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Energy dissipation by submarine obstacles during landslide impact on reservoir - potentially avoiding catastrophic dam collapse

Jeevan Kafle (1), Parameshwari Kattel (1), Martin Mergili (2), Jan-Thomas Fischer (3), Bhadra Man Tuladhar (1), and Shiva P. Pudasaini (4)

(1) School of Science, Kathmandu University, Dhulikhel, Kavre, Nepal (jkafle@student.ku.edu.np), (2) Institute of Applied Geology, BOKU University of Natural Resources and Life Sciences Vienna, Austria, (3) Austrian Research Centre for Forests - BFW, Department of Natural Hazards, Innsbruck, Austria, (4) Department of Geophysics, Steinmann Institute, University of Bonn, Germany

Dense geophysical mass flows such as landslides, debris flows and debris avalanches may generate super tsunami waves as they impact water bodies such as the sea, hydraulic reservoirs or mountain lakes. Here, we apply a comprehensive and general two-phase, physical-mathematical mass flow model (Pudasaini, 2012) that consists of non-linear and hyperbolic-parabolic partial differential equations for mass and momentum balances, and present novel, high-resolution simulation results for two-phase flows, as a mixture of solid grains and viscous fluid, impacting fluid reservoirs with obstacles. The simulations demonstrate that due to the presence of different obstacles in the water body, the intense flow-obstacle-interaction dramatically reduces the flow momentum resulting in the rapid energy dissipation around the obstacles. With the increase of obstacle height overtopping decreases but, the deflection and capturing (holding) of solid mass increases. In addition, the submarine solid mass is captured by the multiple obstacles and the moving mass decreases both in amount and speed as each obstacle causes the flow to deflect into two streams and also captures a portion of it. This results in distinct tsunami and submarine flow dynamics with multiple surface water and submarine debris waves. This novel approach can be implemented in open source GIS modelling framework r.avaflow, and be applied in hazard mitigation, prevention and relevant engineering or environmental tasks. This might be in particular for process chains, such as debris impacts in lakes and subsequent overtopping. So, as the complex flow-obstacle-interactions strongly and simultaneously dissipate huge energy at impact such installations potentially avoid great threat against the integrity of the dam.

References:

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