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Consideration notes on the critical rainfall threshold to predict the triggering of pyroclastic flows

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This paper reports the results of a theoretical analysis carried out designed to evaluate meteoric events that can be defined as critical since they are capable of triggering landslides in partially saturated pyroclastic soils. The study refers to analyses of the pyroclastic covers in the area of Campania, Italy, which is often affected by complex phenomena that begin as rotational or translational slide or fall and evolve into rapid landslides as earth-flows (debris or mud as function of grain size distributions).

The prediction of triggering factors is of extreme importance for the implementation of civic protection schemes, given the dynamic features that characterize these phenomena during their evolution.

The study highlights the fact that it is impossible to define the criticality of a meteoric event by means of empiric laws that correlate the mean intensity of rainfall and the "mean" duration of the event.

However, it is possible to identify the criticality of a meteoric event in partially saturated soils, by means of a more complex approach which is physically conditioned. The rainfall is critical if it is capable of causing the rainwater to filter into the subsoil into "weak" layers where there is an increase in the specific volume with a significant reduction of the suction and resistance to the shear of the terrain (Fredlund et al., 78).

This study focuses exclusively on seepage, regardless of the resistance of the soil, by analyzing, among various aspects, the phenomenon using a simplified subsoil model. For this study, it is assumed that the rainfall is critical when it is capable of saturating the soil cover for a predefined summit thickness Zc.

For the purposes of this study, value Zc could be given an arbitrary value. This has been assumed to be 1m, considering that the experimental evidence has shown that rapid flows, at least when triggered, prove to be superficial. The other hypotheses are:

- 1D infiltration,
- Rigid solid skeleton;
- Atmospheric air pressure;
- Homogenous soil;
- Absence of evapotranspiration.

The Richard's Equation, which regulates the process, has been solved using both the FEM HYDRUS 1D code (Symunek et al, 2005) and a code prepared by the current authors. The characteristic curve and the saturated permeability have been experimentally calculated at the DIGA. The different initial suction conditions are the result of the numerous in situ measurements made by the authors (Scotto di Santolo et al., 2005).

The results obtained show that the criticality of a pluviometric event, besides depending on the intensity of rainfall and the average duration, also depends on numerous factors such as the following:

- Water retention curve and permeability;
- Initial suction conditions
- Forms of temporal development of the rainfall, that is the law i(t) between intensity and time t (the analyses were carried out on the basis of average hours of rainfall).

With reference to this latter aspect, assuming rainfall with a random distribution with a constant total average and height, it is possible to calculate the probability of the event being triggered, for each temporal evolution of the meteoric event.

All these considerations suggest that there is no single model of "critical rainfall" but that each one is valid only on the basis of local conditions. Moreover, it is demonstrated that their use is extremely uncertain and requires the definition of rainfall through two mean parameters such as intensity and duration, regardless of the evolution of

the pluviometric event.