Geophysical Research Abstracts
Vol. 12, EGU2010-8256-1, 2010
EGU General Assembly 2010

Generalised form of a power law threshold function for rainfall-induced landslides

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The following new function is proposed for estimating thresholds for rainfall-triggered landslides: $I = \alpha_1 A_n^{\alpha 2} D^{\beta}$, where I is rainfall intensity in mm/h, D is rainfall duration in h, A_n is the n-hours or n-days antecedent precipitation, and α_1, α_2, β and n are threshold parameters. A threshold model that combines two functions with different durations of antecedent precipitation is also introduced. A storm observation exceeds the threshold when the storm parameters are located at or above the two functions simultaneously. A novel optimisation procedure for estimating the threshold parameters is proposed using Receiver Operating Characteristics (ROC) analysis. The new threshold function and optimisation procedure are applied for estimating thresholds for triggering of debris flows in the Western Metropolitan Area of San Salvador (AMSS), El Salvador, where up to 500 casualties were produced by a single event. The resulting thresholds are $I = 2322\ A_{7d}^{-1} D^{-0.43}$ and $I = 28534\ A_{150d}^{-1} D^{-0.43}$ for debris flows having volumes greater than 3000 m^3. Thresholds are also derived for debris flows greater than 200 000 m^3 and for hyperconcentrated flows initiating in burned areas caused by forest fires. The new thresholds show an improved performance compared to the traditional formulations, indicated by a reduction in false alarms from 51 to 5 for the 3000 m^3 thresholds and from 6 to 0 false alarms for the 200 000 m^3 thresholds.