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Process-based and data-driven approaches for landslide forecasting: A quantitative comparison on regional scale

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In the context of increasing number of landslide disasters, it is important to have efficient Landslide Early Warning Systems (LEWS). LEWS can reduce the risk with sufficient warning time and understanding the hazard and forecasting landslides is an important component of any LEWS. On local or slope scales, an early warning can be achieved with continuous monitoring, but on a regional scale, precise monitoring is still a question due to economical and practical concerns. Regional scale LEWS often relies on data-driven approaches such as rainfall thresholds, while process-based approaches are applied to smaller areas like single basins or watersheds due to complexities associated with precise data collection. The process-based approaches consider both spatial and temporal rainfall triggering factors as inputs, and hence they provide deterministic indices for the stability of a slope, based on both spatial and temporal conditions. In this study, a data-driven approach integrating probabilistic hydro-meteorological thresholds and landslide susceptibility maps (LSM) is used to develop a spatio-temporal landslide forecasting framework for a district in the southern part of India, Idukki. The method is then compared with two process-based approaches (Transient Rainfall Infiltration and Grid-based Regional Slope Stability (TRIGRS) and SHALSTAB) using a receiver operating characteristic curve (ROC) approach, using the landslide data of August 2018. From the analysis, it was observed that the data-driven approach has an efficiency of 81.21 %, while for TRIGRS and SHALTAB, the efficiencies are 72.15 % and 70.10 % respectively. The corresponding area under curve (AUC) values for all three models are 0.92, 0.80, and 0.76 respectively. The results indicate that the proposed data-driven model can perform better than both the process-based approaches, bypassing the complexities associated with physics-based modeling.