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IPL Project (IPL - 245) Annual Report Form 2020

1 January 2019 to 31 December 2019

1. Project Number (approved year) and Title:
   IPL-245 (2019) Laboratory physical modeling of rainfall, slope deformation and landslides triggering.

2. Main Project Fields

   (1) Technology Development

   A. Monitoring and Early Warning,

   (4) Mitigation, Preparedness and Recovery

   A. Preparedness, B. Mitigation

3. Name of Project leader

   Eng. Giovanna Capparelli
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   CAMILab (Laboratory of Environmental Cartography and Hydraulic and Geological Modeling),
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   Core members of the Project
   Names/Affiliations: (4 individuals maximum)

   - **Prof. Eng. Pasquale Versace /** University of Calabria, DIMES, CAMILab, CINID (Interuniversity Consortium for Hydrology).
   - **Eng. Gennaro Spolverino /** University of Calabria, DIMES, CAMILab.
   - **Eng. Emilia Damiano** / University of Campania Luigi Vanvitelli, DICEA.
   - **Prof. Eng. Roberto Greco** / University of Campania Luigi Vanvitelli, DICEA.
   - **Prof. Eng. Lucio Olivares** / University of Campania Luigi Vanvitelli, DICEA.

4. Objectives: (5 lines maximum)

   The project aims to understand the mechanisms that control hydraulic processes in unsaturated soils, responsible for triggering landslides, by experimenting with a slope physical scale model.

5. Study Area: (2 lines maximum)

Tests will be carried out at the University of Calabria using pyroclastic soils sampled around Vesuvio Vulcano area (South Italy)

6. Project Duration (1 line maximum)

3 years

7. Report

1) Progress in the project: (30 lines maximum)

Two Tests have been carried out (T1 and T2) and a third test (T3) which is now being completed.

Pyroclastic soils, collected in Sarno area, (South Italy), was used because these are soils highly susceptible to the triggering of mudslides and over the years.

As regard test T1, the slope was formed by a layer of volcanic ash 0,20 m thick, 1 m width 1,50 m long. This geometry allows the deposit to be assimilated to an indefinite slope. At the base of the model there was an impervious layer in order to simulate conditions similar to those of a natural slope (impermeable bedrock). Inside the artificial slope, 12 tensiometers were installed to measure suction, and six TDR probes to measure volumetric water content. On the bottom of the channel three neutral pressure transducers were arranged, while four laser displacement transducers were installed to measure displacements perpendicular to the slope surface. Rainfall was generated with a sprinkler system placed about 100 cm above the sliding surface. The nozzles were arranged so as to ensure rainfall uniformity and avoid surface erosion. As regard T2, same flume test was fixed, the same sensors inside the artificial slope were installed but the soil was characterized by a different porosity.

In terms of main results:

- failure of T1 test, more compacted deposit, did not trigger a mud-flow but it took the form of a progressive erosion of the more superficial soil layers, initially and chiefly concentrated in the downslope zone, where the intense sub-surface flow resulted in conditions of greater moisture being reached
- T2 test, characterized by high porosity, as failure a mud-flow was generated. Figure 1 shows the appearance of the deposits at the end of the two tests.

Figure 1: Deposit at the end of the test. a) Test 1. b) Test 2.

2) Planned future activities or Statement of completion of the Project (15 lines maximum)

Currently a new test has been prepared, reconstructing a stratified deposit, formed by a layer of pumice, covered by a layer of volcanic ash, in order to determine the influence of these layers on the evolution of the landslide. The pumice layer is 5cm thick, while the ash layer is 15cm thick. Figure 2 shows the reconstruction of the two layers.

It is equipped with tensiometers for measuring the suction inside the slope, pressure transducers at the bottom of the flume to measure positive water pressures, TDR system for measuring volumetric water content and laser-displacement transducers for measuring surface displacements in the orthogonal direction to the sliding plane. The presence of two independent channels also makes it possible to analyze the propagation phase also and allow the positioning of impact structures to evaluate any mitigation strategies. After the calibration of all the sensors and soil characterization, the intent is to observe and interpret laboratory experiments to reproduce and simulate the phenomenon with mathematical model.

3) Beneficiaries of Project for Science, Education and/or Society (15 lines maximum)

Rainfall-induced landslides cause diffuse damage to people, structures and infrastructures. A good predictive model can allow the implementation of an equally good warning system, reducing the risk caused by such phenomena. The main beneficiaries will be the national civil protection, all and those, academic and public agencies, who implement warning systems o deal with disaster risk reduction.

4) Results: (15 line maximum, e.g. publications)

Spolverino G., Capparelli G., and Versace P. (2019). *An Instrumented Flume for infiltration process modeling, landslide triggering and propagation*. Geosciences 2019, 9(3), 108; https://doi.org/10.3390/geosciences9030108.

Capparelli G., Napoli P., Spolverino G., Versace P. (2019). *Laboratory Physical Model for infiltration processes modeling, landslides triggering and propagation*. ISBN 978-88-498-5635-4.

Capparelli, G., Damiano, E., Greco, R., Olivares, L., Spolverino, G. *Physical modeling investigation of rainfall infiltration in steep layered volcanoclastic slopes* (2020) Journal of Hydrology, DOI: 10.1016/j.jhydrol.2019.124199