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Numerical Investigation of Debris Flows on General Topography with Pore Pressure Evolution

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In debris flows, consisting of granular particles and an interstitial fluid, the pore-pressure feedback plays a crucial role and significantly affects the dynamic behavior. It reduces the intergranular friction and, therefore, enhances the mobility of the whole mixture.

In this work, we present a continuum-mechanical model for the description of debris flows, including a pressure diffusion equation, accounting for the extra pore fluid pressure. The thermodynamically consistent model is scaled, depth-integrated and embedded in terrain-following coordinates, adapting the concept of general topography in combination with unified coordinates, allowing for numerical studies of debris flows over complex and non-trivial topography.

Numerical simulations are performed with this model, applying a shock-capturing non-oscillatory numerical scheme. Parameter studies are performed on the properties of the proposed model, complemented by comparison with experimental data. The obtained results are presented and demonstrate that, in comparison to classical debris flow approaches, the proposed model provides a phenomenological insight into the influence of the pore-pressure feedback on the flow dynamics.