# Disaster Monitoring and Early-Warning System for Snow Avalanche along Tianshan Highway

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Tianshan Highway is located through Tianshan Mountain area in Xinjiang Province of China, surrounding area's natural environment of which is in a bad condition because of its steep terrain, high elevation, poor climatic conditions and so on. Many natural disasters exist in this area such as snow avalanche, debris flow, landslip etc., which makes Tianshan Highway's traffic run nearly in standstill. Snow avalanche disaster is a very serious problem in this area. Wide and deep snow, great height difference, steep slopes, well growth herb vegetation and other factors contribute to high occurrence of snow avalanche. Every year when spring comes, warming weather enables snow melt and then easier to occur snow avalanche with great hazards. With the development of information technology and improvement of data acquisition techniques, there is a growing demand for snow avalanche monitoring and early-warning aiming at snow avalanche disaster mitigation.

The method we introduce in this snow avalanche disaster monitoring and early-warning system is described as follows. The system has three components including Database, Model Library and Early-warning system, therefore this is an integration system which can implement several tasks such as data acquisition and management, model analysis for snow avalanche danger and model library management, and publish application area's snow avalanche early-warning report.

In Database part, we designed several databases which can be classified as spatial database and non-spatial database, dynamic database and non-dynamic database. These databases contain different types of factors which can impact the occurrence of snow avalanche, such as snow parameters database, climatic database, terrain and land cover database, snow avalanche archive database etc. Snow parameters database and climatic database will execute data acquisition operation every day which will receive necessary observation data from application area's observation stations, and these two databases are dynamic and non-spatial, but we will produce corresponding distribution map for each factor's data such as Snow Depth Distribution Map and Temperature Distribution Map. Other databases like terrain and land cover database are non-dynamic because data contained in

these databases will not have to be updated very often; they are non-dynamic and spatial which can be used in spatial analysis on the platform of GIS.

Model Library of the system contains models which can be used in snow avalanche danger analysis; we can implement application area's snow avalanche current danger analysis, and also can make forecast analysis based on forecasting climatic data. Since we have designed several databases which contain many snow avalanche factor's data, we can select several factors and form a analysis model by allocating weight values into different factors based on AHP method. And the weight values can be calculated by statistic from Snow Avalanche Archive Database and experts' experience. This system's model library provides an open interface for users to produce different models depending on specific conditions.

Early-warning system is the integration interface between system and users, which is designed and developed on the platform of GIS. Users can input the requests into the system, and acquire analysis result from the system. Early-warning system has two methods for interaction with the users, specifically in C/S and B/S, which can be very convenient for more users. The regular workflow for users is as follows: firstly, users select suitable analysis model from model library, and the selected model will automatically provide an interface for uses to choose necessary data from corresponding database, and then system will produce analysis report and thematic map. In the meanwhile, users can view database's data in GIS which will facilitate users for further analysis.

Snow avalanche disaster monitoring and early-warning system we designed can play an important role in snow avalanche prevention and mitigation. The system has much snow avalanche related data, provides an open interface for researchers to create a specific model, and users can acquire early-warning analysis results in the forms of report and thematic map very conveniently which saves a lot of time. Moreover, the system can be expanded to other application area by updating corresponding databases.

**REFERENCE:**

[1] Christian Jaedicke, Steinar Bakkehøi. Climate database for avalanche consulting and warning in Norway. *Cold Regions Science and Technology*, 2007, 47:171-179.

[2] Hiroyuki Hirashima, Kouichi Nishimura, Satoru Yamaguchi, et al. Avalanche forecasting in a heavy snowfall area using the snowpack model. *Cold Regions Science and Technology*, 2008, 51:191–203.

[3] U. Gruber, P. Bartelt. Snow avalanche hazard modelling of large areas using shallow water numerical methods and GIS. *Environmental Modelling & Software*, 2007, 22:1472-1481.

[4] Vincent Jomelli, Cécile Delval, Delphine Grancher, et al. Probabilistic analysis of recent snow avalanche activity and weather in the French Alps. *Cold Regions Science and Technology*, 2007, 47:180–192.