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Using Newmark Displacement and cluster analysis of topographic factors to reveal possible seismic landslide triggers at Mount Oku, Cameroon

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Attributing seismic or climatic landslide triggers in retrospect is an unresolved problem in landslide science. Particularly in areas with scarce seismic and rainfall records or in the case of delayed slope response to earthquakes it is often difficult to identify the landslide trigger. Understanding the trigger mechanism is however essential for tailoring landslide risk reduction measures.

We here present an approach coupling the geotechnical Factor of Safety (FS) and Newmark Displacement (ND) methods with the k-means clustering unsupervised machine learning technique to reveal the contributions of seismic and climatic factors in the topographic context to landslide occurrences at the western flank of Mount Oku in Cameroon. The study area is located along the Cameroon Volcanic Line, a seismically active region in Central Africa, where small earthquakes and landslides are observed regularly. Only in a few cases, a clear connection between earthquakes and landslides has been demonstrated, while rainfall is usually considered the main landslide trigger.

Based on geomechanical parameters assessed in fieldwork and laboratory tests, we first calculated the static FS and the ND for the study area for different water saturation and landslide depth scenarios and a magnitude 5.2 earthquake at 10 km distance. For 179 landslide polygons mapped in the study area, we assessed the resulting FS and ND values, as well as some topographic factors such as the slope angle, slope aspect, curvature, distance to ridges, and distance to rivers. In a k-means cluster analysis, different combinations of two and three topographic factors were analyzed regarding their ability to identify clusters of earthquake-triggered landslides.

The combination of the two parameters distance to ridges and distance to rivers turned out to have the best clustering performance and it revealed a cluster of landslides triggered at low

distances to ridges and higher distances to rivers with high ND values in the dry case, indicating an influence of seismic acceleration on the formation of these landslides.