

Climate, Snow and Glaciers in High Central Asia in the last 100 years

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People of central Asia totally depend on seasonal snow and glacier melt water. Without snow and glaciers, central Asia will dry out. The glacier changes over central Asia have been historically defined and are anticipated to be more significant than in Polar regions.

The last several decades central Asia suffered intensive droughts and lack of water for agriculture, fast growing economy and population. However, an exsiccation of central Asia is not a phenomenon according to ancient records and recent paleoclimatic (ice-coring) research. Even observational data for the last hundred years show some shifts in climate that impact on depletion of water resources. The early military topographic maps show that some Tien Shan glaciers retreated as much as 3 km during the last 100 years. Based on the aerial photography, Hexagon KH-9, Landsat ETM and ASTER data Tien Shan glaciers shrunk by 3.5% between the middle of 1940th and 1970th and 5,1% during the next 30 years (1,617 km²). Evaluation of the Tien Shan snow cover for the same period by aerial snow surveys, AVHRR and MODIS data reveled 15% (approximately 120 000 km²) seasonal snow covered area reduction. During the last thirty years, the duration of snow melt reduced by 30 days from the date of maximum snow cover to the date of its disappearance. Further decrease in snow cover will be accelerated due to increase of rainfall instead of snowfall in early spring months at high elevations, and consequently a lesser heat expenditure for snowmelt.

Despite of increased in total amount of annual precipitation, mainly over the Aral-Caspian and Taklamakan deserts, the absolute values of precipitation over the whole Central Asia were negative for the last 30 years. Significant decrease of precipitation observed over the Tien Shan high mountains notably above 3000 m a.s.l. for the last 30 years while the western Pamir area represents an increase of annual precipitation over all altitudinal zones. The most significant decrease of precipitation observed in summer season with an exception in Taklamakan desert, where summer precipitation increased and even accelerated during the last thirty years. Variability of annual precipitation for the last 30 years significantly exceeded the previous 30 year variability almost everywhere in central Asia, reaching the maximum at altitudes over 3000 m.

The annual air temperature increased over all central Asia during the last 30 years: 0.65°C positive difference between two thirty-year periods (1942-1972 and 1973-2003). The air temperature increases mainly in summer and over the central Asia prairies and deserts, up to 0.9C for the last 30 years. The lowest difference in air temperature between two periods is observed in high Tien Shan mountains (0.21C). Maximum annual acceleration in air temperature observed at the northern regions of central Asia, i.e. in Mongolia and Altai mountains, and maximum summer acceleration observed in Tien Shan mountains.

The Magic&ScenGen model scenarios for central Asia simulate increase of summer air temperature of 2C to 8C (about 4C) and an increase in precipitation of 0.84–1.24 (about 1.1) in magnitude of precipitation by 2100. An increase in mean air temperature of 4C and precipitation of 1.1 times of the current level could increase glacier ELA by 570 m in central Asia. Under these conditions, the number of glaciers, glacier covered area, glacier volume, and glacier runoff are predicted to be 94%, 69%, 75%, and 75% of current values. The maximum glacier runoff may reach as much as 1.25 times current levels while the minimum will likely equal zero. However, an increase in glacier melt in mountainous regions, while initially may be considered as a positive factor at the end will cause the runoff to decrease.

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