



Surge-type glaciers in the Tien Shan (Central Asia)

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Surge-type glaciers in High Mountain Asia are mostly observed in Karakoram and Pamir. However, few surge-type glaciers also exist in the Tien Shan, but have not comprehensively studied in detail in the recent literature. We identified surge-type glaciers in the Tien Shan either from available literature or by manual interpretation using available satellite images (such as Corona, Hexagon, Landsat, SPOT, IRS) for the period 1960 to 2014. We identified 39 possible surge-type glaciers, showing typical characteristics like looped moraines. Twenty-two of them rapidly advanced during different periods or a surge was clearly described in the literature. For the remaining possible surge-type glaciers either the advance, in terms of time and length, were not mentioned in detail in the literature, or the glaciers have remained either stable or retreated during the entire period of our study. Most of the surge-type glaciers cluster in the Inner Tien Shan (especially in the Ak-Shiirak range) and the Central Tien Shan, are in size and are facing North, West or North West.

Pronounced surge events were observed for North Inylchek and Samoilowitsch glaciers, both of which are located in the Central Tien Shan. Samoilowitsch Glacier retreated by more than 3 km between 1960 (length ~8.9 km) and 1992 (~5.8 km), advanced by almost 3 km until 2006 and slightly retreated thereafter. The most pronounced advance occurred between 2000 and 2002. DEM differencing (based on SRTM3 data and stereo Hexagon and Cartosat-1 data) revealed a significant thickening in the middle reaches (reservoir area) of the glacier between 1973 and 2000 while the surface significantly lowered in the middle and upper parts of the glacier between 2000 and 2006. Hence, the ice mass was transferred to the lower reaches (receiving area) and caused the advance with a maximum thickening of more than 80 m. The ~30 km long North Inylchek Glacier retreated since 1943 and showed a very rapid advance of ~3.5 km especially in the year 1997 with a thickening of the tongue of more than 120 m. Both glaciers showed a surge cycle of about 50 years. The advance was not so pronounced for all other surge-type glaciers. Some of the tributary glaciers behaved differently than the main glaciers in the sense that they continuously advanced during almost the entire period of our study, whereas the main glaciers have remained almost stable or retreated.