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Estimation of the hourly snowmelt based on the heat balance method using the Japan Meteorological Agency observation data alone and application for analyzing groundwater level fluctuation in a landslide site

Takamasa Matsunaga[1] and Shin'ya Katsura[2]
[1]Graduate School of Agriculture, Hokkaido University, Sapporo, Japan (tm04284869@eis.hokudai.ac.jp)
[2]Research Faculty of Agriculture, Hokkaido University, Sapporo, Japan (skatsura@for.agr.hokudai.ac.jp)

The heat balance method has often been used for calculating the snowmelt for the purpose of estimating watershed water resources in the form of snow in winter and analyzing snowmelt runoff. Because the method requires many weather elements, some of which are not observed frequently (e.g., longwave radiation), methods of estimating such less frequently observed weather elements from more frequently observed ones have also been proposed. However, few previous studies have developed a method of estimating the hourly snowmelt based on the heat balance method using the frequently observed weather elements alone and applied for analyzing the hourly groundwater level fluctuation in a landslide site in snow-covered area. In this study, we developed a model of estimating the hourly snowmelt based on the heat balance method using the Japan Meteorological Agency observation data, the most commonly available weather data in Japan, alone, (i.e., temperature, precipitation, wind speed, sunshine duration, atmospheric pressure, and vapor pressure), and applied the model to a past landslide site with deep sliding surface (approximately 20 m) in snow-covered area in Hokkaido, Northern Japan. Moreover, we applied the functional models based on the antecedent precipitation index calculated using (the meltwater and/or rainwater) instead of the rainfall to reproduce the hourly groundwater level fluctuation observed in the site. The results showed good agreement between the observed and calculated snowmelt and groundwater level. The models proposed and used in this study are useful for estimating the hourly snowmelt and analyzing groundwater level fluctuation in a landslide sites in snow-covered area, and should be tested for other landslide sites to further verify the applicability.