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Physically-based quantitative analysis of soil erosion induced by heavy rainfall on steep slopes

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Heavy rainstorms cause either shallow landslides or soil superficial erosion in steep hillslopes covered by coarse unsaturated soils (Cascini et al., 2013), even over large areas (Cuomo and Della Sala, 2013a). The triggering stage of both phenomena is related to ground infiltration, runoff and overland flow (Cuomo and Della Sala, 2013), which are key processes to be investigated. In addition, the mobilization of solid particles deserves a proper physical-based modeling whether a quantitative estimation of solid particles discharge at the outlet of mountain basin is required.
In this work, the approaches for soil superficial erosion analysis are firstly reviewed; then, a relevant case study of two medium-sized mountain basins, affected by flow-like phenomena with huge consequences (Cascini et al., 2009) is presented, which motivates a parametric numerical analysis with a physically-based model carried out for a wide class of soil properties and rainfall scenarios (Cuomo et al., 2013b).
The achieved results outline that the peak discharge of water and solid particles driven by overland flow depends on rainfall intensity while volumetric solid concentration within the washout is related to the morphometric features of the whole mountain basin. Furthermore, soil suction is outlined as a key factor for the spatial-temporal evolution of infiltration and runoff in the basin, also affecting the discharge of water and solid particles at the outlet of the basin. Based on these insights, selected cases are analyzed aimed to provide a wide class of possible slope erosion scenarios. It is shown that, provided the same amount of cumulated rainfall, the sequence of high and low intensity rainfall events strongly affects the time-discharge at the outlet of the basin without significant variations of the maximum volumetric solid concentration.

References

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