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Evaluating the long-term performance for rainfall-induced shallow landslides prediction using a physically-based model in Taiwan

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Rainfall-induced shallow landslides usually occur during typhoons or rainstorms and cause major damage in Taiwan. An efficient prediction could mitigate the loss of life and property. It means that issuing a timely and accurate warning could avoid or reduce the damage before the shallow landslides occur. The objective of this study is to evaluate the long-term performance of rainfall-induced shallow landslides using a physically-based model in Taiwan. The Su-Hua and Southern Cross-Island highways in northeastern and southern Taiwan, suffering major impacts from shallow landslides, were selected as the study areas. The detail hydrologic record and geological information were collected for analysis to test the model performance by running the entire hourly rainfall data. Two comparisons were made to evaluate the model performance: (1) one with observed shallow landslides and (2) another with forecasts form the empirical alert threshold based on rainfall intensity and cumulative rainfall. The analytical results indicated that all of the three methods can efficiently detect the occurrence of shallow landslides (the probability of shallow landslide detection ratio is close to 1.0). However, the empirical alert threshold did not consider the hyetograph (distribution of rainfall depth in the storm event), land cover, geological, geomorphological factors such as slope and contributed area induce the high false alarm ratio (false alarm ratio > 0.5) in the study areas. The proposed physically-based model could efficiently decrease the times of false alarm. Therefore, the proposed physically-based model may be a better choice for predicting the rainfall-induced shallow landslide. The threat score is 0.75 on the Su-Hua highway and 1.00 on the Southern Cross-island highway by proposed physically-based model indicating that the predicted and recorded shallow landslide are in best agreement. The results showed that the long-term performance of the proposed physically-based model is significantly better than the empirical alert threshold. The forecasts of landslide occurrence matched the observed events in time. In conclusion, the physically-based landslide model shows promising potential as a tool to issue real-time shallow landslide warnings and alleviate the loss of life and property.