An evaluation of uncertainty in extreme landslide-triggering precipitation

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There are many sources of uncertainty that present challenges to skillful rainfall-triggered landslide predictions such as road cuts, vegetation changes, and subsurface soil structure. However, perhaps the largest source of uncertainty in landslide probability estimates is hydrologic uncertainty or uncertainty in the volume and spatial distribution of antecedent soil moisture precipitation volume and precipitation intensity during and immediately preceding the landslide event. One key challenge is the wide range of precipitation measurements represented in different available datasets. Here we investigate the contribution of precipitation uncertainty due to choice of measuremen, and subsequently the uncertainty in modeled soil saturation, to the uncertainty of predicted landslide probability. First, we compare precipitation at 257 landslide locations across the continental US and Canada. Precipitation data are taken from five products that cover disparate measurement methods: satellite (Global Precipitation Mission IMERG Early and Final calibrated precipitation), radar (Multi-Radar Multi-Sensor gauge bias-corrected precipitation), gauge (North American Land Data Assimilation System v. 2 Forcing precipitation), and numerical weather prediction (High-Resolution Rapid Refresh real-time precipitation). These products also cover a range of spatial and temporal resolutions as well as spatial extent and real-time or near real-time availability. In order to evaluate the effects of resolution on the results, we also included a version of each dataset re-gridded to match the coarsest spatial and temporal resolution (NLDAS2), resulting in a total of nine precipitation measurements for the US landslides and five for the Canadian ones. We compare the average intensity, peak intensity at the smallest interval available, duration of the landslide-triggering storms, and return period as measured by each product. Next, we compare the intensity and duration of the precipitation to existing regional Intensity-Duration Threshold landslide prediction models. Finally, we evaluate the soil moisture at each site leading up to the landslide by using each precipitation dataset to drive the VIC hydrologic model. The implications of uncertainty in precipitation for the precision of landslide predictions for different precipitation measurement methods, data resolution, and availability for making real-time predictions are explored.