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Geotechnical investigation and dynamic modelling of the 30 April 2006 debris flows on Ischia Island

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Ischia is an active volcanic island located in the Tyrrhenian Sea, approximately 30 km WSW from the city of Naples in Southern Italy. On 30 April 2006, following several hours of rainfall, four small soil slips-debris flows were triggered on the slopes of Mt. Vezzi (ca. 400 m a.s.l.), in the SE portion of the island. Notwithstanding their modest size, the flows caused the deaths of 4 people, forced the evacuation of another 250 inhabitants and destroyed several buildings. These types of events are aggravated by the largely uncontrolled urban expansion on the island, with buildings constructed at the base of steep slopes and the transformation of many stream channels into access roads leading to the buildings. Coupled with the periodical recurrence of soil slip - debris flow type events, the entire island is exposed to high risk conditions. The steep slopes of Mt. Vezzi are conditioned by the volcanic activity of the last 10.000 years: a 1 - 2 m thick soil derived from the weathering of pyroclastic material overlies thick fallout deposits produced by the last eruptions. The debris flows initiated as soil slips at the soil - fallout interface, in hollows with slope gradients ranging between 35° - 40°, and quickly transformed into flows that reached the floodplain at the base of the hill, finally coming to a stop in a low gradient road. The flows started at elevations ranging between 310 and 350 m and stopped at approximately 80 m, corresponding to travel angles of 20-24°. The volumes of the single events ranged from 2000 - 5000 m3. Two field campaigns carried out immediately following the events were focused on collecting geotechnical data in the source area (angle of internal friction, unit weight, water content, grain size, etc.). Material shear strength was determined both in the laboratory on reconstituted samples and in-situ by means of Borehole Shear Tests (BST) coupled with a tensiometer for the measurement of matric suction. Soil strength was assessed both in partially and totally saturated conditions. Soil hydraulic conductiv-

ity was quantified by means of in-situ constant head permeameter tests. These highlighted a marked contrast in permeability between the soil and the underlying volcanic ash layer. Saturated hydraulic conductivity values ranged from 1.2 x 10-5 m/s in the former to 6.2 x 10-8 m/s in the latter. Soil slip triggering conditions were analyzed on the basis of precipitation data related to the 24 hour period prior to the event using a coupled seepage-stability analysis. Back-analyses of the debris flows were used to perform dynamic modelling of the event. DAN-W and FLO-2D were the models selected for this purpose. Calibration was based on deposit thickness and areal extension, and on flow runout and velocity. This data was used to model potential events the source areas of which were identified from fieldwork in order to delineate inundation areas, velocities and deposit thicknesses. The rheological parameters derived from the modelling were comparable to those obtained by Revellino et al (2004) for the Sarno debris flows of May 1998, events which are quite similar to those observed at Ischia.