



Changes in glaciation, climate and runoff over the past four decades in the Naryn basin, Central Asia.

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Glaciers are significant fresh water storage in Central Asian high mountains and are considered to substantially contribute to the summer runoff of Central Asian Rivers. We present a comprehensive study of the glacier area changes in the Naryn catchment - a main tributary to Syrdarya River - with the size of 55,944 km². We analysed the glacier retreat based on the Landsat MSS, TM and ETM+ imagery for the mid-1970s, late 1990s and mid-2000s, and based on a SPOT scene for 2007. Our results show a decreasing glaciation within the region, shrinking from 1,205 km² (2.15% glaciation) in the 1970s to 926 km² (1.66% glaciation) in the mid-2000s, corresponding to an area loss of 23%. The analysis of various glacier characteristics particularly revealed that small glaciers (<1km²) suffered from an area loss of up to 80% within the 30 years investigation period whereas large glaciers (>5km²) only undergo an area loss of about 20%-30% in the same time.

The analysis of trends in temperature and precipitation at climate stations suggests that the glacier retreat is likely to be driven by the increasing summer (April – September) temperature with the rate of about 1.8°C/100ys. This increase in temperature cannot be compensated by the statistically significant precipitation increase in the eastern part of the Naryn catchment. The analysis of the ERA-40 reanalysis data downscaled to the resolution of 12 km using the WRF regional climate model additionally indicated a statistically significant increase of the positive degree days in the high-elevated parts of the catchment. In the headwater sub-catchments of the Naryn basin, positive trends in spring and autumn discharge were detected and are likely to be associated with the enhanced snow and glacier melt caused by increasing temperatures in those months. However, no discharge trends in August – the month with the largest expected glacier contribution – were detected in the Small and Big Naryn sub-catchments.