Numerical simulation of slope stability and landslides under different loadings in the Karongi district, western Rwanda

Sylvain Barayagwiza*[1], Catherine Meriaux*†[1], and Alberto Armigliato*‡[2]

[1]ICTP-East African Institute for Fundamental Research(ICTP-EAIFR)/ University of Rwanda – Rwanda

[2]The University of Bologna – Italie

Résumé

Abstract:
The East African Rift (EAR) provides a unique setting to study interactions between geological processes, ecosystems, and societies. Like other tropical parts of the world, in western Rwanda, within the western branch of the Rift, steep slopes, high rainfall, and seismicity combine to contribute the area most vulnerable to slope failures and landslides. The central part of western Rwanda, Karongi district is the region most affected by landslides. Several investigations have been carried out recently to map landslide susceptibility in Rwanda, using various methodologies. On the other hand, there has been a lacks of physical-based slope stability model resulting in inaccurate landslide forecasting, especially under different forcing factors.

This study explores-slope instability and landslides in the Karongi District through the integration of numerical modeling. High-resolution Digital Elevation Model (DEM) was used in QGIS and simulate slope stability in Scoops3D software using the Limit Equilibrium Method (LEM) namely Bishop's Simplified Method for calculating Factor of Safety (FOS) under a range of conditions in soil characteristics, pore water pressure ratio, and seismic loading which in this case was represented by a Peak Ground Acceleration (PGA) of 0.065g, linking regional tectonic dynamics with localized risk. Historical landslide data between 2000-2019 allowed the validation of the predictive model. The modeled unstable zone having low FOS values (FOS < 1.0) align well with historical landslide locations in the North-West part of the study area and the other few regions of the Eastern part, hence showing the reliability of the model for identifying high-risk zones. The findings of this study also highlighted a horseshoe-shaped zone in the southeastern part of Karongi district that had shown low FOS values, with no recorded historical landslides. By geophysical modeling of slope stability and landslides, the research shows how interdisciplinary activities can make hazard mapping more effective and inform risk reduction activities.

Mots-Clés: East African Rift: Slope stability and Landslides

*Intervenant

†Auteur correspondant: c.a.m.d.meriaux@gmail.com

‡Auteur correspondant: alberto.armigliato@unibo.it