EGU23-12730, updated on 28 Nov 2023
https://doi.org/10.5194/egusphere-egu23-12730
EGU General Assembly 2023

A public-facing landslide early warning dashboard with sparse inventory data and community input: experience from Sitka, Alaska, USA

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Following a fatal debris flow in 2015, community leaders and technical experts in Sitka, Alaska determined the need for a landslide early warning system. Here, we present the development of a public-facing landslide early warning dashboard that relies on statistical models that incorporate only five reported landslide events and station-based precipitation data between 2002 and 2020. We evaluated strategies for training landslide forecasting models with a limited record of landslide-triggering rainfall events, which is a common limitation in remote, sparsely populated regions. We estimated the daily probability and intensity of potential landslide occurrence with logistic and Poisson regression, respectively, employing both frequentist and Bayesian inference. We compared a series of models trained on cumulative precipitation at timescales ranging from one hour to two weeks using Akaike, Bayesian, and Leave-One-Out information criteria. We found that, in Sitka, three-hour precipitation totals were the best predictor of elevated landslide hazard and adding antecedent precipitation (over days to weeks) did not improve model performance, likely reflecting the rapid draining of porous colluvial soils on steep hillslopes. We then evaluated the best-fit three-hour precipitation models using leave-one-out cross validation as well as by testing a subset of the data. We found that probabilistic models trained with few landslide-triggering and many non-landslide-triggering events could effectively distinguish days with landslides from days without. We used the resulting estimates of daily landslide probability to establish two decision boundaries for three levels of warning. Considering community input, we set the lower boundary such that no missed alarms would have occurred between 2002 and 2020, and the upper boundary such that no false alarms would have occurred. With these decision boundaries, the logistic regression model incorporates National Weather Service quantitative precipitation forecasts into a real-time landslide early warning dashboard system (sitkalandslide.org). This dashboard provides accessible and data-driven situational awareness for community members and emergency managers.