Response to Reviewer Comments

Dear Editor,

Thank you for providing the reviewer's comments on our manuscript, "**From typhoon rainfall to slope failure: optimising susceptibility models and dynamic thresholds for landslide warnings in Zixing City, China**." We appreciate the reviewer's thorough reading and constructive feedback, which will significantly improve the quality of our manuscript. We have carefully considered each comment and have outlined our responses below:

1. **Comment**: Define all new terms (e.g., IV, CF, FR, SVM, and others) when they first appear in the text, including in the abstract.

Response: We agree. We will revise the manuscript to define all abbreviations and acronyms (IV, CF, FR, SVM, LightGBM, etc.) at their first appearance in the abstract and main text.

2. **Comment**: Why is it necessary to develop a hazard warning system for typhoon-induced landslides in this specific area? Provide a stronger justification. At present, the manuscript only discusses methodological limitations in the introduction. The research gap is unclear, and the rationale for conducting this work specifically in Zixing City is insufficient.

Response: We acknowledge that the justification for the study area needs strengthening. We will revise the introduction to provide a more detailed rationale for focusing on Zixing City. This will include:

Highlighting the historical frequency and impact of typhoon-induced landslides in Zixing City, including specific examples of past events and their consequences (e.g., economic losses, casualties, infrastructure damage).

Emphasizing the vulnerability of the local population and infrastructure to landslides.

Explaining any unique geological, geomorphological, or climatic characteristics of Zixing City that make it particularly susceptible to typhoon-induced landslides.

Clearly stating the research gap: the lack of a robust, typhoon-specific landslide early warning system tailored to the specific conditions of Zixing City.

We will add references to support these points.

3. **Comment**: The manuscript sometimes uses the term “typhoon-specific hazard monitoring systems” and other times “typhoon rainfall-induced landslide hazard warning system”. It would be better to use consistent terminology throughout. I suggest adopting “typhoon-specific rainfall-induced landslide monitoring systems”, as this best reflects the study’s main objective and reduces confusion for the reader.

Response: We agree. We will revise the manuscript to use consistent terminology throughout. We will adopt the term "typhoon-specific rainfall-induced landslide monitoring systems" as suggested.

4. **Comment**: Provide more information about the study area, including its geographical, geophysical, geological, and hydrological characteristics.

Response: We agree. We will expand Section 2 (Study Area) to include more detailed information about Zixing City's:

Geographical location (coordinates, elevation range).

Geophysical characteristics (e.g., topography, slope angles, aspect).

Geological characteristics (e.g., dominant lithology, fault lines, soil types).

Hydrological characteristics (e.g., drainage patterns, river networks, average rainfall).

We will include relevant maps and figures to illustrate these characteristics.

5. **Comment**: Add the units of the factors shown in Figures 2a and 2b.

Response: We will revise Figures 2a and 2b to include the units for each factor (e.g., meters for elevation, degrees for slope angle, mm for rainfall).

6. **Comment**: In the text, the authors state that they used 705 landslide points, but Figure 3 (the framework flowchart) refers to 645. Please clarify this inconsistency.

Response: We apologize for the inconsistency. The correct number of landslide points used in the analysis is 645. The text will be corrected to reflect this. The discrepancy was due to an initial dataset that was later refined.

7. **Comment**: There are many machine learning models available for classification tasks. Why did you choose SVM and LightGBM over others? Please justify this choice.

Response: We will add a justification for choosing SVM and LightGBM in the Methods section. Our rationale includes:

SVM's effectiveness in high-dimensional spaces and its ability to handle non-linear relationships.

LightGBM's efficiency in handling large datasets, its gradient boosting framework, and its ability to capture complex interactions between factors.

We will also briefly mention other commonly used models (e.g., Random Forest, Logistic Regression) and explain why SVM and LightGBM were considered more suitable for this specific application, based on previous studies and the characteristics of our data.

8. **Comment**: Clarify the mechanism for assigning D7 (or other designations) to each landslide point. Specifically, explain how each of the >700 landslide points was linked to one of the 12 rain gauge stations.

Response: We will clarify the process of assigning rainfall data to each landslide point. The process is as follows:

For each landslide point, we identified the nearest rain gauge station using spatial proximity analysis (e.g., calculating the Euclidean distance between the landslide point and each rain gauge station).

The rainfall data from the nearest rain gauge station was then assigned to that landslide point.

We will add a detailed explanation of this process in the Methods section, including the software used for spatial analysis (e.g., ArcGIS) and the criteria for selecting the nearest rain gauge station.

9. **Comment**: Provide detailed explanations of all factors with significant results in Table 2. The current explanations are not sufficient.

Response: We agree. We will expand the explanations of the factors with significant results in Table 2. This will include:

A more detailed description of each factor and its relevance to landslide occurrence.

Explanation of the relationship between the factor and landslide susceptibility (e.g., why higher slope angles are associated with increased landslide risk).

Citing relevant literature to support these explanations.

10. **Comment**: Include the statistical results of the multicollinearity test in the appendix (or supplementary material), and reference them in the main text.

Response: We will include the statistical results of the multicollinearity test (e.g., VIF values) in the Appendix (or Supplementary Material) and reference them in the main text. This will demonstrate that multicollinearity was assessed and addressed.

11. **Comment**: Explain how you normalised the resolution of the different factor maps. Since the primary data have different scales, all layers must be resampled to the same resolution to create the susceptibility map.

Response: We will clarify the process of normalizing the resolution of the factor maps. We used the following procedure:

We selected a common resolution (e.g., 30 meters) as the target resolution for all factor maps.

We resampled all factor maps to this target resolution using a resampling technique (e.g., bilinear interpolation for continuous data, nearest neighbor for categorical data).

We will add a detailed explanation of this process in the Methods section, including the software used for resampling and the rationale for choosing the specific resampling technique.

12. **Comment**: Adjust the font size in Figures 4, 5, and 6. At present, the text appears disproportionately large compared to the maps.

Response: We will adjust the font size in Figures 4, 5, and 6 to improve the visual balance and readability of the figures.

13. **Comment**: Present the AUC values in separate columns for training and testing in Table 3.

Response: We will revise Table 3 to present the AUC values in separate columns for the training and testing datasets. This will provide a clearer indication of the model's performance on both datasets.

14. **Comment**: Avoid the use of unnecessary em dashes (—) throughout the text.

Response: We will carefully review the manuscript and remove any unnecessary em dashes.

15. **Comment**: Ensure consistency across figures. For example, in Figure 6, landslide points are shown only on the first two maps (SVM and LightGBM), whereas in Figure 7, they are shown on all maps. Standardise this approach.

Response: We will ensure consistency in the presentation of landslide points across all figures. We will either show landslide points on all relevant maps or remove them from all maps, depending on which approach provides the clearest presentation of the results.

16. **Comment**: Adjust the sizes of the maps in Figure 8 so that all are presented at the same scale.

Response: We will adjust the sizes of the maps in Figure 8 to ensure that they are presented at the same scale.

17. **Comment**: Why do you describe the final product as a monitoring system? Will it be hosted online for interactive use? If not, it is more accurate to describe it as a hazard zonation map. At times, you also refer to it as a framework. Please avoid such inconsistencies.

Response: We acknowledge the inconsistency in terminology. We will revise the manuscript to consistently refer to the final product as a "hazard zonation map" unless the system is designed to be dynamic and interactive. If it is not hosted online for interactive use, we will avoid using the term "monitoring system." We will also avoid using the term "framework" to describe the final product.

18. **Comment**: Consider evaluating the performance of the warning zonation maps (Figures 8d and 8e).

Response: We agree. We will explore methods to evaluate the performance of the warning zonation maps (Figures 8d and 8e). This may involve:

Comparing the zonation maps to historical landslide data to assess their accuracy in identifying areas prone to landslides.

Using statistical metrics (e.g., precision, recall, F1-score) to quantify the performance of the zonation maps.

We will add a section in the Results and Discussion to present the results of this evaluation.

19. **Comment**: In the discussion, you state that the system "can identify regions where slopes are already saturated due to pre-typhoon rainfall and are thus highly susceptible to failure during the typhoon's high-intensity rainfall phase." How does it achieve this? Is the system dynamic? The manuscript provides no evidence of using dynamic data; all analyses appear to rely on static datasets. Please clarify.

Response: We acknowledge that the statement about identifying pre-typhoon saturation is misleading. The current analysis relies primarily on static datasets. We will revise the discussion to clarify that the system, in its current form, does not explicitly account for pre-typhoon rainfall saturation. We will discuss the potential for incorporating dynamic rainfall data and soil moisture information in future iterations of the system to improve its ability to assess pre-typhoon saturation levels.

20. **Comment**: The manuscript lacks a sufficiently scholarly discussion. Strengthen the reasoning behind your findings by incorporating more relevant references.

Response: We agree. We will significantly strengthen the discussion by:

Incorporating more relevant references to support our findings and interpretations.

Comparing our results to those of other studies on landslide susceptibility and early warning systems.

Discussing the limitations of our study and suggesting directions for future research.

Providing a more in-depth analysis of the implications of our findings for landslide risk management and early warning practices in Zixing City and similar regions.

We believe that these revisions will address the reviewer's concerns and significantly improve the quality of our manuscript. We look forward to submitting the revised version soon.

Sincerely,

Weifeng Xiao
2025.8.27.