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Modelling the runout of a debris flow of the Western Ghats, Kerala, India

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Debris flows as a result of shallow landslides are increasingly a concern in Kerala, the south western state of India. The plateau margins of highland Kerala (The Western Ghats) have all prerequisites of an active erosion zone where the natural terrain setup is conducive to slope failure/mass movements. Rainfall during two monsoons (South West and North East) that are effective in the state is identified as the primary trigger of debris flows. The flows are confined to the existing drainage lines and widen the streambeds that they follow, causing significant crop destruction (and occasionally loss of lives) along the path. Most often the amount of material that initiates the flows is less than a 1000 m3. Scouring is seen along the runout zone adding often an additional 30 to 80% more material.

One such debris flow event of 2001 which occurred in the Kottayam district of Kerala was modelled with a Coulomb frictional and a Voellmy model in the DAN3D software. DAN3D is based on a Lagrangian formulation that discretises the flow in a number of particles representing bed-normal columns of flow. The values of the field variables for each particle are calculated at each time step using an interpolation technique based on Smoothed Particle Hydrodynamics (SPH). Bed entrainment was simulated after defining an entrainment zone, a maximum depth of supply material and the average growth or erosion rate.

Result of the modeling shows that shallow failures using frictional material overestimates the runout zone and velocities. The Voellmy model underestimate deposit thickness where spreading is dominant but the velocity is better fitted during the course of the flow. Entrainment of material from the path and the ability to change rheology depending on the path material can be important. The reasonable results of the modeling show its flexibility which can be used to predict a simplified behaviour of debris flows.