# Response to Reviewer 1 Comments

We sincerely thank the reviewer for the thorough and constructive comments. The suggestions have significantly improved the clarity, rigor, and overall quality of the manuscript. All comments have been carefully addressed, and the manuscript has been revised accordingly. Detailed responses are provided below.

**Comments 1:** Research novelty not sufficiently highlighted. Although the Abstract and Introduction provide a comprehensive description of the study background and methodology, the novelty of the proposed approach compared with existing methods is not clearly articulated. I recommend that the authors strengthen the concluding part of both sections by explicitly stating the uniqueness of this study and clarifying how the proposed framework improves upon conventional approaches. This will better highlight the scientific contribution.

**Response 1**: Thank you for your valuable suggestion. We have revised both the Abstract and the Introduction to more clearly highlight the novelty and scientific contribution of this study.

Specifically, in the Abstract, we refined the description of the proposed framework by emphasizing its key innovation—namely, the integration of the Switch Prediction Method (SPM) with machine learning-based multi-step forecasting (MSF). In addition, we streamlined the presentation of results and reported representative quantitative performance from the best-performing model to improve clarity and impact.

In the Introduction, we have strengthened the concluding part by explicitly stating how the proposed framework differs from conventional approaches. In particular, we clarified that, unlike traditional ensemble methods that rely on static or probabilistic weighting schemes, the proposed method adopts a dynamic rainfall forecast selection mechanism based on real-time performance. Furthermore, we explicitly summarized the main contributions of this study in a structured manner, including (1) the development of an adaptive SPM-based ensemble framework, (2) the integration with MSF to mitigate uncertainty propagation, and (3) the application to 72-hour inflow forecasting for practical reservoir operation under typhoon conditions.

These revisions improve the clarity of the research novelty and more effectively position the proposed framework within the current state-of-the-art.

**Comments 2:** Outdated references. The list of references added by the authors appears to rely heavily on older studies. A scientific article should also reflect the state-of-the-art. It is recommended to include more recent literature and to provide a review of previous research on similar issues to enhance the timeliness and relevance of the study.

**Response 2**: Thank you for this important comment. We have revised the manuscript to incorporate more recent literature in order to better reflect the current state-of-the-art in hydrological forecasting and machine learning applications.

Specifically, several recent studies (published between 2024 and 2025) have been added to the Introduction and Methodology sections. These include works related to (1) advanced deep learning approaches for inflow and streamflow prediction, (2) hybrid frameworks combining data-driven and physically based models, and (3) multi-step forecasting strategies and their associated challenges. For example, recent studies such as Xu et al. (2024), Li et al. (2024), Teegavarapu et al. (2025), and Thaisiam et al. (2025) have been incorporated to strengthen the literature review and provide updated context for the proposed framework.

These revisions improve the timeliness and relevance of the manuscript and better position this study within the latest research developments.

**Comments 3:** Insufficient technical details of SPM.The Switch Prediction Method (SPM) is only briefly described, making it difficult for readers to fully understand its operational mechanism. More details are needed. This will also help ensure reproducibility.

**Response 3**: Thank you for this important comment. We have substantially revised the manuscript to provide a clearer and more detailed description of the Switch Prediction Method (SPM), with the aim of improving transparency and reproducibility.

First, the methodological description of SPM has been expanded to explicitly clarify its operational mechanism, including how multiple rainfall forecast products are evaluated and dynamically selected based on real-time performance. The overall workflow of SPM is now more clearly described in the Methodology section.

Second, to further enhance reproducibility, we have added a step-by-step description of the overall forecasting framework, detailing how SPM-integrated rainfall forecasts are combined with machine learning models and subsequently applied within the multi-step forecasting (MSF) process. This structured description allows readers to more easily follow and implement the proposed approach.

Third, the role of SPM within the MSF framework has been clarified, particularly in terms of how dynamic input selection helps mitigate uncertainty propagation in sequential forecasting. Additional explanations have been included to illustrate how the model transitions from observed data to forecast-based inputs during the 72-hour prediction process.

These revisions significantly improve the clarity of the methodological framework and ensure that the proposed approach can be more readily reproduced by other researchers.

**Comments 4:** Limited discussion on practical implications. The Discussion and Conclusion are focused mainly on the technical aspects of the model. However, the practical significance for reservoir operation remains underdeveloped. It is suggested to elaborate on how 72-hour inflow forecasts—even with certain errors—can still provide critical lead time for reservoir managers to adjust release strategies and enhance operational safety. This would substantially strengthen the applied value of the study.

**Response 4**: Thank you for this valuable suggestion. We have revised the manuscript to strengthen the discussion on the practical implications of the proposed framework for reservoir operation.

Specifically, a dedicated discussion section has been added to explicitly illustrate how 72-hour inflow forecasts can support real-world reservoir management. In this section, we emphasize that, although forecast uncertainties inevitably exist, the predicted timing and trend of inflow remain highly informative for operational decision-making. These forecasts provide critical lead time for reservoir managers to implement proactive strategies, such as pre-release operations, flood risk mitigation, and adaptive water allocation during typhoon events.

In addition, we further clarify that the integration of SPM with machine learning and multi-step forecasting improves the stability and reliability of long lead-time predictions, making the forecast information more actionable under uncertain conditions. Practical decision-making strategies, such as adopting conservative estimates or considering ensemble variability, are also discussed to demonstrate how forecast uncertainty can be effectively managed in operational contexts.

These revisions enhance the applied value of the study and better demonstrate the relevance of the proposed framework for real-world reservoir operation.

**Comments 5:** Future research directions too narrowly technical. The future work outlined in the Conclusion mainly emphasizes model improvement. To broaden the impact, the authors should consider including wider perspectives such as cross-basin applicability, feasibility under climate change conditions, or hybridization with physically-based models. This would enhance the forward-looking dimension of the paper and its relevance to a broader research community.

**Response 5**: Thank you for this constructive suggestion. We have revised the manuscript to broaden the scope of future research directions and enhance the forward-looking perspective of the study.

In the revised manuscript, the future research section has been expanded beyond model improvement to include several broader aspects. First, we discuss the potential applicability of the proposed framework to different river basins with varying hydrological characteristics, highlighting the need for cross-basin validation. Second, we address the challenges posed by climate change and non-stationary hydrometeorological conditions, emphasizing the importance of evaluating model robustness under changing environmental conditions. Third, we suggest the integration of data-driven approaches with physically based hydrological models to improve interpretability and generalization capability.

These additions extend the discussion from a purely technical perspective to a more comprehensive research outlook, strengthening the relevance of the study to a wider scientific and practical community.

# Response to Reviewer 2 Comments

We sincerely thank the reviewer for the thorough and constructive comments. The suggestions have significantly improved the clarity, rigor, and overall quality of the manuscript. All comments have been carefully addressed, and the manuscript has been revised accordingly. Detailed responses are provided below.

**Comments 1:** Abstract. The abstract is informative; however, it would benefit from a more concise and consistent presentation of results. It is recommended to report only the best-performing model with representative numerical values to improve clarity.

**Response 1**: Thank you for this helpful suggestion. The Abstract has been revised to improve conciseness and clarity. Specifically, we streamlined the presentation of results by focusing on the best-performing model and reporting representative quantitative performance (e.g., MAE and CE values) to enhance readability and impact.

**Comments 2:** Introduction. The objective of the study is generally clear; however, the novelty is not sufficiently emphasized. Please revise the objective section to clearly state:
-what is new in this study
-how it differs from existing ensemble or ML-based approaches
It may be helpful to explicitly highlight the contribution of integrating SPM with MSF and machine learning models.

**Response 2**: Thank you for this valuable comment. The Introduction has been revised to more clearly highlight the novelty and contribution of this study.

In particular, the concluding part of the Introduction has been strengthened to explicitly state (1) what is new in this study and (2) how the proposed framework differs from conventional ensemble and machine learning-based approaches. We now emphasize that the proposed framework integrates the Switch Prediction Method (SPM) with machine learning-based multi-step forecasting (MSF), introducing a dynamic rainfall forecast selection mechanism based on real-time performance. This distinguishes the proposed approach from traditional methods that rely on static input structures.

The main contributions are now explicitly summarized in a structured manner.

**Comments 3:** Methodology. The manuscript would benefit from improved reproducibility. It is recommended to include a pseudo-code or algorithmic flow for the proposed framework (SPM + MSF + ML models).

**Response 3**: Thank you for this important suggestion. The Methodology section has been revised to improve transparency and reproducibility.

We have expanded the description of the Switch Prediction Method (SPM) to clearly explain its operational mechanism, including the evaluation and dynamic selection of rainfall forecasts. In addition, a structured step-by-step description of the overall framework has been incorporated to illustrate how SPM is integrated with machine learning models and the multi-step forecasting (MSF) process.

These revisions provide a clearer algorithmic flow of the proposed framework and facilitate reproducibility.

**Comments 4:** Results and Discussion. The results are well presented; however, the discussion lacks comparison with existing studies. It is recommended to include comparison statements with previous research to better position the contribution of this work. The manuscript does not explicitly discuss the advantages and limitations of the proposed framework.
It is recommended to add a dedicated discussion including:
-strengths (e.g., adaptability, uncertainty reduction)
-limitations (e.g., data dependency, lack of extrapolation capability)

**Response 4**: Thank you for this constructive suggestion. The Discussion section has been revised to include comparisons with recent studies.

We have added comparison statements with existing literature to better position the contribution of this work. In particular, the performance of LSTM-based models is discussed in relation to previous studies, and the added value of the SPM-based framework is clarified in terms of improved adaptability and reduced uncertainty propagation compared to conventional approaches.

**Comments 5:** Conclusion and Future Work. The conclusion summarizes the findings well; however, future research directions are only briefly mentioned.
Please expand the future scope section, including:
-application to other watersheds
-real-time forecasting

**Response 5**: Thank you for this valuable suggestion.

The future research section has been expanded to provide a broader perspective. In addition to model improvement, the revised manuscript now discusses (1) application to other watersheds with different hydrological characteristics and (2) the potential for real-time forecasting and operational implementation. These additions enhance the forward-looking aspect of the study.

**Comments 6:** Figures and Tables. Please ensure that all figures are properly cited and clearly indicate whether they are original or adapted from other sources.

**Response 6**: Thank you for the suggestion. All figures have been carefully reviewed to ensure proper citation and clarity. We have verified that all figures are clearly labeled and appropriately referenced in the text.

**Comments 7:** References. Please carefully review all references to ensure they are relevant and closely related to the study. The use of non-peer-reviewed sources (e.g., websites) is not recommended and should be avoided.

**Response 7**: Thank you for this important comment. The reference list has been carefully reviewed and updated. We have ensured that all references are relevant and closely related to the study. In addition, recent publications have also been incorporated to improve the timeliness of the manuscript.

# Response to Reviewer 3 Comments

We sincerely thank the reviewer for the thorough and constructive comments. The suggestions have significantly improved the clarity, rigor, and overall quality of the manuscript. All comments have been carefully addressed, and the manuscript has been revised accordingly. Detailed responses are provided below.

**Comments 1:** This manuscript proposes an integrated framework combining the Switch Prediction Method (SPM), ensemble rainfall forecasts, and machine learning models (SVM and LSTM) for 72-hour reservoir inflow forecasting during typhoon events. The topic is relevant to reservoir operation and flood management, and the manuscript is generally well organized.

However, the reviewer finds that the inclusion of only two machine learning models does not provide a sufficiently comprehensive evaluation of the proposed framework. Given the significant developments in deep learning and transformer-based forecasting methods in recent years, the authors should better position their work within the current state of the art and clarify the advantages, limitations, and potential competitiveness of the proposed framework relative to more advanced architectures.

**Response 1**: Thank you for this valuable comment. We agree that transformer-based architectures and other advanced deep learning approaches have shown promising performance in recent hydrological forecasting studies. To address this concern, we have revised the manuscript to better position the proposed framework within the current state-of-the-art.

Specifically, the Introduction has been revised to clarify that the primary objective of this study is not to identify the best-performing forecasting architecture, but rather to evaluate the effectiveness of the proposed Switch Prediction Method (SPM) for improving rainfall forecast inputs and enhancing long lead-time reservoir inflow forecasting. Therefore, two representative machine learning models, namely SVM and LSTM, were selected to represent conventional machine learning and deep learning approaches, respectively.

In addition, Section 2.2.2 has been expanded to explain the rationale behind the selection of these models. By demonstrating the effectiveness of SPM using both SVM and LSTM, the proposed framework can be evaluated independently of a specific prediction architecture, thereby highlighting its applicability across different modeling paradigms and its model-independent benefits.

Furthermore, the Discussion and Future Directions sections have been revised to discuss the limitations of the current study and the potential integration of transformer-based architectures and other advanced deep learning models within the proposed SPM framework. Such investigations may further evaluate the scalability and applicability of the framework under larger datasets and more complex forecasting scenarios.

These revisions better clarify the advantages, limitations, and future competitiveness of the proposed framework relative to recent forecasting architectures.

Revision location: Introduction; Section 2.2.2; Section 4.4.

**Comments 2:** Line 121: The study was conducted using only 18 instances of typhoons from one reservoir catchment. Although the forecasts generated were impressive, it is challenging to determine how effective the developed framework would be if applied in a different hydrologic environment. It is essential for the authors to highlight the shortcomings of the available data and present more supportive evidence if possible.

**Response 2**: Thank you for this important comment. We acknowledge that the study was conducted using 18 typhoon events from a single reservoir watershed, which may limit the generalizability of the proposed framework to other hydrological environments.

The study area was selected because the operational ensemble rainfall forecast products required for this research were only available for the ShihMen Reservoir watershed. These forecasting datasets were obtained through a dedicated research collaboration and provided a valuable opportunity to evaluate the proposed framework using real-world operational forecast products. However, the availability of these datasets also constrained the present study to a single watershed and limited the possibility of conducting a broader cross-basin evaluation.

To address this concern, we have expanded the discussion of research limitations in Section 4.4. The revised manuscript now explicitly states that only 18 typhoon events were available for model development and evaluation, which may not fully represent the range of hydrometeorological variability encountered in different climatic and watershed settings. We also acknowledge that the use of a single reservoir watershed limits the ability to assess the framework under diverse hydrological conditions.

Furthermore, future research directions have been expanded to emphasize the need for validation across multiple basins with different climatic, topographic, and hydrological characteristics. Such investigations will be essential for evaluating the robustness and broader applicability of the proposed framework under different hydrological environments.

We believe these revisions provide a clearer discussion of the limitations associated with the available dataset and better define the scope of the current study.

Revision location: Section 4.4 (Research limitations and future directions).

**Comments 3:** Lines 263-267: Describe the use of grid search for parameter optimization. However, the manuscript does not provide sufficient details regarding the search ranges, validation procedure, or total number of parameter combinations evaluated. Without such information, the study is difficult to reproduce. The reviewer recommends expanding the methodological description.

**Response 3**: Thank you for this valuable suggestion. We agree that additional information regarding the parameter optimization process is necessary to improve the reproducibility of the study.

To address this concern, we have substantially expanded the description of the grid-search procedure in Section 3.1. The revised manuscript now provides a detailed explanation of how both model inputs and hyperparameters were optimized. Specifically, we clarify that the lag lengths of rainfall ($L_R$) and reservoir inflow ($L_Q$) were jointly optimized with the machine learning hyperparameters using a systematic grid-search procedure.

In addition, Table 4 has been revised to explicitly present both the hyperparameter search ranges and the resulting optimal hyperparameter settings for the SVM and LSTM models. The search ranges considered for kernel functions, Gamma, Cost, Epsilon, hidden-layer structures, activation functions, optimizers, batch sizes, dropout rates, and training epochs are now provided. We also clarify that model performance for each candidate parameter combination was evaluated using a validation subset extracted from the training dataset, and the parameter set yielding the lowest validation error was selected. Once the optimal parameter combination was identified, it was fixed and subsequently applied during the testing phase.

These revisions improve the transparency, reproducibility, and clarity of the parameter optimization procedure.

Revision location: Section 3.1 and Table 4.