



High-mountainous permafrost under continental-climatic conditions: actual results of different mapping methods and an empirical-statistical modeling approach for the Northern Tien Shan (SE Kazakhstan)

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The knowledge of permafrost occurrence in the continental-climatic mountain systems of Central Asia (Hindukush, Pamir, Tien Shan) plays an important role in terms of:

- (a) storage of fresh water resources,
- (b) causing geomorphologic relevant slow creeping processes and associated landforms,
- (c) permafrost degradation leading to destabilization of formerly frozen slopes and debris storages.

The presented study focuses on the Northern Tien Shan mountains (SE Kazakhstan; 43°N 78°E; highest point: Pik Talgar 4978m) and discusses different indirect field mapping methods to determine the actual permafrost distribution. Therefore, data were obtained from 830 measurements of bottom temperature of snow cover (BTS), 22 long-time BTS and ground temperature profiles and 52 spring temperature measurements. Additionally, 27 electrical resistivity tomography (ERT) profiles and mapped permafrost related phenomena were used for cross-check analysis as well as for detecting permafrost occurrence. It is evident that BTS-measurement is a useful method for permafrost mapping even under continental-climatic conditions provided that the thickness of snow cover is more than one meter.

The data obtained were analyzed statistically related to topographical parameters. Overall, they show a heterogeneous distribution whereas the altitudinal zonation is strongly influenced by slope exposition (and therefore by insolation) as well as by ground surface conditions. Thus, discontinuous permafrost is suggested to be situated between 2800m to 3550m with lowest occurrences in northern expositions. Permafrost in southern slopes exists above 3550m defining the lower boundary of the continuous permafrost zone. Sporadic permafrost can be found even in the montane forested zone (dominated by *Picea schrenkiana*) down to 2400m in relic rockslide accumulation zones.

The obtained statistical correlations between permafrost occurrence and topographic parameters are used to develop an empirical-statistical permafrost distribution model for this region.