

AVALANCHE RELEASE HAZARD MAP USING GIS

by

Yutaka Yamada, Osamu Abe, Kenji Kosugi (Nagaoka Institute of Snow and Ice, NIED), and
Shinichi Watanabe (Argos Inc., Jyohetsu, Japan)

ABSTRACT

Avalanche hazard map that is an indispensable tool in order to evaluate avalanche danger was developed. In this development, we aim the practical avalanche hazard map that can evaluate avalanche danger on personal computer applying Geological Information System technique to easily available data such as Digital Elevation Model and vegetation distribution and others. Using this newly developed avalanche hazard map, avalanche danger assessment in the starting zone of large-scale avalanche disaster that occurred in the Mt. Iwaki was successfully conducted.

INTRODUCTION

Avalanche hazard map is an indispensable tool in order to evaluate avalanche danger, when one investigates cause of avalanche disasters, predicts avalanche release, and plans or designs avalanche protection facilities. Recently, digital data used in GIS (Geological Information System) such as DEM (Digital Elevation Model), vegetation distribution and others have been fully made in Japan. In this development, we aim the practical avalanche hazard map that can evaluate avalanche danger on personal computer applying GIS technique to DEM and vegetation distribution and others. The evaluation of avalanche danger includes that in the starting zone and that in the running zone. Here, the former evaluation in the starting zones mainly treated.

GEOMORPHIC RELEASE FACTOR OF AVALANCHES

Geomorphic factors in the starting zone of avalanches are aspect, inclination, asperity, distance from the ridge and vegetation and others. To make an avalanche hazard map we mainly use the digital elevation map of 50 m grid made by Japanese Geological Survey for calculating the geomorphic factors and the extant vegetation in the Natural Environment Information GIS made by the Nature Protect Board, Department of Environment for vegetation distribution. The four Vegetation index of the technical guideline for avalanche countermeasure works in the habitation area (proposal) (Aggregate Cooperation Snow Center, 1996) was adopted (Table I). A vegetation index shows easiness of avalanche occurrence. The extant vegetation is so extensively

classified than the four vegetations index that the former can be converted to the latter.

Table I. LEGEND OF THE FOUR VEGETATIONS INDEX OF AVALANCHE DANGER

Legend	Evaluation point	Definition
1	6	Gall, Grass, Bush lower than 2 m, Crown Density Smaller than 20 %.
2	5	Bush; 20 to 100 %, Intergraded tree 20 to 50 %.
3	3	Intergraded tree; more than 50 %, Arbor 20 to 50 %.
4	1	Arbor; more than 50 %.

RESULT

A large-scale wet snow full-depth avalanches, which is applied to the present avalanche danger evaluation, released from night 20 to early morning 21 April, 1999 at the Kuranosuke valley on the Mt. Iwaki. Elevation of starting zone was about 1,400 m and the angle of elevation from the head of deposit zone was 28° .

Procedure

Procedure of this software of avalanche hazard map written by Visual Basic is as follows: First, among geomorphic factors, select aspect (North) and inclination (35°) in this case. Next, Vegetation was read as legend 1 in the Table 1 from aerial photographs. Set this category on the pull-down menu. Finally, select avalanche release zone, dragging a rectangle by mouse. Thus, from grids that satisfy selected aspect, inclination and legend 1 of vegetation within this rectangle, a hundred avalanches start (Fig.1).

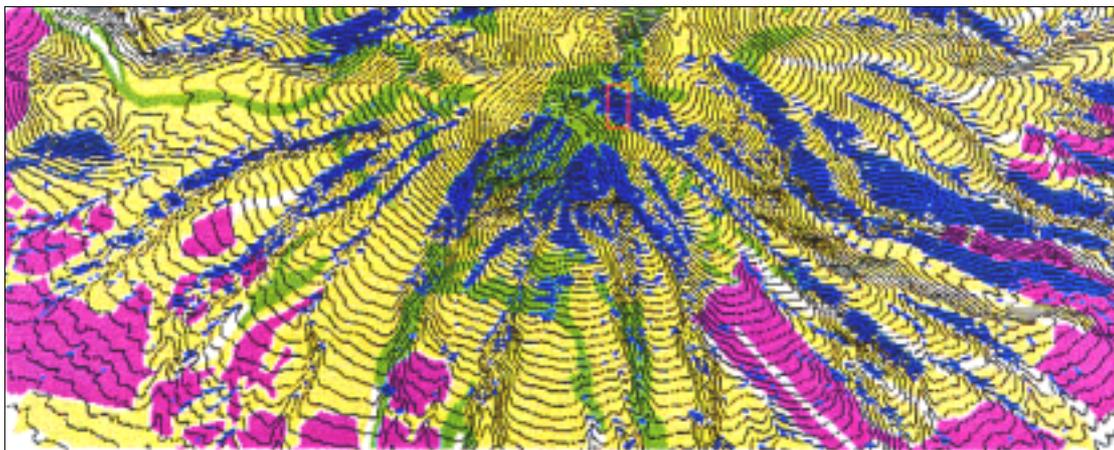


Fig.1 Configuration, vegetation and a selected starting zone, that is surrounded with rectangle, in the Mt. Iwaki.

We use a mass center motion model (Nohguchi 1983; 1989) to calculate avalanches starting from the rectangle. This mass center motion model, which can release avalanches from three-dimensional arbitrary configuration, uses the classical two-parameter representation as resistance force.

$$R = \mu N + m \delta V^2$$

where, μN is the frictional force; μ is the coefficient of friction; $m \delta V^2$ is turbulence term; δ is the constant related to Voellmy's parameter ξ ($\delta = g/\xi h$, where h is the flow height) or $= D/M$ in Perla's model. One can choose types of avalanche setting fitly these two parameters.

Evaluation

Here, 10 m grid DEM made for measure volcano in Japan instead of 50 m grid DEM is used. This software is able to change resistance force automatically according to vegetation on the track and to evaluate the avalanche danger on the running zone (Abe and others, in printing). However, only evaluation on the starting zone is discussed in this paper.

Tracks calculated as a wet full-depth avalanche was one track and shorter than the observed track (left of Fig.2) but tracks calculated as an intergraded avalanche between a dry surface avalanche and a wet full-depth avalanche separated into two tracks in mid course that is the same with the observed track (right of Fig.2). This corresponds to the observed fact that on the upper part of track this avalanche become fluidized and was in the state of slush flow.

Thus, one could effectively evaluate danger of various types of avalanches by this method. Form of track is important as well as danger range for estimating type of avalanches as seen in this case. On the other hand, one could estimate types of avalanches or phase of flow from the form of track. Introducing the extant vegetation in the Natural Environment Information GIS with

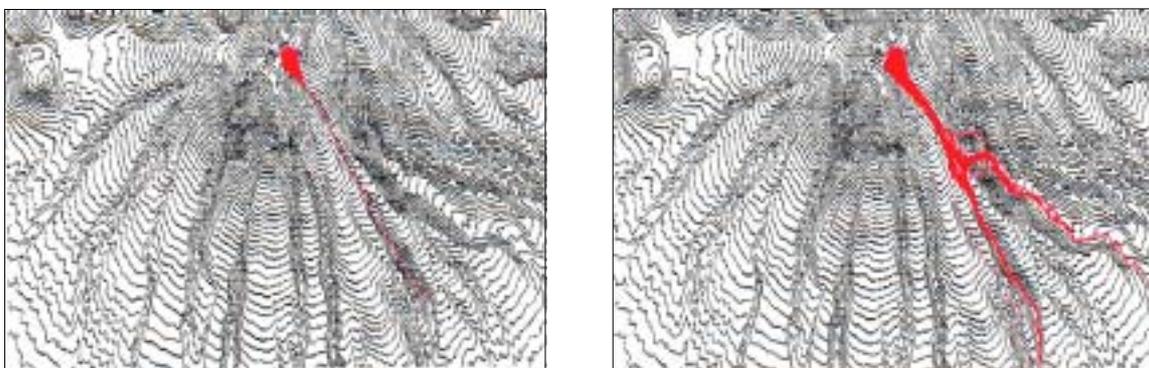


Fig.2 Track of full-depth avalanches (left) and track of avalanche between surface avalanches and full-depth avalanches (right) in the Mt. Iwaki.

configuration parameters such as aspect and inclination appropriate to the mountain in question, one could make a broad avalanche hazard map easily before taking aerial photographs.

CONCLUDING REMARKS

Using avalanche hazard map made from easily available GIS data, large-scale avalanche disaster assessment, which occurred in the Mt. Iwaki, was successfully conducted. Future problem in issue are how to decide general setting parameter of configuration and vegetation for standard evaluation, to confirm applicability to medium- and small-scale configuration or avalanche, and to develop avalanche prediction system on this avalanche hazard map.

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