

Study of the estimation of snow properties at an arbitrary point

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ABSTRACT: It is important for risk assessment such as snow melting hazards along railroad tracks to estimate the snow depth or snow water equivalent in the mountain area from weather data of the flat area. Because there are no weather stations in the mountain areas. Therefore, in this paper, we verified the estimation accuracy of the snow water equivalent by the developed snow melting model. In addition, we tried to estimate the distribution of snow water equivalent in the southern part of the Uonuma Basin from the weather data of the flat area. As a result of comparing the observation value of the snow water equivalent at each observation point in the Uonuma Basin (39 points) with the estimated value by the model, the relationship between them was $R^2 = 0.74$, RMSE = 112 mm. Therefore, it was found that in the Uonuma Basin where the relationship between relative height and the ratio of snow water equivalent is clear, it is possible to estimate the snow water equivalent from weather data of flat area.

KEYWORDS: Snow water equivalent, Snow melting model, AMeDAS weather data

1. INTRODUCTION

About 40% of railway lines in Japan are located in snowy areas. It includes mountainous areas where snow depth as much as 3m. In those regions, there are full depth avalanche or geo-disaster due to snowmelt water in the early spring. Therefore, the countermeasure for these disaster such as track patrol and operation control are carried out. On the other hand, these countermeasures are often based on empirical rules which are determined from disaster records. And, expert employees judges the opportunity to carry out countermeasure. Recently, as expert employees are decreasing, development of a method to decide to go to track patrol based on objective index is expected.

Most of the places where disasters occur during the snow melting season are mountain areas. Therefore, it is important for risk assessment such as snow melting hazards along railroad to estimate the snow depth or the amount of snow water in the mountain area from weather data of the flat area. Because there are no weather stations in the mountain areas.

In this paper, we verified the estimation accuracy of the snow water equivalent by the developed snow melting model and report about the result of trial estimation of the distribution of snow water

equivalent in the southern part of the Uonuma Basin from weather data of the flat area.

2. OUTLINE OF SNOWMELTING MODEL

We have constructed a model¹⁾ to estimate snow depth and density using general weather information (temperature, precipitation, wind speed, hours of sunshine). On the other hand, when evaluating the risk of disaster along railway lines, it is important to estimate snow water equivalent.

In the improved snow melting model, the amount of snow melt water of snow surface is obtained from the estimation formula which partly formulates the heat balance method, using the temperature, precipitation, wind speed, sunshine time as input values. From the amount of snow melt of snow surface and the snow properties of each layer of snowpack, the outflow from bottom of snowpack is calculated. From the difference between the outflow from bottom of snowpack and the amount of precipitation, snow water equivalent can be calculated.

We observed a snow water equivalent on the flat land of Shiozawa Snow Testing Station (Niigata, Japan : Figure 1) in the winter of 2013 to 2017 (using the snow sampler at 9 o'clock every morning)²⁾. Using this observation value, we verified the estimation accuracy of the snow melting model.

The observed value of the snow water equivalent for 5 winter seasons was compared with the estimated value at 9 o'clock snow model (Fig. 2).

As a result, although the variation varies from year to year, the estimated value and the observed val-

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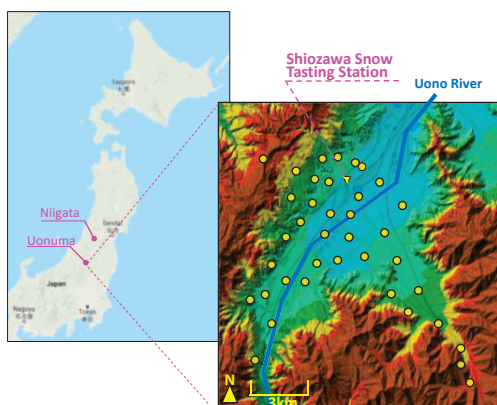


Figure 1: Location of Shiozawa Snow Testing Station (▽) and Snow Water Equivalent Observation Point (○).

ue are in a one-to-one relationship and the determination coefficient $R^2 = 0.84$ and the mean square error square root RMSE = 140 mm. Although estimated precision includes reformability, we used this model to estimate the distribution of snow water equivalent in the Uonuma Basin.

3. ESTIMATION RESULTS OF SNOW WATER EQUIVALENT IN THE UONUMA BASIN

In the Uonuma Basin, we set 39 observation points in the area of 4km northwest, 10km southwest and 13 km southeast, centering on the laboratory, in the range of about 150 - 600m in altitude (Fig.1). At each observation point, the amount of snow water equivalent was measured around the whole area in 1 to 2 days at the beginning of snow melt in the winter of 1999 to 2017 (generally in early March).

First, using the observation results of the winter from 1999 to 2012, the relation between the relative elevation and the snow water equivalent ratio (the ratio of snow water equivalent between the Siozawa and each observation point) was obtained. Using this relationship, snow water equivalent in the basin was estimated from the estimate of snow water equivalent at Siozawa using the snow melting model in the winter of 2013 (Fig. 3). As a result, the relationship between observed values and estimated values at each observation point was $R^2 = 0.74$, RMSE = 112 mm.

4. CONCLUSION

In order to investigate the risk assessment method of the disaster at the snowmelt period along the railroad, we attempted to estimate snow water equivalent in the mountain areas. As a result, it

was found that in the Uonuma Basin where the relationship between relative height and the ratio of snow water equivalent is clear, it is possible to estimate the snow water equivalent from weather data of flat area.

On the other hand, areas along the railway where the relation of snow water equivalent ratio is clear is rare. In the future we will plan to construct a model that can estimate the distribution of snow water equivalent only weather data of the flat area by examining the correction method of weather data for arbitrary points.

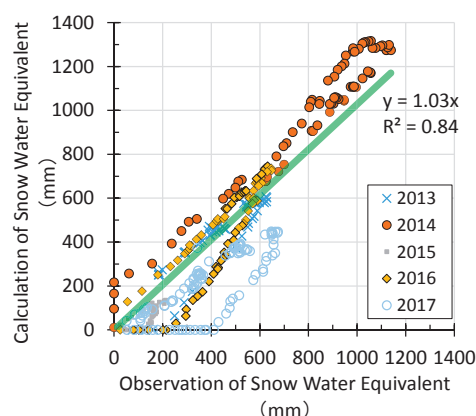


Figure 2: Comparison of calculated values and observed values of snow water equivalent.

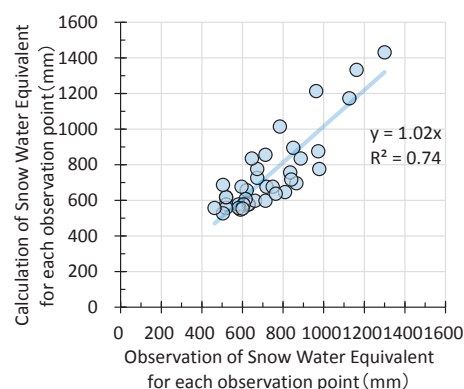


Figure 3: Comparison of calculated values and observed values of snow water equivalent for each observation point.

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