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Improving the calculation accuracy of a tank model for the changes of leachate volume by incorporating snowmelt analysis

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In leachate-controlled landfill in Japan, strict management of leachate is required. In recent years, fluctuations in leachate volume have become larger, making leachate management more challenging and important due to the rise in heavy rainfall caused by climate change.

In this study, we calculated the changes of leachate volume from leachate-controlled landfill using a Tank Model that commonly employed as watershed runoff analysis model. In addition to reflecting the operational conditions that affect the observed leachate volume, by incorporating snowmelt analysis using the heat balance method into this model, we tried to create a model that can calculate leachate volume changes with higher accuracy from meteorological data.

Based on the investigation of the leachate generation pathways in landfill, we used a three-stage series and one-stage parallel Tank Model. A three-stage series Tank Model represents water infiltrating into landfill, while the other one accounts for water not directly infiltrating, such as operational water used at the landfill site.

The parameters of each tank were determined to fit the calculated results to the observed leachate volumes. Rainfall and on-site water usage for operations were based on field data. To estimate evapotranspiration using the Thornthwaite method and the snowmelt analysis, local adjustments were made using data from the nearest meteorological station.

The observed changes in leachate volume generally responded to rainfall. However, discrepancies were also observed, such as the sustained leachate runoff following heavy rains and the melting of winter snow in early spring. As a result of adding snowmelt analysis to Tank Model, it can be possible to calculate the increase in leachate volume due to spring snowmelt during the target period with high accuracy (Fig.1). By comparing the correlation coefficients between the observed and the calculated values in February 2023, the correlation coefficient was greatly improved to 0.72 with considering snowmelt from 0.15 without considering snowmelt (Fig. 2).

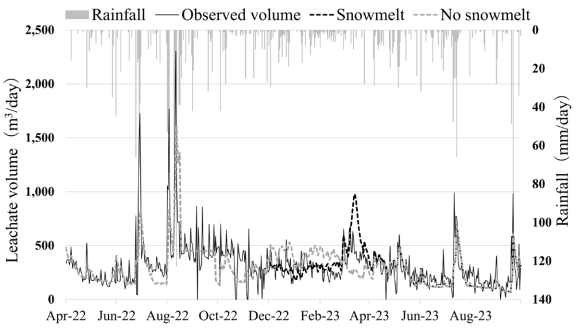

Fig.1 Changes in observed and calculated leachate volume

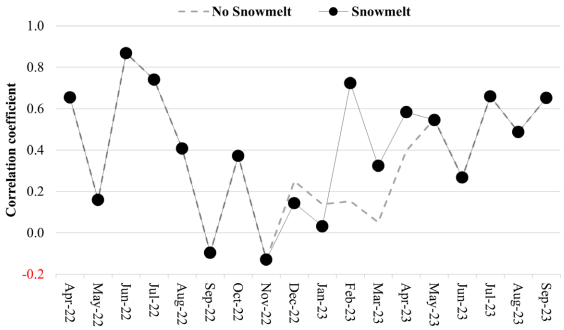

Fig.2 Monthly changes in the correlation coefficient for observed and calculated leachate volume