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Multidisciplinary approach for the characterization of landslides in volcanic areas – a case study from the Palma Sola-Chiconquiaco Mountain Range, Mexico

Martina Wilde (1), Sergio R. Rodríguez Elizarrarás (2), Wendy V. Morales Barrera (2), Daniel Schwindt (3), Matthias Bücker (4,5), Adrián Flores Orozco (5), Emilio García García (6), Carlos Pita de la Paz (6), and Birgit Terhorst (1)

(1) Institute of Geography and Geology, University of Wuerzburg, Würzburg, Germany (martina.wilde@uni-wuerzburg.de), (2) Institute of Geology, National Autonomous University of Mexico, Mexico City, Mexico (srre@unam.mx), (3) Geomorphology and Soil Science, Technische Universität München, Science Center Weihenstephan, Freising, Germany (daniel.schwindt@tum.de), (4) Department of Geophysics, Steinmann Institute, University of Bonn, Bonn, Germany (buecker.matthias@yahoo.de), (5) Department of Geodesy and Geoinformation, Geophysics Research Group, TU-Wien, Wien, Austria (adrian.flores-orozco@geo.tuwien.ac.at), (6) Geotem Ingeniería S.A. de C.V., Mexico (cpita@geotem.com.mx)

The Palma Sola-Chiconquiaco mountain range, situated in the State of Veracruz, Mexico, is highly susceptible to landslides, which is evidenced by the high frequency of landslide events of different sizes. The study area is located near the Gulf of Mexico coastline in the eastern sector of the Trans Mexican Volcanic Belt. There, landslide triggers are intense rainfalls related to tropical storms and hurricanes.
Steeper slopes are commonly affected by rockfalls, whereas moderate slopes, covered by massive slope deposits, are affected by shallow as well as deep seated landslides. Some of the landslides in the slope deposits reach dimensions of more than 1000 m in length and depths of over 30 m. The heterogeneous parent material as well as older slide masses hamper the detailed characterization of the involved materials. Therefore, in this study, a multidisciplinary approach is applied that integrates geomorphological, geological, and geophysical data. The aim is the reconstruction of process dynamics by analyzing the geomorphological situation and subsurface conditions before and after the event. The focus lies on the identification of past landslide areas, which represent areas with high susceptibility for the reactivation of old slide masses. Furthermore, the analysis of digital terrain models, generated before the landslide event, indicate initial movements like extension cracks, which are located close to the current scarp area.
In order to characterize the subsurface of slide masses geophysical investigations are applied. The geophysical survey consists of a total of nine profiles covering relevant key features of the large affected area. Along these profiles, electrical resistivity tomography (ERT) and seismic refraction tomography (SRT) data were collected. Both, electrical and seismic images reveal a sharp contrast between relatively loose and dry material of the slide mass (high resistivities and low seismic velocities) and the former land surface that is characterized by significantly reduced resistivities and higher seismic velocities. This contrast allows to establish the thicknesses of slope deposits and geological layers along all geophysical profiles.
Furthermore, the investigations are complemented by a high resolution digital terrain model of the landslide and its surroundings, which was reconstructed from orthophotos derived from unmanned aerial vehicle photogrammetry.