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Geotechnical and hydrological characterization of pyroclastic soils in Povoação County (S. Miguel island, Azores) for modelling rainfall-triggered shallow landslides

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Pyroclastic materials, mainly provided by the Furnas Volcano, cover a wide area of the Povoação County (S. Miguel Island, Azores) and are subject to recurrent slope instability phenomena triggered by intense rainfall events. In this region, the forecast of both temporal and spatial distribution of shallow landslides is of primary importance for the land use management and to implement early warning systems within the civil protection framework. The development of physically based models, namely the infinite slope stability analysis coupled with hydrological models, should be based on the rigorous and exhaustive characterization of the geotechnical and hydrological parameters of slope materials. The present work focuses on the geotechnical and hydrological characterisation of the pyroclastic soils composed mainly by pumice (silt to gravel grain size particles) that compose 5 unstable slopes in the Povoação County. Geotechnical characterization of pyroclastic deposits has been accomplished by laboratory and in situ tests. Several consolidation drained (CD) direct shear tests were performed on undistributed samples from different stratigraphic layers. Shear strength results have shown two distinctive families of internal friction angle, ranging between 27-32 degrees and 34-43 degrees, respectively. Effective cohesion ranges from 0 to 23 kPa. Specific Gravity (Gs) ranges between 2.21 and 2.90, and Dry density ranges from

0.57 to 1.3 g/cm3. Porosity (n) ranges between 50 and 74% and void ratio (e) from 1.02 to 3.29. The majority of the analysed samples are non plastic or slightly plastic soils using standard Atterberg limits testing. The saturated hydraulic conductivity (Ksat) measured using both in situ (using a double ring constant head permeameter) and laboratory tests (using a constant head permeameter), ranged between 10-3 m/s and 10-6 m/s. These values are in good agreement with the (Ksat) computed from a long term oedometer test. For unsaturated conditions, the Soil-Water Characteristic Curves (SWCC) calculation and unsaturated hydraulic conductivity tests are currently ongoing. To provide a preliminary assessment of slope-failure conditions, we applied a hydrological model coupled with the infinite slope analysis to evaluate the timing of occurrence of shallow slope movements in a test slope that has been monitored during the last 5 years. This application will allow the evaluation of future scenarios accounting for the variation of the pressure head response, related to transient rainfall regime and the hydrological properties of the soil that affect slope stability.