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A new two-phase erosion-deposition model for mass flows

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Erosion, entrainment and deposition are complex and dominant, but yet poorly understood, mechanical processes in geophysical mass flows. Here, we propose a novel, two-phase, erosion-deposition model capable of adequately describing these complex phenomena commonly observed in landslides, avalanches, debris flows and bedload transports. The model enhances an existing general two-phase mass flow model (Pudasaini, 2012) by introducing a two-phase variably saturated erodible basal morphology. The adaptive basal morphology allows for the evolution of erosion-deposition-depths, incorporating the inherent physical process and rheological changes of the flowing mixture. With rigorous derivation, we show that appropriate incorporation of the mass and momentum productions and losses in conservative model formulation is essential for the physically correct and mathematically consistent description of erosion-entrainment-deposition processes. Simulation indicates a sharp erosion-front and steady-state-rear erosion depth. The model appropriately captures the emergence and propagation of complex frontal surge dynamics associated with the frontal ambient-drag which is a new hypothesis associated with erosion. The novel enhanced real two-phase model also allows for simulating fluid-run-off during the deposition process. The model resembles laboratory experiments for particle-fluid mixture flows and reveals some major aspects of the mechanics associated with erosion, entrainment and deposition.

Reference:

Shiva P. Pudasaini (2012): A general two-phase debris flow model. J. Geophys. Res., 117, F03010, doi: 10.1029/2011JF002186.