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Glaciers, permafrost and snow in the upstream Naryn catchments, Kyrgyzstan - Distribution, characteristics and trends for the water budget under climate change conditions

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There is strong scientific consciousness among scientist that the global climate is warming and that glaciers and permafrost worldwide are rapidly responding to this trend. A strong glacial retreat in the Central Asian mountains was especially intensive during the last decades. Its impact on water resources is noteworthy for the arid regions of the Kyrgyz Republic. This research assesses recent glacial and periglacial changes and their impact on water resources of the Upstream Naryn catchments.

Naryn River is the largest river of Kyrgyzstan. It flows from east to west at a length of more than 700 km before reaching Syr-Darya. A period of 45 years (1965-2010) was analyzed using 1:25,000 scale topographic maps and ALOS/AVNIR satellite imagery. The result shows that the glacier area decreased by 17.4% in the Akshyirak mountain massif, 20.8% in the Borkoldoy mountain, 21.9% in the Jetim mountain, 24.6% in the Jetimbel mountain, 28.9% in the Naryn mountain, 20.8% in the Sook mountain, 20.9% in the Terskey mountain (South slope glaciers) and 17.8% in the Uchemchek mountain ranges. The accelerated glacial retreat will have strong effects concerning periods of water shortage in densely populated areas especially for the agriculture. Also the increase of frequent glacial induced hazards (e.g. GLOFs) is obvious.

Whereas the additional runoff supplied by glaciers is well-known, the contribution of slowly melting ground-ice and perennial snow fields is almost unknown. However, this periglacial contribution is significant in the extremely arid mountain areas of the Central Tianshan. Hence, our research was to include this contribution to the water balance. The geomorphology of the study area was mapped, and a network of 18 high resolution thermistor strings and mini data loggers was installed. Hourly temperatures were recorded at various depths of up to 132 cm. The measurements started August 2010, covered three full years, and show that permafrost is wide-spread above 3300 m. a.s.l., the lowermost permafrost areas have been found even below 2700 meters. A ten year observation period (2001 – 2011) of the Tian-Shan Meteorological Station located at 3659 meters a.s.l. is of special interest. It testifies the thawing and development of the active layer with maximum depths observed early August. During the period 2010 to 2013, an average active layer depth of 300 cm depth was reached here. With the detailed identification of parameters determining the active layer thickness and the study of thaw dynamics, large scale modeling of the state of the permafrost in the Central Tian Shan is attempted. It can be shown, that not only negative glacier mass balances but also the degradation of permafrost with melting of ground ice and the reduction of perennial snow patches over the last 12 years contributes considerably to additional run-off.