Geophysical Research Abstracts
Vol. 15, EGU2013-3273, 2013
EGU General Assembly 2013

Vanishing glaciers, degrading permafrost, new lakes and increasing probability of extreme floods from impact waves – a need for long-term risk reduction concerning high-mountain regions

Wilfried Haeberli, Yvonne Schaub, Christian Huggel, and Lorenz Boeckli
University of Zurich, Department of Geography, Zurich, Switzerland (wilfried.haeberli@geo.uzh.ch)

As a consequence of continued global warming, rapid and fundamental changes are taking place in high-mountain regions. Within decades only, many still existing glacier landscapes will probably transform into new and strongly different landscapes of bare bedrock, loose debris, numerous lakes and sparse vegetation. These new landscapes are then likely to persist for centuries if not millennia to come. During variable but mostly extended parts of this future time period, they will be characterised by pronounced disequilibria within their geo- and ecosystems. Such disequilibria include a long-term stability reduction of steep/icy mountain slopes as a slow and delayed reaction to stress redistribution following de-buttressing by vanishing glaciers and to changes in strength and hydraulic permeability caused by permafrost warming and degradation. With the formation of many new lakes in close neighbourhood to, or even directly at the foot of, so-affected slopes, the probability of far-reaching flood waves from large rock falls into lakes is likely to increase for extended time periods.

Quantitative information for anticipating possible developments exists in the European Alps. The present (2011) glacier cover is some 1800 km2, the still existing total ice volume 80 ± 20 km3 and the average loss rate about -2 km3 ice per year. The permafrost area has recently been estimated at some 3000 km2 with a total subsurface ice volume of 25 ± 2 km3; loss rates are hardly known but are certainly much smaller than for glaciers – probably by at least a factor of 10. Based on a detailed study for the Swiss Alps, total future lake volume may be assumed to be a few percent of the presently remaining glacier volume, i.e. a few km3 for the entire Alps. Forward projection of such numbers into the future indicates that glacier volumes tend to much more rapidly vanish than volumes of subsurface ice in permafrost, and lake volumes are likely to steadily increase. Already during the second half of the 21st century, more subsurface ice in permafrost may remain than surface ice in glaciers. The new lakes will then coexist with, or even be surrounded by, largely de-glaciated/de-buttressed over-steepened slopes and mountain peaks with thermally disturbed and degrading permafrost.

Similar scenarios are likely to take place in many cold mountain chains. Using integrated spatial information on glacier/permafrost evolution and lake formation together with models for rapid mass movements, impact waves and flood propagation in connection with vulnerability considerations related to settlements and infrastructure, hot spots of future hazards from flood waves caused by large rock falls into lakes can already now be recognized in possibly affected regions. This enables in-time planning of risk reduction options, which may include adapted spatial planning, early-warning systems, improved preparedness of local people and institutions, artificial lake drainage or lake-level lowering, and flood retention optimally in connection with multipurpose structures for hydropower production and/or irrigation.