Landslide Early Warning in a Data Sparse Region, Challenges and Way Forward: The case of Idukki, Western Ghats, India

Abstract: The Idukki district in Kerala, India, is one of the densely populated districts with a population of 1.11 million and a population density of 254 inhabitants per sq. km. Bordering the Western Ghats, Idukki exhibits two physiographic divisions viz., midlands (7.5-75 m amsl), and highlands (>75 m amsl). Due to the high population density and relatively low flat terrain, people are forced to move to the highlands, increasing anthropogenic stress in the slopes. Coupled with more than 4000 mm annual rainfall, most of which occurs in a five-month monsoon period from June to October, Idukki is a hotspot for frequent and intense rain-triggered landslides. An anomalously high rainfall event in 2018, ranging from the 1st of June to the 29th of August, with a departure of 36% above the average rainfall measure, triggered 2,223 landslides. The succeeding years saw similar landslide activity, with specific landslides having an unforeseen impact on life and property. The Pettimudi landslide of 2020 in Idukki district, killing 62 people, the Kavalappara landslide of 2019 that killed 59 people, in Wayanad, another district bordering the Western Ghats, and the Koottikkal landslide of 2021, in nearby Kottayam district that killed 13 people, all point towards the continuous doom the highland dwelling population of Kerala are subjected to for years. Compounding the risk factor is the lack of robust data that makes efficient modeling of landslides and any credible attempt at their early warning highly challenging. The Idukki district has four operational rain gauges for more than 4000 sq. km. There is also a lack of fine-scale geophysical data to develop accurate slope stability models. To build a robust database on rainfall and geophysical measures, two major steps were carried out: (i) the sparse rain gauge network was extended by installing eight more rain gauges in optimal locations, (ii) planning a 2D ERT (Electrical Resistivity Tomography) geophysical time-lapse survey over the wet and dry periods to collect slope shear strength parameters. The optimal locations for rain gauges were identified using a multi-criteria analysis that utilized landslide density maps, slope stability maps, land cover maps, and satellite precipitation measures. The GPM IMERG (Global Precipitation Monitoring Integrated Multi-Satellite Retrievals for GPM) precipitation records were downloaded, and their cumulative measures over the monsoon months were averaged over five years from 2014 to 2019. The GPM IMERG dataset captures the spatial variability of rainfall but underpredicts the quantity of precipitation, especially in orographic regions like the Western Ghats. Thus, a gauge adjusting process called conditional merging was applied to the GPM IMERG product with the aid of the rainfall measures from the existing rain gauges. This process combines the accuracy of rain gauge measures and spatial variability of GPM IMERG. The eight new rain gauges installed are already operational and rainfall measures for every 30 minutes are available in a cloud-based server. 2D ERT survey for the wet period was completed from October 2021 to January 2022, and 18 profiles were collected. The resistivity inversion will be used to compute shear stress and thereby used to improve existing slope stability models. This project is funded by the Society of Exploration Geophysicists Geoscientists Without Border (SEG-GWB).