Geophysical Research Abstracts
Vol. 20, EGU2018-16682, 2018
EGU General Assembly 2018

Landslide susceptibility and rates in the Mount Elgon region, Uganda

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Studies on landslide risks and fatalities indicate that landslides are present on all continents and are a global threat to humans, infrastructure and the environment. While this is certainly also the case for Africa, this continent remains underrepresented in landslide research. Within Africa, the East African Rift Zone is one of the regions most prone to landsliding, including Mount Elgon in Eastern Uganda. The extinct shield volcano is characterized by steep slopes, intense precipitation and fertile lands supporting a dense population. As a result, landslides frequently damage private property and infrastructure and cause many fatalities. Apart from the number of landslides, also their size determines the extent of negative consequences. However, we have no clue about the relation between landslide susceptibility and landslide size or rates [ton/km^2/y]. Therefore, this research aims (1) to produce a first regional landslide inventory, (2) to construct a first landslide susceptibility map for the entire Mount Elgon region and (3) to investigate the relationship between landslide susceptibility and landslide rates.

During several field campaigns in the past 15 years and based on landslide mapping in Google Earth we compiled a calibration dataset of 638 landslides of which 139 rockfall sites. Additionally, an independent validation dataset of over 400 landslides was produced, to validate the resulting landslide maps. We used Monte Carlo simulations that selected different subsets of the calibration dataset, tested the significance of the considered environmental variables (topography, lithology, rainfall and soil moisture) and evaluated the performance of the fitted multiple logistic regression model against another subset of this calibration data.

Based on these analyses, we constructed two landslide susceptibility maps, at 30 meter resolution, for the entire Mount Elgon region: one for all landslide types and one for rockfalls only. In both maps, topography and lithology were the most significant variables. Also soil moisture, modeled by the Community Land Model (CLM), further improved the model predictions. The models explain about 55% and 85% of the observed variance in landslide occurrence for all landslide types and for rockfalls respectively. These models are valuable tools for regional planning and risk reduction strategies. Landslide size only slightly increases with increasing landslide susceptibility. Therefore, larger landslide rates associated with higher landslide susceptibilities could be expected to result from larger landslide numbers rather than from larger landslides.