REW experiences a change in cumulative storage annually, signifying the operation of new reservoirs within that REW during that year. The scheduling of these new reservoirs follows the initial storage phase rule.

The rules governing the initial storage phase are detailed in Equations (1) to (6). During this phase, if the inlet flow is below the minimum reservoir discharge constraint, the outlet flow equals the inlet flow. Conversely, when the incoming flow meets or exceeds the minimum reservoir discharge constraint, the outlet flow is set to this minimum value. Additionally, once the reservoir storage surpasses the minimum reservoir storage constraint, the initial storage phase concludes, transitioning the reservoir scheduling into the normal operation phase.

$$\mathrm{Q_{out}} = \begin{cases} \mathrm{Q_{in}}, \mathrm{Q_{in}} < \mathrm{Q_{min}} \\ \mathrm{Q_{min}}, \mathrm{Q_{in}} \geq \mathrm{Q_{min}} \end{cases} \tag{1}$$

$$\mathrm{S_t} = \mathrm{S_{t-1}} + \mathrm{Q_{in}} - \mathrm{Q_{out}} \tag{2}$$

$$\mathrm{S_0} = 0 \tag{3}$$

$$\text{if } \mathrm{S_t} \geq \mathrm{S_{min}}, \text{break} \tag{4}$$

$$\mathrm{S_{min}} = 0.2 \times \mathrm{S_{total}} \tag{5}$$

$$\mathrm{Q_{min}} = 0.6 \times \mathrm{Q_{ave}} \tag{6}$$

Where Q_{out} represents the outlet flow, Q_{in} denote the inlet flow, Q_{min} is the minimum reservoir discharge constraint, S_t stands for reservoir storage at time *t*, S_{min} is the minimum reservoir storage constraint, S_{total} denotes the total reservoir storage, and Q_{ave} denotes the average multi-year runoff for each REW during the calibration period (i.e., 2000-2009).

The scheduling rule for the normal operation phase of the reservoir follows the Improved SOP (Standard Operation Policy hedging model) rule (Wang et al., 2017; Morris & Fan, 1998). During this phase, the reservoir operates according to the following rules, prioritized in decreasing order from (a) to (e):"

a. Water balance: $\mathrm{S_t} = \mathrm{S_{t-1}} + \mathrm{Q_{in}} - \mathrm{Q_{out}}$
b. Reservoir storage constraint: $\mathrm{S_{min}} \leq \mathrm{S_t} \leq \mathrm{S_{max}}$
c. Reservoir discharge constraint: $\mathrm{Q_{min}} \leq \mathrm{Q_{out}} \leq \mathrm{Q_{max}}$
d. Reservoir storage is maintained at $\mathrm{S_c}$ in the wet season
e. Reservoir storage is maintained at $\mathrm{S_n}$ in the dry season

Where $\mathrm{S_c}$ represents the reservoir storage corresponding to the flood control level and $\mathrm{S_n}$ denotes the reservoir storage corresponding to the normal storage level.

In addition, the reservoir scheduling rules for the normal operation phase account for two scenarios: the general case and the emergency case, each with distinct constraints. If, after scheduling based on the general case constraints, the outlet flow fails to meet the maximum or minimum reservoir flow constraints, the situation is deemed a contingency case. In such instances, the reservoir is re-scheduled according to the emergency case constraints, which involve appropriately relaxing the constraints on maximum reservoir storage and minimum reservoir flow. This adjustment aims to mitigate excessively high or low outlet flows, thereby reducing flow variability. While ensuring reservoir storage remains safe, the emergency case maximizes the reservoir's regulation capabilities to promote more favorable downstream ecological conditions and support downstream production and livelihoods. The reservoir scheduling rules for the emergency case are denoted by rules (f) and (g).

f. After scheduling, verify whether the outlet flow Q_{out}' is maintained between Q_{min} and Q_{max}: $Q_{min} \leq Q_{out}' \leq Q_{max}$

g. If this condition f is false, repeat steps (a) to (e).

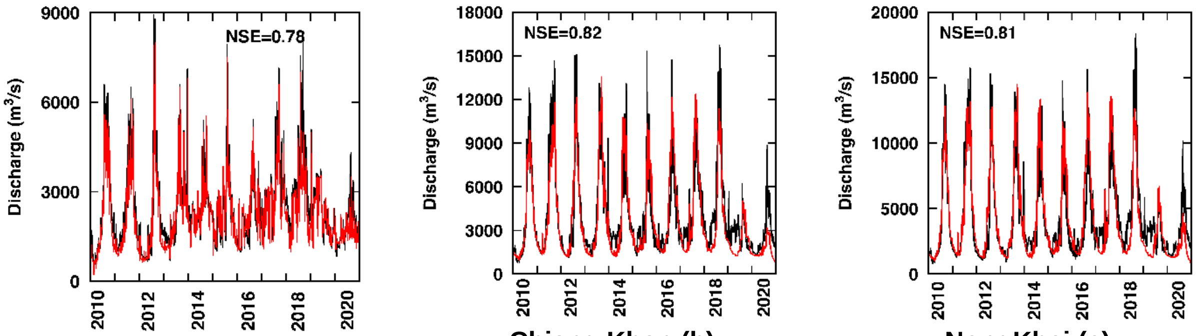
According to Tennant (1976), 30% of the average multi-year flow sustains good survival conditions for most aquatic life forms and basic recreation, while 10% supports the short-term survival of aquatic life forms, and 60% provides excellent habitat during their primary growth period and for recreational uses. Tennant also specified that the maximum flow released from the dam should not exceed twice the average flow. Therefore, in the general case, $Q_{max} = 2 \times Q_{ave}$, $Q_{min} = 0.6 \times Q_{ave}$. In emergency case, $Q_{min} = 0.3 \times Q_{ave}$. Q_{ave}.

Referring to Yun et al., (2020) for S_c and S_n, we set $S_c = S_{min} \times 1.2$ and $S_n = S_{max} \times 0.8$. Here, $S_{min} = 0.2 \times S_{total}$. Under the general case, S_{max} varies seasonally as follows:

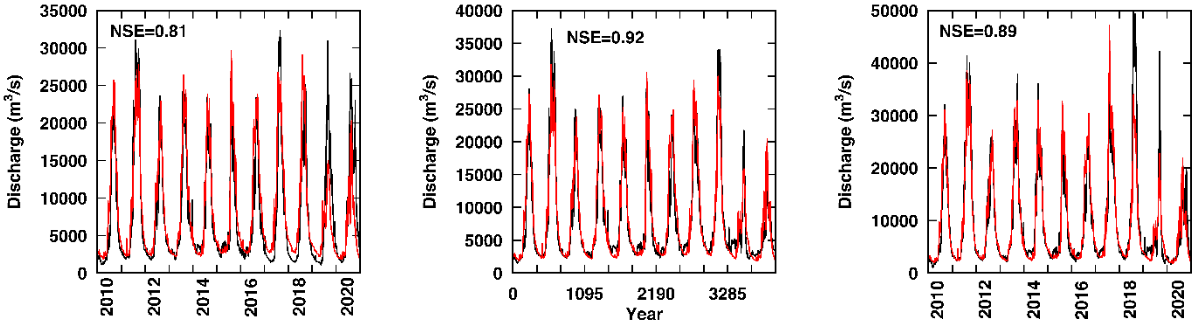
$$S_{max} = \begin{cases} 0.8 \times S_{total}, \text{month} = 6,7,8,9,10 \\ 1 \times S_{total}, \text{month} = 11,12,1,2,3,4,5' \end{cases}$$

Under the emergency case, $S_{max} = 0.8 \times S_{total}$.

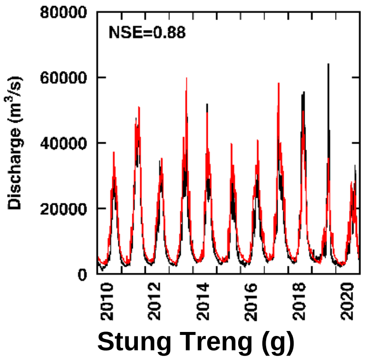
Based on this module, comparisons were conducted for the mainstream from Chiang Saen to Stung Treng, where this study has presented the results. The overall NSE of all stations is relatively high, with NSE values exceeding 0.78 (see below Figure).



Chiang Saen (a) Chiang Khan (b) NongKhai (c)



Nakhon Phanom (d) Mukdahan (e) Pakse (f)



Regarding the second part of the reviewer's comment stating "Could the authors consider looking at other areas where dam construction has not yet begun, to increase the validity of the study?

One example is the Zab sub-basin, where the Zab River is shared by Iran and Iraq. This sub-basin is one of the main contributors to the restoration of Urmia Lake, which has recently faced shrinkage due to climate change and anthropogenic stressors. Many hydraulic structures are being constructed for agricultural purposes and to divert water towards the lake.

Another example is the Mamberamo River in Indonesia, which has remained undammed.

A third example is the Salween River, shared by Myanmar, Thailand, and China.

Dang, H., Pokhrel, Y., Shin, S., Stelly, J., Ahlquist, D., & Du Bui, D. (2022). Hydrologic balance and inundation dynamics of Southeast Asia's largest inland lake altered by hydropower dams in the Mekong River basin. Science of the Total Environment, 831, 154833.

4) It should be pointed out that the author's model can obtain such a high NSE coefficient, which is mainly due to the input of the actual streamflow of the JH station. In fact, if the JH flow data is used directly to evaluate the CS flow data without considering the confluence runoff in the JH-CS sub-basin, its NSE will reach more than 0.85. However, I can't find any description of the JH station flow in the article. Considering that the streamflow data of JH station has been publicly released by the Chinese government, it is necessary for the author to make a detailed explanation.

Response: Thank you for your comment. In the modeling process, we used actual streamflow data of the JH as the inlet boundary for the hydrodynamic model and actual water level data for the outlet boundary (see Figure 2). Additionally, we defined all tributaries flowing into the mainstream within the modeling framework (Figure 2). The discharge of these tributaries was obtained using the THREW model for three defined periods.

Regarding the JH streamflow data, we regret to inform you that we are unable to make this data publicly available. We will mention this point in the revised manuscript. Thank you for your understanding.

5) As far as I know, THREW is not a gridded distributed model, but a model for lumped confluence in small catchments. How could this driven the Delft-3D model? I can't imagine flattening the confluence generated by the lumped model on an uneven DEM and expecting it to produce adequate confluence results.

Response: Thanks for your comment. The reviewer is correct that the THREW model is not a gridded distributed model. However, it is not restricted to small catchments. The THREW model has been successfully applied to large river basins such as the Urumqi River basin (Mou et al., 2009), Han River basin (Sun et al., 2014), and Yarlung Tsangpo-Brahmaputra River basin (Xu et al., 2019; Nan et al., 2021; Cui et al., 2023).

In this study, inundation is not calculated by flattening the runoff generated by the hydrological model across the basin. Instead, inundation is computed using a hydrodynamic model, with the THREW model providing streamflow of the tributaries to be used as inputs to the hydrodynamic model.

In the revised version of Figure 2 (see comment 9), the added part in the right panel shows how additional boundaries are considered in the hydrodynamic model. We mentioned in the paper that the land boundary is considered greater than the river bank. One cell was allocated to each defined tributary. This shows that the outlet discharge of the <u>REW, which is close to the mainstream,</u> was used to define the tributaries in the computational domain of the hydrodynamic model.

Nan, Y., Tian, L., He, Z., et al. (2021). The value of water isotope data on improving process understanding in a glacierized catchment on the Tibetan Plateau. Hydrology and Earth System Sciences. https://doi.org/10.5194/hess-2021-134

Cui, T., Li, Y., Yang, L., et al. (2023). Non-monotonic changes in Asian Water Towers' streamflow at increasing warming levels. Nature Communications, 14(1), 1176.

Sun, Y., Tian, F., Yang, L., et al. (2014). Exploring the spatial variability of contributions from climate variation and change in catchment properties to streamflow decrease in a mesoscale basin by three different methods. Journal of Hydrology, 508, 170-180.

Mou, L., Tian, F., & Hu, H. (2009). Artificial neural network model of runoff prediction in high and cold mountainous regions: A case study in the source drainage area of Urumqi River. Journal of Hydroelectric Engineering, (1), 64-69.

Xu, R., Hu, H., Tian, F., et al. (2019). Projected climate change impacts on future streamflow of the Yarlung Tsangpo-Brahmaputra River. Global and Planetary Change. https://doi.org/10.1016/j.gloplacha.2019.01.012

6) I was unable to open the website https://portal.mrcmekong.org/home successfully, whether using the network service from German, Japan or China. Perhaps the author could consider uploading the data to such as https://zenodo.org/ for safekeeping.

Response: Thank you for your comment. We have recently been informed that the MRC website was hacked, and MRC technicians are currently working to resolve the issue. This information came to our attention during recent communications with MRC and MRCS (Dr. Sarann Ly), who is a co-author of this paper.

We apologize for the oversight regarding our statement in the "Data Availability" section. While we mentioned that data are publicly available, it has come to our attention that they are accessible upon payment, after which researchers receive a license to use the data for research purposes. Due to this limitation, we are unable to upload the data:

"In accordance with the MRC Procedures for Data and Information Exchange and Sharing of 01 November 2001, the MRC Secretariat is the Custodian of the MRC Information System. The Licensee has requested and the Licensor – MRCIS Custodian - is prepared to grant a non-exclusive, non-transferable license to the Licensee to use the Licensed Data for the purposes specified in this Noncommercial Data Use License subject to the terms and conditions contained herein".

7) At line 88, Firstly, the official name of this basin is the Lancang-Mekong River Basin, with upstream Lancang River and downstream Mekong River. Secondly, the length of the river claimed by the author is questionable. Finally, the number of Chinese reservoirs is more than 11 and needs further verification. Considering that the collaborators include a large number of senior Chinese experts in hydraulic research, it is unacceptable to make mistakes in these details and data.

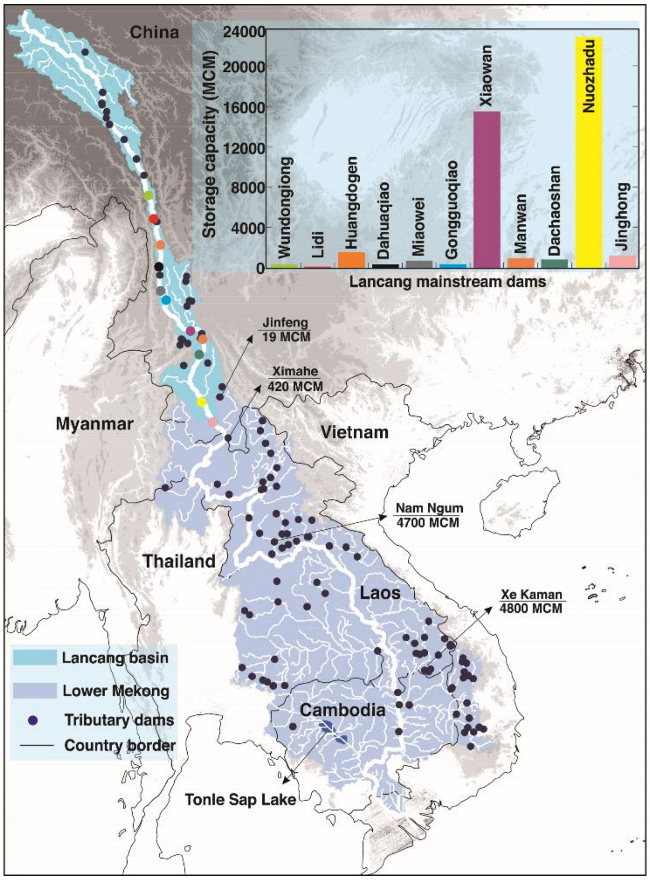
Response: Thanks for your comment. We agree with the reviewer and accordingly will use "Lancang-*Mekong River Basin*" in the manuscript.

Regarding the length of the river, we acknowledge the varying estimates in the literature. To address this, we will revise the manuscript to state that the length of the river is approximately 4800 km.

Regarding the number of large hydropower dams on the mainstream of the Lancang course until 2020, we confirm that there are 11 such dams. We understand that there may be a misunderstanding, and we apologize if the term "mainstream" was not explicitly used in line 92. We will revise the sentence to clarify that we are referring specifically to mainstream hydropower dams. However, Figure 1 and its caption indicate the presence of these 11 mainstream dams. Thank you for your feedback.

8) In Figure 1, what is "the Tonle Sap Lak"? It is recommended that the author carefully checks for the spelling and grammatical errors in the paper, as similar situations occur frequently.

Response: The first author apologizes for the oversight. It should indeed be "Tonle Sap Lake." Below is the updated version of Figure 1.



9) In Figure 2, I don't think it's a good idea to use both red circles and triangles for labeling. I can't distinguish the tributary station and the mainstream station at all. Besides, I think there should be a space separating the "Delft3D".

Response: Thanks for your feedback and suggestions. We use different colors for labeling as you've suggested. The updated version of Figure 2 is as follows:

Regarding the usage of "Delft3D," we followed the format used on the official website and in the user manual, where it is written as "Delft3D." We will maintain this formatting accordingly in the revised manuscript and revise line 141.

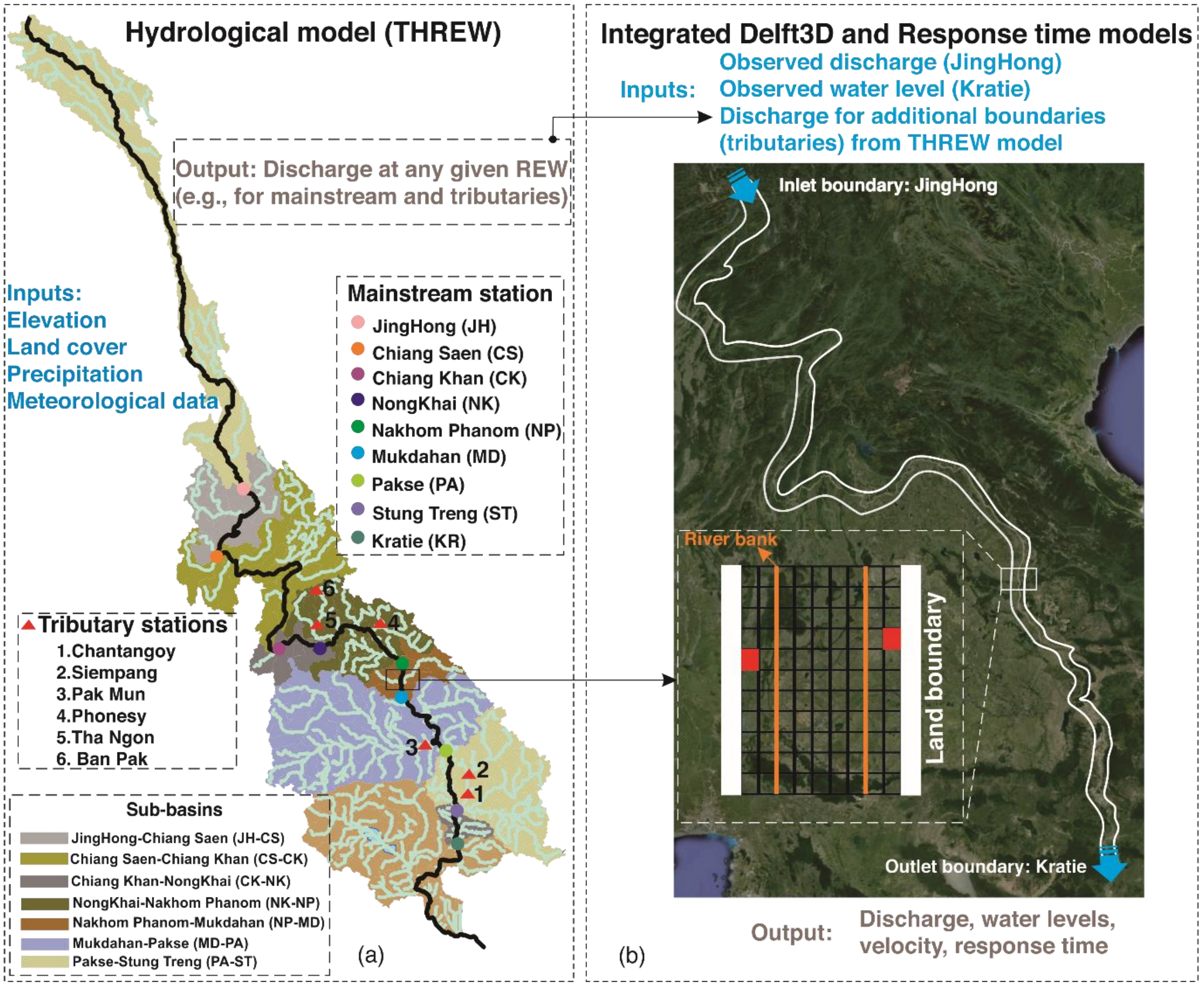


Figure 2: Illustration of developed integrated modeling framework. (a) The THREW hydrological model applied to the LMRB. (b) The defined computational domain (white splines, i.e., land boundary) in the developed hydrodynamic model for analyzing daily river flow fluctuations. Each tributary is represented by a single cell located between the land boundary and the riverbank. Note: The cells in panel (b) do not represent the actual number of cells used in the simulations. The name of each defined sub-basin in this study is based on its upstream and downstream stations (panel (a)).

10) Line 220, "Comparable levels of accuracy are achieved for the years 2019 and 2020, as detailed in the SM, Section 3". My understanding is that you cannot prove the overall model usability by showing only a part. ST is located downstream and has a large main stream flow, making it less affected by reservoir operation. Therefore, using flow velocity assessment at a monthly scale during the rainy season can give better results, but this cannot prove the applicability of the model for basin-wide flow assessment after 2010.

Response: Thank you for your comment. We stated in the manuscript that the basin suffers from insufficient data for tributaries and velocity measurements. Otherwise, we would have been able to provide more comparisons for velocity.

We believe that the ST station can be influenced by its surrounding sub-basins and upstream sub-basins. The significant river flow changes presented in Figure S8 highlight the pronounced contribution of sub-basins to these changes. The ST station is particularly influenced by the 3S basin, which is the most important tributary to the Mekong, contributing up to 20% of its flow and providing more runoff than other sub-basins. This sub-basin produces, on average, around 6600 m^3/s of runoff to the ST station (see Zhang et al., 2023).

Additionally, achieving such high accuracy in velocity at this station means that the input data (e.g., from the THREW model) for an extensive number of upstream tributaries is of high accuracy; otherwise, it would be challenging to obtain such precision using low-accuracy upstream data. The developed hydrodynamic model has produced time series discharge and water levels at all mainstream stations, including the ST station, with high accuracy (NSE > 0.94).

Given these factors and the uncertainties that not only our study faces but also many other models of the Mekong basin, such as data and DEM inaccuracies, achieving MRE values of less than 7.1% based on point-by-point comparisons in different years (mega-dam period) demonstrates good accuracy and reliable modeling.

Please note that the reason we provided point-by-point comparisons for water level and discharge at other stations like Chiang Khan and Pakse (Figure 4) was to illustrate the accuracy of the developed model in simulating sharp river flow changes that occurred over consecutive days or in a short period. Our analysis is event-based rather than time series-based. Such accurate modeling of events cannot be easily observed in time series graphs like Figure 3.

Zhang, K., Morovati, K., Tian, F., Yu, L., Liu, B., & Olivares, M. A. (2023). Regional contributions of climate change and human activities to altered flow of the Lancang-mekong river. Journal of Hydrology: Regional Studies, 50, 101535.

11) The results in Figure 8 seem to be based on the comparison between the actual observed flow and the natural flow simulated by the model, or did the authors include a simulation of reservoir operation in the model? I am not sure if I missed the part about the reservoir being set up in the model. It is recommended that the authors explain how the results were obtained.

Response: Thank you for your comment. This figure does not depict comparisons between actual observed flow and natural flow simulated by the model. Instead, it presents results obtained through our developed modeling framework. We used measured data for inlet and outlet boundaries and modeled discharge using the THREW model, which accounts for approximately 130 dams in the model setup.

In the corresponding section and Figure caption, we specified that these results represent averaged outcomes of all large river flow changes. For instance, at the CS station, there were 22 events recorded from 2010 to 2020, with 58% indicating the average contribution of the sub-basin for these 22 events.

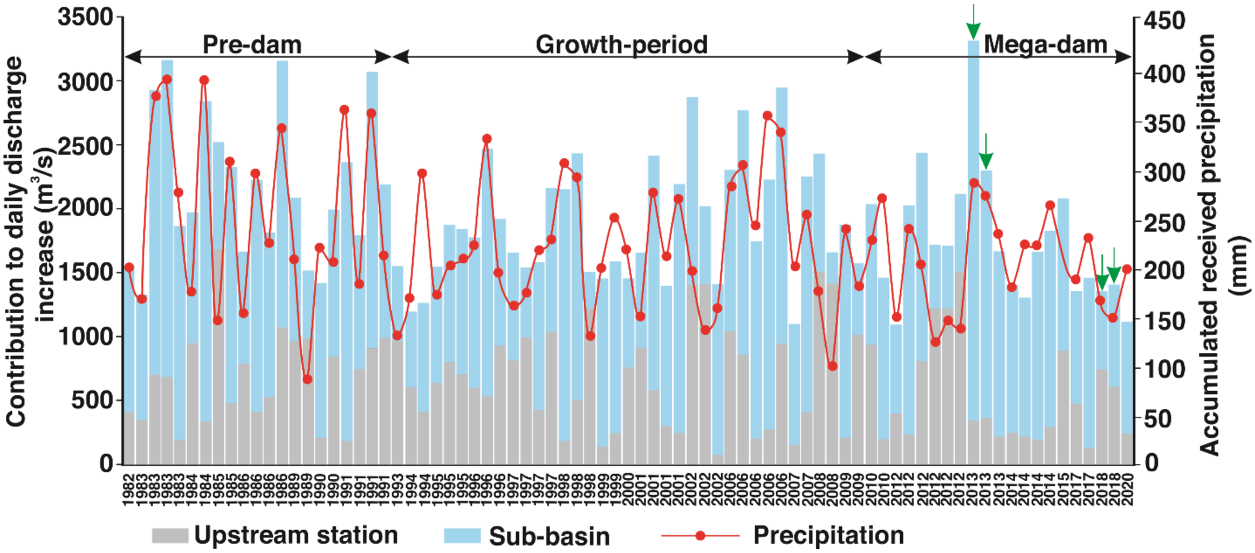
12) In Figure 9, I don't think it's a good idea to remove the year labels on the x-axis of the time series graph, as this only makes the figure harder to understand. Also, what is "recieved rainfall"? It is recommended to avoid the use of rainfall and to use precipitation uniformly.

I suggest that the author consider further detailed checks on the grammar, fonts, font size, etc. of the full text and images. The current version has too many errors.

Response: Thanks for your feedback and suggestions. We have added the years to the x-axis.

"Received rainfall" refers to the cumulative precipitation that the corresponding sub-basin receives during the travel time (response time). As highlighted in the paper, this value does not precisely indicate the precipitation received during the travel time but rather provides an approximate representation of the precipitation pattern during that period.

We will use "precipitation" instead of "rainfall" as suggested. Regarding the font sizes, we acknowledge that there are discrepancies among figures, and we will make specific adjustments accordingly. Figure 9 has been updated accordingly.

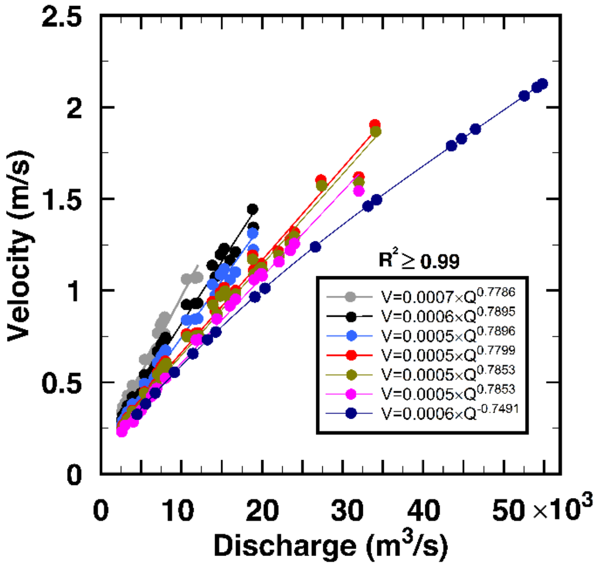


13) In Figure 10, Same as above, what is "contrinution"? I can understand that the author has a few singular and plural errors or tense problems in the manuscript. However, repeated typing errors in important figures are unacceptable.

Response: The first author apologizes for the oversight. The word "contribution" indeed should be spelled correctly. We will carefully review the manuscript to eliminate any typographical errors.

14) In Figure 11, Please add dots of corresponding colors on the basis of the lines in the legend, which can make the image more readable.

Response: Thanks for your suggestion. We have added the dots in the legend as recommended. Thank you.



15) In Figures 6 and 9, I am not sure how R^2 is calculated, what data are used? Please explain in detail.

Response: Thanks for your comment. We did not calculate R^2 for Figure 9. In Figure 6, we utilized the observed upstream discharges as inlet boundaries for the hydrodynamic model and calculated the response time for various events. Subsequently, we used the observed discharge and the derived response time to generate correlations in Excel. We determined that the "power correlation" best represents the relationship between upstream discharge and the time required for propagation to the downstream station (line 20 of the submitted manuscript). R^2 values were calculated for all events at each station using Excel. The same approach was followed in Figure 11.

16) Sources of meteorological soil and vegetation DEM data used in modelling must be listed in the main text in a clear and detailed manner. Layered citations are unacceptable.

Response: Thanks for the suggestion. Soil data were obtained using the global soil database provided by the Food and Agriculture Organization of the United Nations (FAO), with a spatial resolution of 10 × 10 km. DEM data were obtained from SRTM (Shuttle Radar Topography Mission), with a spatial resolution of 250 m.

This information will be added to the revised manuscript accordingly.