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Modeling snowpack on avalanche terrain for its stability estimation

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Snow avalanche danger assessment is an extremely important issue in mountainous regions of the world in general and of Russia in particular. However, in many cases it is not possible to apply commonly accepted methods due to poor data availability and lack of possibilities to obtain the required field data. It forces to use techniques that require smaller data sets and allow lower accuracy but are more feasible to apply in regions with poor avalanche forecast infrastructure.
The presented approach describes the method of snow cover state assessment directly on avalanche slopes. It relies on the Swiss program SNOWPACK modeling snowpack development (employed according to the contract of collaboration between MSU and SLF) and geoinformation tools of spatial analysis (ArcGIS). SNOWPACK is a high-precision one-dimensional snow cover model developed by the SLF. Regarding the data of regular meteorological observations it allows to reconstruct snowpack evolution, and consequently find out the starting time of unstable layers formation, their properties and location in the snow profile. In the given research for the first time SNOWPACK was used to model snow cover at sites distant from the place where meteorological parameters were measured.
The technique consists of the following steps:
[U+F0A7] DEM analysis
[U+F0A7] Meteorological data re-calculation for the number of points on the avalanche sites
[U+F0A7] Running SNOWPACK for all these points
[U+F0A7] Statistical analysis of modeled data, spatial spreading of stability indexes values
[U+F0A7] Marking the spatial zones of possible avalanche formation
The modeling was done for the avalanche sites of the Yukspor Mountain slopes (in the Khibiny Massif, North-Western Russia) using the meteorological data for the winter 2004/05. Before that the verification of SNOWPACK had been implemented in this region. The modeling results were compared with the data of field observations of avalanche activity. On every slope where the avalanche descends took place extensive unstable zones had been observed prior to the avalanche events.
It is expected to run the similar modeling in other terrains, for example in the Elbrus region (central Caucasus), where SNOWPACK is to be verified this winter. The described method is still under development. It is also supposed that introduction of additional calculative algorithms, SNOWPACK adjustment for local meteorological conditions, improvements of statistical approach can significantly increase accuracy of the results and the overall performance of the technique.