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Has the glacial meltwater runoff already diminished and how it affects hydrological extremes in mountainous areas (the North Caucasus case study)?

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The vast majority of glacier mass-balance measurements reveal an active deglaciation process over the last six decades. Moreovera further intensification of glacier mass loss is expected due to predicted near-surface warming. According to common understanding of the processes a temporary increase in glacial runoff due to the intensification of glacier melt is expected. But after some equilibrium point a decrease in glacierized area will lead to drop in ice meltwater runoff and significantly affect the water availability in many regions on the globe. However, due to dramatic lack in hydrometeorological data on alpine regions, no one knows exactly when we are going to cross this equilibrium line, or whether it is already crossed in some regions, and how it affects hydrological regime downstream.

The study conducted for the high-altitude highly glacierized research basin Djankuat, chosen as representative for the Central part of the North Caucasus in course of International hydrological decade, reveals a decrease by 30-40% in Djankuat river runoff in July-August in 2007-2018 compared to 1968-1974. Though the ablation rate of the Djankuat glacier, which occupies 30% of the watershed, increased by more than 50%, shrinking by 20% in area and growth in debris cover outweighed that in terms of runoff formation. Modelling of Djankuat glacier evolution by energy-balance AMelt model shows that its area can drop by 40% more in the next 20 years. That can lead to a formation of summer low flow period during July and August, previously most abundant in river runoff in the Djankuat basin.

In order to reveal a possible signal in these changes on the lower reaches a hydrograph decomposition method using GrWat package was applied for 10 mountainous rivers in the North Caucasus with the watershed area from 400 to 17000 km2. The reduce in the volume of base meltwater component of seasonal flood wave is observed for the rivers of the Central North Caucasus on the background of overall increase in solid and liquid precipitation in the region. In the neighboring Western North Caucasus the base part of seasonal flood doesn't show any significant trends. The maximum discharges that are mostly formed by the rain floods overlapping the maximum meltwater wave are also decreasing in Central North Caucasus while increasing in the Western North Caucasus. Although the volume of rain floods cut from seasonal flood base flow and the excess of rain flood peak over seasonal flood base component don't show any changes through study period in the Central North Caucasus.

As the water storage capacity of the headwater basins in mostly insignificant compared to the lower reaches, groundwater recharge is greatly defined by the climatic conditions in the foothills. A dramatic increase in winter low flow characteristics is observed on the whole plain and foothill gauging stations in the North Caucasus that is associated with a more often thawing due to overall warming in the region.

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