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Modeling of debris flows on hillslopes and in channels in high alpine catchment areas of the Northern Tien Shan, South-East Kazakhstan

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Debris flows in the continental-climatic high alpine mountain systems of Central Asia represents a major land forming process and nevertheless a considerable high risk potential on mountainous settlements. The presented and still running investigations aims to figure out current initiation processes and the spatial distribution of precipitation-induced debris flows as well as their process dynamics on a regional scale (approx. 400km^2) by using recent debris flows models developed in the Alps. The results should also be used in the future to improve risk potential and hazard mitigation in densely populated mountain ranges. The investigation area is situated in the Big Almatinka, Little Almatinka and Left Talgar valleys in Northern Tien Shan Mountains south of Almaty, the former capital of Kazakhstan.

As a basic data for modeling a 5m DEM (derived from digitized Russian topographical maps with a scale of 1:25.000) was used. Detailed GPS mapping and current World-View-2 satellite images were used to identify the process areas of debris flows, including disposition (starting zones), flow path and deposition and additionally the vegetation cover.
In a first step a disposition model is used to identify statistical relationships between mapped process initiation areas and the landscape parameters. Long-term and medium-term variable parameters such as local geology, geomorphology, hydrological indices (i.e. stream flow, CIT-Index) and vegetation were used to describe the basic disposition. In addition, models for permafrost distribution, rock fall and snow avalanches were used to describe short-term variable influencing factors.

On the base of the disposition model, in a second step the calculations of flow path and deposition areas were made. Therefore models primary for wet snow avalanches were used. By using random walk and Markov chain approaches the models allow a realistic representation of the process paths. The derived process areas – and especially the adjusted model parameters – are verified by the mapped process areas. The used parameters (especially parameters for roughness and range) gave information about control mechanism of flow dynamics.