Assessment of glacier lakes development in Central Caucasus

Ivan Lavrentiev\(^1\), Dmitry Petrakov\(^2\), Stanislav Kutuzov\(^1\), and Andrey Smirnov\(^1\)

\(^1\)Institute of geography RAS, Moscow, Glaciology, Russian Federation (ilavrentiev@gmail.com)
\(^2\)Lomonosov Moscow State University, Faculty of Geography (dpetrakov@gmail.com)

Glacier mass loss and consequent termini retreat lead to formation and growth of glacier lakes. In the Mt. Elbrus region, outbursts of lakes formed in recent decades have led to human casualties and significant damage. Building codes of Russian Federation on engineering surveys do not regulate the possibility of glacier lake formation in front of retreating glaciers, which can lead to errors in the future engineering design. Using ground based and airborne GPR data, as well as global ice thickness models, we have identified areas of potential lake formation on glacier bed for a number of glaciers in the Mt. Elbrus region. The method was tested by retrospective modeling for Bolshoy Azau and Djikiugankez glaciers bed topography on the base of 1957 topographic map. In the areas where glaciers disappeared by 2017, out of 13 simulated closed bed depressions 7 existing lakes were predicted by the hydraulic potential. 6 closed depressions on Djikiugankez glacier bed as of 1957 are currently absent, which might be related to the model uncertainties and the original DEMs errors, as well as to possible filling of lakes by sediments. Retrospective modeling of the Bashkara glacier bed topography based on SRTM DEM (2000) showed significant growth potential of the lake Lapa. Retrospective modeling of the Kaayarty glacier bed topography has not provided a clear answer about the possibility if subglacial lake outburst flood was a trigger for catastrophic debris flow formation during the summer of 2000.

In case of total disappearance of Bolshoy Azau, Djikiugankez and Bashkara glaciers at least 11 new lakes with total area of about 1.7 km\(^2\) and an average depth of 8 m will form. While the deepest lake will appear in ablation zone of Bolshoy Azau glacier (at elevation 3100-3400 m a.s.l.) the largest in area (1 km\(^2\)) glacial lake will be formed at the Djikiugankez snout with maximum depth of 40 m and mean depth of 7.2 m. The simulation also showed that in the present conditions, glacier bed lakes of different number and size may also exist under studied glaciers. Our estimates may contain uncertainties due to low resolution of airborne GPR data and the lack of GPR data for Kaayarty glacier, DEM and ice thickness model errors. Detailed ground-based radar survey planned for the summer 2020 will enable the assessment of the size and volume of the potential lakes under Bolshoy Azau glacier.

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