Increased glacial lake outburst flood hazard in Iceland, in the light of ongoing climate changes

Þorsteinn Sæmundsson[1,*], Greta Wells[1]

[1] Institute of Earth Sciences, University of Iceland, Reykjavík, 101, Iceland

*Corresponding author: e-mail address: steinis@hi.is

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Abstract: Over the last 140 years, or from the maximum extent of glaciers during the Little Ice Age, it is estimated that Icelandic glaciers lost over 16% of their mass. During this time interval temperatures have been fluctuating, with exceptionally warm period in the 1920s and 1930s followed by slightly colder interval until beginning of the 1980s. During this time outlet glaciers retreated considerably and in front of several of them proglacial lakes began to form. From around 1970 to 1995 outlet glaciers readvanced, and in some instances proglacial lakes were filled up with ice again. At the end of the 20th century another turning point occurred, with higher temperatures and exceptional rapid retreat of outlet glaciers. Existing proglacial lakes have expanded, and many new ones formed. In some cases, catastrophic break up has occurred, as recent break up at the Heinabergsjökull outlet glacier in SE Iceland.

These glacial fluctuations have and are affecting the slope stability above these retreating outlet glaciers, resulting in various types of mass movements onto outlet glaciers and formation of fractures. The frequency of mass movements on outlet glaciers has increased, from the turn of the century compared to the last 4 decades of the 20th century. New discoveries of unstable slopes above outlet glaciers have also increased since 2000.

The largest mass movement fallen onto an outlet glacier in Iceland occurred in 1967 when a large rockslide fell onto the Steinsholtsjökull outlet glacier in South Iceland and into its proglacial lake, causing a glacial lake outburst flood (GLOF). The GLOF entirely overprinted the pre-existing proglacial landscape in the valley.

Over the last few years several proglacial lakes have been mapped with multibeam sonar scanner, revealing the lake bathymetry for the first time. The lake bathymetry, coupled with radio-echo sound survey of subglacial topography of these outlet glaciers, makes it possible to study the glacial retreat rate and formation of proglacial lakes in light of climate fluctuations and the depth distribution in the lake basins. It also gives possibilities to estimate future lake development and retreat rate.

The potential for mass movement triggered GLOFs in areas where proglacial lakes have formed has increased considerably over the last decades. Many of these areas both attract tourists year-round and have seen recent related infrastructure development in their vicinities. This development raises serious concerns and stresses an urgent need to study and monitor these environmental hazards.