



## **Glacier retreat and climatic variability in the eastern Terskey-Alatoo, inner Tien-Shan between the middle of the 19th century and beginning of the 21st century**

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In this study changes in the extent of glaciers in the eastern Terskey Ala-Too Mountains located in the inner Tien-Shan are evaluated using techniques of remote sensing. Changes in 334 glaciers over the last 140-150 years have been evaluated through the delineation of glacier outlines and the Little Ice Age (LIA) moraine positions on the satellite Landsat TM, ETM+ and ASTER imagery for 1990, 1999 and 2003-2006 respectively. Detailed mapping of 10 glaciers has been completed using historical maps from 1965 and aerial photographs from the 1943-1980 period. In total, by 2003 the glacier surface area has decreased by 19% of the 1860 value which constitutes a 76 km<sup>2</sup> reduction in the extent of clear ice. The average terminus retreat was 438 ± 39 m. Analysis of changes of the selected 10 glaciers has shown that the rates of retreat varied in time. The early 20th century saw a temporary stagnation or even advance of glaciers. The rates of retreat increased considerably between 1943 and 1960 when glacier termini were retreating at an average rate of 10 ma<sup>-1</sup> but in the 1960s-1970s glacier termini were retreating slower, by 6-7 ma<sup>-1</sup>. Glacier recession has intensified in the 1980s and between 1990 and 2003 glacier termini were retreating by 19 ma<sup>-1</sup> on average. Therefore, the last 15 years have been marked by the most rapid glacier retreat since the end of the LIA in the inner Tien-Shan. These changes correlate well with the observed climatic trends. Ablation and accumulation seasons coincide in the inner Tien-Shan extending from May to September. The average May-September temperatures have been increasing throughout the region. The temperature time series from the Tien-Shan meteorological station (3614 m amsl) exhibits a strong warming of 0.02°C a<sup>-1</sup> between 1930 and 2005 with linear trend explaining 28% of the total vari-

ance. This trend is replicated at other stations located at lower altitudes. At the same time, the May-September precipitation at the Tien-Shan station has been declining since the early 1970s. It is concluded that the observed glacier retreat is due to both, increasing air temperatures and decreasing precipitation. The study was supported by the EU INTAS YSFellowship # 5742.