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Short-term hydrologic response of a hillslope

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A consolidated geotechnical approach for shallow landslide triggering in a site assumes that a slope safety factor is strictly related to the local values of soil water pressure, i.e. soil matric potential [Terzaghi, 1925]; this in turn must be provided by an appropriate modelling, in particular an hydrological model should give the watershed response due to a several rainfall event in terms of soil matric potential. In recent years simplified analytical or numerical integrations of Richards' Equation have been applied by many authors to solve the problem: see, for example, the linear diffusion model proposed by Iverson [Water Resour. Res., 36(7), pp. 1897-1910, 2000]. Here we study some local effects on shallow landslide triggering in two specific cases. The first one regards the trigger of some soil slips which occurred in Val Varenna, close to Genoa, Italy, on September 23rd, 1993, during a rainfall event with brief high peak intensity and did not occur during other analysed rainfall events with a higher cumulative water depth. This analysis is thus directed to asses how a high peak intensity may cause a slope failure and the importance of the within storm structure in these events. The analysis also shows that the soil slip possibly happened in the initially unsaturated zone at low depth (50 cm). The second one regards a re-analysis of some cases studied by Torres at al. [Water Resour. Res., 34(8), pp. 1865-1874, 1998] in order to evaluate the hydraulic soil diffusivity D and conductivity k which appear in Iverson's linear diffusion model. A numerical optimization procedure is used to find the D and k values that minimize the root mean square between our numerical solution and linear diffusive solution. Because of high nonlinearities in Richards' Equation, k and D are shown to depend strongly on initial wetness conditions, and it is shown that, only under particular hypotheses, diffusive approach can yield a good evaluation of the slope-normal response.