Geophysical Research Abstracts
Vol. 21, EGU2019-13482, 2019
EGU General Assembly 2019

A three-phase mass flow model applied for the simulation of complex landslide–glacier–lake interactions in Iceland

Sigríður Sif Gylfadóttir (1), Martin Mergili (2,3), Tómas Jóhannesson (1), Jón Kristinn Helgason (1), Þorsteinn Sæmundsson (4), Jan-Thomas Fischer (5), and Shiva P. Pudasaini (6)

(1) Icelandic Meteorological Office, Reykjavik, Iceland (siggasif@vedur.is), (2) University of Natural Resources and Life Sciences (BOKU), Institute of Applied Geology, Vienna, Austria (martin.mergili@boku.ac.at), (3) University of Vienna, Department of Geography and Regional Research, Vienna, Austria, (4) University of Iceland, Department of Geography and Tourism, Reykjavik, Iceland (steinis@hi.is), (5) Austrian Research Centre for Forests (BFW), Department of Natural Hazards, Innsbruck, Austria (jt.fischer@bfw.gv.at), (6) University of Bonn, Institute of Geosciences and Meteorology, Geophysics section, Bonn, Germany (pudasaini@geo.uni-bonn.de)

Important progress has been made in the simulation of complex landslides involving the interaction of rock, debris, glacier ice, and water, which sometimes evolve into cascading mass flows with long run-out distances. A typical example of such a process chain would be a rock avalanche rushing onto a glacier, entraining glacier ice and impacting a proglacial lake, the lake water overtopping and/or eroding a terminal moraine, and the resulting debris flow or debris flood continuing downstream. The most advanced existing models can be used to simulate two-phase flows of solid and fluid material as well as erosion and entrainment, and have recently been applied to reconstruct a glacier outburst flood (jökulhlaup) in the valley of the Svaðbælisá River in southern Iceland. However, the process interactions involved in this type of landslide cascades can be adequately simulated with three-phase models only, taking into account the different material properties and their interactions, e.g. including ice as a separate phase. Consideration of three-phase flows, however, is completely new and has not yet been implemented in operational landslide simulation frameworks.
We present the implementation of a recently developed three-phase flow model in the r.avaflow computational framework and demonstrate and evaluate the new functionalities focusing on two case studies in Iceland:

Back-calculation of the well-documented and well-reconstructed 1967 Steinsholtsjökull landslide, where a rock avalanche rushed onto a glacier, the resulting ice–rock avalanche impacted a proglacial lake, and the impact wave led to a jökulhlaup downstream.

Based on this, forward-calculation of the hypothetic Svínafellsheiði landslide, which is expected to involve similar process interactions as the Steinsholtsjökull landslide, but may potentially involve much larger volumes of rock, ice, and water.

Whereas empirically adequate results are possible to obtain for the back-calculation of the Steinsholtsjökull landslide with optimized model parameters, the forward-calculation of the Svínafellsheiði landslide leads to highly uncertain results, due to the limited transferability of optimized parameter sets to events at different locations and of different magnitudes. Parameter ranges and scenarios are considered in order to deal with these uncertainties.