Meteorological Disaster Hazard Map System

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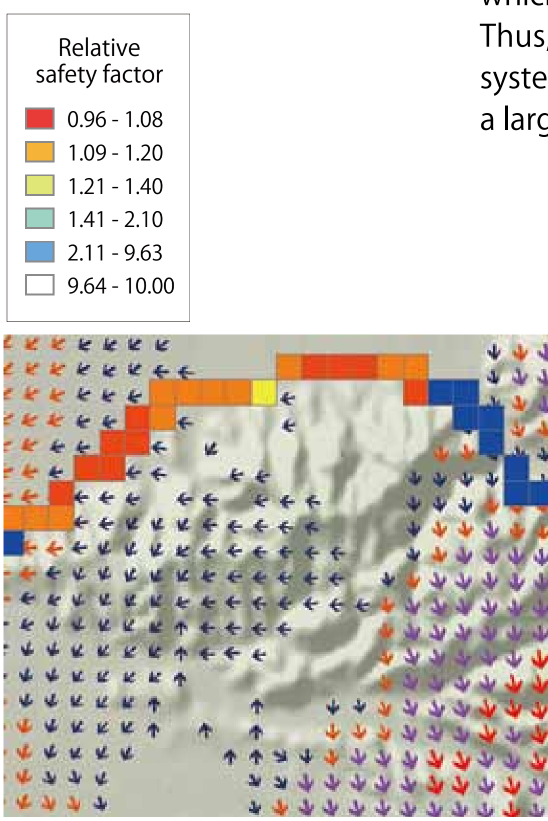
Global warming is said to be responsible for climate change. For example, in Japan there have been increasing numbers of heavy rainstorms that fall on a limited area (with a diameter of several kilometers) in a short period of time. If this type of rain hits a mountainous area, large scale landslide disasters such as a debris floods can occur. In order to prevent such landslide disasters, conventionally it is necessary to conduct slope investigations and identify potentially hazardous locations, and then take countermeasures there before a slope failure occurs. However, large scale landslide disasters like a debris flood often occur at locations far from the railway track. Therefore, in order to identify potentially hazardous locations, extensive investigation has to be conducted, which requires much time and cost.

Thus, Railway Technical Research Institute (RTRI) has developed a system to create a meteorological disaster hazard map that covers a large area and can be used for different potential disasters.



Strong wind hazard map

Wind observation is indispensable to creating hazard map system for strong wind. In order to validate the simulation result for meteorological phenomena, we measure the velocity and the direction of wind which blows in the target areas by propeller anemometers.

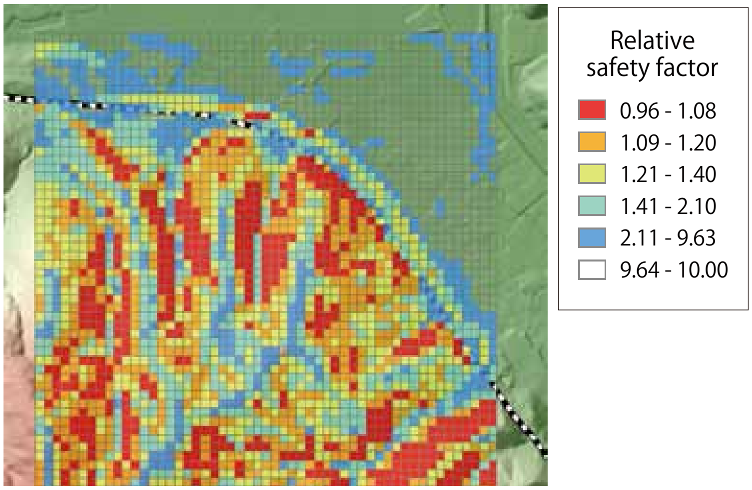
Examples of hazard map

Strong wind disaster

To assess a strong wind hazard, persons in charge of disaster prevention first of all analyzes the past data on a wide range of weather conditions by using a weather simulation model. Next, after extracting the results on the railway track from the entire analysis results, wind conditions are analyzed at an interval of 250 m by using an air-stream model. Based on the data obtained on past wind conditions, the occurrence probability of a wind of arbitrary strength is calculated. In this system, by entering an arbitrary strength of a wind as a reference value, persons in charge of disaster prevention can show the occurrence probability of winds with the strength exceeding that reference value along the railway truck on the map. This evaluation result is used for the selection of locations where countermeasures against strong wind should be preferentially implemented.

Landslide disaster

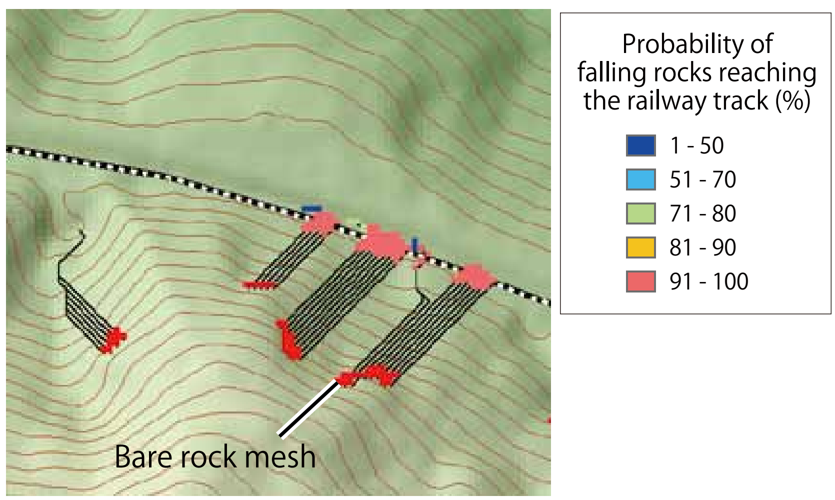
This system to create a hazard map performs a two-step analysis: the primary processing and the secondary processing. In the primary processing, the risk of a mass failure is analyzed at an interval of 1 m on the basis of the data of slope inclination, the shape of a horizontal cross-section, vegetation status, etc.. After studying the results of the primary processing, a system user can select places where the risk of mass failure due to heavy rainfall should be evaluated. When the user enters the data on the temporal change in rainfall into the system, the system calculates the change in the stability of the slope according to the intensity of rainfall and displays the result of the secondary processing on the screen at intervals of 10 m on the slope. By using this system, persons in charge of disaster prevention can extract locations to be watched with extreme caution in response to the expected rainfall. This evaluation result is used for the selection of locations requiring further detailed examination and the selection of places where countermeasures need to be preferentially implemented.



Landslide disaster hazard map

Investigation of the slope conditions in the target areas is indispensable to creating hazard map system for landslide. In order to validate the result generated by the system, we compare it with the result of investigation of landslide traces.

Hazard map system for rockfall identifies the areas where the probability of rockfall is relatively high. In order to validate the result generated by the system, we investigate the stability of the bedrocks in the target areas.

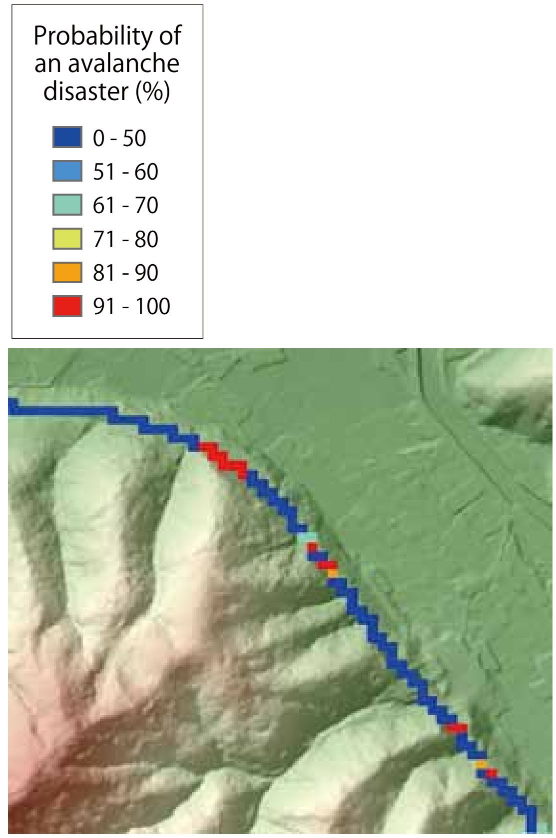


Rock fall hazard map

Rockfall disaster

This system calculates the curvature and inclination of the slope by using topographical information obtained from the data on the slope that was measured at intervals of 1 m, and then, selects the locations where bare rocks are present on the basis of the result. Next, based on the data on the inclination of the slope, the system identifies falling paths that masses of rock go through when they fall off the bare rocks. Based on the path information, the system creates a two-dimensional cross section that simulates the positions that falling rocks will reach in the event of rockfall. The system shows the paths of falling rocks and the probability of those rocks reaching the railway track. This evaluation result is used for the selection of locations where countermeasures should be preferentially implemented as well as for the determination of position where countermeasure work has to be implemented.

In order to build a model for evaluating the stability of the accumulated snow, we investigate the depth, weight, granularity and shape of snow particles on the slope with accumulated snow and measure the shearing force on the contact surface between accumulated snow and the ground. This model is used to evaluate the risk of avalanche occurrence.



Avalanche disaster hazard map

Avalanche disaster

This system calculates the probability of an avalanche based on the inclination of the slope, the density of trees, and the probable maximum snow depth obtained from past data. Also, it calculates an avalanche track by the same method for the evaluation of rockfalls, and calculates the probability of the avalanche reaching the railway track based on the relative positions of the avalanche occurrence location and the location of the railway track. The risk of an avalanche is determined based on its occurrence probability and the possibility of it reaching the railway track.

Addressing the challenges of disaster prevention in Japan

As described in the beginning, it is thought that the forms of disasters will change due to climate change; therefore, disaster prevention engineers need to adapt to such change. Also, it is expected that the number of engineers to evaluate slopes will decrease in the future. There is a concern that a decrease in the number of engineers may bring about a decline in the accuracy of examination, which may result in the occurrence of a disaster at places where no disasters have taken place in the past. The introduced technique for hazard map creation is recognized as an effective tool for the prevention of disasters caused by climate change and the problems of a decline in the accuracy of examination. Further efforts should be made in the future to advance research and development with the aim of solving issues associated with disaster prevention.