Reconstruction of the sudden drainage of a moraine-dammed lake in the Cordillera Vilcabamba (Peru): the 2020 Salkantay event

Oscar Vilca1, Martin Mergili2,3, Adam Emmer2, Holger Frey4, and Christian Huggel4
1Instituto Nacional de Investigación en Glaciares y Ecosistemas de Montaña-INAIGEM, Wanchaq - Cusco, Peru
2Institute of Geography and Regional Science, University of Graz, Heinrichstraße 36, 8010 Graz, Austria
3Institute of Applied Geology, University of Natural Resources and Life Sciences (BOKU), Peter-Jordan-Straße 82, 1190 Vienna, Austria
4Department of Geography, University of Zurich, Winterthurerstrasse 190, 8057 Zurich, Switzerland

On 23rd February 2020, a landslide-triggered GLOF process chain was initiated from the SW slope of Nevado Salkantay, Cordillera Vilcabamba, Peru. An initial slide evolved into a rock/ice avalanche and part of the released material fell into the moraine-dammed Lake Salkantaycocha, triggering a displacement wave which overtopped and eroded the distal face of the dam. Dam overtopping resulted in a far-reaching GLOF causing fatalities and people missing in the valley downstream. In this contribution, we analyse the situation before and after the event as well as the dynamics of the GLOF process chain, based on field investigations, remotely sensed data, meteorological data, and a computer simulation with a two-phase flow model. Comparing pre- and post-event field photographs helped us to estimate the initial landslide volume of 1–2 million m³. Meteorological data suggest rainfall and/or melting/thawing processes as possible causes of the landslide. The simulation reveals that the landslide into the lake created a displacement wave height of up to 27 m. We reconstructed a released volume 57,000 m³ (less than 10% of lake volume) and estimated a total GLOF peak discharge almost 10,000 m³/s at the dam. The lake had 40 m dam freeboard at the time of a GLOF, and the lake level increased by 10–15 m directly after the event, since most of the volume of landslide material deposited in the lake (roughly 1.3 million m³). The model results show a good fit with the observations, including the travel time to the uppermost village. The findings of this study serve as a contribution to the understanding of landslide-triggered GLOFs in changing high-mountain regions.