



Possible future lakes in the Andes of Peru

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Climate change has caused large losses of glacier mass in the Andes of Peru. Also, given the projected changes in climate, based on different IPCC scenarios for 2050 and 2080, simulations with a tropical glacier-climate model indicate that glaciers will continue to retreat. According to the national Peruvian glacier inventories 43% of glacier area has disappeared between 1970 and 2003-2010 in the 19 snowy mountain ranges and a total of 8 355 new lakes have formed in deglaciating terrain. With glacier retreat new lakes form in parts of the glacier tongue where there is an overdeepening, and these lakes can be a source of natural hazards to downstream populations. Therefore, the identification of possible future lakes is important to plan for preventive measures concerning possible lake outbursts as well as to understand changes in freshwater storage in the corresponding source areas.

Modeling of glacier-bed overdeepenings and possible future lakes forming in such topographic depressions when becoming ice-free was done using the SRTM DEM from the year 2000 with a 90 m resolution and the 2003-2010 glacier outlines from the recently published national glacier inventory of Perú. The GIS-based analysis followed three main steps: (1) identification of flat glacier areas with less than 10° surface slope as a first-order spatial approximation to possible occurrences of glacier-bed overdeepenings; (2) application, using Google Earth, of three morphological indications of glacier-bed overdeepenings following Frey et al. (2010): steepening surface slope, onset of crevasse formation, lateral flow-narrowing; and (3) verification of the results from steps (1) and (2) by comparison with GlabTop modeling of bed topographies following Linsbauer et al. (2012) using the SRTM DEM, contour lines and constructed branch lines for all glaciers.

A pilot study has already been carried out for the Cordillera Blanca. The results show that 31 major new lakes may form in the future. The total volume of the new major lakes is estimated at about 60-65 million m^3 . This corresponds to about half a percent of the total glacier volume remaining in the year 2003 and estimated at 15.69 km^3 . This relatively small percentage is due to the fact that most flat glacier parts where bed-overdeepenings can be expected have already disappeared. The same methodology is now being applied to the main glacierized Cordilleras of Perú.

The data obtained will provide important information for responsible governmental authorities related to freshwater resources, hazard prevention, energy production and landscape diversity in view of taking immediate actions for water resource management and disaster risk management. These aspects will be critical for the success of any efforts to adapt to the impacts of climate change in the Andes of Peru.