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Hydrological modelling of slopes from field monitoring data

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A simplified hydrological model of a steep slope covered with loose granular pyroclastic deposits is presented. The slope is located in the mountains northern of Naples, and the soil cover, constituted by layers of loose volcanic ashes and pumices with a total thickness of 2.5m, lays upon a fractured limestone bedrock. At the interface between the bedrock and the soil cover, a layer of weathered ashes, with significant clay fraction, is sometimes observed. The slope has a fairly regular inclination of 40°, and is covered by chestnut woods and thick brushwood growing in late spring. The inclination of the slope is comparable with the internal friction angle of the ashes, thus the equilibrium is possible thanks to the contribution offered to the shear strength by the soil suction in unsaturated conditions. Indeed, in December 1999, a landslide was triggered by prolonged and intense precipitations. As it frequently happens with similar pyroclastic covers, the triggered slide exhibited a flow-like behavior, covering 2km in few minutes, heavily hitting the nearby town of Cervinara (AV).
Since then, the slope has been constantly monitored, and during the last two years an automated station with seven TDR probes for the measurement of soil water content, eight tensiometers for the measurement of soil suction, and a rain gauge, has been operating. The data, collected every two hours, allowed getting more insight of the hydrological behavior of the slope and building up an effective hydrological model.
In the model, the layered soil profile has been replaced with a single homogeneous layer, with water retention curve estimated by coupling the values of water content and suction measured at various depths.
A seasonal top boundary condition has been introduced, related to the annual cycle of the vegetation: the observed precipitations quickly caused changes of soil suction at the depth of -50cm during the entire year, with the exception of the period between the end of May and the early August.
To reproduce the observed behavior of soil suction at the bottom of the profile, a linear reservoir model has been introduced as bottom boundary condition, related to the presence of a small aquifer in the fractured bedrock, which water table, affecting the hydraulic conditions of the soil cover, rapidly deepens during the dry season.
The developed model, calibrated with the data of one year of observation, satisfactorily reproduces the observed soil hydraulic behaviour also during other periods.