Responses to Reviewer:

General comments: *In the MS titled "Optimizing Rainfall-Triggered Landslide Thresholds to Warning Daily Landslide Hazard in Three Gorges Reservoir Area", the authors tried to propose a rainfall threshold for predicting landslides on a daily scale. The topic fits the journal's scope while the entire MS was poorly structured, and the methods were not clearly explained. Hence a major revision is suggested.*

Response: We sincerely thank you for your recommendation and valuable comments, which have greatly contributed to improving this manuscript. We deeply appreciate the thorough and thoughtful review you have provided. In response to your comments, we have made detailed corrections, and we hope these revisions meet with your approval.

Point by point responses to the nine comments:

1. Comment: *There were too many abbreviations, making the MS hard to follow. Please reduce them to a reasonable number (less than 10).*

Response: Thank you for pointing this out. We fully agree with your suggestion that the excessive use of abbreviations made the manuscript more difficult to follow. In response, we have removed abbreviations like “rainfall threshold model (RTM)” and “landslide hazard warning (LHW),” retaining only well-known abbreviations such as RF, SVM, and MLP. We hope this adjustment will enhance the readability of the manuscript.

2. Comment: *The historical landslides were divided into 2 groups. For those that occurred during the dry season (41), "only rainfall thresholds for dry season landslides were calculated for the entire study area". The authors should explain what are the contributing factors for those dry season landslides? What kind of role of these factors are playing during the rainy season?*

Response: Thank you for bringing this to our attention. First, please allow us to explain the reasoning behind dividing the landslides into dry and rainy seasons: factors such as rainfall amount, soil moisture content, and vegetation cover vary significantly between the dry and rainy seasons, leading to substantial differences in rainfall thresholds. For this reason, we categorized the landslides into dry and rainy seasons. The further subdivision of the rainy season was done to better account for the potential impact of topographical factors on rainfall thresholds. In contrast, the small number of historical landslide events during the dry season made it impractical to further divide this group into subregions.

We also fully agree with your point that the influence of different factors on landslides can vary between the dry and rainy seasons, and that these influences should ideally be analyzed separately. However, the primary objective of this study is to investigate the differences in rainfall thresholds under varying topographical and climatic conditions and to validate the feasibility of real-time landslide hazard warning for the Three Gorges Reservoir area based on these thresholds. Due to limitations in manuscript length and the scope of the research, we did not conduct separate assessments of landslide susceptibility during the dry and rainy seasons. We have added an explanation for this decision in Section 5.2. The revised content can be found in lines 384-387 (in red font). We hope our explanation will meet with your understanding.

It is also important to note that the spatial probability of landslide occurrence may vary between dry and rainy seasons, and the influence of different landslide-inducing factors may change under varying climatic conditions. This study primarily focused on the differences in rainfall thresholds across various climatic and topographic conditions, while the variations in spatial probability of landslide occurrence were not extensively explored.

3. Comment*: Following the above question, the water level fluctuation, and the underground water level might be important factors. But these factors had not been considered in section 4.2.1 or Table 5 "Source of data on landslide inducing factors".*

Response: Thank you for pointing this out. Indeed, reservoir water levels and groundwater levels are important factors in triggering landslides. However, due to the large scope of the study area, it was challenging to obtain comprehensive data on these factors, and therefore, they were not considered in this study. This limitation has been acknowledged in Section 5.2, where we have provided an explanation. The revised content can be found in lines

387-389 (in red font).

Additionally, changes in reservoir water levels and groundwater fluctuations in the Three Gorges Reservoir Area are significant factors influencing landslide occurrence; however, these factors were not included in this study due to data limitations.

4. Comment*: In Table 5, the human engineering activities were indicated using "road density", which seems not reasonable, unless it can be clearly figured out from the landslide inventory.*

Response: Thank you very much for your suggestion. The paper titled "Influence of human activity on landslide susceptibility development in the Three Gorges area" indicates that road construction is one of the most significant human activities affecting landslide occurrence in the Three Gorges Reservoir area. Additionally, since most roads in mountainous areas are constructed on cut slopes, their impact range is difficult to standardize. The paper "Prolonged influence of urbanization on landslide susceptibility" (Rohan et al., 2023) used road density to differentiate between urban and non-urban areas, effectively addressing the challenge of accurately determining road impact ranges. Inspired by this approach, we adopted road density instead of proximity to roads as a factor representing human engineering activities that may trigger landslides. In the revised manuscript, we have added references to relevant literature to support our findings. The revised content can be found in lines 253 and 542-543 (in red font).

Based on the research findings of previous scholars (Chen et al., 2021; Chen et al., 2020; Habumugisha et al., 2022; Li et al., 2022; Li et al., 2020; Rohan et al., 2023) and considering the specific conditions of the study area, this study selected a total of 11 factors that potentially induce landslides. These factors include elevation, Normalized Difference Vegetation Index (NDVI), Topographic Wetness Index (TWI), road density, stratigraphic lithology, tectonic density, river distance, slope, curvature, land cover, and slope structure (Table 5).

Li, Y.W., Wang, X.M., Mao, H., 2020. Influence of human activity on landslide susceptibility development in the Three Gorges area. Nat. Hazards 104, 2115-2151.

5. Comment: *The methodology and the framework should be elaborated using a figure. It reads confusing as it includes too many results (Figs. 7-20, Tables 1-8) using several methods from machine learning to threshold curve yielding in different zones.*

Response: Thank you for bringing this to our attention. We understand your concern regarding the complexity of the content and the lack of a flowchart. To more clearly illustrate the methods and steps involved in the article, we have added a flowchart in the revised manuscript (lines 72-74, in red font).

The study flowchart is shown in Fig. 1.

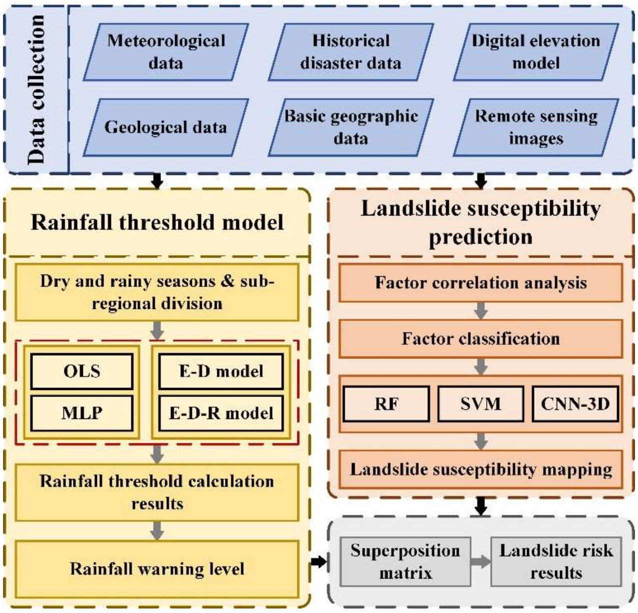

Figure 1. Flowchart of this study.

6. Comment*: Some of the figures are useless, such as Figures 1-2. Some of the figures should be combined.*

Response: Thank you for your suggestion. MLP and CNN are important models in machine learning and have been widely applied in various research fields in recent years. However, the description of the MLP and CNN frameworks in this paper took up considerable space. Additionally, due to the extensive content of the article, the manuscript contained numerous figures and tables, resulting in excessive length, with some figures conveying limited information. Therefore, in the revised manuscript, we have deleted the original Figures 1 and 2 and removed some of the foundational descriptions. Furthermore, we integrated the Thiessen polygon results from the original Figure 5 into the current Figure 2, and combined the bar chart of historical disaster points from the original Figure 6 with the current Figure 3. The original Figure 11, which did not present meaningful information, was also deleted. The revised content can be found in lines 138-139 and 152-154 (in red font).

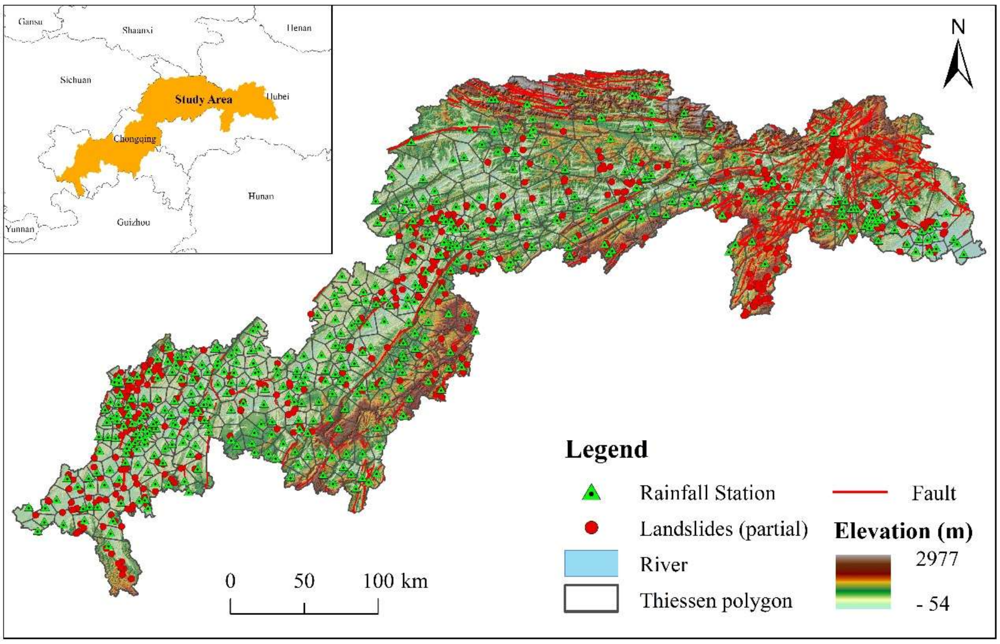

Figure 2: Geographic location of the study area and Thiessen polygon results for rainfall stations.

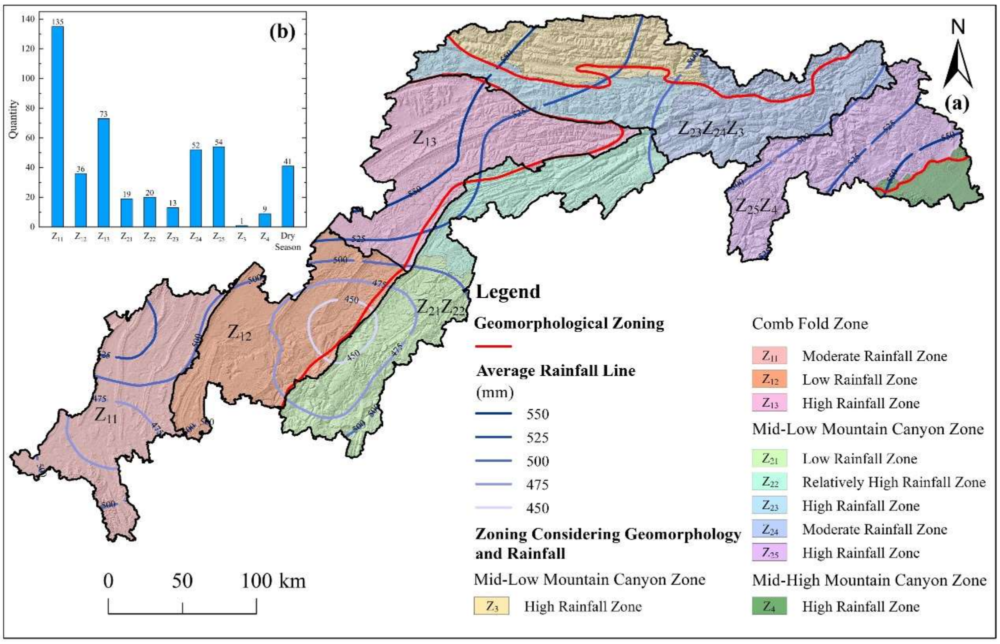

Figure 3: Zoning map of the study area. (a) Schematic diagram of the sub-region merger; (b) Number of historical landslide hazard sites in each sub-region.

*7. **Comment**: Try to find a fault map and include it in Figure 3, it's important and should not be ignored in this mountainous area.*

Response: Thank you for bringing this to our attention. We agree with your suggestion that fault distribution is crucial for studying landslide hazards. In the revised manuscript, we have added fault data to the current Figure 2 (lines 138-139, in red font).

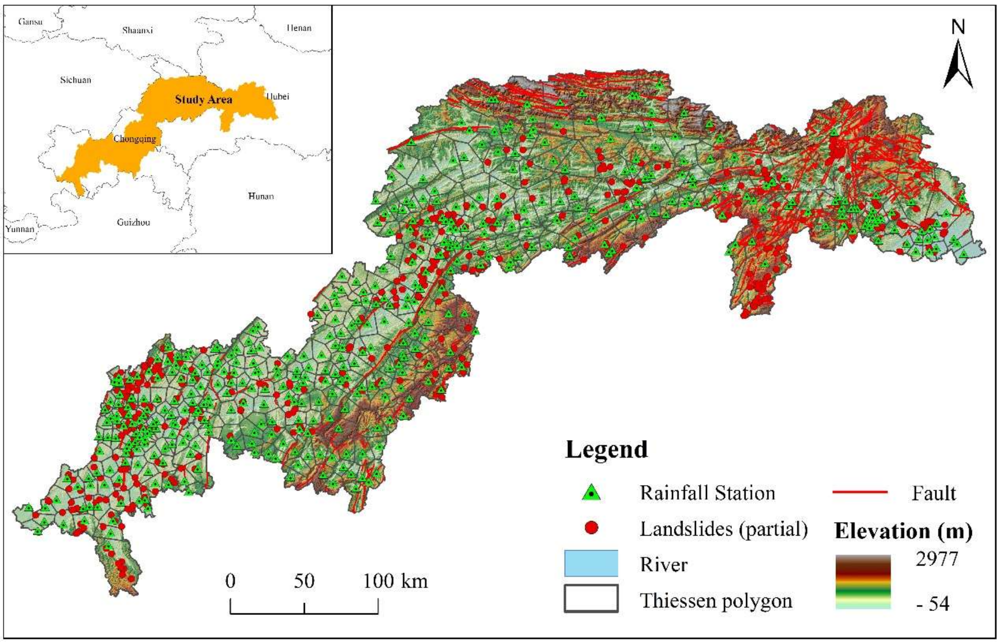

Figure 2: Geographic location of the study area and Thiessen polygon results for rainfall stations.

*8. **Comment**: The details of the rainfall data should be introduced, including the covering period, the temporal resolution, etc.*

Response: Thank you for pointing this out. Two types of rainfall data were used in the study, and we apologize for not clarifying this earlier. In the revised manuscript, we have added details regarding the temporal and spatial resolution of the forecasted rainfall data and distinguished it from the rainfall station data used in the landslide cataloguing. The revised content can be found in lines 221-223 (in red font).

Notably, the rainfall forecast stations used here were established later and differ from the rainfall stations used in the landslide cataloguing (Fig. 2, Rainfall Station). These forecast stations, covering the entire study area at 0.05° intervals, provide real-time updates on forecasted rainfall.

9. Comment*: The Thiessen polygon method was adopted to delineate the study area and the rainfall station (Figure 5), but it is not convincing. The zonation of the rainfall was also conducted (Figure 4). Why two methods were applied for one factor?*

Response: Thank you very much for your suggestion. We apologize for the lack of clarity in our original explanation, which led to some misunderstanding. When cataloguing landslides, it was necessary to obtain rainfall data for each historical landslide event from five days before the landslide occurred to the day of the event. Therefore, we used the Thiessen polygon method to delineate the rainfall station areas to identify which station corresponded to each landslide event and obtain the relevant rainfall data. The subsequent subregion delineation was performed to account for potential differences in rainfall thresholds under varying climatic and topographic conditions. This delineation was aimed at enhancing the accuracy of rainfall thresholds within smaller regions. In the revised manuscript, we have adjusted the logical structure and rewritten section 3.2 to avoid any ambiguity. The revised content can be found in lines 140-163 (in red font).

3.2 Landslide Data Cataloguing and Study Area Subdivision

Cataloging landslide data is crucial for studying rainfall thresholds (Gariano et al., 2021). This process involves recording essential information, including the time of occurrence, geographic location, and associated rainfall stations for each landslide event. The historical landslide data used in this study were provided by the Wuhan Geological Survey Center (http://www.wuhan.cgs.gov.cn/). To identify the corresponding rainfall stations for each historical landslide, the Thiessen polygon method was employed to match each landslide point with the nearest rainfall station (Zhao et al., 2019), thereby obtaining the pre-landslide rainfall data (see Fig. 2, Thiessen polygons).

After filtering and cleaning, a total of 453 historical landslides with accurate rainfall information, dates, and locations were identified (see Fig. 2, Landslides). Historical rainfall data indicate that precipitation in the study area is primarily concentrated between May and October. The differing climatic conditions between the dry and rainy seasons may lead to varying impacts of rainfall on landslide movements (Soralump et al., 2021). Based on this information, the historical landslides were classified into rainy season and dry season landslides according to their occurrence times (Fig. 3(b)).

Given the substantial influence of geomorphological, geological, and climatic conditions on landslide triggers during the rainy season (Dahal and Hasegawa, 2008), rainfall thresholds can vary across different regions. Accordingly, this study further subdivided the landslide data from the rainy season. The study area was divided into several sub-regions based on terrain and climatic conditions, with rainfall thresholds calculated for each region. However, due to the limited historical landslide data in regions Z_{21}, Z_{22}, Z_{23}, Z_3 and Z_4, adjacent regions were merged to mitigate potential inaccuracies in rainfall threshold calculations caused by insufficient data. Specifically, Z_{21} and Z_{22} were combined; Z_{23}, Z_{24}, and Z_3 were combined; and Z_{25} and Z_4 were combined. The final regional subdivision is illustrated in Fig. 3(a). For dry season landslides, due to relatively uniform rainfall and the small number of events, no further subdivision was performed, and the rainfall threshold was calculated for the entire study area.

10. Comment*: In Figure 8, as the landslide data is not sufficient, the rainfall threshold results are derived using scattered E-D points. So, why do the authors have to conduct the zonation of rainfall stations?*

Response: Thank you for pointing this out. As we mentioned in our response to Comment 9, the use of the Thiessen polygon method to delineate the rainfall station areas was intended to accurately obtain the rainfall data for each historical landslide event from five days before the landslide occurred to the day of the event. Regarding the issue of insufficient landslide data points, the calculation of rainfall thresholds requires precise information about the occurrence time and location of historical landslide events, as well as the corresponding rainfall data for those periods. After data cleaning and processing, only 453 historical landslide data points were available for use. To account for spatial variability as much as possible, we adopted a method of partially merging subregions to explore the optimal rainfall thresholds. The results indicate that in regions with a higher number of historical landslide data points, more accurate results were obtained. However, in regions with fewer historical landslide data points, the rainfall thresholds derived from the MLP method were indeed less accurate.

We addressed this issue in Section 5.3, where we highlighted the significant impact of the insufficient number of historical landslide data points on the certainty of rainfall thresholds. Additionally, we emphasized the need to establish a comprehensive historical landslide database. As new landslide events occur, the rainfall thresholds for the relevant subregions can be recalculated. As historical landslide data accumulate, the accuracy of the rainfall thresholds will continuously improve and become more stable.

11. Comment*: Figure 9 shows the E-D-R threshold model for a specific zone, that is, Z_{13}. Why only Z_{13}?*

Response: Thank you very much for your comment. The E-D-R threshold model considers three dimensions, resulting in different rainfall warning levels that are nested within each other in three-dimensional space. To provide a clearer visualization of the E-D-R threshold model results, we used the Z13 region as an example and created the corresponding figure. The E and R axis values in the figure correspond to the rainfall thresholds obtained for the Z13 region using OLS regression. In the revised manuscript, we have clarified in the figure caption that this figure is provided as an example using the Z13 region, to eliminate any unnecessary ambiguity or misunderstanding. The revised content can be found in lines 209-212 (in red font).

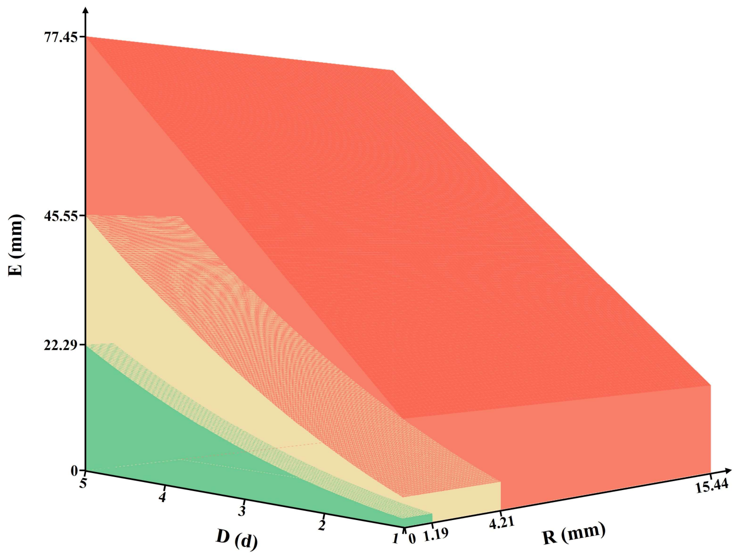

Figure 6: Schematic diagram of the E-D-R rainfall threshold model illustrated using the OLS regression results from the Z13 region as an example. The green, yellow, and red boxes in the figure represent landslide probabilities corresponding to rainfall thresholds of <25%, 25-50%, and 50-75%, respectively.

12. Comment*: "Warning Daily Landslide Hazard" reads confusing. I guess the authors want to emphasize the warning was daily, but why?*

Response: Thank you for pointing this out. The core idea of this paper is to use rainfall thresholds combined with forecasted rainfall data to provide real-time warnings of landslide hazards in the Three Gorges Reservoir area. Due to the randomness and suddenness of landslide events, the risk level of landslides in the same region can vary at different times. Therefore, a single landslide hazard assessment may not be sufficient to support comprehensive prevention efforts, especially in a large area like the Three Gorges Reservoir Area. In this paper, we emphasize "daily" warnings, aiming to utilize a real-time updated rainfall forecasting system to obtain dynamically changing rainfall warning levels, thereby enabling daily updates to landslide hazard warnings. These daily updates allow relevant personnel to focus more precisely on high-risk areas, thus achieving low-cost, high-efficiency landslide disaster response. We hope our response has clarified your concerns regarding the term "Warning Daily Landslide Hazard." We greatly value the issue you raised and hope that our explanation has provided a clearer understanding of the intentions and methods behind our research.

13. Comment*: The writing should be significantly improved. There were too many grammars and typos. The terms should be defined accurately, for instance, "the third dimension indicator 'rainfall for the day' (R)".*

Response: Thank you for bringing this to our attention. We agree with your suggestion that the term "rainfall for the day" was not accurately expressed. In the revised manuscript, we have corrected it to "daily rainfall" to accurately represent the amount of rainfall on the day of the landslide occurrence.

Additionally, we referred to the article "Three ways ChatGPT helps me in my academic writing," published in Nature, which provided useful editing tips, and utilized the ChatGPT tool to conduct a thorough and precise revision of the manuscript. The revised content has been marked in red font in the manuscript.

Special thanks to you for your insightful and valuable comments in detail.