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Monitoring of Bashkara glacial lakes (the Central Caucasus) and modelling of their potential outburst.

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In recent decades due to glacier retreat the glacial lakes in the Central Caucasus, as well as in other high-mountainous areas of the world, have expanded intensively. As result the risk of lake outbursts and destructive floods is raising.

In this paper we present one of the most potentially hazardous lakes of this region – a group of glacial lakes near the Bashkara glacier in the upper Adylsu river valley, to the southeast of Mt. Elbrus. Total area of these lakes is about 100,000m2, and a total volume exceeds 1,000,000 m3. The biggest of them - the Bashkara lake has formed in late 1930s - early 1940s and the small Lapa lake has appeared in the end of 1980s. The Bashkara lake outburst occurred twice in the end of 1950s and produced devastating debris flows of ca. 2 million m3.

We have monitored these lakes since 1999. Our work includes detailed field research: constant measurements of water level during warm period, annually repeated bathymetric surveys, geodetic surveys, observations on dam condition and some special measurements (i.e. water temperature distribution, current velocity). Also we use aerial and satellite images to obtain data about dynamic of areas for the lakes.

From 2001 to 2006 years volume of the Lapa lake has increased 5 times (from 30,000 m3 to 140,000 m3), the Bashkara lake in this period was quasi-stable. In 2006-2008 volume of the Lapa lake has decreased due to sedimentation, however, rapid growth of water level in Bashkara lake (more than 20 sm. per day) has suddenly begun. As a result, volume of the Bashkara lake exceeded 1,000000 m3 in July 2008 whereas in 2001 –2007 year it was about 800,000 m3. Previous maximum of water level was exceeded on 3,5 m, moraine dam with ice core was overtopped and overflow has started. Thus, Bashkara glacier lakes are unstable and risk of outburst is increasing.

To assess parameters and zones of potential outburst flood in the Adylsu River valley we have carried out hydrodynamic simulation. Two computer models, based on solving of two-dimensional Saint-Venant equations –“River” (the Russia, author V.Belikov) and “Flo-2D” (the USA, authors J.S.O’Brien, R.Garcia) were used. The “River” model is based on the irregular triangular grid, therefore it is possible to calculate flow in details. On the other hand there is no debris flow block in this model yet and “Flo-2D” was applied to calculate potential debris flow parameters, because transformation of flood into debris flow is likely here.

Input data for simulation were following: digital terrain model of Adylsu valley, made on the on the basis of map with scale 1:25000, outburst hydrograph, calculated for case of englacial drainage channels formation (Vinogradov’s model, Russia), some empirical relationships between volume of the glacial lake and maximum discharge of outburst (i.e. Clague and Mathews, Walder and Costa) were also applied.

The mean value of the maximum discharge for potential outburst obtained by different methods was about 150 m3 /c. According to results of hydrodynamic modelling, movement of flood wave downstream the valley will be fast, peak of flood will cover distance from upper part of valley to lowest (8 km) for about half an hour. The depth of the flow on the floodplain is about 1-1.5 m and could reach 6 m in some sites. There are hotel, large camping site and several bridges in the hazardous zone. In 2008 early warning system was designed and installed at the Bashkara lake.