EGU22-8382
https://doi.org/10.5194/egusphere-egu22-8382
EGU General Assembly 2022

Co-seismic Landslide Susceptibility Modelling Based on the Fibre Bundle Model

Yuanjing Chen, Bastian van den Bout, Cees van Westen, and Luigi Lombardo
University of Twente (UT), Faculty of Geo-Information Science and Earth Observation(ITC), Applied Earth Sciences (AES), Enschede, Netherlands (y.chen-6@utwente.nl)

Co-seismic landslides are triggered by strong ground shaking in mountainous areas, resulting in threats to human activity and infrastructure. Co-seismic landslide susceptibility assessment plays a vital role in disaster prevention and mitigation. However, existing physical models for susceptibility assessment do not involve the dynamic nature of seismicity and the progressive processes of landslide initiation. The challenge of linking the development of internal cracks caused by dynamic seismic loading with the process of localized failure from abrupt mass movement will be addressed by a new physically based model that bridges the limit-equilibrium stability analysis with the fibre bundle model (FBM), which the FBM is a mathematical framework to simulate the highly nonlinear behaviour of the progressive damage and breakdown of disordered media statistically. Each hillslope in a catchment is depicted as an assembly of virtual bundles of fibres that represented the soil columns. The vibrating seismic load exerted on the mechanical connections causes the fibres to break progressively until restraining forces are exceeded. Since cracks occur at the interface of different soil layers, load redistribution occurs from the broken column to its neighbours through intact mechanical linkages, resulting in a new mechanical state. When the ground columns lose their balance, a load-bearing column can liquefy and trigger a landslide which could spread downstream. primary purpose of this study is to develop a semi-physical model for simulating the earthquake-induced landslides by incorporating earthquake time histories into a spatially distributed slope stability method on the basis of the FBM to represent the localized failure occurring prior to landslide release or after the ground shaking. The study has four specific objectives: (1) Development of a model framework assembled with the limit-equilibrium analysis and FBM for seismic effect simulation on hillslopes; (2) Development of an efficient regional method for physically based simulation of co-seismic slope instability; (3) Derive a method for predicting the increase in susceptibility to rainfall-induced landslides after seismic shaking, taking into account the soil healing process; (4) Determine the effect of vertical variation in soil strength parameters and groundwater table depth on the fibre bundle model by implementing a multi-layer approach. The proposed model framework linking limit-equilibrium stability analysis and fibre bundle model should sufficiently consider the dynamic characteristics of seismicity and progressive slope failure processes of landslide triggering.