Reviewer 1

The article 'How does the choice of the input hydrograph affect reservoir and dam design?'' aims to assess the influence of different methods for defining the hydrological load in the context of reservoir design and verification. Specifically, it relies on a design-event approach (which in this case is unusually independent from the return period) and compares results obtained by routing different reservoir configurations with (i) different combinations of rainfall design events and IUH models and (ii) a 'flow time series' (line 264; I do not understand how it is obtained from the rainfall time series presented in the manuscript – another rainfall-runoff model?). The results, which are not always clearly presented, highlight that, although the findings are not fully generalizable (line 444), there are differences in the mean annual maximum outflow, maximum storable volume, and peak reduction effect obtained by routing a reservoir with a continuous time series and commonly used design 'hyetographs' (line 411).

Reply: We thank the reviewer for the detailed evaluation of the manuscript and for the comments provided. In the following, we address all the points raised and clarify the inconsistencies highlighted. In accordance with the discussion-stage policy of the journal, the revised manuscript has not been uploaded at this stage, although all the modifications discussed below have already been implemented and included in the revised version to be submitted in the next phase of the review process.

Although I found the idea of this comparison interesting and useful for researchers and practitioners, I found: (i) an introduction that does not sufficiently explore the problem

Reply: In the revised manuscript, we now guide the reader more explicitly from the general need to select design hydrograph for reservoirs and dams to the specific challenges associated with choosing one approach over another. The introduction has been reorganized as follows. After the first paragraph, where we introduce the importance of the full design hydrograph for dam and reservoir design, we discuss the possible ways to obtain them: either directly from observed flow time series, where available, or indirectly through rainfall–runoff modelling procedures. We emphasize that, when designing new hydraulic infrastructure, it is often uncommon to have discharge observations exactly upstream of the point of interest.

"The design hydrograph for reservoirs and dams can either represent an observed flood event (Dimas et al., 2025) or a synthetic one that synthesises and preserves some physical properties and statistical information about the flow time series (Aureli et al., 2023; Mediero et al., 2010; Michailidi and Bacchi, 2017). However, most basins are ungauged, thus, flow time series are often unavailable, statistically sparse, or limited to annual peak flows, making it challenging to derive past events or construct reliable design hydrographs directly (Evangelista et al., 2023). Moreover, when designing new infrastructure is rare that there is a flow time series exactly upstream the point of interest. As a result, it is common to rely on indirect procedures to estimate design hydrographs according to rainfall-runoff models."

Then, we clarified that, among the indirect procedures to obtain the design hydrograph, the availability and reliability of hydrological information strongly influence the choice of the methodology, particularly in ungauged or poorly monitored catchments.

"The indirect procedures to estimate design hydrograph span a wide spectrum of complexity. At one end, rigorous distributed or semi-distributed hydrological models simulate the physical processes governing runoff generation and routing in the upstream basin, accounting for spatial variability in precipitation, land cover, soil properties, and topography (Montaldo et al., 2024;). At the other end, simplified lumped rainfall–runoff models aggregate catchment behaviour into a set of parameters with clear physical meaning, offering more practical implementations. The choice of modelling strategy is therefore strongly conditioned by data availability. Indeed, when detailed hydrometeorological datasets exist, more advanced process-based models can be applied; in ungauged or poorly gauged contexts, practitioners are often constrained to lumped rainfall-runoff models. Indeed, rainfall time series and Intensity Duration Frequency (IDF) curve parameters are typically more numerous and geographically uniform than flow records, and rainfall-runoff models are usually based on a few parameters with a clear physical meaning (Cristiano et al., 2017)."

Within the framework of indirect procedures, we also expanded the literature review by citing studies that estimate design hydrographs for reservoirs and dams through rainfall–runoff approaches. In particular, we clarify that a widely adopted procedure consists of transforming a design hyetograph (or design storm) associated with a given return period into the corresponding design hydrograph through a rainfall–runoff model:

"Specifically, Cipollini et al. (2022) adopted rainfall events derived from IDF curves to quantify the impact of multiple reservoirs on flood frequency at the catchment scale. Similarly, Evangelista et al. (2023), in their analysis of the flood attenuation potential of Italian dams, justified the use of IDF-based rainfall inputs as a means of simplifying the hydro-climatological factors controlling design flood peaks while still preserving the dominant influence of rainfall characteristics on flood generation processes."

We then explicitly introduce the core problem addressed by the manuscript: currently, no universal guidelines exist to indicate which combination of design hyetograph and rainfall–runoff model should be adopted for estimating the inflow design hydrograph for reservoirs and dams. Moreover, the simulation of reservoir routing processes for multiple possible hydrographs is computationally demanding, making a comprehensive exploration of all possible scenarios impractical. As a result, design practices are commonly based on the prescriptions of local authorities, which can differ substantially across countries and regions.

"Although numerous studies have focused on the derivation of synthetic hydrographs from rainfall data and on reservoir routing techniques, fewer contributions have explicitly examined how different rainfall-derived hydrograph definitions affect reservoir design outcomes under comparable modelling assumptions. This limitation is particularly relevant when IDF-based approaches are used as the primary source of hydrological input information."

Finally, we conclude the introduction by clearly stating the objective of the study. Specifically, this work investigates how sensitive reservoir and dam design is to the selection of the input design hydrograph by quantifying the resulting differences in key reservoir parameters, such as maximum outflow discharge, maximum storage volume, and peak attenuation effects. More specifically, the objective of this study is to evaluate how different rainfall-based procedures, particularly those relying on IDF-derived design events, influence reservoir routing results and key performance indicators, and to compare these outcomes with those obtained from routing a continuous flow time series.

"The objective of this study is to evaluate how different rainfall-based procedures, particularly those relying on IDF-derived design events, influence reservoir routing results and key performance indicators, and to compare these outcomes with those obtained from routing a continuous flow time series."

(ii) a structure of the paper which is confusing and difficult to follow

Reply: We understand the reviewer's observation regarding the structure of the manuscript. We believe that explicitly outlining the manuscript organization improves navigation and comprehension without altering the original structure of the paper. The following text has been added to the Introduction:

"The remainder of the paper is organized as follows. Section 2 presents the theoretical background, introducing the fundamental concepts of rainfall–runoff modelling and reservoir routing. Section 3 describes the methodology adopted in this study, including the derivation of rainfall inputs from IDF curves, the construction of design hyetographs, the application of IUH-based approaches to obtain the corresponding input hydrographs, and the reservoir routing procedures to obtain the output hydrographs. Section 4 presents the case studies, including both synthetic test cases and a real-world application. Section 5 reports and discusses the results obtained for each case study, maintaining a consistent structure to facilitate comparison. Finally, Section 6 summarizes the main findings and conclusions of the study."

(iii) some assumptions regarding the simulated reservoir configurations that are not clearly presented or discussed

Reply: The assumptions underlying the simulated reservoir configurations have been clarified in the revised manuscript. In particular, the analysis intentionally focused mainly on bottom outlets because the objective of the study was to investigate the sensitivity of flood attenuation and peak reduction to the selected input hydrograph under consistent routing assumptions. Bottom outlets exert a stronger and more continuous control on reservoir routing behaviour, allowing a clearer comparison among different hydrograph definitions.

In contrast, uncontrolled spillways generally become active only for high water levels and mainly function as safety structures to convey excess discharge once the storage capacity is exceeded. Consequently, their influence on attenuation metrics is typically more limited and strongly dependent on the spillway crest elevation and reservoir filling conditions.

The study was not intended to reproduce the full operational behaviour of a specific reservoir system, but rather to isolate and compare the effects of alternative hydrograph-generation procedures while limiting additional sources of variability associated with operational rules, multiple outlet structures, or dynamic reservoir management strategies. Nevertheless, the adopted routing framework remains fully compatible with more complex reservoir configurations and operational schemes.

(iv) an approach that appears more hyetograph-oriented than hydrograph-oriented

Reply: We acknowledge the reviewer's observation that the proposed approach is more hyetograph-oriented than hydrograph-oriented. To better reflect this aspect, we considered revising the title to "How does the choice of rainfall-derived input hydrographs affect reservoir and dam design?", thereby emphasising the central role of rainfall input representation, particularly in the context of poorly gauged or ungauged basins.

Moreover, we revised both the Abstract and the Introduction to explicitly state that the study evaluates reservoir and dam effect in the context of rainfall–runoff modelling approaches used to derive hydrographs from rainfall inputs, particularly those based on IDF curves. Additional text has also been included to more thoroughly frame the underlying problem, emphasising the practical context in which rainfall-based methods are commonly adopted. In particular, we have highlighted that, especially during preliminary design stages, long and reliable flow time series are rarely available immediately upstream the of the point of interest, whereas rainfall information and IDF relationships are typically more accessible. For this reason, rainfall-based approaches remain widely used in engineering practice to evaluate the effects of reservoirs and dams under data-limited conditions. The abstract has been modified as follows:

"Abstract: Reservoir and dam design requires a detailed understanding of the entire input hydrograph rather than relying solely on peak discharge estimates. Input hydrographs are essential both for verification purposes to evaluate the peak attenuation capacity of the reservoir and for design purposes to define reservoir height, its volume and outlet structures. In engineering practice, particularly during preliminary design stages or in ungauged basins, long and reliable discharge records are often unavailable immediately upstream of the point of interest. Consequently, rainfall-based approaches derived from Intensity–Duration–Frequency (IDF) relationships are widely adopted to generate design hydrographs through rainfall–runoff modelling procedures, especially in poorly gauged or ungauged basins. However, no universal guidelines suggest which combination of design hyetograph and rainfall-runoff model should be used to estimate the input design hydrograph for reservoirs and dams. As a result,

practitioners often rely on local regulations and heterogeneous methodologies, frequently without clear evidence regarding the advantages and limitations of different hydrograph definitions. This study investigates how sensitive reservoir and dam design is to the selection of the input hydrograph obtained from rainfall-runoff modelling by quantifying the resulting differences in key reservoir parameters, including maximum outflow discharge, maximum storage volume, and peak attenuation effects. The analysis compares the outcomes obtained using the most commonly adopted rainfall-based hydrograph generation procedures, particularly those based on rainfall time series routing and IDF-derived design events. The study highlights how different rainfall-derived hydrograph definitions can lead to substantially different reservoir routing results and design implications. The findings emphasize the importance of a more informed and consistent hydrograph selection process, especially in data-scarce environments where rainfall-based methods represent the primary source of hydrological information. In addition, the study addresses the computational challenges associated with reservoir routing analyses by discussing efficient yet reliable alternatives for defining input hydrographs in reservoir and dam design practice."

(v) The reviewer observed that the conclusions do not offer sufficiently new insights

Reply: A first important insight emerges from the analysis of maximum outflow discharge estimates. The results show that the widespread assumption that the basin lag time represents the critical rainfall duration for reservoir design does not always hold. In particular, the Uniform hyetograph underestimated key reservoir parameters compared with the Variational hyetograph, indicating that the critical rainfall duration may differ from the basin lag time depending on the adopted rainfall distribution and routing conditions. These finding questions the rigid application of traditional assumptions commonly adopted in engineering practice and highlights the need for a more flexible evaluation of critical storm duration in reservoir design studies.

Another significant insight concerns the estimation of maximum storable volume. The results consistently showed that all event-based design hyetographs underestimated maximum storable volumes compared with continuous time-series routing simulations. This behaviour highlights a fundamental limitation of event-based design methods, namely the implicit assumption that the full reservoir storage volume is available at the beginning of the event. In contrast, continuous simulations account for antecedent hydrological conditions and the cumulative effects of previous events, which can substantially constrain the storage volume effectively available for flood attenuation. Therefore, neglecting antecedent storage conditions may lead to under-designed flood-control infrastructure and unrealistic assessments of reservoir performance.

The study also demonstrates that peak reduction estimates are highly sensitive to the selected input hyetograph. This result emphasizes that the choice of the design hyetograph is critical for obtaining reliable estimates of reservoir attenuation behaviour and overall reservoir efficiency.

Since the peak reduction effect is often considered a proxy for reservoir performance, inaccurate estimates may lead to unrealistic evaluations of reservoir configurations and their effectiveness. This issue may become even more relevant when comparing alternative reservoir layouts or management strategies, as differences associated with the selected input hydrograph may influence the perceived performance of the considered configurations.

Overall, the manuscript provides insights not only into the quantitative differences produced by alternative hydrograph definitions, but also into the conceptual limitations associated with commonly adopted event-based assumptions in reservoir and dam design practice.

(vi) First inconsistency affecting the interpretation of the results: consistency between hyetograph assumptions and modelling purpose

Reply: We agree with the reviewer that simplified rainfall and runoff representations, such as rectangular hyetographs and triangular–trapezoidal hydrographs are commonly adopted when analytical solutions are required and when simplification of the hydrological response is consistent with the purpose of the analysis. In fact, the primary aim of this study is precisely to highlight the implications of using simplified rainfall and runoff representations that allow analytical or semi-analytical solutions, such as rectangular hyetographs. These simplified representations are widely used in preliminary reservoir design because they allow rapid estimation of reservoir response without the need to perform computationally intensive numerical simulations, such as routing detailed design storms (e.g., Chicago-type storms) or long continuous flow time series. For this reason, the choice of simplified rainfall temporal patterns was not intended to approximate reality as closely as possible, but rather to investigate how commonly adopted simplified design assumptions influence reservoir routing results.

(vii) Second inconsistency: independence of the BLUE hyetograph and potential bias

Reply: We acknowledge the reviewer's concern regarding the use of the BLUE hyetograph and the lack of independence in the comparison with the benchmark continuous simulations. In the present study, the BLUE hyetograph differs conceptually from the other rainfall inputs considered because it is not derived from IDF curve parameters. Instead, it is defined using statistical information associated with the mean Annual Maxima of the instantaneous inflow series.

More specifically, the BLUE hyetograph (Eq. 9) requires the specification of the target peak discharge Q. Other studies, such as Alfieri et al. (2008), assumed that the total rainfall depth associated with the BLUE hyetograph was consistent with the IDF curve evaluated at the basin concentration time. However, this approach may generate rainfall intensities exceeding the IDF relationship because the temporal rainfall distribution is constrained only by the IUH shape. To avoid this inconsistency, the present study adopted a different assumption and considers the peak discharge Q equal to the mean Annual Maxima of the instantaneous inflow series obtained from the continuous rainfall–runoff simulations. Consequently, the BLUE hyetograph does not depend on IDF parameters, but rather on flow-based statistical information derived from the benchmark simulations. We agree that this introduces a dependency between the BLUE hyetograph and the continuous simulations, and therefore the comparison is not fully independent. As correctly observed by the reviewer, this shared statistical basis may partially explain the closer agreement between the BLUE hyetograph and the benchmark continuous simulations.

"This study does not adopt the previously described procedure, but considers that the maximum discharge Q of Eq. 9 equals the mean Annual Maxima of the instantaneous Qin. This value is computed after transforming the rainfall time series into the corresponding flow time series. Therefore, this study considers that the BLUE hyetograph does not depend on the IDF parameters, but rather on the mean Annual Maxima of the instantaneous Qin. This assumption represents a methodological limitation of the comparison, and the results involving the BLUE hyetograph should therefore be interpreted with caution, as they partially reflect the shared statistical basis with the benchmark simulations "

For this reason, the revised manuscript now explicitly clarifies this distinction in the Methodology section and consistently highlights it throughout the manuscript. In addition, the interpretation of the results involving the BLUE hyetograph has been revised. Rather than presenting its performance as evidence of a generally superior approach, the discussion now emphasizes that the observed agreement with the continuous simulations should primarily be interpreted as a consistency check resulting from the shared statistical basis between the two approaches, rather than as evidence of superiority over the IDF-based hyetographs.

"Another noteworthy finding that emerged from these results is the strong performance of the BLUE hyetograph in estimating the maximum outflow discharge, which produced highly accurate results using only the peak values from the mean annual maxima inflow series. This result demonstrates that the BLUE hyetograph is particularly appealing in contexts where flow time series are available or even when only annual peak inflows are available, as it effectively bypasses the need for the IDF curve parameters or the complete time series. However, the BLUE hyetograph applicability is limited in data-scarce or ungauged regions, where rainfall or flow time series may not be available, reducing its utility in such contexts."

Regarding the reviewer's question on the practical usefulness of the BLUE hyetograph when flow time series are available, we clarify that when complete and reliable flow records exist, direct hydrograph-based approaches or continuous simulation remain preferable. The BLUE hyetograph may instead be useful in intermediate situations where only limited flow information, such as annual peak discharges, is available, and where deriving representative rainfall inputs may still be advantageous for simplified design analyses.

In addition, reviewer provided the following specific comments:

Line 14: 'maximum storable volume' could you please be more precise about the meaning of this key variable?

Reply: We intend the capacity of the reservoir to store the flood volume thus the maximum storage volume, we'll specify in the revised manuscript.

Lines 15–20: From the abstract, I do not grasp the main conclusions of the work; could you please include some of your findings here?

Reply: We reformulated the conclusions of the abstract to highlight main conclusions:

"The analysis compares the outcomes obtained using the most commonly adopted rainfall-based hydrograph generation procedures, particularly those based on rainfall time series routing and IDF-derived design events. The study highlights how different rainfall-derived hydrograph definitions can lead to substantially different reservoir routing results and design implications. The findings emphasize the importance of a more informed and consistent hydrograph selection process, especially in data-scarce environments where rainfall-based methods represent the primary source of hydrological information. In addition, the study addresses the computational challenges associated with reservoir routing analyses by discussing efficient yet reliable alternatives for defining input hydrographs in reservoir and dam design practice."

Lines 48–49: Does a design-event approach necessarily assume a reservoir empty at the time of a flood event? I think that different reservoir-filled conditions can indeed be simulated.

Reply: We agree that different initial reservoir storage conditions can indeed be simulated within a design-event framework. However, in many practical event-based applications, the reservoir is commonly assumed to be empty, or to have the full flood-control storage available, at the beginning of the flood event. Our intention was not to imply that alternative initial conditions cannot be considered, but rather to highlight a simplifying assumption frequently adopted in practice.

"Moreover, the approach usually assumes that the full reservoir storage capacity is available at the beginning of the flood event, as accounting for partial reservoir occupancy would introduce additional complexity and require assumptions regarding antecedent storage conditions and reservoir operating states."

Line 82: Why did you compute the mean of annual maxima of the variables? Why do you not analyze your results also in terms of return period? I missed this point.

Reply: The use of the mean of annual maxima in this study is consistent with established approaches for characterizing hydrologic regimes when the primary objective is to describe and compare flow magnitudes rather than to perform probabilistic design estimation. In particular, studies such as Assani et al. (2005) have shown that annual maximum flow series can be effectively characterized through statistical descriptors such as magnitude, variability, and distribution properties, even when full frequency analysis is not the central objective. In this framework, the mean of annual maxima represents a robust indicator of the overall magnitude of extreme flows and provides a consistent reference value for comparing different modelling approaches. In the present study, the main objective was to compare the effects of different rainfall-derived hydrograph definitions on reservoir routing behaviour under consistent modelling assumptions, rather than to estimate specific design quantiles associated with predefined return periods. For this reason, the mean of annual maxima was adopted as a representative magnitude indicator, allowing direct comparison among alternative modelling configurations without introducing additional uncertainty associated with extreme value fitting procedures. Furthermore, as discussed in Assani et al. (2005), when analysing altered or simulated hydrologic regimes, the mean of annual maxima can be used as a reference magnitude because it avoids the need to estimate return-period-based quantiles that may be sensitive to assumptions regarding the statistical distribution and sample length. This choice also reduces the uncertainty associated with fitting extreme value distributions to relatively short samples, which may lead to unstable return-period estimates. This consideration is particularly relevant in simulation-based studies such as the present one, where the focus is on evaluating relative differences among modelling assumptions rather than defining regulatory design thresholds. Nevertheless, we acknowledge that interpreting the results in terms of return periods may provide additional context for practical applications. To address this comment, we have clarified in the revised manuscript the rationale for using the mean of annual maxima as a reference magnitude indicator, and additional discussion has been included to explain how the obtained results could be interpreted in relation to return-period-based design values when required.

"The simulations here assume KT=1, representing the base condition without return period adjustments. This assumption (id,T =id) is consistent with the objective of the study, which focuses on comparing reservoir responses under different rainfall-derived hydrograph generation procedures rather than on probabilistic design estimation. In this framework, the mean annual maximum (id) provides a robust reference magnitude for comparing alternative modelling approaches while avoiding additional uncertainty associated with the fitting of extreme value distributions and the estimation of return-period-based quantiles, which can be sensitive to the adopted probabilistic model and sample length (Assani et al., 2006). Return-period effects can nevertheless be incorporated through the growth factor KT in Eq. (5), when required for design applications."

Assani, A. A., Stichelbout, E., Roy, A. G., & Petit, F. (2006). Comparison of impacts of dams on the annual maximum flow characteristics in three regulated hydrologic regimes in Québec (Canada). Hydrological Processes: An International Journal, 20(16), 3485-3501.

Introduction: I feel that references to previous studies addressing this type of analysis and reporting relevant findings are missing. The state of the art is not discussed. I would encourage the authors to include, in the introduction, key results from the existing literature on this topic.

Reply: As discussed in our response to comment (i), the Introduction has been substantially revised to address these issues.

Lines 94–116: Why did you not include this part directly in the Methodology section (as usually done in manuscript structure)?

Reply: We acknowledge that including this part within the Methodology section would also be possible. However, we preferred to maintain a separate section because Lines 94–116 mainly provide the theoretical background and general framework underlying the analysed approaches, whereas the Methodology section is specifically focused on the procedures adopted to investigate the objectives of the study. In our view, this structure improves readability by clearly separating the conceptual framework from the methodological implementation.

Lines 114–116: Here you define the equations describing the reservoir-routing system. Specifically, you include both the possibility of considering a bottom outlet and a free and unregulated spillway. Hence, for the same reservoir, you could have two different equations based on the water level in the reservoir and the spillway crest height. Could you please clarify this aspect? Also, I see that you consider in your simulations only bottom outlets. Am I right? And why did you not simulate the full reservoir behavior?

Reply: The governing routing equation reported in the manuscript is formulated in a general form and is therefore applicable to both bottom outlets and spillways. The distinction between the two configurations is represented through the parameters c and n in Eq. (3), whose values depend on the hydraulic structure and outlet geometry. In practice, different outlet types can be represented within the same routing framework by adopting the corresponding discharge coefficients and reference water levels.

For a spillway configuration, the outflow is activated only when the reservoir water level exceeds the spillway crest elevation, whereas bottom outlets may operate continuously depending on the hydraulic conditions. Therefore, for a real reservoir system equipped with both structures, the total outflow could be represented as the combination of the contributions associated with bottom outlets and spillways.

Regarding the simulations, the analysis intentionally focused on bottom outlets because the objective of the study was to investigate the sensitivity of flood attenuation and peak reduction to the selected input hydrograph. Bottom outlets exert a stronger and more continuous control on reservoir routing behaviour and therefore allow a clearer comparison among different hydrograph definitions. In contrast, uncontrolled spillways generally become active only for high water levels and mainly serve as safety structures to convey excess discharge once the storage capacity is exceeded. As a result, their influence on attenuation metrics is often more limited and strongly dependent on the selected crest elevation.

The study did not aim to reproduce the full operational behaviour of a specific reservoir system, but rather to isolate and compare the effects of alternative hydrograph-generation procedures under consistent routing assumptions. Introducing additional operational rules, multiple outlet structures, or dynamic reservoir management strategies would have introduced further sources of variability that are outside the scope of the present comparative analysis. Nevertheless, the adopted routing framework remains fully compatible with more complex reservoir configurations and operational schemes.

Lines 120–130: If I correctly understood, your aim is to compare a continuous simulation (with the same rainfall-runoff models) with a design-event approach. Am I right? At line 134, you refer in general to Equation 1. Hence, how did you evaluate your reference flow time series? It is not clear to me. At lines 210–212 it is better explained, but it should be addressed earlier.

Reply: In this framework, the continuous rainfall–runoff routing simulations are used as benchmark reference conditions against which the event-based design approaches are evaluated. This aspect was introduced in the first paragraph of the Methodology section. In particular, the rainfall time series is first transformed into continuous flow time series using the five rainfall–runoff models considered in the study (Linear Reservoir, Nash cascade with 2, 3, and 4 reservoirs, and Kinematic Wave). These continuous flow time series are then routed through the reservoir configurations to obtain benchmark outflow time series and the corresponding reference parameters. Subsequently, the same rainfall time series is used to derive the IDF curves and the selected design hyetographs, which are transformed into synthetic design hydrographs using the same rainfall–runoff models. These hydrographs are then routed through the reservoirs, and the resulting key parameters are compared with the benchmark values obtained from the continuous simulations.

Lines 180–186: I do not understand your assumption in the BLUE approach. Indeed, the procedure of Alfieri et al. (2008), as you mentioned, estimates the intensity considering the rainfall depth computed from the IDF curves and the time of concentration of the basin. I found it reasonable compared to your assumption, which depends on the flow time series. This point, as I mentioned before, is not clear to me.

Reply: Please refer to our previous response to Comment (vii), where this aspect is discussed in detail.

Lines 236–240: Why did you consider only bottom outlets and not the unregulated free spillway? How could this affect the results?

Reply: As discussed in the previous response, the analysis intentionally focused on bottom outlets because the main objective of the study was to investigate the sensitivity of flood attenuation and peak reduction to the selected input hydrograph. Bottom outlets exert a stronger and more continuous control on reservoir routing behaviour, thereby allowing a more consistent and clearer comparison among different hydrograph definitions. In contrast, uncontrolled free spillways generally become active only when the reservoir water level exceeds the spillway crest elevation and primarily function as safety structures to convey excess inflow once the available storage capacity is exceeded. Consequently, their influence on attenuation metrics and peak reduction is typically more limited and strongly dependent on the selected crest elevation and reservoir filling conditions. For these reasons, the adopted configuration was considered more suitable for isolating the effects of the input hydrograph definition on reservoir routing response while limiting the influence of additional structural and operational factors.

Lines 258–260: Did you consider here the behavior of the spillway? In Table 4, only the parameters of the bottom outlet are shown.

Reply: The parameters c and n are always defined using the same notation in the routing equation; what changes is their formulation depending on the considered hydraulic structure. In the case reported in Table 4, the values of c and n refer to the spillway configuration rather than to a bottom outlet. This aspect is specified in the manuscript in lines 284-285. Therefore, the spillway behaviour was effectively considered in this case study, and the routing parameters reported in Table 4 correspond to the spillway hydraulic configuration.

Results and Conclusion: As I mentioned before, I found the discussion of the results and conclusions to be more hyetograph-choice oriented than hydrograph-choice oriented. This is because (i) I do not find a clear discussion of the specific rainfall–runoff models adopted, and (ii) I do not fully understand whether the comparison between the continuous simulation and the design-event simulation is carried out using the same IUH models. In the latter case, the manuscript should be framed explicitly as hyetograph-oriented.

Reply: We agree with the reviewer's observation that the manuscript is primarily hyetograph-oriented rather than hydrograph-oriented, and we clarified this aspect throughout the revised manuscript, particularly in the Abstract, Introduction, and Methodology sections.

The objective of the study is to evaluate how different rainfall-derived design hyetographs influence reservoir routing results under consistent rainfall–runoff modelling assumptions. For this reason, the same IUH/rainfall–runoff models are consistently adopted both for the continuous simulations used as benchmark reference conditions and for the event-based simulations derived from the selected design hyetographs. This methodological choice was intentionally made to isolate the effect of the rainfall input definition while minimizing the influence of differences associated with the hydrological transformation model itself.

We also revised the text to better clarify the role of the adopted rainfall–runoff models and the rationale for their use within the comparative framework. The discussion and conclusions were accordingly reframed to emphasize that the observed differences mainly arise from the adopted hyetograph definitions and associated rainfall input assumptions, rather than from differences in the hydrological routing models.

Overall, while I find the topic of the manuscript relevant and the idea of comparing different approaches potentially valuable, the current version of the paper presents, in my opinion, several conceptual and methodological issues that significantly limit the robustness of the conclusions. It is also not well positioned within the scientific context (there is no clear introduction to the problem and no references to other manuscripts that investigate the same topic). For these reasons, I believe that the manuscript requires a major revision before it can be considered for publication.

Reply: We thank the reviewer for the detailed and constructive evaluation of the manuscript. In response to the comments raised, the manuscript has been substantially revised. We believe that these revisions significantly improved the clarity, consistency, and scientific positioning of the manuscript.