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The process of earthflow propagation: insights from an application of the SPH technique to a case history

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An intense reactivation of a large earthflow (about 6 million m3 of soil debris) took place in Montaguto (Southern Apennines, Italy) between 2005 and 2006 as a consequence of the retrogression of a sliding process in the source area at the top of the slope. The earthflow run-out was approximately 2-2.5 km long, with the landslide mass thickness approximately ranging between 5 m and 30 m. Relevant damages were produced at the toe of the slope, since important infrastructures hereby located were covered by large volumes of landslide detritum. In the transition area, that is just downslope the source area, the landslide soil mass was channelized and transformed into a viscous soil flowing down through a natural depression channel, with an average displacement rate estimated to range between 3 and 7 m/day.

In this work an application of the Smoothed Particle Hydrodynamics method has been carried out in order to simulate both the main features of the earthflow propagation, that is the direction and the thickness of the flowing mass, as well as to investigate some factors of the soil mechanical behavior that might have controlled the earthflow mobility. In particular, two different assumptions concerning the soil rheology, i.e. Bingham visco-plasticity and frictional-consolidating soil, the first complying more with the assumption of a flow-like behavior and the latter with a soil-like behavior of the landslide mass, have been made for comparison purposes. Based on the experiences gained from previous authors concerning the in-situ features of similar earthflow soil masses, these landslides are thought to behave more as a viscous fluid during the very first stages of propagation due to phase transition processes and, later on, to recover a soil-like behavior, therefore characterized by sliding mechanism, due to soil consolidation processes. Field evidences of consolidation processes have indeed been observed in situ in recent years based on pore water pressure monitoring.

The SPH numerical results of the Montaguto earthflow propagation seem to be in good agreement with the field observations in terms of both movement direction, run-out distance and thickness of the debris soil mass. The modelling results confirm that these landslide processes can be efficiently modelled by means of the SPH numerical technique, providing that a soil rheology capable of taking into account the main features of the soil behavior that affect the earthflow mobility is used.