

**SURVEYING AND MAPPING OF THE TUYUKSU GLACIER REGION,
KAZAKHSTAN 1:10,000**

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Within the scope of the project “The influence of glacier retreat on water yield from high mountain regions, comparison Alps – Central Asia”, financed by the German Research Foundation (DFG), a completely new survey and mapping of the Tuyuksu glacier region in the Tien Shan Mountains of Kazakhstan was required. The only existing 1:10,000 map, which was the result of a USSR-German Expedition undertaken in the International Geophysical Year, dates back to 1958. The project area, located at 43° 04' N and 77° 05' E, covers the basin of the “Little Almatinka” River above the Mynzhilki gauging station, situated at an altitude of 3,017 m a.s.l.. There are currently eight glaciers with a total area of 7 km² in this high mountain basin of about 21 km².

In order to compute changes in area, volume and mass in a precise way it is necessary to use an identical coordinate system for mapping at the respective points in time. It was possible to use the former USSR system for land surveys as in 1958 because five well-distributed ground control points from the 1958 survey could be identified. These points served as fixed points for coordinate transformations.

In recent times, no aerial photographs could be taken for political reasons, and as an alternative, terrestrial photogrammetry was used. For a complete coverage of the project area, stereo images from 11 baselines with 2–3 different image directions were taken. For absolute orientation of the stereo models, 45 ground control points were measured, trigonometrically based on a network established by 17 trigonometric points measured by GPS. The geographical coordinates, originally obtained by GPS measurements (longitude, latitude and height above the earth ellipsoid), were transferred into Gauß-Krüger coordinates with reference meridian 78° and finally converted by 3-D Helmert transformation into the local system used in 1958. Based on these measurements, the stereo models were set up and evaluated on an Analytical Plotter P1/Zeiss. For DEM generation, regular and irregular distributed points on the terrain surface were measured, including breaklines and special points. The vector data acquisition comprised all border lines of glacier ice, debris-covered glacier ice, dead ice (not in motion), rock faces and cartographic objects like roads, buildings and measurement stations. Outside the survey area of 1998, contours from the 1958 map were digitised to complete the data set.

A regular 20-metre-spaced DEM was generated with the program package HIFI and used

as the basis for computing contours with a 10-metre height interval and a shaded relief model.

The directly recorded data and the products which have been derived from the DEM were combined to create a topographical map using the Freehand (Macromedia) program. As is customary, the contours on the glaciers and the dead ice areas are drawn in blue, while in the surrounding areas they are given in black. Debris cover on glacier ice and dead ice areas were mapped directly in the field. Besides the lakes and streams, the road which leads to the glacier research station was mapped, while the part to the North lying outside the field survey of 1998 could not be drawn as the location changed as compared to 1958. Finally, the most important trigonometric points and a map grid indicating the local and geographical coordinate system was added. The annotation of the map is both in German and Cyrillic, as the geographical names of the project area were given in Russian during the era of the former Soviet Union.