We thank the anonymous reviewer for the constructive suggestions and comments. Below, we provide point-by-point responses to each comment. Our replies are introduced by "Response:". Text highlighted in blue indicates revisions that are incorporated into the revised manuscript.

The study provides a comprehensive and timely analysis of the alterations in flow regime in the Mekong mainstream and their intricate, yet crucial linkage with the Tonle Sap Lake system, both of which have entered a critical phase of change under dam regulation and climate change. This study offers a new perspective on the changes in river flow regime and river-lake connectivity through alternative hydrological metrics, flow extremes, and the response time, as well as reverse flow periods. While the methodology is robust and the conclusions are generally well-supported, several key concerns require clarification and improvement for better readability and scientific rigor. Please find my specific and minor comments as follows.

Response: The authors thank the reviewer for the positive comments, feedback, and suggestions. Please find our replies to each comment below, which show how the authors want to consider the comments in the revised manuscript.

Specific comments:

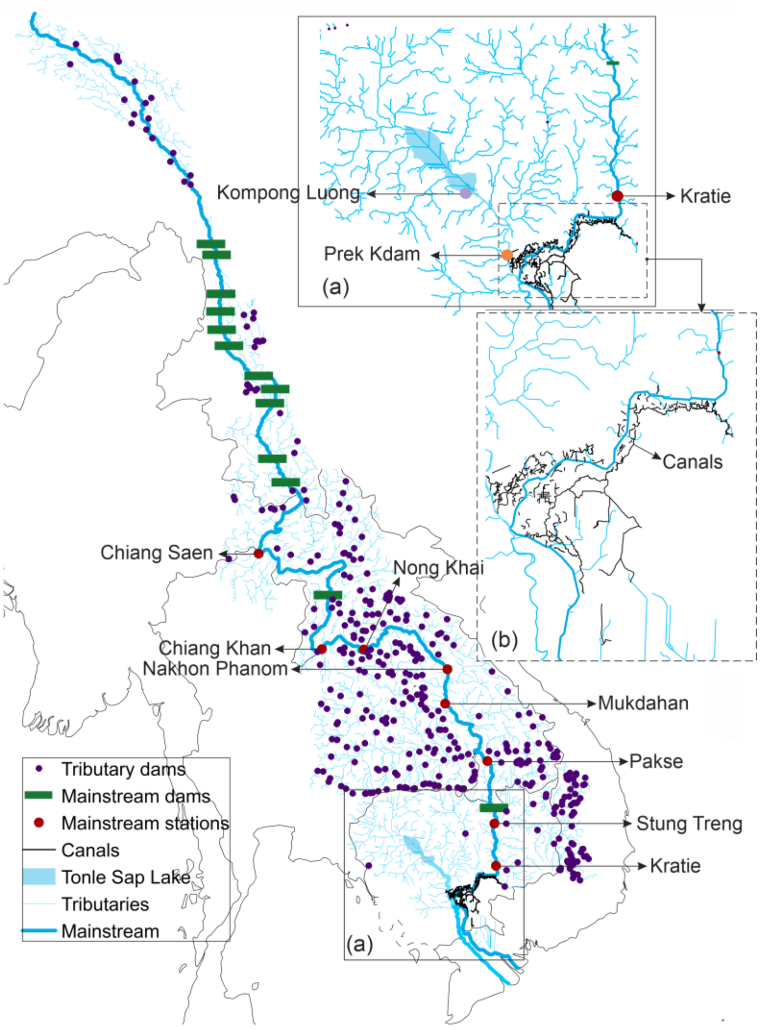
1. L109-L113: Since the study importantly points to the Mekong River-Tonle Sap Lake dynamics, more numerical details on the hydrology/hydrodynamics of the lake are necessary. For instance, Tonle Sap Lake is also contributed by the Tonle Sap tributaries to an extent that is, however, less than the reverse flow contribution.

Response: We thank the reviewer for this helpful suggestion. We agree that, given the central role of Mekong–Tonle Sap coupling in our study, the manuscript should provide clearer quantitative context on Tonle Sap Lake hydrology and the relative magnitude of its inflow components. Accordingly, we add the following information to the revised manuscript.

Downstream, the Mekong River interacts seasonally with the Tonle Sap Lake via the Tonle Sap River. During the wet season, strong mainstream flows cause a hydraulic gradient reversal, pushing water back into the lake and expanding its surface area dramatically—from approximately 2,500 km² to over 13,000 km². Lake water level typically varies from ~ 1.2 to 10.4 m (Dang et al., 2022), corresponding to storage changes of 1.6–59.7 km³ (Kummu et al., 2014). Water-balance analyses indicate that ~42-53.5% of annual inflow originates from the Mekong mainstream, whereas the lake's tributaries contribute ~34-41% and direct precipitation ~12.5% (annual inflow range 51–109 km³; mean ~83.1 km³) (Morovati et al., 2023, Kummu et al., 2014).

2. Section 2.2: The section did not list Phnom Penh Port station, while Figure 1 depicts it. What is the role of the station in the study? Even if the station's location is used, not the hydrological data, how it was used should be clarified.

Response. Thank you for pointing this out. Phnom Penh Port was shown in Fig. 1 inadvertently; it was not used in our flow-regime analyses. To avoid confusion, we have removed Phnom Penh Port from Fig. 1 and updated the figure caption accordingly.



3. Section 2.3: Weather data for the THREW model were not introduced. Please provide the details and sources of all input data for the hydrological and hydrodynamic models.

Response: Thank you for this comment. We agree that the meteorological forcing and other THREW input datasets should be explicitly documented. We revise Section 2.3 to provide the variables and sources used to force THREW (precipitation, temperature, and Penman–Monteith potential evapotranspiration), as well as the land-surface/vegetation datasets used for parameterization (soil properties and MODIS-based vegetation/snow products):

In section 2.3, we add the following details:

The THREW hydrological simulations were driven by station-based precipitation and meteorological observations from the Mekong River Commission (MRC) and the China Meteorological Administration (CMA). Precipitation was obtained from a basin-wide gauge network (105 stations) and air temperature from 35 stations (Fig. S3). Daily potential evapotranspiration was computed using the Penman–Monteith method based on station meteorological variables (including temperature, wind speed, humidity, and *radiation/sunshine duration; Fig. S3). Soil properties were taken from the FAO global soil database (10 km). Vegetation and surface-condition inputs (NDVI, LAI, and snow cover) were derived from MODIS products (500 m, 16-day) following Zhang et al. (2023).*

4. Section 2.4: This section should appear before Data Sources and Preprocessing, as it gives precedent information on changing morphology in the segregated periods.

Response: Thanks for your good suggestion. We agree. Because the period classification governs both the interpretation of regime shifts and our period-specific representation of channel morphology (e.g., selection of 1999 vs 2018 cross-sections), we move the period-classification section to appear before 'Data sources and preprocessing' to improve logical flow and readability. Thank you.

5. L187: Is a one-year warm-up period good enough to initialize the model, given the complex system? Should there be any potential limitations pertaining to this setup?

Response: Thank you for raising this point. We agree that the adequacy of a warm-up period should be justified for a coupled river–lake–floodplain system. We used **a one-year warm-up** because it comfortably exceeds the dominant **hydrodynamic adjustment timescales** of the system and includes a full seasonal cycle (dry-to-wet transition, flood rise, and recession), which is essential for initializing storage and exchange fluxes.
First, our response time analysis (Fig. 5a) indicates that the propagation time of mainstream flow from Kratie to the confluence is ~1–14 days, depending on discharge. This short hydraulic response implies that boundary perturbations and initial condition effects are rapidly flushed from the river network relative to a one-year spin-up.
Second, the lake–floodplain component requires initialization of seasonal storage dynamics. A one-year warm-up explicitly contains one complete flood pulse, allowing lake level, inundation extent, and exchange flows to adjust consistently to the model physics and boundary forcing. Consistent with this, our prior Tonle Sap Lake modelling work used a 3-month warm-up and found it sufficient for stabilizing lake dynamics, even though that domain was smaller than in the present study (Morovati et al., 2023). The longer one-year warm-up adopted here is therefore a conservative choice.
Third, we empirically verify adequacy by examining model performance **immediately after the warm-up year**. If the spin-up were insufficient, the following year would typically show systematic bias or transient drift in simulated water levels. However, the model achieves high accuracy in 2010 when 2009 is treated as the warm-up year (Supplementary Fig. S5), indicating that initial-condition sensitivity has largely decayed.

6. Sections 2.5.1, 2.5.2, and 2.5.3: I believe the order of the three sections should be reorganized, as the development of the hydrological model is crucial as the boundary condition for the hydrodynamic model, and then the response model was embedded in the hydrodynamic framework. This is also in line with the order of the analyses.

Response: Thank you for this helpful suggestion. We agree and reorder Sections 2.5.1–2.5.3 to follow the model dependency chain: THREW (hydrological) → Delft3D-Flow (hydrodynamic) → response-time (age) model. We also correct internal cross-references so that tributary inflows and naturalized discharge are now consistently referenced to the hydrological model section.

7. Section 2.5.2: The response time model is for the stretch between Kratie and the Mekong-Tonle Sap confluence, which is in Phnom Penh, specifically at the Phnom Penh Port location. However, it was stated in Section 2.2 that Prek Kdam and Kompong Loung were listed for hydrodynamic validation and also discharge lag adjustment, implying that either station was considered for adjusting the discharge lags. Please clarify both sections.

Response: Thank you for noting this. The response-time (water-age) model quantifies lag from Kratie to the Mekong–Tonle Sap confluence (Chaktomuk) (line 204), which is the hydraulic control point governing whether the Tonle Sap River reverses direction. The Phnom Penh Port gauge is nearby but not identical to the junction (located on the Tonle Sap River ~4 km from the confluence).

Prek Kdam and Kompong Luong were included for hydrodynamic validation and for characterizing river–lake exchange, **not as the target location for lag adjustment.** We revise this Section to explicitly distinguish (i) the lag-adjustment target at the confluence from (ii) validation stations (Prek Kdam on the Tonle Sap River and Kompong Luong in the lake).

In the revised hydrodynamic section, we can mention that two stations are used for hydrodynamic validation (Prek Kdam on the Tonle Sap River and Kompong Luong in the lake).

8. L288: Higher monsoonal rainfall predominantly in the lower Mekong can also be highlighted in addition to tributary inflows.

Response: We agree and thank the reviewer for this helpful suggestion. In the original text (L288), we attributed the relatively muted downstream changes primarily to compensating effects of tributary inflows. We revise this sentence to explicitly note that these downstream tributary and floodplain contributions are predominantly monsoon-driven, and that intense wet-season rainfall in the lower Mekong enhances local runoff and can partially offset (or mask) the upstream regulation signal. The revised text reads as follows:

….. likely due to the compensating effects of monsoon-driven runoff contributions from downstream tributaries and adjacent floodplains, which become increasingly important in the lower basin.

9. Section 3.3: Some of the methods, like amplitude and peak count, should be briefly explained prior in the Method section.

Response: Thank you for this helpful suggestion. We agree that the definitions of the sub-daily water-level metrics should be provided in the Methods for clarity and reproducibility. In the revised manuscript, we added a short subsection in Section 2.5 describing the computation of (i) sub-daily amplitude (daily max–min water level range), (ii) peak count (number of hourly water-level rises ≥ 0.05 m h^{-1}), and (iii) the implementation of RBI for sub-daily water level time series. This ensures that all metrics used in Section 3.3 are defined consistently before presentation of results. The revised subsection reads as follows:

Sub-daily water-level variability metrics

Sub-daily water-level variability was quantified using three complementary metrics derived from 15-min water level records (available from 2018 onward): (1) amplitude, defined for each day as the difference between the daily maximum and daily minimum water level ($A_d = WL_{max,d} - WL_{min,d}$); monthly values were computed as the mean of daily amplitudes within each month. (2) flashiness (RBI) computed for the sub-daily water-level time series using the Richards–Baker formulation (Eq. 7) by substituting WL for Q and using consecutive sub-daily observations within each month to obtain a dimensionless index of intraday variability. (3) peak count, defined as the number of hourly water-level rises exceeding a threshold of 0.05 m h^{-1}; 15-min records were aggregated to hourly water levels, and an event was counted when $\Delta WL/\Delta t \geq 0.05$ m h^{-1} for a positive rise. Peak count is reported as peaks per day and averaged by month.

10. Figure 3: The figure and its caption mention 2018-2024, but the caption also states 2017-2024. Could you elaborate on the difference?

Response: Thank you for pointing this out. The correct period is 2018–2024. We revise the figure and its caption accordingly.

11. Section 4.1: I find that this discussion section provides new major results along with their discussion. Those results are directly relevant to the topic and objectives. It makes more sense to transition those findings to the Results section; hence, this leaves more room for their implications to be expanded in the Discussion. Equally important is that previous studies should be cited in the section to enhance the interpretation of results and discussion, as the Mekong-Tonle Sap Lake connectivity has been increasingly explored with a wide range of implications beyond hydrodynamics.

Response: Thank you for this helpful suggestion. We agree that the original Section 4.1 mixed new quantitative findings with interpretation. In particular, the travel-time relationship between Kratie and the confluence and the period-wise changes in lag-adjusted discharge thresholds and reverse-flow timing were first presented in the Discussion.
We move these quantitative findings to the Results as a new subsection (**Section 3.5:** ***Travel-time-adjusted discharge thresholds for reverse-flow onset and cessation***), and we revise Section 4 to focus on interpretation and implications. In the revised Discussion, we also expand citation of previous work on Mekong–Tonle Sap connectivity and its broader implications.

Minor comments:

1. L24-25: It is better to mention “one of the world’s most ecologically productive river–lake systems” early in the Abstract to highlight the significance of the study area.

Response: Thank you for this suggestion. We agree and revise the opening sentence of the Abstract to highlight the global ecological significance of the Mekong–Tonle Sap Lake system, which reads as follows:

Dam construction and climate change have profoundly disrupted the hydrological dynamics of the Mekong River–Tonle Sap Lake floodplain system, one of the world’s most ecologically productive river–lake complexes. This study provides an integrated, …….

2. L45 and L47: Please clearly indicate the months in the wet and dry seasons.

Response: Thank you for the suggestion. We agree that the seasonal definitions should be stated explicitly. The revised text reads as follows:

These impacts have been especially pronounced during the dry season (November–April). Räsänen et al. (2017) reported dry-season discharge increases of 121–187% at Chiang Saen in March and 32–46% at Kratie, while Lu and Chua (2021) found a 98% increase in monthly discharge at Chiang Saen during the dry months. In contrast, wet-season flows (May–October) have declined substantially (Lu et al., 2014), weakening the magnitude and altering the timing of flood pulses that sustain floodplain ecosystems.

3. L46: The relative locations of Chiang Saen and Kratie stations should be addressed for the first time (i.e., the most upstream and downstream stations).

Response: Thank you for the comment. We revise the text at L46 to clarify the relative locations of Chiang Saen and Kratie (upstream vs downstream endpoints of the study reach) and added an explicit reference to Fig. 1, which reads as follows:

These impacts have been especially pronounced during the dry season (November–April). Räsänen et al. (2017) reported dry-season discharge increases of 121–187% at Chiang Saen (uppermost station) in March and 32–46% at Kratie (lowermost station) (Fig. 1), while Lu and Chua (2021) found a 98% increase in monthly discharge at Chiang Saen during the dry months. In contrast, wet-season flows (May–October) have declined substantially (Lu et al., 2014), weakening the magnitude and altering the timing of flood pulses that sustain floodplain ecosystems (Fig. 1).

4. L80: For the last paragraph, I noticed that sub-daily variability was not indicated, although it was analysed with its own subsection in the Results. It should be listed here in the Introduction for a full picture of the objectives.

Response: Thanks for this good comment. The revised text reads as follows:

This study addresses these gaps through a multi-decadal, multi-indicator analysis of flow regime shifts at eight mainstream stations along the Mekong River from 1976 to 2024. We quantify changes in daily discharge variability, flashiness, and memory across three hydrological periods: pre-dam (1976–1991), transition (1992–2009), and post-dam (2010–2024), introducing the concepts of disrupted flow memory and fragmented synchrony to describe the breakdown in spatiotemporal coherence. In addition to these indicators, we examine annual discharge extremes, including maximum and minimum daily flows and their associated timing. Finally, using 15-min water-level observations (2018–2024), we quantify sub-daily variability using amplitude, flashiness (RBI), and peak count metrics. We further link these altered flow characteristics to the onset, termination, and duration thresholds of Tonle Sap's reverse flow using a Delft3D-Flow hydrodynamic model to estimate Kratie-to-confluence response time and apply a physically consistent lag adjustment that aligns Kratie discharge with the confluence response.

5. L126: The Delft3D-Flow hydrodynamic model first appeared in Section 2.2. It would be better to mention it first in the Introduction.

Response: Thank you for the helpful suggestion. Please refer to comment 4.

6. L133: (see Figure 2d–f) should be moved to the end of the sentence.

Response: Thanks for this suggestion. We move (see Figure 2d–f) to the end of the sentence, and read as follows:

Except for this case, it is important to emphasize that our analyses reflect the compounded impacts of dam regulation and climate variability, without explicitly disentangling their relative contributions (see Figure 2d–f).

7. L140: Provide the full form of PMFM.

Response: Thanks for your comment. We consider this comment and the revise sentence reads as follows:

For hydrodynamic analyses of the Tonle Sap system, additional time series of lake water levels, reverse flow periods, and discharge were acquired from the MRC and Procedures for the Maintenance of Flows on the Mainstream (PMFM) online platform (https://pmfm.mrcmekong.org/monitoring/6b/)

8. L180: Should (see Sect. 2.5.2) actually refer to Sect. 2.5.3? Please also verify all other cross-references.

Response: Thanks for the comment, and apologies for the oversight. Yes, it refers to Section 2.5.3.

9. L192: Figure 1c should be Figure 1b. Please correct.

Response: Thanks for the comment. Yes, it should be Figure 1b. The revise text reads as follows:

To represent these flows, we extracted canal networks using a machine learning–based remote sensing model developed by Zhao et al. (2025), supplemented by manual digitization from high-resolution satellite imagery (see Figure 1b).

10. L239: Please mention the period of calibration and validation for the model in the main text, although this appears in the supplementary file.

Response: Thanks for the comment. We revise the text as follows:

Model calibration was conducted using an automatic parallel computation framework that optimizes hydrological parameters across multiple REWs simultaneously (Nan et al., 2021) (Table S1). The THREW model was calibrated for 2000–2009 and validated for 1980–1999 using observed discharge at available gauging stations; detailed performance metrics are provided in the Supplement.

11. L279: Change (a-f) to (Figure 2a-f) or (Figure 2)

Response: Thanks for the comment. We revise the text, which reads as follows:

Six rose diagrams (Figure 2a-f) summarize the spatiotemporal evolution of discharge dynamics across eight mainstream stations from Chiang Saen to Kratie.

12. Figure 4: The cross-reference of Figure 4d is apparently missing in the text.

Response. Thank you for noting this omission. We revise the Results text to explicitly cite Fig. 4d, which shows the timing of annual minimum discharge across stations.

The timing of annual minimum flows has consistently advanced across all stations along the Mekong mainstream (Figure 4d). At Kratie, for example, the timing of median minimum discharge shifted from early April (April 10)

13. L408: Figure 6a should be 5a.

Response. Thank you for pointing out this error. We correct the cross-reference at L408; "Fig. 6a" is changed to "Fig. 5a", as follows:

Figure 5a highlights two critical elements: (i) the nonlinear discharge–travel time relationship between Kratie and the confluence, and (ii) …….

14. L421 and L431: Panel 5b and Panel 5c should be addressed as Figure 5b and Figure 5c.

Response: Thank you for noting this. We revise the text at L421 and L431 to replace "Panel 5b/5c" with the correct figure references, "Fig. 5b" and "Fig. 5c," respectively

15. Figure 5a: It is hard to identify the monthly average discharge during the post-dam period. Please improve the figure.

Response: Thank you for the comment. We have revised Fig. 5a to improve readability, particularly for distinguishing the monthly average discharge during the post-dam period (see below).