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Uncertainty and Sensitivity analysis of a physically-based landslide model

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Rainfall-induced landslides are hazardous to life and property. Rain data sources like satellite remote sensors combined with physically-based models of landslide initiation are a potentially economical solution for anticipating and early warning of possible landslide activity. In this work, we explore the output uncertainty of the physically-based USGS model, TRIGRS (Transient Rainfall Infiltration and Grid-Based Regional Slope-Stability) under both an a priori model parameter specification scenario and a model calibration scenario using a powerful stochastic optimization algorithm. We study a set of 50+ historic landslides over the Macon County in North Carolina as an example regional robust analysis. We then conduct a robust multivariate sensitivity analysis of the modeled output to various factors including rainfall forcing, initial and boundary conditions, and model parameters including topographic slope. Satellite rainfall uncertainty distributions are prescribed based on stochastic regressions to benchmark rain values at each location. Information about the most influential factors from sensitivity analysis will help to preferentially direct field work efforts towards associated observations. This will contribute to reducing output uncertainty in future modeling efforts. We also show how we can conveniently reduce model complexity considering negligibly influential factors to maintain example required levels of predictive accuracy and uncertainty.