VALIDATION OF RAIN-INDUCED FAILURE OF UNSATURATED COLLUVIUM SLOPES: A CASE STUDY

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Landslides are a major global hazard that affects human and economic losses every year. The spatial and temporal distribution of landslides is one of the fundamental tools for landslide susceptibility, hazard and risk assessment to establish land use policies and mitigation measures. Sri Lanka has been identified as a hotspot for rainfall-induced landslides, considering the heavy and prolonged rainfalls received during tropical monsoon seasons. Further, favourable preparatory factors for landslides such as ground conditions, geomorphology and anthropogenic activities prevails in the country. The significant weathering in the tropical region due to temperature and humidity can form thick soil layers and geological structures of high variability. The ground conditions in the central hill country in Sri Lanka is highly complex due to the weathering of the crystalline metamorphic rock of Precambrian age which exists in this region. Colluvium soils are a heterogeneous mixture of soil and rock particles accumulated at the toe area of the slope due to previous downslope movements under gravity. Movements within these layers can get easily reactivated due to porewater pressure variations or human interventions. Currently, landslide susceptibility in the mountainous regions of Sri Lanka has been identified and mapped based on a model considering six terrain factors and factor classes on the scale of 1:10,000 and 1:50,000. Landslide early warnings are issued for the high susceptible areas based on the empirical thresholds identified for the whole nation and these can lead to false alarms. Hence it is vital to implement early warning based on rainfall thresholds identified using process-based methods, which is more accurate and reliable. In this study, the suitability of limit equilibrium (LE) and finite element (FE) methods to assess slope stability with rainfall infiltration was evaluated using two case studies. The first case study was conducted on the Kithulgala landslide which occurred on 15th May 2016 in Kithulgala area along the Avissawella-Haton main road. Sobasiripura landslide which occurred on the same day in Hanwella North was selected as the second case study. For the LE study SLOPE/W software was utilised along with the SEEP/W software for FE seepage analysis. Alternatively, PLAXIS 2D software was used to conduct a FE based coupled hydro-mechanical stability analysis. Rainfall for 10 days prior to the failure was considered for the analysis to allow the antecedent rainfall conditions and the equilibrium of the groundwater table. From the results of the study, it was evident that both methods can be used to effectively verify the failure and triggering rainfall that closely resemble the failure surface identified at the site. The failure occurred along the colluvium-weathered rock interface in both cases and the matric suction loss in the colluvium layer was the main reason for the failure rather than the rise of the groundwater table.

Keywords: Finite element analysis, Limit equilibrium, Landslide, Rainfall, Slope stability

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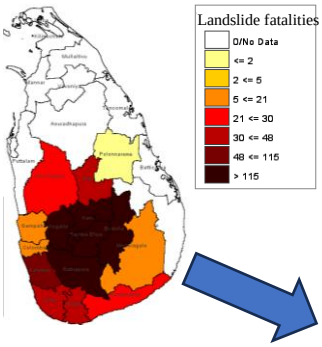
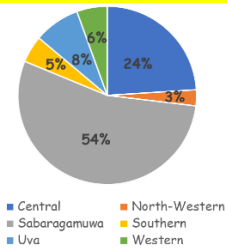
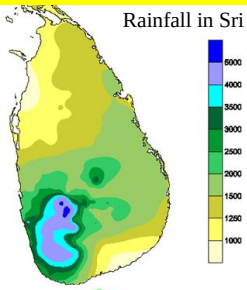
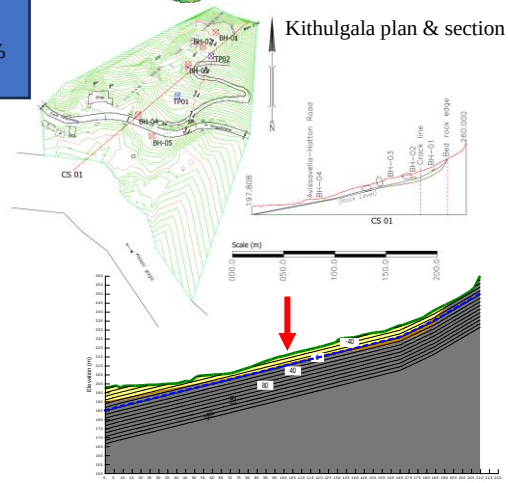


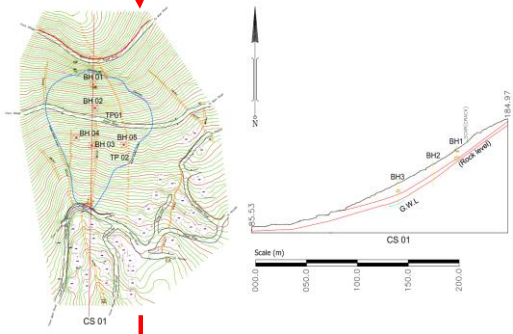




10 districts-30% of total land area & 35% of the population

Kithulgala plan & section view





Sobasiripura plan & section view