Cities on Volcanoes 9
November 20-25, 2016
Puerto Varas, Chile
'Understanding volcanoes and society: the key for risk mitigation'

Initiation mechanisms for rain-triggered lahars: Timescales, susceptibility and hazard modelling

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Keywords: lahar initiation; erosion; shallow landslide; hazard; susceptibility

Accurate and quantitative information on lahar hazards are essential for reducing the impact of these events. Lahar hazard assessments often rely on historic lahar events and expert elicitation to define model inputs. This results in hazard estimates that do not account for the mechanics of lahar initiation. We have developed a physically based model of rain-triggered lahar initiation by combining shallow landslide and overland erosion models. The model relies on detailed information on terrain, deposit characteristics and rainfall. This model has been used to investigate the initiation of specific events. The occurrence probability, volume and concentration of lahars has also been obtained through combining the model with rainfall intensity-frequency-duration (IFD) relationships. Furthermore, results from a case study suggests that lahar volume is controlled by the hydraulic response time which relates the deposit depth to the speed at which pore pressure propagates through the deposit (hydraulic diffusivity). This timescale demonstrates the importance of rainfall duration, rather than intensity, in triggering of large lahars. This observation is also consistent with, and appears to explain, rainfall intensity and duration (I-D) relationships commonly used to determine lahar triggering thresholds. The lahar initiation approach developed here is anticipated to improve lahar hazard assessments by providing quantitative and reproducible estimates of initial lahar volumes; however, validation is currently limited by input data and the lack of detailed studies in lahar source zones. This study highlights the potential of the initiation model in understanding lahar initiation processes and provides a starting point for discussion, research and data needed to improve models of lahar behaviour.