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Modeling impact of GLOF on the the Baksan River runoff (the Central Caucasus, Russia)

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The ongoing intensive deglaciation in high mountain areas is resulting in great instability of mountainous headwater regions, which could significantly extreme hydrological events In this research a model “chain” of hydrodynamic and runoff formation models is adopted to simulate a glacier lake outburst flood (GLOF) from Bashkara Lake, situated in headwater region of the Baksan River and its effect on the downstream.

Two-dimensional hydrodynamic model for the Adylsu River valley was developed, based on the STREAM_2D software (author V. Belikov). The ECOMAG runoff formation model (author Yu. Motovilov) for the entire Baksan River basin was adopted. The output flood hydrograph from the STREAM_2D model was set as additional input into the Baksan River runoff formation model in the upper reaches of the Adylsu River below Bashkara and Lapa Lakes.

Based on field surveys and remote sensing data, actual Bashkara Lake GLOF on September 1, 2017 was modelled. The GLOF event was triggered by extreme precipitation that caused overwetting of the dam and increase in the lake water level. The peak GLOF discharge according to modeling was estimated as 710 m^3/s at the dambreak section and 320 m^3/s at the Adylsu River mouth 40 minutes after the outburst. Two possible mechanisms for re-outburst of Bashkara Lake were taken into account: the rock avalanche impact, forming displacement waves, and the lake outburst due to increase in the water level, accompanied by expansion of the existing dam break. Under the rock avalanche scenario, there was no significant model response. Based on the results of modeling of the second re-outburst scenario, the maximum discharge of the outflow was estimated as 298 m^3/s at the dambreak section and 101 m^3/s in the Adylsu River mouth.

As a result of model chain application contribution of GLOFs and precipitation to an increase in peak discharge along the Baksan River was estimated. The actual outburst flood amounted to 45% and the precipitation - to 30% of the peak flow in the Baksan River at the mouth of the Adylsu river (10 km from the outburst site). In Tyrnyauz (40 km from the outburst site) the components of the outburst flood and precipitation were equalized, and in Zayukovo (70 km from the outburst site)

the outburst flood contributed only about 20% to the peak flow, whereas precipitation - 44%.

Similar calculations were made for a potential re-outburst flood, taking into account expected climate changes with an increase in air temperatures by 2°C and an increase in precipitation by 10% in winter and decrease by 10% in summer. The maximum discharge of the re-outburst flood in the Adylsu river mouth according to modeling can be approximately 3 times less than discharge of the actual outburst on September 1, 2017 and can contribute up to 18% to peak discharge in the Baksan River at the confluence with the Adylsu river.

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