

Approach for Estimating the Outflow of Snowmelt Water from the Bottom of Snowpack

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1. Introduction

In early spring, snowpack begins to melt and snowmelt water flows from surface down to the bottom of the snowpack. The snowmelt volume that flows out from the bottom of the snowpack has an influence on the generation of full-depth avalanches and slope collapses during the snowmelt period. Accordingly, in order to evaluate the risk of these disasters, quantifying the rates of outflow from the bottom of snowpack is important. However, measuring the outflow from the bottom of the snowpack at a great number of locations along the railway lines is not realistic in regard to cost and maintenance efforts. Therefore, estimating the outflow from the bottom of a snowpack utilizing meteorological data and relevant information is desirable. As a result of this study, an approach to estimate the outflow from the bottom of the snowpack has been developed using the observation data from the Japan Meteorological Agency, referring to the observation results of weather and snowmelt, and using past study results.

2. Overview of the estimating method for outflow from the bottom of snowpack

The method we have developed is an approach to 1) estimate snowmelt at the snow surface and 2) estimate the outflow from the bottom of snowpack by taking into consideration the outflow delay time as a consequence of the infiltration of snowmelt water from the surface through the snowpack. The methodology utilizes input data corresponding to the four elements of weather (air temperature, rainfall, sunshine duration and wind velocity) obtained from the observation points of the Japan Meteorological Agency (Fig. 1). The snowmelt at the snow surface was estimated by calculating the heat balance on the surface of the snowpack by using the meteorological data, and the outflow delay time was calculated by using the infiltration coefficients obtained from observation.

3. Accuracy verification of the estimating method for outflow from the bottom of snowpack

The values of outflow from the bottom of the snowpack estimated through this approach have been compared with the results of one hour interval measurements based on the lysimeter method (a method for directly measuring the outflow from the bottom of snowpack) (Fig. 2). The data revealed that the data trends

at one hour intervals for both methods generally coincide. Also, by examining the relationships of the two methods, it was found that the regression coefficient of both is 1.12, and while the estimated value somewhat exceeded the observed value, the determination coefficient R^2 is 0.74, suggesting that there is a good correlation between them (Fig. 3).

As described above, since outflow from the bottom of snowpack can be estimated utilizing the meteorological data obtainable from observation points of the Japan Meteorological Agency, estimating outflow from the bottom of the snowpack at an arbitrary point along the railway lines is possible. Thus, this approach is useful for determining the necessity of patrolling and guarding against probable disasters (full-depth avalanches and landslides) in the snowmelt period.

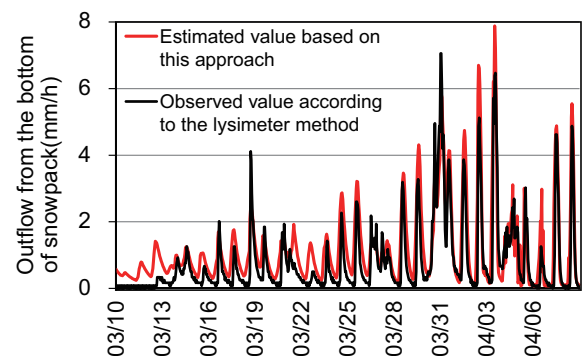


Fig. 2 Estimated results of outflow from the bottom of snowpack

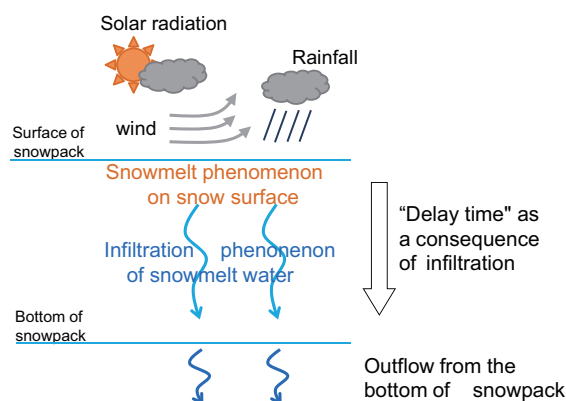


Fig. 1 Conceptual diagram of snowmelt phenomenon

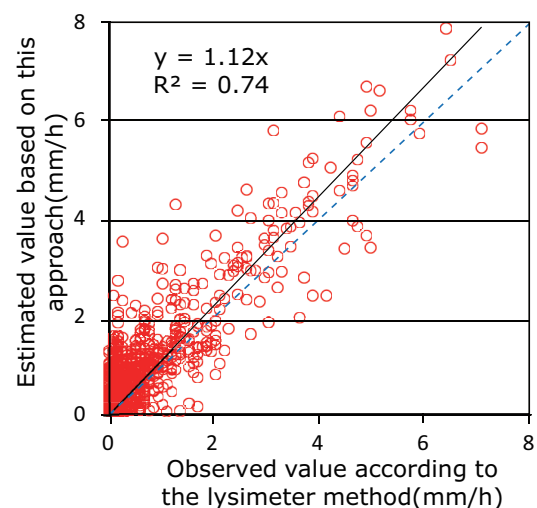


Fig. 3 Correlation between observed values and estimated values (The broken lines indicate one-to-one relationship)