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A rainfall intensity-duration threshold for mass movements in tropical highlands: A case study from Badulla District, Sri Lanka

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Mass movements triggered by rainfall, earthquakes, or volcanic eruptions in hill slopes are common all over the world. In Sri Lanka, rainfall is the recognized as a triggering factor for the initiation of slope instability and mass movement. Determination of amount of precipitation required to trigger slope failures is very important to establish regional early warning systems for the occurrence of mass movement. This study was focused to establish rainfall intensity-duration models to identify the rainfall threshold for mass movements in tropical Highlands in Badulla District, Sri Lanka. For this study, data of forty-four (44) rainfall events that caused the same number of land-slides in Badulla District from year 1986 to 2014 were compiled. For each mass movement event, the exact location of the landslide and the time of initiation of the slope failure was obtained from the National Building Research Organization (NBRO) of Sri Lanka. Then causative amount of mean rainfall (mm) was estimated by interpolating rainfall amount of corresponding rain gauge stations and consequent Duration (D, hr) obtained from the Meteorological Department of Sri Lanka. Corresponding Intensity (I, mm/hr) for each of the 44 landslide events were calculated by dividing the amount of rainfall by corresponding duration. A graph plotted $\ln(I)$ Vs $\ln(D)$ indicated that the rainfall threshold relationship fits to the log linear model of the exponential function, $\ln[I] = \ln[\alpha \cdot D^{-\beta}]$. A threshold fitted to average rainfall expressed as $\ln(I) = 3.9882 - 0.1570 \ln(D)$. The constructed I-D curve revealed that short duration (< 2 h) and high-intensity (> 54 mm/hr) rainfall events can potentially trigger the mass movements. However, long-duration (> 8 hr) and low-intensity (< 25 mm/hr) rainfall events may also trigger mass movements in Badulla district. When compared to global threshold values, Sri Lankan mass movements triggering threshold intensities are fairly high. It confirms that within Badulla district, mass movements are triggered only by very intense and long duration rainfalls events.

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